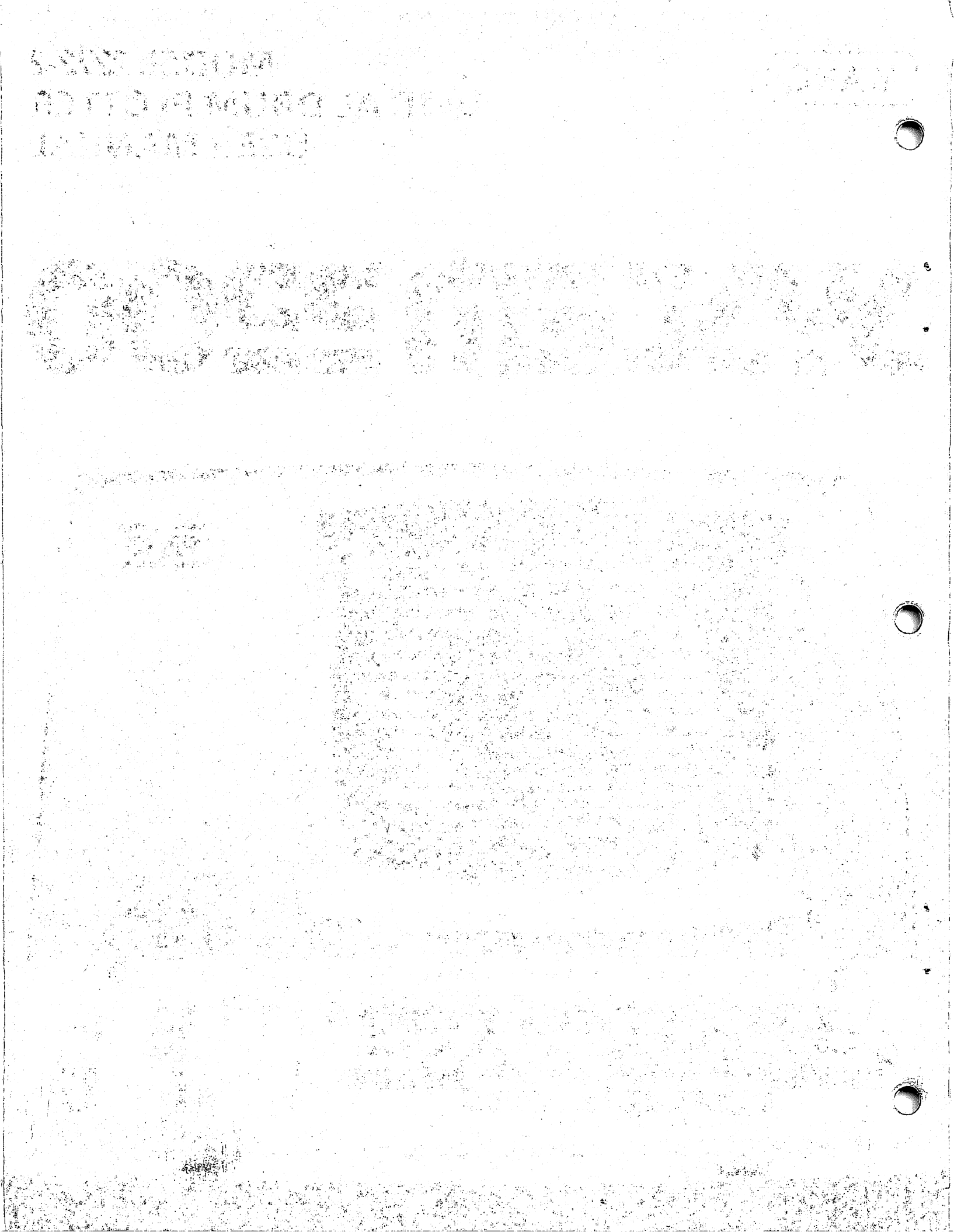
WANG

MODEL 2272-2
DIGITAL DRUM PLOTTER
USER MANUAL

SYSTEM 2200



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DIGITAL DRUM PLOTTER
USER MANUAL

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HOW TO USE THIS MANUAL

This manual provides information concerning the operation of the Model 2272-2 Digital Drum Plotter. It is designed for users who are already familiar with the available Wang System and its BASIC language.

For users who are not familiar with the operation of their system, it is recommended that the Programming in BASIC Manual and the Wang BASIC Language Reference Manual be read before proceeding with this manual. It is also recommended that the user incorporate the Wang 2200 Plotter Utilities and the Graph Utilities System software packages into his system activities to gain the maximum utilization of the plotter.

This manual has been divided into several chapters covering all the operational features of the Digital Drum Plotter. Chapter 1 contains general information on the plotter; Chapter 2 describes plotter operating procedures. Chapter 3 demonstrates the use of the PLOT statement and Chapter 4 describes the use of special plotting codes. Hexadecimal codes, the character set sizes, plotter specifications and paper specifications are collected in the Appendices.

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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual describes the characteristics and operations of the Model 2272-2 Digital Drum Plotter (see Figure 1-1). The Model 2272-2 is a Digital Drum Plotter that provides point plotting and continuous line plotting over a plotter area with a dimensional width of 16 inches (40.6 cm) and a length of 81.9 inches (208 cm). The plotter operates at a rate of 4.5 inches per second (11.4 cm/sec) maximum in each axis with a plotting accuracy of .01 inches plus .1% of plotting distance (.0254 cm plus .1%). The resolution of the plotter is .005 inches (.013 cm) or 200 plotting increments per inch (78.7 per cm)*. The plotter can generate its own set of 64 ASCII characters in 15 selectable sizes. A 400 byte buffer provides overlapped CPU-plotter processing. A set of axis selection switches permits the setting of the X-Y coordinate axis at one of four different orientations. In addition, controls allow for slewing the pen position as required, and for setting the home position (X=0, Y=0) and the dimensional limits of the plotting area on the paper. The plotter utilizes 17 inch wide, fan-fold, sprocket-feed paper.

*A metric version of the Digital Drum Plotter is designated as Model 2272-2M. Its physical and operating characteristics are identical to the Model 2272-2 except that it has the following features:

1 - plotting resolution of .10 mm (100 plotting increments per cm).
2 - plotting accuracy of .25 mm plus .1% of plotting distance.
3 - a maximum plotting speed of 9 cm/sec in each axis.

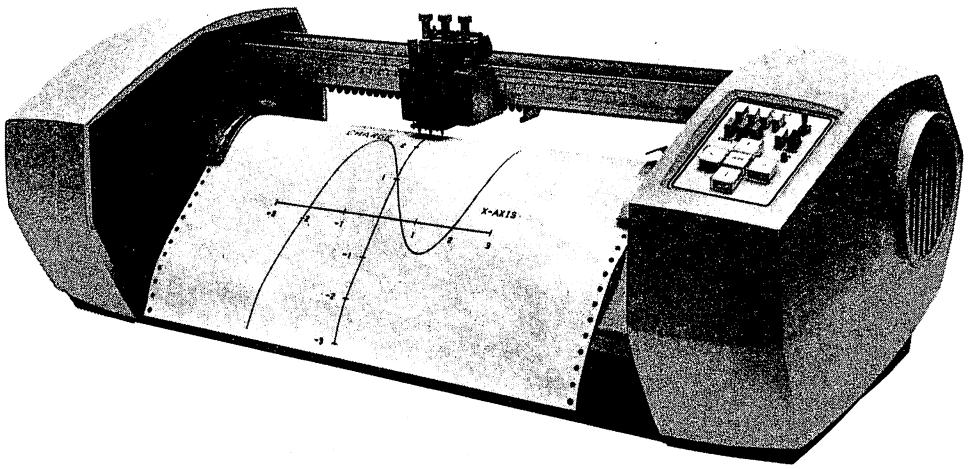


Figure 1-1. Model 2272-2 Digital Drum Plotter

1.2 UNPACKING AND INSPECTION

When you receive your equipment, notify your Wang Service Representative; he should unpack and set up your plotter. Failure to notify your Wang Service Representative will void your warranty.

1.3 INSTALLATION

To install your plotter, the Wang Service Representative uses the following procedure:

1. The Plotter Controller Board must be installed in the CPU chassis of the system CPU. Its screws should be fully tightened.

2. The 36-pin interface connector must be plugged into the Plotter Controller Board on the CPU and its lock clips secured. (Note: the interface connector plugs directly into the PRINTER slot on Wang systems that have internal CPU's.)

3. The power cord from the plotter must be plugged into a wall outlet (see power requirements in Appendix C).

1.4 PAPER INSERTION

Continuous form, pin-feed paper is placed over the plotter drum in the following manner:

1. Open the pin-feed gates, insert the paper holes evenly over the pins, and close the gates. If the distance between the pin-feed mechanisms needs to be adjusted, unscrew the lock knob located below the left-hand pin feed gate; move the knob to the left or the right until the pin holes of the paper are centered over the the pins.

> CAUTION:
>
> The pin-feed gates must be closed before the Plotter is turned on. Failure to do so may cause damage to the pen mount assembly drive motor and the right pin gate (see note below).

2. Turn the ON/OFF switch (located on the left side of the plotter) to the ON position. Depress the SLEW MODE button and then the paper out switch [↑]. The paper advances in steps when this switch is depressed briefly; if the switch is held down the paper advances continuously.

3. NEVER OPERATE THE PLOTTER WITHOUT PAPER.

> NOTE:
>
> When the plotter is turned ON, the pen mount assembly moves completely to right margin (the right pin gate) and returns to a position midway along the plotter drum. This position (marked at 8 inches on the plotter scale) is the default HOME position of the plotter. (Plotter pen positioning is explained in Chapter 2.)

1.5 PEN REMOVAL/INSERTION

The Model 2272-2 has three pen holders on the pen mount assembly (see Figure 1-2). The pen holders can accommodate ball point pens or fiber tip pens. Pen removal/insertion is facilitated by spreading the three pen holders apart before attempting to handle each pen housing. This is accomplished by lifting the two end pen holders and moving them to the left and right respectively. Removal and insertion of each type pen is described as follows:

1. Ball Point Pen

Remove the pen housing from the pen holder by turning the lower groved section of the pen housing counterclockwise (see Figure 1-2). The ball point pen cartirdge is contained within this reusable pen housing. Open the pen housing by unscrewing the pen housing cap. Slip the old cartridge out of the pen sleeve and insert the new pen cartridge. Tighten the cap of the pen housing and insert the housing into the pen holder. Turn the pen housing clockwise in the pen holder until it is securely in place.

2. Fiber Tip Pen

The fiber tip pen and housing are one disposable unit. The housing is threaded so that it screws directly into the pen holder.

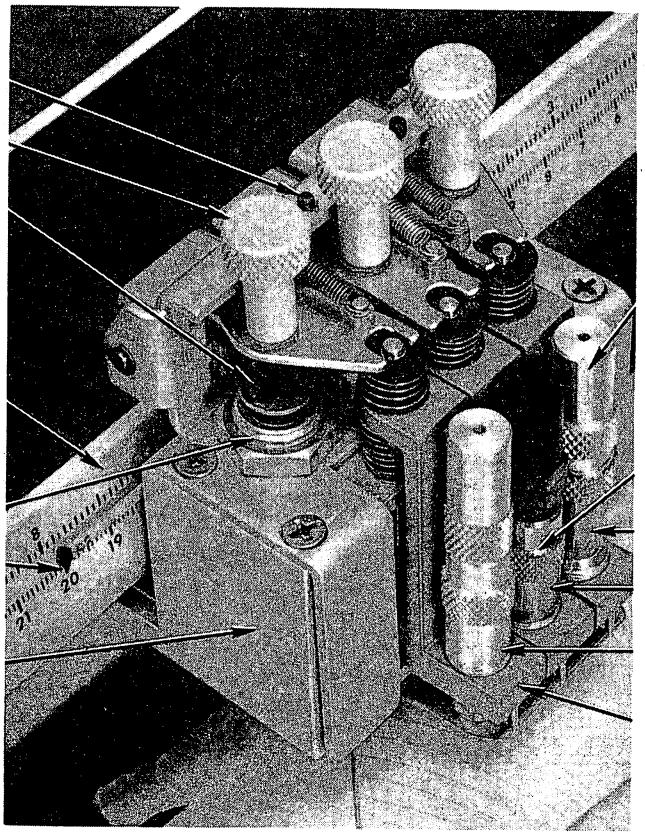


Figure 1-2. Model 2272-2 Pen Mount Assembly

1.6 PEN PRESSURE ADJUSTMENT

Each pen holder has an allen screw for adjusting the height of the pen holder above the plotter drum. In order to bring the pen holder (and the pen) closer to the surface of the paper, the allen screw behind the pen must be adjusted (see Figure 1-2). The screw head accommodates a 3/64-inch allen wrench. Turning the screw clockwise brings the pen holder closer to the plotter drum; turning counterclockwise brings the pen holder away from the plotter drum.

> NOTE:
>
> Adjustments to the pen holder should be made with the pen in the up position.

Adjustment to the tension in the pen solenoid spring is made with the tension adjustment knob. Turning the knob clockwise brings more tension on the pen; counterclockwise removes tension from the pen. The position of the tension adjustment c-clamp (see Figure 1-2) serves as a guide to the proper tension adjustment. Tension adjustments should be made as follows:

1. Manually depress the spring above the pen holder and hold it down so that the pen point touches the paper on the plotter drum.

2. Turn the tension adjustment knob so that the c-clamp spacing with the seat decreases.

3. Use the SLEW Mode to slew the pen mount assembly to test the writing quality of the pen.

4. Repeat steps 1, 2 and 3 until the desired writing quality is attained.

> NOTE:
>
> It is advisable to test the writing quality of the pen on a blank section of paper. Pressure adjustments that are improperly made will either cause the pen to tear into the paper or miss the paper surface altogether.

1.7 FUSE REPLACEMENT

The main line fuse located on the left side of the plotter can be changed by twisting the bad fuse out of the socket and replacing it with a new fuse. The plotter should be turned OFF before changing the fuse.

CHAPTER 2
OPERATING PROCEDURE

2.1 CPU TURN-ON PROCEDURE

1. Verify that all power cords are connected to a source of electrical power and all peripheral cables are connected to your Wang System.

2. Turn on all power switches. When turned on, the system is Master Initialized, i.e., memory is cleared of all programs and variables and addresses of primary drives are set to their default values. The address of the plotter is automatically set to the default value of 413 when the system is Master Initialized.

> NOTE:
>
> The user can select the Model 2272-2 with a SELECT PLOT 413 statement. If the plotter is connected to a 2200VP, a SELECT PLOT C13 should be used which will decrease the time it takes to plot.

2.2 2272-2 TURN-ON PROCEDURE

The control panel on the right-hand side of the plotter contains a number of switches, buttons and light indicators for controlling the manual operations of the plotter (see Figure 2-1).

ON/OFF

The ON/OFF switch is located on the left side of the plotter. To turn the plotter ON, place the ON/OFF switch in the ON position. Whenever the plotter is turned ON, the pen mount assembly moves over to the right pin gate and then returns to a position midway on the plotter drum. This position marked at 8 inches on the plotter scale bar is the default HOME position (X=0, Y=0) of the plotter.

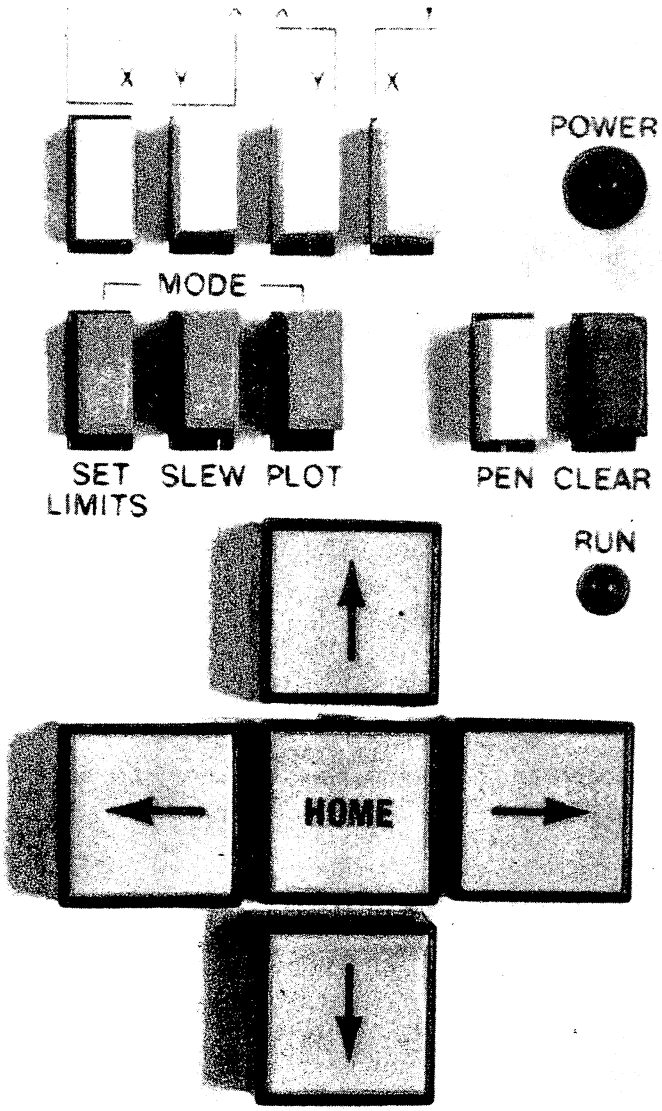


Figure 2-1. Model 2272-2 Plotter Control Panel

To turn the plotter OFF, place the ON/OFF switch in the OFF position. The ON/OFF switch clears the plotter buffer.

After the plotter is turned ON, the user can manually select his own HOME position; he can move (slew) the position of the pen mount assembly and carriage, and he can set the boundary limits of his plotting area. The MODE Selection switches in conjunction with the position switches ←, →, ↑, ↓, and HOME, provide these move (slew) and set operations. The manual use of these switches and their functions are described in the following sections. However, before proceeding, it is important to summarize the steps normally executed before plotting begins. These steps are as follows:

1. Turn plotter ON.

2. Use SLEW Mode and position switches HOME, ←, →, ↑, ↓, to move the PEN assembly and carriage as desired. (Program directed SLEW instructions are described in Chapter 3.)

3. Use SET LIMITS Mode and the position switches to set the HOME position and the left, right, top and bottom boundary limits of the plotting area. (Program directed Set Home instructions are described in Sections 3.12 and 3.13.)

4. Select the appropriate PLOT AXIS switch (Y/X, X/Y, X/Y, Y/X).

5. Use PLOT Mode to prepare the plotter to accept PLOT instructions from your system.

2.3 SLEW MODE

In this mode, the user can set the position of the pen(s) left or right, and move the pen(s) in and out (carriage movement) or move the pen to the selected HOME position. The SLEW Mode is always used before SET LIMITS is executed because the pen must be moved to a "limit" position before it is set at that position (described further in Section 2.4).


Moves pen(s) to the left

In order to move the pen(s) to the left, the SLEW switch is in the down position and the ← button is depressed. If the button is touched briefly, the pen assembly moves in steps; if the button is held down, the Pen assembly moves continuously to the left.


Moves pen(s) to the right

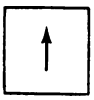
In order to move the pen(s) to the right, the SLEW switch is in the down position and the → button is depressed. If the button is touched briefly, the pen assembly moves in steps; if the button is held down, the Pen assembly moves continuously to the right.

NOTE:

On the plotter control panel, the arrow on the position switch points in the direction you want the pen to move.

NOTE:

The pen mount assembly automatically stops at the left or right-hand margins (the pin feed gates). Normally the pen assembly can be brought back towards the center of the plotter drum by depressing the appropriate left or right button. However, if the user is unable to move the pen assembly away from the margins it means that the mechanical safety limit switch and power cut off switch to the stepping motor have been activated. To recover from this condition, turn the power switch OFF and manually move the pen assembly to the center of the plotter drum. The mechanical limit switch is closed again and the stepping motor becomes operative. Turn the power switch ON to resume normal plotter operation.



Moves pen(s) up on the paper

In order to advance the paper forward from the paper tray to the next sheet, the SLEW switch is depressed and the [↑] button is held down. If the button is touched briefly, the carriage advances the paper in steps; if the button is held down, the carriage advances the paper continuously. (Depressing this button essentially moves the pen up on the paper.)

Moves pen(s) down on the paper

In order to feed the paper back into the paper tray, the SLEW switch is depressed and the [↓] button is held down. If the button is touched briefly, the carriage advances the paper in steps; if the button is held down, the carriage advances the paper continuously. (Depressing this button essentially moves the pen down on the paper.)

Moves pen(s) from current position to the selected HOME position.

In the SLEW Mode, the depression of the HOME switch will cause the Pen assembly and the carriage to move simultaneously until the pen assembly is positioned at the selected HOME position. The currently selected pen (#1, #2, or #3) is positioned to the HOME position. (PEN selection is described in Section 3.11.) As an example assume that the current HOME position is at the extreme left margin and just above the crease of the paper (see Figure 2-2). The current position of the pen assembly is at the extreme right margin just below the crease of the paper. When the HOME switch is depressed, the Pen assembly and carriage move so that the selected pen is positioned at the current HOME.

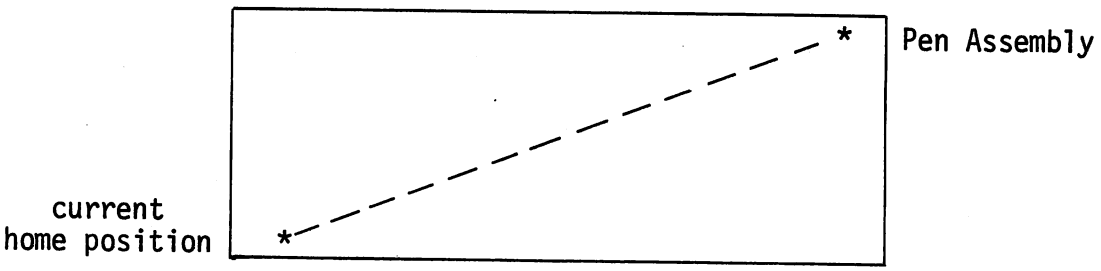


Figure 2-2. HOME Switch in the SLEW Mode

NOTE:

Turning the plotter ON automatically selects pen #1. If the user is not certain which pen is currently selected, this can easily be established by slewing the pen mount assembly to the right margin. If the pointer on the pen mount assembly points to "0" on the plotter scale, pen #1 is selected. If it points to ".5", pen #2 is selected; if it points to "1", pen #3 is selected.

2.4 SET LIMITS MODE

Whenever the user wants to confine the plot to a portion of the paper, the SET LIMITS MODE is used to set the left, right, top and bottom boundaries of the plotting area. SET LIMITS is also used to set the position of HOME, whenever a HOME position other than the default HOME is desired.

The plotter is placed in SET LIMITS MODE when the SET LIMITS switch is depressed. In this mode the user can re-set or CLEAR the setting of the HOME position, the Left and Right movement limits of the pen, and the In and Out movement limits of the carriage. The movement limits represent the points beyond which the pen and carriage are not allowed to move on a plot. This is often useful when the desired plot is confined to a fixed area, such as a smaller plot paper taped onto the carriage feed paper.

NOTE:

It is not necessary to use SET LIMITS if your plot will fit within the bounds of the paper, and the current Home position is acceptable.

NOTE:

Before using SET LIMITS to set a position on the plot area, first the pen must be moved to that position via the SLEW Mode and the appropriate left, right, up, or down positioning switches.

When in SET LIMITS MODE (switch depressed), the positioning and HOME switches are used to set these positions as follows:

LEFT LIMIT

To set the Left Limit of the plot depress the ⊣ switch. This sets the Left Limit to the present position of the currently selected pen.

To CLEAR the Left Limit position, hold down the CLEAR switch, and depress the ⊣ switch. This clears the current Left Limit and restores it to the true left margin.

RIGHT LIMIT

To set the Right Limit of the plot depress the ⊢ switch. This sets the Right Limit to the present position of the currently selected pen.

To CLEAR the Right Limit, hold down the CLEAR switch and depress the ⊢ switch. This clears the current Right Limit and restores it to the true right margin.

NOTE:

The selection of the Left and Right Limits and the Home position are based on the currently selected pen. When the power is first turned on, the selected pen is pen #1. To select pen #2 (middle pen) or pen #3 (rightmost pen), and pen #1 via program control, see Section 3.11.

TOP LIMIT

To set the Top Limit of the plot, depress the [↑] switch. This sets the limit for paper feeding out to the current position of the pen(s) on the drum.

To CLEAR the Top Limit of the plot, hold down the CLEAR switch and depress the [↑] switch. This resets the current limit to 40.8 inches (103.6 cm).

BOTTOM LIMIT

To set the Bottom Limit of the plot, depress the [↓] switch. This sets the limit for paper feeding in to the current position of the pen(s) on the drum.

To CLEAR the Bottom Limit of the plot, hold down the CLEAR switch and depress the the [↓] switch. This resets the current limit to 40.8 inches (103.6 cm).

HOME

To set the HOME position (X=0, Y=0) of the plot depress the HOME switch. This resets the HOME position of the currently selected pen to its present position on the drum.

NOTE:

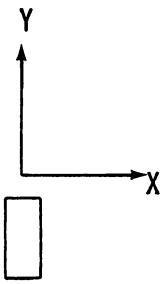
The current HOME position can be manually "cleared" by simply slewing to a new HOME position and then setting this position. Program directed "Set HOME" instructions are described in Section 3.12.

NOTE:

After setting the boundary limits, plotting vectors sent by the CPU which go beyond the defined limits of the plotting area will not move the pen assembly.

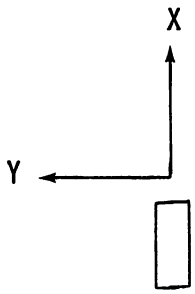
2.5 AXIS SELECTION

The axis selection switches on the control panel allow the user to select the orientation of the X and Y axis on the plotter. At plotter turn on, if no Axis selection is made, the default X-Y Axis is the normal orientation with the positive X axis along the horizontal to the right and positive Y axis along the vertical (up). However, for manual selection of the Axis orientation, the user should proceed as follows:



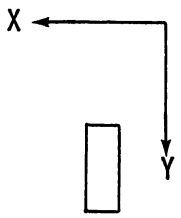
+ X to the right
+ Y up

Depressing this switch positions the orientation of the plot such that the X axis is along the horizontal and the Y axis is along the vertical (normal plot orientation).



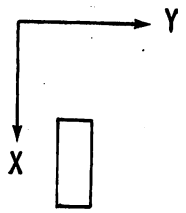
+ X up
+ Y to the left

Depressing this switch positions the orientation of the plot such that the X axis is along the vertical (+ X in the direction of 90°) and the Y axis is along the horizontal (+ Y in the direction of 180°).



+ X to the left
+ Y down

Depressing this switch positions the orientation of the plot such that the X axis is along the horizontal (+ X in the direction of 180°) and the Y axis is along the vertical (+ Y in the direction of 270°).



+ X down
+ Y to the right

Depressing this switch positions the orientation of the plot such that the X axis is along the vertical (+ X in the direction of 270°) and the Y axis is along the horizontal (+ Y in the direction of 360°).

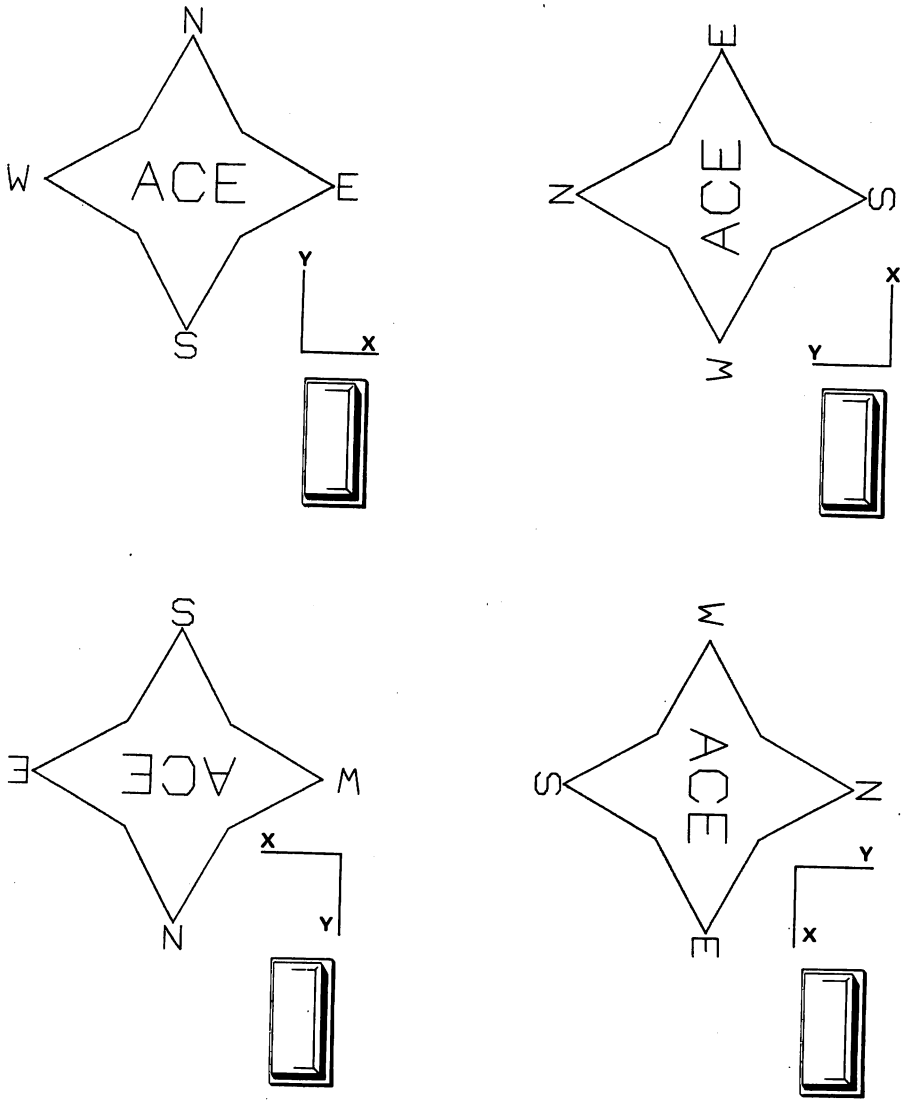


Figure 2-3. Sample Plots with Different Axis Orientation

2.6 PLOT MODE

After the user has set the HOME position and the Plotting Area Limits and selected the Axis Orientation, he is now ready to execute his program on the plotter. The PLOT mode switch must be depressed whenever plotting is to be done. In the PLOT mode, the Plotter is ready to receive program commands from the system CPU and execute them. While in the PLOT mode, the CLEAR switch and Position Array switches are inactive. The RUN light is illuminated when the plotter is plotting; it is extinguished when the plotter is not plotting.

During plotting if the mode switch is shifted from PLOT to SLEW, plotting is temporarily halted. The user may then slew the paper out and examine the plot. When the PLOT switch is again depressed, the pen and paper are automatically repositioned to the last plot position and plotting is resumed.

> NOTE:
>
> While in the SLEW Mode, never depress the CLEAR switch on the control panel. The CLEAR switch will clear all plot vectors and commands currently stored in the plotter buffer and will prevent the pen from returning to the last plot position when reentering PLOT MODE.

2.7 PEN SWITCH

The PEN switch allows the user to manually override a 'pen down' condition on the plotter. That is, when the switch is in the DOWN position, all pens are raised and can not be lowerd under program control until the PEN switch is raised to the UP position. If a vector is being plotted with a pen down, when the PEN switch is depressed, the pen will not be raised until the vector has been completed. With the PEN switch in its normal (UP) position, the up or down state of the pen is controlled by the BASIC program while in PLOT mode. The pens are automatically raised when the SLEW or SET LIMITS switches are pressed.

> NOTE:
>
> The PEN switch is normally used by the Wang Service Representative to perform routine diagnostics on the plotter. To interrupt plotting, it is better to depress the SLEW switch or the HALT/STEP switch on the 2200 System keyboard. The HALT/STEP switch interrupts the program after the data (from the current statement line) in the buffer has been plotted.

2.8 SUMMARY OF DEFAULT POSITIONS

When the Model 2272-2 is Master Initialized (turned on), the following positions are automatically assigned to the plotter selections.

Selection	Default Position
HOME	Current carriage position and pen at the middle of the plotter (pointer at 8 inches on Plotter scale).
Pen	Number 1.
Pen position	UP.
Axis Selection	If all Axis Selection switches are in the up position, the positive X axis is to the right and the positive Y axis is up.
Set Limits (Plotting Area)	8 inches to the left and right limits, 40.8 inches to upper and lower limits.
Character Size	Size 1.
Character Spacing	Zero (no spacing)

CHAPTER 3
PLOT STATEMENTS AND COMMANDS

3.1 THE PLOT STATEMENT

General Form:

PLOT [expression 0]⟨ [expression 1] ,[expression 2] ,[expression 3]⟩ ,[[expression 0] ⟨ . . . , . . . , . . .⟩]

The PLOT statement can be executed in the Immediate Mode or as a statement within a program. The length of the PLOT statement line may not exceed 192 keystrokes.

Example: Immediate Mode

```
:PLOT 2 ⟨,200,D⟩ ,  5⟨A,400,U⟩ , ⟨2,,C⟩ , ⟨26,,S⟩ ,.....
```

Example: Program Mode

```
:10 PLOT 5⟨ 10,10,D⟩ , ⟨8,,U⟩ ,4⟨ 10,,D⟩ , ⟨ ,,R ⟩ , .....
```

Expression 0 PLOT [expression 0] ⟨, ,⟩

Description: Replication factor or the number of times the values or arguments enclosed in ⟨ ⟩ are executed.

NOTE:
Expression 0 must precede each ⟨ ⟩ that is to be repeated.

Example:

```
:10 PLOT 2⟨ 2, ,C ⟩, 2⟨ 26, ,S ⟩, 2⟨ , ,"ABCD" ⟩
```

Allowed value/argument:

1. Positive number (see Limitations).
2. Numeric variable whose numeric value has been defined elsewhere in the program.
3. Mathematical function or expression.
4. BASIC function that produces a positive integer, e.g., VAL, POS, LEN, NUM.

Limitations:

1. Numeric value of expression 0 must be a positive number ≥ 1, and < 1000.
2. If expression 0 is omitted, it is equal to 1.

> NOTE:
>
> In expression 0, expression 1, and expression 2 non-integer values for numeric variables, and mathematical functions and expressions are truncated to integer values.

Expression 1 PLOT [ ] ⟨ expression 1, , ⟩

Description: In the plot statements

a. ⟨ , , U ⟩
b. ⟨ , , D ⟩
c. ⟨ , , ⟩
d. ⟨ , , 'literal string' ⟩
e. ⟨ , 'alphanumeric variable' ⟩

expression 1 represents the number of .005 increments (1. mm for metric plotter) the pen is moved along the current horizontal axis. In this manual, Δ X will represent the number of horizontal increments.

In the plot statement PLOT ⟨ , , C ⟩ ,expression 1 represents the size of the character(s) to be plotted (see Section 3.6).

In the plot statement PLOT ⟨, , S⟩ ,expression 1 represents the horizontal spacing between characters (see Section 3.7).

Allowed value/argument:

1. Positive or negative integer (see Limitations).

2. Numeric variable whose numeric value has been defined elsewhere in the program.

3. Mathematical function or expression.

4. BASIC function that produces a positive integer, e.g., VAL, POS, LEN, NUM.

Limitations:

1. Numeric value of expression 1 must be greater that -1000 and less than +1000 for plot statements a through e.

2. Numeric value of expression 1 must be between 1 and 15 inclusive for statement PLOT ⟨ , , C ⟩ .

3. Numeric value of expression 1 in statement PLOT ⟨ , , S ⟩ must be a factor of 13 to 15 times the value of expression 1 in statement PLOT ⟨ , , C ⟩ .

   Example :10 PLOT ⟨ 2 ,,C ⟩ , ⟨ 26,,S ⟩ ,.....

4. If expression 1 is omitted, it is equal to 0.

Expression 2 PLOT [ ] ⟨ ,expression 2, ⟩

Description: In the plot statements

a. ⟨ , , U ⟩
b. ⟨ , , D ⟩
c. ⟨ , , ⟩
d. ⟨ , , 'literal string' ⟩
e. ⟨ , , 'alphanumeric variable' ⟩

expression 2 represents the number of .005" increments (.1 mm for metric plotter) the pen is moved along the current vertical axis. In this manual, Δ Y will represent the number of vertical increments.

Plot statement PLOT ⟨ , , C ⟩ is insensitive to values of expression 2.

In the plot statement PLOT ⟨ , , S ⟩ , expression 2 represents the vertical spacing between characters when plotting characters vertically (see Section 3.7).

Allowed value/argument:

1. Positive or negative integer (see Limitations).

2. Numeric variable whose numeric value has been defined elsewhere in the program.

3. Mathematical function or expression.

4. BASIC function that produces a positive integer, e.g., VAL, POS, LEN, NUM.

Limitations:

1. Numeric value of expression 2 must be greater than -1000 and less than +1000 for plot statements a through e above.

2. Numeric value of expression 2 must be a factor of -15 to -18 times the value of expression 1 in statement PLOT ⟨ , , C ⟩ .

   Example :10 PLOT ⟨2,,C ⟩,⟨ ,-30 ,S⟩ , ...

3. If expression 2 is omitted, it is equal to 0.

Expression 3 PLOT [ ] ⟨ , , expression 3 ⟩

Description: Expression 3 is used for four purposes:

1. To send special control codes (described below) to the plotter.

2. To send alphanumeric characters to be drawn.

3. To send special HEX control codes to the plotter (see Sections 3.11 - 3.13 and Chapter 4).

4. To send binary vectors to be plotted (see Chapter 4).

Allowed values/argument:

"null"

literal string

alphanumeric variable
special plotter control codes:

U
D
C
S
R

special HEX control codes and vector codes.

Limitations:

1. No numeric values.

2. Literal strings can be any length compatible with the total number of keyboard strokes allowed to express one program line (192 strokes maximum).

3. Alphanumeric variable properly dimensioned.

3.2 THE "NULL" COMMAND

If expression 3 in the PLOT statement is omitted, then the "null" command instructs the Plotter to raise the pen and move the distances Δ X, Δ Y.

Example 1:

```
:PLOT ⟨ 400,-200, ⟩
:RUN (EXEC)
```

Result 1:

In the Immediate Mode the pen advances Δ X = 400 (2 inches) and ΔY = -200 (1 inch) increments while in the UP position.

Example 2:

```
:10 X = 30
:20 PLOT ⟨ X↑2, X+70, ⟩
:RUN (EXEC)
```

Result 2:

The pen advances diagonally Δ X = 900 and Δ Y = 100 increments in the UP position.

Example 3:

```
:PLOT 11 ⟨ ,200, ⟩
:RUN (EXEC)
```

Result 3:

In the Immediate Mode the pen moves up 11 inches (11 x 200 increments).

NOTE:
200 increments = 1 inch.

3.3 THE "U" (UP) COMMAND

This "U" command is essentially identical to the "null" command, but is easier to recognize. It is used to raise the pen before moving the distances ΔX and ΔY.

Example 1:

```
:10 PLOT ⟨ -200,-400, U ⟩
:RUN (EXEC)
```

Result 1:

The pen is raised and advanced diagonally to a point 1 inch to the left and 2 inches down from its current position.

Example 2:

```
:10 X=20:  Y=360000
:20 PLOT ⟨ X↑2, SQR(Y),U⟩
:RUN (EXEC)
```

Result 2:

The pen is raised and advanced diagonally to a point 2 inches to the right and 3 inches up from its current position.

Example 3:

```
:PLOT 22 ⟨ ,200,U ⟩
:RUN (EXEC)
```

Result 3:

In the Immediate Mode the pen is raised and moved up 22 inches (22 x 200 increments).

3.4 THE "D" (DOWN) COMMAND

The "D" specification in expression 3 of the PLOT statement calls for pen DOWN, that is, the currently selected pen is lowered, and the pen assembly is moved the ΔX and ΔY distances given by expressions 1 and 2. After Master Initialization of the Plotter, the pen is UP and remains UP until given the DOWN command.

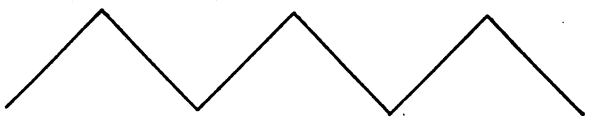
Example 1:

```
:5 FOR N = 1 to 3
:10 PLOT ⟨ 100,100,D ⟩ ,
    ⟨ 100,-100,D ⟩
:30 NEXT N
:40 PLOT  ⟨ , ,U ⟩
:RUN (EXEC)
```

Result 1:

Line 10 is executed 3 times resulting in a saw tooth curve. Note line 40 leaves the pen in the up position at the conclusion of the plot.

Output:



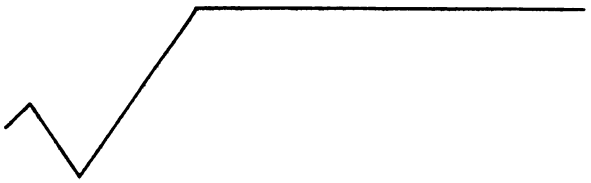
Example 2:

```
:PLOT ⟨ 25,25,D⟩ ,
      ⟨ 50,-75,D ⟩ ,
      ⟨ 125, 175,D⟩ , ⟨ 400, ,D⟩
```

Result 2:

In the Immediate Mode a radical sign (root sign) is plotted.

Output:



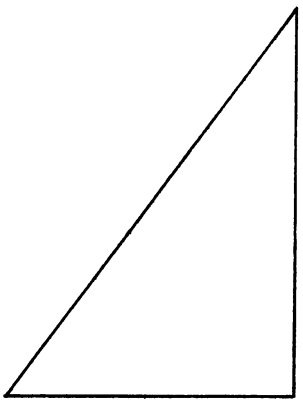
Example 3:

```
:10 X=-300:  Y=400
:20 PLOT  ‹ ABS (X) , ,D›
:30 PLOT  ‹  ,Y,D  ›
:40 PLOT ‹ X,-Y,D  ›, ‹ , ,U›
:RUN (EXEC)
```

Result 3:

The pen draws a right triangle.

Output:



3.5 THE "R" (RESET) COMMAND

An "R" specification in expression 3 of the PLOT statement raises the pen and RESETS THE pen to the plotter's current HOME position. The current HOME position may be the default position, the position set manually with the SET LIMITS switch or the position set with the special Set Home control code HEX (E4) (See Section 3.12). The R command requires no entries in expression 1 and 2.

Example:

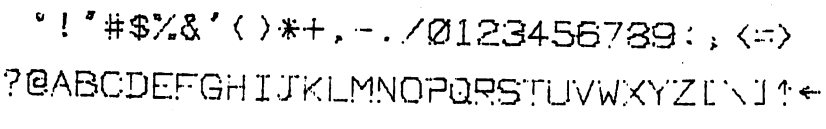
```
:10 PLOT ‹ ,  , R ›
:RUN (EXEC)
```

Result:

The pen is raised and advanced from its present position directly to the current HOME position.

3.6 THE "C" (CHARACTER SIZE) COMMAND

The "C" specification in expression 3 of the PLOT statement is used to set the size of plotted characters. The following characters may be plotted:



"C" determines the character size according to the integer value given by expression 1. (Non integer values in expression 1 are truncated.) For character plotting, this integer must range between 12 and 15 inclusive. The value of 1 assigned to expression 1 commands the smallest size letter/character (.12"), whereas the value of 15 assigned to expression 1 corresponds with the largest (1.81").

Example 1:

```
:10 PLOT ⟨ 9, ,C ⟩,⟨ , ,"B" ⟩
:RUN (EXEC)
```

Result 1:

This statement plots a "B" of character size 9.

Example 2:

```
:10 X = 3.2
:20 PLOT ⟨ X↑2+3 , ,C ⟩ ,
   ⟨ , ,HEX(25)⟩
:RUN (EXEC)
```

Result 2:

A '%' of size 13 is plotted.

Example 3:

```
:10 PLOT ⟨2,,C⟩,⟨200,,"Z"⟩
:RUN (EXEC)
```

Result 3:

The pen plots a 'Z' of size 2 one inch to the right of its current position.

NOTE:

The Character Command is insensitive to values of ΔY in ⟨ ΔX, ΔY,C ⟩.Thus ⟨2,100,C⟩ is executed as ⟨2, ,C⟩ . Also, if no character command is specified the character size defaults to size 1.

Example:

```
:10 PLOT ⟨, , "A"⟩
```

Output: A

NOTE:

Alphanumeric characters should not be printed when the plot pen is at the left or right margins of the paper. The pen position is considered the center of a character so that, if at the left margin, the character will not be correctly printed.

3.7 THE "S" (CHARACTER SPACING) COMMAND

An "S" in expression 3 of the PLOT statement sets the horizontal and vertical spacing between printed characters. Expression 1 specifies the horizontal spacing and expression 2 specifies the vertical spacing. For horizontal spacing, expression 1 should be about 13 to 15 times the character size. For vertical spacing, expression 2 should be -15 to -18 times the character size. Note: The character is always plotted first and then the pen is spaced over ΔX and/or ΔY.

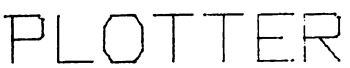
Example 1:

```
:5 A$ = "PLOTTER"
:10 PLOT ⟨ 2, ,C ⟩ ,
    ⟨ 26, ,S ⟩ ,⟨ , ,A$⟩
:RUN (EXEC)
```

Result 1:

Starting at its current position, the pen prints the word 'PLOTTER' with a character size 2.

Output:



Example 2:

```
:5 A$ = HEX(57414E47)
:10 PLOT ⟨ 2, ,C ⟩ ,
    ⟨,-30,S⟩ , ⟨ , ,A$⟩
:RUN (EXEC)
```

Result 2:

Prints vertically the word 'WANG' with a character size 2.

Output:

NOTE:

When using Character Size and Spacing commands, values of ΔX and ΔY must be specified in expressions 1 and 2. Otherwise an error message (Missing Integer) will result.

3.8 PRINT AND PRINTUSING

The Model 2272-2 also can be used to print characters with the PRINT and PRINTUSING statements. In order to do this, the plotter must be selected with the statement:

```
:SELECT PRINT 413
```

The size of characters and spacing within a line, however is controlled by parameters in the PLOT commands, namely the "C" (character size) and "S" (character spacing) parameters.

Example:

```
:10 SELECT PRINT 413
:20 PLOT ‹ 2, ,C ›, ‹26, ,S ›
:30 B$="TOM JONES"  :A=3452.45
:40 PRINTUSING 50,B$,A
:50 %NAME-######### AMOUNT- $#,###.##
:RUN (EXEC)
```

Output: (reduced)

```
NAME-TOM JONES AMOUNT-$3,452.45
```

3.9 CONVERT STATEMENT

The convert statement can be used in a plot program to convert the numeric value of an expression into an ASCII character string. This allows the numeric results of calculations to be plotted as an alphanumeric variable in expression 3 of the PLOT statement.

Example 1:

```
:10 X = 12.195
:20 CONVERT X*2 TO A$, (+##.##)
:30 PLOT ‹ 2, ,C ›, ‹ 26, ,S ›, ‹ , ,A$›
:RUN (EXEC)
```

Output:

```
+24.39
```

Example 2:

```
:2  REM TABLE OF POWERS OF TWO
:5  PLOT ⟨ 1, ,C ⟩ , ⟨13, ,S⟩,⟨,,"POWER"⟩,⟨300,, ⟩ ,⟨ ,,"NUMBER" ⟩
:7  PLOT ⟨ ,,R ⟩ , ⟨ ,-100,U ⟩
:10 FOR N = 0 TO 15
:20 X = 2↑N
:30 CONVERT N TO A$, (##)
:40 CONVERT X TO B$,(#####)
:50 PLOT ⟨ ,,A$ ⟩
:60 PLOT ⟨ 400,,U⟩
:70 PLOT ⟨ ,,B$ ⟩
:80 PLOT ⟨ ,,R ⟩ , ⟨ ,-(50*(N+1)+100),U ⟩
:90 NEXT N
:RUN (EXEC)
```

Output: (reduced)

POWER	NUMBER
ØØ	ØØØØ1
Ø1	ØØØØ2
Ø2	ØØØØ4
Ø3	ØØØØ8
Ø4	ØØØ16
Ø5	ØØØ32
Ø6	ØØØ64
Ø7	ØØ128
Ø8	ØØ256
Ø9	ØØ512
1Ø	Ø1Ø24
11	Ø2Ø48
12	Ø4Ø96
13	Ø8192
14	16384
15	32768

3.10 PLOTTING DIFFERENT SIZE CHARACTERS

A useful application of the plotter is the printing of headings, labels, symbols and scientific expressions. Frequently it is desired that the first character of a heading or a label be printed a larger size than the remaining characters. In the scientific field mathematical expressions and chemical symbols require that characters appear as either subscripts, superscripts or both.

Examples: X^2, H_2O, C^3_R, etc.

In plotting words or expressions that require characters of different size, it is important that all the characters be printed from the same baseline. The Model 2272-2 plots each character from a central reference point within the character. The pen always returns to this central point, and remains there if no character spacing has been specified. If character spacing has been specified, the pen moves ΔX, ΔY and this new point becomes the central point for the next character to be plotted. As an example of how the normal character spacing values described in Section 3.7 effect the plotting of different size characters, consider the following program which results in the output shown in Figure 3-1.

```
:10 PLOT  ⟨10,,C⟩ , ⟨130,,S⟩ , ⟨,, "H"⟩
:20 PLOT  ⟨ 6,,C⟩ , ⟨78,,S ⟩ , ⟨,, "ELP" ⟩
:30 PLOT  ⟨ 2,,C⟩ , ⟨26,,S ⟩ , ⟨,, "ME"⟩
:RUN (EXEC)
```

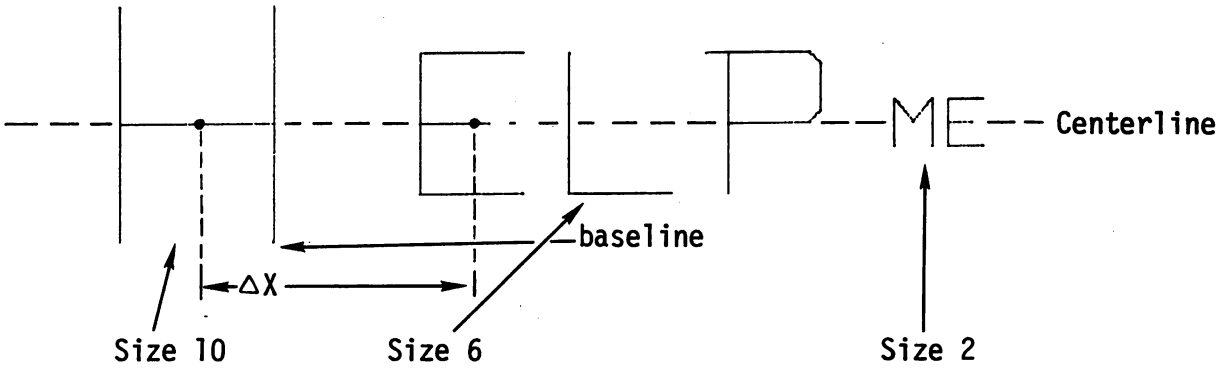


Figure 3-1. Character Size Variation for Model 2272-2

In figure 3-1, in order to move the "E" down to the base of the "H", we must first direct the plotter to move the centerline down (i.e., move the pen $-\Delta Y$ increments before plotting the "E". Also the horizontal spacing between different size characters must be corrected since the normal 13* (character size) rule only applies to a series of characters of the same size. Thus in plotting adjacent characters of different size, both the horizontal and vertical spacing must be corrected.

The corrections in ΔX spacing are made in a PLOT ⟨ ΔX,,S ⟩ statement. The corrections in the vertical spacing (moving the centerline before plotting) are made by the ΔY in the PLOT ⟨ ,ΔY,U ⟩ statement. Tables 3-1 through 3-3 present the values of horizontal and vertical spacing in the ΔX and ΔY increments required for these corrections. In the tables, the left-hand column shows the size of the larger character, while the smaller

character is shown along the top of the tables. The values in table 3-1 are used in the PLOT ⟨ ΔX,,S ⟩ statement. As an example, in order to print a size 2 character to the right of a size 5 character, the required Δ X value is 36. The spacing statement becomes PLOT ⟨36,,S⟩ for this combination. In table 3-2, the correct value of Δ Y for the same size 5 and size 2 characters is -34. The plot "pen up " expression becomes PLOT ⟨ ,-34,U⟩ . The sign of Δ Y is minus because the pen must be moved down so that the size 2 character can be printed at the base of the size 5 character.

Example 1: Plot the word "Help" where the "H" is a size 5 and the "elp" are size 2 characters. The complete plot statement is:

```
:10 PLOT ⟨5,,C⟩ , ⟨36,,S⟩ , ⟨ ,,"H"⟩
:20 PLOT ⟨,-34,U⟩ , ⟨2,,C⟩ , ⟨26,,S ⟩, ⟨ ,,"ELP"⟩
:RUN (EXEC)
```

Output:

Result: In line 10, an "H" of size 5 is plotted and the pen moves X=36 increments to the right (from table 3-1 for large character = size 5 and small character = size 2).

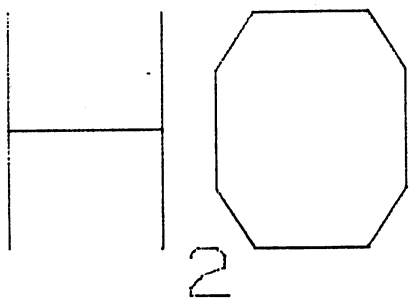
In line 20, the pen is moved ΔY = -34 increments down on the paper and the "ELP" of size 2 is plotted with spacing between characters of ΔX = 26 increments.

> NOTE
>
> After a character is plotted the pen moves a distance specified in the previous spacing statement ⟨ Δ X, ΔY,S ⟩ . All subsequent plotted characters will adhere to this particular spacing statement unless a new spacing statement appears in the program.

Example 2: Plot the symbol H_2O with a size 10 "H" and "O" and a size 2 "2". In this example, ΔX is taken from table 3-1 and ΔY is taken from table 3-3 (spacing values for subscripts and superscripts).

```
:10 PLOT  ⟨ 10,,C ⟩ , ⟨ 54,,S ⟩ , ⟨ ,,"H" ⟩
:20 PLOT  ⟨ ,-145, U ⟩
:30 PLOT  ⟨ 2,,C ⟩ , ⟨54,,S ⟩ , ⟨ ,,"2" ⟩
:40 PLOT   ⟨ ,145,U ⟩
:50 PLOT  ⟨ 10,,C ⟩ , ⟨ ,,"O"⟩
:RUN
```

Output:

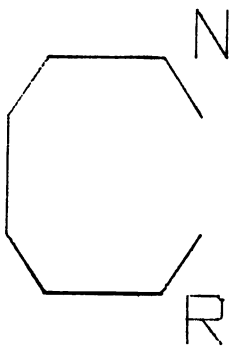


Result: In line 10, an "H" of size 10 is plotted and the pen is directed to move ΔX = 54 increments (from Table 3-1). In line 20, the pen moves down on the paper ΔY = -145 increments (from table 3-3). In line 30, a "2" of size 2 is plotted and the pen moves ΔX = 54 increments because the next character ("O") is a size 10. In line 40, the pen moves up on the paper ΔY = 145 increments so that the size 10 "O" will be plotted along the same centerline as the "H". Line 50 plots the size 10 "O".

Example 3: Plot the mathematical symbol C_R^N where "C" is a character size 10 and the "N" and "R" are size 2. In this example, the ΔX is taken from table 3-1 and ΔY is taken from table 3-3.

```
:10 PLOT  ⟨ 10,,C ⟩ , ⟨ 54,,S ⟩ , ⟨ ,,"C" ⟩
:20 PLOT  ⟨ ,145, U ⟩ , ⟨ 2,,C ⟩ , ⟨ ,,"N"⟩
:30 PLOT  ⟨-108, -290,U ⟩ , ⟨ 2,,C ⟩ , ⟨ ,,"R" ⟩
:RUN (EXEC)
```

Output:



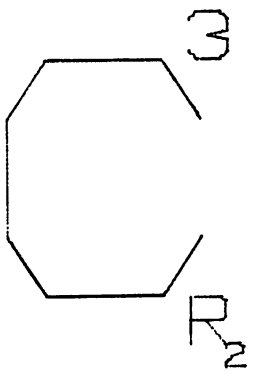
Result: In line 10, the size 10 "C" is plotted and the pen is directed to move ΔX =54 increments (from table 3-1). In line 20, the pen moves up on the paper ΔY = 145 increments (from table 3-3) and the size 2 "N" is plotted. After the "N" is plotted, the last spacing command ⟨ 54,,S ⟩ moves the pen to the right ΔX = 54 increments. In order to align the "R" exactly under the "N" the pen is brought back to the left ΔX = 2* (-54) = -108 increments and down ΔY = 2* (-145) = -290 increments in line 30. Finally, in line 30 the character "R" of size 2 is plotted.

Example 4: Plot the mathematical expression $C^{3}_{R_2}$

where "C" is character size 10, "3" and "R" are size 2 and "2" is size 1. In this example ΔX values are taken from table 3-1 and ΔY values are taken from table 3-3.

```
:10 PLOT  ⟨ 10,,C ⟩ , ⟨ 54,,S ⟩ , ⟨ ,, "C" ⟩
:20 PLOT  ⟨ ,145,U ⟩ , ⟨ 2,,C⟩ , ⟨ ,, "3" ⟩
:30 PLOT  ⟨ -108,-290, U ⟩ , ⟨2,,C ⟩
:40 PLOT  ⟨ 15,,S ⟩ , ⟨ ,, "R" ⟩
:50 PLOT  ⟨ ,-36,U ⟩ , ⟨ 1,,C ⟩, ⟨ ,, "2" ⟩
:RUN (EXEC)
```

Output:



Result: Lines 10, 20, and 30 are the same as in example 3. In line 40, the size 2 "R" is plotted to the right of the "C" and the pen moves to the right ΔX = 16 increments from table 3-1). In line 50, the pen moves down on the paper ΔY = -36 increments and the size 1 "2" is plotted.

Size of Larger Character	Size of Smaller Character												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	13												
2	16	26											
3	20	24	39										
4	24	30	36	52									
5	28	36	42	48	65								
6	32	42	48	54	60	78							
7	36	45	52	57	65	-	91						
8	40	48	56	60	70	80	-	104					
9	44	51	58	63	63	83	-	-	117				
10	48	54	60	66	76	86	90	-	-	130			
11	-	57	64	70	79	89	94	100	-	-	143		
12	-	60	68	74	82	92	98	104	112	-	-	156	
13	-	66	73	78	86	95	102	108	115	-	-	-	169
14	-	72	77	82	90	98	105	112	119	-	-	-	-
15	-	76	82	88	97	106	114	122	140	-	-	-	-

Table 3-1. Horizontal Spacing ΔX Increments Required in ⟨ ΔX, , S ⟩ for Printing Adjacent Characters of Different Size

Size of Larger Charac.	Size of Smaller Character												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0												
2	-12	0											
3	-24	-11	0										
4	-36	-22	-14	0									
5	-48	-34	-24	-12	0								
6	-60	-46	-33	-20	-10	0							
7	-70	-58	-45	-32	-20	-10	0						
8	-80	-70	-57	-44	-32	-20	-	0					
9	-93	-82	-68	-55	-43	-31	-	-	0				
10	-106	-94	-80	-66	-54	-42	-31	-	-	0			
11	-	-105	-92	-80	-67	-54	-42	-31	-	-	0		
12	-	-116	-105	-94	-80	-66	-54	-42	-31	-	-	0	
13	-	-128	-118	-108	-94	-80	-66	-54	-42	-	-	-	0
14	-	-140	-131	-122	-108	-94	-80	-66	-65	-	-	-	-
15		-152	-140	-131	-122	-108	-94	-80	-66	-	-	-	-

Table 3-2. Vertical Spacing Δ Y Increments Required in ⟨ , Δ Y, U ⟩ for Printing Adjacent Characters of Different Size.

Size of Larger Charac.	Size of Smaller Character													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	24													
2	36	47												
3	48	59	71											
4	59	71	83	94										
5	71	83	95	106	118									
6	84	95	107	119	131	144								
7	96	108	120	131	144	157	169							
8	108	120	132	144	156	169	181	193						
9	121	132	144	156	168	181	193	205	218					
10	133	145	157	168	180	193	206	218	230	243				
11	145	157	169	180	193	206	218	230	243	255	267			
12	157	169	181	192	205	217	230	242	254	267	279	291		
13	169	181	193	205	217	230	242	254	267	279	291	303	315	
14	181	193	205	216	229	241	254	266	278	291	303	315	327	
15	193	205	216	228	240	253	266	278	290	303	315	327	338	350

Table 3-3. Vertical Spacing ΔY Increments Required in ⟨ , Δ Y, U ⟩ to Create Character Subscripts and Superscripts.

3.11 Pen Selection HEX(E1), HEX(E2), HEX(E3)

Pen selection is accomplished under program control by transmitting codes HEX(E1), HEX(E2), or HEX(E3) to the plotter to select Pen #1, Pen #2, or Pen #3 respectively.

Examples:

```
:100 PLOT ⟨ ,, HEX(E1) ⟩    (Select Pen 1)
:100 PLOT ⟨ ,, HEX(E2) ⟩    (Select Pen 2)
:100 PLOT ⟨ ,, HEX(E3) ⟩    (Select Pen 3)
```

When the plotter is first turned on, pen #1 is always automatically selected. Thereafter the other pens can be selected (pen #1 can be reselected) under program control by the appropriate codes.

When a new pen is selected, the plotter automatically does a pen up, moves the pen mount assembly the appropriate offset distance to position the newly selected pen to the current plotting position, and then restores the pen to the previous up or down states. This is a completely automatic function and does not require any allowances in the plotting program other than selecting the desired pen.

Example:

```
:40 PLOT  ⟨ 600,,D ⟩ , ⟨ ,,HEX(E2) ⟩
          ⟨,400,D  ⟩ , ⟨ ,,HEX(E3) ⟩
          ⟨-600,,D ⟩ , ⟨ ,,HEX(E1) ⟩
        ⟨,,-400,D  ⟩
```

Result:

This program draws a rectangle 2 inches high and 3 inches wide. Pen #1 (the default pen) advances Δ X=600 (3 inches) and draws a straight line. Pen #2 is selected and it advances up ΔY=400 (2 inches). Pen #3 is selected and a horizontal line is drawn 3 inches toward the left. Pen #1 is selected and a vertical line 2 inches long completes the figure.

3.12 Set Home Position (HEX(E4)

With one exception, this code duplicates under program command the function of setting the plotter home position (X=0, Y=0) which is done manually via the plotter control panel. The home position (X=0, Y=0) is set to the position at which the plotter pen and drum is currently positioned by the following command.

```
:100 PLOT ⟨,,HEX(E4)⟩
```

In this operation, the horizontal limits are not altered but the vertical limits are reset to power on default values (i.e., 40.8 inches above and below Home). Set Home Positition can be extremely useful when the user desires to do a series of plots automatically on successive sections of paper. When one plot is completed, the program can be designed to return to home on the current plot, position up to the next portion of paper and reset the home position.

Example:

Result:

```
:100 PLOT ⟨ ,,R ⟩
:110 PLOT 11  ⟨ ,200,U ⟩  , ⟨  ,,HEX(E4) ⟩
```

Move the paper out 11 inches (11 x 200 increments) to the next plot area and resets the home position.

It should be noted that although additional plots could be made without resetting the home position, it is good practice to do so because:

1. It is often more convenient and flexible to utilize the Set Home position operation in plotting programs and utilites because it allows more modularity in plotting subroutines.

2. The plotter automatically keeps track of the current position of the plotter relative to home. The maximum displacement allowable is 16,383 increments (81.9 inches). Beyond that displacement, the home position must be reset or erroneous operation can occur.

3.13 Power On/Set Home HEX(E5)

This code in the Plot statement duplicates the operations performed by the plotter when it is just turned on. The HEX(E5) code does the following:

1. Moves the pen mount assembly to the right until it encounters the mechanical right margin of the plotter and then positions the assembly back to the exact center of the plotting surface for pen #1 (8 inches from each margin). Sets the home position at this point.

2. Selects pen #1 and places all pens in the up position.

3. Sets the default limits as:

   Pen left margin - left edge of plotter surface.
   Pen right margin - right edge of plotter surface.
   Paper out margin - 40.8 inches.
   Paper in margin - 40.8 inches.

The HEX(E5) code can be used when it is desired to have the plot program initialize the plotter prior to plotting. It is also recommended when the pen position is approaching the maximum displacement limit from the current home position and it is desired to advance the paper beyond this limit.

Example:

```
:100 PLOT 11 ⟨ ,200,U ⟩ , ⟨ ,,HEX(E5) ⟩
```

> NOTE:
>
> The Power On/Set Home operation does not clear the buffer of output data, whereas the buffer is cleared when the plotter is normally turned on.

CHAPTER 4
SPECIAL TECHNIQUES

4.1 Long Binary Plot Vector HEX (E0), Short Binary Plot Vector HEX (E6)

The System 2200 PLOT command provides the most generally useful means of controlling the plot vector since it operates to conveniently allow BASIC numeric variables and expressions to specify plot vector increments. However, it can be occasionally useful and efficient to store and transmit plot vector pen/paper movements in a compressed binary format. This could be useful when doing special lettering, symbol generation, or if it is desired to use a prestored set of plot vectors, for example, to generate an axis or chart. The Model 2272-2 supports two binary plot vectors which allow the following character formats to be sent: (1) a five character (byte) vector which can specify pen/paper movement to + 16,383 or -16,384 increments for both Δ X and ΔY, and (2) a three character (byte) binary plot vector which can specify pen/paper movement to + 127 or -128 increments for both Δ X and Δ Y.

LONG BINARY PLOT VECTOR

HEX (E0)	X X	Y Y
character 1	characters 2 and 3 = two-byte two's complement binary* representation of X (-16,384 to +16,383)	characters 4 and 5 = two-byte two's complement binary* representation of Y (-16,384 to +16,383)

SHORT BINARY PLOT VECTOR

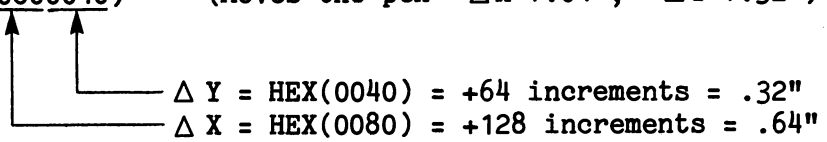
HEX(E6)	X	Y
character 1	character 2, a one-byte two's complement binary* representation of X(-128 to + 127)	character 3, a one-byte two's complement binary* representation of Y(-128 to + 127)

Binary vectors can be used in either the PRINT or PLOT commands.

*Two's complement binary notation is explained in section 4.3.

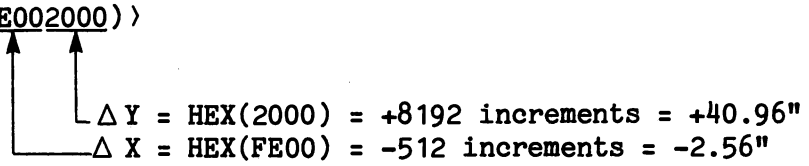
Example 1:

```
:100 SELECT PRINT 413
:200 PRINT HEX(E000800040)      (Moves the pen  ΔX=+.64",  ΔY=+.32")
```



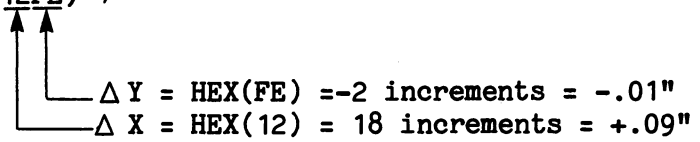
Example 2:

```
:200 PLOT ‹  ,, HEX(E0FE002000)›
```



Example 3:

```
:200 PLOT ‹  ,, HEX(E612FE) ›
```



It should be noted that the five character binary plot vector allows specification of vector movements up to 16,383 increments, whereas the PLOT command is limited to 999 increments.

> NOTE:
>
> The short binary plot vector is most useful when storing a large quantity of vectors whose lengths are less than .6 inches. A significant amount of 2200 memory space can be saved in this way.

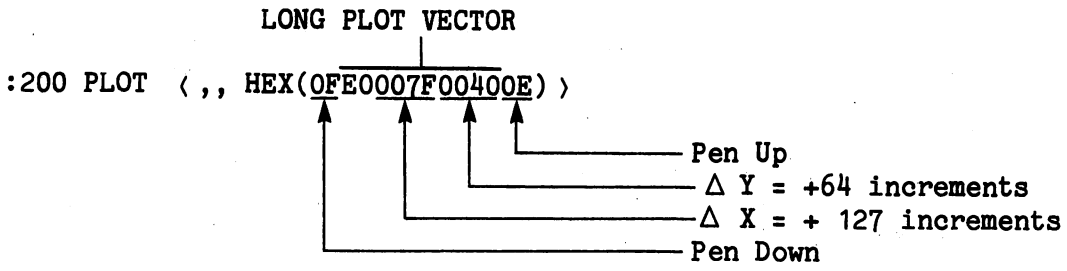
4.2 HEX CODES FOR BINARY PLOT VECTORS

When using the binary plot vector, it is usually necessary to specifically place the pen up or down or RESET to Home position prior to or after the movement. The PLOT command uses the operands U and D to indicate pen up or pen down and R to indicate Reset. However, when using the binary plot vector, it is necessary to express pen up or down and RESET with the hexadecimal codes internally reserved for these operations in the 2200 system. These codes are:

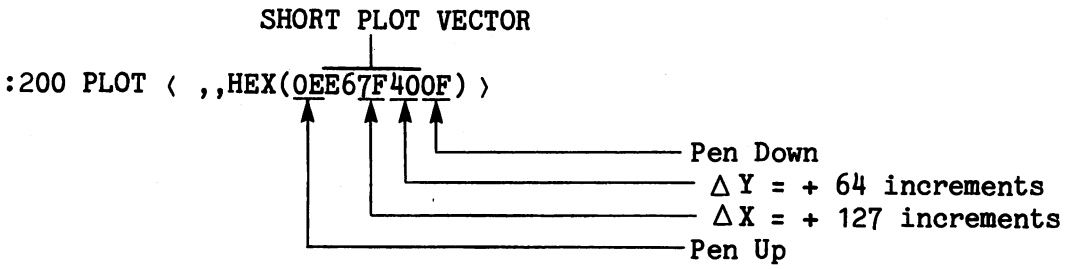
```
HEX(0E)  --  Pen Up
HEX(0F)  --  Pen Down
HEX(FA)  --  RESET to Home Position
```

The codes can be used before or after plot vectors to move the pen up or pen down or return to Home before or after the movement expressed by the vector.

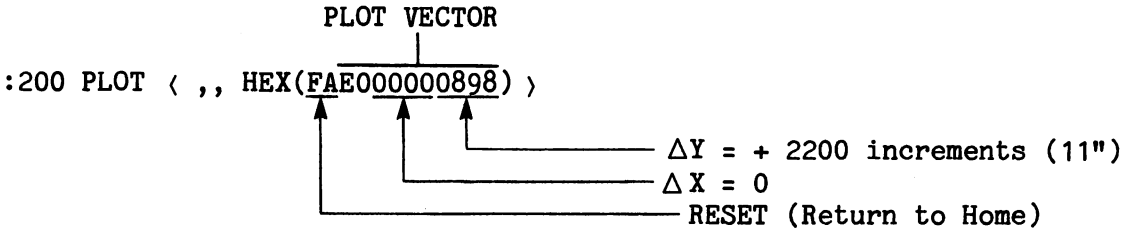
Example 1:



Example 2:



Example 3:

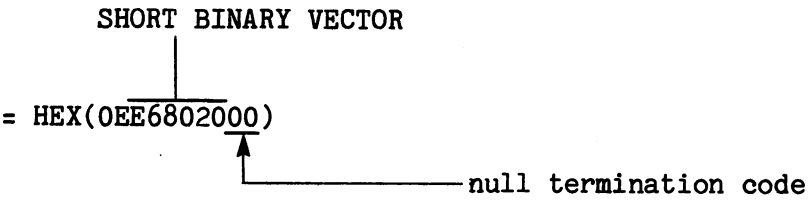


It should be noted that in all the previous examples, binary plot vectors and pen control codes were specified by HEX functions. It is also possible and generally more useful to store a combination of one or more binary vectors and pen control codes into an alphanumeric variable (up to 64 bytes) and use that as an argument in a PLOT or PRINT statement to transmit the plot data to the plotter. There is one requirement to be satisfied. Trailing space codes, HEX(20), contained in the variable are not transmitted. If a binary vector were the last item in the variable and if its last byte was a HEX(20), it would not be transmitted. To insure against this, two approaches can be taken:

a. Always use a STR function to specify the number of characters to be sent. For example,

```
:100 A$ = HEX(0EE680400FFAE000000898)
:110 PLOT  ⟨ ,, STR(A$,1,11) ⟩
```

b. Always terminate a sequence with a HEX(00) code. The HEX(00) code is ignored by the plotter (unless it is part of a binary vector). For example:




```
:200 PLOT  ⟨ ,, A$ ⟩
```

or

```
:100 INIT (00) A$                  Initialize A$ to all HEX(00) codes.
:120 STR(A$,1,1) = HEX(0E)         Insert pen up command.
:130 STR(A$,2,5) = B$              Insert a binary vector from B$.
:140 PLOT ⟨ ,,A$ ⟩                 Send to plotter.
```

In the above example, A$ was first initialized to all HEX(00) codes which are ignored by the plotter; then plot information is inserted in A$ via the STR function. It should be noted that STR function is used to insert a binary vector contained in B$. If the statement A$ = B$ is used, the remaining space in A$ is filled with trailing space codes (HEX(20)) which are not transmitted to the plotter.

4.3 TWO'S COMPLEMENT BINARY

Binary numbers consist of digits whose value can only be 0 or 1. These binary digits are called bits. Each higher order bit (digit) in a binary number represents a power of 2 greater than the bit to the right of it. For example,

The binary numbers represented by the bits $X_7X_6X_5X_4X_3X_2X_1X_0$ has a value of

$$X_7(2^7) + X_6(2^6) + X_5(2^5) + X_4(2^4) + X_3(2^3) + X_2(2^2)$$
$$+ \quad X_1(2^1) + X_0(2^0)$$

Thus, if $X_7X_6X_5X_4X_3X_2X_1X_0$ = 0000 1011

Its value in the decimal system equals

$$0(2^7)+0(2^6)+0(2^5)+0(2^4)+1(2^3)+0(2^2)+1(2^1)+1(2^0)$$
$$= \quad 0 \quad +0 \quad +0 \quad +0 \quad +1(8) \quad +0 \quad +1(2) \quad +1$$

$$= \quad 11$$

A negative value in binary two's complement format is formed by complementing the value (i.e., changing all 1's to 0's, and 0's to 1's) and then adding 1. For example,

-11 = complement (+11) + 1 = complement of 0000 1011 + 1 =
1111 0100 + 1 = 1111 0101 = HEX(F5)

-4 = complement (+4) + 1 = complement of 0000 0100 + 1 =
1111 1011 + 1 = 1111 1100 = HEX(FC)

-10.000 = complement (+10,000) + 1 = complement of 0010 0111 0001 0000 + 1
= 1101 1000 1110 1111 + 1
= 1101 1000 1111 0000
= HEX(D8F0)

NOTE:

The high order bit of the binary number is not used to express the value of the number but merely indicates the sign of the number (0 = +, 1 = -). Thus HEX (00) through HEX (7F) are positive and HEX (80) through HEX (FF) are negative.

To form a positive value from a negative one, the number is again complemented and one is added. For example,

+11=complement(-11)+1=complement(1111 0101)+1=(0000 1010)+1=0000 1011=HEX(0B)
+4 =complement(-4)+1=complement(1111 1100)+1=(0000 0011)+1=0000 0100=HEX(04)
+10,000 = complement (-10,000) +1 = complement (1101 1000 1111 0000) +1
= 0010 0111 0000 1111 + 1
= 0010 0111 0001 0000 = HEX(2710)

4.4 HEXADECIMAL NOTATION

It often is easier to express binary values in hexadecimal notation. In this representation, the binary number is divided into four bit groups and each group of 4-bits is expressed by single hexadecimal character 0 - 9 or A - F as follows:

0000 = 0	1000 = 8
0001 = 1	1001 = 9
0010 = 2	1010 = A
0011 = 3	1011 = B
0100 = 4	1100 = C
0101 = 5	1101 = D
0110 = 6	1110 = E
0111 = 7	1111 = F

Therefore, HEX(23) = 0010 0011
↑ ↑
2 3

HEX(7E) = 0111 1110
↑ ↑
7 E

4.5 TWO'S COMPLEMENT BINARY NOTATION FOR PLOT VECTORS

Since the five character binary plot vector in the Model 2272-2 utilized two bytes (16-bits) to express both ΔX and ΔY in two's complement binary notation, the value then can be expressed as:

$S \quad X_{14}X_{13}X_{12}X_{11}X_{10}X_9 \; X_8 \; X_7 \; X_6 \; X_5 \; X_4 \; X_3 \; X_2 \; X_1 \; X_0$

i.e., $S \quad X_{14}(2^{14}) + X_{13}(2^{13}) + \quad \ldots \quad + X_1(2^1) + X_0(2^0)$

High order bit (S) reserved for sign (0 = +, 1 = -)

The maximum positive value that can be expressed is $2^{15} - 1 = 32,767$

The maximum negative value that can be expressed is $-2^{15} = -32,768$

For example,
HEX(4001) = (0100 0000 0000 0001) = $1(2^{14})+1(2^0)$= 16,384+1 = 16,385
HEX(EFFF) = negative value = - (comp(HEX(EFFF))+1)
= - (HEX(1000)+1) = - (2^{12}+1)
= - (4096+1) = -4097

The Model 2272 is designed to buffer and store vector counts internally in terms of half increments. This allows better resolution for drawing slanted lines. Therefore, the maximum binary number that can be expressed in the plot vector is:

1/2 (32,767) = + 16,383
1/2 (-32,768) = - 16,384

The three character binary plot vector in the Model 2272 utilizes one byte each (8 bits) to express both ΔX and ΔY in two's complement binary notation. This value can be expressed as:

$S \; X_6X_5X_4X_3X_2X_1X_0$

i.e., $S \; X_6(2^6) + X_5(2^5) + \ldots + X_0(2^0)$

High order bit (S) reserved for sign (0 = +, 1 = -)

The maximum positive value that can be expressed is $2^7-1 = +127$

The maximum negative value that can be expressed is $-2^7 = -128$

For example,
HEX(74) = (0111 0100) = $+1(2^6)+1(2^5)+1(2^4)+1(2^2)$
= +(64 + 32 + 16 + 4)
= 116

HEX(80) = negative value = -(complement (HEX(80)+1)

= -(HEX(7F)+1)

$= -(2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0 + 1)$

= -(64 + 32 +16 + 8 + 4 + 2 + 1 + 1)

= -128

4.6 CONVERSION OF BASIC NUMERIC VALUES TO TWO'S COMPLEMENT

2200T Users

Numeric values can be converted into two's complement binary numbers with the Wang BASIC BIN statement. The BIN statement converts a BASIC numeric value to binary. Since however, the BIN statement produces only a binary value consisting of a single byte (8-bits), the number must be factored by 256 (the minimum value + 1 of one byte) to produce a two byte number. The following BASIC subroutine receives a numeric value (presumably an integer value less than 16,383) converts it to two's complement binary notation and stores it in the first two bytes of the variable A$.

```
:10 REM SUBROUTINE TO GENERATE TWO BYTE TWO'S COMPLEMENT BINARY NUMBERS
      (FOR LONG BINARY PLOT VECTOR)

:100 GOSUB' 50 (X1)                          X1 = numeric integer value to be
                                             converted to two's complement which
                                             will be stored in A$.

:400 DEFFN' 50 (X)
:404 DIM A$2
:405 IF ABS(X) < = 16383 THEN 410
:408 STOP: PRINT "ABS(X) TOO LARGE"
:410 T = INT (ABS(X/256))                    (Factor 256)
:420 BIN(A$) =T                              (Convert to form high order byte)
:430 BIN(STR(A$,2)) = ABS(X)-T*256           (Convert to form low order byte)
:440 IF SGN(X) <0 THEN 450:RETURN            (Check if negative, return if positive)
:450 XOR(STR(A$,1,2),FF)                     (Complement binary value)
:460 ADDC(STR(A$,1,2),01)                    (Add 1)
:470 RETURN


:10 REM SUBROUTINE TO GENERATE A ONE BYTE TWO'S COMPLEMENT NUMBER
      (FOR SHORT BINARY PLOT VECTOR)

:100 GOSUB' 60 (X1)                          X1 = Numeric integer value between -128
                                             and +127 which will be converted to 2's
                                             complement and stored in A$.

:500 DEFFN' 60 (X)
:505 DIM A$1
:510 BIN(A$) = ABS(X)                        (Convert to binary)
:520 IF SGN(X) <0 THEN 530:RETURN            (Test if negative; return if positive)
:530 XOR(STR(A$,1,1),FF)                     (If negative, complement)
:540 ADDC(STR(A$,1,1),01)                    (Add 1)
:550 RETURN
```

2200VP Users

Numeric values can be converted directly into a two byte binary number by using the BASIC 2 BIN statement. The following routines can be used on the 2200VP system.

```
:10 REM SUBROUTINE TO GENERATE TWO BYTE TWO'S COMPLEMENT BINARY NUMBERS (FOR
    LONG BINARY PLOT VECTOR)

:100 GOSUB' 50 (X1)
     .
     .
     .
     .
:400 DEFFN' 50 (X)
:410 DIM A$2
:420 IF ABS(X)< = 16383 THEN 440
:430 STOP: PRINT "ABS(X) TOO LARGE"
:440 Y=ABS(X)
:450 A$=BIN(Y,2)
:460 IF SGN (X)<0 THEN 470: RETURN
:470 XOR(STR(A$1,2),FF)
:480 ADDC(STR(A$1,2),01)
:490 RETURN

:10 REM SUBROUTINE TO GENERATE ONE BYTE TWO'S COMPLEMENT NUMBER (FOR SHORT
    BINARY PLOT VECTOR)

:100 GOSUB' 60 (X1)
     .
     .
     .
     .
:500 DEFFN' 60(X)
:505 DIM A$1
:510 Y = ABS(X)
:520 A$ = BIN(Y)
:530 IF SGN(X)<0 THEN 540: RETURN
:540 XOR(STR(A$,1,1),FF)
:550 ADDC(STR(A$,1,1,01)
:560 RETURN
```

ROUTINE TO BUILD A LONG BINARY PLOT VECTOR HEX (E0)

Assuming X1 and Y1 are integer numeric values less than 16,384, the following program sequence uses the conversion subroutine to form a long binary plot vector followed by a pen down code and a plot statement.

```
:100 B$ = HEX(E0)              (Put binary plot vector code into B$)
:110 GOSUB' 50 (X1)            (Convert ΔX)
:120 STR(B$,2,2) = A$          (Place in B$)
:130 GOSUB' 50 (Y1)            (Convert ΔY)
:140 STR(B$,4,2) = A$          (Place in B$)
:150 STR(B$,6,1) = HEX(0F)     (Place pen down code in B$)
:160 PLOT  ( ,,B$ )            (Send out plot vector)
```

ROUTINE TO BUILD A SHORT BINARY PLOT VECTOR HEX (E6)

This program assumes X1 and Y1 are integer numeric values between -128 and +127.

```
:200 B$ = HEX(E6)              (Put HEX(E6) short vector code in first byte)
:210 GOSUB' 60 (X1)            (Convert ΔX)
:220 STR(B$,2,1) = A$          (Store ΔX)
:230 GOSUB" 60 (Y1)            (Convert ΔY)
:240 STR(B$,3,1) = A$          (Store ΔY)
:250 STR(B$,4,1) = HEX(00)     (Place null code in B$ after vector)
:260 PLOT  ( ,, B$ )           (Send out short plot vector)
```

NOTE TO 2200T USERS:

The maximum number of bytes in an alpha variable string is 64. Combinations of plot vectors larger than 64 bytes can be entered on the Plotter via the $GIO statement (see program below), or by using more than one ⟨ ,, ⟩ argument.

PROGRAM TO BUILD A SERIES OF BINARY PLOT VECTORS LARGER THAN 64 BYTES

```
100 REM   PROGRAM FOR GENERATING LONG FORM BINARY PLOT VECTORS AND PLOTTING
          THESE VECTORS VIA $GIO STATEMENT
110 REM   L$=CURRENT ALPHA STRING VARIABLE WHICH RECEIVES BINARY PLOT VECTORS
          (MUST NOT EXCEED 64 BYTES)
120 REM   P$(1)=ALPHA ARRAY USED AS AN INTERMEDIATE STORAGE LOCATION FOR
          BINARY PLOT VECTORS IN L$.
130 REM   C$()=ALPHA ARRAY WHICH IS FILLED WITH ALL PLOT VECTORS GENERATED BY
          THE PROGRAM, VECTORS ARE SENT TO THE PLOTTER FROM THIS ARRAY.
140       DIM A$2,B$2,L$64,P$(1)64,C$(120)10
150       N2=1
160       L$=HEX(OFEO):N=3
170 REM   ENTER NUMERIC VALUES FOR X AND Y INCREMENTS.  THE NUMBER OF PAIRED
          INCREMENTS SHOULD NOT EXCEED 12.
180       INPUT "X INCREMENT , Y INCREMENT",X,Y
190       IF ABS(X) <16383 THEN 200 :IF ABS(Y) < 16383 THEN 210:PRINT "VALUE
          TOO LARGE":GOTO 180
200       GOSUB '40(X)
210       GOSUB '50(Y)
220 REM   ADD THE TWO'S COMPLEMENT BINARY NUMBER FOR X TO L$
230       STR(L$,N,2)=A$
240 REM   ADD THE TWO'S COMPLEMENT BINARY NUMBER FOR Y TO L$
250       STR(L$,N+2,2)=B$
260 REM   DISPLAY L$ AND THE CURRENT VALUE OF THE LENGTH OF L$
270       PRINT LEN(L$);:HEXPRINT L$:PRINT
280 REM   MORE X AND Y INCREMENTS ? (Y OR N)
290       INPUT "MORE X AND Y INPUTS? (Y OR N)",K$
300       IF K$="N" THEN 340
310 REM   IF K$="Y" THEN ADD A HEX(EO) TO L$ TO START ANOTHER LONG FORM BINARY
          PLOT VECTOR; INITIALIZE N TO THE LENGTH OF L$ PLUS 1
320       STR(L$,N+4,1)=HEX(EO):N=LEN(L$)+1 :GOTO 180
330 REM   IF K$="N" THEN ADD A PEN UP CODE HEX(OE) AND PRINT OUT L$ ON THE
          CRT.  USE "N" AT CONVENIENT POINT LESS THAN 64 BYTES INTO L$.
340       STR(L$,N+4,1)=HEX(OE)
350       GOTO 560
360 REM   SUBROUTINE FOR CHANGING THE NUMERIC VALUE OF X TO A TWO BYTE TWO'S
          COMPLEMENT BINARY NUMBER
370       DEFFN'40(X)
380       DIM A$2
390       T=INT(ABS(X)/256)
400       BIN(A$)=T
```

```
410         BIN(STR(A$,2,1))=ABS(X)-T*256
420         IF X < 0 THEN 430:RETURN
430         XOR (STR(A$,1,2),FF)
440         ADDC (STR(A$,1,2),01)
450         RETURN
460 REM     SUBROUTINE FOR CHANGING THE NUMERIC VALUE OF Y TO A TWO'S COMPLEMENT
            BINARY NUMBER
470         DEFFN' 50(Y)
480         DIM B$2
490         T=INT(ABS(Y)/256)
500         BIN(B$)=T
510         BIN(STR(B$,2,1))=ABS(Y)-T*256
520         IF Y <0 THEN 530:RETURN
530         XOR (STR(B$,1,2),FF)
540         ADDC (STR(B$,1,2),01)
550         RETURN
560         HEXPRINT STR(L$,1,LEN(L$))
570 REM     PLACE THE CONTENTS OF THE ALPHA STRING VARIABLE L$ INTO A ONE
            ELEMENT ALPHA ARRAY P$
580         P$(1)=L$
590 REM     COPY THE CONTENTS OF P$ INTO THE ARRAY C$.  ARRAY C$ WILL BE FILLED
            WITH ALL THE PLOT VECTORS GENERATED BY THIS PROGRAM
600         MAT COPY P$() ‹ 1,LEN(L$) ›  TO C$() ‹ N2,LEN(L$) ›
610 REM     INCREMENT THE STARTING LOCATION IN C$ BEFORE LOADING A NEW SET OF
            VECTORS INTO C$
620         N2=N2+LEN(L$)
630 REM     ARE THERE ANY MORE PLOT VECTORS?
640         INPUT "MORE PLOT VECTORS",K$
650         IF K$="Y" THEN 690
660 REM     IF THERE ARE MORE PLOT VECTORS INITIALIZE L$ AND P$ TO ZERO AND
            ENTER MORE X AND Y DATA
670 REM     IF THERE ARE NO MORE PLOT VECTORS THAN SEND PLOT VECTORS OUT TO THE
            PLOTTER VIA THE $GIO STATEMENT
680         $GIO PLOT/013(A000,R$)C$() ‹1,N2-1›  :GOTO 700
690         INIT(00)L$,P$(): GOTO 160
700   END
```

4.7 SPECIAL SYMBOL EXAMPLES

Aside from the plotting capabilities offered in Wang plotter utility packages, the user can make his own library of special programs devoted to creating special characters, symbols, or curves (for example, extra large printed characters, symbols, logos, etc.).

The following steps are recommended for generating a special character or symbol using the binary plot vectors:

1. Dimension the special character/symbol.

2. Lay out the character/symbol on grid paper.

3. Convert dimensions to ΔX and ΔY movements (Model 2272-2 increment = .005").

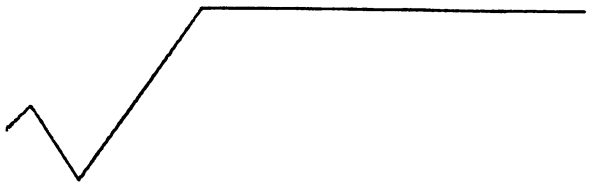
4. Place Δ X and Δ Y values into appropriate subroutine to generate a one or two byte two's complement binary number (see Section 4.6).

5. Use appropriate subroutine to establish alphanumeric string or array ready to plot (i.e., A$ = HEX(....)).

Example 1: Plotting a mathematical symbol (root sign)

```
:10 DIM A$ 18
:20A$ = HEX(0FE61919E632B5E0007D00AFE001900000FA)
:30 PLOT ⟨ ,,A$ ⟩
:RUN (EXEC)
```

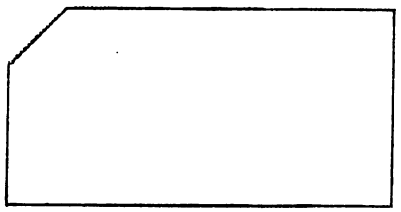
Output:



Example 2: Plotting a flow chart symbol (punched card)

```
:5 DIM A$ 25
:10 A$ = HEX(0FE00000008CE63C3CE001540000E00000FF38E0FE7000000E)
:20 PLOT ⟨ ,,A$ ⟩
:RUN (EXEC)
```

Output:



Example 3: Plotting Meteorology Symbols (Funnel Cloud)

```
:5 DIMA$ 25
:10 A$ = HEX(0FE60A0AE60050E6F60A0EE628000FE6F6F6E600B0E60AF6FA)
:20 PLOT ⟨ ,,A$ ⟩
:RUN (EXEC)
```

Output:

APPENDIX A — HEXADECIMAL CODES

HEX CODES	PLOTTER CHARACTER	HEX CODES	PLOTTER CHARACTER
HEX(00)	Ignored	HEX(42)	B
HEX(0E)	Pen up	HEX(43)	C
HEX(0F)	Pen down	HEX(44)	D
HEX(1F)	∘	HEX(45)	E
HEX(20)	Space	HEX(46)	F
HEX(21)	!	HEX(47)	G
HEX(22)	"	HEX(48)	H
HEX(23)	#	HEX(49)	I
HEX(24)	$	HEX(4A)	J
HEX(25)	%	HEX(4B)	K
HEX(26)	&	HEX(4C)	L
HEX(27)	'	HEX(4D)	M
HEX(28)	(	HEX(4E)	N
HEX(29)	)	HEX(4F)	O
HEX(2A)	*	HEX(50)	P
HEX(2B)	+	HEX(51)	Q
HEX(2C)	,	HEX(52)	R
HEX(2D)	-	HEX(53)	S
HEX(2E)	.	HEX(54)	T
HEX(2F)	/	HEX(55)	U
HEX(30)	0	HEX(56)	V
HEX(31)	1	HEX(57)	W
HEX(32)	2	HEX(58)	X
HEX(33)	3	HEX(59)	Y
HEX(34)	4	HEX(5A)	Z

HEX(35)	5	HEX(5B)	[
HEX(36)	6	HEX(5C)	\
HEX(37)	7	HEX(5D)	]
HEX(38)	8	HEX(5E)	↑
HEX(39)	9	HEX(5F)	←
HEX(3A)	:	HEX(E0)	Binary Plot Vector (Long Form)
HEX(3B)	;	HEX(E1)	Select Pen #1
HEX(3C)	<	HEX(E2)	Select Pen #2
HEX(3D)	=	HEX(E3)	Select Pen #3
HEX(3E)	>	HEX(E4)	Set Home
HEX(3F)	?	HEX(E5)	Power on Set Home
HEX(40)	@	HEX(E6)	Binary Plot Vector (Short Form)
HEX(41)	A	HEX(FA)	RESET (Return to Home)

NOTE:

All other HEX codes are treated as illegal non-printable characters and cause the plotter to produce a space.

APPENDIX B — PLOTTER ASCII CHARACTER SET SIZES

SIZE 1

SIZE 2

SIZE 3

SIZE 4

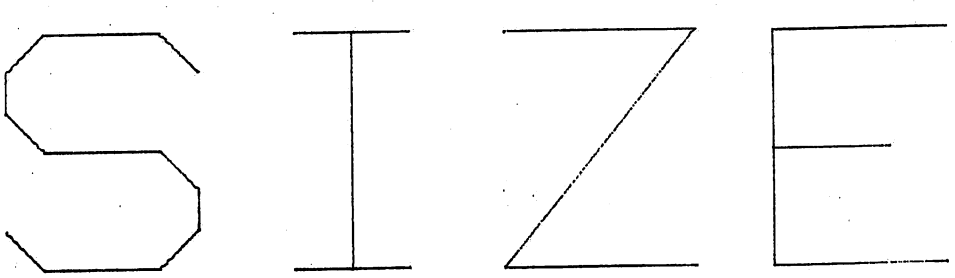
SIZE 5

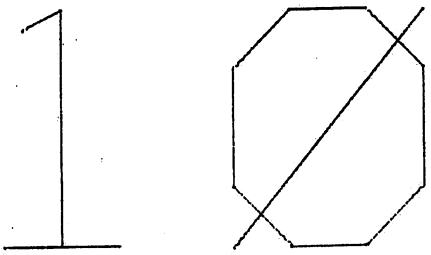
SIZE 6

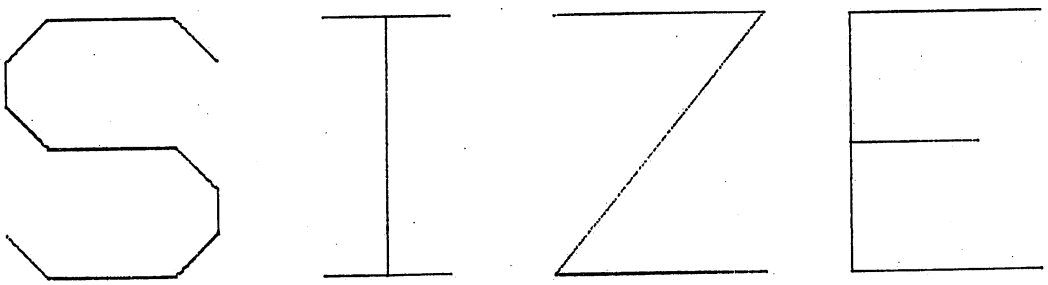
SIZE 7

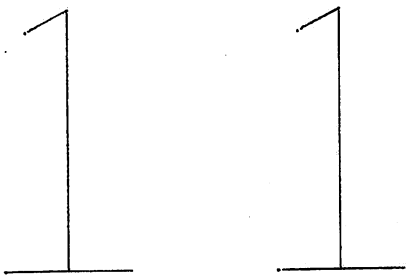
SIZE 8

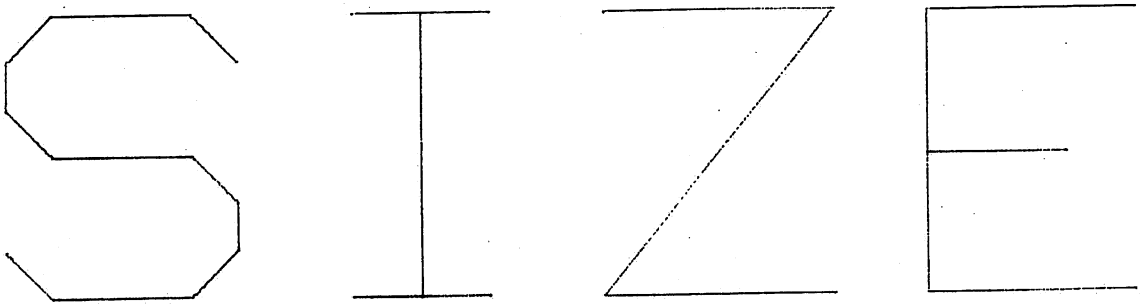
SIZE 9

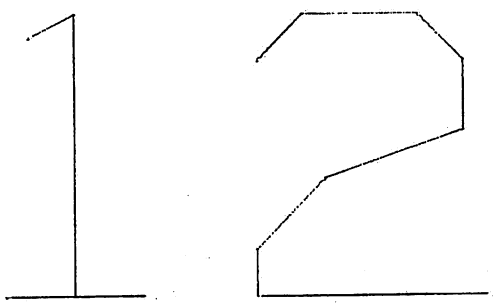












SIZE 13

SIZE 14

SIZE
15

APPENDIX C — SPECIFICATIONS

Plotting Area:
16 in. (40.6 cm) wide by 81.9 inches (208 cm) long.

Plotting Increment:
.005 in. (.0127 cm)

Plotting Accuracy:
.01 in. plus .1% (.0254 cm plus .1%)
.02 in. (.0508 cm) maximum for immediate retrace.

Plotting Speed:
4.5 in./sec (11.4 cm/sec) maximum in each axis

Pen:
Accommodates fiber tip pens and ball point pens (pens programmably selectable).

Approx Net Weight:
68 lb (31 kg)

Size:

Height	10.2 in. (25.6 cm)
Width.	33 in. (83.8 cm)
Depth.	14 in. (35.6 cm)

Buffer:
400 bytes

Alphanumeric Plotting:
64 ASCII characters, 15 selectable sizes.

Connecting Cables:
8 ft (2.4 m) cable to CPU; 8 ft (2.4 m) power cord.

Controller:
Standard Wang Line Printer Controller/CPU interface.
Separate Line Printer Controller must be ordered separately to drive more than one printer/plotter on current models.

Power Requirements:
115 or 230 VAC $\pm$ 10%
50 or 60 Hz $\pm$ 1 Hz
Fuse: 3A(SB) for 115 VAC, 1.5A (SB) for 230 VAC

Operating Environment:
50° to 90°F (10° to 32°C)
30% to 80% relative humidity, allowable
35% to 65%, recommended

APPENDIX D — PAPER SPECIFICATIONS

Maximum width: (edge-to-edge): 18 in. (45.7 cm)

Material: margin perforated fan-fold paper stock

Thickness: .0025 in. (.063 mm) to .0027 in. (.068 mm)

Weight: 15 lb

Sprocket holes:

must run along both margins 0.25 in. (0.635 cm) from paper edge to hole-center lines;

distance between hole centers must be 0.5 in. (1.27 cm) non-accumulative in any 11 in. (27.9 cm) length;

hole diameters must be 0.156 in. (0.396 cm)

perforation must be 0.50 in. (1.27 cm) from paper edge

PREVENTIVE MAINTENANCE INFORMATION

MAINTENANCE

It is recommended that your equipment be serviced quarterly. A Maintenance Agreement is available to assure this servicing automatically. 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: Your equipment is inspected quarterly 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; more frequent billing can be obtained, if desired.

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

NOTE:

Wang Laboratories, Inc. does not guarantee or honor maintenance agreements for any equipment modified by the user. Damage to equipment incurred as a result of such modification becomes the financial responsibility of the user.

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Printed in U.S.A.
700-3869B
5-78-5C
Price: see current list