WANG

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Graphic CRT Plotter
User Manual

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HOW TO USE THIS MANUAL

This manual provides information concerning the operation of the Model 2282 Graphic CRT 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 (or BASIC-2 Language Reference Manual) be read before proceeding with this manual.

This manual has been divided into several chapters covering all the operational features of the Model 2282. Chapter 1 contains general information on the Graphic CRT. Chapter 2 demonstrates the use of the PLOT statement and Chapter 3 describes the use of special plotting codes. Hexadecimal codes, character sizes, plotter specifications, and use of two's complement binary arithmetic are collected in the Appendices.

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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual describes the characteristics and operation of the Model 2282 Graphic CRT (see Figure 1-1). The Model 2282 Graphic CRT provides high contrast, CRT plotting and fully automatic lettering capability to your Wang system. The Graphic CRT interfaces directly with the System 2200 via the Line Printer Controller board on the CPU. The Model 2282 has a 12-inch diagonal CRT screen with a 7.8 inch (19.8 cm) wide by 5 inch (12.7 cm) high viewing area. The graphic matrix on the screen consists of 800X by 512Y addressable locations (dots). Plotting vectors and characters are generated by causing a series of dots to be turned on. Lines and characters are selectively erased by causing a series of dots to be turned off. In addition to plotting line vectors, a 112 character ASCII set can be plotted on the Model 2282 in 15 selectable sizes. The Model 2282 is programmed using the PLOT statement (see Chapter 2) and by a comprehensive set of Wang plotter utilities packages.

The plotting capability of the Graphic CRT can be enhanced by the addition of the Model 2231W-3 Line Printer. This matrix impact printer provides an accurate reproduction of the graphics information displayed on the Model 2282. When the Model 2231W-3 is not used to copy the CRT image, it responds to normal printing commands from the System 2200 CPU. Operating instructions for the Line Printer are contained in the Model 2231W-3 Line Printer User Manual (700-4457).

> NOTE:
>
> The hardcopy plot on the Line Printer is approximately 43% larger than the image on the Graphic CRT.

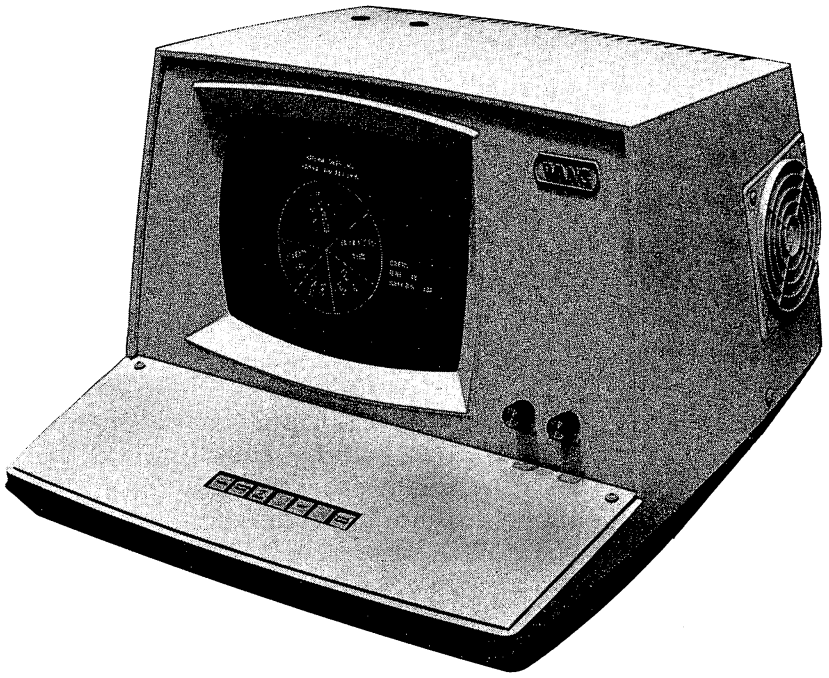


Figure 1-1 Model 2282 Graphic CRT

1.2 UNPACKING, INSPECTION, AND INSTALLATION

Your Graphic CRT must be unpacked, inspected, and installed by a Wang Service Representative. Upon receipt of your Graphic CRT, be sure to notify your Service Representative so that he may perform these services. Failure to follow this procedure will void your warranty.

Your Service Representative will ensure that the controller cable from the Model 2282 is connected to the Line Printer board in the CPU, the cable from the Model 2231W-3 is properly connected to the Graphic CRT and the power cords are properly plugged into a source of power. It is recommended that your Graphic CRT be connected to a power line reserved exclusively for its use; the line should not be shared by other office equipment such as water coolers, calculators, air conditioners, typewriters, or copiers.

1.3 PLANNING YOUR INSTALLATION

The Graphic CRT is extremely compact, and can fit comfortably on a large desk or any similar work surface. If the Model 2231W-3 Line Printer is to be used with the Graphic CRT, more space will be needed.

In selecting a site for the Graphic CRT there are four important environmental factors to be considered. These are temperature, humidity, cleanliness and electrical interference.

The temperature is an important factor to consider because it can vary greatly from day to day. The recommended operating temperature range is from 65°F to 75°F (18°C to 24°C), but the allowable range is from 50°F to 90°F (10°C to 32°C).

If an air conditioning unit is already installed, or if one is to be installed, it is imperative that a separate power line be used. If a separate power line is not used, system errors may occur when the air conditioning is in use.

While air conditioning is good for maintaining the proper temperature, it also removes moisture from the air, thereby lowering the humidity. If the system is installed in a carpeted room, the lower humidity plus the static generating capability of carpets and synthetic clothing impart static electrical charges to operating personnel. When an operator comes in contact with the system, the resultant static spark is uncomfortable, causes system malfunctions, and can even destroy recorded data.

If carpeting is to be installed, be sure it is a non-static variety. If carpeting already exists, and it is not a non-static carpet, it must be treated with an anti-static spray. Carpets treated with an anti-static spray should be thoroughly cleaned before the first treatment, and retreated at least once every three months thereafter. Alternatively, an electrically conductive mat can be installed to prevent a static charge build-up. If an electrically conductive mat is used, it should be installed under the system operating area and must be properly connected to an earth ground.

The recommended humidity range is from 35% to 65% relative humidity, but 20% to 80% relative humidity is allowable. (In cold weather, the humidity in heated buildings can be 10% or lower.) Humidifiers and dehumidifiers should be installed to increase or decrease the humidity as required.

Dirt and grease can accumulate rapidly on circuit boards and components, and can form a film that traps heat and provides a leakage path for signals. To prevent unnecessary failures due to dirt, all air conditioning, heating and ventilating units should have air filters. These filters should be cleaned or replaced regularly. In areas where ordinary filters do not remove airborne dirt sufficiently, an electrostatic filter should be installed.

A 15 ampere, 115 VAC power line is adequate for the Graphic CRT. This line must be regulated to within $\pm$10% and must be noise free. It is recommended that the 2200 system have its own AC power line.

If the power line is not sufficiently regulated to the limits indicated, a constant voltage transformer should be installed. If the line is noisy, however, a detailed analysis of the problem must be performed to ensure a correct solution.

Since computers and peripherals are extremely susceptible to Electromagnetic Interference (EMI), the source of the EMI must be determined before a solution is proposed. EMI can enter the system by conduction along wiring and cabling or by direct radiation. If sources of EMI, which include office machines, air conditioning units, electric motors, machinery and arc welders, are in close proximity to your system, EMI will enter by direct radiation. The noise generating device should be moved, repaired or filtered to prevent it from interfering with the system. If the source of the noise cannot be found, an isolation transformer or line conditioner should be installed on the system's AC power line. In all cases, be sure the AC power line has been properly installed in steel conduit, and the conduit is properly connected to junction boxes. Also, ensure that other devices, including fluorescent lighting, are not connected to the same AC power line. The AC power lines should have properly grounded (3 prong) outlets. In extreme locations, such as those with nearby arc welders, it may be necessary to shield the peripheral cables.

1.4 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 devices are set to their default values. Initialization automatically selects default addresses for certain classes of I/O operations as listed below:

I/O Class	Default Address	Normal Device
Console Input	001	Keyboard
Console Ouput	005	CRT
Print	005	CRT
Input	001	Keyboard
Disk	310	Disk
Plot	413	Plotter

NOTE:

The user must select the Model 2282 with a SELECT PLOT 413 statement. If the Model 2282 is connected to a 2200VP, a SELECT PLOT C13 should be used which will decrease the time it takes to plot.

1.5 2282 TURN-ON PROCEDURE

The control panel on the front of the Model 2282 contains a number of switches, buttons, and light indicators for controlling the manual operations of the Graphic CRT (see Fig. 1-2).

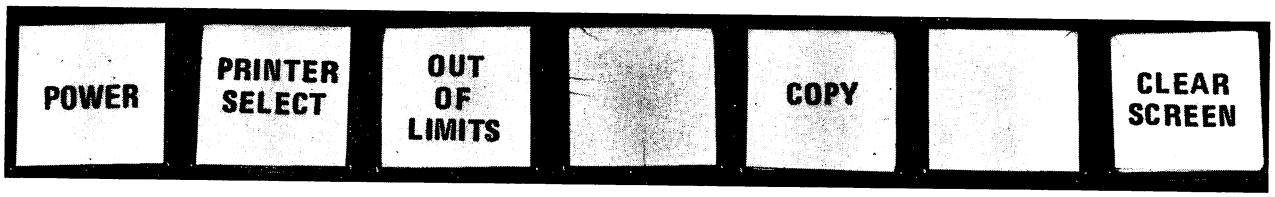


Figure 1-2 Control Panel

ON/OFF

The ON/OFF switch is located at the rear of the Model 2282. To turn the Graphic CRT ON, turn the switch to the ON position (up). The power lamp at the control panel is illuminated. Whenever the Graphic CRT is turned ON, the default HOME position of the "pen" cursor is the lower left corner of the screen. The "pen" cursor is in the "up" position, e.g., there is no point illuminated on the screen.

To turn the Graphic CRT OFF, turn the switch to the OFF position; the power lamp is extinguished.

CLEAR SCREEN

When the CLEAR SCREEN button is depressed, the Graphic CRT screen is cleared and the current "pen" position is reset to HOME. CLEAR SCREEN performs the same function as turning the Model 2282 OFF and then ON.

NOTE:

The HOME position of the "pen" cursor is the current home position set by the plotting program. If no home position has been set, the default HOME is the lower left corner of the screen.

COPY

When the COPY button is depressed, a copy of the image on the Graphic CRT screen is printed on the Model 2231W-3 Line Printer. This switch operates when the PRINTER SELECT lamp is either on or off.

PRINTER SELECT

Depressing the PRINTER SELECT button illuminates the lamp and causes all further data from the CPU to be transferred directly to the Model 2231W-3 line printer. When the PRINTER SELECT button is pressed again, the lamp is extinguished and all further output from the CPU is directed to the Graphic CRT. The PRINTER SELECT button setting can be altered under program control by issuing a HEX(04) code (Select Printer) or a HEX(06) code (Select CRT). (See page 18).

> NOTE:
>
> Setting the PRINTER SELECT button to 'Select Printer' allows the Model 2231W-3 to be used as a standard output printer for BASIC program PRINT, LIST and Console Output (CO) operations.

OUT OF LIMITS

The OUT OF LIMITS lamp flashes when the vector currently being plotted falls partially or fully outside the physical limits of the Graphic CRT display. In an 'Out of Limits' condition, the system checks each subsequent vector to determine if its end point will move the "pen" back within the CRT boundaries. When a suitable vector is found, the OUT OF LIMITS lamp is extinguished and the 'in bounds' portion of the vector is plotted. Plotting then continues from the end point of the current vector. (See Section 2.4, example 2).

The OUT OF LIMITS lamp can also be extinguished (and "pen" moved back inbounds) by one of the following procedures:

1 - Turning the Model 2282 OFF and then ON.

2- Depressing the RESET key on the 2200 keyboard.

3- Depressing the CLEAR SCREEN button.

4- Executing a Power ON/Set Home command, Plot <, , HEX(E5)> . (See Chapter 3).

1.6 FUSE REPLACEMENT

The main line fuse located at the rear of the Model 2282 can be changed by twisting the bad fuse out of the socket and replacing it with a new fuse. The Graphic CRT should be turned OFF and unplugged before changing the fuse. (See Figure 1-3.)

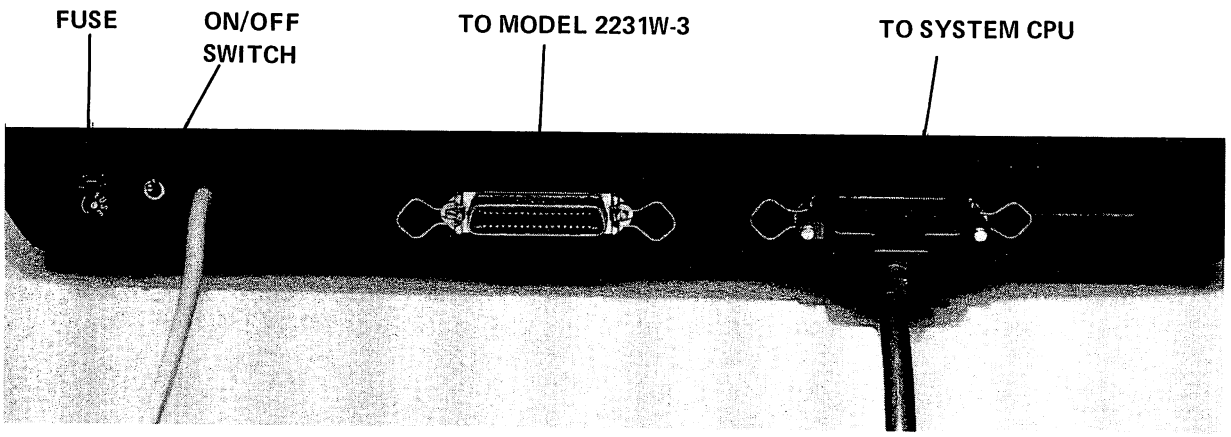


Figure 1-3 Rear View of Model 2282

CHAPTER 2
PLOT STATEMENTS AND COMMANDS

2.1 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 the program mode. The length of the PLOT Statement line may not exceed 192 keystrokes.

Expression 0 PLOT [expression 0]<, ,>

Description:

The value of expression 0 specifies the number of times the values of arguments enclosed in <> are executed.

NOTE:
Expression 0 must precede each <> that is to be repeated.

Example:

```
:SELECT PLOT 413
:10 PLOT  <2,,C> ,  <20,,S> , 2< ,,"ABCD">
```

Allowed values/arguments:

1. 1 ≤ expression 0 < 1000; if omitted, expression 0 = 1.

2. Numeric variable whose 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.

> 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 statement for character sizing, PLOT <,,C >, expression 1 represents the size of the character(s) to be plotted. The numeric value of expression 1 must be an integer between 1 and 15.

In the PLOT statement for character spacing, PLOT <,,S >, expression 1 represents the horizontal spacing between characters. The numeric value of expression 1 in <,,S> should be a factor of 10 times the value of expression 1 in <,,C >.

Example:

```
10 PLOT <2,,C> , <20,,S> ,....
```

In the following plot statements expression 1 represents the number of ΔX increments the "pen" is moved horizontally from its current plot position.

```
PLOT <,,U>
PLOT <,,D >
PLOT <,, >
PLOT <,,'literal string'>
PLOT <,,'alphanumeric variable'>
```

For the above statements, the allowable range of values for expression 1 is -1000 < expression 1 < 1000.

> NOTE:
>
> Since the Model 2282 screen is 800 increments wide, any value outside the range -800 < expression 1 < 800 will move the current plot position 'Out of Limits'.

Allowed values/arguments:

1. Positive or negative integer. If expression 1 is omitted, it is equal to 0.

2. Numeric variable whose 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.

Expression 2 PLOT [] <,expression 2,>

Description:

In the PLOT statement, PLOT <,,S > ,expression 2 represents the vertical spacing between characters. The numeric value of expression 2 in <,,S >is normally a factor of +20 or -20 times the value of expression 1 in <,,C> .

Example:

```
10 PLOT < 2,,C > , <,-40,S > ,....
```

In the following PLOT statements expression 2 represents the number of ΔY increments the "pen" is moved vertically from the current plot position.

```
PLOT <,,U>
PLOT <,,D >
PLOT <,,>
PLOT <,,'literal string'>
PLOT <,,'alphanumeric variable'>
```

For the above statements the allowable values of expression 2 are -1000 < expression 2 < 1000.

NOTE:
Since the Model 2282 screen is 512 increments high, any value outside the range -512 < expression 2 < 512 will move the current plot position 'Out of Limits'.

Allowed values/arguments:

1. Positive or negative integer. If expression 2 is omitted, its value is equal to 0.

2. Numeric variable whose 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.

Expression 3 PLOT [ ]<,,expression 3>

Description:

Expression 3 is used to:

1. Send special plotter control codes (described below) to the Model 2282.

2. Send alphanumeric characters to be drawn.

3. Send special HEX control codes and binary vector codes to the Model 2282 (See Section 3.2).

Allowed values/arguments:

1. "Null"

2. Literal string

3. Alphanumeric variable (e.g., A$)

4. Special plotter control codes:
   U . . . (PEN UP)
   D . . . (PEN DOWN)
   C . . . (CHARACTER SIZE)
   S . . . (CHARACTER SPACING)
   R . . . (RESET TO HOME)

5. Special HEX control codes and binary vector codes.

2.2 THE "NULL" COMMAND

If expression 3 in the PLOT statement is omitted, then the "null" command instructs the Model 2282 to set the pen indicator to "pen up" and move the distances △X and △Y.

Example 1:

```
:PLOT <400,200,>
```

Result:

In the immediate mode the vector defined by △X=400 and △Y=200 is added to the current position while the "pen" is set to "pen up".

Example 2:

```
:10 X=12
:20 PLOT <X↑2,X+70,>
:RUN(EXEC)
```

Result:

The vector defined by △X=144 and △Y=82 increments is added to the current plot position while the "pen" is set to "pen up".

2.3 THE "U" (UP) COMMAND

The "U" command is essentially identical to the "null", but it is easier to recognize. This command sets the pen indicator to "pen up" before moving the distances △X and △Y.

Example 1:

```
:10 PLOT <-200,-400,U>
:RUN(EXEC)
```

Result:

The pen indicator is set to "pen up" and the vector defined by △X=-200 and △Y=-400 is added to the current plot position.

Example 2:

```
:10 X=20:Y=3600
:20 PLOT <X↑2,SQR(Y),U>
:RUN(EXEC)
```

Result:

The pen indicator is set to "pen up" and the vector defined by △X=400 and △Y=60 is added to the current plot position.

2.4 THE "D" (DOWN) COMMAND

The "D" code in expression 3 of the PLOT statement sets the pen indicator to "pen down" and draws a vector defined by the △X and △Y values given in expressions 1 and 2.

Example 1:

```
:10 PLOT 3 <100,100,D>
:RUN(EXEC)
```

Result:

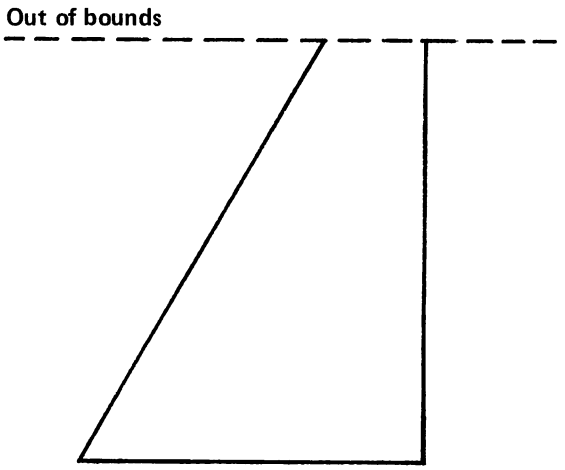
The < 100,100,D > in line 10 is executed 3 times, resulting in a 45° vector drawn from the current plot position.

Example 2:

```
:10 X=-300:Y=900
:20 PLOT <ABS(X),,D>
:30 PLOT <,Y,D>
:40 PLOT <X,-Y,D>
:RUN(EXEC)
```

Result:

A right triangle is drawn on the CRT. Note that vector defined by Y = 900 goes 'Out of Bounds' as shown below.



2.5 THE "R" (RESET) COMMAND

An "R" in expression 3 of the PLOT statement sets the current plot position to the current home position. The R command requires no entries in expressions 1 and 2.

Example:

```
:PLOT <,,R>
```

Result:

The pen indicator is set to "pen up" and the system sets the current plot position to the current home position.

2.6 THE "C" (CHARACTER SIZE) COMMAND

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

âêîôûäëïöüàèùÄÖÜ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOP

QRSTUVWXYZ[\]↑←° abcdefghijklmnop qrstuvwxyz§£éç

Command "C" determines the character size of all subsequent characters according to the integer value specified by expression 1. (Non-integer values in expression 1 are truncated.) For character plotting, this integer must range between 1 and 15 inclusive. The value of 1 assigned to expression 1 commands the smallest size character (.125"), whereas the value of 15 corresponds to the size (2.00"). Note: All characters are plotted with the current plot position at the center of the character.

Example 1:

```
:10 PLOT <9,,C> , <,,"B">
:RUN(EXEC)
```

Result:

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

Example 2:

```
:10 PLOT <2,,C> , <200,,"Z">
:RUN(EXEC)
```

Result:

A 'Z' of size 2 is plotted 200 increments to the right of the current plot position.

Example 3:

```
:10 PLOT <2,,C>, <20,,S> <,,"NO SMOKING">
:20 PLOT <4,,C>, <40,,S> <,, "PLEASE">
 RUN(EXEC)
```

Output:

NOTE:

The character command does not respond to values of △Y in < △X, Y,C >. Thus <2,100,C> is interpreted as <2,,C>.
Also, if no character command is specified the character size defaults to size 1.

Example:

```
:10 PLOT <,,"A">
:RUN(EXEC)
```

Output:

2.7 THE "S" (CHARACTER SPACING) COMMAND

An "S" in expression 3 of the PLOT statement sets the horizontal and vertical spacing between plotted characters. Expression 1 specifies the horizontal spacing and expression 2 specifies the vertical spacing. For horizontal spacing, expression 1 should be about 10 times the character size. For vertical spacing, expression 2 should be +20 or -20 times the character size. Note: The character is always plotted first and then spaced over $\triangle X$ and/or $\triangle Y$.

Example 1:

```
:10 A$ = "GRAPHICS"
:20 PLOT <2,,C> ,
 <20,,S >, <,,A$>
:RUN(EXEC)
```

Result:

Starting at the current plot position, the word "GRAPHICS" with a character size 2 is plotted.

Output:

Example 2:

```
:10 A$ = "STOP"
:20 PLOT <2,,C> , <,-40,S>
  ,,A$
:RUN(EXEC)
```

Result:

The word 'STOP' is plotted vertically, with a character size 2.

Output:

NOTE:

When using Character Size and Spacing Commands, values of $\triangle X$ and $\triangle Y$ must be specified in expressions 1 and 2, otherwise an error message is displayed.

2.8 PRINT AND PRINTUSING

The Model 2282 can also be programmed to plot vectors and characters with the PRINT and PRINTUSING statements. In order to do this, the Model 2282 must be selected with the statement:

```
:SELECT PRINT 413
```

Example 1:

```
:10 SELECT PRINT 413
:20 PRINT HEX(0FE00065033A)
```

Example 2:

```
:10 SELECT PRINT 413
:20 PLOT <2,,C>,<20,,S>
:30 PRINT "ABCD"
```

> NOTE:
>
> The size of characters and spacing must still be controlled by the "C" and "S" parameters in the PLOT statement.

Example 3:

```
:10 SELECT PRINT 413
:20 PLOT <2,,C>,<20,,S>
:30 B$="SAM ADAMS": A=3452.45
:40 PRINTUSING 50, B$, A
:50 %NAME:######### AMOUNT:$#,###.##
 RUN(EXEC)
```

Output: (reduced)

NAME: SAM ADAMS AMOUNT: $3,452.45

CHAPTER 3
HEX CODES

3.1 THE HEX FUNCTION

The HEX function is used in a BASIC program to output characters and special plotter control codes to the Model 2282. The HEX function has the form:

HEX(hh[hh][..].)

where h = a hex digit 0 to 9 or a letter A to F in hexadecimal notation. An even number of hex digits must always appear in a HEX function; spaces are not allowed. In hexadecimal notation a binary number is divided into four bit groups and each group of four-bits is expressed by a single hexadecimal character as follows:

0000 = 0	1000 = 8
0001 = 2	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

Examples: HEX(FE) = 1111 1110 , HEX(20) = 0010 0000

F E 2 0

The left 4-bits of a two hex digit code are called the "high-order" bits. The right 4-bits of a two hex digit code are called the "low-order" bits.

3.2 CONTROL CODES

The special control codes for the Model 2282 are:

Function	HEX Code	Description
Clear the Graphic CRT	HEX(03)	The CRT is cleared, the current plot position is set to the current home position and the pen indicator is set to "pen up". If the current home position is the default position, HEX(03) sets the current plot position to the lower left-hand corner of the CRT. Examples: :PLOT <,,HEX(03)> :100 PRINT HEX(03)
Select the printer	HEX(04)	When this command is executed, all subsequent input from the 2200 system is transferred directly to the Model 2231W-3. The PRINTER SELECT lamp on the Model 2282 is turned ON. The Model 2282 can be reselected by one of the following methods: 1. Execute a HEX(06) command (SELECT CRT). 2. Depressing the PRINTER SELECT switch. 3. Turning the Model 2282 OFF and then ON. 4. Depressing the CLEAR SCREEN switch. Examples: :PLOT <,,HEX(04)> :100 PRINT HEX(04)
Select the Graphic CRT	HEX(06)	When this command is executed, all subsequent input from the 2200 system is transferred directly to the Model 2282. The PRINTER SELECT lamp on the Model 2282 is extinguished. The Model 2231W-3 can be reselected by one of the following methods. 1. Executing a HEX(04) command (Select printer) 2. Depressing the PRINTER SELECT switch on the Model 2282.

Function	HEX Code	Description

Example:

```
:PLOT <,, HEX(06)>
:100 PRINT HEX(06)
```

Binary Plot Vector (Long Form) — HEX(E0)

Introduces a four-byte plot vector. The first and second bytes represent the △X component of the vector. The third and fourth bytes represent the △Y component of the vector. The values of △X and △Y are in two's complement hexadecimal format. (See Appendix D.)

Example 1:

```
:100 PLOT <,,HEX(E0012AFF9C)>

△X = 298 increments
△Y = -100 increments
```

Result:

The vector defined by △X=298 and △Y=-100 is added to the current plot position with the "pen up".

Example 2:

```
:100 PRINT HEX(E001F000A0)

△X = 496 increments
△Y = 160 increments
```

Function	HEX Code	Description
		Result: The vector defined by △X=496 and △ Y=160 is added to the current plot position with the "pen up".
Select "pen 1"	HEX(E1)	When pen 1 is selected, all vector plots and characters are generated by turning on dots on the CRT screen. Pen 1 is automatically selected when the Model 2282 is turned ON or following a HEX(05) command. Examples: :100 PLOT <,,HEX(E1)> :100 PRINT HEX(E1)
Select "pen 2"	HEX(E2)	When pen 2 is selected, all vector plots and characters are generated by turning dots off on the CRT screen. This command is used to erase plotted information by selectively retracing the desired portions of the screen with pen 2 selected. Examples: :100 PLOT <,,HEX(E2)> :100 PRINT HEX(E2)
Select "pen 3"	HEX(E3)	Plots of lines and characters following the HEX(E3) code are drawn by turning dots on. (HEX(E3) is the same as HEX(E1)). Examples: :100 PLOT <,,HEX(E3)> :100 PRINT HEX(E3)
Set Home	HEX(E4)	Sets the home position at the current plot position. Examples: :100 PLOT <100,100,U >, <,,HEX(E4)> :100 PRINT HEX(E00011F60BE4)

Function	HEX Code	Description
Power ON/Set Home	HEX(E5)	Sets both the current position and the current home position to the lower left corner of the CRT. "Pen 1" is also reselected and the pen indicator is set to "pen up". Character size is reset to size 1 and character spacing is reset to 0.

Examples:

```
:100 PLOT <,,HEX(E5)>
:100 PRIN HEX(03E5)
```

Binary Plot Vector (Short Form)	HEX(E6)	Introduces a two-byte plot vector. The first byte is the △X component of the plot vector. The second byte is the △Y component of the plot vector. The values of △X and △Y are in two's complement hexadecimal format (See Appendix D).

Example 1:

```
:100 PLOT <,,HEX(E62A9C)>
```

△X = 42 increments
△Y = -100 increments

Result:

The vector defined by △X=42 and △Y=-100 is added to the current plot position with the "pen up".

Example 2:

```
:100 PRINT HEX(E65080)
```

△X = 80 increments
△Y = -128 increments

Result:

The vector defined by △X=80 and △Y=-128 is added to the current plot position with the "pen up".

Function	HEX Code	Description
Copy the Graphic CRT	HEX(E7)	Causes the Graphic CRT image to be reproduced on the Model 2231W-3 Printer. The PRINTER SELECT lamp on the Model 2282 should be extinguished when this command is used.

Example:

```
:PLOT <,,HEX(E7)>
```

Reset	HEX(FA)	Sets the current plot positon to the current home position.

Examples:

```
:100 PRINT HEX(E65082FA)
:100 PLOT <,100,D> , <,,HEX(FA)>
```

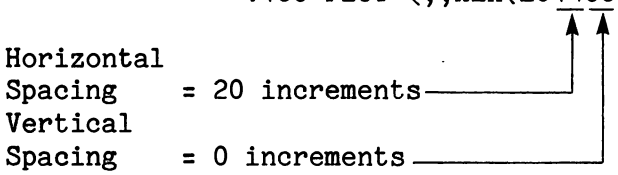
> NOTE:
>
> The codes on the following pages perform the specified functions only when the Graphic CRT is selected for output from the CPU. When the printer is selected for output the codes are interpreted as printer control codes. (See the Model 2231W-3 Line Printer User Manual (700-4457).

Set Character Spacing	HEX(0A)	Used with the binary plot vector to set the spacing between characters, both horizontally and/or vertically. The plot vector is stored as the spacing vector. The current plot position is saved prior to printing a character on the Graphic CRT. After the character is printed, the spacing vector is added to the current plot position to get the new plot position. Note: When a character is plotted on the Graphic CRT, the current plot position is the center of the character. After the Character is plotted the current plot-position is returned to this point and the spacing vector is added to this position.

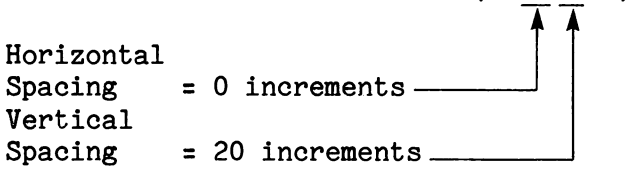
Function	HEX Code	Description

Examples:

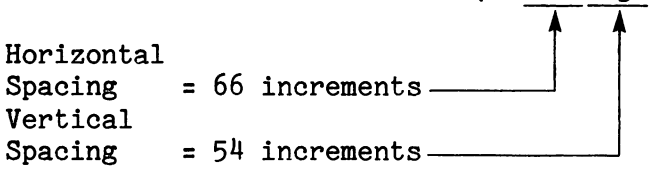
```
:100 PLOT <,,HEX(E614000A)>
```




```
:100 PRINT HEX(E600140A)
```




```
:100 PRINT HEX(E0004200360A)
```



Set Character Size — HEX(0D)

Used with the binary plot vector to set the size of the character. The character size is stored in the ΔX value of the plot vector and must be an integer from 1 to 15. Any other size is converted to a value between 1 and 15 by using only the low order hexadecimal digit as the size. When drawing a character, each "pen movement" is multiplied by the character size before the "pen movement" is initiated.

Examples:

```
:100 PRINT HEX(E0000500000D)
:100 PRINT HEX(E605000D)

:100 PRINT HEX(E000A500000D)
:100 PLOT <, ,  HEX(E6A5000D)>
```

Each of the above statements sets the character size to 5.

Function	HEX Code	Description
Pen up	HEX(0E)	Used with the binary plot vector to set the pen indicator to the "pen up" position.

Examples:

```
:100 PLOT <,,HEX(0EE638F2)>
:100 PRINT HEX(0EE00065003A)
:100 PRINT HEX(0FE638F20E)
```

Pen down	HEX(0F)	Used with the binary plot vector to set the pen indicator to the "pen down" position and allow vectors to be plotted on the screen.

Examples:

```
:100 PLOT <,,HEX(0FE638F2)>
:100 PRINT HEX(0FE00065003A0E)
```

APPENDICES

APPENDIX A

HEXADECIMAL CODES

HEX CODE	GRAPHIC CRT CHARACTER	HEX CODE	GRAPHIC CRT CHARACTER	HEX CODE	GRAPHIC CRT CHARACTER
HEX(03)	Clear Graphic CRT	HEX(34)	4	HEX(5D)	]
HEX(04)	Select Printer	HEX(35)	5	HEX(5E)	↑
HEX(06)	Select Graphic CRT	HEX(36)	6	HEX(5F)	←
HEX(0A)	Set Character Spacing	HEX(37)	7	HEX(60)	°
HEX(0D)	Set Character Size	HEX(38)	8	HEX(61)	a
HEX(0E)	Pen Up	HEX(39)	9	HEX(62)	b
HEX(0F)	Pen Down	HEX(3A)	:	HEX(63)	c
HEX(10)	â	HEX(3B)	;	HEX(64)	d
HEX(11)	ê	HEX(3C)	<	HEX(65)	e
HEX(12)	î	HEX(3D)	=	HEX(66)	f
HEX(13)	ô	HEX(3E)	>	HEX(67)	g
HEX(14)	û	HEX(3F)	?	HEX(68)	h
HEX(15)	ä	HEX(40)	@	HEX(69)	i
HEX(16)	ë	HEX(41)	A	HEX(6A)	j
HEX(17)	ï	HEX(42)	B	HEX(6B)	k
HEX(18)	ö	HEX(43)	C	HEX(6C)	l
HEX(19)	ü	HEX(44)	D	HEX(6D)	m
HEX(1A)	à	HEX(45)	E	HEX(6E)	n
HEX(1B)	è	HEX(46)	F	HEX(6F)	o
HEX(1C)	ù	HEX(47)	G	HEX(70)	p
HEX(1D)	Ä	HEX(48)	H	HEX(71)	q
HEX(1E)	Ö	HEX(49)	I	HEX(72)	r
HEX(1F)	Ü	HEX(4A)	J	HEX(73)	s
HEX(20)	Space	HEX(4B)	K	HEX(74)	t
HEX(21)	!	HEX(4C)	L	HEX(75)	u
HEX(22)	"	HEX(4D)	M	HEX(76)	v
HEX(23)	#	HEX(4E)	N	HEX(77)	w
HEX(24)	$	HEX(4F)	O	HEX(78)	x
HEX(25)	%	HEX(50)	P	HEX(79)	y
HEX(26)	&	HEX(51)	Q	HEX(7A)	z
HEX(27)	'	HEX(52)	R	HEX(7B)	§
HEX(28)	(	HEX(53)	S	HEX(7C)	£
HEX(29)	)	HEX(54)	T	HEX(7D)	é
HEX(2A)	*	HEX(55)	U	HEX(7E)	ç
HEX(2B)	+	HEX(56)	V	HEX(E0)	Binary Plot Vector (Long Form)
HEX(2C)	,				
HEX(2D)	-	HEX(57)	W	HEX(E1)	Select Pen 1
		HEX(58)	X	HEX(E2)	Select Pen 2
HEX(2E)	.	HEX(59)	Y	HEX(E3)	Select Pen 3
HEX(2F)	/	HEX(5A)	Z	HEX(E4)	Set Home
HEX(30)	0	HEX(5B)	[	HEX(E5)	Power ON/Set Home
HEX(31)	1	HEX(5C)	\	HEX(E6)	Binary Plot Vector (Short Form)
HEX(32)	2				
HEX(33)	3			HEX(E7)	Copy Graphic CRT
				HEX(FA)	Reset to Home

APPENDIX B

MODEL 2282 CHARACTER SET SIZES

H SIZE 1

H SIZE 2

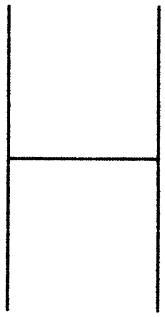
H SIZE 3

H SIZE 4

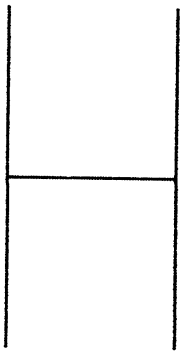
H SIZE 5

H SIZE 6

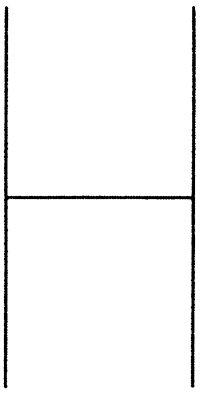
H SIZE 7



SIZE 8



SIZE 9

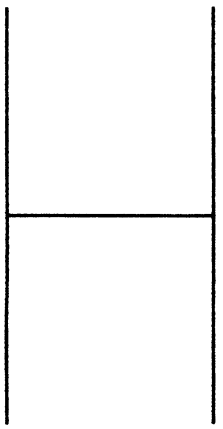


SIZE 10

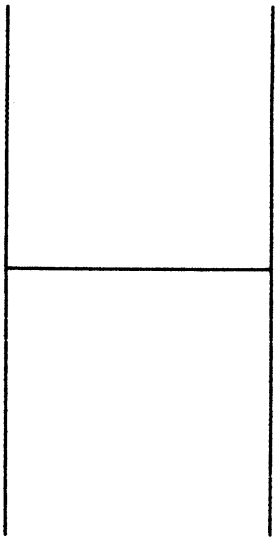
NOTE:

Characters were reproduced on the Model 2231W-3 Line Printer. Character size on the Graphic CRT is 70% smaller than shown here.

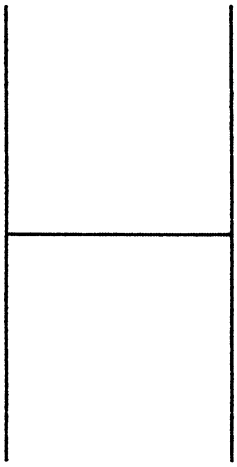
MODEL 2282 CHARACTER SET SIZES (cont.)



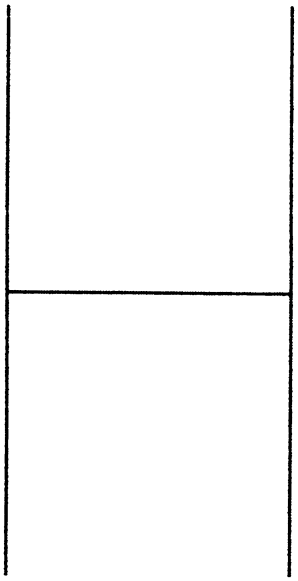
SIZE 11



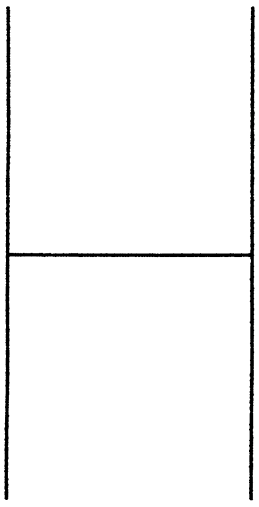
SIZE 14



SIZE 12



SIZE 15



SIZE 13

APPENDIX C

MODEL 2282 SPECIFICATIONS

Display Size:

12 in. diagonal (30.4 cm)

Viewing Area:

7.8 in. x 5 in. (19.8 cm x 12.7 cm)

CRT Phosphor:

P39

Screen Array:

800X by 512Y addressable locations (dots)

Refresh Rate:

30 fps (frames per second) with 60 interlaced half frames

Plotting Time:

0.048 sec (full screen horizontal vector)

Vector Plotting rate:

60 microseconds/dot

Approx Net Weight:

38 1/2 lb (17.4 kg)

Size:

Height . . . . . 13 1/2 in. (34.3 cm)
Width. . . . . 20 1/2 in. (52 cm)
Depth. . . . . 19 3/4 in. (50.2 cm)

Character Generation:

112 ASCII characters, 15 selectable sizes.

Connecting Cables:

8 ft (2.4 m) power cord.
12 ft (3.66 m) cable with connector to the CPU.

Controller:

Standard Wang Line Printer Controller/CPU interface. When used with the Model 2231W-3 Line Printer, the printer interface connector cable plugs into the output connector of the Model 2282.

Power Requirements:

115 or 230 VAC $\pm$ 10%
50 or 60 Hz $\pm$ 1 Hz
65 watts

Fuse Size:

3 amps @ 115V
1.5 amp @ 230V

Operating Environment:

50° to 90°F (10° to 32°C)
20% to 80% relative humidity, allowable
35% to 65%, recommended

APPENDIX D

TWO'S COMPLEMENT BINARY

D.1 INTRODUCTION

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 number represented by the bits $X_7X_6X_5X_4X_3X_2X_1X_0$ has a value of

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

Thus, if $X_7X_6X_5X_4X_3X_2X_1X_0$ = 0000 1011

Its value in the decimal system equals

$$0(2^7) + 0(2^6) + 0(2^5) + 0(2^4) + 1(2^3) + 0(2^2) + 1(2^1) + 1(2^0)$$

$$= 0 + 0 + 0 + 0 + 1(8) + 0 + 1(2) + 1(1)$$

$$= 11$$

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)

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)

NOTE:

The high order bit (left-most position) indicates the sign associated with the number.

0 = positive (+)
1 = negative (-)

Thus HEX(0h) through HEX(7h) are positive and HEX(8h) through HEX(Fh) are negative.

Converting a hexadecimal number to its decimal equivalent follows the same procedure as above. For example,

HEX(74) = positive number = (0111 0100) = 64+32+16+4 = 116

HEX(80) = negative number = -(complement (HEX(80)+1)
= -(HEX(7F)+1)
= -(0111 1111 +1)
= -(1000 0000) = -128

D.2 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 800) 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$2
:405 IF ABS(X) < = 800 THEN 410
:408 STOP: PRINT "ABS(X) TOO LARGE"
:410 T = INT (ABS(X/256))              (Factor 256)
:420 BIN(A$) = 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 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)
: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$2
:420 IF ABS(X) <= 800 THEN 440
:430 STOP: PRINT "ABS(X) TOO LARGE"
:440 Y=ABS(X)
:450 A$=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)
: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
```

D.3 ROUTINE TO BUILD A LONG BINARY PLOT VECTOR (E0)

Assuming X1 and Y1 are integer numeric values less than 800, the following program sequence uses the conversion subroutine to form a long binary plot vector followed by a pen down code and plot it.

```
:100 B$ = HEX(E0)              (Put binary plot vector code into B$)
:110 GOSUB' 50 (X1)            (Convert  X)
:120 STR(B$,2,2) = A$          (Place in B$)
:130 GOSUB' 50 (Y1)            (Convert  Y)
:140 STR(B$,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)
```

D.4 ROUTINE TO BUILD A SHORT BINARY PLOT VECTOR (E6)

This program assumes X1, and X2 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  X)
:220 STR(B$,2,1) = A$          (Store  X)
:230 GOSUB' 60 (Y1)            (Convert  Y)
:240 STR(B$,3,1) = A$          (Store  Y)
:250 STR(B$,4,1) = HEX(00)     (Place Null Code in B$ after vector)
:260 PLOT  <,, B$>             (Send out short plot vector)
```

APPENDIX E

TRAILING SPACES (HEX(20)) OR THE HEX(0D) CODE IN AN ALPHA VARIABLE.

E.1 Trailing Spaces (HEX(20)) in an Alpha Variable

When an alpha variable is printed to a peripheral the 2200 BASIC truncates all trailing spaces. This can present problems when the alpha variable is used to send plotting or forms positioning vectors to the Model 2282.

For example,

```
:10 DIM A$32
:20 A$ = HEX(E701A90120)
:30 PRINT A$; "SUB-TOTAL"
```

The variable A$ is dimensioned large enough to hold a number of vector commands. In line 20, A$ is set equal to a relative move command which should cause the form to be repositioned 425 increments to the right and 288 increments down from the form's home position (HEX (01A9) = decimal 425, HEX (0120) = decimal 288). Normally, the entire vector would be sent to the plotter, followed by the ASCII codes for SUB-TOTAL.

```
i.e., HEX E7 01A9 0120 5355422D544F54414C 0D00
             ↑    ↑          ↑            ↑
             X    Y       SUB-TOTAL       CR
```

The 2200 BASIC language, however, truncates all trailing spaces (HEX 20) including the last byte of the Y-vector (HEX 0120). What is sent to the Model 2282 is an incorrect code sequence.

```
i.e., HEX E7 01A9 0153 55422D544F54414C 0D00
             ↑    ↑          ↑            ↑
             X    Y       UB-TOTAL        CR
```

The plotter's internal microcode interprets the first code of the ASCII message (HEX 53) as the final byte of the Y - vector component. The printed output will therefore appear in the wrong position on the form, and the first character will be missing.

E.2 HEX (0D) in an Alpha Variable

Depending on the device type selected in the SELECT PRINT statement, the 2200 BASIC always inserts one or two control codes following the occurence of a HEX (0D) code in an alpha variable. If the device type is 2 (SELECT PRINT 215), the HEX (0D) is followed by a HEX (00); if the device type is 4 (SELECT PRINT 415 or SELECT PRINT 413), the HEX (0D) is followed by a HEX (0A00). Needless to say, these codes are treated as part of the vector in the plotter's internal microcode.

Example 1: (Device Type 2)

```
:10 SELECT PRINT 215
:20 DIM A$32
:30 A$ = HEX(E7040D0135)
:40 PRINT A$; "SUB-TOTAL"
```

The desired output is the code sequence:

```
HEX E7 040D 0135 5355422D544F54414C 0D00
       ↑    ↑          ↑            ↑
       X    Y        SUB-TOTAL      CR
```

The actual code sequence is:

```
HEX E7 040D 0001 355355422D544F54414C 0D00
       ↑    ↑          ↑            ↑
       X    Y        5SUB-TOTAL     CR
```

Example 2: (Device Type 4)

```
:10 SELECT PRINT 415
:20 DIM A$32
:30 A$ = HEX(E7040D0135)
:40 PRINT A$; "SUB-TOTAL"
```

The desired output is the code sequence:

```
HEX E7 040D 0135 5355422D544F54414C 0D0A00
       ↑    ↑          ↑            ↑
       X    Y        SUB-TOTAL      CR/LF
```

The actual code sequence is:

```
HEX E7 040D 0A00 01355355422D544F54414C 0D0A00
       ↑    ↑          ↑                ↑
       X    Y  (string not printed)     CR/LF
```

E.3 Plotting with $GIO

A common solution to the problems in E.1 and E.2 above is to use $GIO for outputting all plot or forms positioning vectors.* In the following examples the $GIO statement sends only the specified portion of the alpha variable to the plotter, with no additional control characters:

Example 3:

```
:10 SELECT PRINT 215
:20 DIM A$32, B$10
:30 A$ = HEX(E7010D0120)
:40 $GIO/015, (A000, B$) STR(A$,1,5)
:50 PRINT "SUB-TOTAL"
```

In the above example, the $GIO statement prevents additional control characters from being sent out following the 0D code in A$. Using the STR(function forces BASIC not to omit trailing spaces, so the HEX 20 is sent to the plotter.

Example 4:

```
:10 SELECT PRINT 215
:20 DIM A$32, B$10
:30 INIT (00) A$
:40 STR (A$,1,5) = HEX(E7010D0120)
:50 STR (A$,6,9) = "SUB-TOTAL"
:60 STR (A$,15,2) = HEX(0D00)
:70 $GIO/015, (A000, B$) A$
```

In the above example, all 32 bytes of A$ are sent to the device. The plotter's internal microcode correctly interprets all vector and print data, and ignores the trailing HEX 00 code.

*2200T users - see General I/O Instruction Set Reference Manual (700-3514).
2200 VP/MVP users - see BASIC-2 Language Reference Manual (700-4080).

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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