

ENHANCED GRAPHICS MODULE—OPTION 34

Identification

To determine if your Terminal contains this option, attempt to draw a dotted vector. First, erase the page, and then enter Graph Mode by pressing CTRL SHIFT M (GS). Follow this with ESC a (4014) or ESC A (4015). Now send the following coordinates:

(4014) SPACE RUBOUT SPACE @ 8 RUBOUT ? _

(4015) SPACE RUBOUT SPACE ^ 8 RUBOUT \ —

If your Terminal contains the Enhanced Graphics Module, a dotted vector will be drawn from the lower left to the upper right corner of the display. If your Terminal does not contain this factory installed option, ignore the remainder of text in this section.

General

The Enhanced Graphics Module is installed at the factory. It consists of an additional circuit card (termed the Discrete Plot Card) and modifications to existing Terminal

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hardware. It offers increased graphic capabilities that include the following:

1. 12-bit graphic resolution (4096Y by 4096X addressable points) that increases the address resolution by a factor of four over the standard 1024X by 1024Y. 4096 addressability requires the use of a fifth "Extra" byte in the graphic address.
2. Vector Line Formats that in addition to the solid line vectors include:
 - a. Dotted vectors
 - b. Short-dashed vectors
 - c. Long-dashed vectors
 - d. Dot-dashed vectors
3. Incremental Plot Mode that enables the Terminal to plot in one of eight directions (in written or unwritten increments) in response to a specific increment character.
4. Point Plot Mode that enables the Terminal to plot the end point of the vector; hence, the term point plot. The address data is identical to Graph Mode data.
5. Special Point Plot Mode is similar to Point Plot in that the end points of the vectors are drawn. In addition, the intensity of the plotted point can be controlled by an "intensity" character that must immediately precede each point address.
6. Outputs are available to drive the majority of mechanical plotters in use today.

INSTALLATION

General installation of the Enhanced Graphics Module is performed at the factory. Therefore, on-site procedures consist of selecting strap options, connecting the Discrete Plot Card to an outboard mechanical plotter (if used), and adjusting the Discrete Plot Card to match the mechanical plotter. The mechanical XY plotter may be connected to the Discrete Plot Card by means of an optional cable (Tektronix Part Number 012-0410-00) which connects to the J5 pins and exits through the cable opening at the rear of the pedestal. A clamp secures the cable to the sill of the opening.

Without XY Mechanical Plotter

Two strap options on the Discrete Plot Card should be checked to ensure they are in the 4014 position. These are the WRITE and TIMING (settling) straps. Fig. 1-14 shows strap locations. The GREY SCALE adjustment is used to adjust the intensity of the plotted point when operating in Special Point Plot mode. Fig. 1-14 also shows the location of this adjustment.

With XY Mechanical Plotter

Installation procedures are similar for most plotters that the Enhanced Module (EGM) is designed to interface with. Similar procedures include performing, as required, the information provided in the above ("Without Plotter") information. In addition, the Discrete Plot card needs to be connected to the plotter and specific adjustments and straps need to be checked.

Cabling

Fig. 1-15 shows the optional interconnecting cable pin assignments. The plotter cable connects to J5 on the Discrete Plot circuit card that connects to the Terminal minibus. The cable is then routed through the opening in the back of the pedestal and fastened to the sill with a cable clamp. The other end of the cable is connected to the plotter. Apply power to equipment and make any necessary adjustments. See below for information on strap options and adjustments.

Strap Options

Fig. 1-14 for location of straps. In addition to the WRITE and TIMING straps previously mentioned, other straps are pertinent for operation with a plotter. These are:

REMOTE SELECT—IN or OUT. The Remote Select Strap allows the plotter to control its on-line status. While in Incremental Plot Mode, the Terminal may act as a rapid XY plotter or will operate as a slow XY plotter when providing parallel information from the J5 pins to a suitable mechanical plotter. With the REMOTE SELECT strap in the IN position, the plotter may control which of these plotting conditions exists by feeding appropriate information to J5 pins 1 and 2. With the REMOTE SELECT strap in the OUT position, control of these functions is transferred to one of the spare Terminal keyboard switches or a signal applied to pin J6-2 as selected by the PLOTTER SELECT strap.

PLOTTER SELECT—SW1, SW2, SW3 or OUT. With the Remote Select strap in the OUT position and the Plotter Select strap in the OUT position, the plotter is removed from the system. Placing the PLOTTER SELECT strap in the SW1 or SW2 position allows the Terminal keyboard switch 1 or 2 to place the plotter on line by the operator depressing the right side of the selected switch.

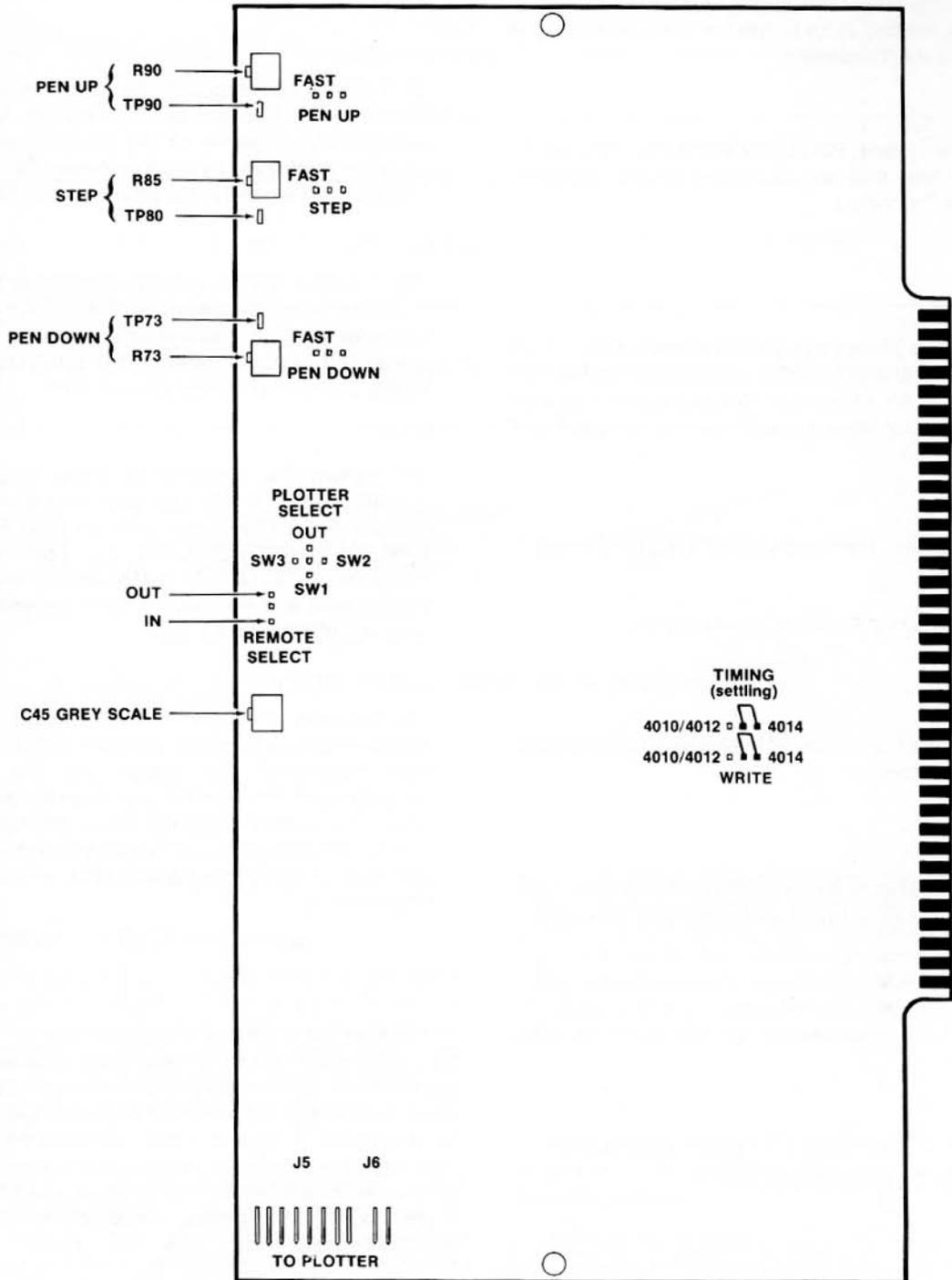


Fig. 1-14. Discrete Plot Card strap options and adjustment locations.

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Placing the PLOTTER SELECT strap in the SW3 position allows the plotter status to be controlled by pin J6-1, much in the same way as J5-2 discussed earlier. This additional control of plotter status is provided for use in systems other than already described. For initial installation, set this strap to SW1 or SW2, whichever is available on the Terminal.

Two other straps, PEN DOWN and PEN UP, are for adjustment use and are described in the following Adjustment Procedure.

Adjustment

This procedure allows adjustment of the rate at which data is fed to a mechanical plotter during Incremental Plot mode operation. An adjustment is also provided to shift the display intensity scale available during Special Point Plot mode.

An oscilloscope of low bandwidth (1 kHz) may be used.

- 1) Disconnect the Terminal power supply.
- 2) Remove the front cover of the pedestal held in place by two thumbscrews.
- 3) Locate the Discrete Plot card in the minibus. Refer to Fig. 1-14 for adjustment and test point locations.
- 4) Connect the oscilloscope to test point 73 (PEN DOWN time).
- 5) Place the Terminal in LOCAL.
- 6) Turn on the Terminal power supply.
- 7) Place the Terminal in Incremental Plot mode by entering an RS command at the keyboard (CTRL SHIFT N).

8) Depress the P (4014) or * (4015) key periodically. Observe on the oscilloscope a pulse of duration controlled by potentiometer R73. Adjust this pulse width to correspond to the plotter's specified Pen Down time.

9) Transfer the oscilloscope probe to test point 80 (STEP time). Depress the A (4014) or α (4015) key periodically. Observe on the oscilloscope a pulse of duration controlled by potentiometer R85. Adjust pulse width to correspond to the plotter's specified Step time.

10) Transfer the oscilloscope probe to test point 90 (Pen Up time). Depress the SPACE key periodically. Observe on the oscilloscope a pulse of duration controlled by potentiometer R90. Adjust to correspond to the plotter's specified pen up time.

11) Return the Terminal to Alpha mode operation (PAGE, CR, ESC FF, US, etc.) and then transfer to Special Point Plot mode with an ESC FS (ESC key followed by CTRL SHIFT L). Transmit intensity character @ (4014) or $\bar{\text{~}}$ (4015) setting intensity at the lowest level and then return to Incremental Plot mode with RS (CTRL SHIFT N).

12) Depress an upper case P (4014) or * (4014) followed by a repetitively pulsed A (4014) or α (4015) and observe on the screen how the Terminal is beginning an incremental plot beginning at that point where the cursor appeared while previously in Alpha mode. Because an A (or *) contains active bit 1 in the absence of other step commands, movement to the right occurs.

Because an intensity character @ (or $\bar{\text{~}}$) was input during Special Point Plot mode, the plot observed is at the lowest of the 32 intensity levels stored by the Discrete Plot Card. Now adjust the trimming capacitor C45 (adjacent to U41) (see Fig. 1-15) and notice that it has an effect on the intensity of subsequently written points. When the intensity reaches the desired minimum value, leave the capacitor at that setting. The minimum intensity in Table 2-23 has been established.

This ends the Adjustment procedure, and the Discrete Plot Card may now be permanently installed in a vacant pedestal slot. The cable to the mechanical plotter, attached to the J5 Connector pins, exits through the opening on the rear of the pedestal and is secured by the cable clamp (optional accessories).

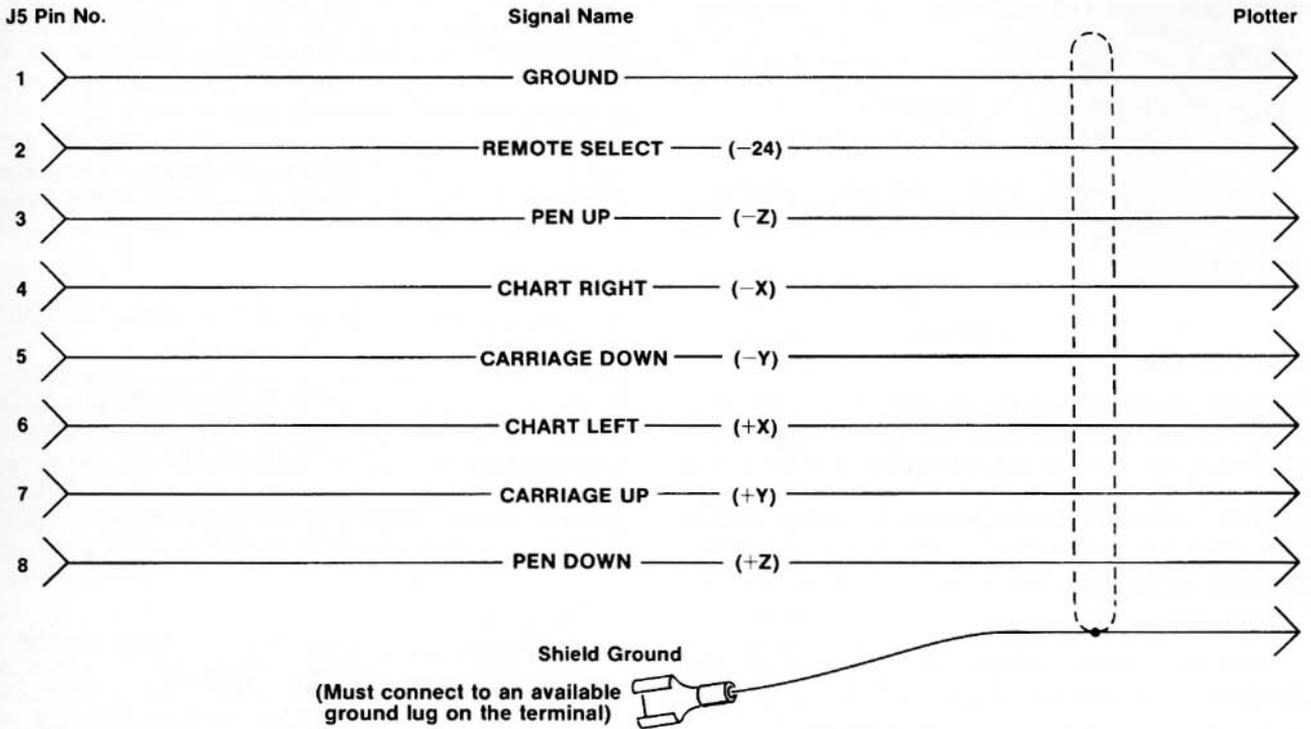


Fig. 1-15. Plotter connector (J5) pin assignments.

OPERATION

4096 Resolution (12-Bit Addressing)

General. To establish an address in the addressable point grid of 4096X by 4096Y, 12 bits of X and 12 bits of Y data (24 bits total) must be transmitted to the Terminal. This necessitates the use of an "Extra" 7-bit byte in the vector address. The transmission order is shown in Table 2-21, which also shows the byte content.

This system of address transmission is both upward and downward compatible with the Tektronix 4010-series Computer Display Terminal, 10 bit addressability software. That is, if the 4014/4015 is driven from a program written for a 4010/4012/4013, the 4014/4015 will default to a 1024X by 1024Y addressable condition and the plot will appear full screen, (therefore magnified by the ratio of screen sizes). Furthermore, if a 4010/4012/4013 is driven from a program written for the 4014/4015 with Enhanced Graphics Module installed, the plot will simply appear full screen on the 4010, (therefore reduced by the ratio of screen sizes).

The Extra Byte need not be sent, but when it is, the Low Order Y byte must always be sent. The rules for shortened address transmission only change (over that of the standard Terminal as mentioned in preceding text) as the Extra Byte changes. In which case, send the Extra, Low Y, and Low X bytes. Also refer to Table 2-21.

Operational Check. To checkout 12-bit addressing, enter GS (CTRL SHIFT M) at the keyboard followed by the following address

(4014) , ~ ~ 0 @

(4015) , ◇ ◇ 0 -

Repeat the last character entry of the address and note a written point near display center. Enter

(4014) , 0 ~ 0 @

(4015) , 0 ~ 0 -

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Note a minute beam movement about the width of two written points up and to the left of the original point. Enter

(4014) , ~ ~ Ø @

(4015) , ◇ ◇ Ø⁻

Note that the beam has positioned back over the first written point. Enter SHIFT RESET to return the Terminal to Alpha Mode.

Vector Formats

General. Additional vector formats of dotted, dot-dashed, short-dashed, and long-dashed can be program controlled as can the focused, defocused and write-thru states of each of the types. Code information is provided in Table 2-19. Because focused, defocused and write-thru vectors have been discussed in preceding text, these operational features will not be discussed here.

Operational Check. Operational checkouts for the vector types are as follows.

1. Dotted Vectors Enter GS (CTRL SHIFT M) at the keyboard followed by:

(4014) , ~ Ø @

(4015) , ◇ Ø⁻

repeat the last character of the address to disclose beam position near display center. Now enter a dotted vector command of ESC a (4014) or ESC A (4015). Then enter

(4014) SP DEL SP @

(4015) SP DEL SP⁻

Note a dotted vector drawn from the center of the display to the lower left corner.

2. Dot-Dashed Vectors Enter ESC b (4014) or ESC B (4015). Then enter

(4014) SP DEL ?

(4015) SP DEL \ ≥

Note a dot-dashed vector drawn across the lower edge of the screen.

3. Short-Dashed Vectors

Enter ESC c(4014) or ESC C (4015) the enter

(4014) 8 ~ ? A

(4015) 8 ◇ \

Note a short-dashed vector drawn along the right side of the screen.

4. Long-Dashed Vectors

Enter ESC d (4014) or ESC D (4015) then enter

(4014) SP DEL SP @

(4015) SP DEL SP⁻

Note solid vector along the left side of the screen.

5. Return to normal vectors

Enter ESC ` (4014) or ESC ◇ (4015) then enter

(4014) SP DEL SP @

(4015) SP DEL SP⁻

Note solid vector along the left side of the screen.

Enter PAGE to erase the display and return to Alpha Mode. PAGE, as well as SHIFT RESET, CR, ESC FF, and LF if strapped to provide a carriage return, will clear not only Graph Mode but also the vector-type memory. A vector-type character can be retained in memory by exiting Graph Mode with US. Graph Mode may then be reselected with the preceding vector type displayed.

Point Plot, Special Point Plot, and Increment Plot Modes

General. These Enhanced Graphics modes have one common characteristic — beam intensity can be program controlled. Beam intensity control is provided by Special Point Plot and its use, in conjunction with Point Plot and Incremental Plot, provides a "grey scale" capability that approximates that of newspaper photographs. Special Point Plot Mode is discussed first.

Special Point Plot. Special Point Plot Mode is entered by sending the Terminal the two-character sequence of ESC FS. The character that immediately follows FS and must precede each point address thereafter, must be an Intensity Character. The Intensity Character sets the on-time of the display beam, and in this manner controls the dot size and brightness. Table 2-23 shows the percentage of on-time of the beam for a given Intensity Character.

TABLE 1-3

Action	Effect
1) Power Up Terminal (and plotter if connected to Discrete Plot Card).	Terminal enters Alpha Mode, and alphanumeric may be written.
2) Enter Graph Mode with a GS (CTRL SHIFT M).	The Alpha cursor disappears.
3) Enter a point address of Y=575, X=545 by depressing the key sequence (4014) 1 DEL 1 A (4015) 1 DEL 1 α	Screen remains dark.
4) Repeat last key depressed (A or α), hold momentarily.	Point appears at 575Y, 545X on the display.
5) Transmit another point, Y=31, X=26 with the sequence (4014) SP DEL SP Z (4015) SP DEL SP ⊂	A line segment appears between points 575Y, 545X and 31Y, 26X
6) Return to Alpha Mode with the PAGE key.	The Screen is erased; the Alpha cursor reappears.
7) Enter Point Plot mode by sending an FS command (CTRL SHIFT L).	The cursor disappears.
8) Enter again the address (575Y, 545X) with the aforementioned keyboard sequence.	The point is written instantly, without need of repeating the last character.
9) Enter again the address (31Y, 26X) with the keyboard sequence previously mentioned.	The point is written, and no connecting line segment appears as it did in Graph Mode.
10) Enter Special Point Plot mode with the control character sequence ESC FS (ESC CTRL SHIFT L).	Screen remains the same.
11) Depress the @ (4014) or ⌘ (4015) key momentarily.	Screen remains the same.

As previously mentioned, each point address while in Special Point Plot must be preceded by an Intensity Character. However, Point Plot or Incremental Plot can be selected following the Intensity Character. The intensity thus set in Special Point Plot will be retained in Point and Incremental Plot modes until either Terminal power is turned off or the SHIFT and RESET keys (Reset Function) are pressed; at which time the beam intensity returns to a default intensity setting. Special Point Plot uses the same graph address sequence as normal Graph Mode.

Point Plot. Point Plot is entered by sending the Terminal the FS control character. Beam intensity is controlled by an intensity setting performed in Special Point Plot Mode as previously discussed. If the Intensity Character memory has been cleared by an initializing function (Power on or SHIFT RESET), beam intensity defaults to a pre-determined intensity. Beam addressing data is identical to normal Graph Mode addressing.

Incremental Plot. This mode is entered by sending the Terminal the RS control character. This mode inhibits the normal "byte" loading that occurs during the other graph modes, and instead reads the data as a command to pulse the X and Y counters in one of eight directions and to unblank or blank the writing beam as the beam is incremented. Beam intensity is controlled by an Intensity Character loaded into a memory circuit during Special Point Plot Mode.

Operational Check. Operation checkouts of the aforementioned modes of operation are listed in Table 1-3.

This tabular checkout procedure allows the user to explore the range of system capabilities.

A mechanical plotter may be connected to the J5 pins, as outlined in the preceding text.

While following the procedure, it will be helpful to refer to Fig. 2-5 (Terminal modes diagram).

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|---|--|--|---|
| 12) Transmit the point 351Y, 346X with the sequence | A point of low intensity appears at 351Y, 346X, which may be too dim to store. | 20) Go to Special Point Plot mode with the ESC FS sequence (ESC CTRL SHIFT L). | The cursor vanishes. |
| (4014) * RUBOUT * Z | | | |
| (4015) ≠ RUBOUT ≠ C | | | |
| 13) Depress the w (4014) or W (4015) key momentarily. | Screen remains the same. | 21) Enter the Intensity Character @ (4014) or ~ (4015) establishing the lowest intensity level. | No change to screen. |
| 14) Transmit the point 351Y, 186X with the sequence | A point of higher intensity appears to the left of that previously written. As is discussed in the text, Special Point Plot mode operation allows an Intensity Character to precede each point address. In this procedure the @ (or ~) sets a low intensity, and w (or W) sets a high intensity. | 22) Return to Incremental Plot mode with RS (CTRL N). Assert a PEN DOWN command of P (4014) or * (4015), then hold down the CARRIAGE UP command of D (4014) or L (4015). | The beam pulses upwards at a weak intensity (perhaps too low to store). |
| (4014) * DEL * Z | | | |
| (4015) ≠ DEL ≠ C | | | |
| 15) Send the Command RS (CTRL SHIFT N) establishing Incremental Plot mode. | No change to screen. | 23) Route through Alpha Mode back to Special Point Plot mode with sequence US ESC FS (CTRL SHIFT O ESC CTRL SHIFT L). | No change to screen. |
| 16) Send a CHART LEFT command A (4014) or ∞ (4015), holding the key for a few seconds. | No change to screen. | | |
| 17) Send a PEN DOWN command P (4014) or * (4015) and then CHART LEFT command as before. | The display acts as an incremental plotter, and a line grows toward the right of the screen. | 24) Enter intensity character w (4014) or W (4015) establishing the highest intensity level. | No change to screen. |
| 18) Transmit the Incremental Plot commands as shown in Fig. 1-16. | Observe that the pen up/down commands are "remembered", and need not be input prior to each step command. | 25) Return to incremental Plot mode with the RS command (CTRL SHIFT N). Assert and hold CARRIAGE UP | A line of higher intensity continues and grows from the tip of of the low intensity line (if stored) written in Step 22. (This intensity range may be varied, as described in the Adjustments section.) |
| 19) Return to Alpha Mode with a US (CTRL SHIFT O). | The Alpha cursor appears at the last entered address. | (4014) D
(4015) L | |

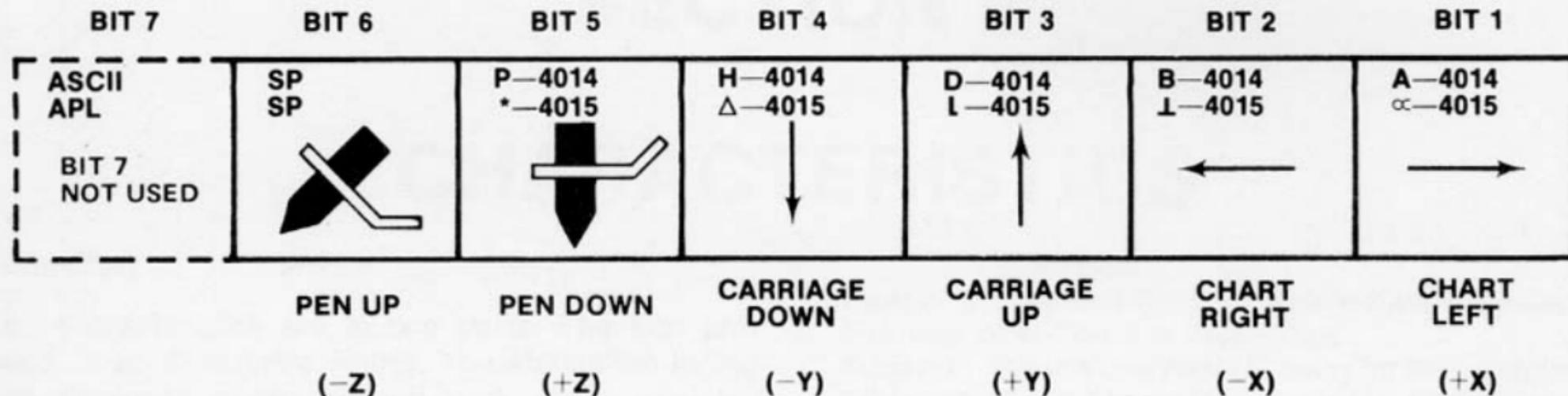


Fig. 1-16. Interpretation of the Incremental Plot Mode Word. Each of BIT1 through BIT6 has a particular effect on the plotter as shown above. For example, the word 1011010 (ASCII z) would cause a combined down and left step with the pen enabled. The ASCII and APL character corresponding to each command is shown.