TEKTRONIX®

Device 20

4662

INTERACTIVE DIGITAL PLOTTER USERS

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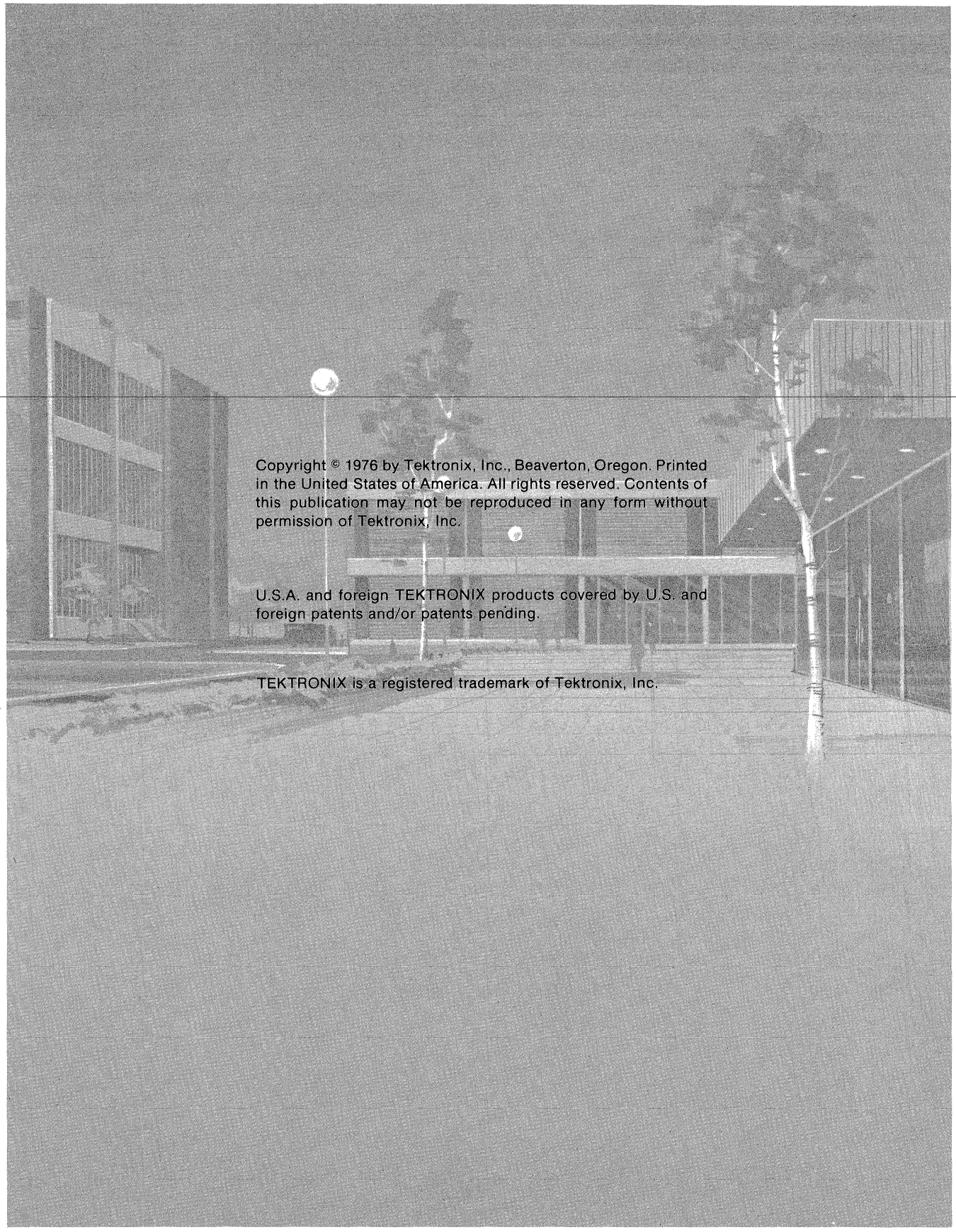

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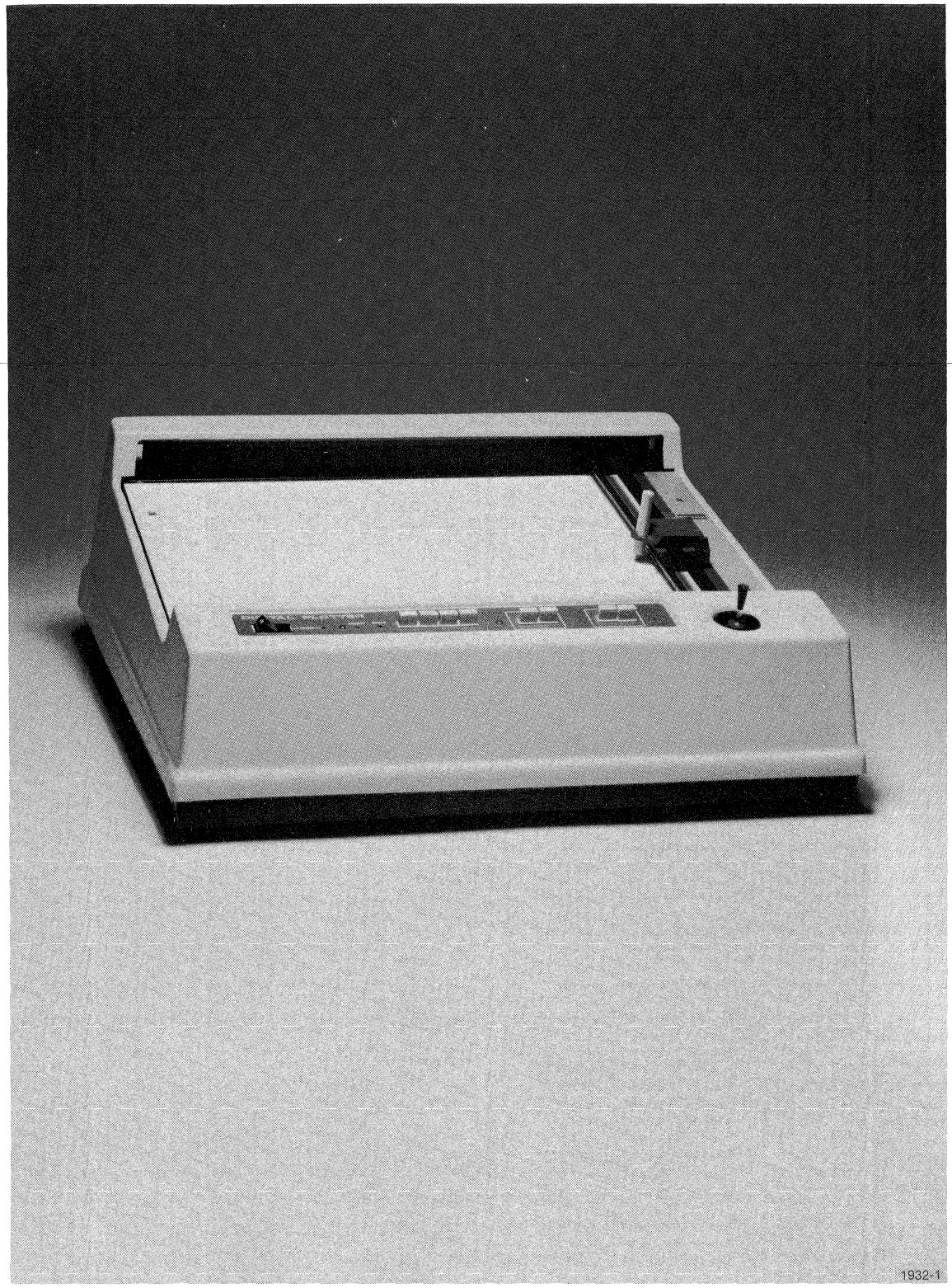

Fig. 1-1. 4662 Interactive Digital Plotter.

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Section 1
INTRODUCTION

GENERAL DESCRIPTION

The 4662 (Fig. 1-1) is an Interactive Plotter that is digitally stepped and controlled. It provides permanent graphic recording capabilities for devices that have either the RS-232-C interface (such as a Tektronix 4010-series Terminal based system) or the GPIB (IEC)[1] interface (such as the Tektronix 4051 Graphic System). This choice of interfaces allows the Plotter to be used with a wide variety of systems and equipment.

Each axis of the plotter is propelled by a four-phase stepping motor. Each motor pulley drives a plastic-covered cable that is attached to the pen carriage to move the carriage along the appropriate axis. Internal circuitry controls the number of steps in each axis to create the appropriate vector. Each motor step results in .005 inch of linear motion in that motor's axis.

The 4662 will accept paper sizes up to 11 inches (27.9 cm) in Y by 17 inches (43.2 cm) in X; maximum plotting size is 10 inches (25.4 cm) by 15 inches (38.1 cm). The Page Scaling feature of the 4662 allows the plot size to be easily adjusted from the front panel to fit the paper size being used. The paper is held in position by electrostatic attraction generated by the platen.

A complete list of 4662 specifications is found in Appendix A.

The 4662 performs three basic types of operations. It can print Alphanumeric characters, drawing the ASCII character received on the plotting surface. (Refer to the Hardware Alphanumerics description, found later in this section.) The Plotter can also produce graphics by moving the pen across the plotting surface, lifting and lowering the pen to produce written vectors only when desired. In addition, the (Graphic Input) GIN operation allows the Plotter to act as a digitizer, transmitting the coordinate position of the pen along with pen status (up or down) upon command. Actual implementation of these operations varies according to the interface being used. Detailed instructions may be found in the Operation section, found later in this manual.

[1]The GPIB interface is defined in IEEE Standard 488-1975: IEEE Standard Digital Interface for Programmable Instrumentation. A description of interface characteristics is found in Appendix C.

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Other features of the 4662 include the ability to scale the alphanumeric character sizes (independently from the plot size) and to rotate the alphanumeric characters. In addition, a number of plotters may be linked together with different device addresses assigned to each. In this way, data may be sent to only one of a group of plotters, selectively.

PLOTTER INPUT and OUTPUT

When power is applied to the Plotter and it is connected into an operating system its operations fall into two categories at the interface level. It can accept output from a host system, or it can provide input to a host system. The operations that fall into each category are summarized in Table 1-1.

TABLE 1-1

Plotter Input and Output Operations

Plotter Input (accepts host output)	Plotter Output (provides host input)
Plotter Graphics	GIN (pen position & status) data
Alphanumeric Printing	Status Information
Operating Commands	Size Information
	Block Acknowledge (RS-232-C only)

INTERFACES and OPERATION

As stated earlier, the 4662 has two resident interfaces available, RS-232-C and GPIB (IEC). These interfaces are fundamentally different in their handling of data and in the types of commands that they decode. This results in an instrument which is functionally identical regardless of interface, but which is operationally different, depending on the interface being used. That is, different commands are used from the two interfaces to cause the same operations to occur.

For the above reasons this manual will break down Operation, Familiarization, and Installation into discussions pertaining to the respective interfaces. Information of a general nature pertaining to both interfaces will be located at the beginning of the section. Detailed information by interface will be located later in the section.

HARDWARE ALPHANUMERICS

The Hardware Alphanumerics feature of the plotter allows alphanumeric text to be printed on plots without requiring character generation software support by the host system. The ASCII characters which are accepted include the 95 ASCII printing characters plus BEL, BS, CR, FF, HT, LF, and VT Control Characters. A complete ASCII character chart is located in Appendix B.

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The Hardware Alphanumeric capability is provided in a different manner with each interface. Refer to the Operations section for details. The ASCII character functions are listed in Table 1-2.

The Alphanumerics feature may be modified to suit the requirements of each individual plot by the use of three modifying commands. These are Alpha Scale (which allows modification of character size), Alpha Rotate (which allows rotation of the printing plane), and Alpha Font (which allows selection of special character fonts).

TABLE 1-2

ASCII Character Functions

Character Received	Function
ASCII Printing Characters	All ASCII printing characters, upper case, lower case, and space are drawn on the plotting surface unless part of a command sequence.
BEL	The BEL character rings the bell on the Plotter. The bell is normally used to alert the operator to a special condition or operation.
BS (Back Space)	The BS character causes the pen carriage to move back (in the alphanumeric printing plane) one currently defined character space.
CR (Carriage Return)	The CR character causes the pen carriage to move back to the currently-defined left margin on the present line. (If CR→LF is selected on the rear-panel switches, a CR-LF sequence occurs.)
FF (Form Feed)	FF is interpreted as a PAGE or HOME command when using the GPIB interface. To perform the same function, it must be preceded by ESC when using the RS-232-C interface. It causes the pen to move to the HOME position, one character line-space below the upper-left corner of the currently defined page.
HT (Horizontal Tab)	HT causes the pen carriage to move ahead one currently-defined character space on the present line. (The same operation occurs for a SPACE character.)
LF (Line Feed)	LF moves the pen carriage down one currently-defined line space. It does not cause a space or a carriage return.
VT (Vertical Tab)	VT is the opposite of Line Feed. It causes the pen carriage to move up one currently-defined line space.
SPACE	The SPACE character causes the pen carriage to move ahead one currently-defined character space on the present line.

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FRONT PANEL SWITCHES and INDICATORS

The following is a description of the function of each of the switches and indicators located on the front panel (Fig. 1-2).

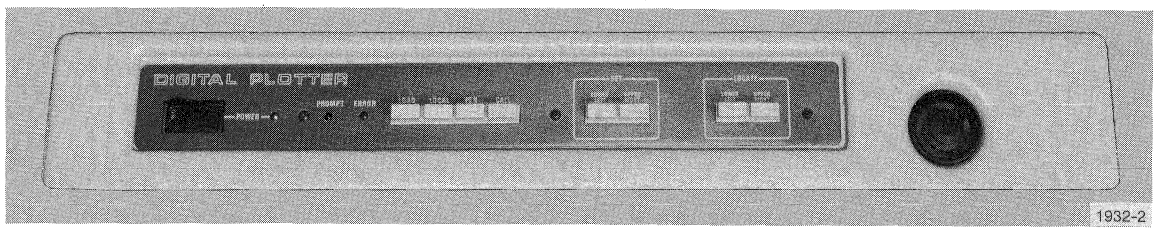

Fig. 1-2. The Front Panel.

POWER SWITCH

The POWER switch is a rocker switch used for applying power to the 4662.

POWER INDICATOR

The POWER indicator is an LED that monitors the +5 V supply. When on, it indicates the presence of power to the 4662.

PROMPT INDICATOR

The PROMPT indicator is an LED that may be turned on and off under external program control. It is usually used to issue a prompt to the Plotter operator, indicating that the program expects some operator action. When the PROMPT indicator is on, the automatic pen lift is inhibited for convenience in digitizing.

ERROR INDICATOR

The ERROR indicator is an LED which, when on, indicates one of three conditions (Error bits in the status word):

1. A transmission error when operating with the RS-232-C Interface.
2. An internal plotter error (none are currently defined).
3. An external programming error, such as an illegal or undefined function.

The Error bits are reset, and the ERROR indicator turned off, by an external program Read Status Word Ø command or a Reset command. The Error bits can also be reset by cycling the power off and then on again to restart the Plotter, or by releasing the LOAD button.

LOAD SWITCH

The LOAD switch is used when a new sheet of paper is to be loaded into the Plotter. When the switch is pressed in, the Plotter will lift the pen from the plotting surface and move it to the upper-right of the platen. In addition, the electrostatic paper hold-down is turned off to allow

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removal and replacement of paper. The LOAD switch remains in, once pressed; it is released by being pressed again.

While the LOAD switch is pressed in, external communications activities of the interfaces are not disabled. However, any commands in the input buffers are deleted, and processing of any further motion commands received is suppressed. (Non-motion commands are processed as usual.) When the LOAD switch is returned to its normal (out) position, the electrostatic paper hold-down is restored and the Plotter is ready to accept manual or program-initiated commands.

NOTE

Pressing the LOAD button does not clear the Plotter Output queue.

LOCAL SWITCH

The function of the LOCAL switch varies with the interface in use. The switch locks in when pressed; it is released by being pressed again.

When the LOCAL switch is pressed in while operating through the RS-232-C interface, data communication will be between the Plotter and the terminal only. Communication between the Plotter and the modem is disabled.

When the LOCAL switch is pressed while operating with the GPIB interface, the Plotter will ignore all commands. To the controller, it will appear that the Plotter is not connected to the bus.

Regardless of the interface, when the LOCAL button is released the STATUS WORD error bits are cleared and the ERROR indicator turned off. Also, any action of the LOCAL button causes the commands currently in the input buffer to be deleted.

PEN SWITCH

When the PEN switch is pressed, the up-down state of the pen is changed. That is, if the pen is up when the button is pressed, the pen will be lowered to the plotting surface, and vice-versa. If the plotter is busy when the PEN button is pressed (executing a Move, Draw, or Alphanumeric print command), it will ignore the PEN change command.

CALL SWITCH

The CALL switch is used to store the current coordinate position of the pen for transmission, such as when the Plotter is being used as a digitizer. If the RS-232-C interface is in use when the CALL switch is pressed, the pen coordinates are transmitted in accordance with the communications protocol in effect at the time.

If the CALL switch is used in conjunction with the GPIB interface, two kinds of operations may take place. If the CALL switch is pressed in response to a CALL GIN command, the pen coordinates are sent immediately. If the CALL switch is pressed prior to receipt of a CALL GIN command, the coordinates are stored in an internal queue. As soon as the coordinate values are available, the Plotter asserts SRQ on the GPIB interface. This must then be serviced by a CALL GIN command from the controller.

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For both interfaces, the pen coordinates are stored when the button is pressed and placed into the output queue when the button is released. If the output queue is full, the bell rings to indicate that the coordinates have not been accepted.

If the CALL switch is held down for about 1 second (the bell will ring once) a system status block is transmitted in place of the GIN coordinate block. This facility may be used to terminate variable length GIN input sequences.

In addition, if the CALL button is held down until the bell rings twice, the Self-Test sequence is activated. The Self-Test feature is described later in this section.

SET CONTROLS

The SET controls consist of two push switches; LOWER LEFT and UPPER RIGHT. Their function is to alter the area on the platen which may be plotted upon. This is done by moving the pen to the desired boundary point and then pressing the associated set key. Each time a SET operation is performed, the button must be held pressed for about .8 second; the Plotter bell will ring to signify that the SET operation is complete. This feature may be used for Page Scaling, Mirror Image, or Page Positioning, as described in the General Operating Instructions section.

LOCATE CONTROLS

The LOCATE controls consist of two pushbuttons, marked LOWER LEFT and UPPER RIGHT. When either of these buttons is pressed, the pen moves to the associated corner of the currently-defined page.

POSITIONING CONTROL (JOYSTICK)

The POSITIONING control is a Joystick located on the front panel. It allows the operator to manually move the pen to any location on the plotting surface. Direction of pen motion is indicated by the direction in which the control lever is tilted; pen velocity increases with the displacement angle of the control lever.

REAR PANEL CONTROLS

There are four sixteen-position rotary switches on the rear panel; each may be rotated by means of a small screwdriver. These switches control many of the user-definable features of the Plotter. These features vary according to the interface being used and include interface selection. The specific switch settings and features are described in the Operation and Installation sections of this manual, under each interface.

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SELF-TEST

The Plotter has internal self-testing features that perform two separate test types. One check occurs when the Plotter is powered up; it automatically performs internal checks on the RAM (buffers) and the ROM in which the controlling program is stored. In addition, the pen location is initialized by moving it to the lower-right corner; the selected interface is then enabled. If an error is detected in this sequence, the Plotter bell will sound continuously until power is turned off.

The other self-test feature is activated by holding the CALL button depressed until the Plotter bell rings twice. When the CALL button is released, the self-test sequence begins and is not interruptible. The test consists of a predetermined plot, shown in Fig. 1-3, which may be examined to determine plotter integrity. Refer to the 4662 Interactive Digital Plotter Service Manual .

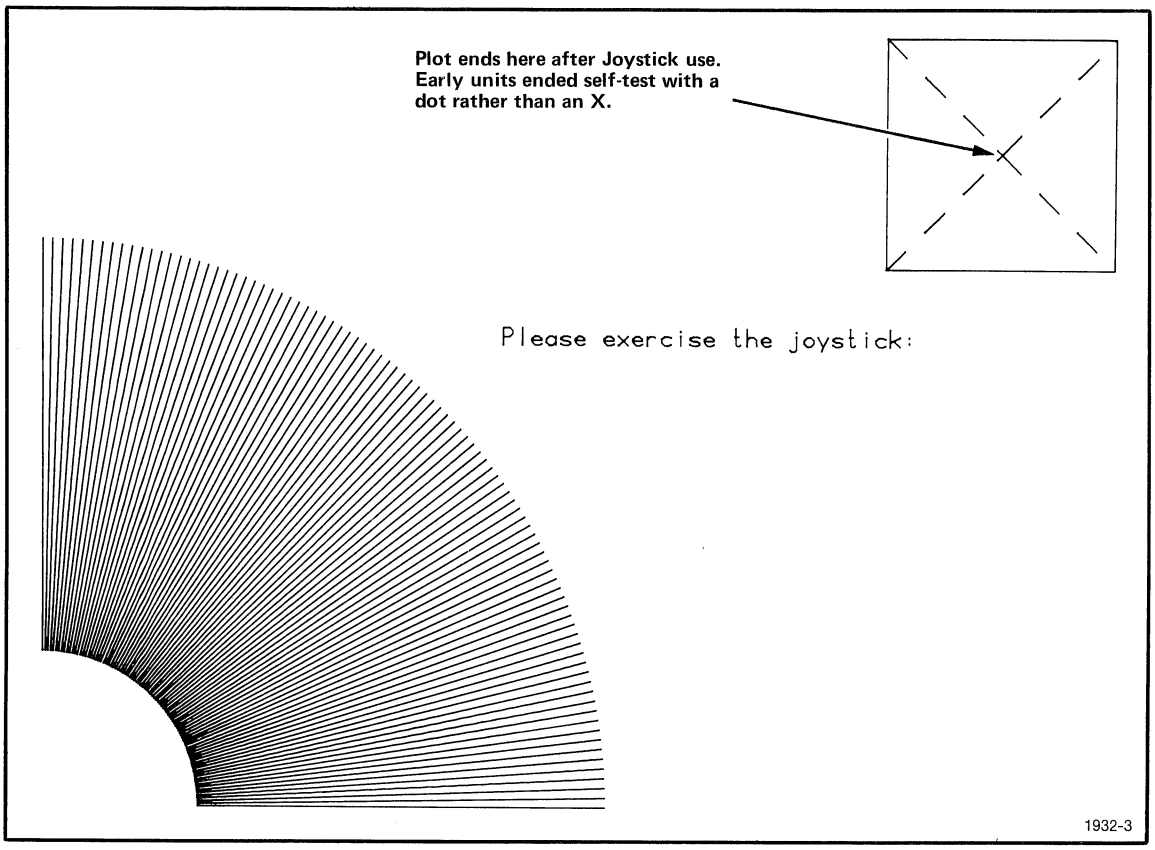

Fig. 1-3. Test Pattern Produced by Self-Test Feature.

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Section 2
OPERATION

ABOUT THIS SECTION

This section provides the operating and programming information necessary to use the 4662 Interactive Digital Plotter. Information in this section is divided into three categories: General Operating Instructions, Program-Controlled Operation using the RS-232-C interface, and Program-Controlled Operation using the GPIB interface. General Operating Instructions includes all information pertinent to the Plotter regardless of the interface being used. This includes Paper Loading and Positioning, Page Scaling, Mirror Image, and other information of a general nature.

Since programmed operation of the Plotter changes with the interface employed, the programming information is divided into the two remaining sections by interface. These are Program-Controlled Operation Using the RS-232-C interface, and Program-Controlled Operation Using the GPIB interface. For detailed Programming and Operation information, refer to the appropriate section for the interface you are using.

GENERAL OPERATING INSTRUCTIONS

APPLYING POWER

After connecting the plotter to an appropriate power source, rock the POWER switch to the right to apply power. The POWER indicator will light, and the following sequence of events will take place. The pen carriage will move from its present location until it reaches the right boundary. The pen will then move down along the right boundary until it reaches the lower-right corner, where it will stop. This process initializes the internal circuitry to establish the plotting surface boundaries and initial pen position.

If the LOAD switch is pressed in when power is applied, the initialization process is the same with one exception: when the pen carriage reaches the lower-right corner of the platen, it will immediately proceed to the upper-right corner LOAD position.

LOADING PAPER

Push the LOAD button in to its locked position. The pen will lift and move to the LOAD position (upper right corner), and the electrostatic paper hold-down will be disengaged. Carefully lift the pen holder to the 45° or 90° detent position.

Remove any paper present on the platen, and position a new piece of paper on the plotting surface. When using standard-size (11″ by 17″) paper, the lower-left corner of the paper should be positioned to the lower-left corner of the platen. The bottom edge of the paper should lie evenly along the paper guide (Fig. 2-1).

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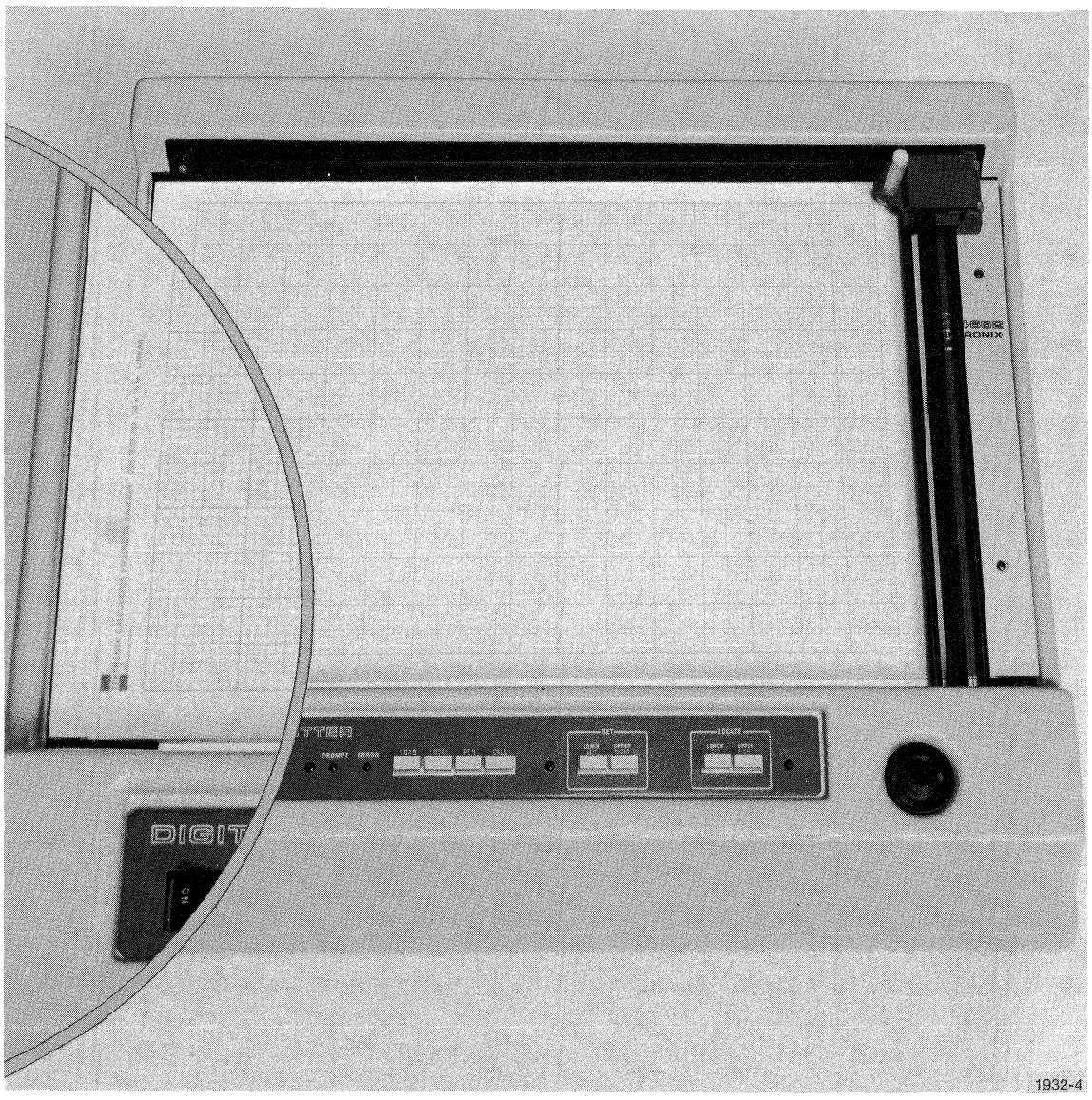

Fig. 2-1. Paper Position on the Platen.

Press the LOAD button to release it from its locked position and activate the electrostatic paper hold-down. If "bubbles" appear between the paper and the platen, smooth the paper across the surface with your hand. Lower the pen to the "ready to plot" position.

INSTALLING A PEN

Press the LOAD button to lift the pen from the plotting surface and move the pen to the upper-right corner. Manually lift the pen to the 45° or 90° detent position to avoid accidentally marking on the plotting surface.

Remove the pen (if one is installed) by turning it one-quarter turn counterclockwise. This will align the tabs on the pen with the slots on the pen holder, and the pen may be removed (Fig. 2-2). Place the pen cap over the tip for storage.

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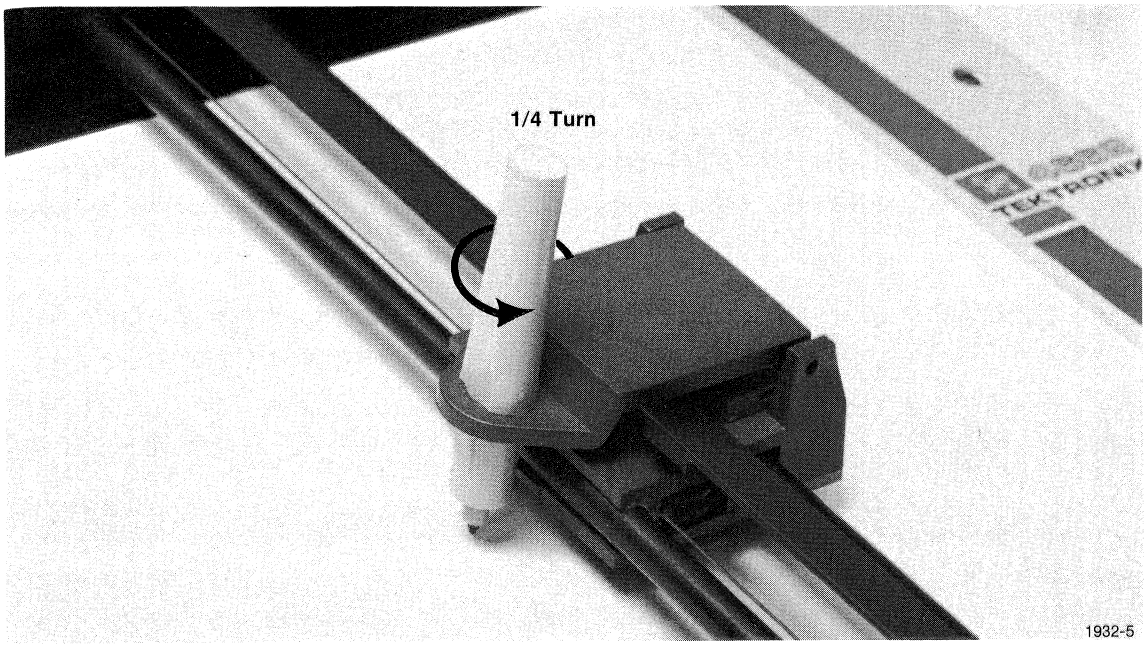

Fig. 2-2. Removing the Pen.

NOTE

For maximum life, pens should always be capped when not in use.

To install a new pen, align the tabs on the pen with the slots on the pen holder and install the pen into the holder. Turn the pen one-quarter turn clockwise to lock it into place. To ready the pen for plotting, remove the protective cap and lower the pen to the "ready to plot" position. Push the LOAD button to release it from the LOAD position and engage the paper hold-down.

MANUAL PEN POSITIONING

The pen may be positioned to any point on the plotting surface using the Joystick located on the front panel. This is used for Digitizing operations, as well as with other controls for defining plotting area size, orientation, and location.

The direction of pen motion corresponds to the direction in which the Joystick control lever is tilted. The pen velocity is increased with the displacement angle of the Joystick control lever.

PAGE SCALING

The size of the defined page may be changed to any dimension 10 inches by 15 inches or less. When the page size is scaled down, all alphanumeric and graphic data are plotted within the scaled-down page, and will reflect any change in the X-Y aspect ratio.

To change the Page Scale, first use the Joystick to position the pen to the desired lower-left corner of the scaled page. The lower-left corner of the scaled page may be the existing

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(default) corner or any other location on the plotting surface. Press the SET LOWER LEFT key and hold it for about one second. The Plotter bell will ring to signify the completion of the SET operation. (If the existing lower-left corner is to be used for the scaled lower-left corner, it is not necessary to reset the position as described above.) Position the pen to the desired upper-right corner location, using the Joystick; then press the SET UPPER RIGHT button for about one second. The Plotter bell will ring to signify the completion of the SET operation; this also completes the Page Scaling operation. Refer to Fig. 2-3.

Notice that reduction of page size is local scaling. That is, all incoming data is scaled down and plotted at a reduced page size. No modification of incoming data is required.

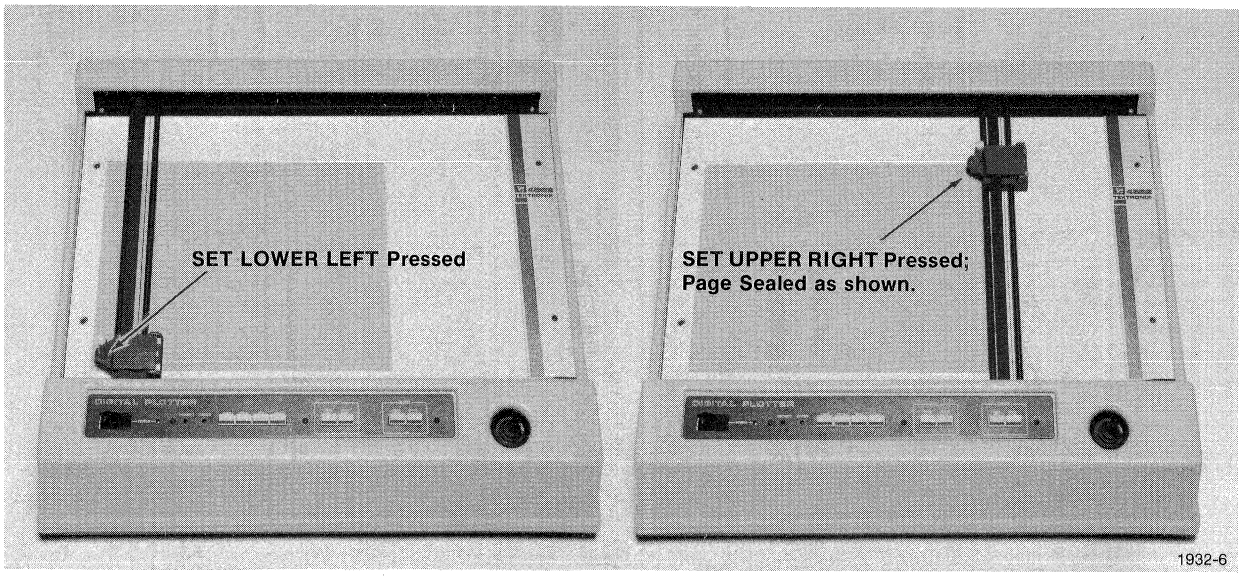

Fig. 2-3. A typical Page Scaling Operation.

PAGE POSITIONING

A scaled-down page may be placed in any position within the 10 inch by 15 inch plotting area. This is accomplished by changing the lower-left reference point; it is not necessary to reset the upper-right corner point when changing only the page position on the plotting surface. Refer to Fig. 2-4.

To change page position, move the pen to the desired lower-left corner using the Joystick. Then press the SET LOWER LEFT button and hold it for about one second. The Plotter bell will sound to signify the completion of the SET operation.

NOTE

The upper-right corner location cannot be moved past the boundaries of the platen. If the lower-left corner location is moved too far up or to the right, positioning either the right or upper boundary past the platen boundary, the page is automatically scaled to the boundary value. If the page is then moved back within the platen area, it retains its "squeezed" page size.

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SETTING FOR MIRROR IMAGE, REVERSED AND ROTATED PLOTS

The Plotter may be set to orient the plotting area to produce "mirror image" or "reversed" graphs in which all graphics and alphanumerics are plotted as reversed images. Or, the page orientation may be rotated. Refer to Fig. 2-5. This feature is useful for preparing negative-image plots and projection transparencies. The Joystick and the SET controls are used to implement mirror-image plots in the following manner.

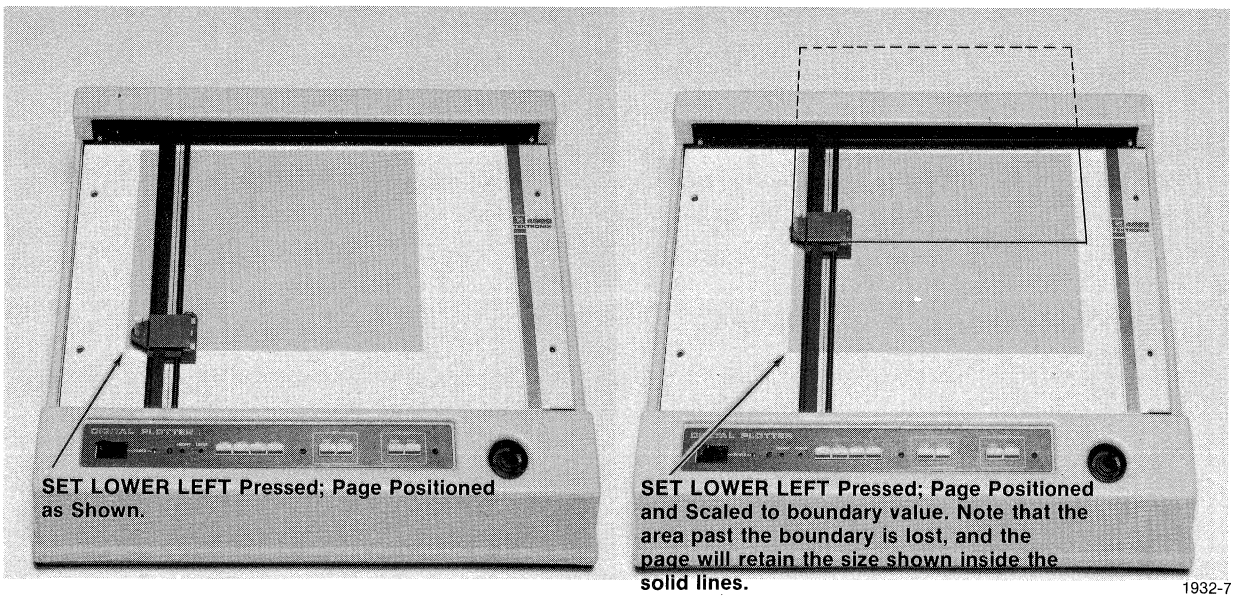

Fig. 2-4. Previously-scaled pages repositioned on the platen. Note that if either page boundary, passes the platen boundary, the page is scaled to the platen boundary.

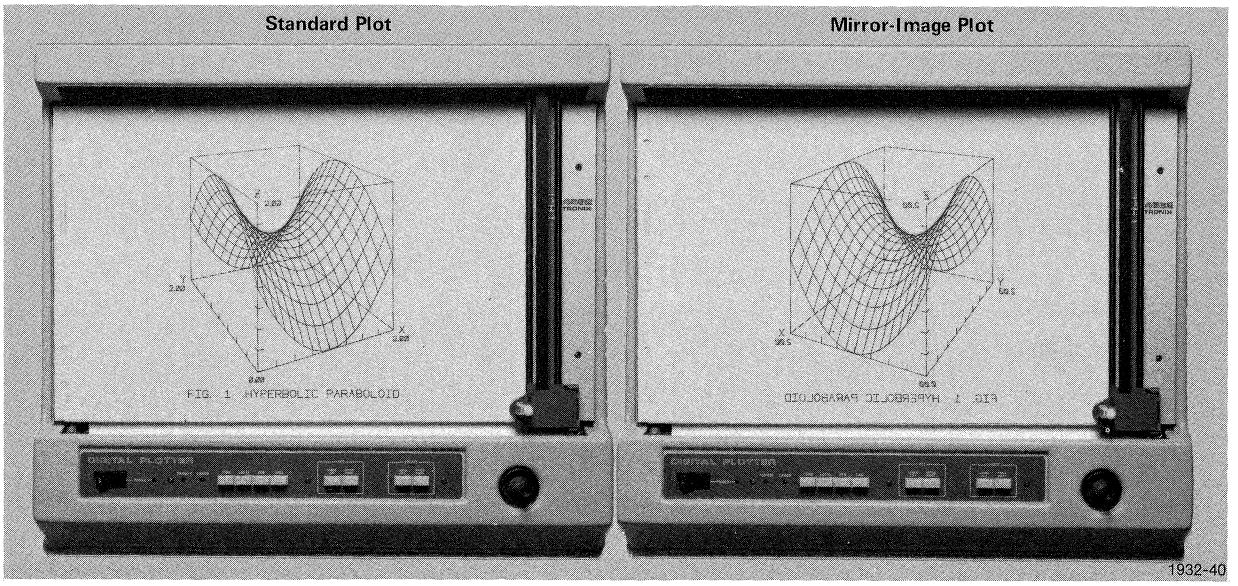

Fig. 2-5. Mirror Image Plot.

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Position the pen to the desired corner of the plotting area (this may be any corner), then press and hold the SET LOWER LEFT button for about one second. The Plotter bell will ring to signal the completion of the SET operation. Position the pen to the opposite corner of the platen, then press and hold the SET UPPER RIGHT button for about one second. The Plotter bell will ring again. Using this procedure, the upper-right and lower-left corners may be set in any corner. Plots can thus be made backwards (Mirror X), upside-down (Mirror Y), or both.

RAISING AND LOWERING THE PEN

Pressing the PEN button changes the up-down state of the pen. If the pen tip is touching the platen when the button is pressed, it will be lifted, and vice-versa.

When producing plots under program control, the Plotter automatically lifts and lowers the pen to perform its MOVE, DRAW, and PRINT operations. These operations occur at the completion of a commanded vector draw operation. If no further commands are received within one-half second, the pen will automatically lift from the paper. This automatic pen lift function is inhibited when the PROMPT indicator is on.

LOCATING THE PAGE BOUNDARIES

The existing page boundary locations may be checked from the front panel prior to executing a plot, if desired. This is accomplished by pressing the LOCATE UPPER RIGHT and LOCATE LOWER LEFT buttons to send the pen to those boundary points.

THE PROMPT LIGHT

The PROMPT light is used under program-control to notify the operator that some action is required. It is normally used to signal the operator that the CALL button should be pressed for a GIN input to the host/controller. However, various programs may use the PROMPT light for other signals, such as loading a fresh sheet of paper.

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PROGRAM-CONTROLLED OPERATION USING THE RS-232-C INTERFACE

This section deals exclusively with commands and command formats that are used to operate the Plotter under program control through the RS-232-C interface. Information on program-controlled operation through the GPIB interface and with the 4051 Graphic System is found later in this manual.

GENERAL INFORMATION

The RS-232-C interface allows the Plotter to be operated from a host computer transmitting data over RS-232-C communication lines. Asynchronous full-duplex transmission can occur at user-selectable data transfer rates of 110, 150, 300, 600, or 1200 baud. All data must be transmitted in ASCII.

The RS-232-C interface has two connection ports on the rear panel, one for a terminal and one for a modem. This arrangement allows the plotter to be "chained" to other devices, such as the Tektronix 4006-1 or 4010-series terminals, the 4923 Option 1 Digital Cartridge Tape Recorder, or other devices with this type of RS-232-C interface. (Refer to Fig. 2-6.) This allows time-sharing program preparation and execution to be performed.

When the Plotter power is off, the TERMINAL and MODEM ports are directly connected, allowing direct terminal-to-modem communication. This terminal-to-modem communication can utilize any line protocol or baud rate.

Refer to the Data Transmission description later in this section for communication considerations when the Plotter is enabled.

OPERATING MODES

The 4662 has three basic operating modes; Alphanumeric (Alpha), Graphic Plot (Graph), and Graphic Input (GIN). These modes are described in greater detail in the following paragraphs.

Alpha Mode

In Alpha mode the Plotter draws any of the printable ASCII characters received at the interface. After each printed character, the pen lifts and moves to the lower-left corner of the next character position. Other features of Alpha mode are the ability to scale the character size (Alpha Scale), to rotate the characters (Alpha Rotate), and to select alternate characters (Alpha Font). These features are described in detail in the Operating Commands description.

The printing and non-printing characters that cause Plotter response in Alpha mode are listed in Section 1, Table 1-1.

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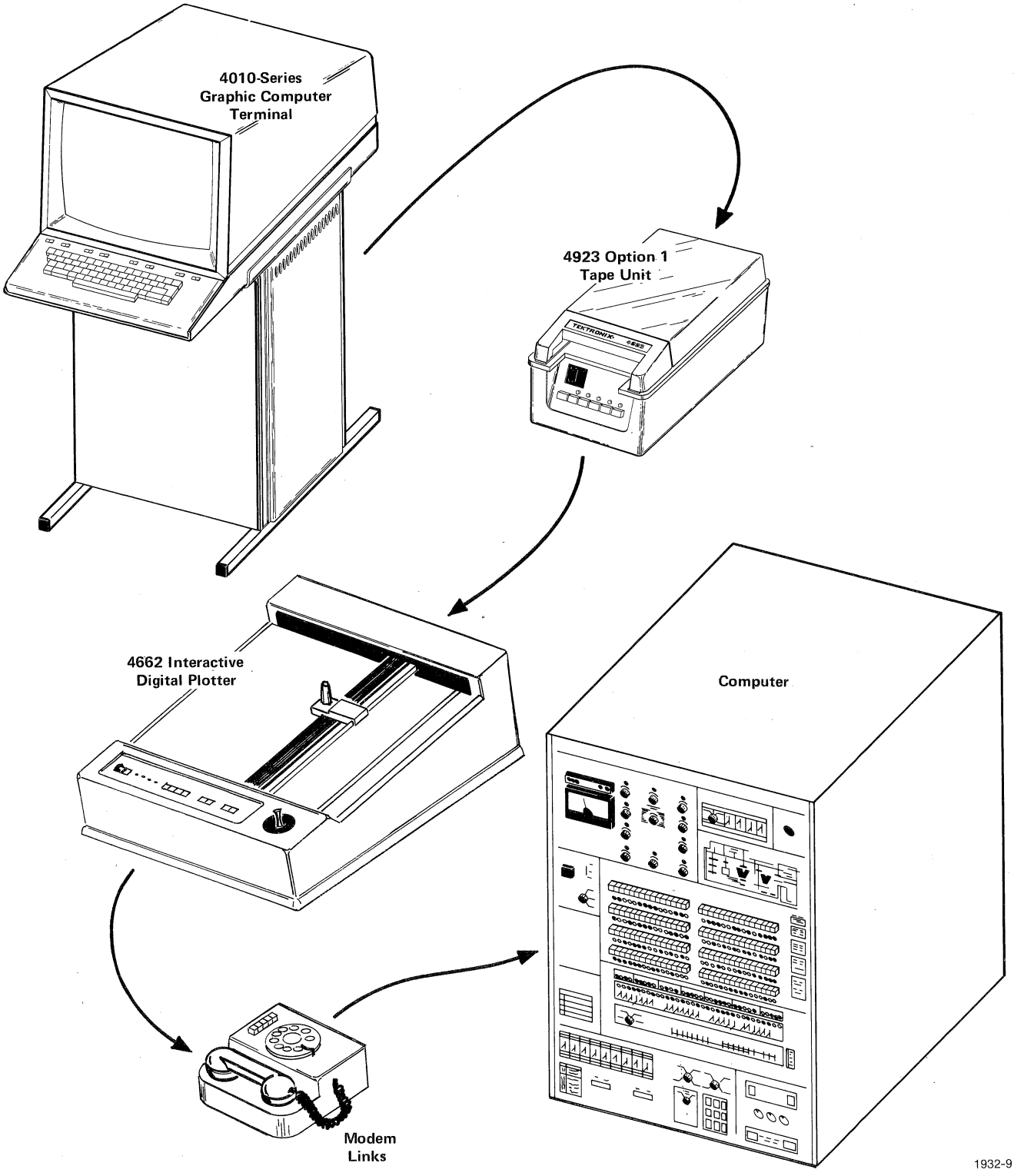

Fig. 2-6. A Typical RS-232-C System, utilizing the 4662.

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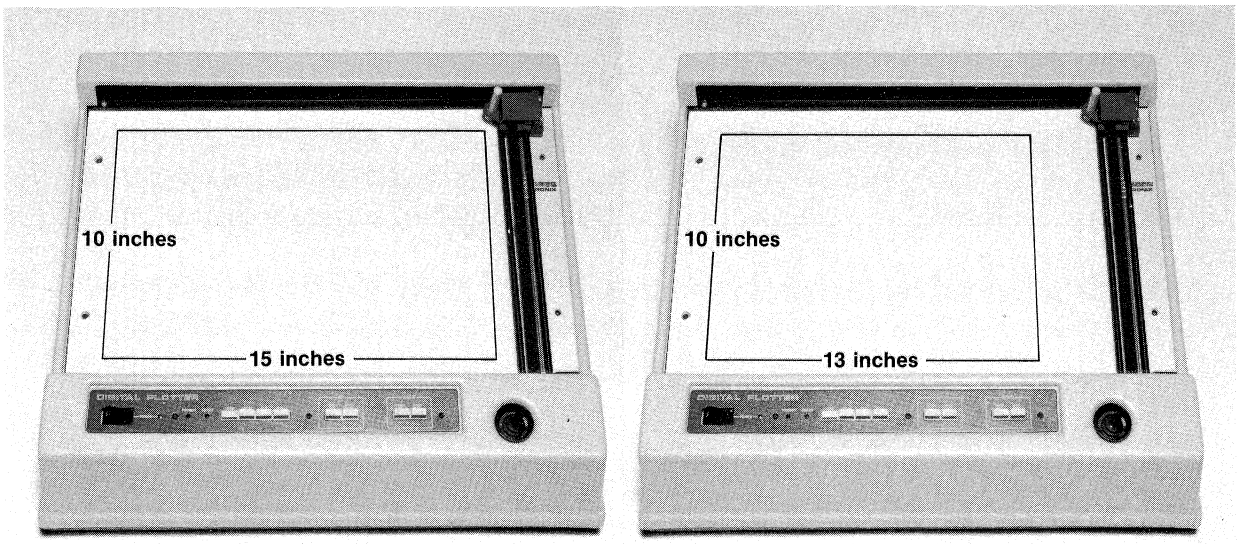
Graph Mode

In Graph mode, the pen can be positioned to any point on the 10 inch by 15 inch plotting surface when operating with Standard plotting condition set. (Refer to Fig. 2-7.) When operating with Copy plotting condition set, the plotting area is scaled to 10 inches by 13 inches to retain the aspect ratio of the Tektronix 4010-series terminals. In this case, the right two inches of the platen cannot be addressed. Refer to the Switch Options section for a description of the differences between Standard and Copy plotting conditions.

When operating in Graph mode, the display points are sent to the Plotter in the form of coordinate messages. Each message consists of up to five data bytes. Two bytes provide the basic Y coordinate information and two bytes provide the basic X coordinate information. These bytes are called HIY, LOY, HIX, and LOX respectively. The fifth byte, XLOY, is an extra bytes which may or may not be used, depending on user data resolution requirements. It provides an extra two bits of X data and an extra two bits of Y data for higher graphic resolution. These coordinate message bytes are decoded by internal logic to determine the coordinate position on the plotting surface to which the pen is to draw (or move). The bytes must be sent to the Plotter in the format:

HIY, (XLOY), LOY, HIX, LOX

These bytes are represented by ASCII characters which have the appropriate bit combination for that part of the coordinate. Refer to the Graphic Data Coding discussion for further information on determining the characters for graphic-address messages.



1932-10

Fig. 2-7. Standard plotting condition vs. Copy plotting condition. Note that the right two inches are not addressable in the Copy plotting condition; the Y-axis corresponds to the viewable Y-axis of the TEKTRONIX 4010-Series Terminals.

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GIN Mode

GIN (Graphic Input) mode allows the Plotter to provide Graphic data input to the computer, allowing the Plotter to be used for digitizing operations. In GIN mode, as well as when Plotter status is requested, the Plotter logic converts the present pen position into data bytes representing that location and transmits the bytes to the host. The conversion from pen position to coordinate bytes is described in the GIN Mode Coordinate Coding discussion. Refer to Fig. 2-8.

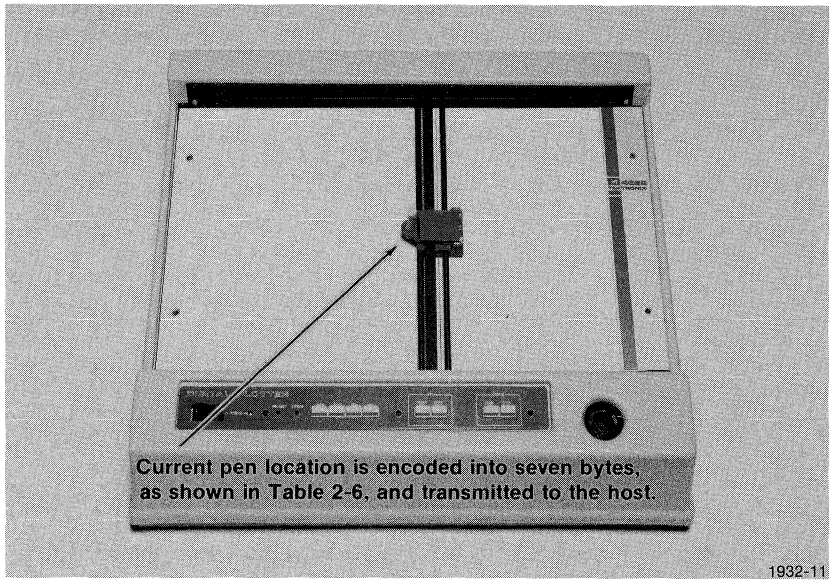

Fig. 2-8. GIN mode operation.

OPERATING COMMANDS

The ASCII US and GS control characters are used to place the Plotter in Alpha and Graph modes, respectively, as shown in Table 2-1. The US character sets the Plotter to Alpha mode. In Alpha mode, the Plotter prints ASCII characters on the plotting surface as they are received.

The GS character causes the Plotter to enter Graph mode. The first vector after a GS is interpreted as an unwritten vector (move) unless the GS is immediately followed by a BEL character. All subsequent vectors are written vectors (draws), until another GS is received.

NOTE

In Alpha mode an ASCII FF is ignored. The sequence ESC FF is interpreted as a HOME command, sending the pen to the Home position near the upper-left corner of the plotting surface.

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TABLE 2-1

Graph Mode and Alpha Mode Commands

Command	Sequence	Description
Graph Mode	(GS)(XY)(XY)...	The GS control character is followed by the coordinate bytes, as described in Graphic Data Coding. The pen lifts and moves to the specified coordinates. If the coordinate is out of the page boundary, the nearest boundary value(s) will be substituted. Subsequent coordinates cause the Plotter to draw a vector, unless the GS is repeated.
Graph Mode	(GS)(BEL) (XY)(XY)...	Placing a BEL after the GS causes the vector to be a written vector (draw) rather than an unwritten vector. In Graph mode, a vector is drawn from the current pen position to the new coordinate each time a coordinate is received. If the new coordinate is outside the page boundary, a MOVE to the nearest boundary value is substituted.
Alpha Mode	(US)(ASCII Characters)	The ASCII text characters are printed. The US normally precedes the text to be printed to place the Plotter in Alpha mode. However, the Plotter powers up in Alpha mode.

Additional 4662 operations are commanded by a three (or more) character sequence of ESC (device) (command) where (device) is an ASCII character switch-selected as the address and (command) is the command character that determines the operation. The switch-selectable address allows selection of one particular Plotter when more than one (up to four) is located on the same RS-232-C communication line.

The additional operating commands are listed and described in the following paragraphs. The qualifiers used in the description are as follows:

(device)	Switch-selected as A, B, C, or D.
(delim)	Delimiter; a comma or a space.
(term)	Data terminator for numeric ASCII data. May be another command sequence or any non-numeric character except a delimiter, +, −, or E.

In addition, numeric arguments for all commands are ASCII decimal numbers in unsigned integer format, most significant digit first, except that the Set Status and Alpha Rotate arguments *may* be negative.

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Alpha Scale

The Alpha Scale command is used in Alpha mode to set the alphanumeric scale sizes for character spacing (X) and line spacing (Y) for operation in Alpha mode. These are specified in the XVAL and YVAL arguments, which are in pen addressing units. XVAL and YVAL are transmitted to the Plotter as ASCII decimal integers, and the default values are character space (XVAL) = 56, line space (YVAL) = 88. Refer to Fig. 2-9. The actual character height is 11/18 the line space (YVAL), and the character width is 6/9 the character space (XVAL).

The Alpha Scale command uses the following format:

ESC device I XVAL delim YVAL term

Alpha Rotate

The Alpha Rotate command is used in Alpha mode to set the angle at which alphanumeric characters are printed on the plotting surface. The range is from zero to +360°. Any real value (not only integers) may be used to set the angle, with negative and positive wrap-around allowed. The angle is measured counterclockwise with respect to the positive X axis; the power-up default angle is 0°.

In addition, an Alpha Rotate command sets the current pen position as the carriage return (CR) reference point in a line perpendicular to the rotation angle set. This is used for CR, LF, and VT commands encountered in Alpha operations. Refer to Fig. 2-10.

The Alpha Rotate command uses the following format:

ESC device J ANGLE term

NOTE

Attempting to print rotated characters past the page boundary causes undefined results, and should be avoided.

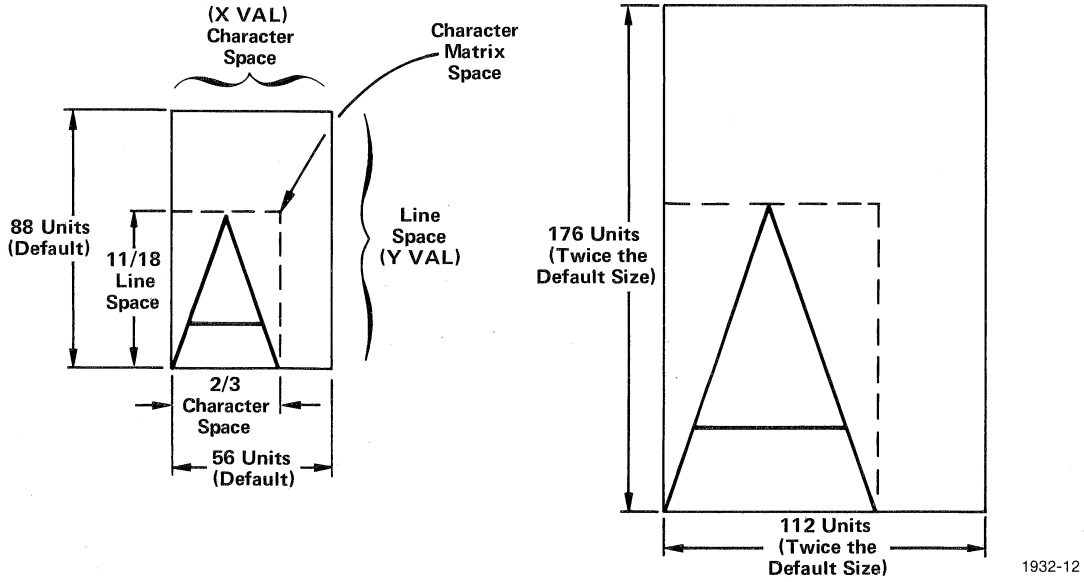

Fig. 2-9. Alpha Scale, showing the character A doubled in both axes (four times the original size). Note the relationship between the character and the character space.

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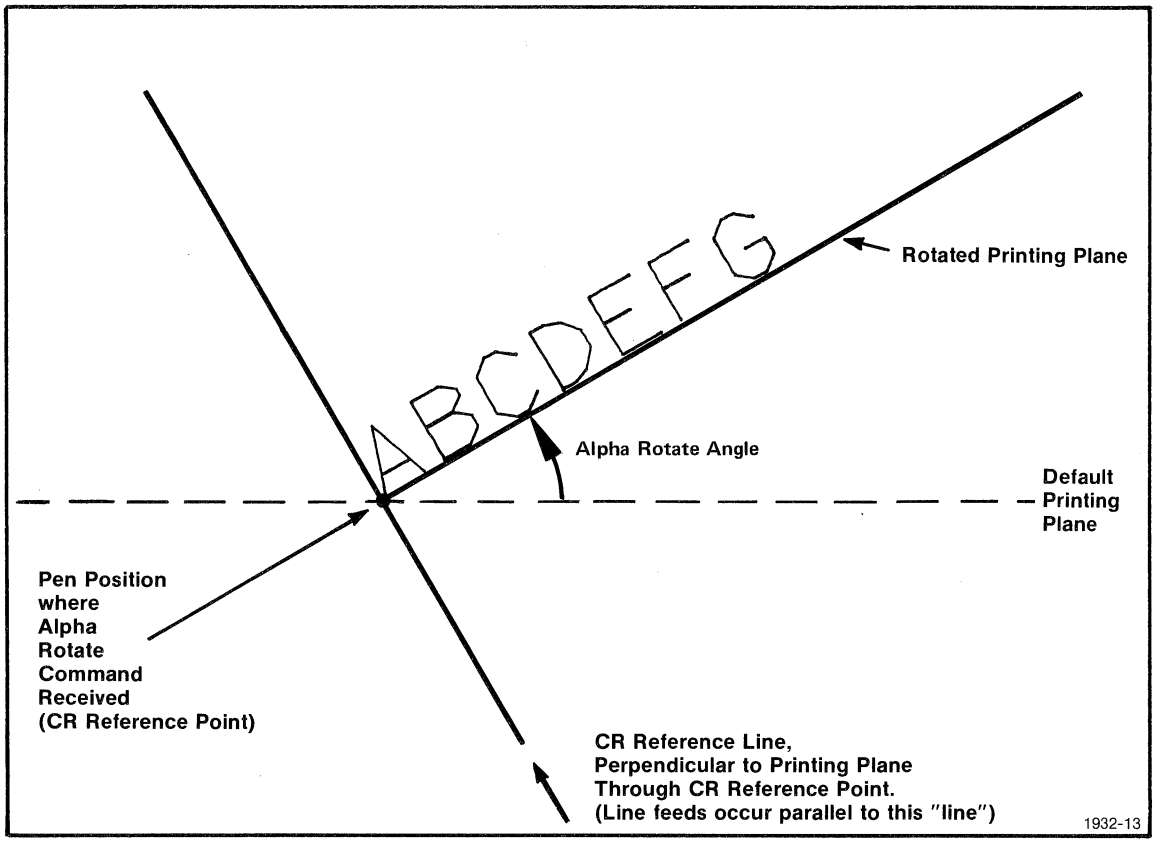

Fig. 2-10. Alpha Rotate, showing the new Carriage Return/Line Feed references.

Alpha Font

The Alpha Font command is used in Alpha mode to select one of seven available printing fonts, numbered Ø through 6. Selections 7 through 16 are reserved for expansion and custom modification. The printing fonts differ only in the printing of certain special characters, as shown in Fig. 2-11.

The Alpha Font command uses the following format:

ESC device T font

A

Plotter On

The Plotter On command is used to enable the Plotter to decode other commands and recognize data. This command is not necessary if Copy mode is set by the rear panel switches (causing the Plotter to power up in the "on" condition), as long as the Plotter Off command is not used. When the Plotter is enabled, data from the modem will not be sent to the terminal unless Terminal Mute is selected at the rear panel.

The Plotter On command takes the following format:

ESC device E

A

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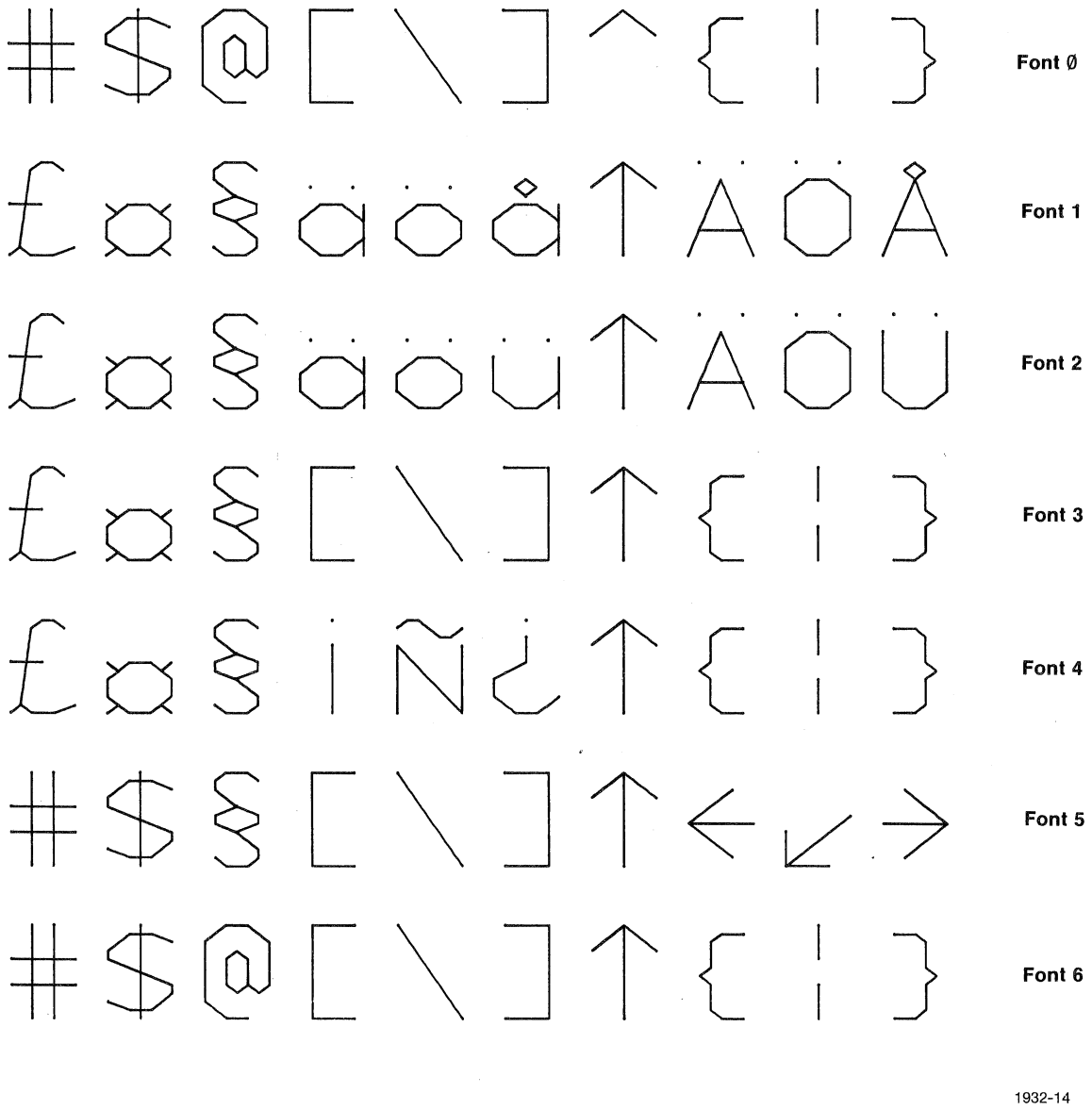

Fig. 2-11. Alpha Font character changes.

Plotter Off

The Plotter Off command causes the Plotter to go "offline," ignoring data and commands until turned on again with a Plotter On command.

The Plotter Off command uses the following format:

ESC device F

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Reset

This command resets all programmable parameters to their default (power-up) values. These parameters include Alpha Scale, Alpha Rotate, Alpha Font, Prompt Light, Turnaround Delay, Block Size, Prompt Character, Bypass Cancel Character, and Signature Character. Refer to the description of each of these parameters to find their default values. The Graph memory is cleared, the Plotter is set to Alpha mode, the output buffer is cleared, and the Carriage Return reference point is set to the Home position.

The Reset command uses the following format:

ESC device N

Alpha Reset

This command resets the Alphanumeric printing parameters to their default values. These include the Alpha Scale, Alpha Rotate, and Alpha Font parameters and the Carriage Return reference point, which is re-established at the Home position.

The Alpha Reset command uses the following format:

ESC device V

Prompt Light On

This command turns on the front panel PROMPT light, and initiates a Prompt scan if a Prompt character is programmed. The automatic pen lift feature is inhibited when the PROMPT indicator is on. It uses the following format:

ESC device K

Prompt Light Off

This command turns off the front panel PROMPT light, and terminates Prompt mode. It uses the following format:

ESC device L

Turnaround Delay

The Turnaround Delay command sets the turnaround delay time for the RS-232-C communication link. This delay follows the last-received character prior to Plotter-to-host transmission or occurs between successive output transmissions. Turnaround Delay is specified in milliseconds, and uses the following format:

ESC device G DELAYTIME term

GIN Mode

The GIN mode command places the Plotter in GIN (Graphic Input) mode, causing the Plotter to encode the current pen coordinates and pen up/down status for transmission to the host system and place that data in the output queue. The pen status bit (bit 3) within the last byte is set to 1 if the pen is down and Ø if the pen is up. GIN data transmission is described in the Plotter Output Data Coding description; after transmission the Plotter immediately exits GIN mode. The GIN mode command uses the following format:

ESC device M

A

This operation differs from Call GIN, which is implemented by pressing the CALL button. When the CALL button is pressed, pen coordinates are transmitted in accordance with Input/Output protocol in effect at the time.

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Bypass Cancel Character

In Plotter output modes (GIN, etc.), characters transmitted by the Plotter may be echoed by your computer system. These echoed characters will be suppressed (not printed) until after the Bypass Cancel Character is received. This command sets the Bypass Cancel Character to the desired ASCII character. The default (power-up) value is a NUL character, indicating that no suppression is to take place. The command to set the Bypass Cancel Character takes the following format:

ESC device U ASCII Character

(ASCII character) is the desired Bypass Cancel Character, and may be set to LF for most timeshare systems.

Prompt Character

This command sets the Prompt character to the desired ASCII character. When using Prompt mode, this character must be received from the host before initiating an input transmission (Plotter to host). It takes the following format:

ESC device R ASCII Character

Signature Character

This command sets the optional Signature character, which is prefixed to each transmission from the Plotter. This allows the host system to differentiate between inputs from multiple devices. The command to set the Signature character takes the following format:

ESC device S ASCII Character term

Block Start

This command is used for Block mode transmission; it signals the beginning of a new block and starts the checksum accumulation with the character "(". The checksum includes all transmitted ASCII characters up to and including ")" except NUL, SYN, and DEL (unless DEL→LOY is selected with rear-panel switches). The Block Start command format is as follows:

ESC device (

Block End

The Block End command comes from the host to signal the end of a transmitted block, and to indicate that the current checksum accumulation ends following the character ")". The checksum value that follows is an ASCII decimal number in the range Ø — 4Ø95, representing the 12-bit checksum value. The Block End command format is as follows:

ESC device) CHECKSUM VALUE term

Following verification of the checksum value received, the Plotter transmits a positive (A) or negative (I) acknowledgement to the host system. If a Signature Character is programmed, it precedes this transmission. Note that the form of this acknowledgement is as described in the Plotter Output Data Coding description.

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Block Size

The Block Size command sets the maximum number of characters in a block, including Block Start and Block End Escape sequences (i.e., number of data characters plus 6), that the host system will be transmitting. When the Plotter receives a Block End command, requiring a checksum verification, it cannot give a positive checksum verification response until it has buffer space available for one new block. The Block Size is specified as a number representing the number of bytes to be transmitted in one block; the default value is zero. The command format is as follows:

ESC device H BLOCKSIZE term

Size

The Size command causes the Plotter to send the X and Y dimensions of the physical plotting surface to the host system in inches, along with options information. The options information includes the firmware release number, the RAM (input buffer) size, and contains space for notation of custom modifications (such as special character sets). The message takes the form described in the Plotter Output Data Coding description. The data is encoded within the message as shown in Table 2-2. The command format is as follows:

ESC device Q

TABLE 2-2

Size Message Coding

Data	Bits															
	16	15	14	13	12	11	1Ø	Ø9	Ø8	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1
X coordinate	X Size								Y Size							
Y coordinate	Options										RAM Size			Firmware Release Number		

NOTE: Pen = Ø, type = 11

Read Status

The Read Status command causes the Plotter to send one status word to the host system. There are 16 possible status words, labeled Ø through 15. The Plotter will transmit the status word number and the contents of the status word as an X-Y coordinate in accordance with current Input/Output parameters, in the format described in Plotter Output Data Coding. Within the message pen status = Ø type = 1Ø.

Of the 16 possible status words, the first four are read only; the remainder may be set. Ø and 1 are defined by the 4662 as shown in Table 2-3. Status words 2 through 7 are reserved for expansion. Words 8 through 15 are only used with optional memory installed, and are undefined in standard units. They cannot be addressed unless optional memory (PROM) is installed. The format of the Read Status command is as follows, where X is an ASCII number representing the desired status word (Ø—15):

ESC device O X term

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NOTE

Bit 16 of a status word is a sign bit and should be considered as such when decoding the status word, using standard two's complement arithmetic. This will conform to the Set Status Format.

Set Status

The Set Status command is used to place a particular value in one of the programmable status word positions 4 through 15. The desired status word to be set is represented in the format as X, and the value to be stored therein is the variable N. The N value (−32768 to 32767) is converted to 16-bit 2's complement binary form and stored in the status word (4 through 15) defined by X. As with the Read Status command, Words 8 through 15 cannot be addressed in the standard product. The format is as follows:

ESC device P X delim N term

DATA TRANSMISSION

There are two modes of communication to the Plotter, Continuous Mode and Block Mode. These operate as follows.

Continuous Mode

When data is transferred continuously to the Plotter, the host system must guard against possible Plotter input buffer overflow in one of the following ways:

1. Padding the data with an algorithm to insert the appropriate number of SYNC, NUL, or DEL (unless DEL→LOY is selected) characters after each alpha character or graphic vector.

2. Transmitting commands in blocks with an appropriate time delay between blocks.

3. Transmitting at a low enough rate (baud) for the Plotter to keep up with commands.

Refer to Appendix D for further information on over-run protection.

In Continuous mode, transmission error checking is done only by character parity checking, as selected by the rear-panel switches. A parity error will light the error indicator and ring the bell; a framing error or an overrun error will also light the ERROR indicator.

Block Mode

In Block mode transmission the Plotter controls the information rate from the host system by accepting and acknowledging blocks of characters. This allows the Plotter to prevent input buffer overflow as well as providing additional means of error detection and recovery.

In Block Mode, the host sends a block of Plotter commands, preceded by a Block Start command and followed by a Block End command (containing a checksum value). Refer to the Checksum Accumulation description.

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TABLE 2-3

Defined Status Words

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status Word # Ø : System Status																
ON=1	Unused			Low Speed	CR CRLF	Pen Down	Load Switch In	Mirror Image X	Mirror Image Y	X Above (Right)	X Below (Left)	Y Above	Y Below	I/O Error	Prog. Error	Inter-nal Error
OFF=Ø				Normal Speed	CR CR	Pen Up	Load Switch Out	Normal X	Normal Y	on Scale				No I/O Error	No Prog. Error	No Inter. Error
Status Word # 1 : RS-232-C I/F Status																
ON=1	Unused		Copy Mode	Ignore DEL	Term= CR + EOT	Term= CR	NUMBER OF INPUT BUFFER BYTES AVAILABLE									
OFF=Ø			Normal Mode	DEL LOY	No EOT	No CR										

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The host then pauses for acknowledging input from the Plotter. If the checksum was good and there were no framing, parity, or overrun errors, and when there is room in the input buffer for another block, the Plotter responds with a positive Block Acknowledge ("A"); another block may then be sent. If the checksum is bad or if a transmission error has occurred, the block is discarded, a negative Block Acknowledge ("I") is sent, the ERROR indicator lights, and the Plotter bell rings. This calls for retransmission of the "bad" block. If the following block is accepted, the I/O error bit in the system Status Word is reset. This extinguishes the ERROR light if there are no other system errors. The Block Acknowledge messages are always followed by the rear panel switch-selected GIN Terminator and are preceded by the Signature character if one has been selected. They may be preceded by Call GIN blocks entered while the block was being transmitted (which may or may not be ignored by the operating program). Refer to Fig. 2-12.

Unless the Block size is set to a non-zero value by a Block Size command, a positive Block Acknowledge will be immediately returned if the checksum is good.

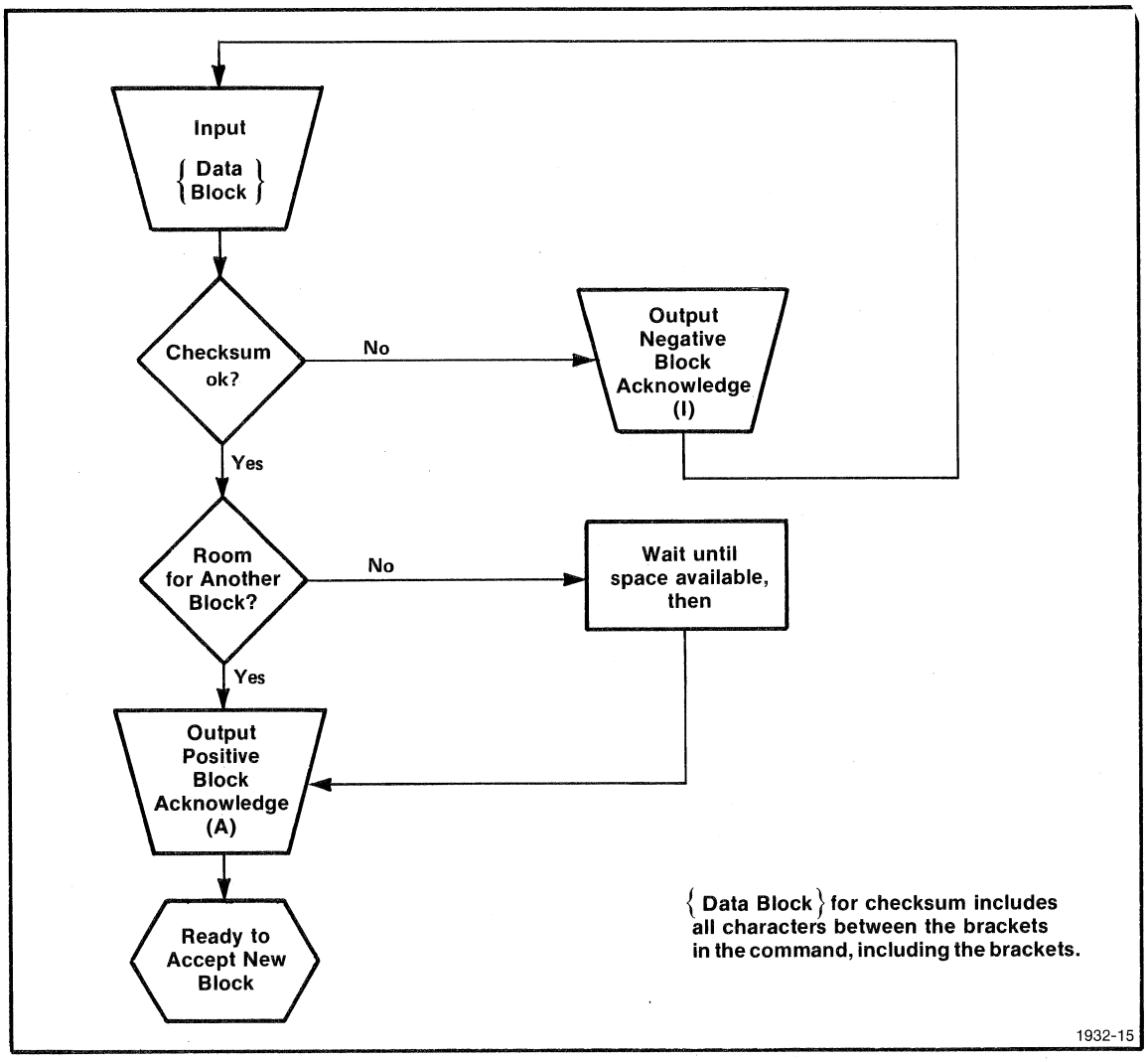

Fig. 2-12. Block Mode communication.

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Since Block Mode communication causes output to be sent to the host, all communication parameters must be sent to the Plotter in Continuous Mode before Block Mode is initiated. These include Prompt Character, Turnaround Delay, Bypass Cancel Character and Block Size. This will ensure that all transmissions to the host will be sent in the form expected by the host (including a negative Block Acknowledge sent in response to the first block of a Block Mode transmission that contains an error). The use of these parameters governing transmission to the host are described in the Plotter-to-Host Transmission description.

Communication Mode Selection

When the Plotter is activated by a Plotter On command, communication is automatically initialized to Continuous Mode. This mode is maintained until the first Block Start command is received, which causes Block Mode to be initiated. (Block Mode may be initiated directly by substituting a Block Start command for the Plotter On/Block Start combination.)

There are two Plotter states within Block Mode. The In Block state occurs between the Block Start and the Block End Command. In this state, the following commands (which normally affect communications) are ignored:

Plotter On
Plotter Off
Turnaround Delay
Block Size
Prompt Character
Signature Character
Bypass Cancel Character
Block Start
Reset*

The Between Block state occurs between a Block End command and the next Block Start command. In this state, only the Plotter Off command and the Reset or Plotter On commands (used to change to Continuous Mode) or a Prompt character are acted upon. All other commands above are ignored.

Data Transmission (Plotter-to-Host)

The Plotter is capable of transmitting four types of output blocks to the host system. (The transmission formats are described in the Plotter Output Data Coding description.) The block types and the circumstances that cause them to be generated are described in the following paragraphs.

Block Acknowledge. Either a positive or negative acknowledgement is returned to the host in response to a Block End command. This block is always followed by the rear-panel switch-selected GIN terminator.

Size. Plotter size is returned to the host in response to a Size command.

*** Does not clear Turnaround delay, Block size, Prompt character, Signature character, or Bypass Cancel character, but does perform all other Reset functions.**

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Status. A Status block is returned to the host in response to a Status command or when the front panel CALL button is held down long enough to ring the Plotter bell once.

GIN. A GIN block is returned to the host in response to a GIN command or when the front panel CALL button is pressed momentarily.

The assembling of the blocks into an output transmission and the initiation of the output transmission may be controlled to some extent by the transmission parameter commands. The circumstances under which each command would be used and the effects of their use are discussed in the following sections.

If none of the transmission parameters are invoked, Plotter-to-Host transmission is unrestricted (i.e., Full Duplex). That is, the Plotter will start transmission as soon as there is something to send. The output is buffered, so that output blocks may be generated faster than the communication link can handle them. (Buffer size is seven output blocks.) Transmission can only occur when the Plotter is logically "on". If the output is unrestricted and there are output blocks in the buffer when the Plotter is enabled (i.e., by a Plotter On command), transmission will occur immediately.

Since the Plotter is capable of initiating input not requested by the host, the host input software must be able to handle unsolicited input data.

A Reset command must be used to disable the transmission parameter characters when none are desired. Character default values are NULs, which cannot be sent to the Plotter as they are stripped from the incoming data.

Signature Character

A unique Signature character may be prefixed to each output block to allow the host system to identify the source of an input transmission when there is more than one device on the communication link capable of transmitting.

Bypass Cancel Character

Many host systems use a computer echo system in which all input from a device on the communication link is echoed back to the device. Such a system may cause undesirable action by the Plotter. This may be prevented by setting the Bypass Cancel character to some character other than NUL, enabling the Plotter's Bypass Mode. Bypass Mode is then activated each time a Plotter-to-Host transmission is initiated. All incoming data is then discarded by the Plotter until the Bypass Cancel character is received. The Bypass Cancel character is also discarded; subsequent data is acted upon in the normal manner.

By utilizing specific settings for the Plotter Output (GIN) terminator, Bypass Mode may be automatically entered and exited during Plotter-to-Host transmission. For example, if the host were to echo CR-LF when a CR is received, the Plotter Output (GIN) terminator may be set to CR and the Bypass Cancel character set to LF. Bypass Mode would thus be canceled when the Plotter received the echo of the last character associated with transmission to the host.

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If Terminal Mute is selected, the discarded data will also be blocked from other devices further down the communication link (such as a terminal).

Turn-around Delay

Some host systems cannot support simultaneous transmission and reception of data (even over a hardware full-duplex communication link). To operate in such a system, the Turn-around Delay may be set to a value greater than the time it takes to receive a character at the prevailing baud rate plus the time required for the host communications hardware to be set for reception. This will inhibit the Plotter from initiating transmission as long as data is being received from the host. Once transmission is initiated, however, it will continue until all Plotter output blocks are sent, even if characters are received from the host.

A similar situation occurs with some line-oriented host systems that initiate a sequence of operations when they receive a CR character. This prohibits further reception for some period of time. The Turn-around Delay may be used to provide a delay equal to the specified value between the transmission of a GIN terminator and the start of transmission of the next output block.

Prompt Character

Some host systems can only accept input at certain times, even though their communications hardware supports full-duplex operation. The host normally indicates that it is available for input by transmitting a Prompt Character. The receipt of the Prompt Character, when one is set, is used to enable transmission. Once transmission to the host ceases, it cannot be initiated again until the Prompt Character is received. Once transmission begins, it continues until the first GIN terminator is encountered in the output buffer. The terminator is transmitted, and transmission ceases. The effect of the prompting capability upon Continuous Mode communication and Block Mode communication is described in the following paragraphs. An input block will never be greater than 72 characters in length.

Prompted Continuous Mode. When a Prompt Character is set in Continuous Mode, output blocks are entered into the output buffer as they are generated *without* a GIN terminator following each block. When the Prompt Character is received, the GIN terminator is entered after the last block in the buffer, and transmission is initiated.

The Prompt Character, because it is described only as a single alphanumeric character, is usually not unique in the Plotter input data. Therefore, some restrictions must be placed on where a Prompt Character may occur to be properly identified as a Prompt. In Continuous Mode, turning on the PROMPT light (which normally indicates that the host expects input) enables a scan of the input data for the Prompt Character. In addition, Read Status, Read Size, and GIN commands initiate a Prompt scan. During a scan the only commands that are accepted are Plotter On, Plotter Off, Prompt Light Off, and Reset, any of which will terminate the scan.

Prompted Block Mode. This condition operates in a different manner to accommodate Block Acknowledge transmissions. Output blocks are entered in

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the output buffer without an output (GIN) terminators except for the Block Acknowledge blocks, which are always followed by an output (GIN) terminator. Receipt of a Prompt Character causes a terminator to be entered in the output buffer only if one is not already present. Transmission then occurs up to the first terminator encountered. This method allows output blocks to be sent in the largest group possible.

In Block Mode the Plotter's scan for the Prompt Character occurs only between blocks. The only commands that are accepted during the scan are Plotter On, Plotter Off, Block Start, and Reset, each of which cancel the scan.

CHECKSUM ACCUMULATION

In Block mode, a Checksum method of error checking is employed. This is accomplished by adding the decimal equivalent of each ASCII character into an initially zero accumulator (see Appendix B for ASCII decimal equivalents). The accumulation starts with the "(" character in the Block Start command and ends with the ")" character in the Block End command; both are included. The Plotter internally computes its checksum in a 12-bit accumulator, using end-around carry. Thus, when the host accumulator value exceeds 4Ø95 ($2^{12}-1$), you must subtract 4Ø94 (−4Ø95+1) from it. The resulting binary result is converted to ASCII decimal and transmitted as a Checksum. Any disparity between the checksum values computed on each end of the transmission is interpreted as a checksum error. Refer to Fig. 2-13.

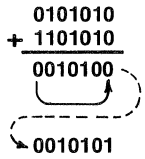

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Fig. 2-13. Checksum Accumulation.

GRAPHIC DATA CODING

In Graph mode the 4662 plotting surface is addressed in the following manner when operating through the RS-232-C interface.

The coordinates on the plotting surface are represented by binary numbers. The X coordinate range is Ø through 4Ø95. The Y coordinate range is Ø through 2731 in Standard plotting mode, or Ø through 3124 in Copy plotting mode. (Refer to the Switch Options description in the Installation section for further detail on the differences between Copy and Standard plotting modes.) An equal change in the coordinate value for each axis represents an equal distance in each axis on the plotting surface (Fig. 2-14), unless the page aspect ratio has been altered by scaling.

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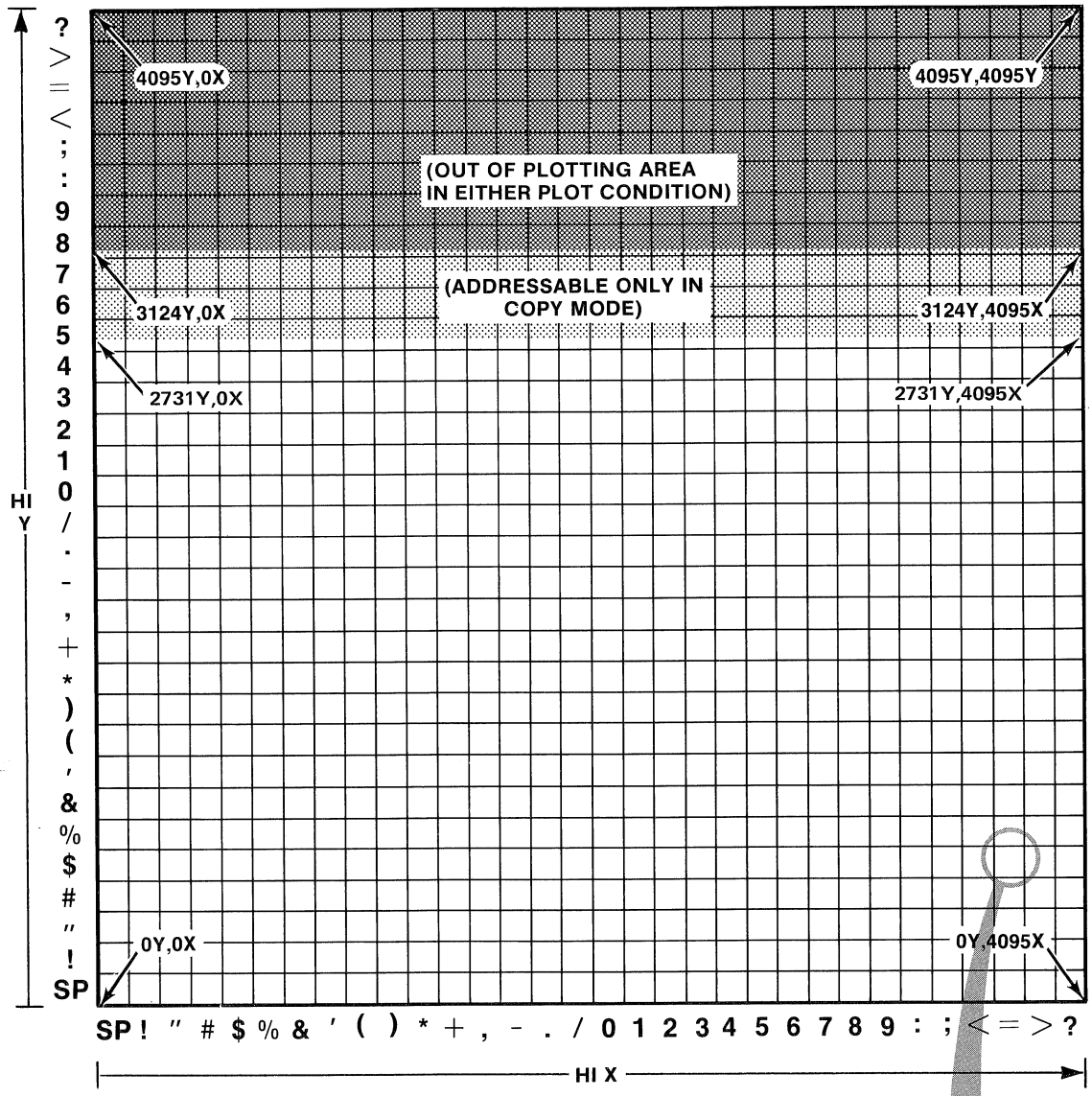

XLOY

l	m	n	o
h	i	j	k
d	e	f	g
\	a	b	c

Note that characters from the second LOY column may also be used; these are shown for consistency.

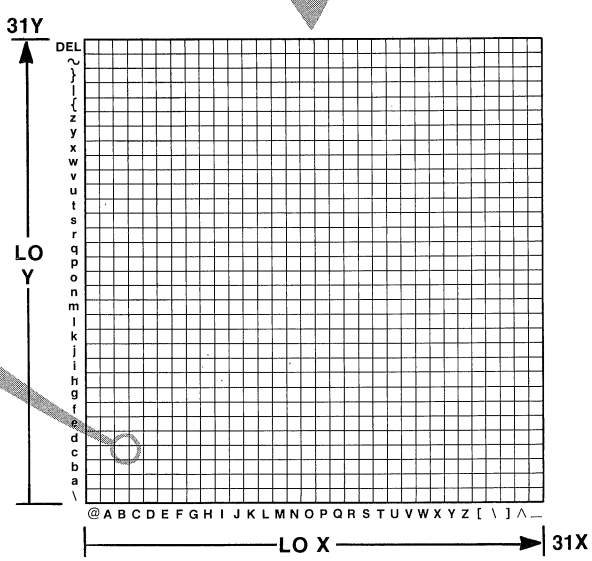

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Fig. 2-14. X-Y Coordinates.

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In this coding system, each coordinate is represented by a 12-bit binary number, the 24-bit total of which is coded into five bytes as shown in Table 2-4. Note that the Plotter is also compatible with 10-bit resolution systems that do not use the XLOY byte.

TABLE 2-4

Graphic Data Byte Values

Byte Number	Byte Name	7-Bit ASCII Character						
		Tag	Bits	Address Message				
		7	6	5	4	3	2	1
1	High Order Y (HIY)	Ø	1	5 most significant bits (MSB) of Y coordinate				
2	Extra Byte (XLOY)	1	1	Not used	? LSB of Y		2 LSB of X	
3	Low Order Y (LOY)	1	1	5 intermediate bits of Y coordinate				
4	High Order X (HIX)	Ø	1	5 MSB of X coordinate				
5	Low Order X (LOX)	1	Ø	5 intermediate bits of X coordinate				

All five bytes (HIY, XLOY, LOY, HIX, LOX) are required to represent a complete 12-bit coordinate, but fewer are required when the HIX and HIY bits do not change, or when the Y coordinate bits (HIY, LOY) do not change. In addition, the extra byte (XLOY) need not be sent, but LOY must always be sent if XLOY is sent. The rules for shortened addressing are shown in Table 2-5. Note that LOX must always be sent to signify the completion of a coordinate.

TABLE 2-5

Shortened Address Requirements

Changed Bytes	Bytes That Must Be Sent				
	HIY	XLOY	LOY	HIX	LOX
HIY	#				#
XLOY		#	#		#
LOY			#		#
HIX			#	#	#
LOX					#

This system of XY coordinate transmission is patterned after the Tektronix 4Ø14 and 4Ø15 terminals, which use similar 12-bit address messages. Note, however, that the XLOY byte need not be sent, allowing the Plotter to be compatible with 1Ø-bit resolution addressing as used in the Tektronix 4ØØ6-1 and 4Ø1Ø-series terminals.

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PLOTTER OUTPUT DATA CODING

In Plotter Output modes (GIN mode, status, etc.), the Plotter utilizes only ASCII characters 32-95 (SPACE to —). Two 16-bit values (up to decimal 65535) are encoded into seven characters according to Table 2-6. These values have different meanings depending on the information requested by the host system.

TABLE 2-6

Plotter Output Bytes

Byte Number	Byte Name	7-Bit ASCII Character						
		Tag Bits		Address and Data Bits				
		7	6	5	4	3	2	1
1	Highest X	Ø	1	5 MSB of X (bits 15—11)				
2	Highest Y	Ø	1	5 MSB of Y (bits 15—11)				
3	High X	Ø	1	5 bits of X (bits 1Ø—6)				
4	High Y	Ø	1	5 bits of Y (bits 1Ø—6)				
5	Intermediate X	Ø	1	5 bits of X (bits 5—1)				
6	Intermediate Y	Ø	1	5 bits of Y (bits 5—1)				
7	Low X,Y, Status	1	Ø	Low X bit	Low Y bit	Pen Status	Data Type	

Notice that his method allows transmission of 16 bits. The full 16 bits are used only for status and size messages. For GIN coordinates the Plotter sends only the 12 high order bits (bits 15—4), with the other four bits set to Ø.

The Pen Status bit within the last byte has meaning only for GIN mode, indicating the pen up/down state:

1 = Pen Down
Ø = Pen Up

The Data Type bits of the Status Message are encoded as:

ØØ = Graphic Input (GIN)
Ø1 = Block Acknowledge
1Ø = Status Input
11 = Size Input

All four data types use the same general message format when transmitting to the host. All bytes are always sent except when sending a Block Acknowledge. In that case only the last byte is sent, and is always an "A" or an "I".

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SWITCH OPTIONS

The rear panel of the 4662 contains four hexadecimal (sixteen-position) switches, labeled A, B, C, and D. The switches provide control over a number of system and interface parameters, allowing the 4662 to conform to various program and system requirements. The switch-selectable options that relate to the RS-232-C interface requirements are as follows:

1. Data Transfer Rate (Baud): 11Ø, 15Ø, 3ØØ, 6ØØ, 12ØØ.
2. Parity: even, odd, none.
3. Plotter Output (GIN) Terminator: CR, CR+EOT, none.
4. DEL (RUBOUT) Interpretation: DEL, DEL implies LOY.
5. Device Address: A, B, C, D.
6. Copy Mode: on, off.
7. Stop Bits: 1,2.
8. CR→CR + LF: on, off.
9. Low-speed Plotting: on, off.
1Ø. Terminal Mute: on,off.
11. RS-232-C Interface Enable: on, off.

Because these parameter settings are vital to proper system operation, the switch positions must be carefully selected. Refer to the installation instructions in Section 4 for a detailed description of parameters and the method of switch selection. Fig. 2-15 shows the switch positions.

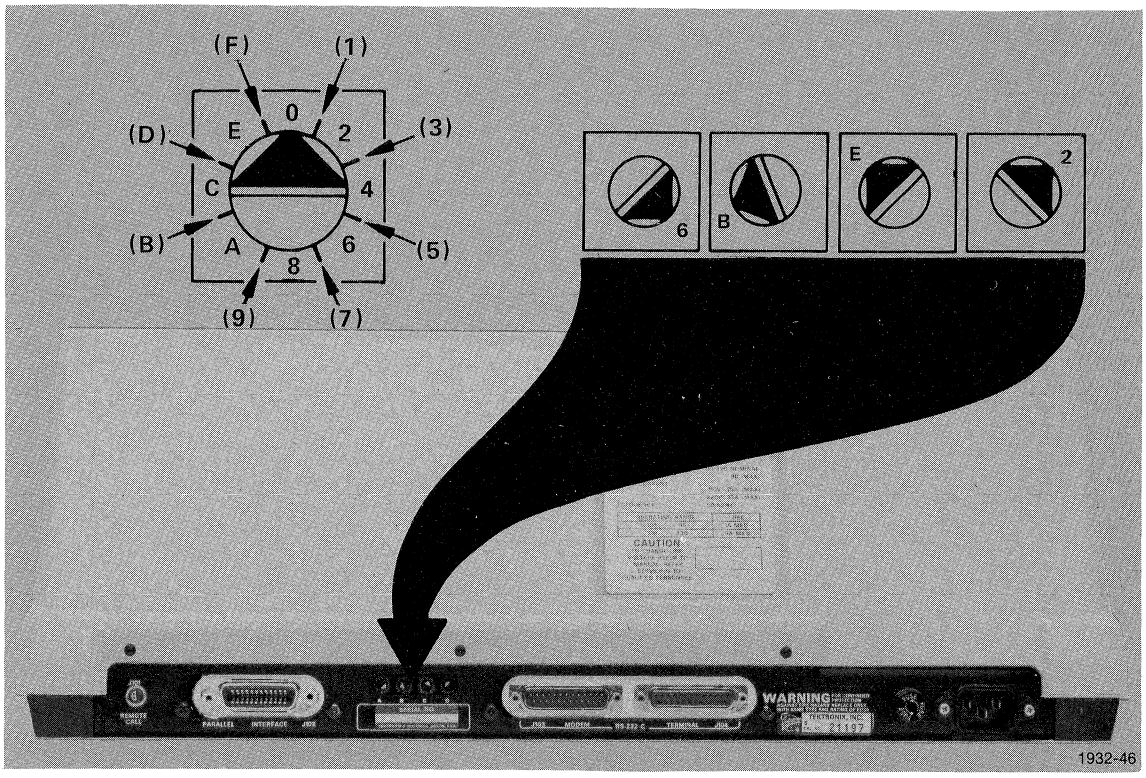

Fig. 2-15. Switch Positions and Locations (example settings only).

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PROGRAM-CONTROLLED OPERATION USING THE GPIB INTERFACE

This section deals exclusively with commands and command formats used to operate the 4662 under program control through the GPIB interface. Information on operating the Plotter through the RS-232-C interface is found elsewhere in this manual.

GENERAL INFORMATION

The General Purpose Interface Bus (GPIB) is an interface that allows the Plotter to be used as part of an instrumentation system. The design of the interface allows three different types of devices: listeners, talkers, and controllers. The addressing capability of the General Purpose Interface Bus allows specific listeners and talkers to be activated and deactivated independently. The responsibility of the Controller is to designate which devices are active to listen and to talk. The controller may be the Tektronix 4Ø51 Graphic System or any other programmable controller with the GPIB-type interface. (Details on the interface may be found in Appendix C.)

In the GPIB system, the 4662 can be a listener (as it can accept data and commands to produce Graphs and printed Alphanumerics), or it can be a talker (as it can send the current pen coordinates and status messages to the Controller or another listener device). A controller, such as the 4Ø51, is necessary to oversee which devices are active and when, unless the Plotter is set to Listen Only or Talk Only mode. Listen Only and Talk Only modes are used in a system configuration with no active controller, if offline.

An interconnecting cable for the GPIB system is available for connection to the controller or other device. The cable is designed to allow chaining devices together or connection in a parallel bus-type fashion. Refer to Fig. 2-16.

NOTE

For the Plotter to operate properly in Listen Only mode, it must be set to accept DAB commands. MSA commands will be ignored.

COMMAND FORMS

In the following descriptions of Programmable Functions, two forms of the address and command sequences are shown. The variables used in these sequences are defined as follows:

MLA	My Listen Address; the primary address used to address the Plotter to listen to the incoming data.
MTA	My Talk Address; the primary address used to address the Plotter to cause it to transmit data.
MSA	My Secondary Address; the secondary address, which may be used as the command to cause some operation to occur. For example MSA12 is equivalent to secondary address 12, or a Print command.

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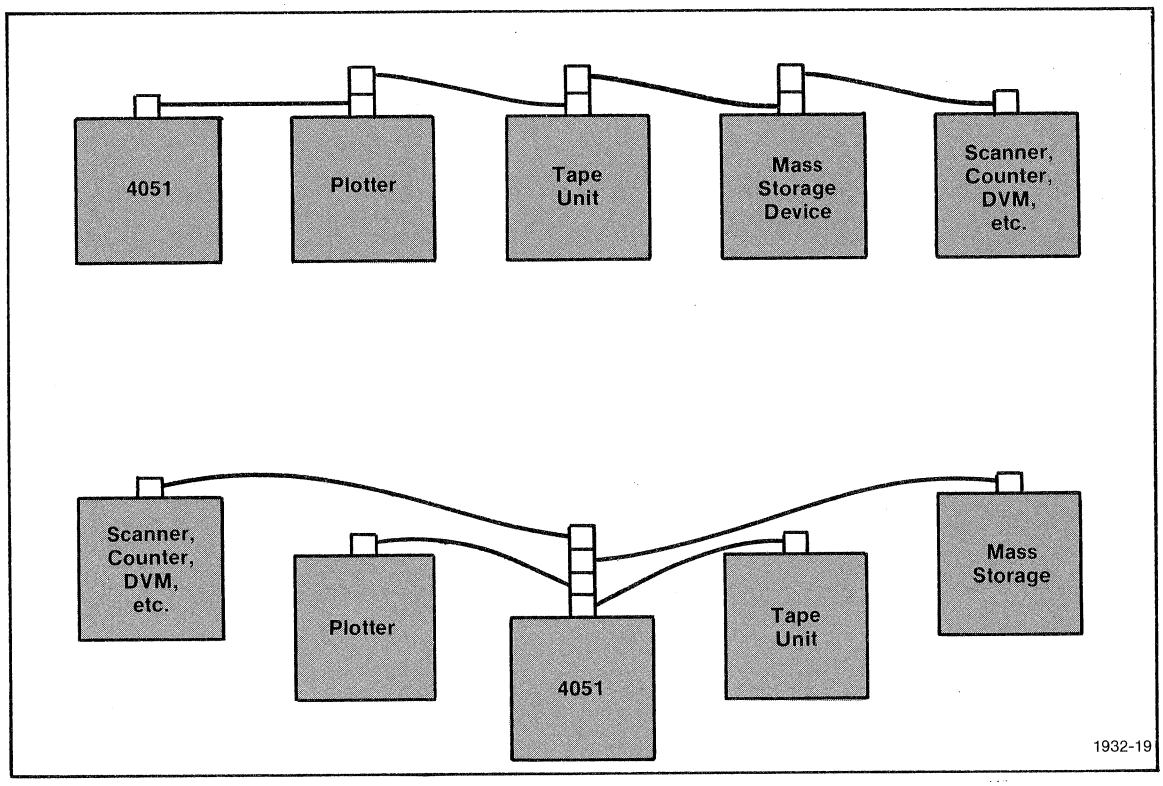

Fig. 2-16. Two types of GPIB connection, showing the 4051 Graphic System as a controller.

DAB — Command Data Byte; a single data byte (ASCII character) that may be used to cause some operation to occur. For example, a P after the Primary Address is the DAB equivalent of a Print command.

When secondary addresses are used as commands, transfers of data take the following form:

(MLA) (MSA) data to Plotter (term) or
(MTA) (MSA) data from Plotter (EOI)

When Command Data Bytes are used to cause Plotter operation, data transfers take the following form (note that the = or ? delimiters are optional):

(MLA) (DAB) = data to Plotter (term) optionally followed by other commands without a new (MLA)
(MLA) (DAB) ? (term) (MTA) data from Plotter (EOI)

Notice that many DAB commands may be appended into one command string.

For example, a Home (H), Prompt Light on (T1) and Print (P THIS IS TEXT) may be appended as follows:

HT1 (delim) P THIS IS TEXT (ETX) M 75,50 CR

The home command is a single letter, and needs no arguments. The prompt light command requires a numeric argument; here a 1 is used to turn it on. The print command prints the text following the command until a print delimiter is seen; here an ETX control character (control-C). The move command needs x and y coordinates, separated by a comma or a space.

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DAB draw commands are not limited to a single coordinate pair. The following example draws a square, followed by a home.

D50,50;60,50;60,60;50,60;50,50;H

The semicolon after each coordinate pair is used for illustration, and is optional; it is interchangeable with a comma or space.

PROGRAMMABLE FUNCTIONS

The following paragraphs describe the Programmable Functions of the 4662 when it receives and transmits data using the General Purpose Interface Bus, regardless of the controller used. Details on the general command sequences used to activate the various Programmable Functions through the GPIB are found in the Operating Commands section. The commands (BASIC language statements) used to implement these functions from a 4Ø51 Graphic System are described later, in "Operating the Plotter from the 4Ø51 Graphic System." All graphic operation coordinates are specified in Graphic Display Units (GDU), described later in the "Graphic Display Units" discussion.

Move

The Move command is used to move the pen to a specified X-Y coordinate position without drawing a line. The X-Y coordinate position is specified in GDUs. If the coordinates determine a point outside the plotting area, the nearest boundary value(s) will be substituted as the coordinate position for the move. (Refer to Fig. 2-17.)

Note that lifting and lowering of the pen is automatic. If the pen is down when a Move command is received, the pen will be lifted prior to the Move operation.

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA21) or (MLA) M

The format is as follows:

MOVE X delim Y term

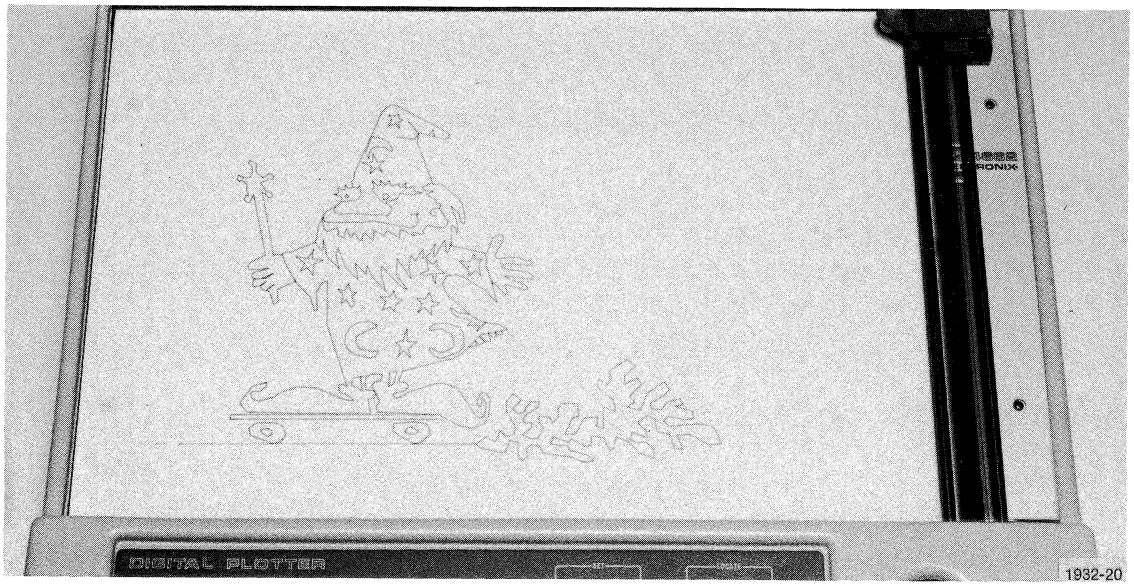

Fig. 2-17. Move and Draw operations were combined to create this plot.

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Draw

The Draw command is used to draw a line from the current pen position on the plotting surface to the specified X-Y coordinate point. The X-Y coordinate position is specified in GDUs. If the coordinates determine a point outside the plotting area, the nearest boundary value(s) will be substituted and a Move operation will occur. No line will be drawn. (Refer to Fig. 2-17.)

Note that the pen status is remembered and controlled by the Plotter electronics. The pen is automatically lowered at the beginning of a Draw operation and lifted when the line is completed. The automatic pen lift feature is inhibited when the PROMPT indicator is on. This allows the Digitizing Sight to remain in contact with the surface during digitizing operations.

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA20) or (MLA)D

The format is as follows:

DRAW X delim Y term

Print

The Print command causes the Plotter to print the ASCII character string that follows. The current pen position is used on the lower-left corner (starting point) for the first character, if the PRINT command follows a MOVE, DRAW, or joystick operation. Otherwise, the Plotter performs a HOME first.

The characters are printed using the Alpha Scale, Rotation, and Font values currently in effect. That is, any modifying functions for the text to be printed must be set prior to the transfer of the printed text.

The two forms (MSA and DABM) for this command are as follows:

(MLA)(MSA12) or (MLA)P

The format is as follows:

PRINT ASCII characters term

Alpha Scale

The Alpha Scale command sets the alphanumeric character scaling factors, in Graphic Display Units (GDUs) for the character space and line space values. The default character size values in effect upon power-up and after Reset or Alpha Reset are character space = 1.792 GDU and line space = 2.816 GDU. The characters are scaled within this block (refer to Fig. 2-18).

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA17) or (MLA)S

The format is as follows:

ALPHASCALE X delim Y term

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Alpha Rotate

The Alpha Rotate command sets the angle at which alphanumeric characters are printed on the plotting surface. The range is from Ø° to +360°. Positive and negative wrap-around is allowed. The angle is measured counterclockwise with respect to the positive X axis; the default angle is Ø°.

In addition, the Alpha Rotate command sets the current pen position as the carriage return (CR) reference point in a line perpendicular to the rotation angle set through the current pen position. This is used for CR, LF, and VT commands encountered in Print operations (Refer to Fig. 2-19).

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA25) or (MLA)R

The format is as follows:

ALPHAROTATE ANGLE term

NOTE

Attempting to print rotated characters past the page boundary causes undesirable results, and should be avoided.

Alpha Font

The Alpha Font command is used to select one of seven available printing fonts, numbered Ø through 6. Selections 7 through 16 are reserved for expansion and custom modification. The printing fonts differ only in the printing of certain special characters, as shown in Fig. 2-20.

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA18) or (MLA)F

The format is as follows:

ALPHAFONT FONTNUMBER term

Alpha Reset

This command resets the Alphanumeric printing parameters (Alpha Scale, Alpha Rotate, Alpha Font) to the default GPIB values.

The two forms (MSA and DAB) are as follows:

(MLA) (MSA7) or (MLA) A

Reset

The Reset command is a signal line on the General Purpose Interface Bus that resets all Programmable Function parameters to their default values and clears the output queue. The pen position and hardware page size (which is not programmable) are not reset. GIN mode is canceled by this command. Reset is the IFC (Interface Clear) GPIB signal line.

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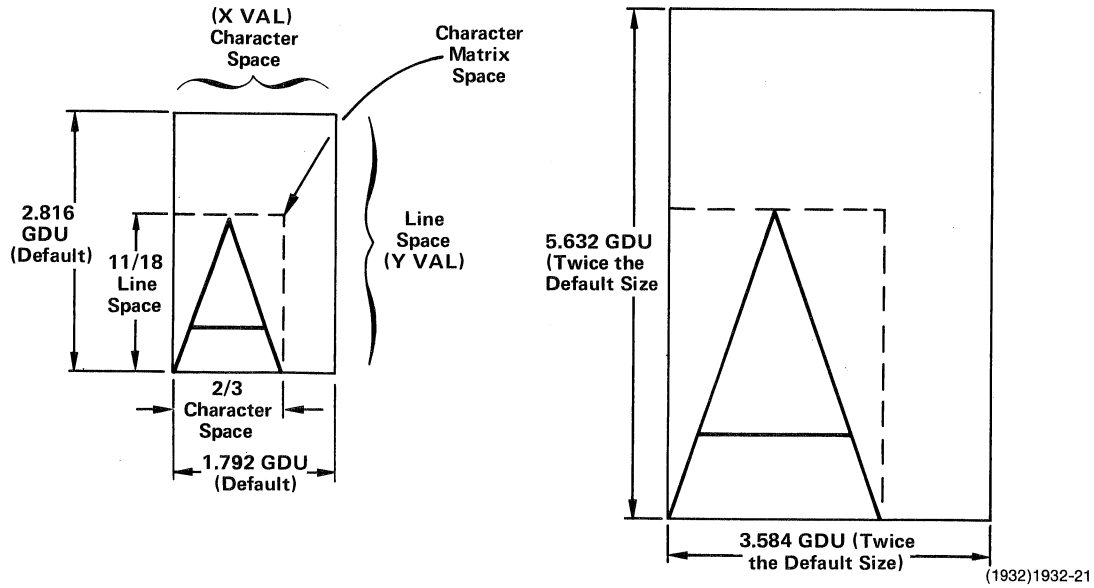

Fig. 2-18. Alpha Scale, showing the character A doubled in both axes (four times the original size). Note the relationship between the character and the character space.

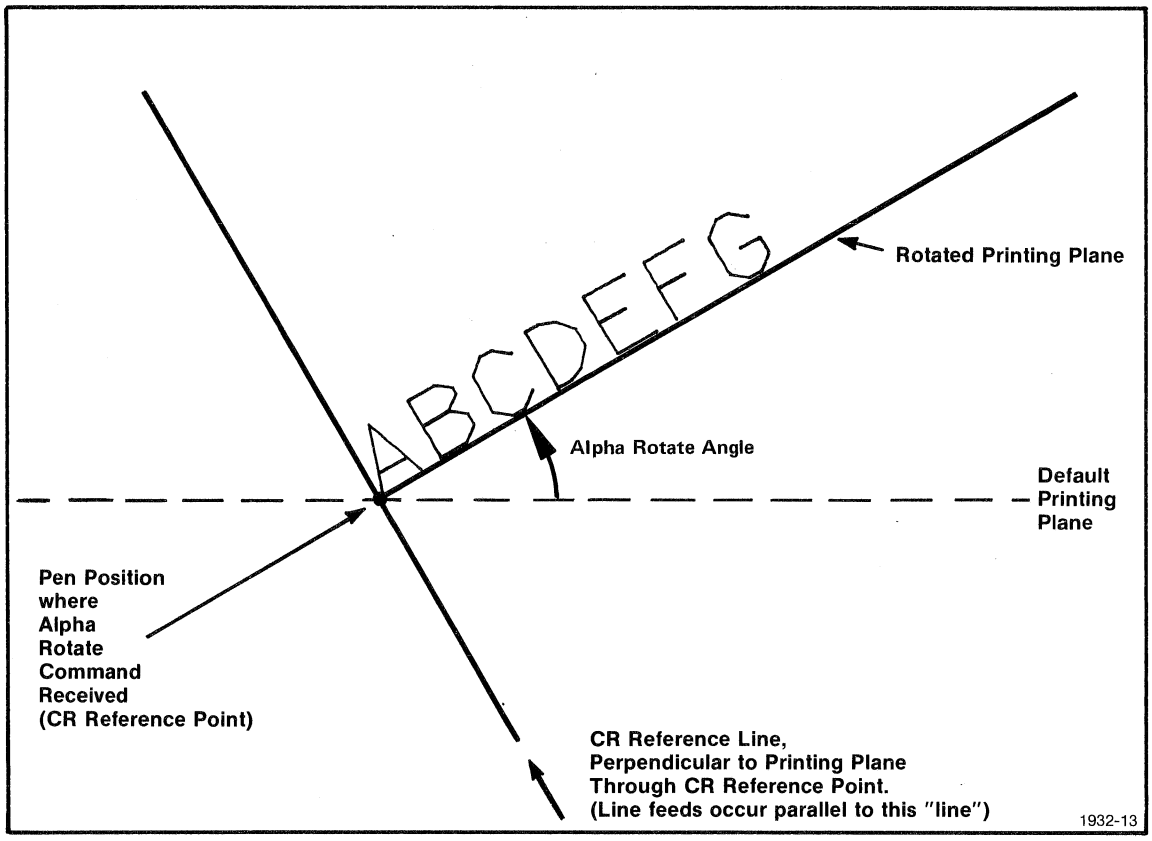

Fig. 2-19. Alpha Rotate, showing the new Carriage Return/Line Feed references.

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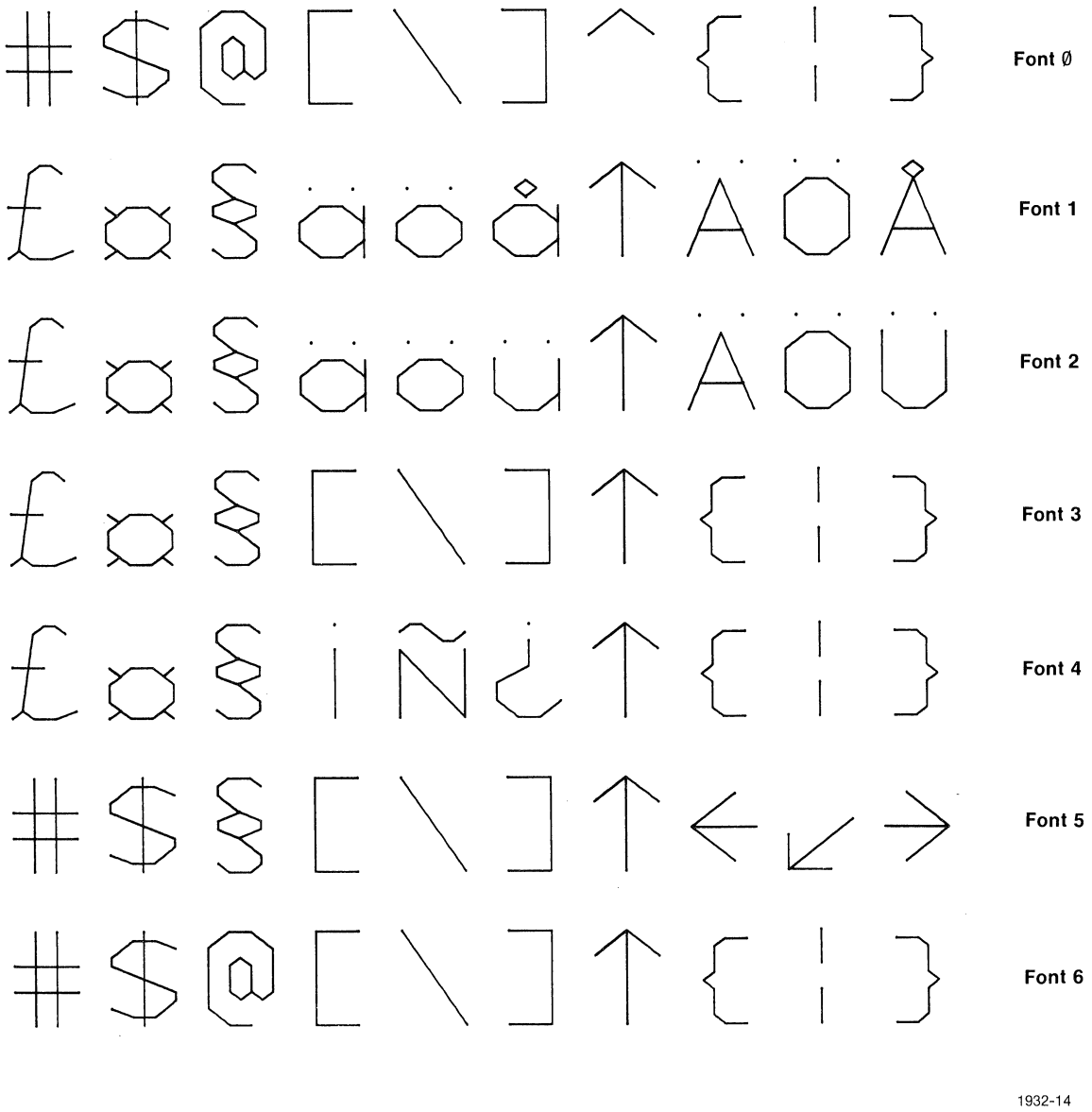

Fig. 2-20. Alpha Font character changes.

Home

The HOME command sends the pen to the Home position without drawing a line. The Home position is defined as a position near the upper left corner, with enough space left for one non-rotated character, as shown in Fig. 2-21.

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA23) or (MLA)H

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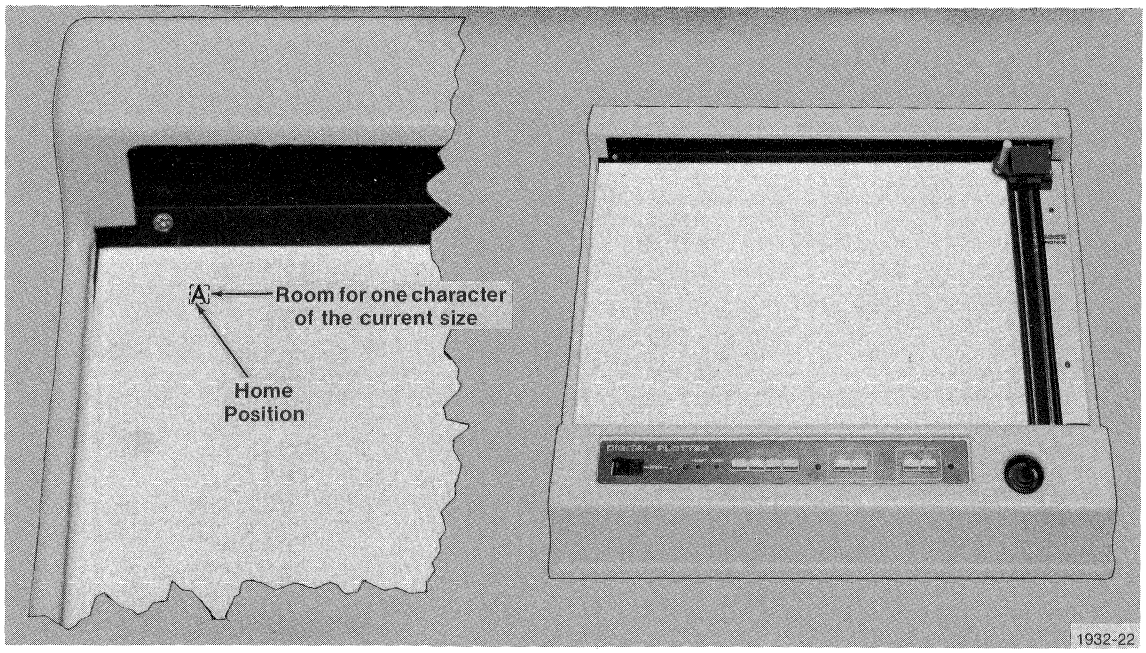

Fig. 2-21. Home position.

Page

The Page command is identical in function to the HOME command. It is included for convenience when using the 4051 Graphic System as a controller.

The form (MSA) for this command is as follows:

(MLA) (MSA22)

Size

The Size command causes the Plotter to return the page dimensions and the Plotter identification word to the listening device(s). The page dimensions, in GDU's, are 150 (X) and 100 (Y). The identification word contains the information listed in Table 2-7.

Table 2-7
IDENTIFICATION WORD

Bits 0—3	Firmware release number
Bits 4—5	Physical size of the input buffer 00≤600 bytes 01≤1100 bytes 10≤1600 bytes 11>1600 bytes
Bits 6—15	These bits are reserved to indicate the presence of optional or custom firmware.

The two forms (MSA and DAB) for this command are as follows:

(MTA) (MSA13) or (MLA) I (MTA)

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Set Status Word

The Set Status Word command is used to place a particular value in one of the writeable status word positions. These are 4—7 (or 4—15 if the Plotter has optional firmware modules installed). The desired status word location to be set is represented in the format by the variable R, and the value to be stored therein is the variable S. The S value (−32768 to 32767) is converted to 16-bit 2's complement binary form and stored in the status word location defined by R. Refer to the following chart.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Status Word #0 : System Status

ON=1	← Unused →	Low Speed	CR → CRLF	Pen Down	Load Switch In	Mirror Image X	Mirror Image Y	X Above (right)	X Below (left)	Y Above	Y Below	I/O Error	Program Error	Internal Error
OFF=0		Normal Speed	CR → CR	Pen Up	Load Switch Out	Normal X	Normal Y	← On Scale →				No I/O Error	No Program Error	No Internal Error

Status Word #: GPIB I/F Status

ON=1	Unused	CR → CRLF	Unused	Inhibit MSA Cmds	Inhibit DAB Cmds	← NUMBER OF INPUT BUFFER BYTES AVAILABLE →
OFF=0		CR → CR	Unused	Accept MSA Cmds	Accept DAB Cmds	

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA16) or (MLA)W

The format is as follows:

SETSTATUS WORD location value term

Read Status Word

The Read Status Word command causes the Plotter to send the contents of the internal status word represented by the *variable* R. (Supply R as an integer in the range Ø—7, or Ø—15 if optional firmware modules are installed). The Status Word returned will be an ASCII integer in the range −32768 to 32767.

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSAØ) R (MTA) (MSAØ) or (MLA) V R (MTA)

After the Secondary Address (MSA) command form followed by the Device Address, any valid talk secondary address will cause the Plotter to transmit status. For example, (MTA) (MSA13) will return status, not size.

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GIN

The GIN (Graphic Input) command causes the Plotter to send the current XY coordinate location of the pen and the Z-axis (pen up/pen down) information. The pen status bit (bit 3) within the last byte is set to 1 if the pen is down or Ø if the pen is up. If the pen is outside the defined page boundaries, the boundary values are substituted and transmitted.

The two forms (MSA and DAB) for this command are as follows:

(MTA) (MSA24) or (MLA) G (MTA)

Call GIN

The Call GIN command causes the Plotter to send the XY pen coordinates and Z-axis (pen up/down) information existing at the time the CALL button is pressed. The pen status bit (bit 3) within the last byte is set to 1 if the pen is down or Ø if the pen is up. If CALL is pressed in response to a Call GIN command, the GIN data is sent immediately. If call is pressed when a Call GIN command has not been received, the GIN data is stored in an internal GIN queue with a capacity of two coordinate sets, and SRQ is asserted by the interface. The GIN data is then sent after the controller sends a Call GIN command. If more GIN points are digitized than the queue can handle, the bell sounds to indicate that the last point was not stored.

The two forms (MSA and DAB) for this command are as follows:

(MTA) (MSA27) or (MLA) C (MTA)

NOTE

The CALL GIN command resets the SRQ on the bus if there are no other coordinates in the output buffer. The GIN command does not.

Prompt Light

The Prompt Light command turns the PROMPT light on the front panel on and off. In the command sequence, a single digit (represented by the variable R) controls the on/off function, with Ø = off and 1 = on.

The two forms (MSA and DAB) for this command are as follows:

(MLA) (MSA26) or (MLA)T

NOTE

Other values than 1 may cause the PROMPT light to turn on. A 1 is recommended for system continuity.

OPERATING COMMAND SEQUENCES

When operating the Plotter through the GPIB interface, it is addressed by the controller. Each device on the General Purpose Interface Bus is assigned a device number, called a Primary Address, selected by the positions of Switches C and D on the rear panel. The same Primary Address is used as a Listen Address (MLA) and Talk Address (MTA). (More information on Primary Address selection is found under Switchable Options.)

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When the controller wants to address the Plotter, it sends this Primary Address over the GPIB, followed by a command to tell the Plotter which programmable function is to be performed by the Plotter along with arguments as required. The command may or may not be followed by data transfer. The command that defines the programmable function may take one of two forms, dependent on requirements of the controller (if one is present) and the system. It may be a command data byte (DAB) or it may be a secondary address (MSA); the DAB command may be followed by an optional equal sign (=) or question mark (?). Rear panel switch settings allow selective disabling of either the MSA or the DAB type of commands. (Disabling the MSA command form allows compliance with the Talk and Listen functional specifications of IEEE 488-1975.)

In the description of the programmable functions, the DAB and MSA command form are both listed for each programmable function. Table 2-8 contains a summary of the Programmable Function Sequences, in which the function name is used as a variable, enclosed in parentheses. Substitute for this variable either the MSA or DAB command form, as found in the Programmable Functions description. Data returned from the Plotter is underlined.

TABLE 2-8

Programmable Function Formats

Programmable Function	Format
Move	(MOVE) X (delim) Y (term)
Draw	(DRAW) X (delim) Y (term)
Print	(PRINT) ASCII character string (term)
Alpha Scale	(ALPHASCALE) X (delim) Y (term)
Alpha Rotate	(ALPHAROTATE) (angle-in degrees) (term)
Alpha Font	(ALPHAFONT) font number (term)
Alpha Reset	(ALPHA RESET)
Reset	(RESET)
Home	(HOME)
Page	(PAGE)
Size	(SIZE) 15Ø, 1ØØ, options data (EOI)
Set Status Word	(SET STATUS WORD) location, status value (term)
Read Status Word	(READ STATUS WORD) location (term) status (EOI)
Gin	(GIN) X, Y, Z (EOI)
Call GIN	(CALLGIN) X, Y, Z (EOI)
Prompt Light	(PROMPTLIGHT) on/off (term)

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Table 2-9
4662 GPIB COMMAND SUMMARY

Command	Secondary Address Command	DAB Command	Data to Send or Returned
MOVE	21	M	SEND X,Y
DRAW	20	D	SEND X,Y
PRINT	12	P	SEND CHARACTER STRING
ALPHASCALE	17	S	SEND X SIZE, Y SIZE
ALPHA ROTATE	25	R	SEND ANGLE
ALPHA FONT	18	F	SEND Ø—16
ALPHA RESET	7	A	— — —
RESET	—	—	SEND IFC BUS SIGNAL
HOME	23	H	— — —
PAGE	22	H	— — —
SIZE	13	I	RETURNS 150, 100, ID WORD
SET STATUS WORD	16	W	SEND LOCATION, VALUE
READ STATUS WORD	Ø	V	SEND LOCATION RETURNS VALUE
GIN	24	G	RETURNS X, Y, Z
CALL GIN	27	C	RETURNS X, Y, Z
PROMPT LIGHT	26	T	SEND (Ø = OFF; 1 = ON)

Other variables in the Programmable Function Formats are defined as follows:

(delim) The delimiter; a comma or space.

(term) Data terminator; it may be one of the following:
1. an (MLA), (MTA), (MSA), or UNL command.
2. an ETX byte (control-C on most devices).
3. a CR with (EOI) asserted.
4. a CR, comma, or space when the data sent to the Plotter is numeric and all expected data values have been received.

NOTE

2 and 3 above are the only valid terminators following text in a PRINT statement.

(EOI) The EOI signal on the General Purpose Interface Bus.

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SERIAL POLL

The 4662 has provision to respond to a "serial poll" from the GPIB. The serial poll operation is normally initiated by the 4051 Graphic System or other GPIB controller in response to a service request (SRQ) message sent it by one of the devices on the GPIB.

To determine which device on the GPIB is requesting service, the GPIB controller pulls the GPIB's ATN line active low and sends over the GPIB data bus the universal command "SPE" ("Serial Poll Enable"). With the ATN line still low, it sends the primary talk address of one of the devices on the line; then it lets ATN float inactive high and waits for the device it has just addressed to send back to it a "status byte" over the GPIB.

The GPIB controller repeats this procedure for each of several devices: it "polls" each device by sending its primary talk address and listening for a "status byte" in response.

When, during such a serial poll, the 4662 is addressed, it sends to the GPIB a status byte; its format is specified in Table 2-11.

When the controller has finished the serial poll, it signals this to the 4662 (and the other devices on the GPIB) by sending the universal command "SPD" (Serial Poll Disable).

The 4662 generates an SRQ when the call button is pushed momentarily, simultaneously saving the point at which the call button was pushed. A serial poll informs the controller as to which device on the bus is requesting service.

GRAPHIC DISPLAY UNITS

The basic unit of Graphic addressing on the plotting surface is the Graphic Display Unit (GDU). This unit is defined as 1/1ØØ of the Y range. For the default (1Ø inch by 15 inch) page size, the GDU equals Ø.1 inch; when the page is scaled down, the size of the GDU is scaled down with the Y axis.

When operating the Plotter through the GPIB interface, X-Y coordinate values are transmitted as ASCII decimal numbers in GDU. The X and Y values are separated by a delimiter (a comma or a space), and the full scale page graphic data ranges are Ø—15Ø GDUs (X) and Ø—1ØØ GDUs (Y). (Refer to Fig. 2-22.)

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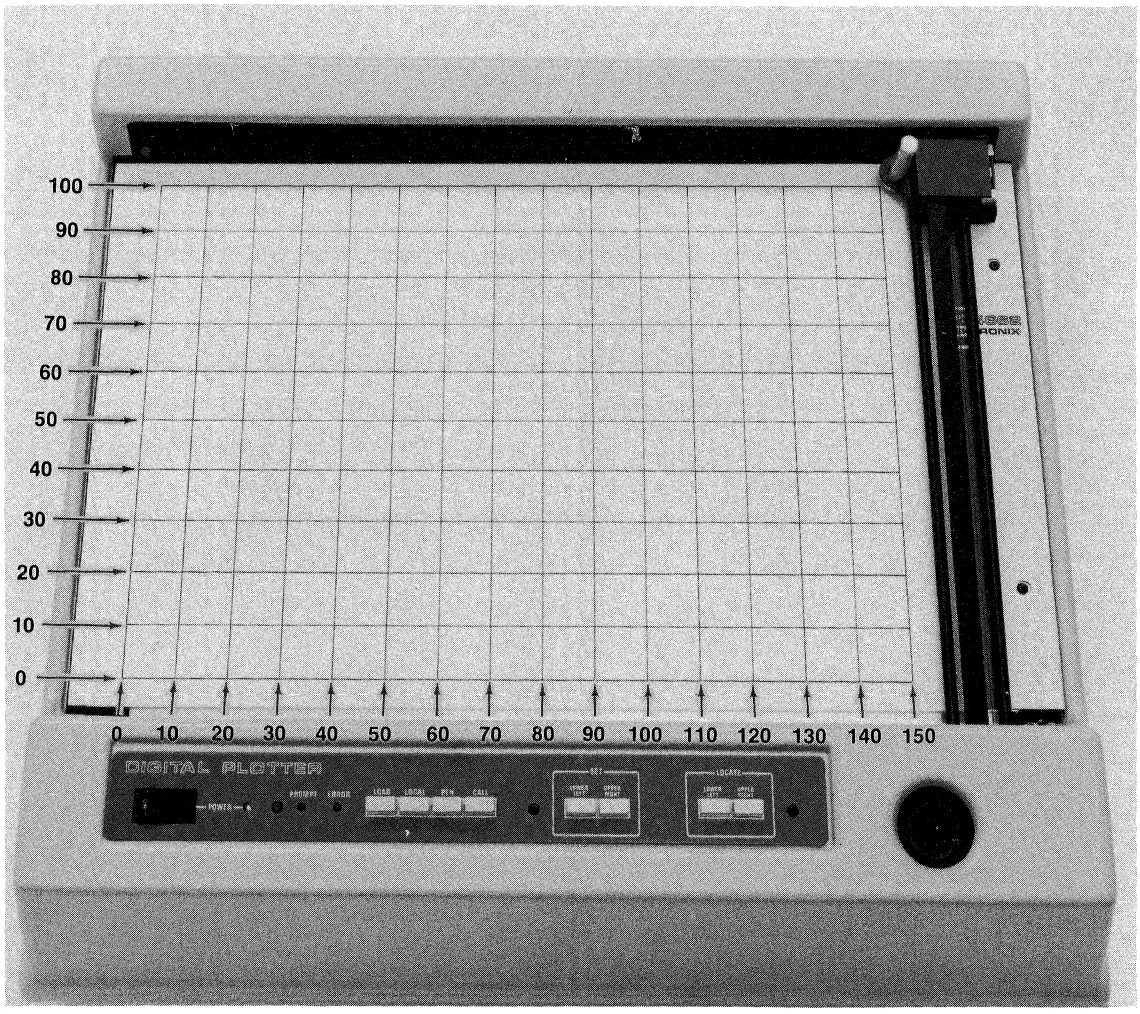

Fig. 2-22. Graphic Display Units, showing the full scale size.

OPERATING THE PLOTTER WITH THE 4Ø51 GRAPHIC SYSTEM

When operating the Plotter with the 4Ø51 Graphic System, the Plotter becomes an integral part of that system. The 4Ø51 Graphic System will automatically control the Primary Addresses (MLA, MTA) and Secondary Addresses (MSA) that are placed on the bus, according to the addresses specified in the BASIC language statement. It is only necessary to specify the Primary Address of the Plotter (selected by rear-panel switch position) in the BASIC statement when output to (or input from) the Plotter is desired.

Additionally, the Secondary Address for various commands is not always required in the BASIC statement. Print, Move, Draw, and (sometimes) GIN command secondary addresses are automatically specified by the 4Ø51 without being called out in the BASIC statement.

The BASIC language formats used by the 4Ø51 to implement the various commands are shown in Table 2-11. In these examples, the device Primary Address is shown as a "1" (i.e., Print @ 1:...). To use another device Primary Address, substitute the desired address for the "1".

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NOTE

The 4Ø51 limits its DRAW outputs to 13Ø GDU (default) in the X axis. To access the full X axis of the platen, the Window and Viewport of the 4Ø51 must be altered to encompass 15Ø GDU's in the X axis. Enter WIN Ø, 15Ø, Ø, 1ØØ then VIE Ø, 15Ø, Ø, 1ØØ.

Table 2-10

4Ø51-Plotter Command Formats

Command	BASIC language statement
Move	Move @ 1: X, Y
Draw	Draw @ 1: X, Y
Print	Print @ 1: "text to be printed"
Alpha Scale	Print @ 1, 17: xval, yval
Alpha Rotate	Print @ 1, 25: angle
Alpha Font	Print @ 1, 18: font number (0—7)
Alpha Reset	Print @ 1, 7:
Reset	Init
Home	Home @ 1:
Page	Page @ 1:
Size	Input @ 1, 13: X, Y, S (where S is the identification word)
Set Status Word	Print @ 1, 16: status word number, status value
Read Status Word	Print @ 1, Ø: status word number. Then Input @ 1, Ø: X. The status value is then stored in X.
Gin	Gin @ 1: X, Y (This format does not provide for Z-axis information.)
	Input @ 1, 24: X, Y, Z (This format provides for X, Y, and Z axis inputs.)
Call GIN	Input @ 1, 27: X, Y, Z
Prompt Light	Print @ 1, 26: Ø (off) or 1 (on)

Table 2-11

SERIAL POLL STATUS BYTE

BIT	8	7	6	5	4	3	2	1
	Ø	SRQ	Ø	Ø	Ø	Ø	Ø	Ø

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SWITCH OPTIONS

The rear panel of the 4662 contains four hexadecimal (sixteen-position) switches, labeled A, B, C, and D. The switches provide control over a number of system and interface parameters, allowing the Plotter to conform to a variety of program and system requirements. The switch-selectable options that relate to the General Purpose Interface Bus requirements are as follows:

1. Device Primary Address: Ø through 3Ø
2. General Purpose Interface Bus select: on, off
3. Accept DAB Commands: yes, no
4. Accept MSA Commands: yes, no
5. Listen Only mode: on, off
6. CR (Carriage Return) Effect: CR only, CR→CR+LF
7. Talk Only mode: on, off
8. Low Plotting Speed: on, off

Because these parameter settings are vital to proper system operation, the switch positions must be carefully selected. Refer to the Installation instructions in Section 4 for a detailed description of parameters and the method of switch selection.

LISTEN ONLY/TALK ONLY

The 4662 can be set to Listen Only mode or Talk Only mode when operating over the GPIB. This allows the Plotter to be used in systems with no active controller present on the bus. Selection is made by rear panel switch setting, as described in the Installation description. Plotter power should be turned off when setting for Talk Only or Listen Only. If power is on when these modes are selected, the POWER switch must be cycled off and then on again.

Talk Only

The 4662 Digital Plotter has the capability of digitizing without the presence of a controller on the bus. In order to digitize off-line, the Plotter must be set to Talk Only (switch A = 2). A listener device, such as the 4924 Digital Tape Unit, must be connected to the bus and set to its Listen Only mode. Refer to the Operators manual for the listener device. More than one device may be on the bus in the Listen Only function, but only one device can be allowed on the bus in the Talk Only function. Other devices (such as the 4051) may be idle on the bus.

After the bus is set up, the user may then digitize by positioning the digitizing sight over the point to be digitized, then pushing the call button. Upon release of the call button, the X, Y, and Z coordinates of the point will be transmitted to the listener device(s). Any number of points may be sent, dependent only on the capabilities of the listening devices.

When the call button is pushed and released momentarily (<1.6 seconds) data is sent by the Plotter in the form: (X location Ø—150 E-format)","(Y location Ø—1ØØ E-format)","(Ø or 1 for pen up or down) <CR> <LF>

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When the digitizing is completed, and EOI signal is required. This signal can be generated by pushing the call button until the bell rings **once**, then releasing it, and push it one more time momentarily. This will cause the Plotter to send one more data point, and the EOI signal will be asserted with the <LF> byte.

Care must be taken to remove the 4662 from the bus or reset it to normal operation if other devices are to be addressed as talkers. Conditions on the bus are not defined when more than one talker is present. The Plotter must be in normal mode for proper operation with an active 4051 controller. When in Talk Only mode, the Plotter will ignore all command messages (MTA, MLA, Serial Poll, etc.), and cannot be unaddressed. IFC (init) will cause the call buffer to be emptied.

When the Plotter is in the Talk Only mode, it is unable to perform a listen function, and cannot execute any plotting commands.

Listen Only

Off-line plots can be created when the Plotter is in Listen Only mode. In this mode the Plotter will be continuously addressed as a listener, and can be sent plotting commands using the DAB format. The 4662 will ignore all MSA commands, since these are not generally sent by a Talk Only device. Note that switch B must be set so that the Plotter can accept DAB commands.

Unlike most DAB commands (which require no terminator or a numeric terminator of a space or comma), the print command requires a command terminator. While in Listen Only mode the only terminators that can be sent to the Plotter are <CR> with <EOI> asserted and the control character ETX (control-C). Since some devices capable of talk only cannot be programmed to send the <CR> <EOI> combination, it is recommended that an ETX be used as the last character in a print string.

GIN, Call GIN, Size, and Read Status commands will be ignored, since the Plotter is incapable of performing a talk function when in Listen Only mode.

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Section 3
FAMILIARIZATION

ABOUT THIS SECTION

This section provides a sequence of operations that may be used to familiarize the first-time operator with the various functions of the Plotter. Like the Operation section, programming information in this section is separated into two subsections, according to the interface employed. Refer to either First-Time Operation through the RS-232-C interface, or First-Time Operation through the GPIB interface for the applicable programmed-operation Familiarization Procedure.

These procedures are intended to provide familiarity with many of the various command sequences through first-hand experience. This will give the first-time operator some idea of the actions the Plotter will take in response to these commands. The familiarization procedures do not cover every possible command or sequence of commands, but rather provide a general overview of Plotter operation.

Each of the operations and operating commands is described in detail in the Operation section.

NOTE

In the following discussions, it is assumed that the Plotter is connected in its normal operating configuration, and that power is applied.

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FRONT PANEL OPERATIONS

LOADING PAPER

To place a sheet of paper on the plotting surface, use the following procedure:

1. Press the LOAD button. The pen carriage will move to the upper-right corner of the plotting surface, and the electrostatic hold-down will be disengaged.

2. Place a sheet of paper in the desired position on the platen. Standard (default) sized sheets should be aligned with the left-hand edge of the platen and the paper guide at the forward edge of the platen. (Refer to Fig. 3-1.)

3. Press the LOAD button to release it and engage the electrostatic hold-down. Smooth any "bubbles" which may appear in the paper surface.

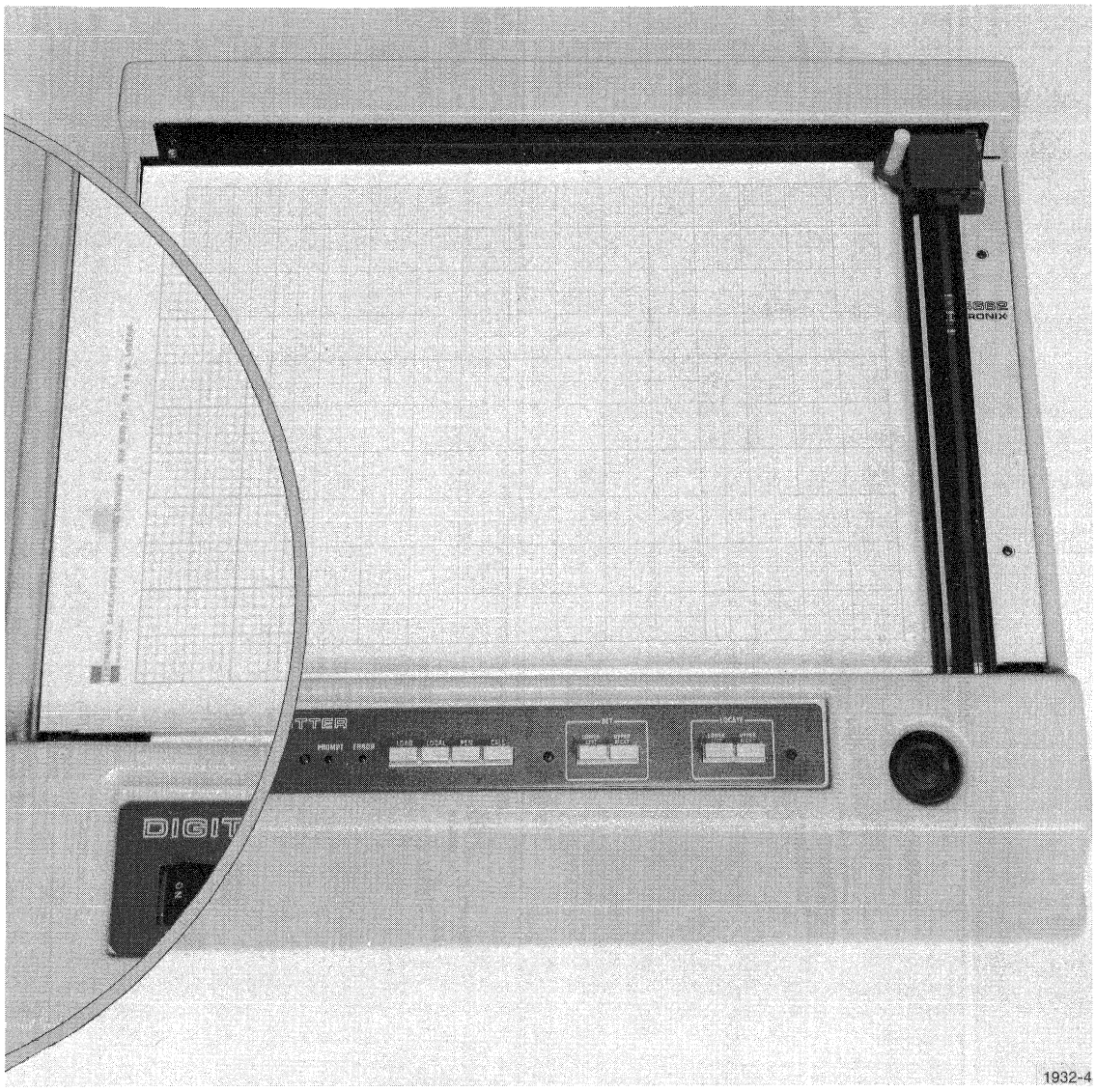

Fig. 3-1. Standard-size paper positioned on the platen.

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PAGE SCALING

1. Place an 8-1/2 x 11 inch sheet of paper near the lower-left corner, following the instructions in the "Loading Paper" description.

2. Using the Joystick, position the pen to the lower-left corner of the paper. Press the SET LOWER LEFT button and hold it until the Plotter bell rings.

3. Using the Joystick, position the pen to the upper-right corner of the paper. Press the SET UPPER RIGHT button and hold it until the Plotter bell rings.

4. Press the LOCATE buttons (LOWER LEFT and UPPER RIGHT) one at a time to verify that new page boundaries have been established. All incoming data intended for the full size page will now be scaled down and plotted within this area. (Refer to Fig. 3-2.)

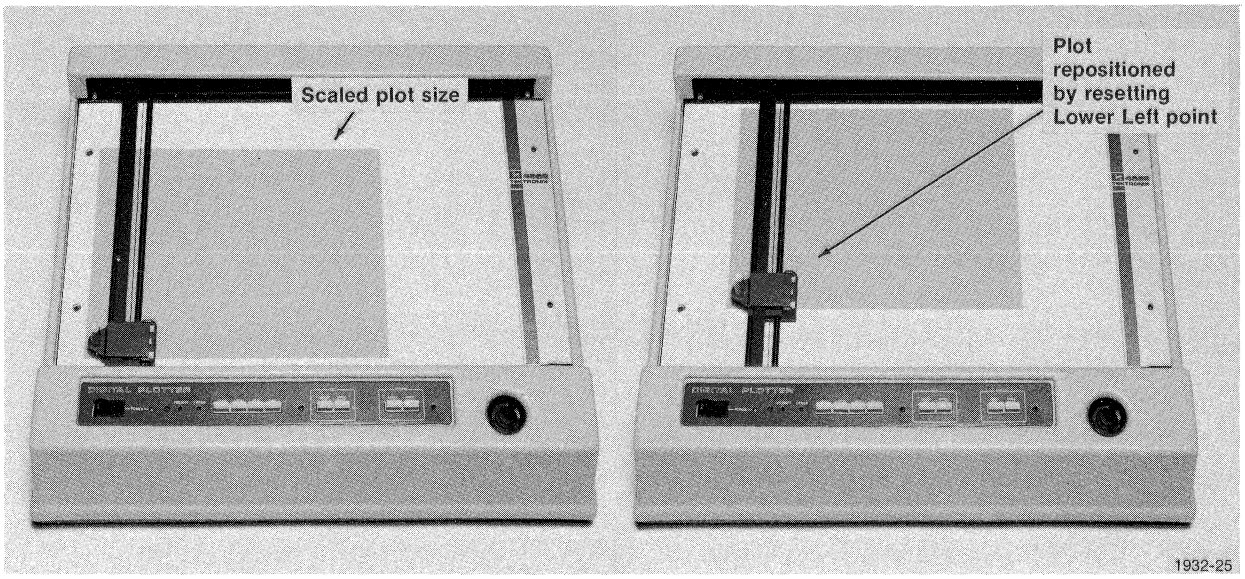

Fig. 3-2. Page Scaling and Positioning using the SET Controls.

PAGE POSITIONING

1. Press the LOAD button, then move the 8-1/2 x 11 inch sheet of paper to a new position on the platen. Press the LOAD button again to engage the electrostatic hold-down.

2. Using the Joystick, position the pen to the lower-left corner of the paper. Press the SET LOWER-LEFT button and hold it until the Plotter bell rings.

3. Press the LOCATE buttons (UPPER RIGHT and LOWER LEFT) one at a time to verify that the previously-scaled page boundaries have been moved to the new location. (Refer to Fig. 3-2.)

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FAMILIARIZATION WITH PROGRAM-CONTROLLED OPERATION THROUGH THE RS-232-C INTERFACE

ABOUT THIS SECTION

This section provides a sequence of operations which may be performed to familiarize the first-time operator with the programmable features of the Plotter, when operating the Plotter through the RS-232-C interface. A similar section for GPIB operation is found elsewhere in this manual.

SETTING UP FOR OPERATION

To perform the Familiarization Procedure, the Plotter must be connected in accordance with instructions in the Installation section of this manual. If the Plotter is being used in a Terminal-Plotter-Modem/Computer system, as shown in Fig. 3-3, it is recommended that the LOCAL button be pressed. All familiarization commands should then be issued from the terminal keyboard.

The Rear-Panel switches must be set with the following considerations:

Low Plotting Speed, It is not necessary to set for Low Plotting Speed when standard pens are employed.

Terminal Mute. This option is normally selected, unless it is desirable to have all characters sent to the terminal.

Copy Mode. The Plotter may be set for Copy Mode if it is being operated with a Tektronix 4010-series terminal.

CR Effect. For the purpose of the Familiarization Procedure, Carriage Return (CR) should be set to imply a Line Feed (LF) also.

Delete Interpretation. Delete (DEL, or RUBOUT) should be set to imply LOY.

Plotter Output Terminator. This option may be set to system requirements.

Stop Bits. This option should be set to system requirements.

Parity. This option should also be set to system requirements.

RS-232-C Interface Select. This option must be selected to operate through the RS-232-C interface. If the selection is changed, power to the Plotter must be cycled.

Device Address. In the Familiarization Procedure, the Device Address will be a "D". The Plotter may be set to a different address, but it will be necessary to substitute the selected address for the "D" in the procedures.

Data Transfer Rate. The Data Rate may be set to any of the selectable rates between 110 baud and 1200 baud, as long as the system components (Plotter, Terminal, etc.) are set to the same rate.

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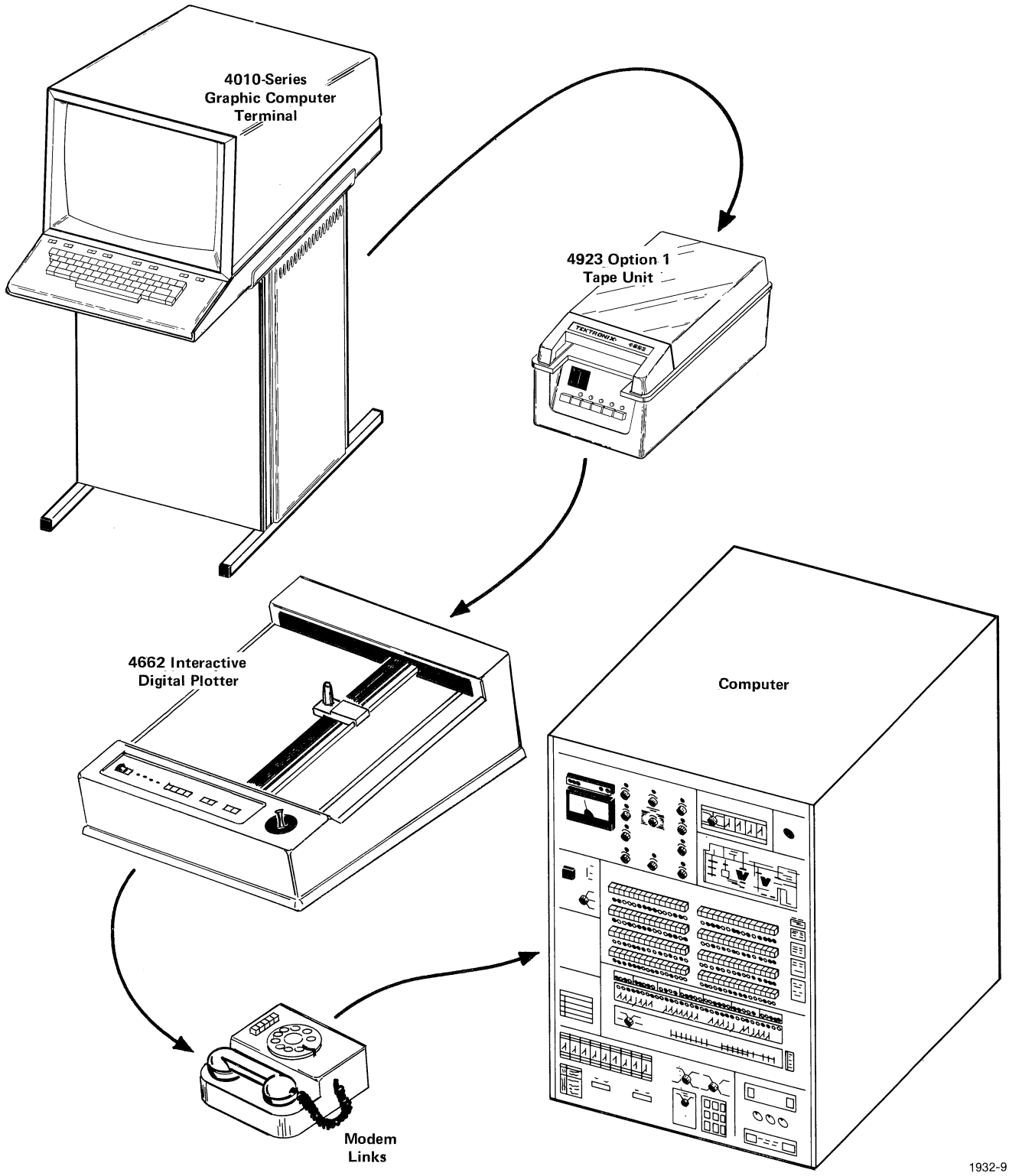

Fig. 3-3. A Typical Terminal System with the plotter included.

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FAMILIARIZATION PROCEDURE

General

It is assumed that the Plotter switch options have been set according to the "Setting Up For Operation" description, and that the Plotter has subsequently been powered up. If the Plotter commands are being issued from a terminal, as is suggested, the Plotter LOCAL button must be depressed.

NOTE

If the Copy Plotting mode option is selected, the Plotter powers up in the "Plotter On" state. In that case, it is not necessary to perform step 1.

ESC A E

1. Plotter On. Issue the Plotter On command (ESC ~~D~~ E). This command causes the Plotter to listen to (interpret) subsequent commands.

2. Alpha Mode. The Plotter normally powers up in Alpha mode. Transmit the following text and note that the characters (upper- and lower-case) are printed as transmitted:

4662 Interactive Digital Plotter

3. Plotter Off. Transmit the Plotter Off command (ESC ~~D~~ A F), then repeat step 2 and note that no printing occurs. Repeat the Plotter On command (ESC ~~D~~ A E) to turn the Plotter logically on again.

4. Graph Mode. Transmit the ASCII GS (Control Shift M on Tektronix 4010-series terminal keyboards) followed by the following sequence of coordinate commands:

NOTE

In the following coordinate data, only 10-bit addressing is used; the Plotter is compatible with higher resolution systems, as described in the Operation section.

Bold *characters in these commands need not be sent.*

Transmit SPACE DEL SPACE @ (corresponds to Y=124, X=0). The pen carriage should move to a position near the lower-left corner of the platen.

NOTE

Note that the first vector (normally a dark, or unwritten vector) may be drawn by following the GS command with a BEL character.

Transmit 7 **DEL SPACE** @ (corresponds to Y=3068, X=0). A line should be drawn to upper-left corner of the platen.

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Transmit **7** DEL ? _ (corresponds to Y=3068, X=4092). A line should be drawn to the upper-right corner of the platen.

Transmit SPACE **DEL ?** _ (corresponds to Y=124, X=4092). A line should be drawn to a point near the lower-right corner of the platen.

Transmit **SPACE** DEL SPACE @ (corresponds to Y=124, X=0). A line should be drawn to the original point.

The resulting plot should correspond to that illustrated in Fig. 3-4. The diagonal vectors can be drawn as follows:

Transmit 7 DEL ? _ A line will be drawn diagonally to the upper-right corner of the plot. If a dark vector (move) is desired before starting the next vector, which will repeat a previously drawn vector, transmit a GS (Control Shift M).

Transmit SPACE DEL ? _ This will cause either a written or unwritten (dark) vector, depending on whether a GS has preceded it.

Transmit 7 DEL SPACE @ A diagonal vector should be drawn to the upper-left corner of the platen.

5. Resetting to Alpha Mode. Reset the Plotter to Alpha mode by transmitting the ASCII US character (Control Shift O from Tektronix 4010-series terminal keyboards). The Plotter may also be reset to Alpha mode by a Page command [ESC FF], or by a RESET command [ESC ~~D~~ N], but these reset other parameters as well. Transmit four Line Feed (LF) characters and note the Plotter response. Transmit some ASCII characters and note that they are printed as transmitted.

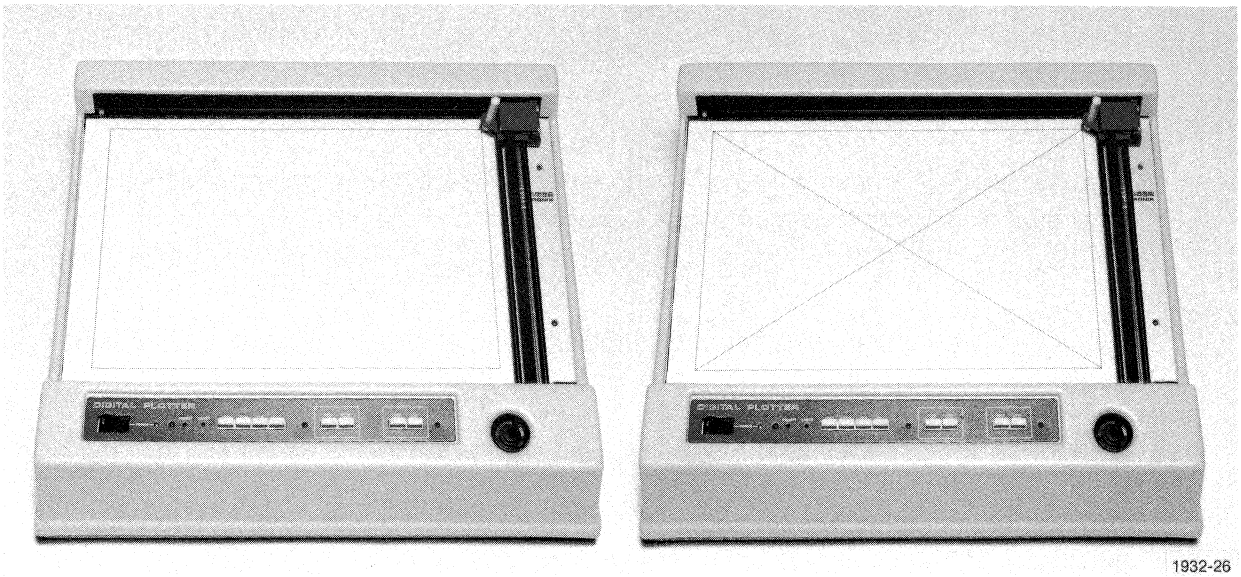

Fig. 3-4. Plot resulting from the coordinates in Step 4, when Copy plotting mode is in effect.

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6. Alpha Rotate. Transmit the command to rotate the alphanumeric printing angle 90°. The sequence is as follows:

ESC ~~D~~ A J 9Ø CR

Transmit "4662" to the Plotter followed by a "CR" and "4662" again. Note that the CR causes a Line Feed also; note as well the new CR and LF return points which were set by the Alpha Rotate. (Refer to Fig. 3-5.)

Reset to the original printing angle by transmitting the following sequence:

ESC ~~D~~ A J Ø CR

Transmit four Line Feed (LF) characters.

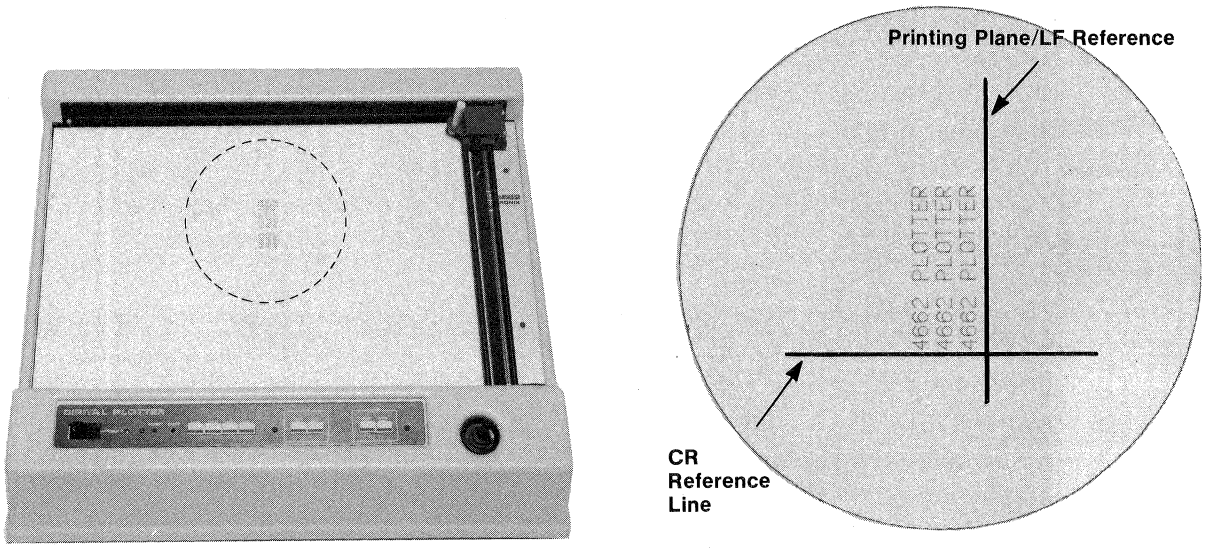

Fig. 3-5. Alphanumeric Characters Rotated 90°.

7. Alpha Scale. Transmit the command to enlarge the alphanumeric characters to four times their original size. The sequence is as follows:

ESC ~~D~~ A I 112, 176 CR

Note that the X and Y values are twice the default values. Transmit "4662" and note that the characters are printed four times their original size.

Reset to the original character size by transmitting the following sequence:

ESC A I 56, 88 CR

8. Press the LOAD button and place a fresh piece of paper on the platen. Press the LOAD button again to activate the electrostatic hold-down.

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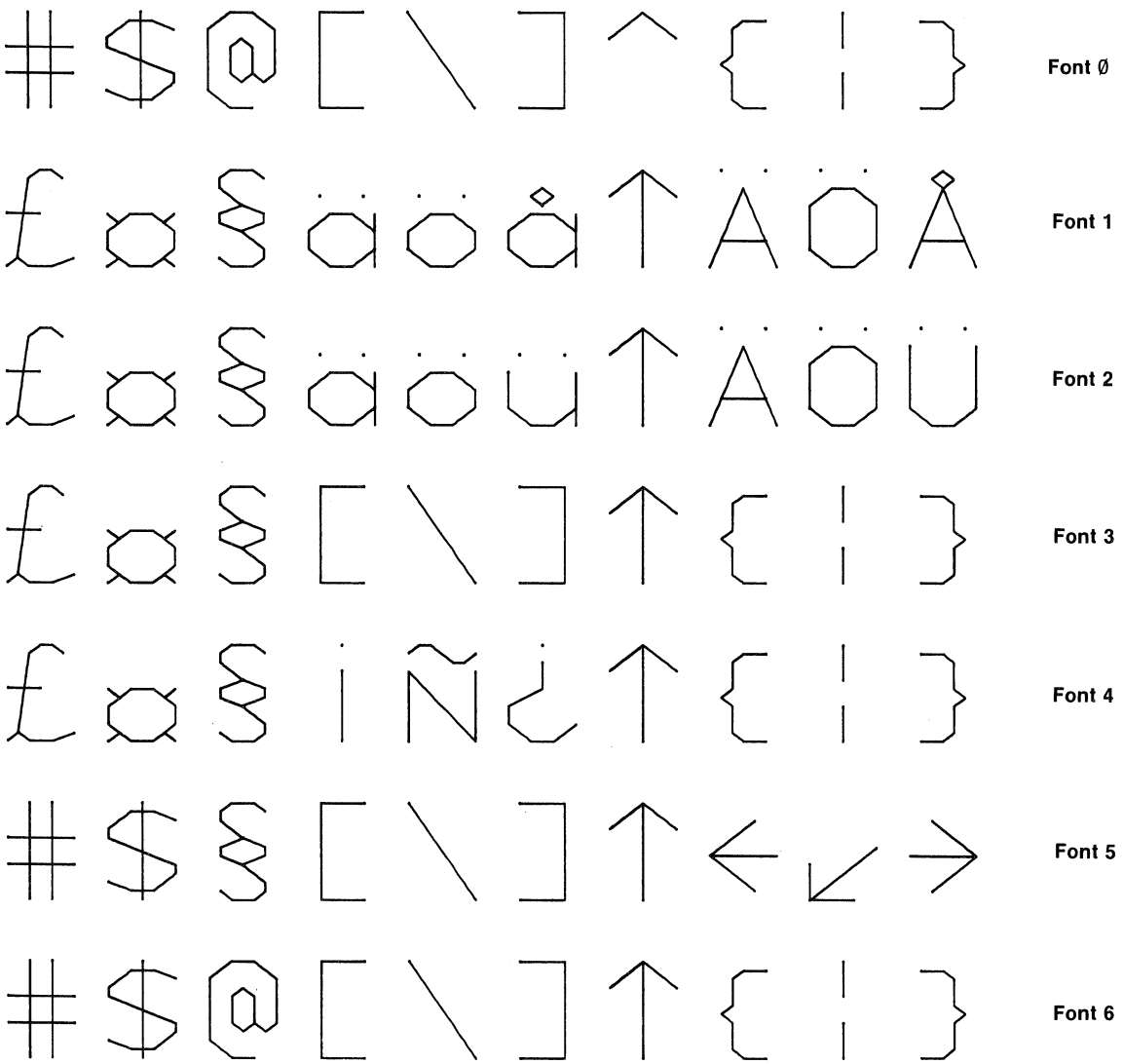

1932-14

Fig. 3-6. Characters that change when alternate Alpha Fonts are selected.

9 Home Command. Transmit ESC FF to the Plotter to cause the pen carriage to move to the HOME position near the upper-left corner of the platen.

10. Alpha Font. Transmit the following sequence of alphanumeric characters to illustrate the default (Font Ø) characters which (with the exception of the CR) will be changed when alternate fonts are selected:

$ @ [/] ^ { | } CR

Their bit configurations are shown in the ASCII chart in Appendix B.

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Transmit the command sequence for selection of Font 1 (ESC Ø T 1), then repeat the character sequence above and note that the Font 1 alternate characters are printed. Repeat for Fonts 2 through 7; the results should be as shown in Fig. 3-6.

11. Alpha Reset. Reset the Plotter to the default font (Font Ø) by transmitting the Alpha Reset command (ESC Ø V). This command also resets the Alpha Scale and Alpha Rotate parameters to their default values.

12. GIN Mode. Using the Joystick, position the pen to the lower-left corner of the platen, then transmit a Plotter GIN command (ESC Ø M). The Plotter should immediately return the corresponding coordinate data.

Move the pen to another location and press the CALL button; note that the corresponding coordinate data is returned in a similar manner. The differences are described in the Operation section.

This concludes the Familiarization Procedure for RS-232-C operation.

FAMILIARIZATION WITH PROGRAM-CONTROLLED OPERATION THROUGH THE GENERAL-PURPOSE INTERFACE BUS, USING THE 4051 AS A CONTROLLER

ABOUT THIS SECTION

This section provides a sequence of operations which may be performed to familiarize the first-time operator with the Plotter's programmable features when operating the Plotter through the General-Purpose Interface Bus (GPIB). The commands listed in this section are those that would be used from the 4051 Graphic System. If another device is used as the GPIB controller, substitute the appropriate statement to cause the desired device address and secondary (command) address to appear on the GPIB.

SETTING UP FOR OPERATION

To perform the Familiarization Procedure, the Plotter must be connected to the GPIB connector on the 4051 as described in the Installation section. (Refer to Fig. 3-7.) The LOCAL button must not be depressed, as this causes a logical disconnect from the GPIB.

The Rear-Panel switch options must be set with the following considerations:

Low Plotting Speed. Low Plotting Speed is not required when standard pens are used.

Talk Only. The Talk Only option should not be set for the purposes of this procedure.

CR Effect. For this procedure, CR (Carriage Return) should be set to imply a Line Feed (LF).

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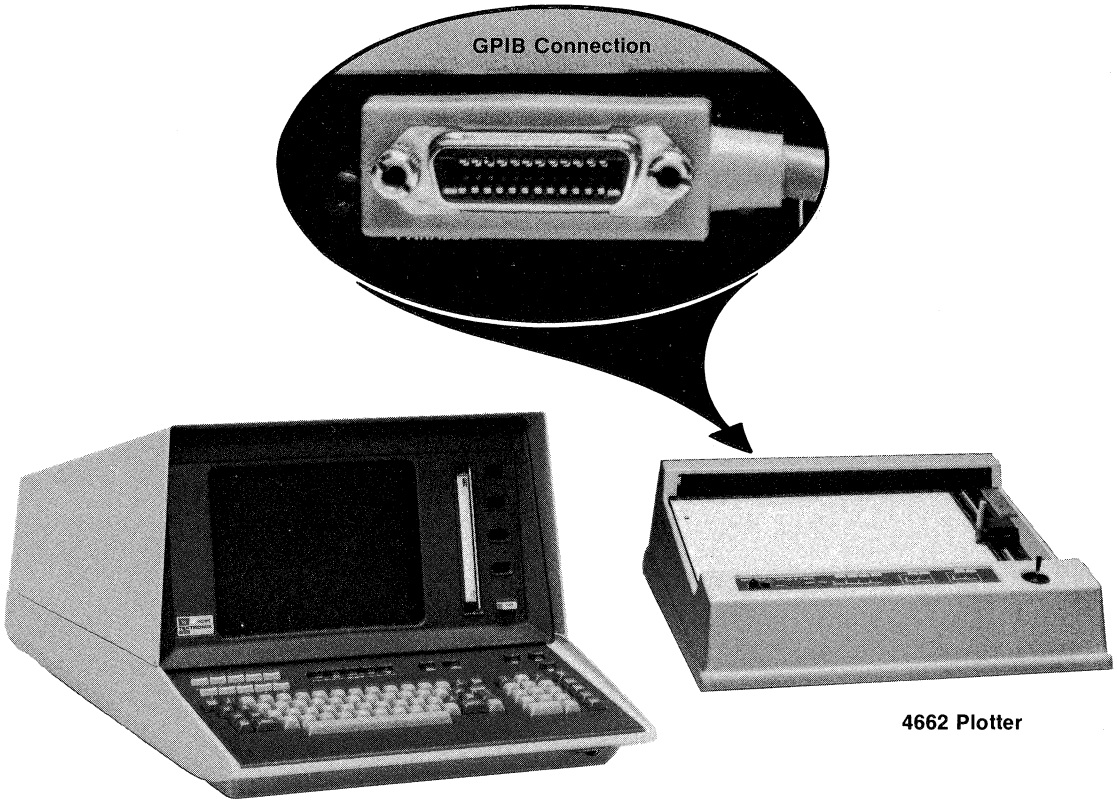

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Fig. 3-7. 4662 Connection to the Controller.

MSA Commands. The Plotter should be set to accept MSA (My Secondary Address) commands.

DAB Commands. The Plotter should not be set to accept DAB commands for the purposes of this procedure.

Primary Address. The Familiarization Procedure assumes a Primary Device Address of "1." Other addresses (0 through 30) may be used; simply substitute the selected address for the "1" in the procedure.

NOTE

The 4051 limits its DRAW outputs to 130 GDU's in the X axis; this is less than the platen allows. To access the Full platen, enter WIN 0,150,0,100 followed by VIE 0,150,0,100 to change the 4051 Window and Viewport.

FAMILIARIZATION PROCEDURE

General

It is assumed that the Plotter Switch Options have been set according to the "Setting Up For Operations" description, and that the Plotter has subsequently been powered up.

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1. **Home Command.** Enter the following sequence from the terminal keyboard to cause the pen carriage to move the HOME position near the upper-left corner of the plotting area:

   Home @ 1 : CR

2. **Print Operations.** Type the following sequence from the 4051 keyboard:

   Print @ 1 : "4662 Interactive Digital Plotter" CR

The alphanumeric text within the quotes should be printed, followed by a Carriage Return/Line Feed sequence (Fig. 3-8).

Note that the Secondary Address (12) is not required from the keyboard, the 4051 automatically places the appropriate secondary address on the bus for a Print operation.

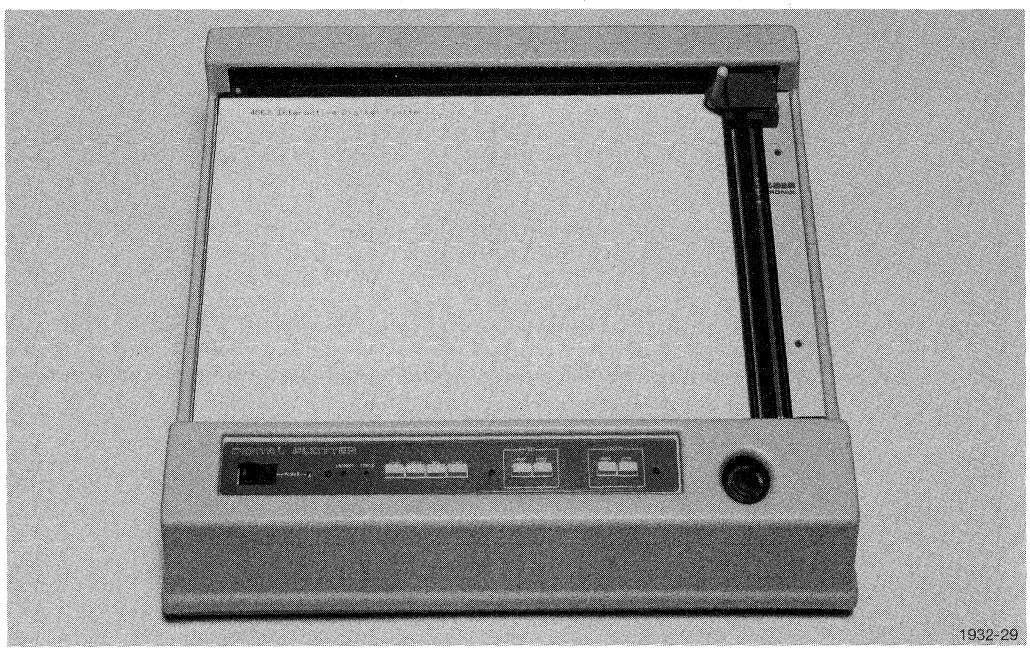

Fig. 3-8. A Typical Print Operation.

3. **Move Operations.** Enter the following command from the 4051 keyboard:

   Move @ 1 : 0, 0 CR

The pen carriage should move to the lower-left corner of the plotting area. Note that the Secondary Address is not required from the keyboard; the 4051 automatically places the appropriate Secondary Address on the bus for a Move operation.

4. **Draw Operations.** Enter the following commands from the 4051 keyboard:

   Draw @ 1 : 0, 100 CR
   Draw @ 1 : 150, 100 CR
   Draw @ 1 : 150, 0 CR
   Draw @ 1 : 0, 0 CR

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The resulting plot should correspond to the pattern in Fig. 3-9. The diagonal vectors can be drawn with the following commands:

Draw @ 1 : 150, 100 CR
Draw @ 1 : 150, 0 CR
Draw @ 1 : 0, 100 CR

NOTE

The Secondary Address for a Draw operation (20) need not be specified from the keyboard; the 4051 automatically places the appropriate secondary addresses on the bus for Move, Print, and Draw commands. In the following commands, however, the Secondary Addresses must be specified.

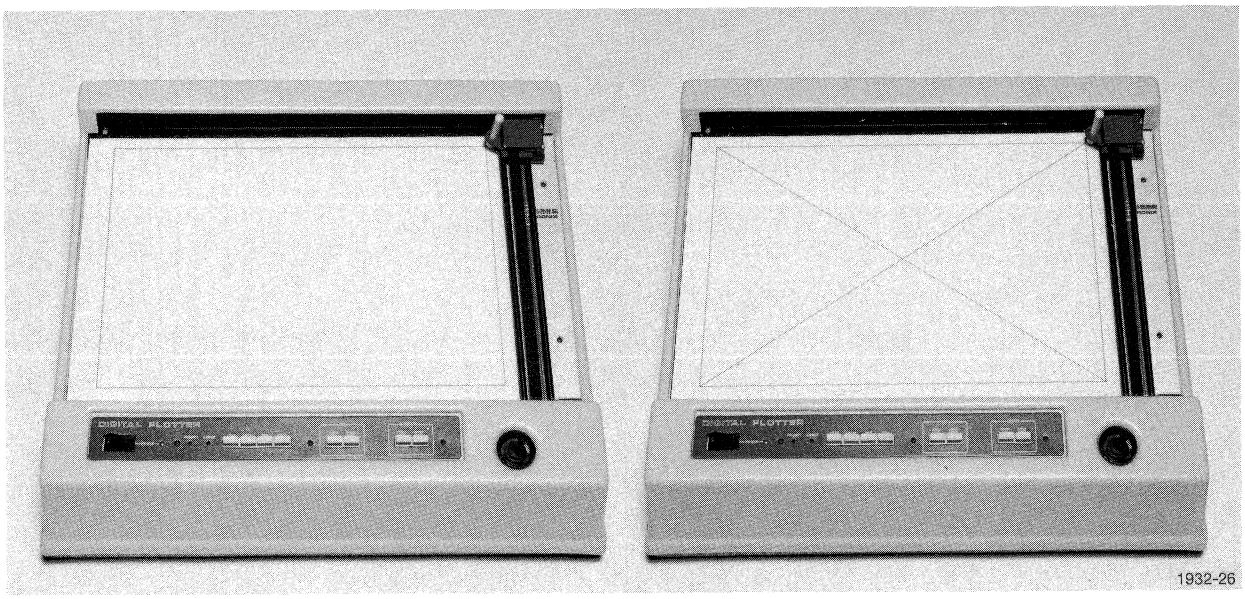

Fig. 3-9. The Plot Resulting from Step 4, in Two Stages.

5. Alpha Scale. Enter the following sequence from the 4051 to change the alphanumeric character scale to four times the default size:

Print @ 1, 17 : 3.584, 5.632 CR
Print @ 1 : "LF"
Print @ 1 : "4662 PLOTTER" CR

Note that the alphanumeric characters are printed at four times their original size. (Fig. 3-10.)

6. Alpha Reset. Transmit the Alpha Reset command (Print @ 1, 7 : CR) to the Plotter to reset the alphanumeric character size to the default value.

7. Alpha Rotate. Position the pen carriage to the center of the page using the following command:

Move @ 1 : 75, 50 CR

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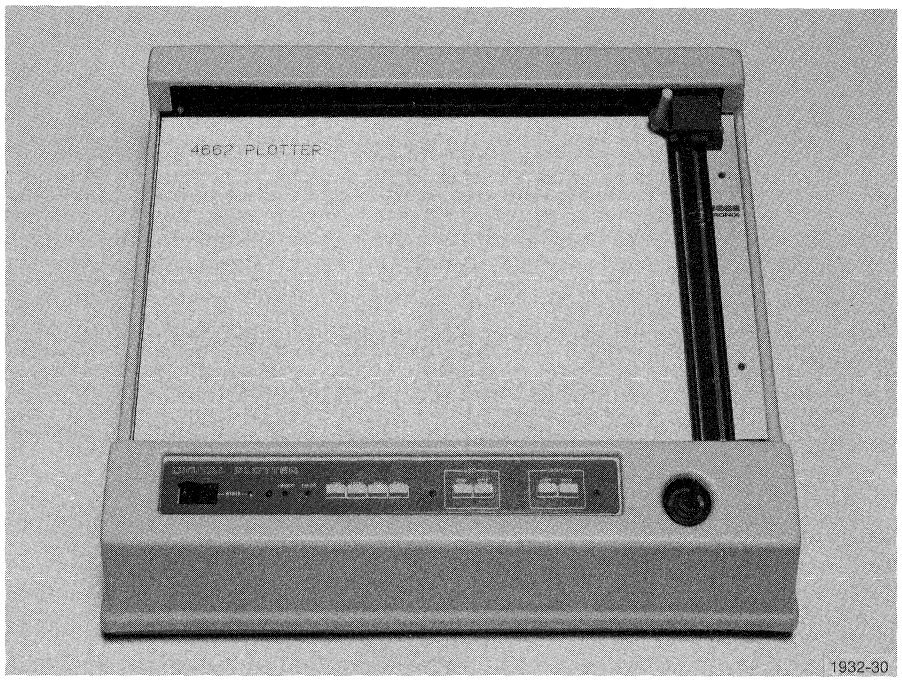

Fig. 3-10. Enlarged Alphanumeric Characters.

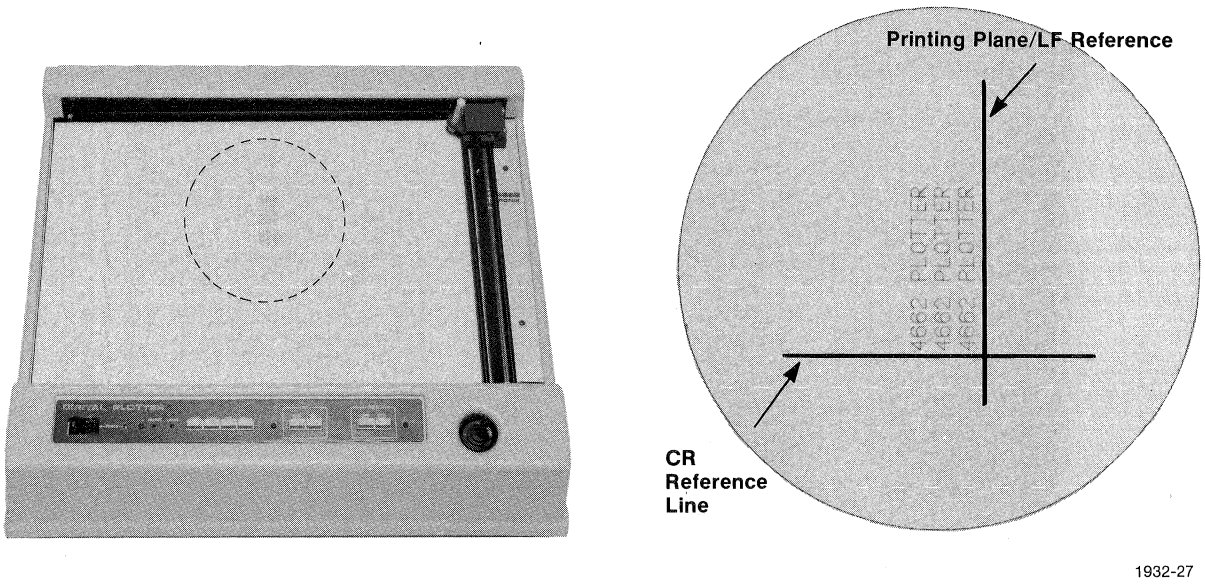

Fig. 3-11. Rotated Alphanumeric Characters, showing Rotated CR Reference Line.

Now enter the following command to rotate the alphanumeric printing angle 90 degrees:

Print @ 1, 25 : 90 CR

Enter the following Print command several times and observe the new Carriage Return and Line Feed references that have been established (refer to Fig. 3-11):

Print @ 1 : "4662 PLOTTER" CR

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8. Repeat step 6 to Reset the alphanumeric printing angle to the default value. Press the LOAD button, place a fresh sheet of paper on the platen, then press the LOAD button again to engage the electrostatic hold-down.

Enter a Home command (Home @ 1 : CR) to send the pen to the HOME position near the upper-right corner of the plotting area.

9. Alpha Font. Enter the following sequence to illustrate the default (Font Ø) characters which will be changed when alternate fonts are selected:

Print @ 1 : " # $ @ [/] ^ { ¦ } " CR

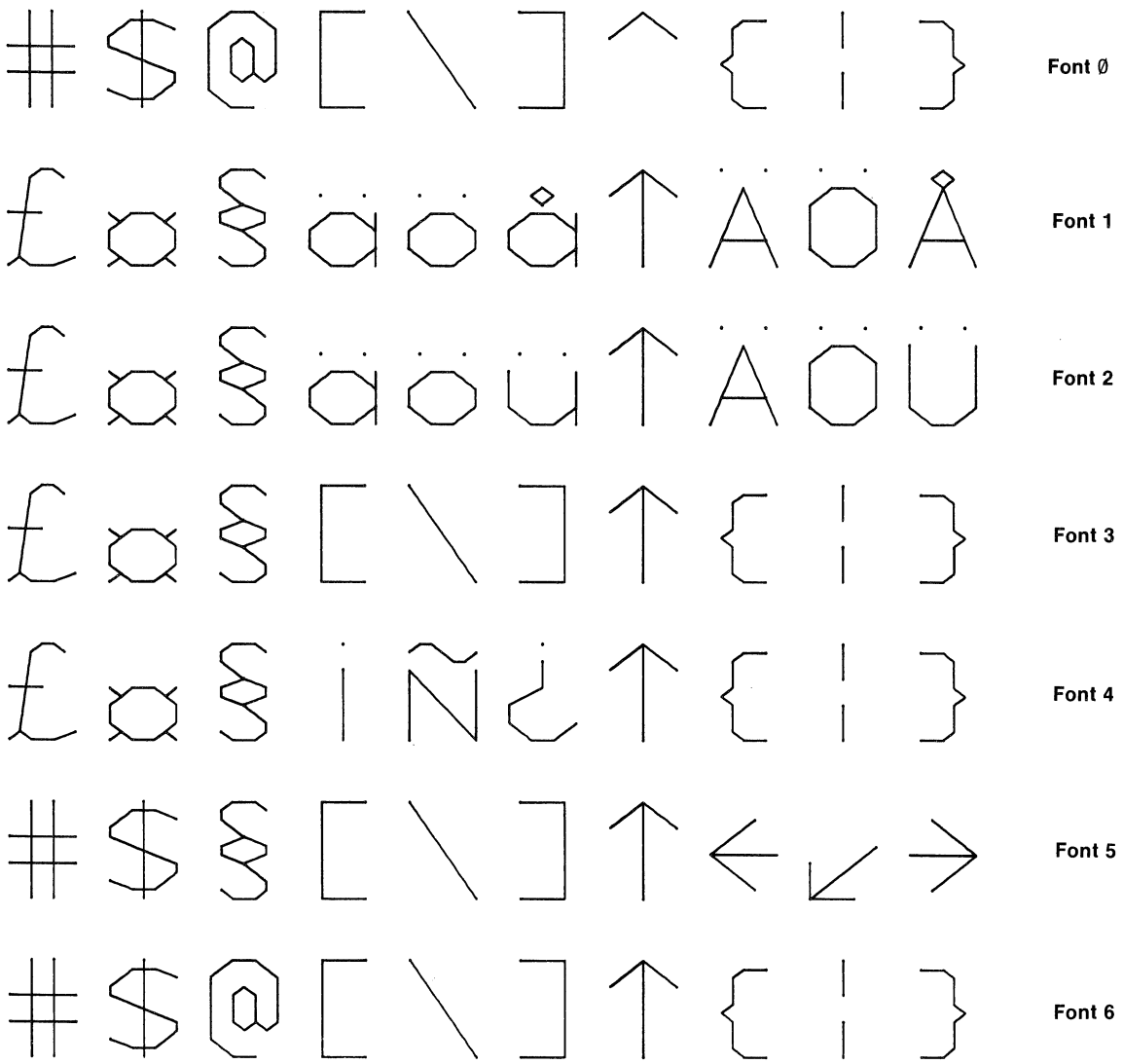

Fig. 3-12. Characters that change when Alternate Alpha Fonts are selected.

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Their bit configurations are shown in the ASCII chart in Appendix B.

Transmit the command sequence for selection of Font 1 (Print @ 1, 18 : 1 CR), then repeat the character sequence above and note that the Font 1 alternate characters are printed. Repeat for fonts 2 through 7; the results should be as shown in Fig. 3-12.

10. GIN Operations. Position the pen to the approximate center of the plotting area by using the Joystick, then enter the following command from the 4051 keyboard:

Input @ 1, 24 : X, Y, Z CR

The GIN coordinates are immediately returned to the 4051. Press X, RETURN, Y, RETURN, Z and RETURN to cause the X, Y, and Z coordinate values to be printed on the 4051 display.

11. Call Gin Operations. Use the Joystick to position the pen to approximately the top center of the plotting area, then perform the following sequence of operations to use the two types of Call GIN operations.

Enter Input @ 1, 27 : X, Y, Z Return

Note that the 4051 waits for the return of GIN Coordinates (The alpha cursor disappears). Press the CALL button on the Plotter; the coordinates are sent and the cursor reappears. Enter X, RETURN, Y, RETURN, Z, RETURN to display the coordinates.

Move the pen; then press the CALL button to store the coordinates. This causes the Plotter to send an SRQ (Serve Request) over the GPIB. The screen will display:

NO SRQ ON UNIT - MESSAGE NUMBER 43

Enter the Call GIN command (Input @1, 27 : X, Y, Z Return); the stored coordinates are returned immediately.

Enter X, RETURN, Y, RETURN, Z, RETURN to cause the coordinates to be printed on the 4051 display.

This concludes the Familiarization Procedure.

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Section 4
INSTALLATION

ABOUT THIS SECTION

This section provides the information necessary for connecting the 4662 into a system. With a few exceptions (Line Voltage Selection and Removing and Replacing the Platen), the information varies according to the interface employed. Therefore, there are three major divisions within this section, as follows:

Line Voltage Selection
Installing the Plotter into an RS-232-C System
Installing the Plotter into a GPIB System

LINE VOLTAGE SELECTION

CAUTION

The 4662 is intended to operate on a single phase power source which has one of its current-carrying conductors (grounding) connected to Safety Earth (ground potential). Operation from other power sources which have both current-carrying conductors live with respect to ground (such as phase-to-phase on a multi-phase system or across the legs of a 117-234 volt single-phase three-wire system) is not recommended since only the line conductor has over-current (fuse) protection within the instrument.

The Plotter is designed to operate on a 115 or 230 volt nominal line voltage source with a frequency of 48 to 66 Hz. In addition, either of two voltage ranges for the 115 or 230 Vac may be selected. The ac power connector is a three-wire polarized plug with one lead connected directly to the instrument frame to provide electric shock protection. Connect this plug only to a three-wire outlet which has a safety ground. If the unit is connected to any other power source, the Plotter frame must be connected to a safety ground system. The connector configuration and color coding is shown in Fig. 4-1. The power cord is to be replaced only with another of the same polarity.

The appropriate line voltage is selected by the use of jumpers on the transformer within the Plotter. To select line voltages, proceed as follows.

Turn off power to the Plotter and disconnect the power cord; then remove the platen to gain access to the Plotter interior. Follow the instructions in "Removing and Replacing the Platen" in this section.

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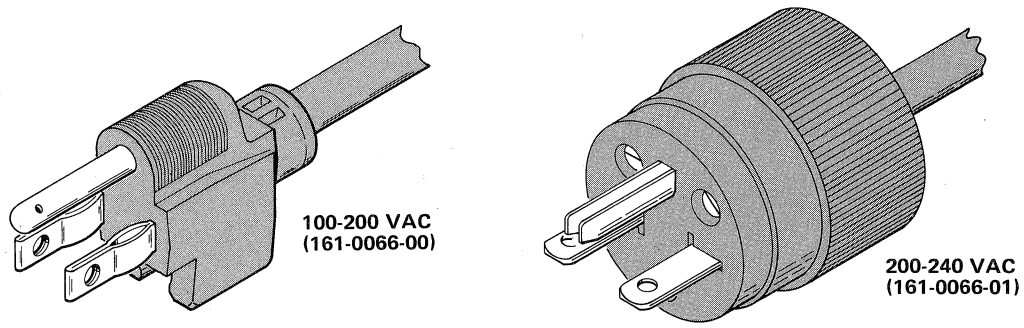

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

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Fig. 4-1. USA standard power cord sets.

WARNING

Do not remove the platen or otherwise expose the interior circuitry of the Plotter with power applied.

The appropriate line voltage is selected by the use of jumpers on the transformer terminals. The transformer location, selectable ranges, and jumper positions for the various line voltage ranges are all shown in Fig. 4-2.

When operating with line voltages in the 210 or 232 volt range, the line fuse and the power cord must be changed. For the 105 and 116 volt ranges, the line fuse is a 1 A (slow-blow).

When converting the Plotter to 210 or 232 volt operation, the power cord is replaced with a 200-240 Vac power cord and the fuse value is changed to a 0.5 A (slow-blow).

To select the proper line voltage, measure the voltage at the power outlet to which the Plotter is to be connected. Position the transformer jumpers accordingly (Fig. 4-2), and change the rear panel line voltage indicator to the new value.

REMOVING AND REPLACING THE PLATEN

It is necessary to remove the platen to gain access to components on the interior of the Plotter. This should normally be necessary only upon initial installation, and then only if the line voltage is to be changed from the factory-wired selection. Whenever the platen is removed, it must be aligned when it is placed back into position. (Refer to the description of Aligning the Platen.)

1. Position the pen carriage to the upper-right corner of the platen, then turn off power if it has been applied. The carriage may be carefully moved by hand if the Plotter is not wired to conform with available power supplies.
2. Remove the four allen-head screws that attach the platen and platen trim strip (Fig. 4-3).

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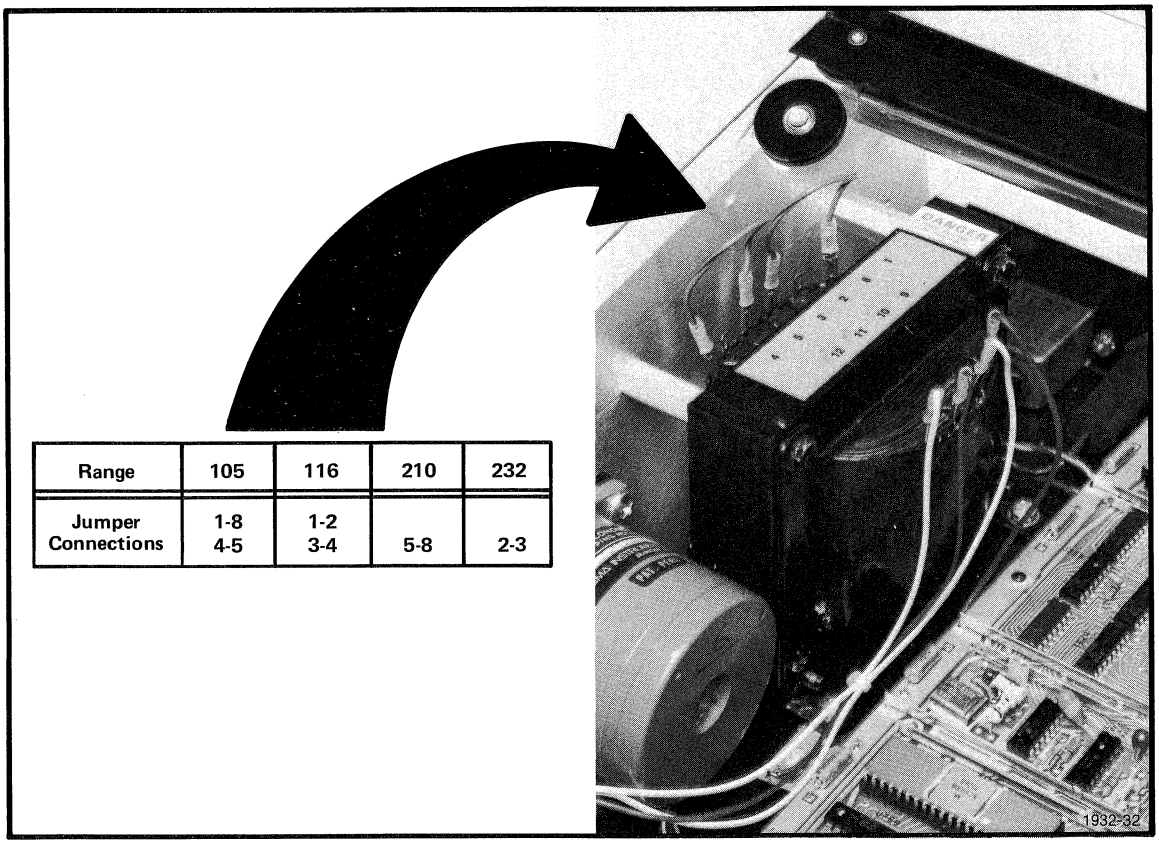

Range	105	116	210	232
Jumper Connections	1-8 4-5	1-2 3-4	5-8	2-3

Fig. 4-2. Line voltage selection.

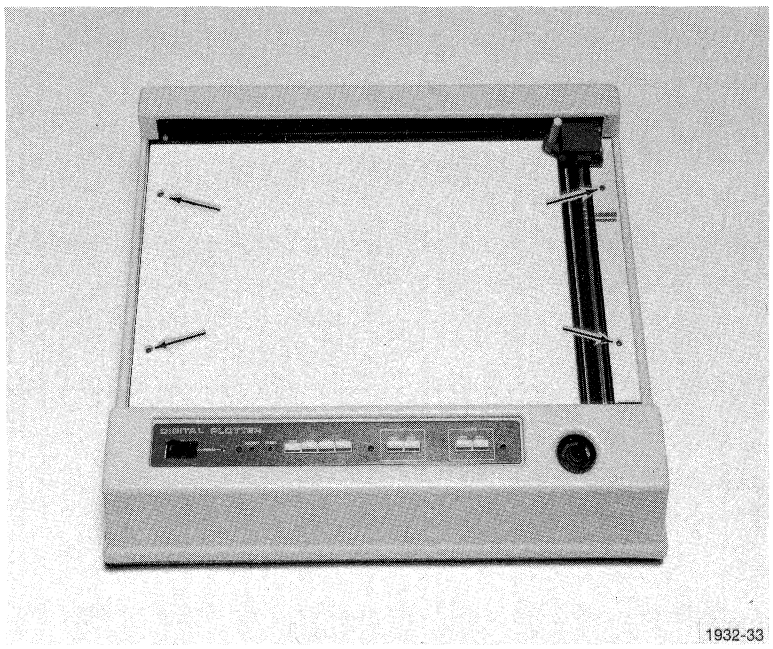

Fig. 4-3. Platen and trim strip attaching screws.

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3. Gently lift the platen and work it to the left of the Plotter (as you face it from the front). When the platen is approximately half removed, reach in and disconnect the platen connector from the Plotter board (Fig. 4-4). The platen may then be completely removed.

4. To replace the platen, simply follow steps 2 and 3 in reverse order. Use caution not to pinch the wire beneath the platen.

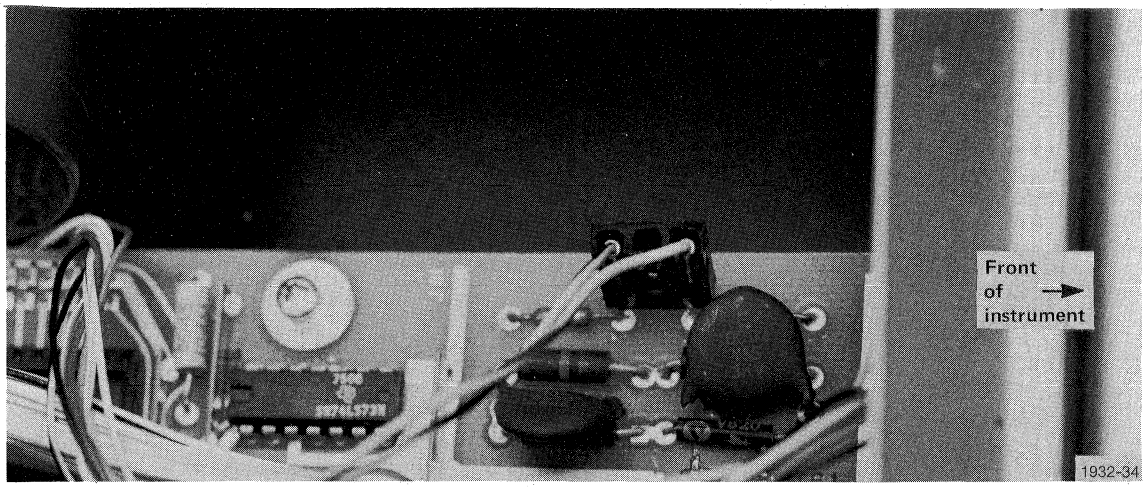

Fig. 4-4. Platen connector position.

ALIGNING THE PLATEN

Whenever the platen is removed and replaced, it must be aligned with the pen mechanism so that the paper guide at the forward edge of the platen is parallel with a line drawn straight across the page. Use the following procedure.

1. With the platen screws snug, but not tight, position a piece of grid paper on the platen, making certain that is is aligned flush with the paper guide.

2. Position the pen, without drawing, to the lower-left corner of the plotting surface.

3. Using the Joystick or programmed move operations, draw a line to the lower-right corner of the plotting surface; then lift the pen.

4. The line drawn should align with the paper grid, as shown in Fig. 4-5. If not, loosen the platen screws and align the platen again; then repeat steps 2 and 3. When the platen is properly aligned, carefully tighten the platen screws without moving the platen.

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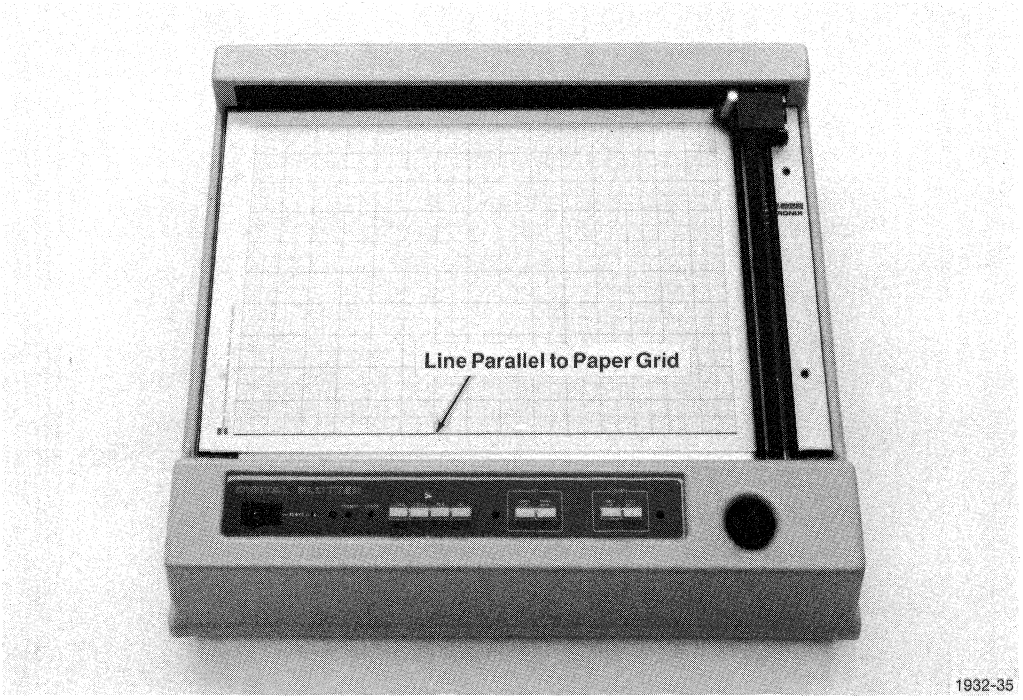

Fig. 4-5. X-axis line parallel to paper grid.

INSTALLING THE PLOTTER INTO AN RS-232-C SYSTEM

GENERAL INSTALLATION INSTRUCTIONS

Installing the Plotter into an RS-232-C system consists of selecting the line voltage setting (described earlier), installing the interconnecting cables, connecting the power cord to an appropriate power outlet, and selecting the various switch-selectable options.

The interconnecting cables are installed into the designated rear-panel connection ports. Two ports are provided; one for a terminal (such as a Tektronix 4010-series Graphic Terminal) and the other for a modem/computer connection. Refer to Fig. 4-6.

When installing other devices into this link, such as a 4923 Option 1 tape unit, the direction of data flow is continued in the same manner. (Refer to Fig. 4-6.)

SELECTING SWITCH OPTIONS

Several programmable parameters are provided to allow the Plotter to conform to various system requirements. These parameter options are selectable by switch-positions on the rear panel. There are four hexadecimal (sixteen-position) switches on the rear panel, labelled Switch A, B, C, and D, that control the parameters. The parameters and the switch settings that select the parameters are detailed in the descriptions that follow.

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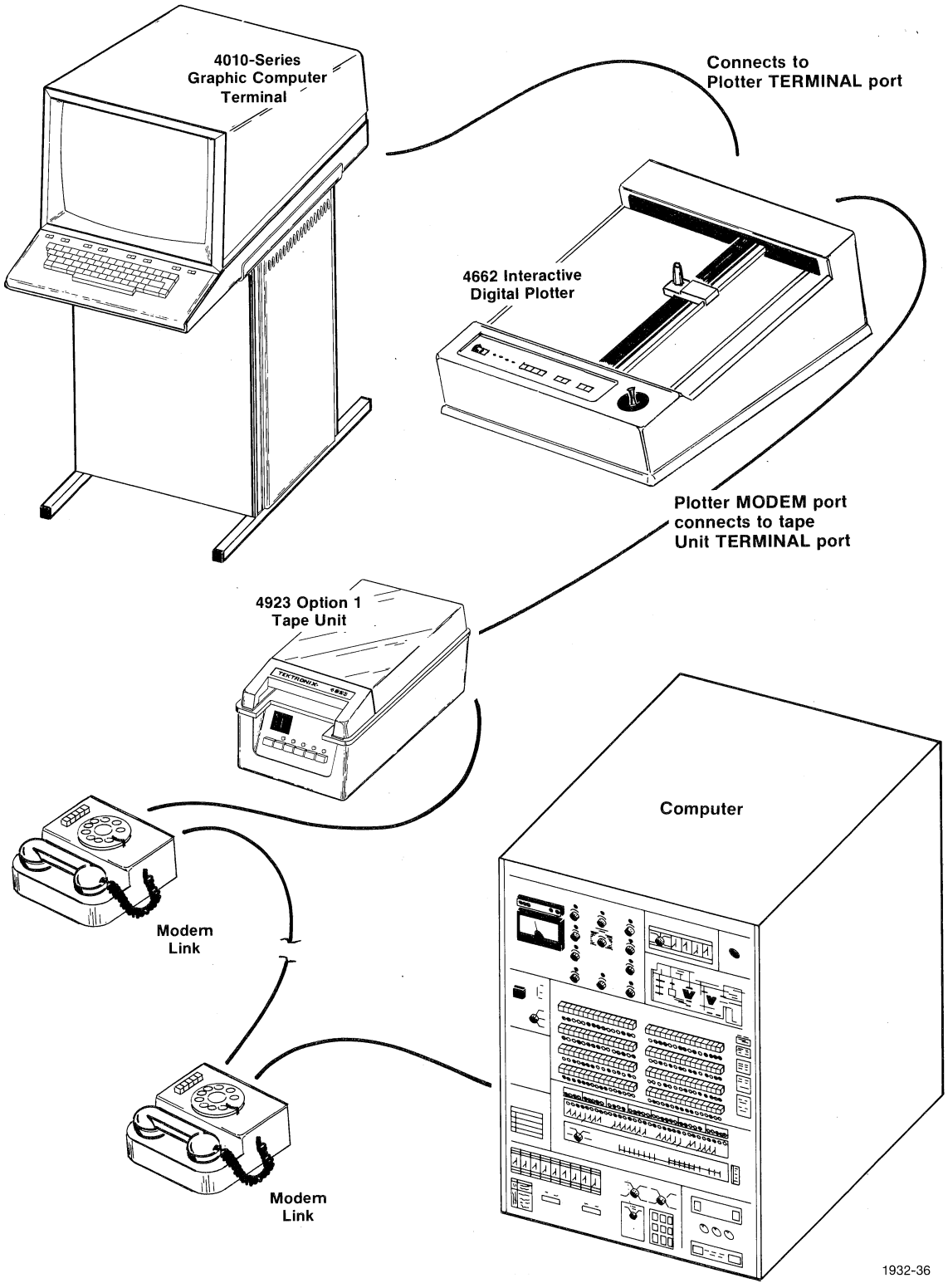

Fig. 4-6. RS-232-C Connection.

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Selectable Parameters

The selectable parameters that pertain to Plotter operation in an RS-232-C environment are described in Table 4-1. The method of selecting these features is described later.

TABLE 4-1

RS-232-C Selectable Parameter Descriptions

Parameter	Description
Low Plotting Speed	The Low Plotting Speed option allows the Plotter to use custom pens that do not allow ink to flow as readily (or rapidly) as the standard pens. It causes the pen carriage to move at one-half its normal rate.
Terminal Mute	When data is being received from the Host, the terminal may be muted (no data transferred to the terminal) while the Plotter is logically "on" after a Plotter On command. This muting can be turned off, which allows all data from the host to pass through the interface to the terminal also, regardless of the logical Plotter On/Off state.
Copy Mode	The Copy plotting mode option is normally used to allow the Plotter aspect ratio to correspond to that of the Tektronix 4010-series terminals. If the full-scale Plotter X-axis is used to correspond to the terminal's X-axis, a portion of Y-axis data intended for the terminal screen falls above the Plotter's upper boundary. Setting the Copy plotting mode option allows the Plotter Y-axis to correspond to that of the terminal; the X-axis is scaled down to preserve the aspect ratio. Refer to Fig. 4-7, and note that a small portion on the right side of the plotting surface is inaccessible when Copy plotting mode is used.
CR (Carriage Return) Effect	This option determines whether an ASCII CR will be interpreted as a Carriage Return only or whether the Plotter will also generate an automatic Line Feed (CR→LF).
DEL (Delete) Interpretation	The ASCII DEL character is normally used as a LOY character in Graph mode (refer to the ASCII chart in Appendix B). To allow transmission of Graphic Data from host systems that use the ASCII DEL character for special system functions, this option is provided to allow the Plotter to ignore DEL characters. In this instance, an ESC? sequence may be used as a Low Order Y (LOY) equivalent to the DEL character.

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TABLE 4-1 (cont)

Parameter	Description
Plotter Output (GIN) Terminator	This combination of two switch bits selects the Plotter Output terminator sequence that is transmitted at the end of each transmission from Plotter to host. There may be no terminator at all, a CR character, or a CR and an EOT, depending on switch position.
Stop Bits	This feature selects the number of RS-232-C stop bits that the Plotter transmits and expects to receive. It should be set to conform to system requirements.
Parity Select	The eighth bit in each byte is a parity bit, used in many systems as an error check on each byte. This option allows for disabling of the Parity Check and Generation (No Parity), Even Parity, or Odd Parity.
RS-232-C Interface Select	This option **must** be selected (the option bit set) when the RS-232-C interface ports are in use. If changed, power must be cycled.
Device Address	This option allows any one of four device addresses (A, B, C or D) to be selected. This allows up to four plotters to be "chained together" in the same RS-232-C system and selectively activated.
Data Transfer Rate (Baud)	This switch option allows selection of data transfer rate at rates of 110, 150, 300, 600, or 1200 baud.

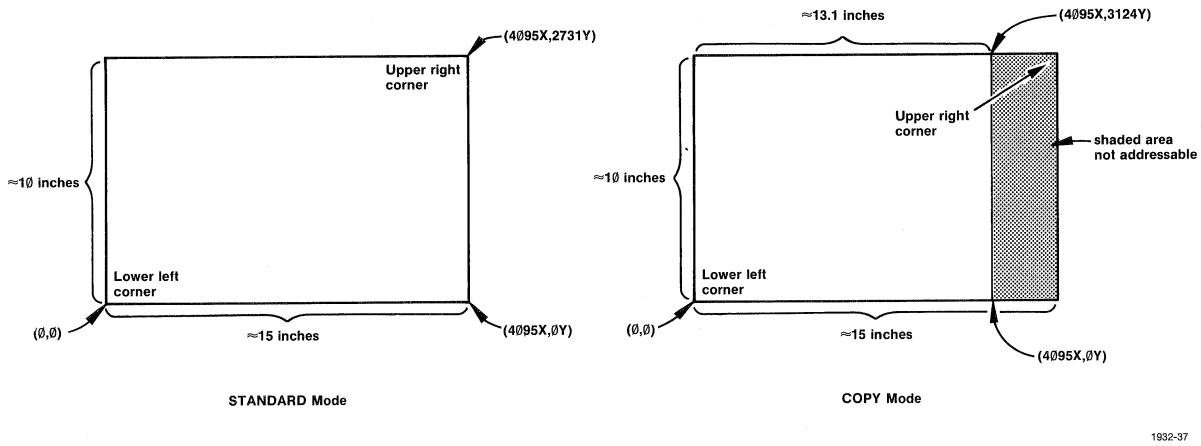

Fig. 4-7. Standard Plotting Mode vs. Copy Plotting Mode.

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Switch Settings

Each switch controls the encoding of four bits of information for the internal Plotter electronics. The bits (or combination of bits) in turn control one of the Switchable Option parameters. Each bit within the controlling combination is weighted with a bit value (Table 4-2). The bit values for the parameters to be selected are then summed (0 through 15), and the sum value is converted to a switch position as follows:

Sum : Ø 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Setting: Ø 1 2 3 4 5 6 7 8 9 A B C D E F

Refer to Fig. 4-8 for a method of selecting switch positions.

TABLE 4-2
RS-232-C Switchable Option Settings

Switch A				Switch B		
8	4	2	1	8	4 2	1
Low Plotting Speed	Terminal Mute	Copy Mode	CR Effect	Delete Interpretation	Plotter Output (GIN) Terminator	Stop Bits
1 = yes 0 = no √	1 = off √ 0 = on	1 = yes 0 = no √	1 = CR→CR+LF 0 = CR→CR √	1 = IGNORE √ 0 = DEL→LOY	00 = NONE 01 = CR 10 = CR+EOT	0 = 2 Stop Bits 1 = 1 Stop Bits

Switch C			Switch D
8 4	2 1	8	4 2 1
Parity	RS-232-C Interface Select	Device Address	Data Transfer Rate (Baud)
11 = Odd 10 = Even 01 = none 00 = none	1 = yes √ 0 = no	00 = A 01 = B 10 = C √ 11 = D	000 = 150 baud 001 = 300 baud 010 = 600 baud 011 = 1200 baud √ 100 = 110 baud

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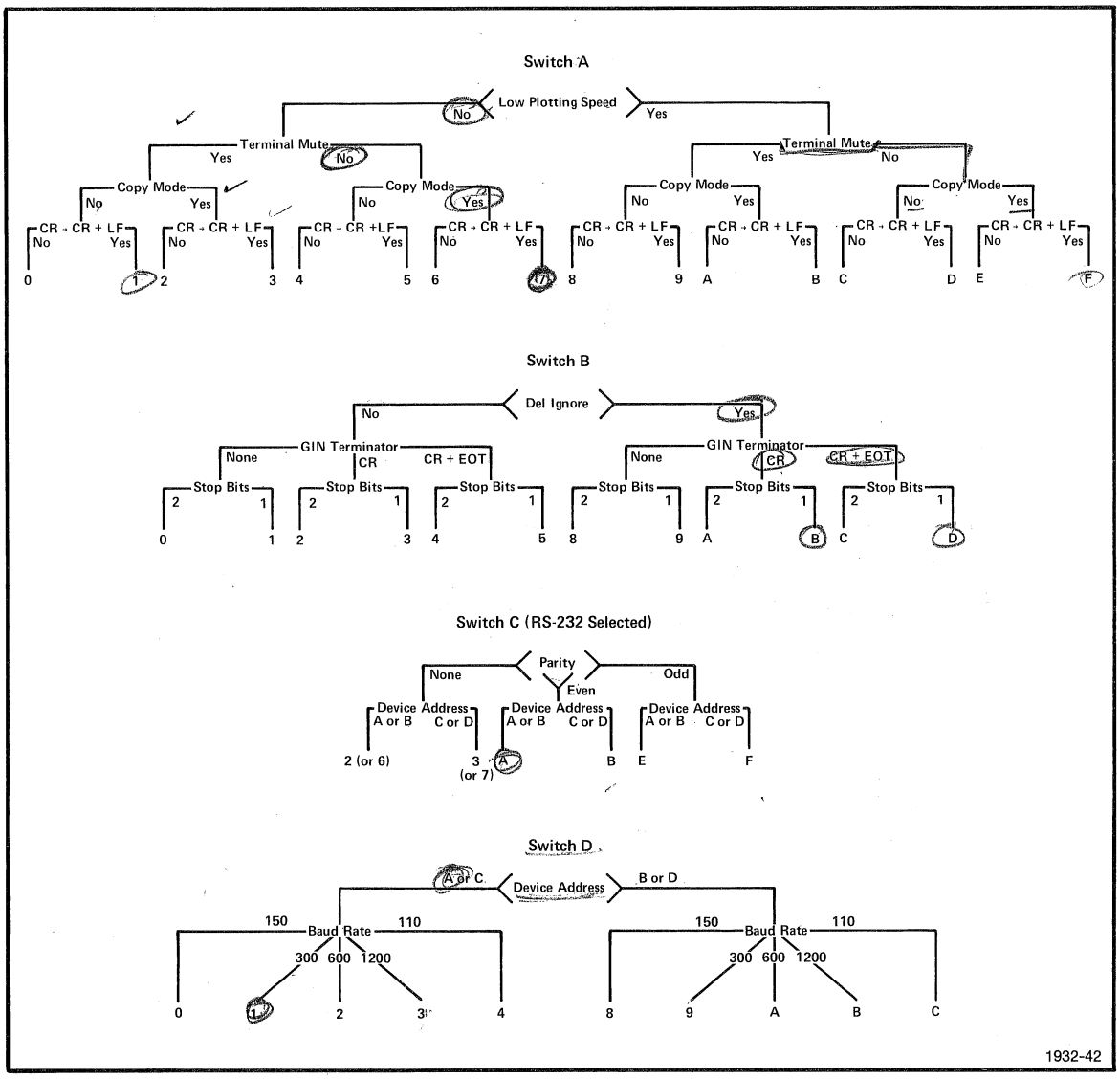

Fig. 4-8. Switch Positions and example.

A B C D
7 3 4 1
7 3 4 3

4015 operation @ 300 Baud
" " " 1200 "

INSTALLING THE PLOTTER IN A GENERAL PURPOSE INTERFACE BUS (GPIB) SYSTEM

GENERAL INSTALLATION INSTRUCTIONS

Installing the Plotter in a General Purpose Interface Bus (GPIB) system requires selection for the available line voltage (described earlier), connection to the appropriate power outlet, selection of the desired switchable options, and connection to the General Purpose Interface Bus.

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The standard GPIB Interconnecting cable allows devices to be linked together sequentially or branched out from a central controller, as shown in Fig. 4-9. Connect the Plotter GPIB cable between the Plotter and the controller (or other GPIB device) as shown in Fig. 4-9. A 4051 Graphic System is shown as a controller in the example.

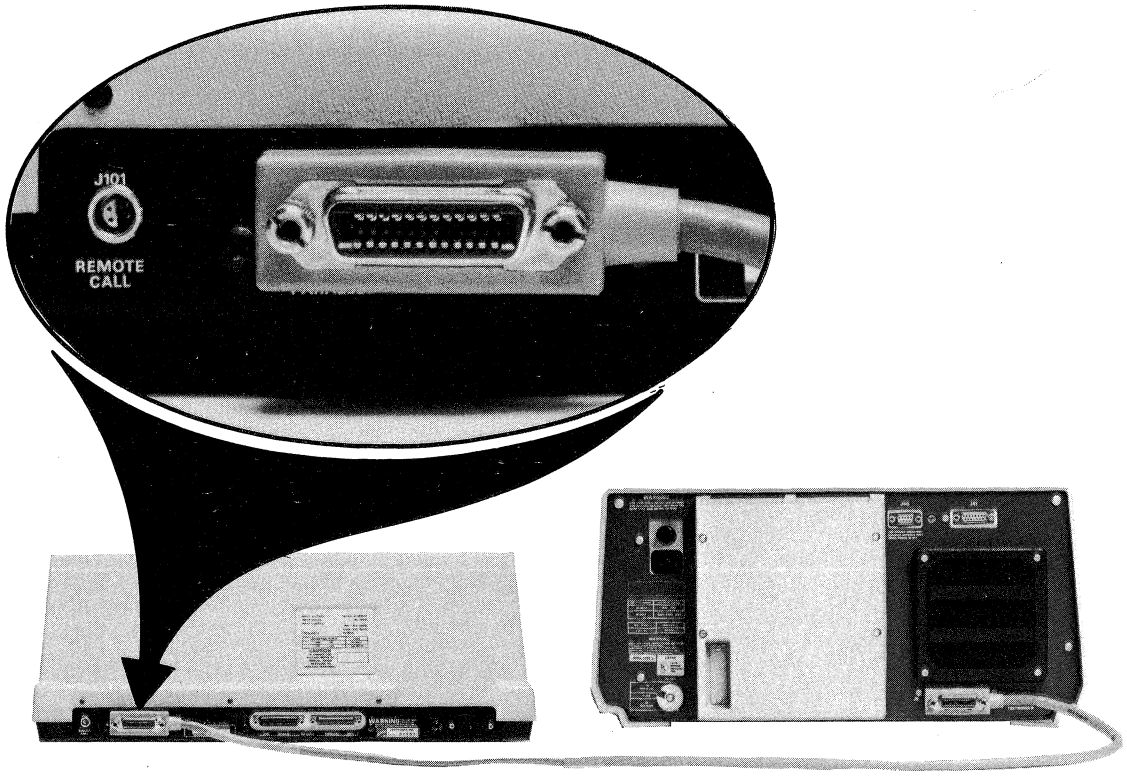

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Fig. 4-9. Installing the Plotter into a GPIB system.

NOTE

According to the IEEE GPIB Standard: If several devices are connected to the GPIB bus, one more than 50% of the devices must be turned on (regardless of whether they are actually used), or the bus may be loaded down by the turned-off devices, causing a spurious SRQ signal on the bus.

SELECTING SWITCH OPTIONS

Several programmable parameters are provided to allow the Plotter to conform to the requirements of various systems. These parameter options are selectable by switch positions on the rear panel. There are four hexadecimal (sixteen-position) switches on the rear panel (labelled Switch A, B, C and D) that control the parameters. The parameters and the switch settings that select the parameters are detailed in Table 4-3.

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TABLE 4-3

GPIB Selectable Parameter Descriptions

Parameter	Description
Low Plotting Speed	The Low Plotting Speed option allows the Plotter to use custom pens that do not allow ink to flow as readily (or rapidly) as the standard pens. When selected, it causes the pen carriage to move at one-half its normal rate.
Talk Only	This option causes the Plotter to operate in the GPIB "Talk Only" mode; it will not plot or print alphanumerics. An example might be a GPIB system with no controller where the Plotter provides digitizing input to another device.
CR (Carriage Return) Effect	This option setting determines whether the Plotter will respond to an ASCII CR as a Carriage Return only, or whether a Line Feed will also be generated automatically (CR→LF).
Listen Only	This option causes the plotter to operate in the GPIB "Listen Only" mode; it will not provide GIN-type output. This mode might be used to produce plots on a GPIB system with no controller. DAB-type commands must be selected.
MSA Commands	This switch option allows selective disabling and enabling of GPIB MSA (My Secondary Address) commands. MSA commands are normally used with the 4051 Graphic System. Disabling the MSA commands allows the Plotter to conform strictly to the talk and listen functions of the GPIB standard (IEEE 488-1975).
DAB Commands	This switch option allows selective disabling and enabling of GPIB DAB (Command Data Byte) commands. The Plotter should be set to respond either to MSA commands or DAB commands, depending on system requirements.
GPIB Interface Select	This option **must** be set (the option bit Ø) when the General Purpose Interface Bus is in use. If not, the Plotter is logically disconnected from the bus. If the selection is changed, power must be cycled.
Primary Address	The Primary Address (from Ø to 30) used to address the Plotter for talk and listen functions (MTA, My Talk Address; and MLA, My Listen Address — respectively) is set by this combination of switch bits. The selectable address feature allows several devices to be connected to the bus and selectively activated.

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Switch Settings

Each Switch controls the encoding of four bits of information for the internal Plotter electronics. The bits or combination of bits in turn controls one of the Switchable Option parameters. Each bit within the controlling combination is weighted with a bit value (Table 4-4). The bit values for the parameters to be selected are then summed (0 through 15), and the sum value converted to a switch position as follows:

Sum : Ø 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Setting: Ø 1 2 3 4 5 6 7 8 9 A B C D E F

Refer to Fig. 4-10 for a method of selecting correct switch settings.

TABLE 4-4

GPIB Switchable Option Settings

Switch A				Switch B			
8	4	2	1	8	4	2	1
Low Plotting Speed	No Effect	Talk Only	CR Effect	Listen Only	MSA Com-mands	DAB Com-mands	No Effect
1 = yes Ø = no		1 = yes Ø = no	1 = CR+LF Ø = CR	1 = yes Ø = no	1 = no Ø = yes	1 = no Ø = yes	

Switch C				Switch D			
8	4	2	1	8	4	2	1
No Effect		GPIB Interface Select	(16)	(8)	(4)	(2)	(1)
		1 = no Ø = yes		Primary Address Ø through 3Ø			

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DEV. 1
1 0 0 1 FOR BASIC PROGRAMS DONE @ TDF (5/21/82)

A B C D
1 2 1 4 Device 20

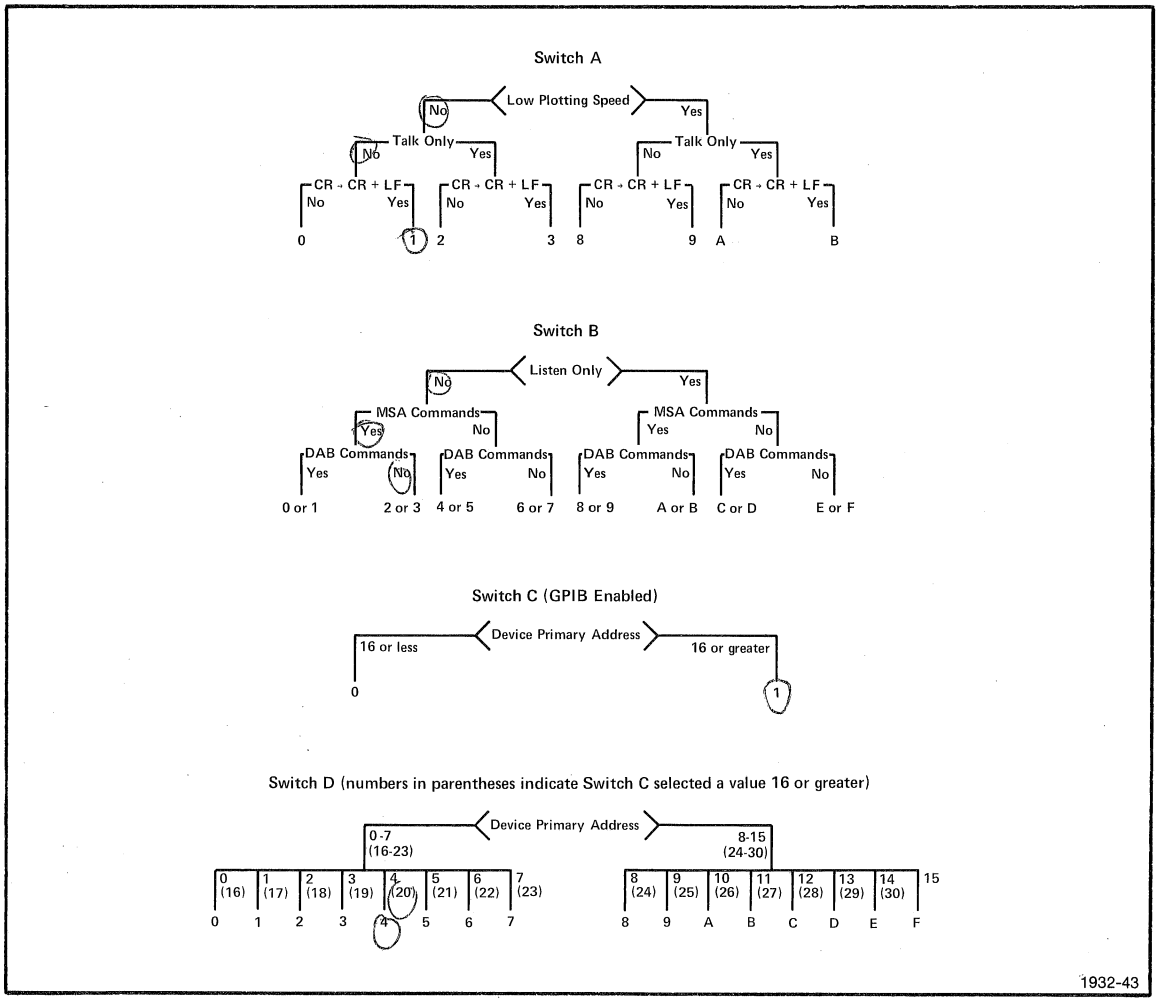

Fig. 4-10. Switch Positions with example.

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APPENDIX A
SPECIFICATIONS

The following specifications for the 4662 Interactive Digital Plotter are included for information only. These values are subject to change without notice.

Physical Specifications

Height	8 inches (20.3 cm).
Width	20.5 inches (52 cm).
Length	19 inches (48.3 cm).
Weight	32 pounds (14.5 kg).

Electrical Specifications

Power Consumption	90 watts maximum. 60 watts typical.
Line Voltage	115 or 230 volts nominal. Line voltages are strappable within the Plotter to select 105, 116, 210, or 232 volts (±14%).
Line Frequency	48 to 66 Hz.
Line Fuse	1 amp (slow-blow) when operating in the 115 V range. 0.5 amp (slow-blow) when operating in the 230 V range.

Environmental Specifications

Temperature	−55 to +75°C, non-operating. 0 to +50°C, operating.
Altitude	To 50,000 feet, non-operating. To 15,000 feet, operating.

Standard Accessories

Power Cord	161-0066-00
Pens (packages of 3)	
Red	016-0589-00
Green	016-0589-01
Black	016-0589-02
Blue	016-0589-03
Users Manual	070-1932-XX

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Digitizing Sight	214-2409-01
Paper	
1 package (100 sheets, 10 x 10 to 1 inch)	006-1698-00
RS-232-C Interface Cable	
(Standard with Basic Unit only)	012-0690-00
GPIB Interface Cable (2 meter)	
(Standard with Option 1 Unit)	012-0630-01

Optional Accessories

Pens (packages of 3)	
Red	016-0589-00
Green	016-0589-01
Black	016-0589-02
Blue	016-0589-03
Paper (packages of 100 sheets)	
11 x 16.5 inch linear square chart paper, 10 x 10 to 1 inch	006-1698-00
11 X 16.5 inch linear square chart paper, 10 x 10 to 1 cm	006-1699-00
11 x 16.5 inch semi-logarithmic chart paper, 10 inch x 3 cycles	006-1700-00
11 x 16.5 inch semi-logarithmic chart paper, 15 inch x 2 cycles	006-1701-00
11 x 16.5 inch full logarithmic chart paper, 2 cycles x 3 cycles	006-1702-00
Dust Cover	016-0345-00
GPIB Interface Cable	012-0630-01
RS-232-C Interface Cable	012-0690-00
Remote CALL foot/hand switch	

Performance Specifications

Plotting Area	X-axis: greater than 15 inches (38.1 cm). Y-axis: greater than 10 inches (25.4 cm).
Initial Pen Position	Lower right corner of the platen.
Vector Length	The Plotter will draw vectors of any length within the plotting area.

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Scaling	The Plotter will scale incoming data that is intended for full-scale plotting into any size plot within the plotting area.
Plotting Accuracy	Default: ±0.0025 inch, ±0.4% of vector length. Calibratable: ±0.005 inch.
Repeatability	The Plotter will return to any previously-plotted point within ±0.0025 inch.
Vector Linearity	Geometry: the mean vector line will not deviate more than 0.0007 inch, per inch of line length, from a straight line drawn between two points. Line Aberrations: Short-term non-linearities of a vector will not deviate more than ±0.005 inch from the mean vector.
Plotting Rate	Greater than 16 inches per second (per axis) maximum. Maximum rate achieved after about 100 ms, or about 1.3 inch of pen travel.
Manual (Joystick) Moves	The pen may be moved by using the front panel joystick at vector rates variable from 0.015 inch per second to 4 inches per second.
Point Plotting Rate	Pen action rate (up/down) is 10 points/second maximum. Plotted points per second decrease for an increasing distance between points.
Paper Retainer	Electrostatic hold-down.
Data Resolution	0.005 inch.
Motor Drive Resolution	Approximately 8 times the Data Resolution (0.000625 inch).

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APPENDIX B
ASCII CODE CHART

B7 B6 B5 (BITS)				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		HIGH X & Y GRAPHIC INPUT		LOW X		LOW Y & XLOY	
Ø	Ø	Ø	Ø	Ø NUL	16 DLE	32 SP	48 Ø	64 @	8Ø P	96 `	112 p
Ø	Ø	Ø	1	1 SOH	17 DC1	33 !	49 1	65 A	81 Q	97 a	113 q
Ø	Ø	1	Ø	2 STX	18 DC2	34 "	50 2	66 B	82 R	98 b	114 r
Ø	Ø	1	1	3 ETX	19 DC3	35 #	51 3	67 C	83 S	99 c	115 s
Ø	1	Ø	Ø	4 EOT	2Ø DC4	36 $	52 4	68 D	84 T	1ØØ d	116 t
Ø	1	Ø	1	5 ENQ	21 NAK	37 %	53 5	69 E	85 U	1Ø1 e	117 u
Ø	1	1	Ø	6 ACK	22 SYN	38 &	54 6	7Ø F	86 V	1Ø2 f	118 v
Ø	1	1	1	7 BEL BELL	23 ETB	39 '	55 7	71 G	87 W	1Ø3 g	119 w
1	Ø	Ø	Ø	8 BS BACK SPACE	24 CAN	40 (	56 8	72 H	88 X	1Ø4 h	12Ø x
1	Ø	Ø	1	9 HT	25 EM	41)	57 9	73 I	89 Y	1Ø5 i	121 y
1	Ø	1	Ø	1Ø LF	26 SUB	42 *	58 :	74 J	9Ø Z	1Ø6 j	122 z
1	Ø	1	1	11 VT	27 ESC	43 +	59 ;	75 K	91 [	1Ø7 k	123 {
1	1	Ø	Ø	12 FF	28 FS	44 ,	60 <	76 L	92 \	1Ø8 l	124 ¦
1	1	Ø	1	13 CR RETURN	29 GS	45 -	61 =	77 M	93]	1Ø9 m	125 }
1	1	1	Ø	14 SO	3Ø RS	46 .	62 >	78 N	94 ^	11Ø n	126 ~
1	1	1	1	15 SI	31 US	47 /	63 ?	79 O	95 _	111 o	127 RUBOUT (DEL)

Note that either "LOY" column may be used for the XLOY byte, since bit 5 is not used.

@

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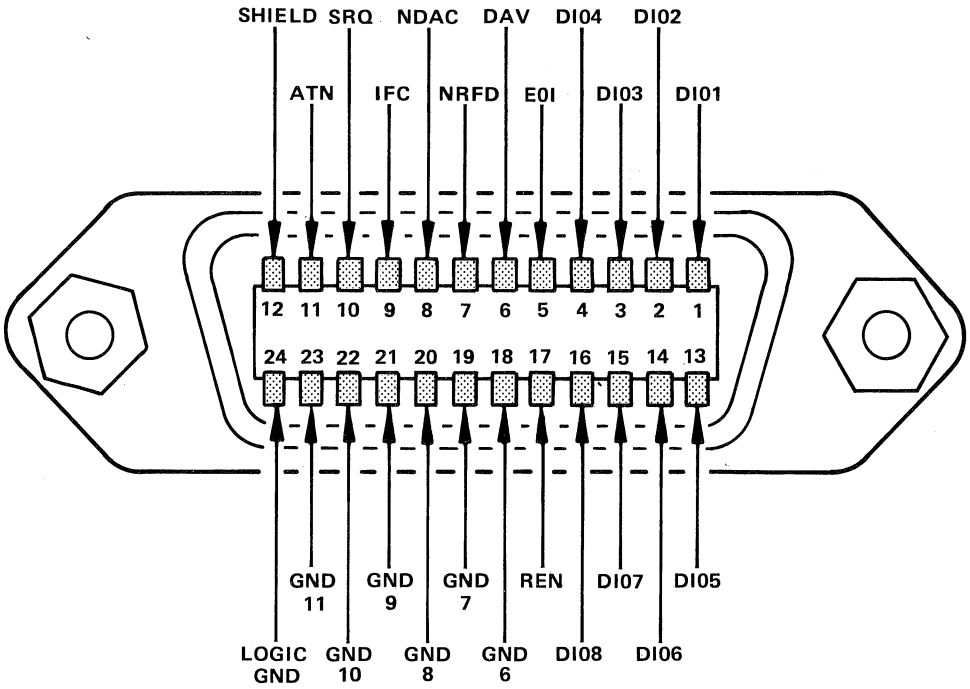
APPENDIX C
GPIB DESCRIPTION

THE GENERAL PURPOSE INTERFACE BUS (GPIB)

The GPIB Connector

The GPIB connector is located on the rear panel of the Plotter main chassis. This connector allows external peripheral devices to be connected into a system. The devices must conform to IEEE Standard #488-1975 which describes a byte-serial, bit-parallel interface system for programmable measuring apparatus. The GPIB connector is a standard 24-pin connector such as an Amphenol Micro-Ribbon® connector, with sixteen active signal lines and eight interlaced grounds. The cable attached to the GPIB connector must be no longer than 2Ø meters maximum with no more than 15 peripheral devices connected at one time. The connector pin arrangement and signal line nomenclature is shown below:



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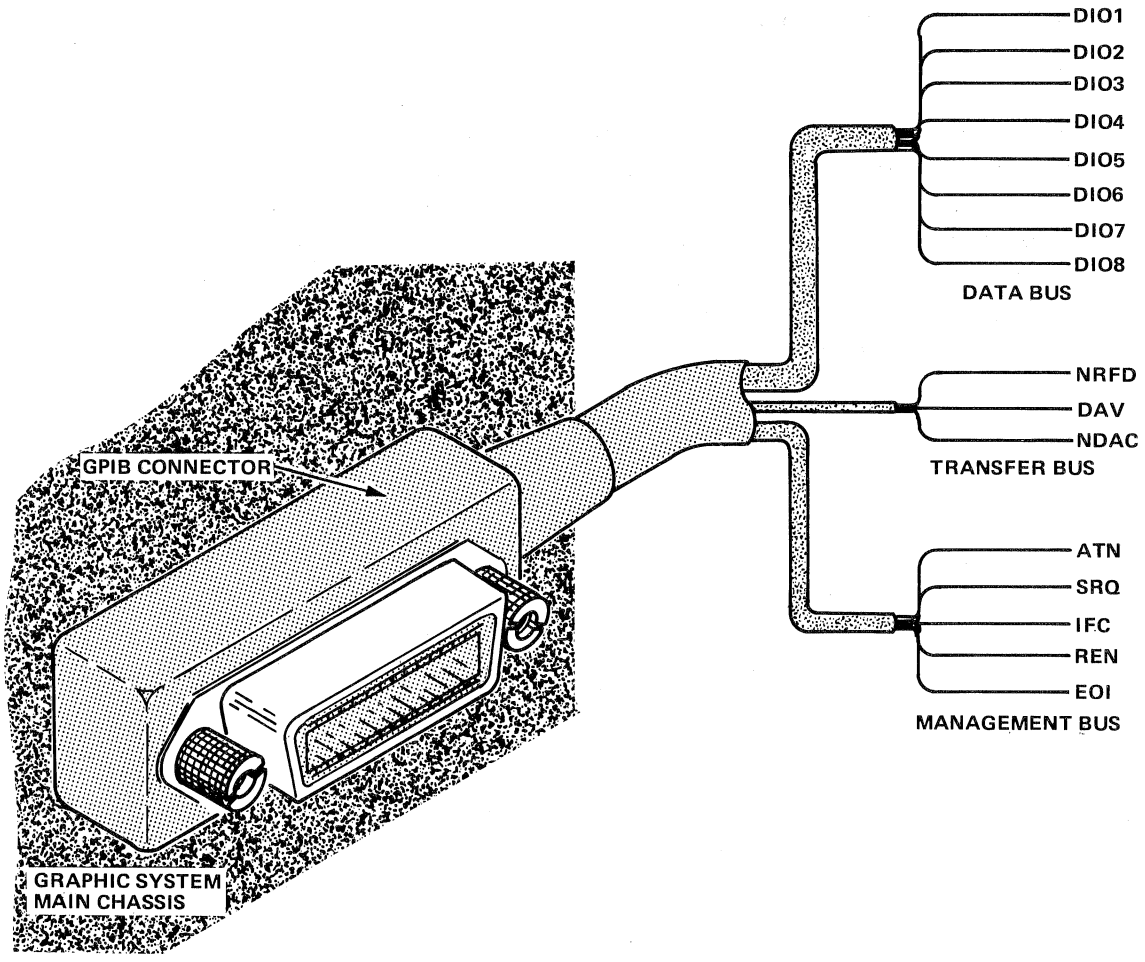
The GPIB Interfacing Concept

The GPIB is functionally divided into three component busses; an eight-line Data Bus, a three-line Transfer Bus, and a five-line Management Bus for a total of 16 active signal lines. This bus structure is shown in the diagram below:



The transfer rate over the Data Bus is a function of the slowest peripheral device taking part in a transfer at any one time. The bus operates asynchronously with a maximum transfer rate of 25ØK bytes/second (one megabyte/second with tristate drivers). Both peripherial addresses and data are sent sequentially over the Data Bus. Once peripheral addresses are established for a particular transfer, successive data bytes may be transmitted in a burst for higher effective data rates.

Peripheral Devices on the GPIB are designated as talkers and listeners. When the plotter is used with a TEKTRONIX Graphic System, the Graphic System acts as the controller to assign peripheral devices on the bus as listeners and talkers. The Graphic System further assumes that it is the only controller on the bus and it has complete control over the direction of all data transfers. There is no provision for other devices on the GPIB to take turns as controller-in-charge.

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A talker is a device capable of transmitting information on the Data Bus. There can be only one talker at a time. The Plotter microprocessor has the ability to assume the role of the talker when it is commanded to do so.

A listener is a device capable of receiving information transmitted over the Data Bus. There may be up to 14 listeners taking part in an I/O operation at any one time. The Plotter microprocessor has the ability to assume the role of a listener any time it is commanded to do so.

GPIB Signal Definitions

Data Bus. The Data Bus contains eight bidirectional active-low signal lines, DI01 through DI08. One byte of information (eight bits) is transferred over the bus at a time. DI01 represents the least significant bit in the byte; DI08 represents the most significant bit in the byte. Each byte represents a peripheral address (either primary or secondary), a control word, or a data byte. Data bytes can be formatted in ASCII code, with or without parity (the Plotter forces no parity), or they can be formatted in machine dependent binary code.

Management Bus. The Management Bus is a group of five signal lines which are used to control data transfers over the Data Bus. The signal definitions for the Management Bus are as follows:

Signal	Definition
Attention (ATN)	This signal line is activated by the controller when peripheral devices are being assigned as listeners and talkers. Only peripheral addresses and control messages can be transferred over the Data Bus when ATN is active low. After ATN goes high, only those peripheral devices which are assigned as listeners and talkers can take part in the data transfer.
Service Request (SRQ)	Any peripheral device on the GPIB can request the attention of the controller by setting SRQ active low. The controller responds by setting ATN active low and executing a serial poll to see which device is requesting service.
Interface Clear (IFC)	The IFC signal line is activated by the controller when it wants to place all interface circuitry in a predetermined quiescent state.
Remote Enable (REN)	The REN signal line is activated whenever the system is operating under program control. REN causes all peripheral devices on GPIB to ignore their front panel controls and operate under remote control via signals and control messages received over the GPIB.

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End of Identify (EOI)	The EOI signal can be used by the talker to indicate the end of a data transfer sequence. The talker activates EOI as the last byte of data is transmitted. When the controller is listening, it assumes that a data byte received is the last byte in the transmission, if EOI is activated. When the controller is talking, it always activates EOI as the last byte is transferred.

The Transfer Bus. A handshake sequence is executed by the talker and the listeners over the Transfer Bus each time a data byte is transferred over the Data Bus. The Transfer Bus signal lines are defined as follows:

Signal	Definition
Not Ready for Data (NRFD)	An active low NRFD signal line indicates that one or more assigned listeners are not ready to receive the next data byte. When all of the assigned listeners for a particular data transfer have released NRFD, the NRFD line goes inactive high. This tells the talker to place the next data byte on the Data Bus.
Data Valid (DAV)	The DAV signal line is activated by the talker shortly after the talker places a valid data byte on the Data Bus. An active low DAV signal tells each listener to capture the data byte presently on the Data Bus. The talker is inhibited from activating DAV when NRFD is active low.
Date Not Accepted (NDAC)	The NDAC signal line is held active low by each listener until the listener captures the data byte, NDAC goes inactive high. This tells the talker to take the byte off the Data Bus.

GPIB Data Formats. Any series of bit patterns can be transitted over the GPIB. This allows both numeric data and alphanumeric data to be transmitted.

Transferring ASCII Data. ASCII numeric data can be transferred in either standard (free) format or scientific format, and must be transmitted most significant digit first. Valid ASCII characters are digits Ø through 9,E,e,+,−, and decimal point. ASCII character strings can be transmitted as any sequence of valid ASCII characters. ALL ASCII data transfers, both numeric and alphanumeric are terminated with a Carriage Return character or by activating the EOI signal line of the Management Bus, or both.

GPIB to IEEE Compatibility

Introduction. The following text describes the interfacing compatibility of the Graphic System's General Purpose Interface Bus with IEEE Standard #488-1975 which describes a byte-serial, bit-parallel interface system for programmable measuring apparatus.

In general, the Plotter acts as a standard talker and listener.

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GPIB Interfacing Compatibility in Detail

Reference: IEEE Standard #488-1975.

The Graphic System GPIB falls into the following interface function subsets as defined in the IEEE Standard #488-1975 document:

Section 2.3 SH (Source Handshake Function)
SH1—completely compatible

Section 2.4 AH (Acceptor Handshake Function)
AH1—completely compatible

Section 2.5 T (Talker Function)
TE1—basic extended talker

Section 2.6 L (Listener Function)
LE1—basic extended listener

Section 2.7 SR (Service Request Function)
SR1—completely compatible

Section 2.8 RL (Remote Local)
RLØ—no compatibility

Section 2.9 PP (Parallel Poll Function)
PPØ—no capability

Section 2.1Ø DC (Device Clear Function)
DCØ—no capability

Section 2.11 DT (Device Trigger Function)
DTØ—no capability

Section 2.12 C (Controller Function)
CØ—no capability

Handshake Process Timing Sequence

Each data byte transferred by the interface system uses the handshake process to exchange data between source and acceptor. Typically, the source is a Talker and the acceptor is a Listener.

Figure C-1 shows the handshake process by illustrating typical waveforms on the DAV, NRFD, and NDAC signal lines. The NRFD and NDAC signals each represent composite waveforms resulting from two or more Listeners accepting the same data byte at slightly different times due to variations in the transmission path length and different response rates (delays) to accept and process the data byte.

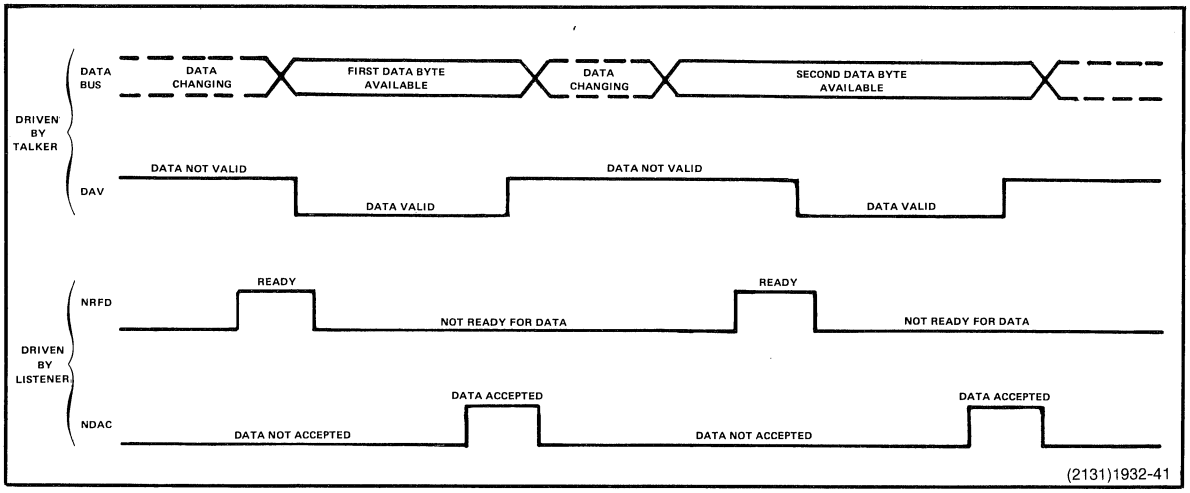

Fig. C-1. Signal line timing sequence for one Talker and multiple Listeners using the handshake process. Note: H ⩾+2.0 V; L ⩽+0.8 V.

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APPENDIX D

DRAWING TIME CHARACTERISTICS

In RS-232-C Continuous Mode communication, the host system must guard against possible input buffer overflow by transmitting at a low enough baud rate to allow the plotter to keep up with input, or by padding the data with non-operational characters or space between blocks. These methods are related in Section 2 under DATA TRANSMISSION.

The information here provides a basis for deciding how much time to allow for data transmission, based on the baud rate and the number of bytes, the printing time of the various characters in Alpha Mode (Table D-1), and the execution time for vectors of varying lengths.

Figure D-1 is a chart that can be used to determine the time required for vectors shorter than 2.55 inches. The time required for vectors longer than 2.55 inches may be determined from the following formula:

Time = 241.6 + (vector length −2.55) (61.44)
Length is indicated in inches, and time is calculated in milliseconds.

These conditions are handled automatically in the TEKTRONIX 4662A01 PLOT-10 Utility Routines software package.

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Table D-1

ALPHA CHARACTER EXECUTION TIMES

CHARACTER	TIME	CHARACTER	TIME	CHARACTER	TIME
SPACE	100	@	509	`	155
!	278	A	362	a	387
"	265	B	476	b	412
#	585	C	343	c	327
$	523	D	367	d	398
%	536	E	368	e	377
&	424	F	344	f	383
'	158	G	394	g	440
(	266	H	314	h	295
)	268	I	326	i	275
*	424	J	256	j	338
+	301	K	329	k	378
,	179	L	270	l	178
-	160	M	264	m	364
.	139	N	254	n	268
/	170	O	377	o	347
Ø	400	P	325	p	391
1	204	Q	438	q	399
2	312	R	378	r	244
3	448	S	402	s	415
4	274	T	251	t	331
5	368	U	280	u	289
6	421	V	201	v	180
7	239	W	265	w	231
8	519	X	314	x	309
9	418	Y	255	y	233
:	239	Z	257	z	252
;	291	[	257	{	320
<	231	\	165	|	280
=	322	]	257	}	322
>	232	^	180	~	216
?	371	_	158		

Time (in milliseconds) for printing of default ASCII printing characters. Conservative times for other character sizes may be obtained by assuming a direct linear relationship for larger sizes (i.e. twice as big take twice as long) and using the above figures for smaller sizes.

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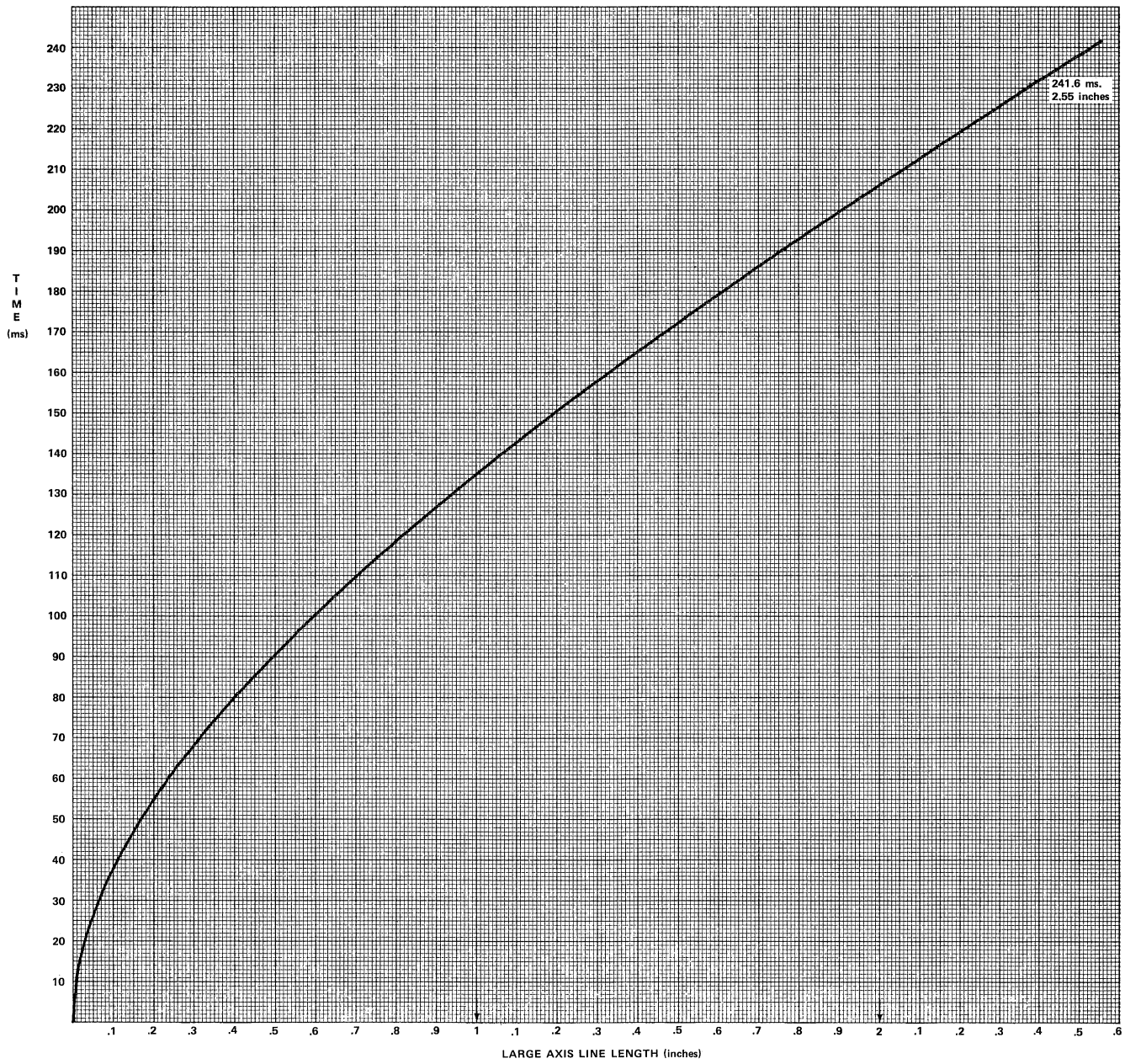

Fig. D-1 Short vector drawing time requirements.

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APPENDIX E

4662 OPTION 30 INSTALLATION AND OPERATION

The 4662, Option 30, Interactive Digital Plotter includes an interface card and cable for use with the 4081 Graphic System. This appendix describes the Installation procedure required to complete the Plotter/Graphic System connection. Special operating considerations that pertain to using Tektronix Plot 80 software with the Plotter are also outlined in this appendix.

INSTALLATION PROCEDURE

Installing the Plotter and 4081 interface card consists of verifying switch and strap settings, placing the interface card in a free slot in the 4081 card cabinet, and connecting the cable between the interface card and Plotter.

If the Plotter is ordered along with the 4081, the interface card is already installed in the 4081's card cabinet. In this case connecting the cable to the Plotter is all that is required (Step III).

If the Opt. 30 Plotter is ordered separately from the 4081, all of the following steps must be performed. The following steps also apply to installation of the 021-0203-00 interface kit which consists of just the interface card (672-0606-00) and interconnecting cable (012-0714-00).

I. Verify Strap And Switch Settings.

Figure E-1 illustrates the required settings of straps on the interface card. When the interface card is ordered for use with the Plotter, straps are set for proper operation. These strap settings are listed in Table E-1.

Table E-1

INTERFACE STRAP SETTINGS

Strap	Setting
ADDRESS	X'30' (0011 00XX)
TRANSMIT IMO	15
RECEIVE IMO	15
EXT CLK SOURCE	INT
MODEM RATE SELECT	ALL ELSE
RS-232-C	C
TBUSY*	No Strap
CTS STAT*	NONFLAG
EOC BUSY*	NONFLAG
CTS INT*	Strapped
CBUSY*	NONFLAG
SPLIT RATE*	÷8

*Cut Strap

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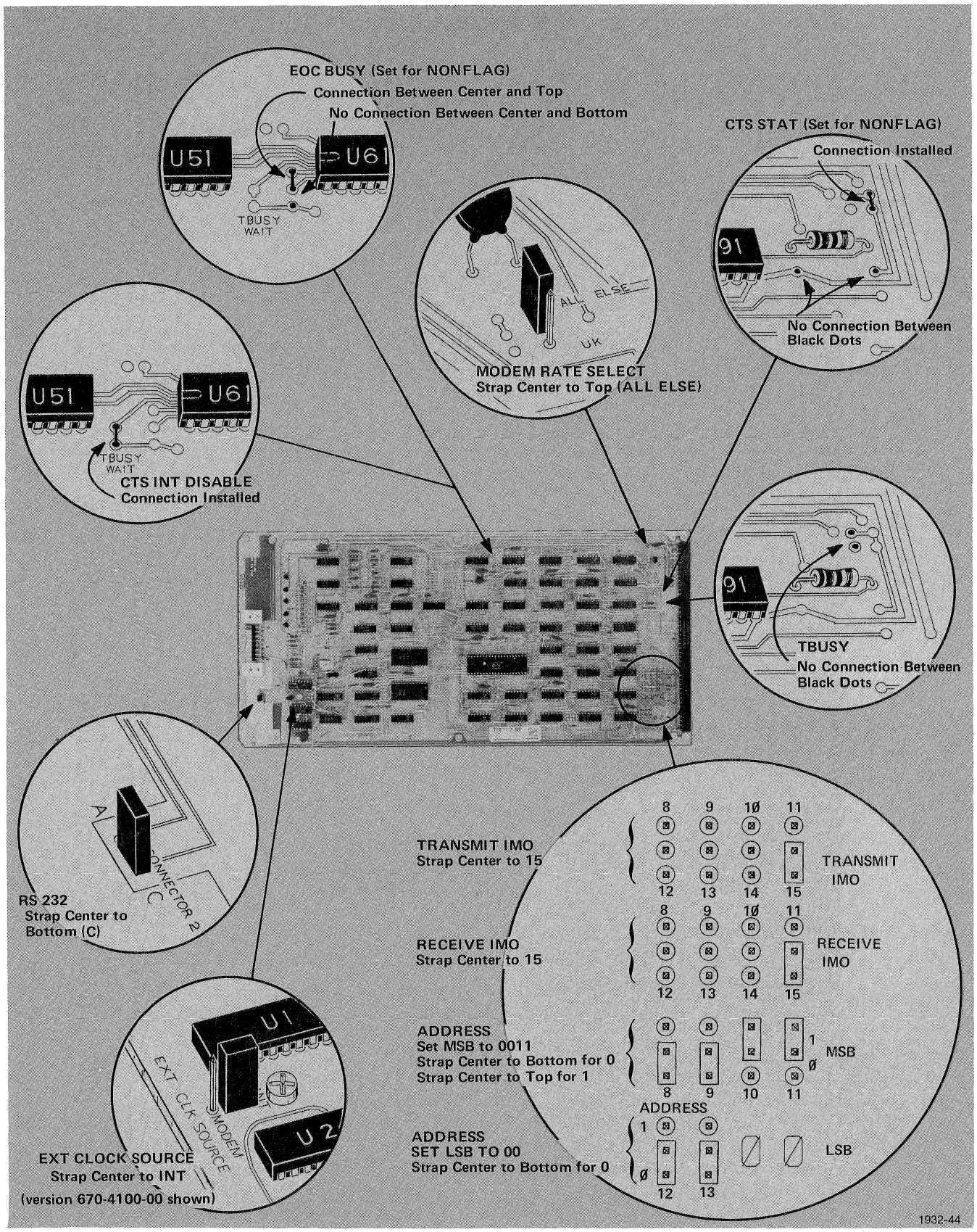

Fig. E-1. Strap settings for Plotter interface card.

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The 16-position switches at the rear of the 4662 (Fig. E-2) must be set according to Table E-2.

Table E-2

4662 SWITCH SETTINGS

SWITCH	SETTING
A	1
B	2
C	2
D	3

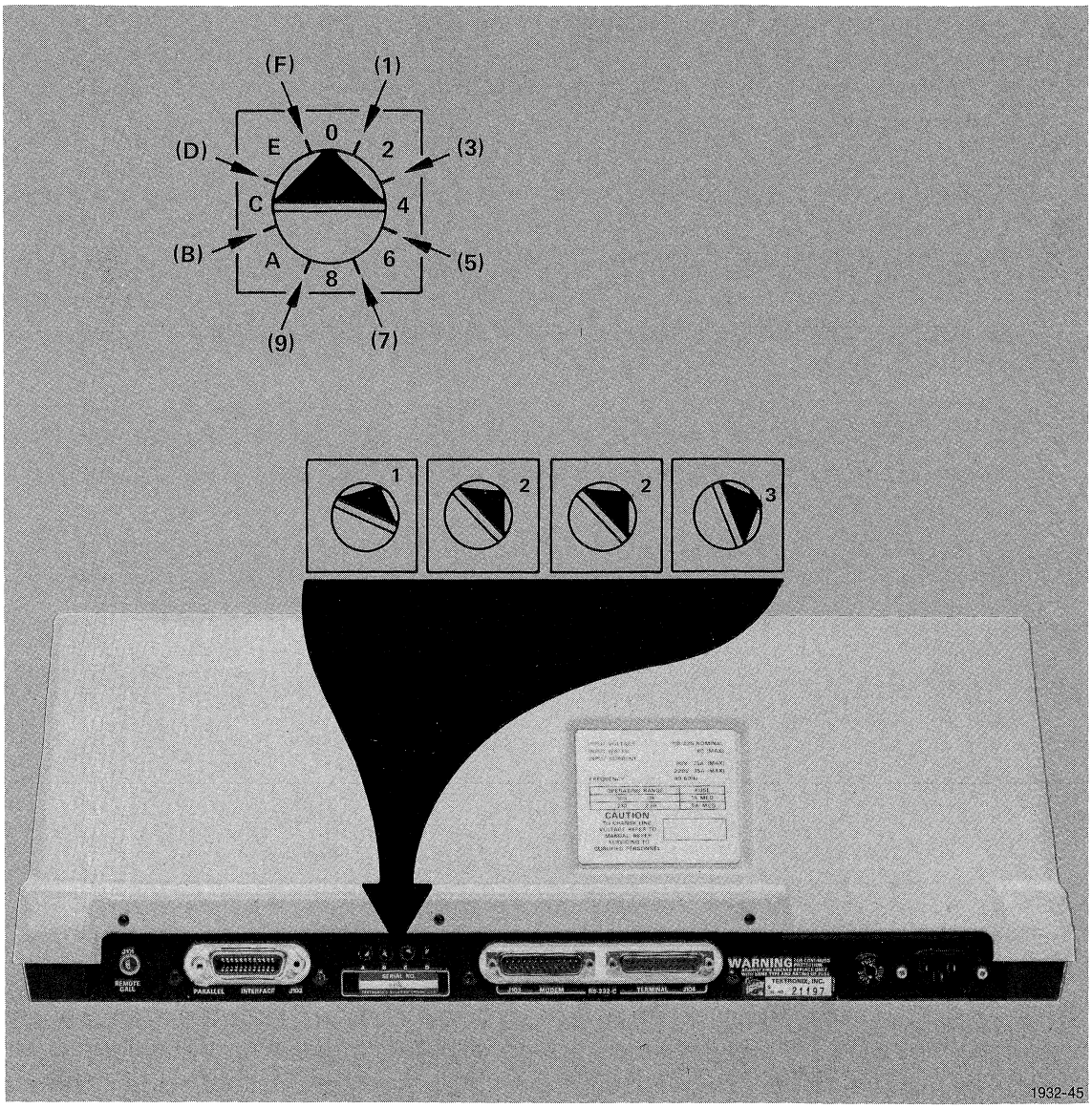

Fig. E-2. Plotter switch settings for operation with 4081.

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II. Install The Interface Card In The 4081 Card Cabinet.

The Plotter interface card is a half-size card. To be properly supported in the card cabinet of the 4081, two half-size cards must be fastened together with connecting bars, making an assembly as large as a full-size circuit card. If another half-size card is not available, a blank dummy board (670-4627-00) must be used to fill out the assembly.

CAUTION

Turn off power to the system before removing or installing circuit cards to prevent circuit card damage.

1. Remove the four screws on the front of the circuit card cabinet. Take off the cover, and set it aside. Remove the 4081 card cabinet's rear cover by turning each of the four fasteners 1/4 turn counterclockwise.

2. Attach the interface card to a half-size card with the connecting bars and eight screws.

3. Select any unused slot in the Main or Secondary Backplanes except the three upper-right slots in the Secondary Backplane (J1001, J1101, and J1201). Slide the circuit card in the selected slot. The connecting pins must be fully engaged (the front edge of the card is flush with the other cards).

4. Working from the rear of the unit, thread the end of the interconnect cable with the 16-pin connector over the circuit card rack. Attach the 16-pin connector to the Plotter interface card's cable connector.

5. At the rear of the card cabinet clamp the bared portion of the cable to chassis ground with a metal clamp.

6. Remove the RACKO—TACKO strap for the selected slot. See the 4081 Installation Manual for details on this step.

7. Replace the front and rear covers of the card cabinet.

III. Connect the Cable.

Locate the end of the interconnect cable with the 25-pin RS-232-C type connector. Plug the cable into J103, the MODEM connector, at the rear of the Plotter, securing the connection with two screws. Plug the Plotter's power cord into the 4081's System Power Bus located at the rear of 4081 behind the Cartridge Tape Unit. The 4662's power switch may be left on to allow single-switch control with the 4081's main power switch.

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OPERATING THE 4662 WITH THE 4081

The 4081 uses the 4662 Plotter as either an output or input device for graphic data. The 4081 transmits ASCII character data or binary coordinates to the Plotter and receives input coordinates from the Plotter's Joystick. A command to the Plotter allows redefinition of the plotting area.

Programming details are offered in this appendix as supplementary information to be used along with standard 4081 programming procedures. The 4081 Operator's Reference Manual and the Plot 80: GOS Programmer's Reference Manual are primary sources of programming and operating information.

PLOT System Utility

The GOS system utility program PLOT directs the 4081 to transmit a specified file to the Plotter. The file to be plotted must be a spooled graphic output file (default extension of .PLT) that is created using SVC1 or SVC15 instructions. The format of the PLOT utility command is:

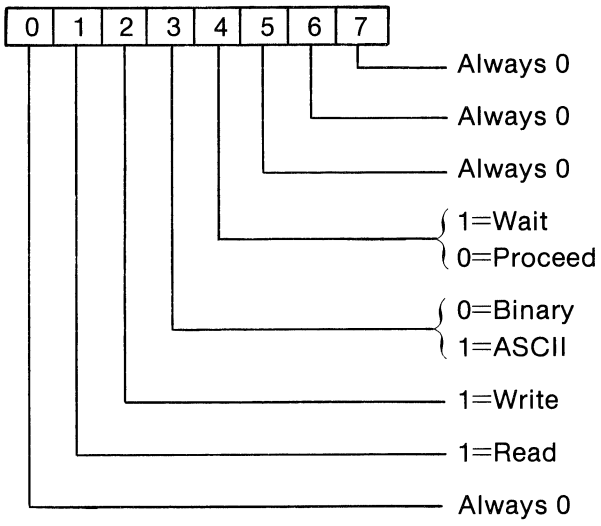
PLOT file.specifier

No switches or wild cards are allowed. Generally, any file that can be displayed on the 4081's display screen can also be plotted on the 4662 using PLOT. Operations or commands in the display file that do not pertain to the Plotter (such as intensity control) are ignored by the Plotter.

Programming For The Plotter Using SVC1

SVC1 (Device Independent I/O) is described in detail in the Plot 80: GOS Programmer's Reference Manual. SVC1 is used to transfer a block of data between the 4081 Processor and peripheral devices. A parameter block that contains a function byte controls the type of operation performed by SVC1.

The Data Transfer function byte has the following format:



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Write. When transferring data to the Plotter, Bit 2 of the function byte is set. The data in the SVC1-addressed buffer may be ASCII characters or binary (graphic) data. In general, the same data that can be sent to the display screen can also be sent to the Plotter; functions that do not apply to the Plotter are ignored (such as intensity control or Hard Copy). The block checksum method of error detection prevents plotting of any data that is transmitted erroneously.

If Bit 3 of the function byte is not set, the buffer's contents are plotted as standard ASCII characters. The ASCII control characters listed in Table E-3 perform the indicated function; unlisted control characters have no effect.

Table E-3

FUNCTION OF ASCII CONTROL CHARACTERS

Control Character	ASCII Code (HEX)	Plotter Function
BEL	07	Bell rings
BS	08	Backspace
HT	09	Space
LF	0A	Line Feed
VT	0B	Reverse Line Feed
FF (sent as ESC FF)	0C	Return to HOME (upper left corner)
CR	0D	Carriage Return—Line Feed

Transmission of graphic commands and data is selected by setting Bit 3 of the function byte (Binary). The contents of the SVC1 buffer are interpreted as commands to the Plotter. These commands are defined in Table E-4, which lists the command by operation codes (Op Codes). If the command requires additional argument(s), they are placed after the Op Code in the buffer. The Op Code must not be separated from its arguments by the boundaries of a SVC1-addressed buffer, which should be limited to 256 bytes for use with the PLOT utility. Intervening, unused bytes between an Op Code and argument must be zero. Op Codes marked by a single asterisk are to be used with SVC15 only. A double asterisk signifies a SVC1 operation only. Shaded areas of the table denote functions that are ignored by the Plotter or cause unrecoverable errors if used.

Table E-4

FUNCTION CODES FOR SVC1 AND 15

		Byte #	Ø	1	2 3	4,5	6,7
Function	**Result**		**OP-CODE**	**ARGUMENTS**			
**NO-OP	No Action		Ø				
*DUMP	Transmit Buffer			LU			
*S2V	Converts Screen Coordinates To Virtual Coordinates		1	LU	Screen X	Screen Y	Virtual X 8,9=Virtual Y

***SVC15 Only**
****SVC1 Only**
Arguments below dotted line in block apply to SVC15 only.
Functions in shaded areas are ignored by Plotter or cause unrecoverable errors.

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Table E-4 (cont)

Function	Result	Byte # Ø OP-CODE	1 ARGUMENTS	2	3	4,5	6,7
*V2S	Converts Virtual Coordinates To Screen Coordinates	2	LU	Virtual X		Virtual Y	Screen X 8,9=Screen Y
*SW CHAR	Transmits Vectors Forming Specified Character	3	LU	Ø	Char		
(Not Used)	Unrecoverable Error	4					
RESET	Ignored	5	LU				
END OF BUFFER	Stop Processing Op Codes	6					
OPEN	Ignored	7	Obj # LU		Obj #		
CLOSE	Ignored	8	LU				
POST	Ignored	9	Obj # LU		Obj #		
UNPOST	Ignored	A	Obj # LU		Obj #		
KILL	Ignored	B	Obj # LU		Obj #		
*ATTACH	Attach Graphic Control Block to specified LU	C	LU	Address of GCB			
APPEND	Ignored	D	Obj # LU		Obj #		
DIRECT POINT	Point to Desired Location	E	LU	Virtual X		Virtual Y	
DIRECT DASH	Interpreted as draw to	F	LU	Virtual X		Virtual Y	
DIRECT MOVE	Move to Desired Location	1Ø	LU	Virtual X		Virtual Y	
DIRECT DRAW	Draw to Desired Location	11	LU	Virtual X		Virtual Y	
SET INTENSITY	Ignored	12	LU	Intensity			
SET DASHTYPE	Ignored	13	Obj # LU	Dashtype	Obj #	Dashtype	
FIX	Ignored	14	Obj # LU		Obj #		

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Table E-4 (cont)

Function	Result	Byte # Ø OP-CODE	1	2	3	4,5	6,7
			ARGUMENTS				
CLEAR	Ignored	15	LU				
SET CHAR SIZE	Set Plotter Character Size To n (n = 1 to 10)	16	LU	Char Size			
*SW CHAR STRING	Transmits Addressed Buffer Of Char. to Plotter	17	LU	Address of First Char.		Address of Last Char.	
(Not Used)	Unrecoverable Error	18					
SET BLINK	Ignored	19	Obj # LU	Blink Rate	Obj #	Blink Rate	
(Not Used)	Unrecoverable Error	1A					
SET INT ATTRIBUTE	Ignored	1B	Obj # LU	Intensity	Obj #	Intensity	
(Not Used)	Ignored	1C					
SET POSITION	Ignored	1D	Obj # LU	Virtual X	Obj #	Virtual Y Virtual X	Virtual Y
SET POINT INTENSITY	Ignored	1E	LU	Vector Intensity	Point Plot Intensity		
MAKE COPY	Ignored	1F	LU				
ERASE	Moves pen to "Load" Position, turns on Prompt Light, and rings bell. Operator loads paper, presses CALL to continue operation.	20	LU				
(Not Used)	Unrecoverable Error	21					
RELATIVE POINT	Point Relative to Present Location	22	LU	Virtual X		Virtual Y	
RELATIVE DASH	Interpreted as Draw Relative	23	LU	Virtual X		Virtual Y	
RELATIVE MOVE	Move Relative to Present Location	24	LU	Virtual X		Virtual Y	
RELATIVE DRAW	Draw Relative to Present Location	25		Virtual X		Virtual Y	

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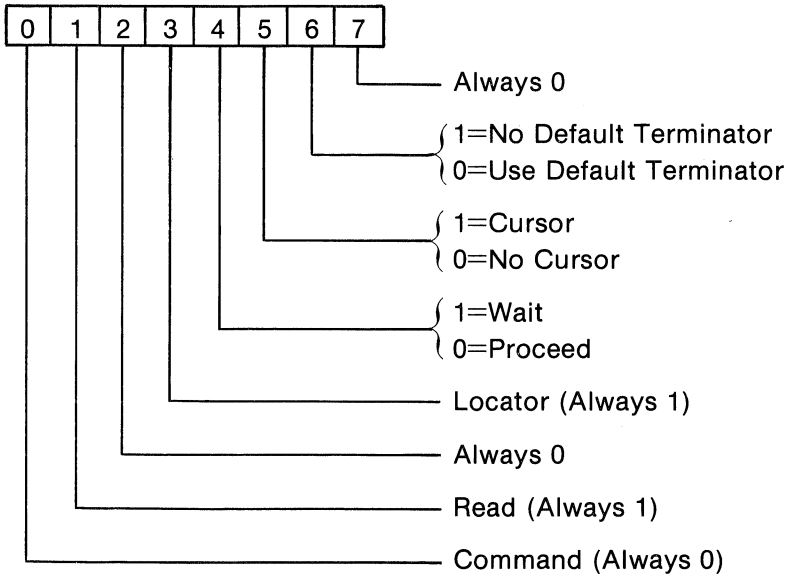
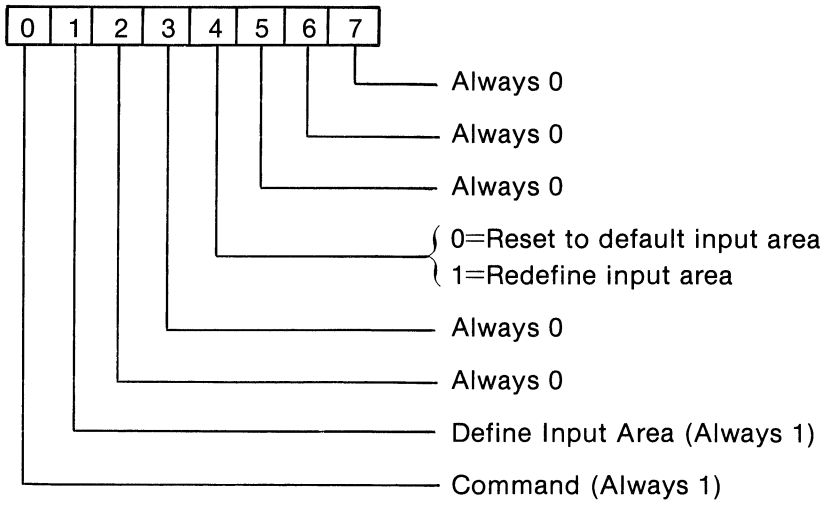
Read. The Read (Graphic Input) function allows the Plotter to return pen coordinates to the 4081. Only Locater Mode, which reads a single point at a time, can be used. Cursor definition is enabled by setting Bit 5 of the function byte and specifying the object number of the cursor in the last halfword of the SVC1 parameter block. If the cursor definition halfword is zero, the standard crosshair cursor is specified. The function byte for a read operation is as follows:



A read operation involving the Plotter turns on the Prompt light on the Plotter control panel. The operator uses the joystick to position the pen over the desired point and then presses the CALL button. When the coordinates are accepted, the Prompt light turns off. During this operation, if a cursor is specified by Bit 5 of the read function byte, cursor movement does not follow pen movement while the pen is being positioned over the desired spot. The cursor on the display screen jumps from its initial position to the pen position when the CALL button is pressed.

Command. Bit 1 of the function byte, when set, specifies a command to the Plotter. The command redefines the plotting area that is used by the Graphic Operating System. The function byte is:



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When this command (with Bit 4 set) is received by the Plotter, the Prompt light turns on to indicate need for operator response. Using the joystick, the operator should position the pen at the lower-left corner of the desired plot area, push the CALL button momentarily, reposition the pen to the upper-right corner of the desired area, and momentarily press the CALL switch again. The Prompt light is turned off when the coordinates of the two points are received.

If Bit 4 of the command function byte is zero, the command resets the plotting area to the default size, which is 10 inches (25.4 cm) by 15 inches (38.1 cm). No operator response at the tablet is required.

Redefining the plotting area using SVC1 has the same effect as using the Plotter's SET buttons to define plotting area. However, with GOS, using the SVC1 command is preferred over a plotter SET operation in order to preserve device independence of the routine.

Plotter Programming Using SVC15

SVC15 (Graphic Transform Package) uses the same Op Codes listed in Table E-4. When using the Op Codes in Table E-4 with SVC15, the second byte (byte 1) must identify the logical unit (assigned by SVC4 Assign instruction) that each command refers to. The arguments for SVC15 that differ from SVC1 arguments are shown below the dashed lines in Table E-4. A double asterisk marks Op Codes that cannot be used with SVC15. A single asterisk marks Op Codes that are used only with SVC15.

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