

4027A
COLOR
GRAPHICS
TERMINAL

*Please Check for
CHANGE INFORMATION
at the Rear of this Manual*

WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the users at their own expense will be required to take whatever measures may be required to correct the interference.

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MANUAL REVISION STATUS

PRODUCT: 4027A Color Graphics Terminal

This manual supports the following versions of this product: Serial Numbers B031651 and up.

REV DATE	DESCRIPTION
OCT 1981	Original Issue
MAR 1982	Revised: page A-3.

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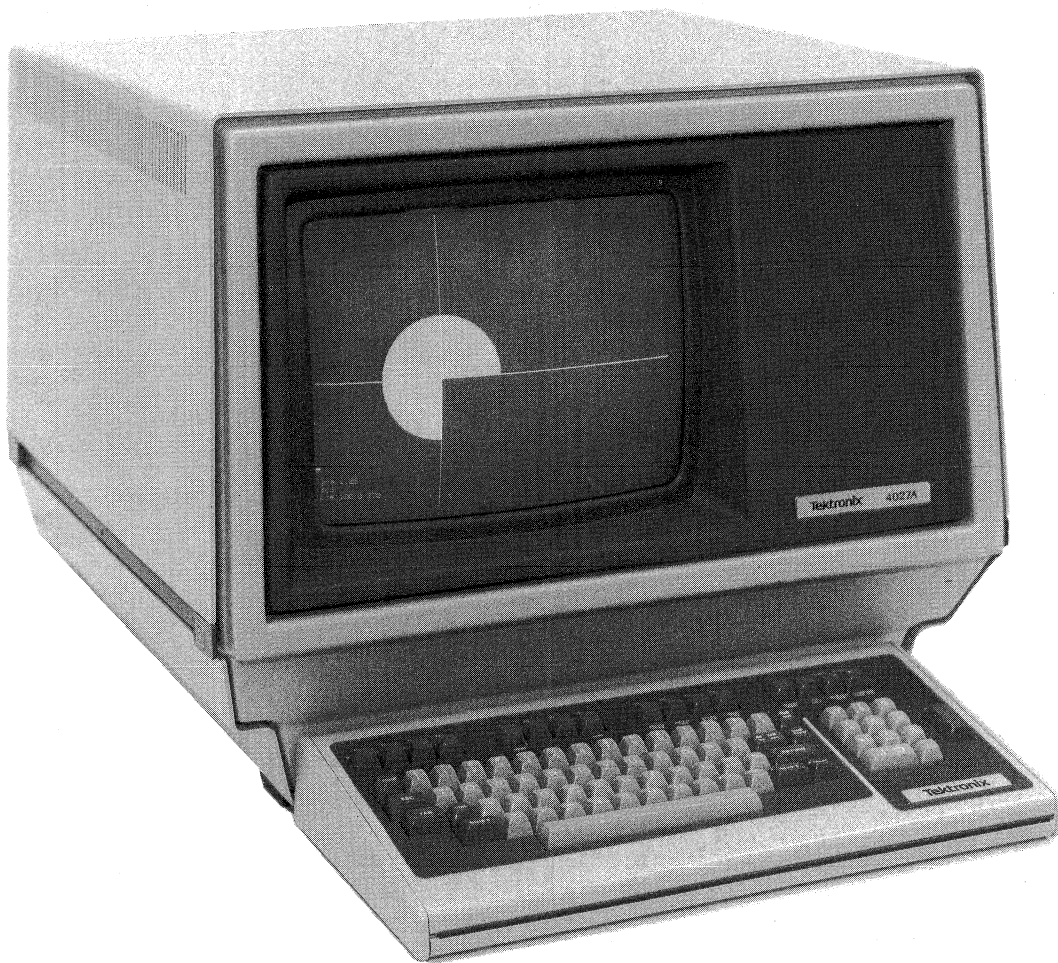
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Figure 1-1. 4027A Color Graphics Terminal.

Section 1

INTRODUCTION

This manual provides an introduction to the TEKTRONIX 4027A Color Graphics Terminal. It includes descriptions of the keyboard, the "workspace" and "monitor" areas of memory, and those commands which may be needed by a data entry or data retrieval operator. For a complete description of all commands, see the 4027A Color Graphics Terminal Programmer's Reference Manual.

Appendix B gives examples of commands, including those not described in this manual.

THE 4027A

The TEKTRONIX 4027A Color Graphics Terminal (Figure 1-1) will produce colored vectors, display colored polygons (panels), colored characters and will create and display colored symbols. Eight colors may be displayed at one time to enhance both alphanumeric and graphic displays.

The 4027A has the following features:

- Graphics. Displays color graphics; polygons, pies and circles as part of a form or other text in the workspace. Draws solid lines and several types of dashed lines, and can erase lines previously drawn. Also included in graphics is the ability to define new character sets: any character the user desires.
- Buffered text. Can hold a line of text (as many as 80 characters), allowing the line to be edited before being sent to the computer.
- Local editing. Can hold text in the workspace, where it can be edited before being sent to the computer.
- Forms. Holds forms in a workspace and allows the operator or the computer to fill in the blanks.
- Visual enhancements. Displays forms with visual enhancements, such as blinking, inverted or colored backgrounds.
- Definable keys. Learns new definitions for most of the keys of its keyboard. The operator or the computer can assign any character or string of characters to a key. Thereafter, whenever that key is pressed, the terminal interprets it as the defined character or string of characters. Commands, as well as text strings, may be included in these key definitions.
- Split screen. Divides the screen into two areas when told to do so by the operator or the computer. The upper part of the screen displays the workspace, an area for editing text or filling out forms. The lower part of the screen displays the monitor, where messages to and from the computer may be displayed without overwriting the text in the workspace.
- Scrolling. Scrolls text on the screen up and down. Text scrolled off the screen is not lost, but is saved as long as memory is available to hold it.
- Programmable operating parameters. Sets parameters such as baud rate and parity in response to commands from the computer or the operator. Remembers these settings even after power has been turned off.
- Self test. When the terminal is turned on, it checks its memory and displays an error message if it has "forgotten" operating parameters or detects a memory defect. When commanded to do so, the terminal also check its firmware and displays checksums and samples of all its characters.
- Remotely programmable. Changes its settings under computer control. Uses "English-language" commands, rather than non-printing control characters; this simplifies sending commands from the computer.
- Detached keyboard. Has a detached keyboard, which may be placed where convenient for the operator.

INTRODUCTION

- **Hard copies.** Makes copies on a TEKTRONIX 4632 Hard Copy Unit. The copies can show anything displayed on the screen, including rulings characters and graphs. One or several pages of the display memory can be copied. Each hard copy page is about 8 1/2 by 11 inches in size and can show 34 lines of 80 characters each.

These additional capabilities are available as options:

- **Printed hard copies.** Prints copies on a TEKTRONIX 4642 or 4641 Printer or any RS-232 printer.
- **Rulings.** Draws vertical or horizontal single or double lines on forms in the workspace.
- **Alternate character sets.** Displays characters in the workspace using any of several fonts (character sets). Rulings characters, special math characters, and characters of different alphabets are available.
- **Current loop interface.** Communicates with other devices using a 20 mA current loop, rather than the standard RS-232 interface.
- **GPIB interface.** Communicates over a GPIB (General Purpose Interface Bus) with peripheral devices: TEKTRONIX 4924 Digital Cartridge Tape Drive and 4662 or 4663 Interactive Digital Plotter.
- **International character sets.**

SPECIFICATIONS

Appendix E of this manual lists the terminal's specifications. Some of the more important specifications are:

- **Transmission/reception speed** of up to 9600 baud (about 960 characters/second). The following baud rates are selectable by command from the keyboard or the computer: 50, 75, 110, 150, 300, 600, 1200, 1800, 2400, 4800, and 9600 baud. A baud rate of 0 is provided for a "X1" external clock (requires Opt.1).
- **Thirty-four lines of display**, each holding up to 80 characters.
- **Size of display memory:** 16384 characters standard; may be expanded to 32,768 characters (Option 22).

ACCESSORIES

The following standard accessories are provided with each terminal:

- 1 4027A Programmer's Reference Guide
- 1 4027A Color Graphics Terminal Operator's Manual
- 1 Large (1x2) blank keycap
- 1 Large (1x2) keycap cover
- 4 Small (1x1) blank keycaps
- 4 Small (1x1) keycap covers
- 6 Keyboard overlays

These optional accessories are also available:

- 4027A Color Graphics Terminal Programmer's Reference Manual
- 4027A Color Graphics Terminal Service Manual
- Keyboard overlay
- Large (1X2) blank keycap
- Large (1X2) keycap cover
- Small (1X1) blank keycap
- Small (1X1) keycap cover

THE SPLIT SCREEN: MONITOR AND WORKSPACE

You can divide the terminal's display into two different work areas, or "scrolls" of memory (Figure 1-2). The bottom part of the screen displays the "monitor" scroll, while the top part displays the "workspace" scroll.

Text typed on the keyboard can be directed to either scroll; so can text coming from the host computer. When the keyboard types into the monitor, the cursor (an underline serving as a position marker) appears in the monitor. Likewise, when the keyboard types into the workspace, the cursor appears in the workspace.

The two scrolls each have specific uses. The workspace can hold text while it is being edited, or it can hold forms that are being filled out. The workspace also provides an area for graphic displays. The monitor provides a separate area where messages to and from the computer may be displayed without overwriting the text in the workspace.

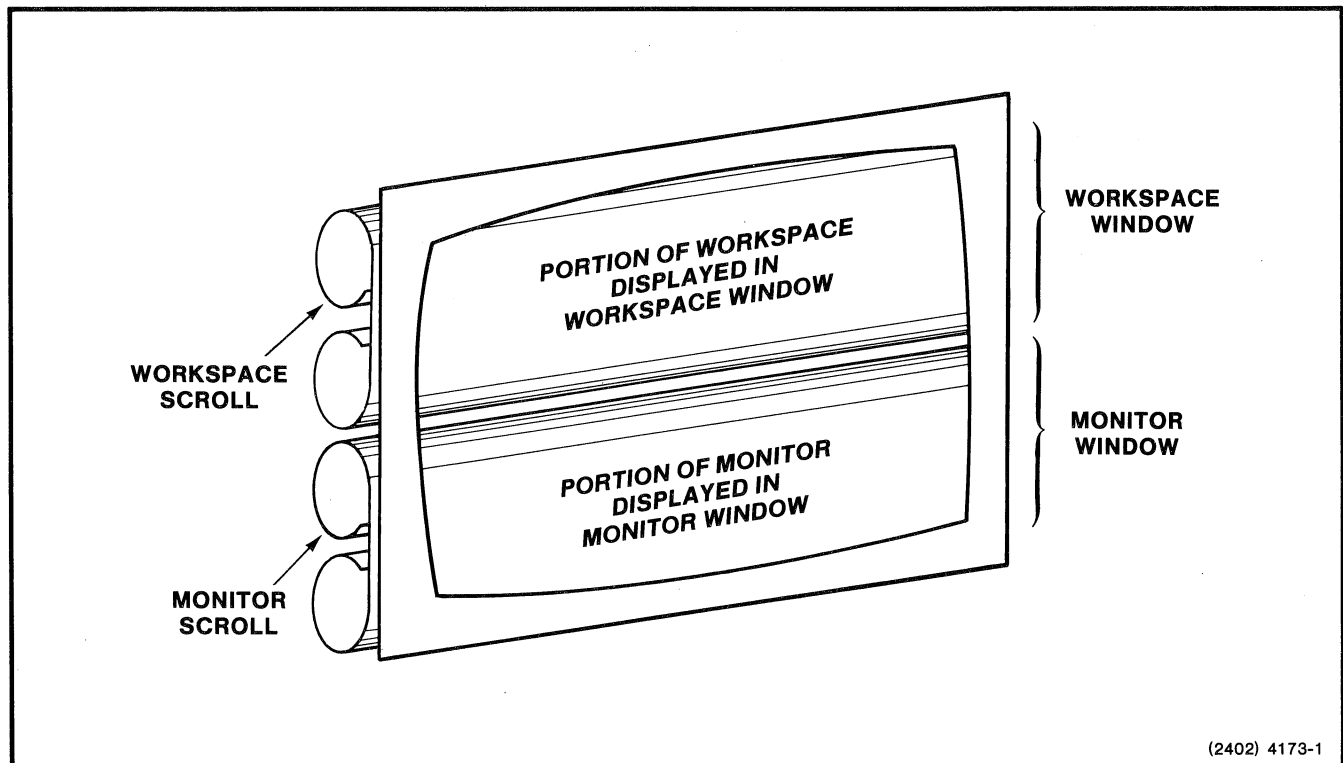


Figure 1-2. The Split Screen: Workspace and Monitor Scrolls.

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INTRODUCTION

MONITOR

Text typed into the monitor is sent to the computer. When logging in on a time-sharing system, you would have both the keyboard and the computer send text to the monitor. (The monitor then acts like the roll of paper coming out of a teletypewriter.)

WORKSPACE

Text typed into the workspace is stored there, and is not automatically sent to the computer. This lets you add or delete characters or lines with the special editing keys. When the text is as you like it, you can send the entire workspace contents to the computer.

The workspace can also hold a "form" whose blanks either you or the computer can fill in. With the 4027 in "form fillout mode," you can fill in some or all of the form's blanks and then send the contents of those blanks to the computer.

The workspace provides an area for graphic displays. This area is the graph paper on which polygons, pies, circles, vectors, and graphs are drawn.

SCROLLING

The two scrolls can each hold more text than is visible on the screen. Special scrolling keys allow you to roll the workspace and monitor scrolls up and down. When the keyboard types into the workspace (cursor in the workspace), the scrolling keys move the workspace scroll; when the keyboard types into the monitor, the scrolling keys affect the monitor scroll.

Section 2

OPERATOR CONTROLS

This section introduces you to the keys of the terminal's keyboard and to its other switches and controls. Exercises are included to help you become familiar with the terminal.

CAUTION

Do Exercise 3 before doing any of the exercises which follow it. (Exercise 3 sets the terminal so that you can practice on it without accidentally communicating with the computer.)

Should you put down this manual, be sure to do Exercise 3 before resuming your reading and doing any more exercises.

TURNING POWER ON

THE POWER SWITCH

The POWER switch is on the right side of the terminal's cabinet (Figure 2-1); it has an internal lamp which lights when power is on.

When power is applied, the terminal tests certain parts of its memory. Should the test reveal a failure, a RESET or RAM ERROR message will appear on the screen. (If that occurs, consult Section 4.)

CAUTION

Do not place papers, books, etc. on the terminal's cabinet. Be especially careful not to cover the slits in the cabinet cover. These slits are needed to ventilate the terminal's internal components.

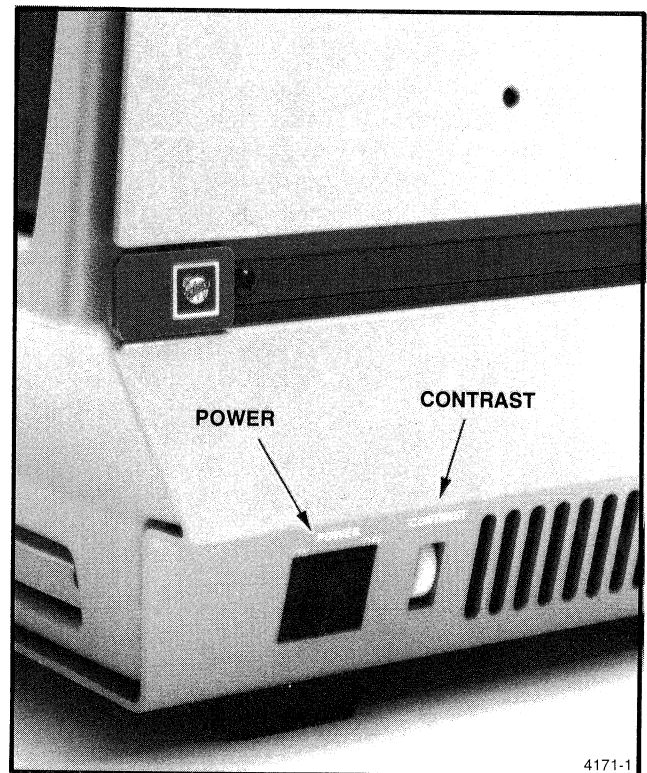


Figure 2-1. POWER and CONTRAST Controls.

MASTER RESET BUTTON

The MASTER RESET button is next to the DEGAUSS button on the back of the terminal (Figure 2-2). This button resets the terminal to its "power up" condition; pressing it is like turning the terminal off and then on again.

CAUTION

If the terminal contains information you wish to keep, do not operate the POWER switch or the MASTER RESET button. Doing so destroys any text or programmable key definitions you have stored in the terminal.

DEGAUSS BUTTON

The DEGAUSS button located on the back of the terminal is used to demagnetize the CRT. Degaussing the CRT is part of the convergence adjustments procedure.

NOTE

In this manual, expressions such as "press SHIFT-STATUS," or "press CTRL-G" mean "while holding down the SHIFT key, press the STATUS key," or "while holding down the CTRL key, press the G key."

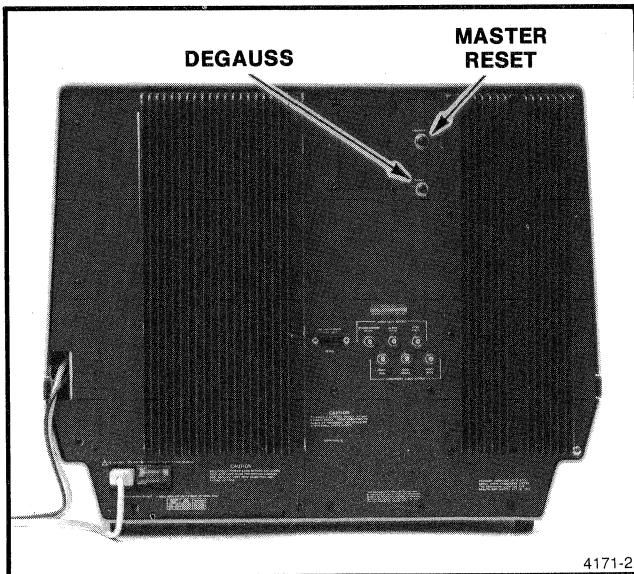


Figure 2-2. MASTER RESET and DEGAUSS Controls.

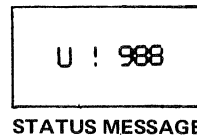
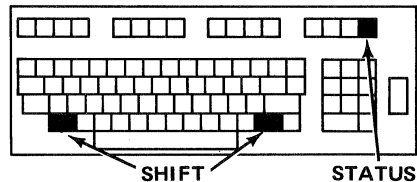
Exercise 1

Turn on the POWER switch; its green light should turn on. After a delay of about 15 seconds, a cursor (underline) will appear in the upper left corner of the screen.

(Should a RESET message appear, consult Section 4 of this manual.)

Press SHIFT-STATUS; the "status message" should appear on the screen. (Do not touch any other keyboard keys yet, as you may inadvertently send data to the computer.)

Press the MASTER RESET button. The screen will erase and the cursor will appear in the upper left corner of the screen, just as it did when you first applied power.



After applying power or pressing MASTER RESET, there is a delay of about 15 seconds before the cursor appears. During this time, the terminal is testing its memory. Should the test reveal that essential settings like baud rate and parity have been forgotten, a RESET message will appear. (In that case, refer to Section 4.)

Should a RAM ERROR message appear, call your Tektronix Service Center; there is a defect in the terminal's memory.

CONTRAST CONTROL

The CONTRAST control is located near the POWER switch (Figure 2-1). It functions like the contrast control of a television set: CONTRAST adjusts the degree of contrast between the light and dark parts of the display.

Exercise 2

Press SHIFT-STATUS. The status message will appear on the screen. (Do not touch any other keys yet; doing so may send data to the computer.) Experiment with the CONTRAST control, adjusting it until the display pleases you.

HOW TO AVOID TALKING TO THE COMPUTER

It is sometimes possible to "confuse" a computer by sending improper data to it. The following discussion shows how to prevent this, by directing text from the keyboard to the terminal's internal workspace rather than to the computer.

If your terminal is always connected directly to the computer (constantly "on line"), use the following procedure to avoid talking to the computer:

1. Press SHIFT-STATUS. The terminal will display the "status message." Notice the second character displayed in this message: this is the command character, which you must use whenever you type commands to the terminal.
2. Check to be sure that the light on the COMMAND LOCKOUT key is off. If the light is on, press the key once to turn it off.
3. Now type the command character. Immediately after it, type the command "WORKSPACE 15 K" and press the RETURN key.

For instance, if the command character is the exclamation point (!), you type: ¹

```
!WORKSPACE 15 K <CR>
```

4. After the screen erases, a cursor (underline) appears in the upper left corner of the screen. You may now type on the keyboard without sending information to the computer.

¹In these examples, and throughout this manual, the RETURN key is denoted by <CR>. Also, in most examples, we shall assume that the command character is the exclamation point (!).

Exercise 3

Perform the procedure just described. That is, examine the short-form status message to learn the command character. Then check that the COMMAND LOCKOUT light is off and, using the command character, give the "WORKSPACE 15 K" command.

(This command defines a "workspace," allots 15 lines of the screen to displaying the workspace, and causes characters typed on the keyboard to be stored in the workspace rather than sent directly to the computer. The "workspace," and the "WORKSPACE 15 K" command, are described in Section 3, under "The Workspace and the Monitor.")

THE KEYBOARD

The keyboard is shown in Figure 2-3. Its keys fall into three categories:

- **ASCII keys.** The ASCII keys are used to send data to the computer. (They are called "ASCII keys" because they send characters of the ASCII code — the American Standard Code for Information Interchange. This code is described in Appendix C.)
- **Cursor/numeric pad keys.** The keys of the cursor/numeric pad serve two functions:

When the pad acts as a "cursor pad," some of its keys move the cursor on the screen, and others "scroll" text in view up and down.

When the pad acts as a "numeric pad," its keys are used to enter numeric data.

- **Function Keys.** The function keys control the terminal, causing it to erase text from its memory, insert or delete characters or lines of text, and so on. Some of these keys have no pre-defined meaning; they are reserved for programming by the user (or the computer).

NOTE

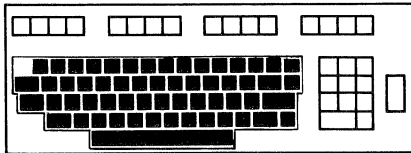
If you have Option 4A, 4B, or 4C, refer to Appendix D for optional keyboard configuration.



Figure 2-3. Keyboard.

ASCII KEYS

The main part of the keyboard, which holds the ASCII keys, resembles an ordinary typewriter keyboard. However, there are some important differences. The easiest way to learn about these is to experiment with the keyboard. To guide you in this experimentation, this manual includes exercises to try.



ASCII KEYS

Exercise 4

(Be sure that you have done Exercise 3 first.)

Type a few words of some test sentence. Then press the RETURN key.

As you type, the cursor moves to the right. The cursor always indicates where the next character you type will be displayed.



The distinction between the ASCII keys and the other keys is important when you are communicating directly with the computer by typing on the keyboard:

- As you press an ASCII key, the terminal sends a character to the computer. Thus, if you move the cursor by pressing RETURN, LF, or BK SPAC (which are ASCII keys), the computer is informed that you have moved the cursor.
- On the other hand, if you move the cursor with the cursor control keys (which are not ASCII keys), no characters are sent to the computer. Therefore, the computer is not informed that the cursor has moved.

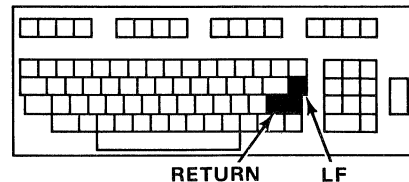
The ASCII keys fall into three categories: alphanumeric keys, keys for non-alphanumeric characters, and the BREAK key. (While the BREAK key does not actually send an ASCII character, it does communicate with the computer by sending a "break" signal. Therefore, it is convenient to discuss it together with the ASCII keys.)

The alphanumeric keys, colored light gray, send the "printing" ASCII characters to the computer. These represent letters, numerals, and special symbols. ("Space" is considered a printing character.)

The non-alphanumeric keys, colored dark gray, send special "non-printing" ASCII characters. These include the "rub out" (or "delete") character, and the "escape," "horizontal tab," "backspace," "carriage return," and "line feed" characters. Also included among the non-alphanumeric keys are the SHIFT and CTRL keys, which help select the characters sent when alphanumeric keys are pressed.

RETURN and LF

The RETURN and LINE FEED keys send the "carriage return" and "line feed" ASCII characters. "Carriage return" returns the cursor to the left edge of the screen, and "line feed" advances the cursor to the following line.



Exercise 5

Type a few words of text; do not press RETURN. Then press LF a few times and watch the cursor move down the screen.

Type a few more lines, pressing RETURN at the end of each line.

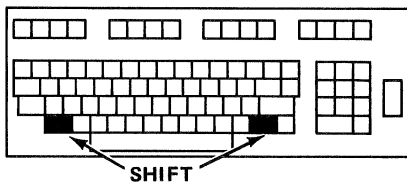
NOTE

When communicating with a computer, the characters sent when you press RETURN may differ as required by the system. However, the net visual response will be the same: pressing RETURN moves the cursor to the start of the next line.

OPERATOR'S CONTROLS

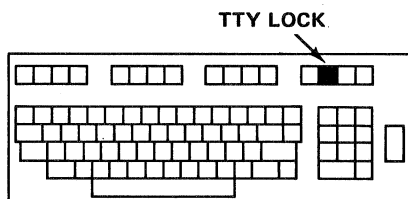
SHIFT

Most of the keys have two meanings: the "normal" and "shifted" meanings. For instance, pressing the Q key while holding down SHIFT sends the uppercase letter (Q); pressing the same key without SHIFT sends the lowercase letter (q). Function keys, as well as other keys, have "shifted" meanings: SHIFT-HOME is not the same as HOME.



TTY LOCK

The terminal does not have a "shift lock" key like a typewriter. Instead, it has the TTY LOCK function key. Pressing TTY LOCK lights the light on that key and locks the keyboard so that it cannot send lowercase letters of the alphabet. (TTY LOCK does not affect the action of the other keys.) Pressing TTY LOCK again unlocks the keyboard and turns off the TTY LOCK light. An advantage of TTY LOCK is that you can type numerals using the alphanumeric keys with TTY LOCK active, whereas a "shift lock" key would not permit this. (You should use the TTY LOCK key when using computers or computer programs that do not accept lowercase letters.)

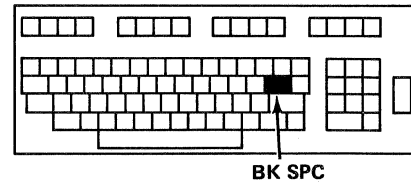


Exercise 6

Press TTY LOCK; the light in that key will turn on. Type a few words, and notice that they are displayed in all uppercase letters. Then press TTY LOCK again, and type a few more words, using lowercase letters.

BK SPC

The BK SPC (backspace) key sends the "backspace" ASCII character. This moves the cursor backwards (to the left) one character position.



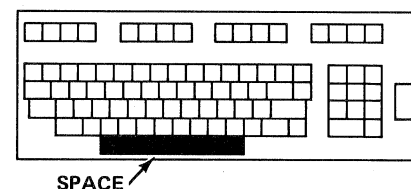
Exercise 7

Type a few words and then use BK SPC to move the cursor back to the beginning of the line. Repeat this several times, typing over the words which you have previously typed. Notice that as you type over characters already displayed on a line, the characters typed replace characters formerly on the line. This provides an easy way to change text in the workspace.

The Space Bar

The space bar sends the ASCII "space" character. The terminal and the computer treat "space" just like any other letter of the alphabet. For instance, when you type over previously entered characters with the space bar, those characters are replaced with spaces.

This means that you cannot use the space bar just to move across the page, as you would the space bar of a typewriter. To move the cursor without entering or changing text, you must use the cursor control keys, discussed later in this section.



Exercise 8

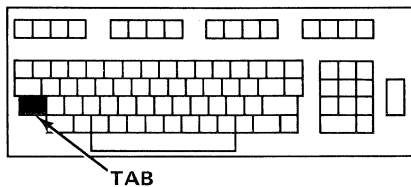
Type a few words of text. Use BK SPC to move the cursor back to the beginning of the line. Then hold the space bar down; notice that as the cursor moves to the right, characters previously on the line are erased (replaced with spaces).

TAB

The TAB key sends the "tab" character of the ASCII code.

When you are typing into the workspace rather than directly to the computer, TAB moves the cursor to the next tab stop, or to the beginning of the next line if there are no tab stops defined to the right of the cursor. If you are filling in the blanks of a form (terminal in "form fillout mode"), TAB moves the cursor to the next blank in the form.

When you are typing from the keyboard directly to the computer, you should avoid using TAB unless you know how the computer will respond to that character.

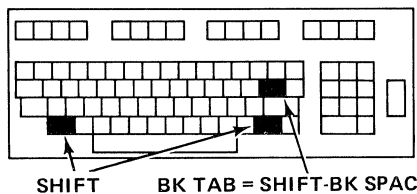


BK TAB

When SHIFT is held down, the BK SPC key becomes the BK TAB (backtab) key.

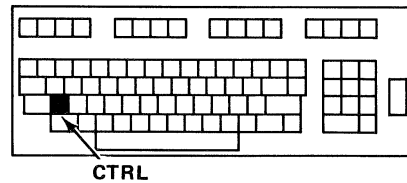
When you are typing into the workspace rather than directly to the computer, BK TAB moves the cursor to the previous tab stop in a line, or to the beginning of the line if there are no tab stops to the left of the cursor. If you are filling in the blanks of a form (terminal in "form fillout mode"), BK TAB moves the cursor to the preceding blank of the form.

When you are typing from the keyboard directly to the computer, BK TAB moves the cursor to the preceding tab stop in a line, but does not send any character to the computer. (There is no "backtab" character in the ASCII code.) Thus, BK TAB serves only to move the cursor; it sends no information to the computer.



Control Characters and the CTRL Key

The ASCII alphabet includes a number of "control" characters which have special meanings. For instance, "carriage return" and "line feed" are control characters; so are "bell" and "form feed." Only a few of the control characters have their own keys on the keyboard: the RETURN, LF, BK SPC, TAB, ESC, and RUB OUT keys.



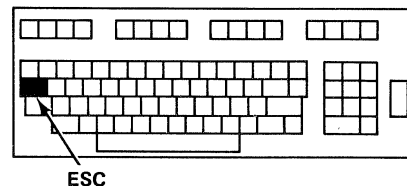
By means of the CTRL key, when you type into the monitor in unbuffered mode, you can send any of the control characters. To do this, hold down CTRL while typing another key. For each control character there is a key which, when pressed while holding CTRL down, sends that control character.

For instance, CTRL together with "G" sends the "bell" character, and CTRL-J sends "line feed."

Exercise 9

Hold down the CTRL key and type the letter "G." Then, while holding down CTRL, type "J." CTRL-G sends the "bell" character, ringing the 4027's bell. CTRL-J sends "line feed," moving the cursor down one line. Table C-2 in Appendix C lists the ASCII control characters with the keys to press to send those characters.

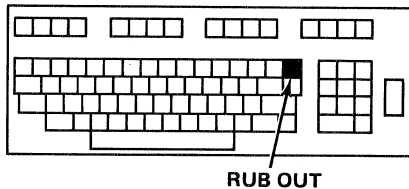
ESC. When you are typing from the keyboard directly to the computer, the ESC key sends the ASCII "escape" character. "Escape" is one of the non-printing control characters of the ASCII code.



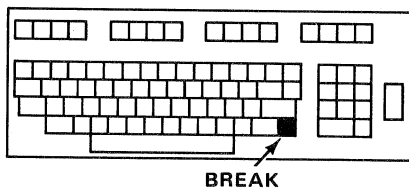
When typing into the workspace rather than directly to the computer, ESC exits the CALIBRATE command. (See Appendix B for the CALIBRATE command.)

OPERATOR'S CONTROLS

RUB OUT. The RUB OUT key sends another special ASCII character, the "rub out" or "delete" character. Like ESC, RUB OUT has no effect when typing into the workspace.



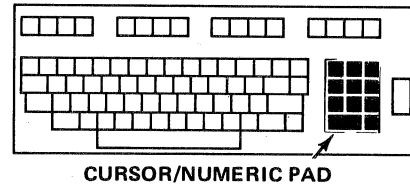
BREAK. The BREAK key is occasionally used to interrupt the host computer, but should be used with caution. (Consult your computer systems analyst to learn when to use BREAK.) One press of the BREAK key transmits a TDATA break time of 350 msec.



You can also use the BREAK key to remove the terminal from buffered mode, to clear the input and output buffers, to exit keyboard lock, and to terminate various peripheral operations. These functions require that the BREAK key be pressed twice in quick succession.

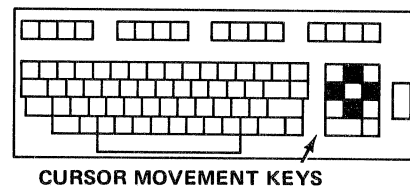
CURSOR/NUMERIC PAD KEYS

The "cursor/numeric pad" consists of the eleven light gray keys located to the right of the ASCII keys. They can be used in two ways: as a "cursor pad" and as a "numeric pad."



Functioning as a Cursor Pad

When the light on the NUMERIC LOCK key is off, the pad acts as a "cursor pad." The four keys marked with arrows move the cursor or the graphic crosshair (when it is visible) in the direction of the arrows.



Exercise 10

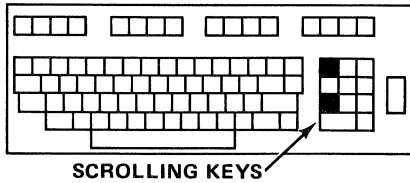
Check that the light on the NUMERIC LOCK key is off. (If the light is on, press NUMERIC LOCK once to turn it off.) Then experiment with the cursor control keys, moving the cursor about on the screen.

The two keys with triangular markings scroll the text in the workspace up and down. (If the keyboard is typing into the "monitor," rather than the workspace, these keys move the monitor scroll rather than the workspace scroll.)

When the terminal is in GIN mode, the cursor control keys move the crosshair. For instance, the crosshair can be used to establish a starting point for pies and circles. (This will be discussed in Section 6, Graphics.)

Exercise 11

Type several lines of text, until the display scrolls upward to accommodate the text you have entered. You now have enough text in the workspace to use the scrolling keys. Type several more lines of text, and then use the scrolling keys to move the text up and down.

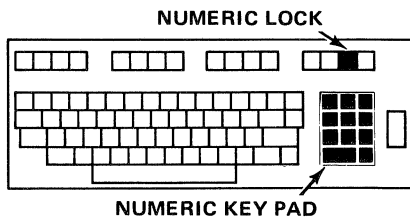


NOTE

The scrolling keys will not move the workspace or monitor scrolls past the end of the text already in memory. Thus, if the entire text is in view, the scrolling keys will have no effect. ("Text in memory" includes empty lines that may have been inserted by moving the cursor below the end of the scroll.)

Functioning as a Numeric Pad

To use the keypad to enter numeric data, press the NUMERIC LOCK key; the light on that key will turn on. To return the pad to its cursor control functions, press NUMERIC LOCK again; the light will turn off. With NUMERIC LOCK on, you can use the pad as a numeric keypad; its keys send ASCII characters for the numeric digits. With NUMERIC LOCK off, the keys do not send ASCII characters to the computer; they only move the cursor (and the graphic crosshair).

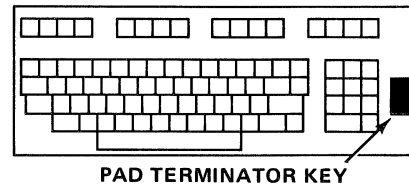


Exercise 12

Press NUMERIC LOCK, and use the numeric pad to type several numbers. Then press NUMERIC LOCK again, and use it to move the cursor.

You can move the cursor even when the pad is functioning as a numeric pad (NUMERIC LOCK on). To do this, hold SHIFT down; the "shifted" versions of the pad keys still function to move the cursor and scroll text up and down.

The pad terminator function key (labeled "PT") is just to the right of the cursor/numeric pad. Pressing this key has no effect unless you or the computer has assigned a meaning to it. (This is done with the LEARN key, discussed in Section 3.)



For instance, you might use a "space" to separate numbers to be entered. In that case, you would program the PT key to mean "space." After entering each number, you would press the pad terminator key to type a "space" before entering the next number.

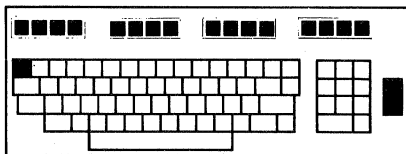
(Alternatively, after entering each number, you might want to give a SEND MOD command, as described in Section 3. In that case, PT could be programmed to give the SEND MOD command.)

OPERATOR'S CONTROLS

FUNCTION KEYS

The function keys control the terminal, causing it to erase the screen, display the status message, insert characters, etc. These keys do not necessarily send ASCII characters to the computer, although most of them can be programmed to do so.

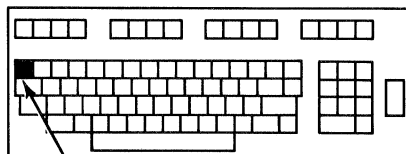
Some of the function keys have no labels describing their functions. These are reserved for you or the computer to program with the LEARN key or the LEARN command. (The LEARN key is described in Section 3. For the LEARN command, see the 4027A Programmer's Reference Manual.)



FUNCTION KEYS

ERASE

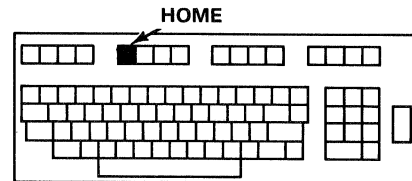
The ERASE key erases the scroll (workspace or monitor) into which the keyboard is typing. (The "workspace" and "monitor" are described in Section 3.) If you are typing into the workspace, the entire workspace is erased. (This includes any text that may be scrolled up out of view.) Similarly, if you are typing into the monitor, ERASE clears the entire monitor.



ERASE

HOME

The HOME key moves the cursor back to the beginning of the workspace or the monitor, rewinding the workspace or monitor scroll if necessary. If you are typing into the workspace, the cursor moves to the beginning of the workspace. Likewise, if you are typing into the monitor, HOME moves the cursor to the beginning of the monitor.

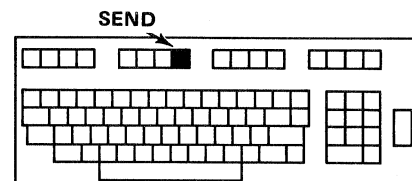


Exercise 13

Press HOME, and see the cursor move back to the start of the workspace. Then press ERASE to clear the workspace.

SEND

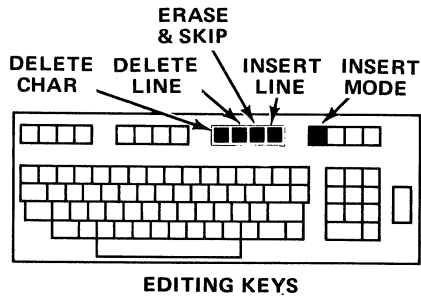
When the SEND key has been suitably programmed, you can use it to give the SEND ALL or SEND MOD commands. The SEND ALL command sends the entire contents of the workspace to the host computer, while the SEND MOD command sends only certain parts of the workspace to the computer. (For more information on these commands, see "Sending Workspace Contents to the Computer," in Section 3 of this manual.)



NOTE

Unlike the other labeled function keys, the SEND key performs no function until the terminal has LEARNed a meaning for it.

Editing Keys



Five of the function keys are used for editing text in the terminal's memory.² These are the DELETE CHAR, DELETE LINE, ERASE & SKIP, INSERT LINE, and INSERT MODE keys.

The DELETE CHAR key deletes the character at the cursor position from the text on the screen. Characters to the right of the cursor move left to fill the gap.

The DELETE LINE key deletes the entire line in which the cursor is located. Lines below it move up to fill the gap left by the deleted line.

The ERASE & SKIP key deletes the characters from the cursor position to the end of the line. The cursor moves to the start of the next line.

The INSERT LINE key inserts a blank line below the present cursor position and moves the cursor to the beginning of that line.

The INSERT MODE key lets you insert characters into a line. When you press INSERT MODE, a light on that key turns on. While the light is on, any characters typed are inserted in the line at the present position of the cursor. Characters at or to the right of the cursor move right to make room for the inserted characters. (If any of these characters move right off the end of the line, they are lost.) Pressing the key again removes the terminal from "insert mode" and turns off the INSERT MODE light.

²You can edit text typed into the workspace, and then later send that text to the computer with the SEND ALL or SEND MOD command, as described in Section 3.

Exercise 14

Type some text, and then experiment with the DELETE CHAR, DELETE LINE, ERASE & SKIP, INSERT LINE, and INSERT MODE keys. You will find these keys quite useful for editing text.

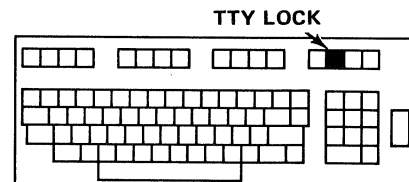
Ordinarily, you would use the editing keys only when typing into the workspace, as you have been doing in the exercises in this section.

You should not use the editing keys when typing text from the keyboard directly to the computer. The editing keys only affect the display, and do not send information to the computer. Consequently, if you use the editing keys to change text already typed in the monitor and sent to the computer, the display will be edited, but the text already sent to the computer won't be.

An exception to this occurs when the terminal is operating in "buffered mode," described in Section 3. In "buffered mode," you can use the editing keys to edit each line of text typed in the monitor, but only before you press RETURN. Once you press RETURN, that line of text is beyond recall.

TTY LOCK

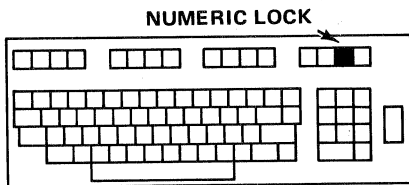
The TTY LOCK key has already been mentioned in connection with the ASCII keys. It is used with those keys much like a typewriter's "shift lock" key. Pressing this key lights a light on the key and locks the keyboard so that it cannot send lowercase letters of the alphabet. (The corresponding uppercase letters are sent instead.) Pressing the key again unlocks the keyboard and turns off the light.



OPERATOR'S CONTROLS

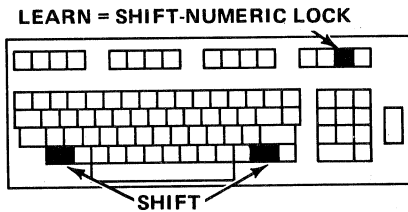
NUMERIC LOCK

The NUMERIC LOCK key has already been mentioned in connection with the cursor/numeric pad. Pressing this key lights the light on the key and lets the cursor/numeric pad function as a numeric pad for entering numbers. Pressing the key again turns off the light and returns the pad to its usual cursor movement function.



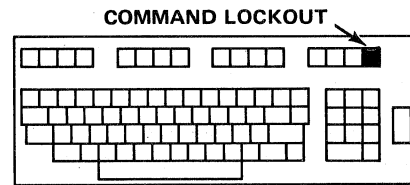
LEARN

The LEARN KEY is the shifted version of the NUMERIC LOCK key. It is discussed in Section 3, under "Using the LEARN Key."



COMMAND LOCKOUT

The COMMAND LOCKOUT key is the rightmost of the four lighted function keys. Pressing this key turns on the light on the key and causes the terminal to ignore the command character which signals the start of a command. (The command character is described in Section 3, under "Typing Commands on the Keyboard.") With COMMAND LOCKOUT active, the terminal will not respond to commands typed on the keyboard or received from the computer; anything typed on the keyboard or sent from the computer is treated as text. Pressing the key again turns off the light and enables the terminal to respond to commands.



STATUS

The STATUS key is the "shifted" version of the COMMAND LOCKOUT key. Use this key to examine the "status message." (Figure 2-4.)

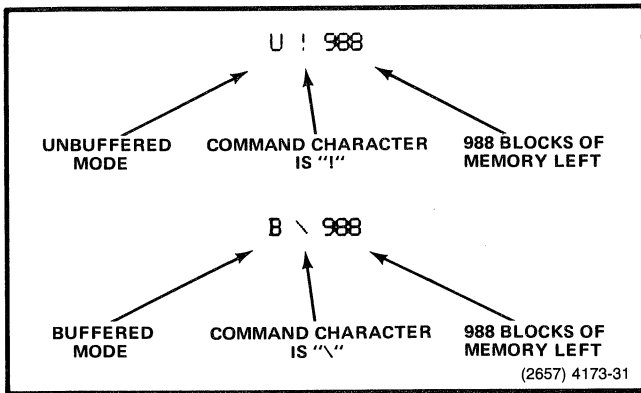
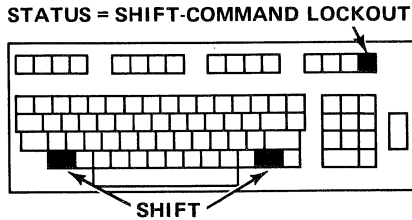


Figure 2-4. Status Message.

Exercise 15

While holding down SHIFT, press STATUS. A "short-form status message" will appear.

The status message has three parts:

- The first part is a single letter, either "U" (for "unbuffered") or "B" (for "buffered"). This indicates whether the terminal is operating in "buffered mode."³
- The second part of the short-form status message is a single character. This is the command character, which you must use to give the 4027 most of its commands.

NOTE

If the command character is one of the non-printing ASCII characters (such as "escape," for instance), a two-letter mnemonic for the character appears in the status message. Table C-2 in Appendix C shows the two-letter mnemonic for each ASCII control character.

- The third part of the status message shows the number of blocks of memory left in the 4027. (Each block contains 16 words of memory, and may hold from 7 to 14 characters of text.) The example shows 988 blocks of memory left. The number of blocks available depends on memory option and will vary.

³"Buffered mode" is described in Section 3 of this manual.

1
1
C 1
1
1
1
1
1
1
1
1
C 1
1
1
1
1
1
1
1
1
1
C 1
1
1

Section 3

COMMANDS

This section describes some of the commands which you can give the terminal. Not all the commands are discussed; for more information, see the 4027A Programmer's Reference Manual. Also, Appendix B gives examples of commands, including those not described in this manual. The topics in this section are:

- Typing commands on the keyboard.
- Interpreting the SYSTAT message.
- Using the two scrolls (workspace and monitor) which the terminal displays on its screen.
- Setting margins and tab stops.
- Buffered operation.
- Making the terminal "learn" new meanings for its keyboard keys; and making it "forget" what it has "learned."
- Selecting a different command character.
- Setting the communications parameters: baud rate, parity, etc.

TYPING COMMANDS ON THE KEYBOARD

You can give a few commands to the terminal just by pressing keys such as ERASE or HOME. Most commands, however, must be typed on the keyboard or sent from the computer.

Before typing a command, be sure the COMMAND LOCKOUT light is off. (If the light is on, the terminal will not respond to the commands you type, although it will respond to keys like ERASE and HOME.) If the light is on, press the key once to turn it off.

To type a command, begin by typing the command character. (See the discussion of the STATUS key in Section 2.) This notifies the terminal that a command follows. The terminal responds by moving the cursor to the monitor (if it is not already there) and displaying the command character.

Type the command immediately after the command character, with no intervening spaces. Each command starts with a "keyword" — the name of the command. For instance, to set the tab stops, you type the keyword STOPS. (If you wish, you may abbreviate any keyword by typing only its first three letters with the exception of DISCONNECT (DISC) and DISABLE (DISA).

NOTE

If you misspell the keyword, or otherwise mistype the command, the terminal will display an error message. (It will display "WHAT?" and the mistyped command.) If this happens, type the command again correctly.

Follow the keyword with a space, and then type any parameters which the command may require. ("Parameters" are additional numbers or letters which give the terminal more details about what you want it to do.) Separate the parameters from the keyword with a space, and from each other with commas or spaces. After typing the parameters, if any, end the command by pressing RETURN.

Suppose, for instance, that the command character is the exclamation point(!), and that you want to make hard copies of two pages of the text in the workspace. You would type:

```
!HCOPY 2 WORKSPACE<CR> or !HCO 2 W<CR>
```

(In this example, "2" and "W" are parameters for the HCOPY command. (This command is described in Section 8.)

If the command character were the ampersand (&) and you wanted to erase the monitor, you would type:

```
&ERASE MONITOR<CR> or &ERA M<CR>
```

THE SYSTAT MESSAGE

The terminal's system status message, or "SYSTAT" message, tells you almost everything you may need to know about the terminal's status. You should examine this message after changing any of the terminal's settings. If you ever become confused about the terminal's operation, examining the SYSTAT message may help you understand what is happening.

On the last page of this manual, there is a table in which you should record the SYSTAT settings for you particular computer operation. (Your computer systems analyst can tell you what these settings should be.)

To see the SYSTAT message, type:

ISYSTAT<CR> or ISYS<CR>

The following "translation" interprets the message in Figure 3-1. Some of the settings will be explained later in this manual, and many are of interest only to the person who programs the computer to talk to the terminal. (See the Programmer's Reference Manual for more information about these settings.)

TB= 2400 RB= 2400
The transmitting and receiving baud rates are each set to 2400 baud.

DL= 0
The delay before the terminal responds to a prompt from the host computer is set to 0 milliseconds.

LM= 1 RM=70
The workspace's left margin is set at column 1, and the right margin at column 70.

WL=20
The visible workspace length is set to 20 lines. That is, 20 lines of the screen are used to display the workspace, and the remainder (14 lines) to display the monitor.

V#=3.0
This terminal has firmware version 3.0 installed.

TS= 5 8 12 26 0 0 0 0 0
The tab stops are set at columns 5, 8, 12, and 26.

CC=!
The command character is the exclamation point (!).

FS=␣
The field separator is "carriage return."

PR=?
The prompt string consists of a single character, the question mark (?).

EL=␣
The end-of-line string consists of a single character, "carriage return."

RS=D3 D1 D3 D1
The Remote Start Stop parameters are set to host stop (DC3), host start (DC1), terminal stop (DC3), terminal start (DC1).

DU=F
The terminal is set for "full duplex" data communications.

BU=N
The terminal is not in "buffered" mode.

EC=R
The terminal is set for "remote echo" rather than "local echo."

FF=N
The terminal is not in "form fillout" mode.

SN=N
The terminal is not in "snoopy" mode.

KB=M
Text coming from the keyboard is directed to the monitor.

CM=W
Text from the computer is directed to the workspace.

PA=N
No parity checking is being done.

C0-C7
The eight default colors and their HLS parameters are displayed.

NOTE

There may be additional information in the SYSTAT message, beyond that shown in this example, if the terminal is equipped with certain options.

```

!sys
TB= 2400 RB= 2400 DL= 0 LM= 1 RM=70 WL=20 V#=3.0
TS= 5 8 12 26 0 0 0 0 0 0 0 0 0 0 0 0
CC=! FS=␣ PR=? EL=␣ RS=␣ ␣ ␣ ␣
DU=F BU=N EC=R FF=N SN=N KB=M CM=W PA=N
C0 0,100,100 C1 120, 50,100 C2 240, 50,100 C3 0, 50,100
C4 180, 50,100 C5 300, 50,100 C6 60, 50,100 C7 0, 0,100
    
```

4171-3

Figure 3-1. The SYSTAT Message.

THE WORKSPACE AND THE MONITOR

TWO SCROLLS OF MEMORY

Think of the display memory as consisting of two scrolls (Figure 3-2). The screen displays part of each scroll, but not the entire scroll.

The reason for having two scrolls is this: you can use one scroll to hold the text, graph or form on which you are working, and the other to display your communications with the computer. That way, messages from the computer are not written over your text, graph, or form.

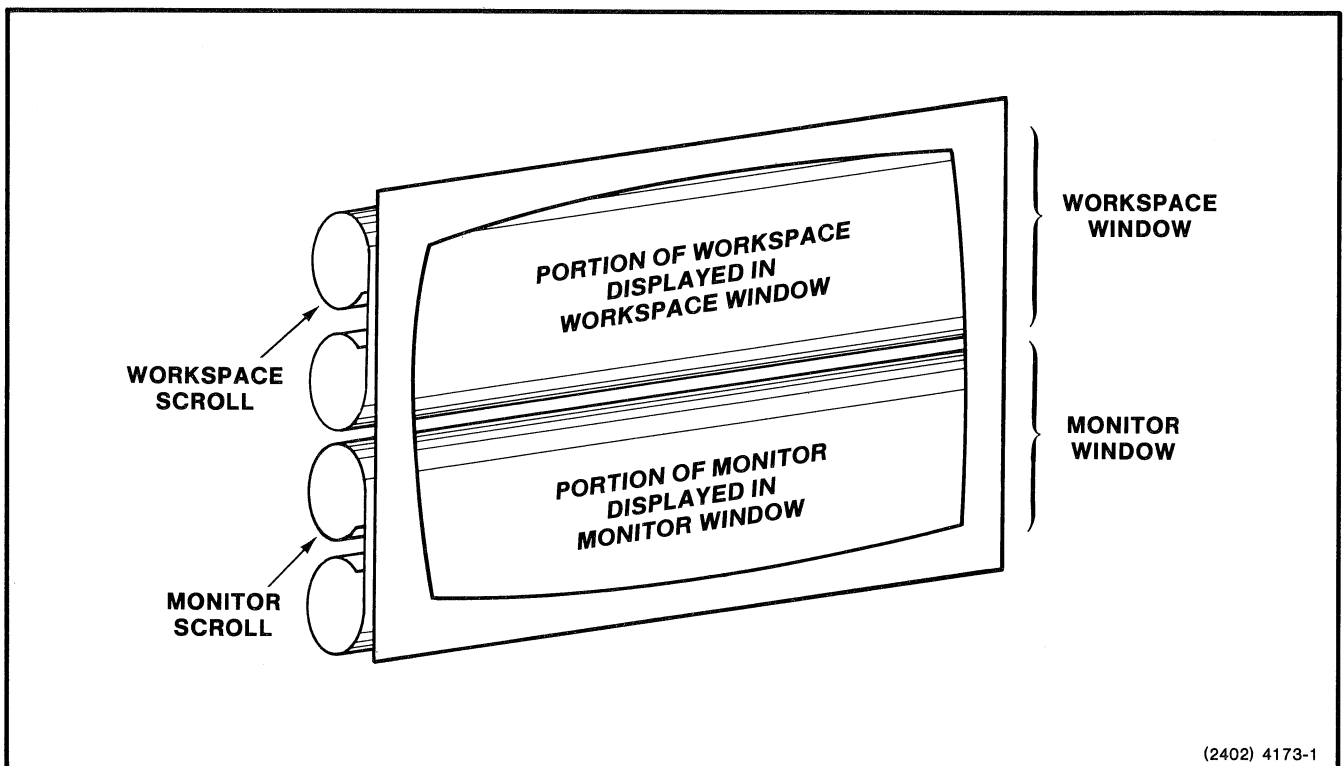
The bottom scroll is the monitor. (When the terminal is first turned on, the monitor occupies the entire screen; there is no "top scroll.") The monitor has two uses:

1. The monitor displays conversations that you have with the terminal. For instance, whenever you type a command, that command is displayed in the monitor. Similarly, if the terminal does not understand the command, it displays an error message in the monitor. When you press SHIFT-STATUS or give a SYSTAT command, the status or SYSTAT message appears in the monitor.

2. You can use the monitor to display conversations between you and the host computer. When you use the terminal this way, it behaves like an ordinary teletypewriter; the monitor scroll imitates the roll of paper on which a teletypewriter prints.

The top scroll is the "workspace." The workspace has many features which the monitor lacks:

- Colored or patterned polygons and pies (panels), colored circles, vectors, and graphs can be drawn in the workspace. Also you can define your own alternate character sets, and so display special characters in the workspace.
- Text typed into the workspace is not immediately sent to the computer, but instead is held until you command the terminal to send that text. This allows you to edit the text, perhaps deleting or adding characters or lines to get it just right before sending it on to the computer.
- In the workspace (but not the monitor), you can set right and left margins.



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Figure 3-2. The Workspace and the Monitor.

COMMANDS

- The workspace can hold a form with blanks which either you or the computer can fill. With the terminal operating in "form fillout mode," you can send to the computer the contents of all the blanks in the form, or only those blanks whose contents have been modified.
- In creating a form, you can make the terminal emphasize certain parts of the text by displaying them with distinguishing visual attributes, such as inverted, colored backgrounds or blinking colors.
- If your terminal has the optional rulings character (Option 32), you can draw vertical and horizontal lines in the workspace to create forms.
- With other optional character sets installed, the workspace can display other special characters, such as math characters (Option 34).

DEFINING A WORKSPACE

When the terminal is first turned on, the monitor occupies the entire screen; no workspace exists. Before you can use a workspace, you (or the computer) must create that workspace. This is called "defining a workspace," and it is done with the **WORKSPACE** command or the **MONITOR** command.

More precisely, when you define a workspace, you do two things:

- You cause the terminal to separate its display memory into two parts: the workspace and monitor scrolls.
- You tell the terminal the number of lines of the screen to use for displaying the workspace scroll, and the number of lines to use to display the monitor scroll.

The screen can display 34 lines of text. In defining a workspace, you can either tell the terminal how many lines to use for the workspace, or you can tell it how many to use for the monitor.

- You can use a **WORKSPACE** command to tell the terminal how many lines of the screen to use for displaying the workspace. The terminal will then use the remaining lines to display the monitor.
- You can use the **MONITOR** command to designate how many lines to use for displaying the monitor. The terminal will then use the remaining lines to display the workspace.

CAUTION

Whenever a workspace is defined (or redefined), the contents of the monitor and the workspace (if already defined) are lost. Therefore, you should define a workspace only at the start of your work.

To create a workspace and reserve the top 30 lines of the screen for displaying it (leaving the bottom four lines for the monitor), type this:

```
!WORKSPACE 30< CR> or !WOR 30< CR>
```

To reserve the bottom five lines of the display for the monitor and leave the remaining 29 lines above it for the workspace, type this:

```
!MONITOR 5< CR> or !MON 5< CR>
```

The parameter in a **WORKSPACE** command may be any number from 0 to 33; in a **MONITOR** command may be any number from 1 to 34. (There are 34 lines in the display, at least one of which must be reserved for the monitor.)

DIRECTING TEXT TO THE WORKSPACE OR THE MONITOR

Text entered from the keyboard can go to either the workspace or the monitor, as can text coming over the communications line from the host computer. Use the WORKSPACE and MONITOR commands to tell the terminal where to put text coming from the keyboard or the computer.

Characters typed on the keyboard fall into two categories:

- “Conversational” communications between you and the terminal are always displayed in the monitor. That is, when you type a command, the command appears in the monitor. Also, when you use the LEARN key, described later in this section, a “key definition” is displayed in the monitor.
- Text (everything but commands and key definitions) typed on the keyboard can go to either the workspace or the monitor. To send text from the keyboard to the workspace, type:

!WOR<CR> or !WOR K<CR>

(The “K” stands for “keyboard.”)

To send text from the keyboard to the monitor, type:

!MON<CR> or !MON K<CR>

Characters coming over the communications line from the host computer also fall into two categories:

- Commands from the computer that are executed, but not displayed.
- Text (everything but commands) from the computer that can go to either the workspace or the monitor.

To direct text from the computer to the workspace, type:

!WORKSPACE H<CR> or !WOR H<CR>

(The “H” stands for “host computer.”)

To direct text from the computer to the monitor, type:

!MONITOR H<CR> or !MON H<CR>

(It is possible in one WORKSPACE or MONITOR command to define a workspace and direct text to it or to the monitor. For instance,

!WOR 15 H K<CR>

creates a workspace, allots the top 15 lines of the screen to it, and directs text from the computer and from the keyboard to that workspace.)

COMMANDS

Exercise

Type a WORKSPACE 20 H K command, and then examine the SYSTAT message. You should see "WL=20," "KB= W," and "CM= W."

```
!sys
TB= 2400 RB= 2400 DL= 0 LM= 1 RM=70 WL=20 V#=3.0
TS= 5 8 12 26 0 0 0 0 0 0 0 0 0 0 0 0
CC=! FS=r PR=? EL=r RS=r r r r
DU=F BU=N EC=R FF=N SN=N KB=W CM=W PA=N
C0 0,100,100 C1 120, 50,100 C2 240, 50,100 C3 0, 50,100
C4 180, 50,100 C5 300, 50,100 C6 60, 50,100 C7 0, 0,100
```

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Then type a MONITOR 30 H command, and examine the SYSTAT message again. You should have "WL= 4". (With 30 lines taken for the monitor, only the top four lines of the screen will display the workspace.) The keyboard still types into the workspace ("KB= W"), but the computer now types into the monitor ("CM= M").

```
!sys
TB= 2400 RB= 2400 DL= 0 LM= 1 RM=70 WL= 4 V#=3.0
TS= 5 8 12 26 0 0 0 0 0 0 0 0 0 0 0 0
CC=! FS=r PR=? EL=r RS=r r r r
DU=F BU=N EC=R FF=N SN=N KB=W CM=M PA=N
C0 0,100,100 C1 120, 50,100 C2 240, 50,100 C3 0, 50,100
C4 180, 50,100 C5 300, 50,100 C6 60, 50,100 C7 0, 0,100
```

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When the terminal is first turned on, or when MASTER RESET is pressed, there is no workspace defined ("WL= 0" in the SYSTAT message), and both computer and keyboard send text to the monitor ("KB= M", "CM= M").

ERASING THE WORKSPACE OR THE MONITOR

One way to erase the contents of the workspace or the monitor is to press the ERASE key. Pressing this key erases the scroll (workspace or monitor) into which the keyboard is typing.

You can accomplish the same thing by typing this:

!ERASE<CR> or !ERA<CR>

Suppose, however, that you are typing text into the workspace, but you want to erase the monitor rather than the workspace. To do this, designate the monitor in an ERASE command:

!ERASE MONITOR<CR> or !ERA M<CR>

Similarly, while typing in the monitor, you can erase the workspace by typing:

!ERASE WORKSPACE<CR> or !ERA W<CR>

Erasing the workspace or the monitor frees some memory for other uses.

FORM FILLOUT MODE

The terminal has a "form fillout" mode of operation. In this mode, the workspace holds a prepared form, and either you or the computer can fill in the "blanks" of the form. Ways of using form fillout mode are summarized here; look in Section 7 to learn how to create a form in the workspace.

To see whether the terminal is in form fillout mode, examine the SYSTAT message (Figure 3-3). Look for the "FF=" part of the message: "FF= Y" means the terminal is in form fillout mode, and "FF= N" means it is not.

These are the special features of form fillout mode:

- You can type only in the "blanks" of the form (the "unprotected fields"). If you try to type elsewhere, the bell sounds and the the character typed is inserted in the next blank.
- The TAB key no longer moves the cursor to the next tab stop. Instead, it moves the cursor to the next blank of the form. Similarly, BK TAB moves the cursor back to the preceding blank. If not at the beginning of a blank field, BK TAB moves the cursor to the first character of the blank field it is in.
- HOME moves the cursor to the start of the first blank, rather than to the start of the first line.
- ERASE doesn't erase the whole workspace, but just the data in the blanks of the form.
- Some of the blanks (the "numeric fields") will accept numerals and special characters, but not letters of the alphabet.
- Data entered into the blanks of the form may be sent to the host computer without sending the form itself.

```
!sys
TB= 2400 RB= 2400 DL=    0 LM= 1  RM=70 WL= 4  V#=3.0
TS= 5  8 12 26  0  0  0  0  0  0  0  0  0  0  0  0
CC=!  FS=5  PR=?  EL=5  RS=0  0  0  0
DU=F  BU=N  EC=R  FF=Y  SN=N  KB=W  CM=M  PA=N
C0  0,100,100  C1 120, 50,100  C2 240, 50,100  C3  0, 50,100
C4 180, 50,100  C5 300, 50,100  C6  60, 50,100  C7  0,  0,100
```

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Figure 3-3. SYSTAT Indication of Form Fillout Mode.

COMMANDS

KEYBOARD LOCK MODE

This mode, normally controlled by the computer program, enables the keyboard to be locked and unlocked to prevent unwanted data or command entry from the keyboard. The commands are:

- IPAD 205 to lock the keyboard.
IPAD 203 to unlock the keyboard (BRK-BRK will also unlock the keyboard).

SENDING WORKSPACE CONTENTS TO THE COMPUTER

The SEND command sends the workspace contents to the computer. This command takes two forms: SEND ALL and SEND MOD. (If you leave out the word "ALL" or "MOD", the terminal interprets the command as a SEND ALL command.) These commands perform differently when the terminal is in form fillout mode than when it is not.

CAUTION

Use the SEND command (or the SEND key) only as required by the particular host computer program you are using.

When the 4027 is not in form fillout mode, the SEND ALL and SEND MOD commands are treated alike. Each

of these commands sends the entire contents of the workspace to the computer:

!SEND ALL
or
!SEND MOD

In form fillout mode, the SEND ALL and SEND MOD commands behave as follows:

SEND ALL. The SEND ALL command sends the contents of all the blanks in the form.

SEND MOD. The SEND MOD command sends the contents of only those blanks whose contents have been modified since the last SEND or SEND MOD command.¹

SYSTAT FIELDS PERTAINING TO THE SPLIT SCREEN

Figure 3-4 illustrates the parts of the SYSTAT message which pertain to the workspace and the monitor. The SYSTAT message shows:

- The number of lines of the screen used to display the workspace.
- Whether the keyboard types into the workspace or the monitor.
- Whether text from the communications line is directed to the workspace or the monitor.

¹It is, however, possible to designate other parts of the form ("protected" fields) as "modified," so that they, too, will be sent each time a SEND MOD command is executed. This is described in Section 7.

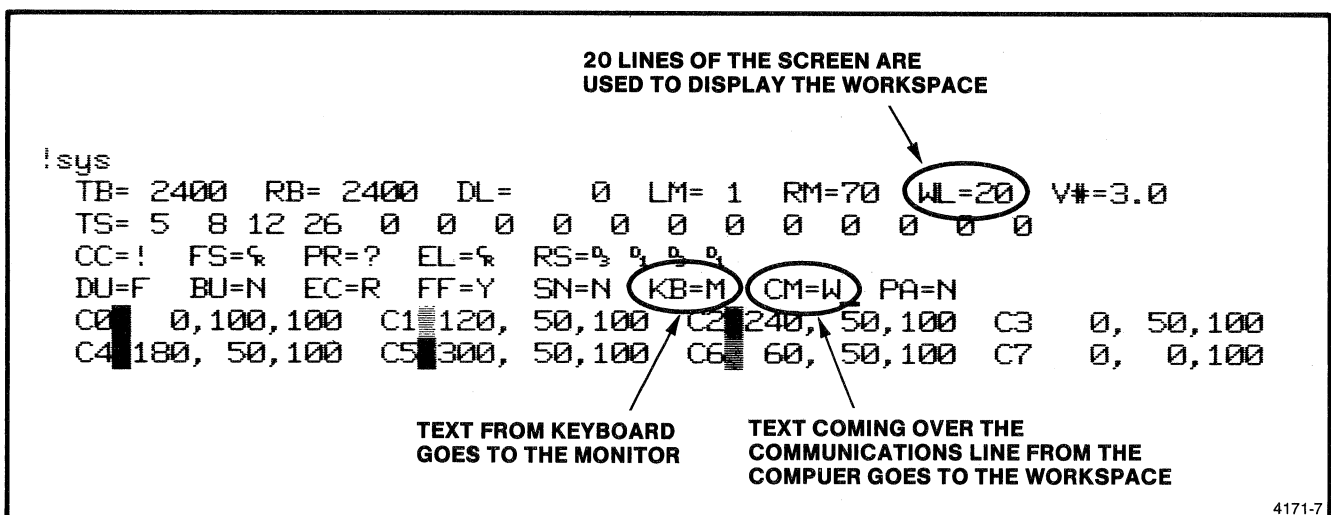


Figure 3-4. Parts of the SYSTAT Message Pertaining to the Workspace and the Monitor.

MARGINS AND TAB STOPS

Either you or the computer can set margins and tab stops in the workspace, similar to the margins and tab stops in a typewriter. (Margins affect only the workspace; tab stops also affect the monitor.) There are 80 character positions (columns) in each line, and you can set the margins at any of these. You can define up to 16 tab stops, putting them in any of the columns except column 1.

MARGINS

To set the margins at the extreme left and right edges of the screen, type this command:

`!MARGINS<CR>` or `!MAR<CR>`

To set the left margin at column 10 and the right margin at column 70, type this:

`!MARGINS 10,70<CR>` or `!MAR 10,70<CR>`

To change the setting of the left margin without disturbing the right margin, enter only one number in the command. For instance, to set the left margin at column 15 (leaving the right margin where it is) type:

`!MARGINS 15<CR>`

You cannot type to the left of the left margin, but you can type beyond the right margin (right out to column 80). If you type beyond the column in which the right margin is set, the bell sounds.

The "LM" and "RM" parts of the SYSTAT message (Figure 3-5) tell you the current settings of the left and right margins. It is wise to examine the SYSTAT message to check that you have set the margins correctly.

The terminal "remembers" margin settings even after you turn off the power or press the MASTER RESET button.

```
!sys
TB= 2400 RB= 2400 DL=  0 LM= 1 RM=70 WL=20 V#=3.0
TS= 5 8 12 26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
CC=! FS=% PR=? EL=% RS=D3 D1 D3 D1
DU=F BU=N EC=R FF=Y SN=N KB=M CM=W PA=N
C0 0,100,100 C1 120, 50,100 C2 240, 50,100 C3 0, 50,100
C4 180, 50,100 C5 300, 50,100 C6 60, 50,100 C7 0, 0,100
```

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Figure 3-5. SYSTAT Indication of Margin Settings.

COMMANDS

TAB STOPS

The STOPS command sets the tab stops. For instance, to set tab stops in columns 10, 15, and 20, type this:

```
!STOPS 10,15,20<CR>
```

You may set up to 16 tab stops, in columns 2 to 80. When using the STOPS command, you should remember two things:

- You must list the column numbers in increasing order. For instance, you may type

```
!STOPS 10,15,20<CR> ,
```

but you should not type

```
!STOPS 15,10,20<CR> .
```

- Each time you use the STOPS command, you must list all columns where you want tab stops. If you leave any column numbers out, tab stops previously at those columns are deleted.

Figure 3-6 shows how the SYSTAT message indicates where the tab stops are located. After setting the tab stops, it is wise to check the SYSTAT message to be sure that you have set them correctly.

The terminal remembers tab stop settings, like margin settings, even after it has been turned off or reset with the MASTER RESET button.

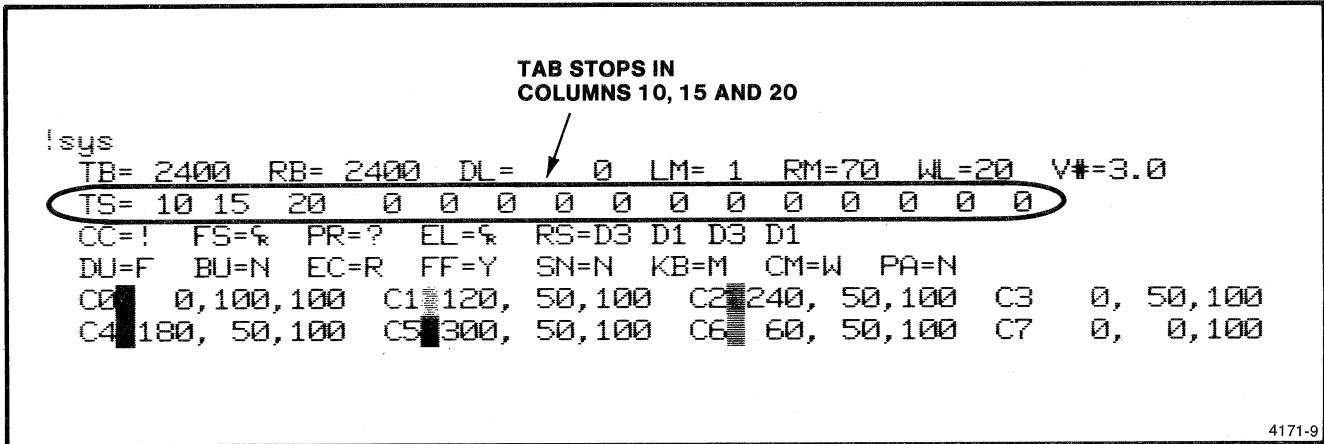


Figure 3-6. SYSTAT Indication of Tab Stops.

BUFFERED OPERATION

The terminal has a "buffered" mode of operation, in which it sends data to the computer only when the computer has requested that data.

To learn whether the terminal is in buffered mode, press SHIFT-STATUS. The terminal will display the status message (Figure 3-7). The first character in this message is a B if the terminal is in buffered mode, and a U if it is not.

SENDING TEXT FROM THE KEYBOARD TO THE COMPUTER

Buffered operation differs from unbuffered operation in the way that text typed into the monitor is sent to the computer. In unbuffered mode, as you type into the

monitor, the terminal sends each character to the computer as soon as you type it. In buffered mode, on the other hand, the terminal does not send the characters right away. Instead, it holds each line of text and sends that line to the computer only after (a) you press RETURN to mark the end of the line, and, moreover, (b) the computer has asked for that line to be sent.

Figure 3-8 illustrates buffered operation. As you type into the monitor, you can change a line of text any time before pressing RETURN. When you press RETURN, the terminal copies that line into a part of its memory called the "transmit buffer." You can continue to type in lines of text. As you press RETURN at the end of each line, that line is copied into the transmit buffer, where it waits its turn to be sent to the computer.

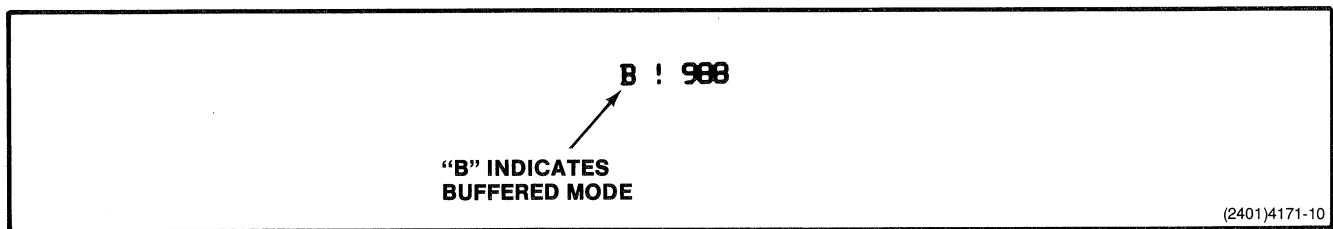


Figure 3-7. Status Message.

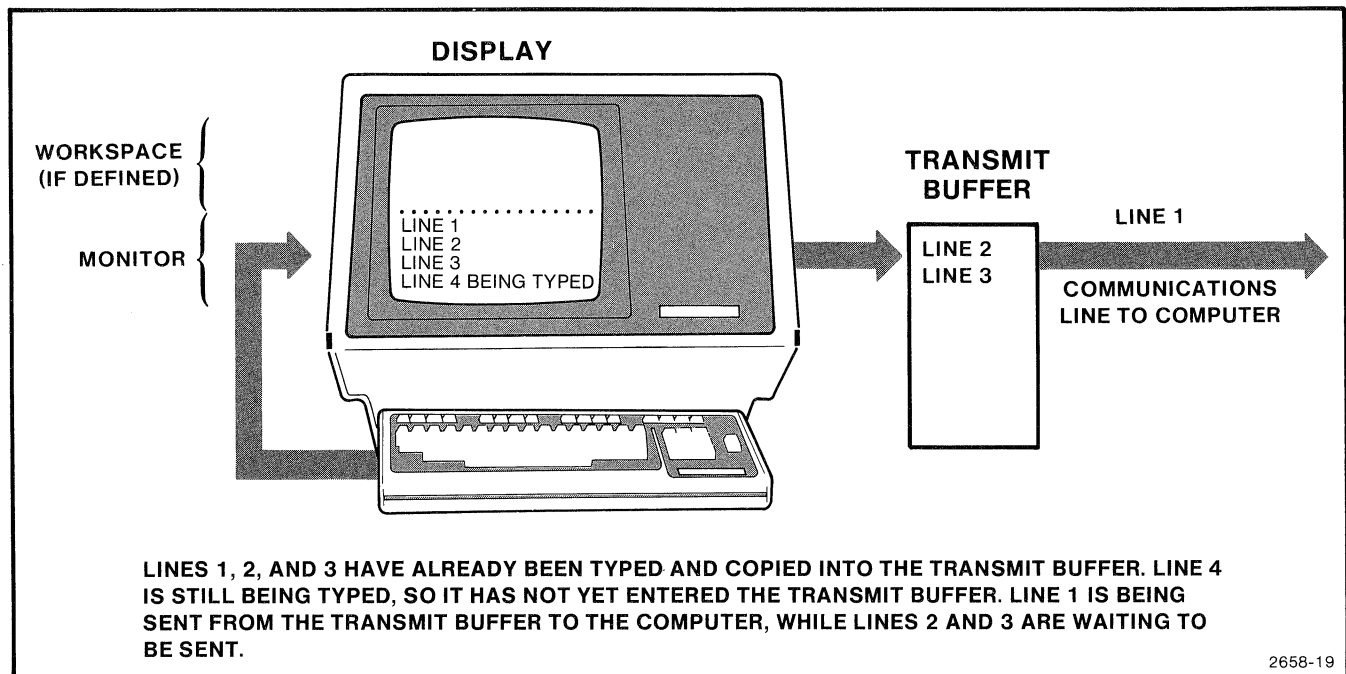


Figure 3-8. Buffered Operation.

COMMANDS

The terminal sends lines of text from the transmit buffer one at a time, in order. If you type several lines of text, the computer must make several requests for data from the terminal. At each request, the terminal sends one line of text.

CAUTION

The terminal will not go on to its next task (such as executing a command typed on the keyboard) until it has finished sending the contents of its transmit buffer. If the computer does not send the necessary prompts, the terminal cannot go on to the next task.

If this happens, press BREAK twice in quick succession. This removes the terminal from buffered mode and sends a "break" signal to interrupt the host computer.

If you ever encounter this difficulty, consult your computer systems analyst; there may be a fault in the computer's program.

SENDING THE WORKSPACE CONTENTS

Suppose the terminal is in buffered mode, and you want to send the workspace contents to the computer. To do this, give a SEND ALL or SEND MOD command, either by typing the command, or by pressing the SEND key. (The SEND key must first be programmed to give the SEND ALL or SEND MOD command. This may be done by the computer or by means of the LEARN key, described later in this section.)

When the terminal executes the SEND command, it copies the contents of the workspace into its transmit buffer and waits for the computer to request that each line be sent. When the computer has requested and received each line from the transmit buffer, the 4027 is ready for its next task.

ENTERING BUFFERED MODE

When you first turn on the terminal, it powers up in unbuffered mode. To put it in buffered mode, type the BUFFERED or BUFFERED YES command. For instance, if the command character is the exclamation point (!), you would type:

!BUFFERED< CR> or !BUF< CR>

LEAVING BUFFERED MODE

There are four ways to remove the terminal from buffered mode:

- Use the BUFFERED NO command. That is, to remove the 4027 from buffered mode, type:

!BUFFERED NO< CR> or !BUF N< CR>

When the terminal has emptied its keyboard buffer, it will execute the BUFFERED NO command and revert to unbuffered mode.

- Another way to exit buffered mode is to press the BREAK key twice in quick succession. (In addition to removing the terminal from buffered mode, this sends a "break" signal to interrupt the computer.) You would use this method if the terminal were not responding to commands because the host was not sending prompts. (Without the prompts, the terminal could not empty its transmit buffer and go on to the next command.)
- Since the terminal powers up in unbuffered mode, you can remove it from buffered mode by turning the power off, and then on again. This method is not recommended, as it destroys any text in memory.
- Pressing MASTER RESET has the same effect as turning power off, and then on again. It also has the same disadvantages.

USING THE LEARN KEY

You can assign a new meaning to almost any key on the keyboard. Defining a new meaning for a key is called "programming" that key, and it is done with the LEARN key. (The LEARN key is the "shifted" version of the NUMERIC LOCK function key.)

NOTE

Anything the LEARN key can do can also be done by the computer with the LEARN command (described in the 4027A Programmer's Reference Manual). Since the computer ordinarily programs the function keys, you normally need not use the LEARN key.

Unless you need to program a key, you need not read the following explanation of the LEARN key.

PROGRAMMING A KEY

To program a key:

1. Press SHIFT-LEARN.
2. Press the key you want to program.
3. Press, in order, the keys whose meanings you want to assign to the key being programmed.
4. Press SHIFT-LEARN again.

As you program a key, the terminal displays in the monitor the meaning (key definition) you are assigning to that key. Figure 3-9 illustrates what would appear in the monitor if you assigned the meaning "This is a test" to the "{" key.

Exercise

Program the "{" key to mean, "This is a test." That is, press SHIFT-LEARN and type "{"; then type "T", "h", "i", etc., to spell "This is a test." Finally, press SHIFT-LEARN again.

As you do this, notice the message that appears in the monitor. First, as you press SHIFT-LEARN, the word LEARN appears. Then, as you press the key being

programmed, the character for that key appears. (If the key has no ASCII character, a "blotch" — the "rubout" symbol — appears instead.) After displaying the character (or "blotch") for the key being programmed, the display shows two left angle brackets (<<). Next, as you press the keys whose meanings you are giving the key being programmed, the characters for those keys appear. Finally, as you press SHIFT-LEARN again, two right angle-brackets (>>) appear.

Now try pressing the "{" key. Instead of the character "{", you see the message, "This is a test."

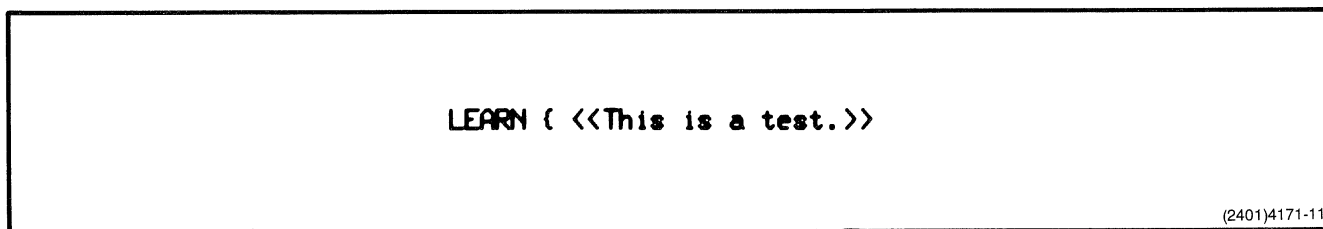
The shifted and unshifted versions of each key are programmed independently. For instance, when you programmed "{", you did not change the meaning of "[".

Every key that you press while programming a key will be interpreted as part of the key definition. Thus, you cannot use the cursor movement keys or editing keys in the usual way. If you make a mistake while programming a key, terminate the programming by pressing SHIFT-LEARN. Then start over again.

During a key definition you can press keys such as RETURN or LF if you wish; the corresponding ASCII characters will become part of the key definition. In fact, you can include any ASCII character in a key definition. (The control characters are represented in the monitor by two-letter mnemonics, such as CR for "carriage return.") You can also incorporate function keys or cursor control keys in a key definition. These have no corresponding ASCII characters, so they are represented by "blotches" in the display.

The only keys you can't program, and can't incorporate into the programming of other keys, are:

- The rightmost three of the lighted function keys.
- CTRL, SHIFT, and BREAK.



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Figure 3-9. Key Definition Displayed in the Monitor.

COMMANDS

MAKING THE TERMINAL "FORGET" A KEY DEFINITION

To restore a key to its original meaning:

1. Press SHIFT-LEARN.
2. Press the key you wish to restore to its original meaning.
3. Press SHIFT-LEARN again.

Exercise

Restore the "{" key to its original meaning. When you have done so, press "{" to check that it no longer means "This is a test."

THE CLEAR COMMAND

You can restore all the keys of the keyboard to their ordinary meanings by typing the CLEAR command. For instance, if the command character were the exclamation point, you would type:

!CLEAR<CR> or !CLE<CR>

SELECTING THE COMMAND CHARACTER

Normally, you should leave the command character unchanged, so that the terminal always responds to commands from the computer. The terminal "remembers" its command character even after being turned off; it would only "forget" if the battery powering that part of its memory should fail. (In that case, a RESET message appears when you turn on the terminal.)

If you do get a RESET message, use the COMMAND command to set the command character. For instance,

!COMMAND <CR> or !COM <CR>

changes the command character from "!" to " ".

To set the command character to one of the non-printing ASCII control characters, use the ASCII decimal equivalent for that character in the command. (Table C-1 in Appendix C gives ASCII decimal equivalents for all the ASCII characters.) For instance, the ASCII decimal equivalent for the "shift out" control character is 14, so

!COM 14<CR>

changes the command character from "!" to "shift out."

CAUTION

When using the ASCII decimal equivalent to specify a control character in the COMMAND command, you must type the ASCII decimal equivalent as a two- or three-digit numeral. (A one-digit numeral is not interpreted as an ASCII decimal equivalent, but as the character itself.)

For instance, !COM 02 sets the command character to the "start of heading" character, whose ASCII decimal equivalent is 2; but !COM 2 sets the command character to the digit "2".

SETTING THE COMMUNICATIONS PARAMETERS

To communicate successfully with the host computer, certain of the terminal's settings must agree with what the computer expects. For instance, if the terminal transmits characters at 1200 baud (120 characters/second), and the computer expects to receive characters at 110 baud (about 10 characters/second), the computer will not understand what the terminal is saying.

You should not normally have to set the communications parameters, since the terminal "remembers" these settings even when its power is turned off. You should, however, keep a note of the proper settings in the table on the last page of this manual.

If the terminal "forgets" these settings, it will display a RESET message when you turn it on. In that case, you should refer to your notes on the last page of this manual and then reset the command character and the communications parameters.

Also, if you dial up a different computer, you may have to change some of these settings to agree with what that computer expects.

The "communications parameters" which must be set correctly are:

- Transmitting and receiving baud rates.
- Parity.
- Remote or local echo.
- End-of-line string.
- Prompt string.

With these five parameters set correctly, it should be possible to log in on a computer system. Once you have logged in, each application program that you run on the computer will set the terminal's other settings as needed.

BAUD RATES

The transmitting and receiving baud rates are the speeds at which the terminal sends and receives characters from the computer. These speeds are indicated by the "TB=" and "RB=" parts of the SYSTAT message.

Exercise

Examine the SYSTAT message by typing the SYSTAT command, and note the transmitting and receiving baud rates. Write these down for future reference in the table on the last page of this manual.

To set the transmitting and receiving baud rates, we use the BAUD command. The following baud rates may be specified: 0, 50, 75, 100, 134.5, 150, 300, 600, 1200, 1800, 2400, 4800, and 9600 baud. For example, to set both transmitting and receiving rates to 600 baud, you would type:

```
!BAUD 600< CR> .
```

The transmitting and receiving baud rates may be set independently. For instance, to set the transmitting rate to 1200 baud and the receiving rate to 4800 baud, type:

```
!BAUD 1200,4800< CR>
```

There is a table on the last page of this manual, in which you should record the proper baud rates for use with your computer. (While the terminal "remembers" its baud rate settings even after it has been turned off, it depends on an internal battery to provide power for this memory. Should the battery fail, the terminal will display a RESET message. In that case, you would refer to your notes on the last page of this manual, and use the BAUD command to reset the terminal to the right baud rates.)

COMMANDS

PARITY

The "parity" setting determines how the terminal treats the eighth bit ("parity" bit) in each ASCII character. There are five possible parity settings: "even," "odd," "none," "data" and "high." If the host computer uses the parity bit, then the terminal's parity setting must correspond with that of the computer. (If the computer uses even parity, so must the terminal.) You can learn the terminal's "parity" setting from the "PA=" part of the SYSTAT message.

Exercise

Type the SYSTAT command, and examine the SYSTAT message. Write down the parity setting in the table in the back of this manual.

To set the terminal for "even" parity, type:

```
IPARITY E< CR>
```

To set it for "odd" parity, type:

```
IPARITY O< CR>
```

To set "parity" to "none," type:

```
IPARITY N< CR>
```

To set "parity" to "data," type:

```
IPARITY D< CR>
```

To set "parity" to "high," type:

```
IPARITY H< CR>
```

ECHO

When you are typing directly to the computer (typing into the monitor in unbuffered mode), there are two ways that the characters you type may be displayed on the screen: "remote echo" and "local echo."

In "remote echo" data communications, characters you typed into the monitor are sent to the computer without first being displayed. As the computer receives each character, it "echos" it back to the terminal. It is the received, rather than the original transmitted character, that the terminal displays on its screen. This has the following advantages:

- As you type each character into the monitor, you can tell immediately whether the computer has received the character correctly.
- "Selective echo" is possible, because the computer can be programmed to decide which characters to echo. For instance, in time sharing systems, the computer usually does not echo the password typed when logging in.

In "local echo" data communications, as you type each character into the monitor, the terminal supplies the "echo" within itself. That is, it displays each character sent to the computer without waiting for the computer to echo the character back to the terminal. ("Remote echo" requires "full duplex" data communications, in which both computer and terminal may transmit simultaneously.)

The ECHO command is used to choose between "remote echo" and "local echo" data communications. To choose remote echo, type:

```
!ECHO REMOTE< CR> or !ECH R< CR>
```

To choose local echo, type:

```
!ECHO LOCAL< CR> or !ECH L< CR>
```

After typing an ECHO command, check the SYSTAT message to be sure that you have set the echo parameter correctly. Look for the "EC=" part of the SYSTAT message "EC= R" means "remote echo," and "EC= L" means "local echo."

END-OF-LINE STRING

The terminal sends the computer an "end-of-line" string at the end of each line of text. For instance, when you are typing directly to the computer (that is, with keyboard typing into the monitor), the terminal sends the end-of-line string whenever you press RETURN. Similarly, when sending the workspace contents to the computer, the terminal inserts an end-of-line string at the end of each line of text.

Some computers may expect to receive "carriage return" (<CR>) at the end of each line, while others may require "carriage return, line feed," (<CR>,<LF>) or a string of characters. For this reason, the terminal has an EOL command for setting the end-of-line string as required.

You can learn the current end-of-line string by examining the "EL=" part of the SYSTAT message (Figure 3-10). Usually the end-of-line string does not include ordinary letters of the alphabet, but instead consists of one or more non-printing ASCII control characters. These control characters are represented by two-letter mnemonics in the SYSTAT message. You can learn the meanings of these mnemonics by consulting Table C-2 in Appendix C.

Exercise

Type the SYSTAT command to examine the end-of-line string setting. Record this for future reference in the table on the last page of this manual.

To set the end-of-line string, use the EOL command. The 4027A Programmer's Reference Manual describes several forms this command may take. One way to give the EOL command is to list (as parameters in the command) the ASCII decimal equivalents of the characters which are to make up the end-of-line string.

Table C-1 in Appendix C lists the ASCII decimal equivalents for all the characters of the ASCII code. For instance, the ASCII decimal equivalents for "carriage return" and "line feed" are 13 and 10, respectively. Thus, to set the end-of-line string to "carriage return, line feed," you would type:

```
!EOL 13,10<CR>
```

Similarly, to set the end-of-line string to be just "carriage return," you could type:

```
!EOL 13<CR>
```

If you omit the ASCII decimal equivalent in the EOL command, the terminal sets the end-of-line string to "carriage return." Thus,

```
!EOL<CR> and !EOL 13<CR>
```

have the same effect.

After setting the end-of-line string, you should examine the SYSTAT message to be sure that you have set it correctly.

```
!sys
TB= 2400 RB= 2400 DL=   0 LM= 1 RM=70 WL= 0 V#=3.0
TS=10 15 20 0 0 0 0 0 0 0 0 0 0 0 0
CC=! FS=␣ PR=? EL=␣ RS=␣ ␣ ␣ ␣
DU=F BU=N EC=R FF=Y SN=N KB=M CM=M PA=N
C0 0,100,100 C1 120, 50,100 C2 240, 50,100 C3 0, 50,100
C4 180, 50,100 C5 300, 50,100 C6 60, 50,100 C7 0, 0,100
```

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Figure 3-10. SYSTAT Indication of End-of-Line String.

COMMANDS

PROMPT STRING

If you use the terminal in buffered mode, you should be sure that the terminal and the computer agree on what characters comprise the "prompt string." The prompt string is the character or characters which the computer sends when it is ready for the terminal to send it another line of text. The prompt string must contain the last characters sent by the terminal.

You can specify any prompt string up to ten characters by naming the ASCII decimal equivalents of those characters in the PROMPT command. (You can find the ASCII decimal equivalent for any character in Table C-1 in Appendix C.) For instance, the ASCII decimal equivalents for "ampersand" and "line feed" are 38 and 10. To set the prompt string to "ampersand, line feed," type:

```
!PROMPT 38,10<CR> or !PRO 38,10<CR>
```

After setting the prompt string, you should check it by examining the "PR=" part of the SYSTAT message. The "non-printing" ASCII characters are represented in the SYSTAT message by two-letter mnemonics; the meanings of these mnemonics are given in Table C-2 of Appendix C.

Information on other forms of the PROMPT command can be found in the 4027A Programmer's Reference Manual.

REMOTE START STOP

Under certain circumstances, a host computer or the terminal may be limited as to the number of characters which can be received at a time, especially at high baud rates. When these conditions are known to exist, the terminal can be programmed to stop and restart transmission under host control, and if the host has the capability, the terminal can send characters to stop and resume host transmission.

To set the terminal to respond to host control of the data from the terminal to the host with default parameters of DC3 for stop and DC1 for start, type:

```
!RSS H<CR>
```

Where the host stop and start characters are other than DC3 and DC1, type:

```
!RSS H (ADE STOP) (ADE START)<CR>
```

To set the terminal to control the host, with the default parameters of DC3 for stop and DC1 for start, type:

```
!RSS T<CR>
```

To turn off the RSS control of the currently active device, type:

```
!RSS N<CR>
```

To set both the terminal and host control, with default parameters of DC3 for stop and DC1 for start, type:

```
!RSS B<CR>
```

To check the current status of the RSS control, type:

```
!RSS S<CR>
```

The terminal will respond with:

RSS CONTROL: OFF	if not active
RSS CONTROL: BOTH	if both active
RSS CONTROL: HOST	if host mode active
RSS CONTROL: TERMINAL	if terminal mode active

Section 4

OPERATING PROCEDURES

CAUTION

Do not place papers, books, etc. on the terminal's cabinet. Be especially careful not to cover the slits in the cabinet cover. These slits are needed to adequately ventilate internal components.

WHEN YOU TURN THE POWER ON

When you turn on the terminal, or when you begin working with it, you should familiarize yourself with its current settings.

1. Press SHIFT-STATUS to examine the status message. Check to see what the command character is.
2. Type a SYSTAT command to examine the SYSTAT message. Look especially for these things:
 - Whether a workspace is defined. ("WL= 0" if there is no workspace.)
 - Whether text from the keyboard is directed to the workspace ("KB= W") or to the monitor ("KB= M").
 - Whether text from the computer is directed to the workspace ("CM= W") or to the monitor ("CM= M").
 - Whether text from the computer is directed to the workspace ("CM= W") or to the monitor ("CM= M").

You should also check that the terminal is correctly set for talking to the computer. Check these parts of the SYSTAT message:

- The transmitting and receiving baud rates. (The "TB" and "RB" settings.)
- Whether the echo is remote ("EC= R") or local ("EC= L").
- Whether the prompt string and end-of-line string are their usual values. (The "PR" and "EL" settings.)

At the end of this manual is a table for recording the most important SYSTAT settings for future reference.

If a RESET or RAM ERROR message is displayed when you turn on power (or press MASTER RESET), refer to "If You get a RESET or RAM ERROR Message," later in this section.

USING THE WORKSPACE AND THE MONITOR

The workspace and the monitor each have their uses. Do not use the workspace to do things for which the monitor is designed, or vice versa.

Use the monitor to display general conversations with a computer time sharing system. For instance, when you first dial up a computer and "log in," you should direct text from both the keyboard and the computer to the monitor.

Use the workspace only to hold the particular text or form on which you are working. Don't use it to display general conversation with the computer; this will quickly exhaust the terminal's memory.

If you are filling out a form, the form will be in the workspace, so text from the keyboard should be directed to the workspace. If the computer is filling in some of the blanks in the form, text from the computer should be directed to the workspace. Should the computer send an error message, it will first send the MONITOR H command so that the error message is displayed in the monitor and does not overprint text in the workspace.

You can use the workspace to hold text which you are editing before sending it to the computer. However, if the text is lengthy, the terminal may run out of memory. If this happens, the text you type will overprint the last line of the workspace.

WHAT TO DO . . .

IF YOU GET A RESET OR RAM ERROR MESSAGE

When you turn on the terminal, or press MASTER RESET, the terminal checks its memory before displaying the cursor. If all is well, only the cursor will appear. However, if the check discloses a memory error, one of two messages will appear.

RESET

The RESET message indicates that the terminal has "forgotten" operating parameters such as the baud rate, command character, etc. (Normally, a battery-powered memory device "remembers" these settings when the terminal is turned off. Should the batteries run down, the settings would be "forgotten." In that case, the terminal resets the operating parameters to their original factory settings, and displays the RESET message.)

If the RESET message appears, press SHIFT-STATUS to see the command character. Then give a SYSTAT command and examine SYSTAT message. Compare each of the SYSTAT settings with the settings for your computer installation. (There is a table in the back of this manual in which to record your settings.) Then, by typing the appropriate commands, set these settings back to their proper values. It is particularly important to reset the transmitting and receiving baud rates, the

end-of-line string, and the command character. Once these are correct, the terminal can receive the settings for the other operating parameters from the computer.

RAM ERROR

The RAM ERROR message indicates that the terminal has detected a malfunction within itself. You should call your Tektronix Service Center to have the terminal repaired.

IF THE CHARACTERS TYPED ARE NOT DISPLAYED PROPERLY

If the characters you type are not displayed properly, you should examine the SYSTAT message. Check the "echo" setting and look to see where text from the keyboard and the computer is sent.

Displayed Not At All

If you are typing into the monitor rather than the workspace, it is possible that the characters you type may not be displayed. This is probably because neither the terminal nor the computer is providing the necessary "echo" of each character typed. The following are possibilities:

- You may not be connected to the computer. (You may have forgotten to dial its telephone number, or the telephone connection may be faulty.)

- The computer may not be set to echo the characters you type. In that case, you should type a command to the computer, telling it to provide this echo.
- Your computer installation may expect the terminal, rather than the computer, to provide the "echo" — and the terminal is set for "remote echo" rather than "local echo." If this is the case, type an ECHO L command:

```
IECHO L< CR>
```

Displayed Twice

If both terminal and computer are providing "echoes," the letters you type will appear twice on the screen. To remedy this, set the terminal for "remote echo," as follows:

```
IECHO R< CR>
```

Displayed in the Workspace When Typing Into the Monitor

If the computer is providing a "remote echo" for the characters you type, it is possible for these characters to appear in the workspace, even if you are typing into the monitor. Examine the SYSTAT message, and see if the following is the case:

- Text from the keyboard is directed to the monitor ("KB= M").
- Text coming over the communications line from the computer is directed to the workspace ("CM= W").
- The terminal is set for "remote echo" ("EC= R").

If this is the case, then each character that you type into the monitor is sent to the computer, which "echos" it — sends it back for display on the screen. The echoed character, coming from the computer rather than the keyboard is displayed in the workspace. To display the echoed characters in the monitor, type: |

```
MON H< CR>
```

This causes text from the computer to be directed to the monitor.

IF THE TERMINAL DOES NOT RESPOND TO COMMANDS

If the terminal does not respond to commands, check the following:

1. Check whether the COMMAND LOCKOUT light is on. If it is, press the COMMAND LOCKOUT key to turn it off.
2. Press SHIFT-STATUS, and examine the status message:
 - Is the command character what it should be? If you type commands using the exclamation point (!) when the command character is the ampersand (&), the terminal will not understand the commands. If the terminal is set to a different command character, you can use the COMMAND command to set it to. For instance, if the command character is the ampersand, you can change it to the exclamation point by typing this:

```
!COMMAND !< CR>
```

- Is the terminal in buffered mode? (If it is, the first letter of the status message will be B instead of U.) In buffered mode, the terminal cannot execute commands until it has emptied its transmit buffer — and it cannot empty the transmit buffer until it receives the necessary prompts from the computer.

You can break the terminal out of buffered mode, so that it will respond to commands, by pressing the BREAK key twice in quick succession. (This also sends a "break" signal to interrupt the computer.)

IN CASE OF DIFFICULTY

If the terminal settings are not what you expect them to be, you can easily become confused. In case of difficulty, then, press SHIFT-STATUS and examine the status message. Then, knowing the command character, type the SYSTAT command and examine the SYSTAT message. Often this message will give you a clue to the difficulty, since it displays almost all the terminal's settings.

If the difficulty persists, consult your computer systems analyst.

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Section 5

COLOR

The 4027A Color Graphics Terminal adds the dimension of color to its display of graphics and alphanumeric data. It can display up to eight colors at one time.

Through the use of color, the terminal provides four basic functions:

- Color provides coding for separating information.
- Color emphasizes important information.
- Color clearly defines patterns.
- Color adds appeal.

COLOR CONCEPTS

The color concept for the 4027A Color Graphics Terminal is expressed by the double-ended cone (Figure 5-1). The cone is sampled by seven planes which intersect the cone in circles. Each plane contains color mixtures. The sixty-four represented color mixtures are made from combinations of the three primary colors, red, green, and blue. (See Appendix A for a full color illustration.)

Color selection is specified by hue, lightness, and saturation which is called the HLS method. The definitions are as follows:

- Hue:** The quality of color which describes red, yellow, green, blue, etc. Hue is a gradation of color advanced by degrees thus represented as an angle from 0 to 360 in a color circle.
- Lightness:** The quality of color described by light, dark, etc., relating the color to a similar level of gray. Lightness is expressed as a parameter ranging from 0 to 100% along the axis of the cone, with black being 0% (bottom of cone) and white being 100% (top of cone). Each intersecting plane contains color mixtures of equal lightness. The purest colors, blue, magenta, red, yellow, green, cyan, etc. are at 50% lightness. Pastels will have more than 50% lightness, all darker color mixtures will have less than 50% lightness.
- Saturation:** The quality which describes the extent to which a color differs from a gray of the same lightness value. Saturation is the degree of dilution with gray, expressed in percentage. Saturation is a radial scale showing how far a color mixture is from the central axis of the cone. Shades of gray have 0% lightness and lie in the axis of the cone. Color mixtures with 100% saturation lie on the outer surface of the cone. The reddest reds, bluest blues, etc. have 100% saturation and 50% lightness.

Colors are arranged by hue in hue circle on each plane, by lightness from top to bottom, and by saturation according to distance out from the scale of grays making up the center column.

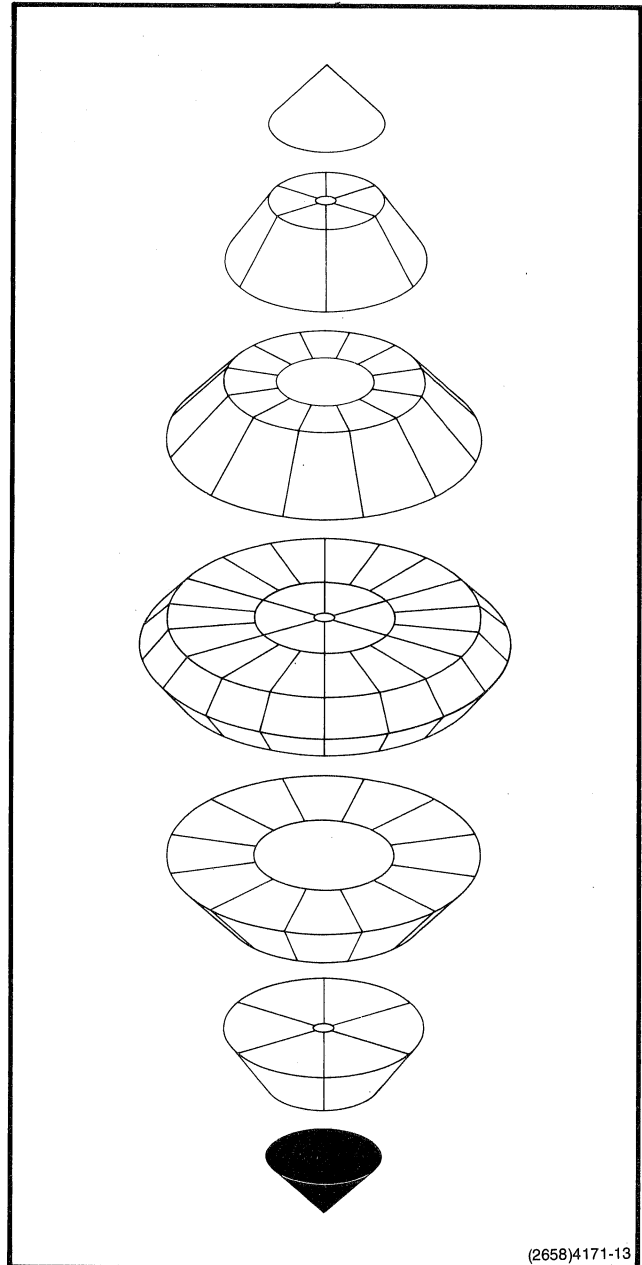


Figure 5-1. Double-Ended Color Cone.

(2658)4171-13

APPLICATION

All sixty-four color mixtures on the Color Cone are colors which can be produced on command. The parameters for hue, lightness and saturation are specified in the MAP command in this order; hue being an angle between 0 and 360 degrees, lightness and saturation being a percentage between 0 and 100 percent.

To locate a particular color mixture in this three dimensional cone, three numbers or "color coordinates" are used. These numbers describe three parameters of a color mixture: hue, lightness, and saturation.

Using blue as an example, the following parameters would apply: hue — 0 degrees, lightness — 50% and saturation — 100%. Therefore the terminal will produce a specified color provided the parameters are in proper order; blue — 0,50,100. (See Figure 5-2.)

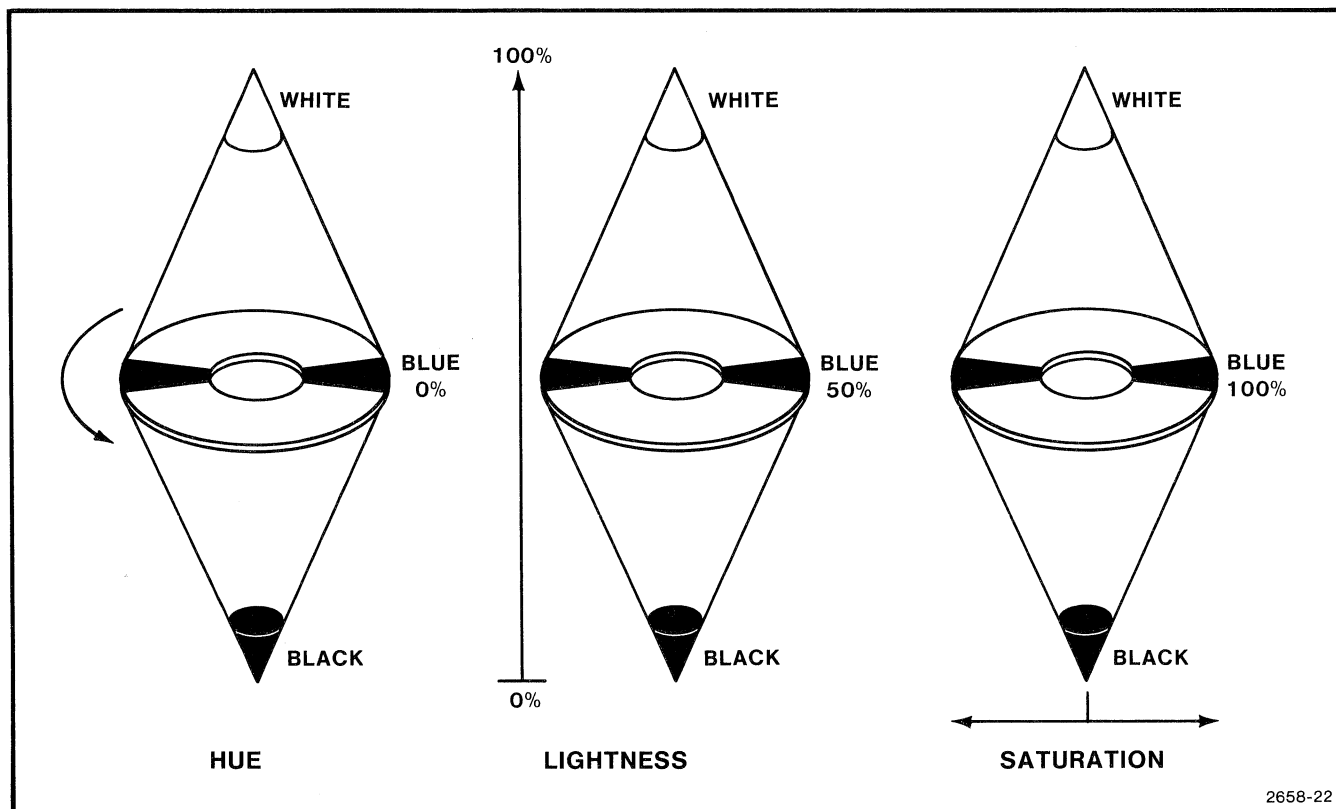


Figure 5-2. HLS Parameters for Blue.

COLOR

A better understanding of the color standard can be shown with a cross section of the double-ended cone (Figure 5-3). There are four gray planes which appear in the middle of the cone. At 0% saturation the four scales of gray are black, dark gray, light gray, and white. At any other value of saturation, different hues (color mixtures) are obtained. Hue has no effect at 0% saturation. A maximum of seven different "planes" of color can be obtained at any other value of saturation except 0%.

The lightness planes for the four gray scales with saturation at 0% are as follows:

- Lightness = 71-100% (white)
- Lightness = 43-70% (light gray)
- Lightness = 14-42% (dark gray)
- Lightness = 0-13% (black)

The eight colors which can be displayed are labelled C0-C7. The color assigned to each of these "color numbers" can be changed by command.

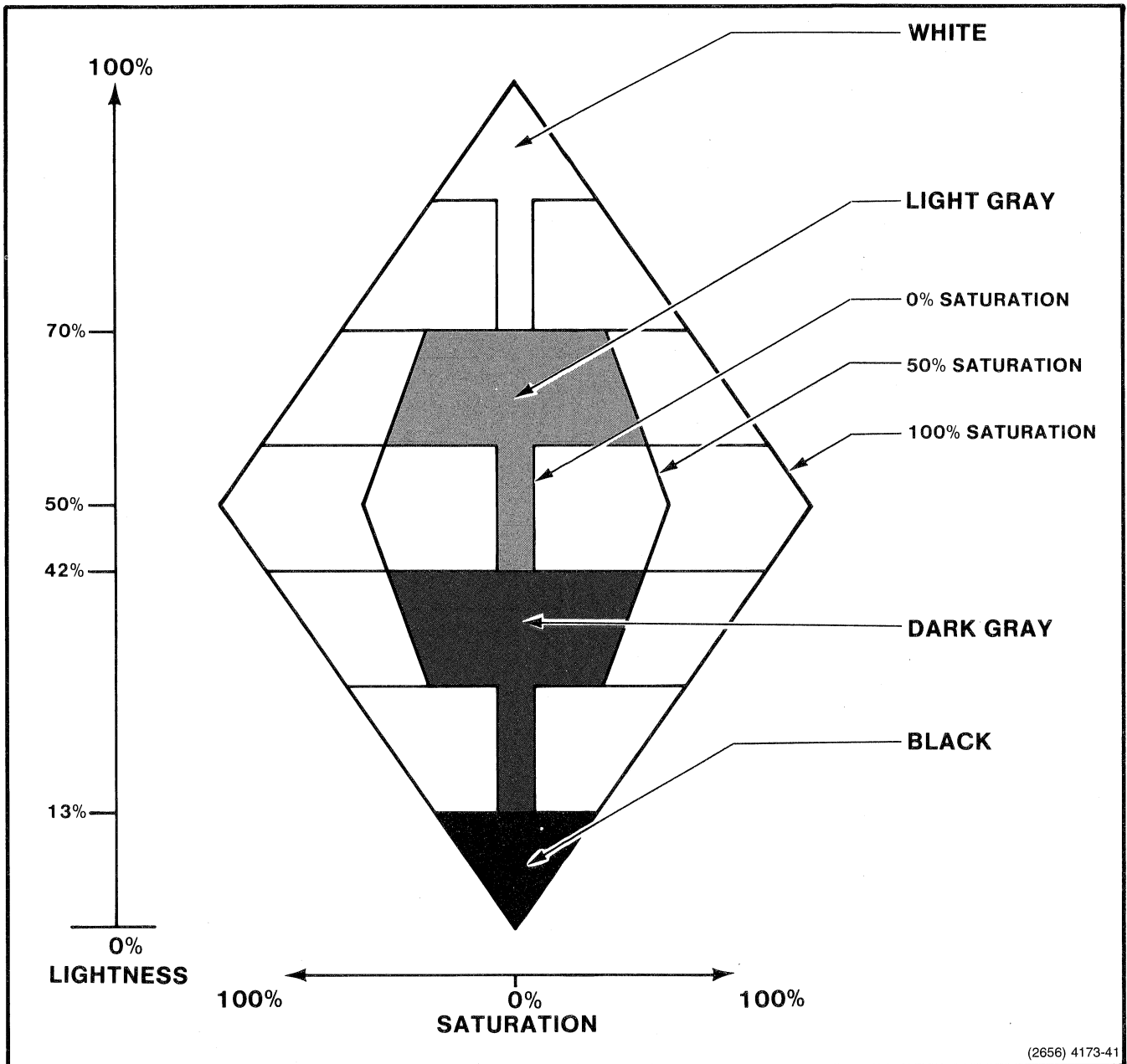


Figure 5-3. Cross Section of the Double-Ended Color Cone.

The eight colors (currently defined) and their HLS parameters are as follows:

C0 = White =	0,100,100
C1 = Red =	120,50,100
C2 = Green =	240,50,100
C3 = Blue =	0,50,100
C4 = Yellow =	180,50,100
C5 = Cyan =	300,50,100
C6 = Magenta =	60,50,100
C7 = Black =	0,0,100

NOTE

Portions of the color concepts from "Principles of Color Technology" are produced with permission of John Wiley & Sons, New York.

Commands in this section are:

- The COLOR command, which sets the desired color for graphic displays.
- The ERASE G command, which erases all lines drawn in the graphic area.
- The MAP command, which sets one of the eight color numbers to a specified color mixture by the HLS method.
- The RMAP command, which changes a color mixture by the amounts specified in the three color parameters.
- The MIX command, which sets one of the eight color numbers to a specified color mixture by the RGB method.

THE COLOR COMMAND

The COLOR command sets the current polygon (panel) and vector color. The second color number sets the outlining color for graphic displays.

For example,

```
!COL C1> CR>
!COL C1 C2< CR>
```

The COLOR command always precedes the command to which the color applies and remains in effect until another COLOR command is given. Color numbers are C0 through C7 which represent the eight current colors.

Exercise

Type these commands:

```
!WOR 30< CR>
!GRA 1,25< CR>
!COL C3< CR>
!POL 0,0,150,0,75,150< CR>
```

The first command sets up a workspace containing 30 rows. The second command sets up a graphic area, occupying rows 1 through 25, enabling you to display graphics. COLOR C3 states what color the fourth command, POLYGON, will be drawn and filled in with. Polygons will be discussed in Section 6, Graphics.

THE ERASE G COMMAND

The ERASE command with the parameter G (rather than M or W) erases all lines in the graphics area without affecting the rest of the workspace.

Type an ERASE G command:

!ERASE G<CR> or !ERA G<CR>

The terminal erases the lines you have drawn. If you wish, you may use the COLOR command (changing the color number) and the same POLYGON command as stated in the previous example; the graphic area itself has not been removed, just the lines drawn in it. (However, if you erase the workspace with the ERASE key or the ERASE W command, the graphic area is destroyed with the rest of the workspace contents.)

The graphics area can also be erased with a color or a pattern. (Patterns will be discussed in Section 6, Graphics.)

For example:

!ERA G C6<CR>
!ERA G P1<CR>

Experiment with erasing the graphics area with different colors. Remember that the eight color numbers are C0 through C7.

THE MAP COMMAND

The MAP command sets one of the eight color numbers to a specified color mixture by the HLS method. The eight color numbers can be mapped to any one of the sixty-four color mixtures. (See Appendix A.)

For example:

!MAP C1 0,50,100<CR>

Color C1 (default red) is mapped to a specified color by changing the HLS parameters. Hue — 0 degrees, lightness — 50%, and saturation 100%.

Exercise

Type these commands:

!ERA G<CR>
!MAP C1 100,50,10<CR>
!COL C1<CR>
!POL 0,0,150,0,75,150<CR>

Color 1 is changed to the color specified by the three HLS parameters given in the MAP command. The COLOR command sets the color for graphic displays. The POLYGON command displays the mapped version of Color 1. (Polygons will be discussed in Section 6, Graphics.)

After doing the example, type the SYSTAT command and notice that C1 (red) and the default parameters have been changed in memory. The last page of this manual allots space to record the eight default colors for reference.

To regain the default color, MAP the color back using the original parameters that you recorded in the back of this manual. If the terminal has been reset or turned off, the mapped color or colors are no longer effective. The SYSTAT message will display the default colors and their parameters.

By mapping C0 and C7, all black and white areas on the screen (workspace and monitor) are also mapped to the specified colors.

THE RMAP COMMAND

The RMAP command sets one of the color numbers to a specified color by using the HLS method. The three parameters are adjusted by adding or subtracting the values given in the command to those currently defining the color. Any or all of the parameters can be changed. A zero represents no change when used as one of the command parameter values.

For example:

```
IRMAP C1 0,-10,0<CR>
```

The color C1 is changed by (the second parameter) —10% lightness relative to the current lightness parameter.

Exercise

Type these commands:

```
!ERA G<CR>
!RMAP C3 0,30,-10<CR>
!COL C3<CR>
!POL 0,0,300,0,150,250<CR>
```

The second and third HLS parameters (lightness and saturation) of color C3 (default blue) are changed by 30% and —10% respectively. Hue remains unchanged. The third command sets the color for the POLYGON command. The POLYGON command displays the relative mapped color. Again, if the terminal is reset or turned off, the color defaults to its original HLS parameters. (Polygons will be discussed in section 6, Graphics.)

THE MIX COMMAND

The MIX command sets one of the color numbers to a specified color by the RGB method. This method mixes the red, green and blue primaries expressed in percentages (from 0-100) of the full intensity of the three colors. The MIX command assumes that the percentages will be given in the specified order; red, green, and blue.

For example:

```
IMIX C4 25,0,100<CR>
```

The color (C4) is mixed with 25% — red, 0%— green, and 100% — blue to create a shade of purple. Like the MAP and RMAP commands, if the terminal is turned off, the color number defaults to its original HLS parameters. Use of the MIX command sets the parameters for the specified color in the SYSTAT message to all zeroes, the HLS parameters are no longer correct.

Exercise

Type these commands:

```
!ERA G<CR>
!MIX C4 25,0,100<CR>
!COL C4<CR>
!POL 150,0,300,0,150,150<CR>
```

The second command mixes C4 to be a shade of purple, the COLOR command states that the POLYGON will be drawn in the mixed version of Color 4.

Experiment with the MIX command by using one of the POLYGON commands in the previous exercises. (Refer to Appendix A for color selection.)

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Section 6

GRAPHICS

The 4027A Color Graphics Terminal can create a graphics area in the workspace to draw colored polygons, pies, circles and graphs. The graphs can be made of solid lines or a variety of dashed lines. This section describes how to do this.

In addition, you (or the computer) can create additional character sets, or "fonts." In these fonts, you can specify any characters you choose, by telling the terminal how to draw them. (See the 4027A Programmer's Reference Manual.)

Topics in this section are:

- The GRAPHIC command, which sets up a graphics area in the workspace.
- The VECTOR command, which draws lines in the graphics area.
- The POLYGON command, which draws polygons in the graphics area.
- The PIE command, which draws pies in the graphics area.
- The CIRCLE command, which draws circles in the graphics area.
- The PATTERN command, which defines a pattern for use in pie and polygon filling and vector drawing.
- The LINE command, which specifies the type of line the VECTOR command can draw. Lines can be solid or dashed, or they can be "erase vectors" (invisible) which erase lines previously drawn.
- 4010-Style Graphics Commands, which provides a format acceptable to the terminal.

THE GRAPHIC COMMAND

The GRAPHIC command defines the boundaries of a "graphics area" in the workspace. This area is the "graph paper" on which polygons, pies and vectors are drawn. The following example illustrates the GRAPHIC command:

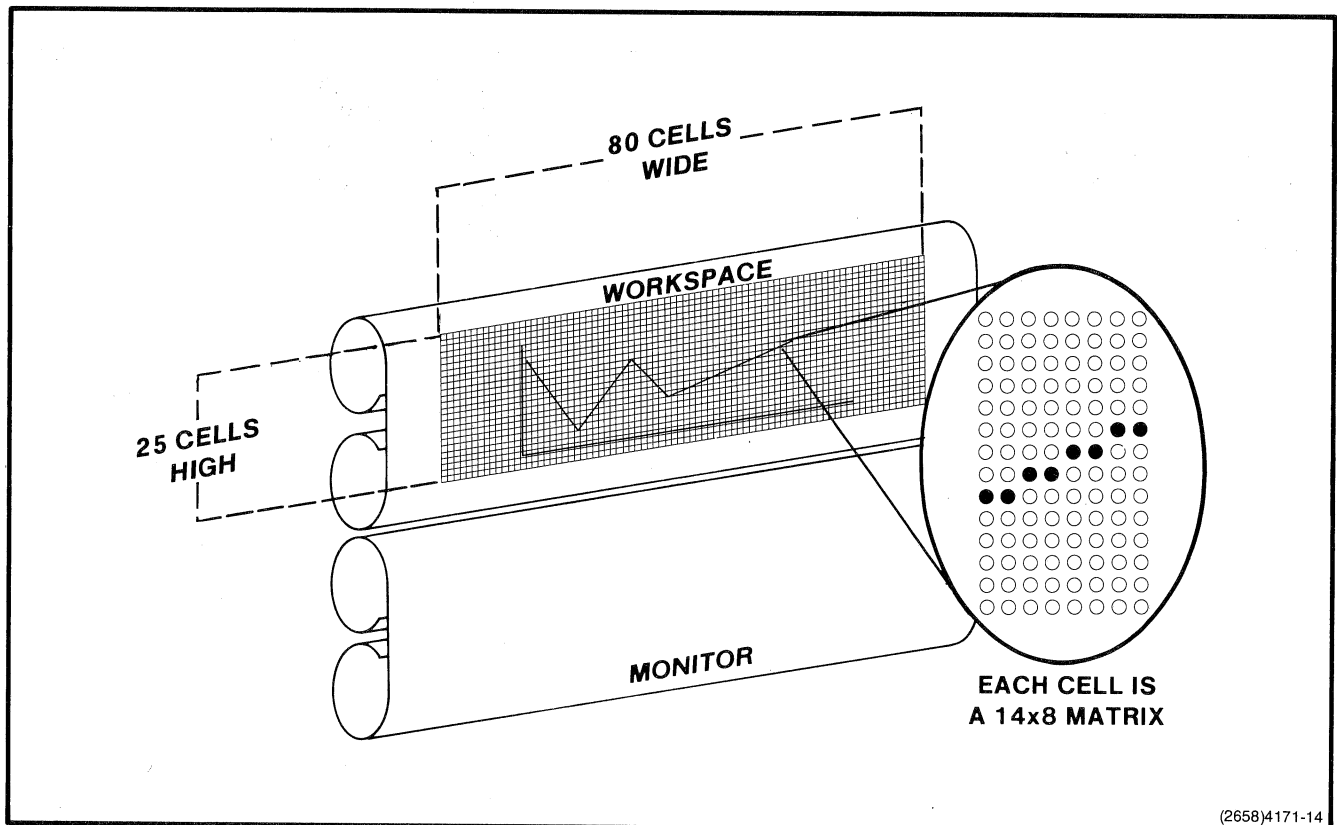
```
!GRA 1,25,1,80<CR>
```

This creates a graphics area which occupies (in the workspace) rows 1 through 25, columns 1 through 80. This graphics area, 80 cells wide and 25 cells high, holds 2000 character cells (Figure 6-1). Minimum number of rows is one, maximum is 53. Minimum number of columns is one, maximum is 80.

Each cell contains 112 "dot positions;" it is 8 dots wide and 14 dots high. Each dot can be turned on or off (displayed in colors). The VECTOR command draws lines by turning on patterns of these dots.

The columns of dots are numbered from left to right across the graphics area, starting with 0 for the leftmost column. In this example, the 640 columns of dots (80 cells, each 8 dots wide) are numbered from 0 to 639.

The graphics area has 350 rows of dots: it is 25 cells high, each cell 14 dots high. These rows are numbered from 0 to 349 from bottom to top.



Thus, for each dot in the graphics area, there is a pair of numbers: its X and Y-coordinates. The X-coordinate names the column in which the dot is located, and so gives its position from left to right across the graphics area. Likewise, the Y-coordinate gives the dot's vertical position. These coordinates are used in the POLYGON and VECTOR commands.

NOTE

Setting up two overlapping graphics areas may demand an erase of the workspace to restore the display. Overlapping graphics areas can cause the limit on information in one character row to be exceeded, creating undesired results on the display.

THE VECTOR COMMAND

The VECTOR command draws lines in the graphics area. Each VECTOR command names two or more points by their X- and Y-coordinates. The VECTOR command draws a series of line segments, starting at the first point, and passing through the other points named in the command.

For instance,

```
!VEC 0,0 10,10 50,100< CR>
```

means start at location (0,0) — the lower left corner — and draw a line to location (10,10). From there, draw a line to (50,100). (The parameters 0, 0, 10, 10, 50, 100 may be separated by either commas or spaces.)

Again, the command

```
!VEC 120,120 91,30 168,85 72,85 149,30
120,120< CR>
```

Start at (120,120) and draw a line to (91,30); from there draw a line to (168,85), and so on through points (72,85), (149,30), and (120,120). Figure 6-2 shows the effect of this command.

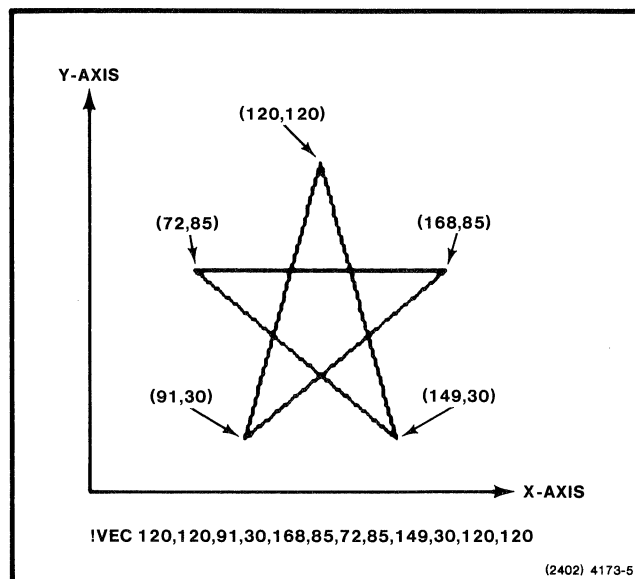


Figure 6-2. Effect of a VECTOR Command.

THE POLYGON COMMAND

The POLYGON command causes a colored panel (defined by the given X and Y-coordinates) to be drawn in the graphics area. The coordinates are designated as in the VECTOR command. If the last X and Y-coordinate is not the same as the first, then a closing edge is automatically created.

For example:

```
!POL 0,0,230,0,150,150< CR>
```

Starting at (0,0) it defines the outline with the given X and Y-coordinates and fills in the polygon with the appropriate color. If no COLOR command is given before the POLYGON command (as in the example), it will default to the previous color used. If the previous COLOR command had a second color number included, the outline of the polygon will be drawn in that color.

Type these commands:

```
!ERA G< CR>
!COL C5< CR>
!POL 75,0,375,0,375,150,75,150< CR>
```

The first command erases the graphics area, the COLOR command sets the color for the POLYGON command.

THE PIE COMMAND

The PIE command creates a circular polygon to be drawn around the current graphic cursor position. The PIE command has the following form:

```
!PIE <radius> <start angle> <end angle>
<increment angle> <CR>
```

The radius of the pie is set by the first parameter while the next two parameters determine (in degrees) the boundaries of the pie slice to be drawn. If the <start angle> does not equal the <end angle> then the polygon is drawn to the center point, giving a pie slice sector. The graphic beam is left at the center point. (The 0 degree line is a horizontal line extending to the right from the center point of the polygon. Angles are read counterclockwise from this line.) The increment angle is a positive integer which represents the angle between points on the circumference that become vertices of a polygon.

For example:

```
!PIE 100,45,360<CR>
```

The radius of the pie is given in 100 dots (screen units). The area of the pie to be filled in is from 45 degrees to 360 degrees, which creates a pie slice sector.

Type these commands:

```
!ERA G C1<CR>
!COL C2<CR>
!PIE 125,90,270<CR>
```

The first command erases the graphics area in Color 1, the COLOR command sets the color for the PIE command. The radius of the pie is 125 dots (screen units) with the start angle at 90 degrees and the end angle at 270 degrees, giving a 1/2 pie shape.

NOTE

When you are working in the graphics area, the crosshair key (+) in the numeric key pad may be used to display the crosshair for positioning of circles and pies. By pressing the crosshair key, while in the graphics area, the crosshair will appear and can be positioned with the four arrow keys in the numeric key pad.

After you position the crosshair, any key other than the four crosshair movement keys will lock the crosshair in position. To remove the crosshair from the graphic area, press the (0) key. The effect of the crosshair key is the same as the ENABLE and DISABLE commands. (See the 4027A Programmer's Reference Manual.)

THE CIRCLE COMMAND

The CIRCLE command causes a polygon to be drawn around the current graphic cursor position. The CIRCLE command has the following form:

```
!CIRCLE <radius> <start angle> <end angle>
<increment angle> <CR>
```

The radius of the circle is set by the first parameter. The next two parameters (optional) are angles of degrees to create an open circle effect. The increment angle is a positive integer which represents the number of degrees between the vertices of the polygon. The CIRCLE command will only outline, not fill in the polygon.

For example, the command:

```
!CIR 100<CR>
```

draws an outline of a circle with a radius of 100 dots (screen units).

When in the graphics area, press the crosshair key (in the numeric key pad) to set the crosshair in the middle of the graphics area and lock it in before doing the following exercise.

Type these commands:

```
!COL C2<CR>
!CIR 75,45,360<CR>
```


These commands draw an outline of a partial circle with a radius of 75 dots (screen units) with the < start angle> at 45 degrees and the < end angle> at 360 degrees in Color 2.

Notice that PIE and CIRCLE commands will draw over information already in the graphics area. Erase the graphics area and type the above commands again.

NOTE

For PIE and CIRCLE commands there is a fourth parameter. It is the existence of this parameter (increment) which necessitates the use of the word "polygon" rather than circle or pie. If the (increment angle) is given, the PIE or CIRCLE command will create a polygon with vertices every < increment angle> degrees. The default value for < increment angle> is 4 degrees. (See the 4027A Programmer's Reference Manual for additional information.)

THE PATTERN COMMAND

The PATTERN command defines a user definable pattern for use in vector drawing and polygon filling. Up to 120 patterns (labeled P0 to P119) can be generated.

For example:

```
!PAT P1 C3 C6 0,0,0,0,60,60,60,60,60,0,0,0,0< CR>
```

This command generates pattern P1. Color 3 will be the background color and all the dots not specified in the command are set to that color. The remainder of the command consists of specific dots that are to be Color 6, the foreground color. Dots are specified by integers whose binary representations are masks of the dots to be turned on in a given row, as in the SYMBOL command. (See SYMBOL command in The 4027A Programmer's Reference Manual.)

Exercise

Type in the above PATTERN command. Then type:

```
!ERA G P1< CR>
```

The terminal erases the graphic area with pattern P1.

Type these commands:

```
!PAT P2 C1 C2 0,15,30,0,15,30,0,15,30,0,15,30< CR>
!COL P2< CR>
!POL 0,0,400,0,200,200< CR>
```

A second pattern (P2) has been generated in Color 1 and Color 2. The COLOR command states that pattern 2 will be displayed in the graphics area. The POLYGON command defines the panel in which P2 will be displayed.

Notice that the second PATTERN command has twelve dot parameters. (The bottom two rows of dots will be Color 2, the background color.) A maximum of fourteen dot parameters can be specified in generating a pattern.

THE LINE COMMAND

The LINE command specifies the type of lines that subsequent VECTOR commands will draw.

Exercise

Type these commands:

```
!ERA G< CR>
!LIN 2< CR>
!VEC 0,0 100,100< CR>
!VEC 0,0 200,100< CR>
!LIN 1< CR>
!VEC 0,0 150,100< CR>
```

The ERASE G command erases all previously drawn lines from the graphics area. The LINE 2 command then sets the line type to type 2 (a dashed line), and the two VECTOR commands draw two of these dashed lines. The second LINE command sets the line type back to type 1 (solid line); the final VECTOR command draws a solid line.

There are ten line types, which you may specify in the line command with the numbers 1 through 8, or the letters E and P. If no numbers or letters are specified, line type 1 is assumed — a solid line. Line types 2 through 8 are different styles of dashed lines, shown in Figure 6-3.

If you specify line type E in a LINE command, the VECTOR commands that follow draw erase vectors. These erase vectors are invisible; they do not draw lines, but instead erase any lines in their paths. You can erase previously drawn lines by drawing over them with erase vectors.

If you specify line type P in a LINE command, any VECTOR commands that follow do not draw lines, but only plot points. For instance, the commands

```
!LIN P< CR>
!VEC 0,0,50,50,100,100< CR>
```

set the line type to P and turn on dots at the points (50,50) and (100,100). The VECTOR command states, "Move from (0,0) to (50,50) and plot a point there; then move to (100,100) and plot another point."

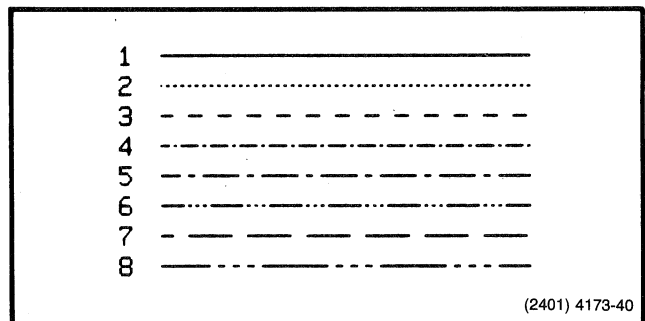


Figure 6-3. Line Types.

4010-STYLE GRAPHICS COMMANDS

The terminal will accept graphics commands given in the format used by TEKTRONIX 4010 Series terminals. This format is discussed in the 4027A Programmer's Reference Manual.

You can use the following commands to set the terminal to respond properly to 4010-style commands:

```
!GRAPHIC 1,35 <CR>
!SHRINK <CR>
```

(The GRAPHIC command sets up a graphics area which is the right shape for holding a 4010-style graphic display. The SHRINK command accomodates the terminal to the dimensions of a 4010-style graphic display; this command is described in the 4027A Programmer's Reference Manual.)

Once you have given the terminal the GRAPHIC 1,35 and SHRINK commands, you may send it graphic commands like those used for the 4010 Series terminals. The terminal may, however, run out of graphic memory if the picture it is asked to display has too many lines. If this happens, the terminal will display as much of the picture as its memory allows.

THE DELETE/IGNORE PAD COMMAND

The terminal has the capability of ignoring the delete character (ADE 127), as controlled by the PAD command. By ignoring the delete characters, the terminal can display 4010-style graphics from comput-

ers which randomly output delete characters. The PAD command is described in the 4027A Programmer's Reference Manual.

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Section 7

CREATING FORMS

This Section describes how to create a "form" in the workspace, with blanks that either you or the computer can fill in. Topics included are:

- General overview: form fillout mode, creating a form.
- Basic concepts: lines and fields, the display list, attribute codes.
- The ATTRIBUTE command: how it affects the display list.
- Visual attributes: colors used to display text and blinking between two different colors, etc.
- Logical attributes: protected and unprotected fields, and the alphanumeric and numeric types of unprotected fields.
- Character set attributes: alternate character fonts.
- Rulings: drawing vertical and horizontal lines on a form.

GENERAL OVERVIEW

Creating a form consists of attaching properties ("attributes") to parts of the workspace. The process is as follows:

1. With the terminal not in form fillout mode use the ATTRIBUTE command to create the form. (The ATTRIBUTE command is described later in this section.)
2. By means of a FORM or FORM YES command, put the terminal into form fillout mode.

Once you have created the form, you can use it: fill in the blanks, send the contents of the blanks to the computer, etc. The special properties of forms, and of form fillout mode, are described in Section 3, under "Form Fillout Mode."

When you have finished using the form, you would usually:

1. Remove the terminal from form fillout mode with a FORM NO command.
2. Erase the workspace and use it for something else.

NOTE

The ATTRIBUTE command, used to create forms, has no effect when the terminal is in form fillout mode. Therefore, one must always create a form with the terminal not in form fillout mode, and then put it into form fillout mode with a FORM or FORM YES command.

Also, in form fillout mode, certain parts of the form are protected from being erased or written over. Therefore, in order to erase a form, one must always remove the terminal from form fillout mode.

BASIC CONCEPTS

LINES AND FIELDS

Each line consists of one or more "fields," which are subdivided into the individual characters of text.

Figure 7-1 shows the parts of a typical form. A form consists of several "lines" of text in the workspace.

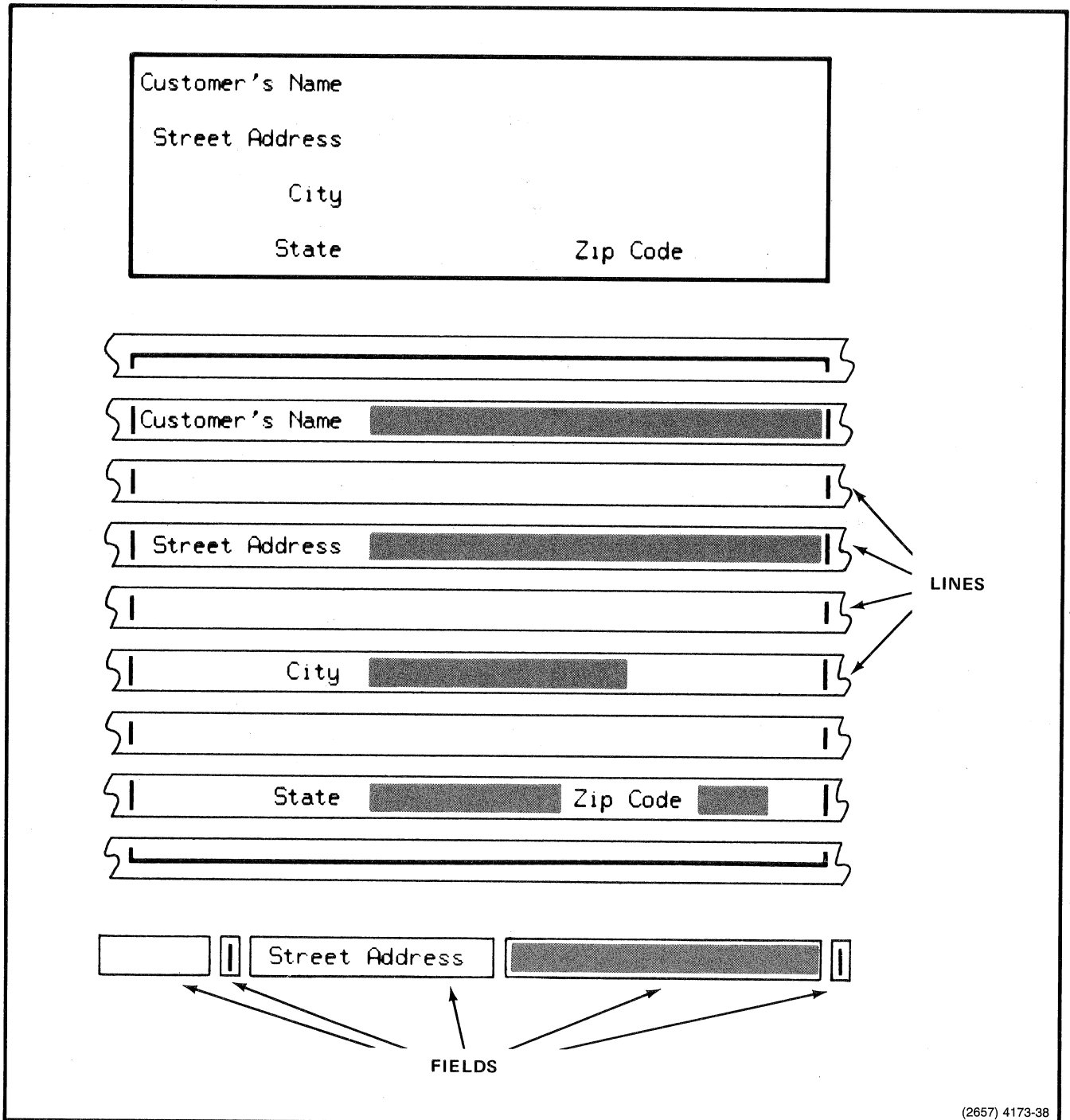


Figure 7-1. The Parts of a Typical Form.

THE DISPLAY LIST AND ATTRIBUTE CODES

To display text in the workspace, the terminal must store that text in a part of its memory reserved for the workspace scroll. This part of memory is called the workspace "display list." In addition to characters actually displayed on the screen, the display list includes markers which are not displayed. These markers are of two types:

- Markers indicating where one line of text ends and the next begins.
- Markers, called "attribute codes," that divide a line into fields and determine the properties (attributes) of those fields. (Figure 7-2.)

Field attributes are of three types:

- Visual attributes: standard, inverted, C1, C2, blinking between C5 and C6, etc.
- Logical attributes: alphanumeric, numeric, and protected.
- Character font attributes: font zero, font one, font two, etc.

The terminal scans the display list from left to right across each line. When it encounters an attribute code, it starts a new field. It may also change one or more of the attributes in effect, as called for by that attribute code. Each line starts with the "default" attributes: standard visual attribute, alphanumeric logical attribute, and font zero character font attribute.

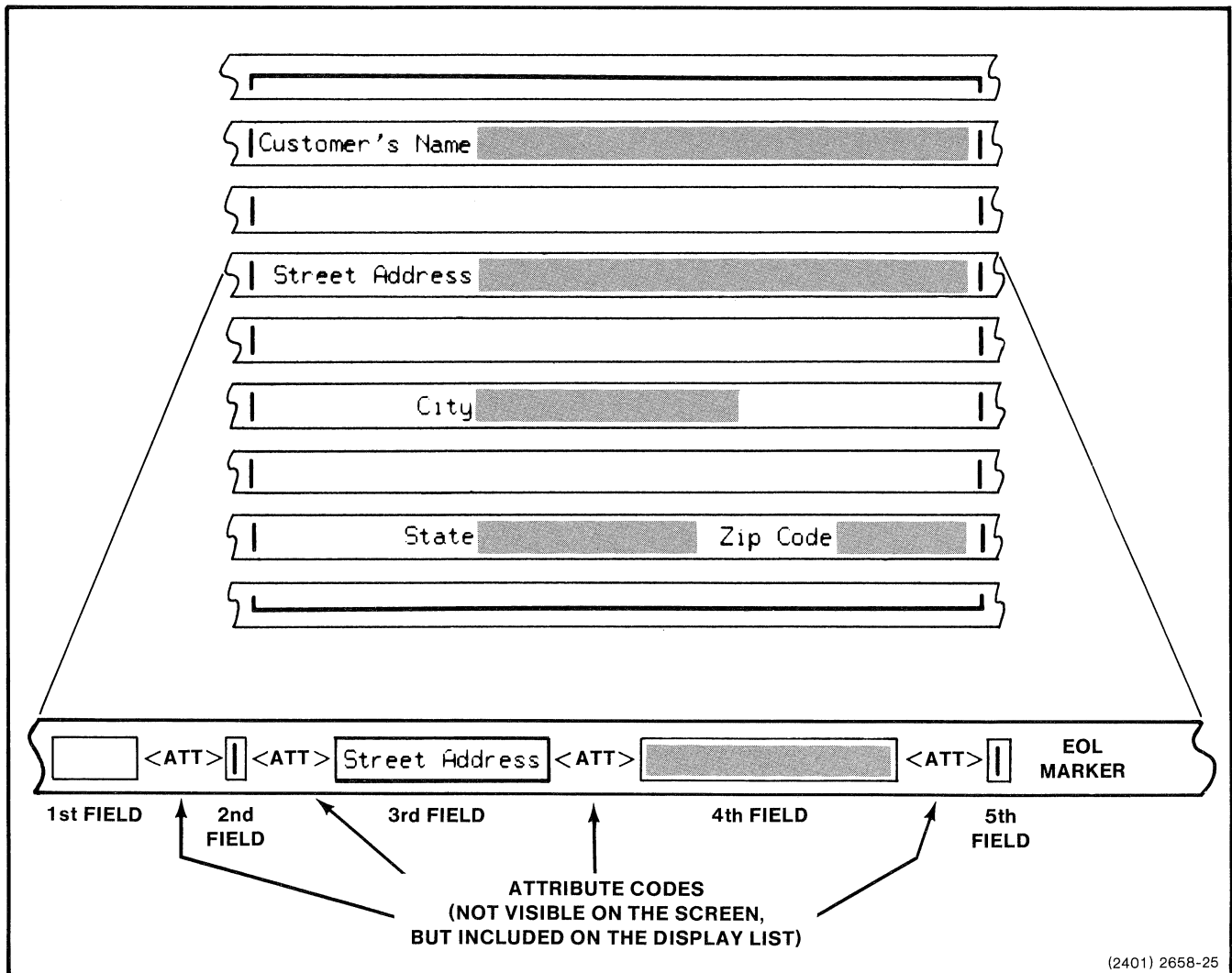


Figure 7-2. Position of Attribute Codes in a Display List.

CREATING FORMS

If an attribute code specifies a visual attribute, the fields to its right will have that visual attribute — until another attribute code changes the visual attribute or the next line begins. However, the logical and character font attributes do not change unless the attribute code also specifies new logical or character font attributes.

Similarly, the logical attribute may change without affecting the visual or character font attributes, and a character font attribute may change without affecting visual or logical attributes.

Figure 7-3 illustrates the process. As the terminal scans the display list, it begins the line with the default attributes. The first attribute code changes the visual attribute to color C2, but does not affect the logical or character font attributes. The second attribute code changes the visual attribute to color C4, and the logical attribute to protected.

THE ATTRIBUTE COMMAND

As stated earlier in this section, creating a form consists of attaching attributes to parts of the workspace. This may now be restated with more precision: you create forms by using the ATTRIBUTE command to insert field attribute codes into the display list.

To see how the ATTRIBUTE command works, do the following exercise:

1. First, define a workspace, if one is not already defined. (See "Defining a Workspace" in Section 3.) Direct the keyboard to type into that workspace. (See "Directing Text to the Workspace or the Monitor," in Section 3.)

2. Erase the workspace, and type the following text:
The quick brown fox jumped over the lazy dog's back.
3. Move the cursor to the letter "q" that starts the second word of the test sentence. (Use the cursor control keys.)
4. Type the ATTRIBUTE C2 command:

```
!ATTRIBUTE C2<CR> or !ATT C2<CR>
```

You have now divided the line into two fields. The first field has the standard visual attribute (Color 0 on Color 7), while the second field, starting with the word "quick," has the C2 visual attribute (Color 2 on Color 7). Visual attributes are displayed on the screen as color attributes.

5. Move the cursor to the start of the word "brown," and type the ATTRIBUTE I command:

```
!ATTRIBUTE I<CR> or !ATT I<CR>
```

Now the line is divided into three fields. The first field has the standard visual attribute (Color 0 on color 7), the second field the C2 visual attribute (Color 2 on Color 7) and the third field the inverted visual attribute (Color 7 on Color 0).

When you typed the ATTRIBUTE commands, you inserted attribute codes into the display list. The first ATTRIBUTE command, typed when the workspace's cursor was at the start of the word "quick", inserted an attribute code just before that word. Likewise, the second ATTRIBUTE command inserted an attribute code just before the word "brown."

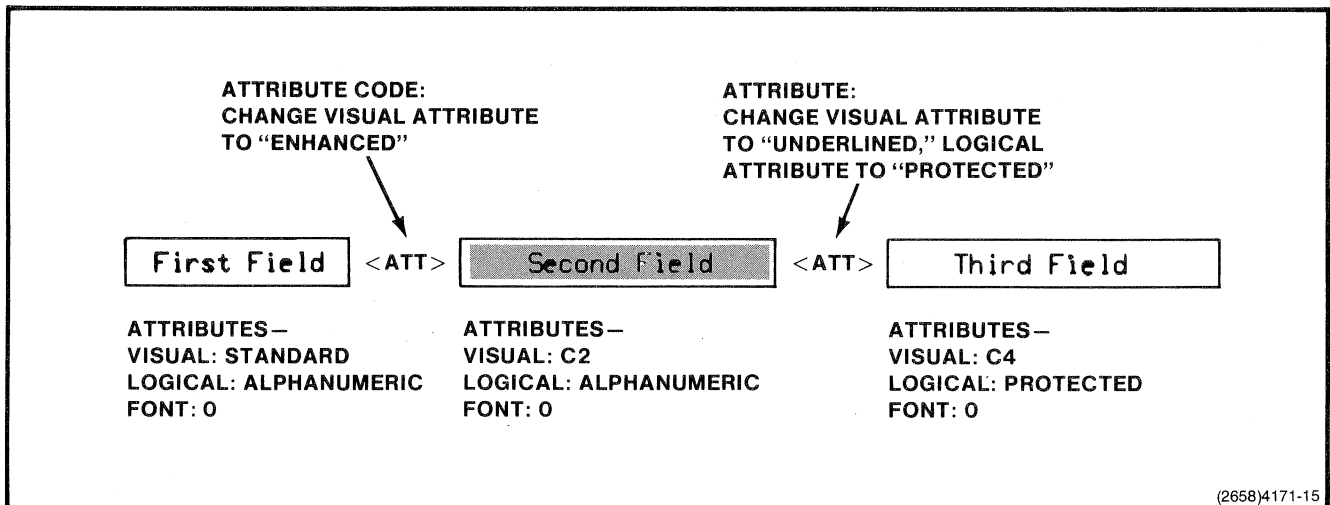


Figure 7-3. Effect of Field Attribute Codes.

We may summarize the previous exercise as follows —

To insert an attribute code into the display list:

1. Move the cursor (with the cursor control keys) to the place in the workspace where you want to put the attribute code.
2. Type the appropriate ATTRIBUTE command on the keyboard.

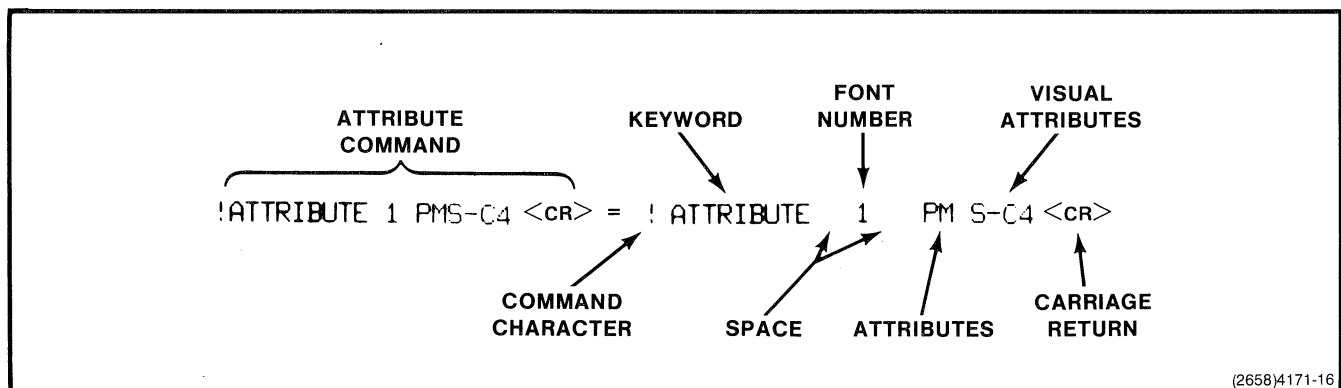
Syntax

Figure 7-4 illustrates the format, or “syntax” of the ATTRIBUTE command.

There are eight possible parts to an ATTRIBUTE command, some of which are optional:

- The command character (required).
- Immediately after the command character, the word ATTRIBUTE (required). It may be abbreviated to its first three letters. No spaces are allowed between the command character and the keyword.
- A space (required) to separate the keyword from the parameters to follow.
- A number (optional) to designate which of several character fonts is to be used in the field to follow. (This will be discussed later, under “Alternate Character Sets.”)
- A space (optional) to separate the number designating the character font from the parameters to follow.
- One or more letters (optional) to designate logical attributes.
- One or more letters (optional) or a color number to designate visual attributes. No spaces are allowed between the characters designating logical and visual attributes.
- A carriage return to mark the end of the command. (A “terminator” to end the command is required; carriage return is one such terminator. The 4027A Programmer’s Reference Manual describes other possible terminators.)

Now that the general syntax of the ATTRIBUTE command has been discussed, let’s examine the visual, logical, and character font attributes in more detail.



(2658)4171-16

Figure 7-4. Parts of the ATTRIBUTE Command.

VISUAL ATTRIBUTES

A field's visual attributes determine how it is displayed on the screen. The default visual attribute is "standard." The standard attribute displays characters in Color C0 on a background of Color C7. Color attributes are specified by color numbers or letters. Other color attributes are "I," "E," and "U." These attributes may be used alone or in combination. (Refer to the Visual Attribute Chart later in this section.)

STANDARD

The standard attribute is the absence of the other three visual attributes. It is denoted by the letter S in the ATTRIBUTE command. Since standard is the default visual attribute (Color 0 on Color 7), you don't need an ATTRIBUTE command to designate the first field of a line as standard.

COLOR

The color visual attribute displays a colored field designated by the color number. The color attribute enables the user to select the desired color displayed. For example:

```
!ATT C4<CR>
```

Exercise

Move the cursor down a few lines in the workspace and type the test sentence:

The quick brown fox jumped over the lazy dog's back.

Now move the cursor to the start of the word "quick," and type an ATTRIBUTE C2 command:

```
!ATTRIBUTE C2<CR> or !ATT C2<CR>
```

Move the cursor to the start of the word "brown," and type an ATTRIBUTE C4 command:

```
!ATTRIBUTE C4<CR> or !ATT C4<CR>
```

The two attribute codes you inserted divide the line into three fields. The first field has the standard visual attribute, since each line starts with the default attributes unless you specify differently with an ATTRIBUTE command at the start of the line. The second field has the color C2 attribute. The third field has the color C4 attribute.

INVERTED

The inverted visual attribute displays a field with (default colors) C7 on a C0 background, rather than C0 characters on a C7 background. Inverted is designated by the letter I in the ATTRIBUTE command. The I attribute inverts the two colors used for displaying text. The background color becomes the color in which the text is displayed, while the color used for characters now becomes the background color.

Exercise

Experiment with the ATTRIBUTE I command: Move the cursor to a likely spot in the text in the workspace, and then type:

```
!ATT I<CR>
```

NOTE

For compatibility of host programs written for the TEKTRONIX 4025A Computer Display Terminal, the 4027A recognizes E and U attributes. Attribute E is the same as attribute C2 (Color C2 displayed on a background of Color C7). Similarly, attribute U is the same as attribute C4 (Color C4 on a background of Color C7). In the 4025A, the letters E and U represent enhanced background and underlined text. The 4027A does not have enhanced backgrounds or underlines; it uses colors instead.

BLINKING BETWEEN VISUAL ATTRIBUTES

You can set up a field which "blinks," or alternates, between two visual attributes or sets of visual attributes. To do this, specify both visual attributes (or sets of visual attributes) in the ATTRIBUTE command, and separate them with a hyphen, as follows:

```
!ATT C2-C3< CR>
!ATT S-I< CR>
!ATT IC1-IC2< CR>
!ATT S-C1< CR>
```

The first of these examples defines a field which alternates between C2 and C3. The second example makes a field alternate between standard and inverted, while the third example defines a field which blinks between inverted with C1 and inverted with C2. The fourth example defines a field which alternates between standard and C1.

The blinking attribute can not be displayed in the graphics area, only in the workspace outside any graphics area.

The Visual Attribute Chart states the colors that will be displayed when using the color attributes:

VISUAL ATTRIBUTE CHART

Attributes	Colors
S= Standard	Color 0 on Color 7
E= Enhanced	Color 2 on Color 7
I= Inverted	Color 7 on Color 0
U= Underscored	Color 4 on Color 7

Combined Attributes

```
EU= Color 6 on Color 7
EI= Color 7 on Color 2
IU= Color 7 on Color 4
EIU= Color 7 on Color 6
```

LOGICAL ATTRIBUTES

It is the logical attributes of fields in a form which make the form behave as a form, rather than just a collection of words in the workspace.

Logical attributes have effect only when the terminal is in form fillout mode. (You create the form with the terminal not in form fillout mode, and then put it into form fillout mode with a FORM YES command.) With the terminal in form fillout mode, fields have the following logical properties:

- Those fields with protected logical attributes act as the "permanent" parts of the form. That is, they are the parts which remain the same each time the form is filled out.
- Those fields with unprotected logical attributes comprise the form's blanks. These are the blanks into which you type when filling out the form.

You can specify four different logical attributes in ATTRIBUTE commands: the alphanumeric, numeric, protected, and modified attributes. The first two of these specify different kinds of unprotected fields. The protected attribute sets up protected fields. Modified is an additional attribute which you may give to fields which you have already designated protected.

ALPHANUMERIC

The first logical attribute is called alphanumeric unprotected, or alphanumeric for short. You can type any text into alphanumeric fields. Such fields are used as the blanks of a form.

Alphanumeric is the default logical attribute. That is, each line starts with an alphanumeric field, unless you specify otherwise with an ATTRIBUTE command. The alphanumeric attribute remains in effect until the first field whose attribute code specifies a different logical attribute.

In the ATTRIBUTE command, the letter A designates an alphanumeric field. For example, these two commands set up alphanumeric fields:

```
!ATTRIBUTE A< CR>
!ATT AC2< CR>
```

The first command sets only the logical attribute of the field it defines; that field will share the visual attributes of the preceding field in its line. The second command sets up an alphanumeric field and defines that field's visual attribute to be C2.

CREATING FORMS

NUMERIC

The second logical attribute is numeric unprotected, or numeric for short. Like alphanumeric fields, numeric fields are used for the blanks of a form. The difference is that numeric fields will not accept letters of the alphabet. You can type numbers and certain special symbols into a numeric field, but not letters.

In an `ATTRIBUTE` command, the letter `N` designates a numeric field. For instance, these commands set up numeric fields:

```
!ATTRIBUTE N< CR>  
!ATT NC4< CR>
```

The first of these examples sets up a numeric field, but does not specify the visual attributes of that field. The field will share the visual attributes of the preceding field in its line.

The second example defines a numeric field with the `C4` visual attribute.

PROTECTED

The protected logical attribute designates the "permanent" fields of a form. These are the fields into which you cannot type with the terminal in form fillout mode.

In an `ATTRIBUTE` command, the letter `P` designates a protected field. For instance, these commands set up protected fields:

```
!ATTRIBUTE P< CR>  
!ATT PC2< CR>  
!ATT PI-C5< CR>
```

The first example sets only the logical attribute of the field it defines. That field shares the visual attributes of the preceding field in its line.

The second example defines a protected field with the `C2` visual attribute, while the third example sets up a protected field which blinks between the inverted and `C5` visual attributes.

MODIFIED

Modified is an additional attribute which you can attach to a protected field. (There is no benefit to specifying an unprotected field as modified, although there is nothing to prevent you from doing so. An unprotected field is modified only by changing its contents.)

The modified attribute affects how a field is treated when the terminal executes a `SEND MOD` command. In form fillout mode, `SEND MOD` sends to the computer the contents of only those blanks whose contents have been modified. Ordinarily, this is text from unprotected fields whose contents have not already been sent to the computer. However, you can also designate protected fields as modified, so that their contents will also be sent during a `SEND MOD` operation.

To designate a protected field as modified, use the letter `M` in the `ATTRIBUTE` command that sets up the field. For instance, these commands define fields with the modified logical attribute:

```
!ATTRIBUTE PM< CR>  
!ATT PMS-C6< CR>  
!ATT M< CR>
```

In the first example, the `ATTRIBUTE` command sets up a protected field which is tagged as modified for future `SEND MOD` operations. Since the command does not specify the visual attributes, this field shares the visual attributes of the preceding field on its line.

The second example sets up a protected field, labels it modified for `SEND MOD` operations, and causes it to be displayed as blinking between standard (`Color 0`) and `Color C6`.

The third example sets up a new field and attaches the modified label for `SEND MOD` operations. The field shares the other logical and visual attributes of the preceding field in its line. If the preceding field is protected, then this field will be protected also; if the preceding field is displayed with blinking between standard and `C6`, this field will blink between standard and `C6`.

(See the 4027A Programmer's Reference Manual for more information on the modified logical attribute and the `SEND MOD` command.)

ALTERNATE CHARACTER SETS

The terminal can display characters of alternate alphabets in its workspace. Besides the ordinary English alphabet, there are rulings characters (Option 32), math characters (Option 34), and others. You can create new alphabets by telling the terminal how to draw the characters of those alphabets. (See SYMBOL command.)

The different character sets, or "fonts," are numbered. Font 0 is always the standard character set. The rulings characters, if installed, comprise Font 1; other fonts have different numbers.

The attribute code starting a field may name the character font for that field, as well as the logical and visual attributes. Each line starts with Font 0, the standard character set. To switch to another font, an attribute code naming that font is needed.

To name a character font, give the font number in the ATTRIBUTE command:

```
!ATTRIBUTE 1<CR>
!ATT 0<CR>
!ATT 2 PC2<CR>
```

The first example specifies Font 1, the rulings font. (The characters of the rulings font are used to draw vertical and horizontal lines on a form. They are discussed later in this section, under "Drawing Rulings.")

The second example names Font 0, the standard character set. (Font 0 is the default font; each line in the workspace starts out with Font 0, unless another font is specified with an ATTRIBUTE command at the start of the line.)

The third example specifies Font 2. This command also specifies the protected and C2 attributes for the field it defines.

NOTE

Font 31 is reserved for storing user defined patterns. The use of 31 in the FONT command is illegal. If Font 31 is used in a FONT command an error condition will occur. The only way to recover from the error is to press the RESET button on the terminal. This destroys any text or forms you have created.

RULINGS

As mentioned earlier, one of the alternate character sets is the rulings set (Option 32). The rulings characters are used to place horizontal and vertical lines in a form, and to join those lines.

The rulings characters, if installed, are Font 1. (The standard character set is Font 0.) One way to see the rulings characters is to define a field using Font 1, and then type the letters of the alphabet into that field. For each letter, a corresponding rulings character is displayed.

Exercise

If you have not already done so, define a workspace and set the keyboard to type into that workspace. Move the cursor to the start of a new line, and type an ATTRIBUTE 1 command. For instance, if the command character is the exclamation point (!), type:

```
!ATTRIBUTE 1<CR> or !ATT 1<CR>
```

Then type the letters of the alphabet. As you type each letter, the corresponding rulings character will appear. (If the rulings character set is not installed, you will see blanks — character cells in which no dots are turned on.)

Move the cursor to another line, and type the alphabet again. Then move the cursor back to the start of the line, and type another ATTRIBUTE 1 command. Notice that the display changes from the standard character set to the rulings character set.

You can change back to the standard character set with an ATTRIBUTE 0 command, since the standard character set is Font 0.

DRAWING RULINGS

The easiest way to draw rulings is by means of the rulings commands, VRULE and HRULE. In each command, you define the line to be drawn (in the workspace) by specifying four numbers:

- The first number in the command tells the terminal at which line of the workspace to begin the ruling.
- The second number specifies at which character position in that line to put the first rulings character.
- The third number specifies how many character positions the ruling is to occupy.
- The fourth number specifies whether the ruling is to be a single line or a double line.

The VRULE command draws vertical rulings, and the HRULE command draws horizontal rulings.

Exercise

Type an HRULE 1,1,10,1 command. That is, if the command character is the exclamation point, type:

```
!HRULE 1,1,10,1<CR>
```

The 4027 will draw a horizontal ruling, starting at the first line of the workspace, first character in that line, and continuing for 10 character positions. The ruling drawn will be a single line, rather than a double line.

Now try these commands:

```
!HRULE 2,1,10,2<CR>
!HRULE 5,10,10,1<CR>
!VRULE 1,1,10,1<CR>
!VRULE 1,10,10,2<CR>
```

As the terminal executes a VRULE or HRULE command, it does the following things:

- First, the terminal inserts attribute codes to set up "rulings fields." A rulings field is a field in which characters are displayed using the rulings characters, Font 1. An HRULE command draws its ruling in only one line of the workspace, so only one rulings field is needed. A VRULE command, however, inserts a one-character rulings field in each horizontal line through which the vertical ruling passes.

- Secondly, the terminal inserts the appropriate rulings in the rulings field or fields it has created.

For single vertical lines, it inserts the left bracket character (l), which appears as a vertical line when displayed with the rulings font.

Similarly, for a double vertical line, it inserts the underscore character (-); for a single horizontal line, the capital letter Y; and for a double horizontal line, the right bracket (r).

- Thirdly, the terminal terminates each rulings field by inserting another attribute code after the rulings field. This attribute code defines a new field and returns the character font to what it was before the rulings characters were inserted.

GETTING THE JUNCTIONS RIGHT

While the HRULE and VRULE commands are convenient, they do not draw the junctions where one ruling joins another. To display these junctions correctly, we need other rulings characters.

Figure 7-5 shows all the rulings characters, both as they are displayed in "rulings fields" (fields in which Font 1 is used) and as displayed with the standard character font (Font 0). You can quickly pick out from this figure exactly which character you need to make a neat junction between two rulings.

To illustrate how to use the figure, let's draw the following form:

n	2n	3n	4n
1	2	3	4
2	4	6	8
3	6	9	12
4	8	12	16
5	10	15	20
6	12	18	24

Rulings (Font 1)	Standard (Font 0)
	<pre>@YYGYAYYYYB [- [[\]]M]]K]]]]^ [- [[HYOYYIYYYYJ [- [[[- [[[- [[PYWYYQYYYYR</pre>
	<pre>D]]C]]E]]]]F - [- - XYIYYOYYYYZ - [- - L]]K]]M]]]]N - [- - - [- - - [- - T]]S]]U]]]]V</pre>
	<pre>d))c))e)))))f ? [? ? xYYIYYoYYYYz ? [? ? l))k))m)))))n ? [? ? ? [? ? ? [? ? t))s))u)))))v</pre>
	<pre>h]]E]]]]]]j [- [[[- [[:))y))(())~ [- [[[- [[p]]]]]]U]]]r</pre>
	<pre>a]]]]g]]]]b - ? - - ? - XYYYYoYYYYX - ? - - ? - qYYYYwYYYYi</pre>

2401-20

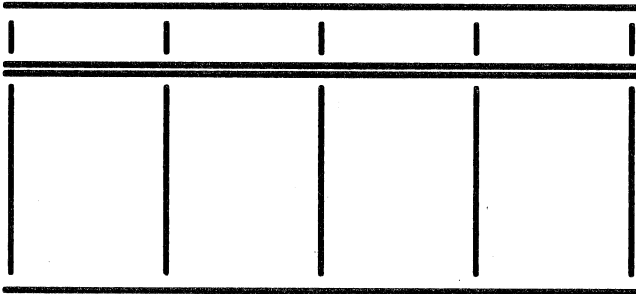
Figure 7-5. Rulings Characters.

CREATING FORMS

Begin by erasing the workspace and drawing the rulings with several rulings commands. Assuming the command character is the exclamation point, type:

```
IVRU 3,20,10,1<CR>
IVRU 3,30,10,1<CR>
IVRU 3,40,10,1<CR>
IVRU 3,50,10,1<CR>
IVRU 3,60,10,1<CR>
IHRU 3,20,41,1<CR>
IHRU 5,20,41,2<CR>
IHRU 12,20,41,1<CR>
```

At this point, the workspace looks like this:

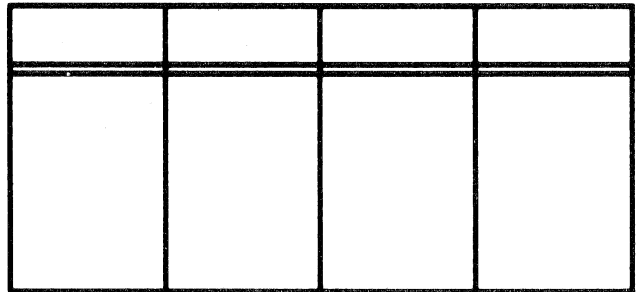


The rulings are in place, but their junctions aren't right. To remedy this, consult Figure 7-5 to see which characters in the rulings font give the correct junctions. For instance, the upper left corner can be made with an @ character, that the "T" junctions in the top row can be made with the letter A, and the upper right corner can be made with the letter B.

Accordingly, move the cursor to the upper left corner of the box formed by the rulings, and type an @. The rulings character for the upper left corner appears. Similarly, move the cursor to the "T" junctions along the top of the form, and type the letter A at each junction; the rulings characters for the "T" junctions appear.

Likewise, type the letter B at the upper right corner of the rulings, and the characters \, K, K, K, ^ at the five junctions of the horizontal double line with the vertical lines. We finish making the junctions by typing the characters P, Q, Q, Q, R at the junctions of the bottom horizontal line with the vertical lines.

At this point, the workspace looks like this:



To finish the form, you need only type the text inside the boxes formed by the rulings characters.

Section 8

MAKING HARD COPIES

Provided your 4027 has the correct options installed, you can make hard copies of the text in its memory on

two different devices: the TEKTRONIX 4632 Hard Copy Unit or the 4642 Line Printer.

COPYING ON A 4632 HARD COPY UNIT

You can use a TEKTRONIX 4632 Hard Copy Unit to make copies of the contents of the workspace or the monitor, or of what is in view on the screen. The copies can show anything that is displayed on the screen, including rulings, alternate character sets, and graphs. Color displays are converted to appropriate gray scale. One or several 34-line pages from the workspace or the monitor can be copied. Each page of copy is about 8 1/2 by 11 inches in size.

To copy the terminal's screen, type:

!HCOPY S<CR> or !HCO S<CR>

To copy one page of the contents of the workspace, type:

!HCOPY W<CR> or !HCO W<CR>

To copy one page of the monitor, type:

!HCOPY M<CR> or !HCO M<CR>

MAKING HARDCOPIES

Figure 8-1 illustrates what happens when you make a hard copy from the workspace or the monitor. Notice that the copy shows more of the workspace or monitor scroll than in view on the screen prior to the command. The copy starts with the line of the scroll which occupies the top line of the screen, and continues for a total of 34 lines.

You can copy more than one page from the workspace or monitor. To do this, type on the keyboard:

```
!HCO 2 W<CR>
or
!HCO 3 M<CR>
```

In the first example, the terminal copies two pages of text from the workspace. In the second example, it copies three pages from the monitor. The first page of copy starts with the first line of text displayed on the screen. Subsequent pages continue in sequence.

If you tell the terminal to copy five pages of text from the workspace, and the workspace has only two and one half pages of text stored in it, the terminal will give you three pages of hard copy. It will not waste hard copy paper by producing five pages, only three of which have information on them. However, the HCOPY command will always produce at least one page of copy, even if there is nothing on that page.

If you leave out the "S" or "W" or "M" in typing the HCOPY command, the terminal will copy from either the workspace or the monitor, depending on which of these is receiving text from the keyboard. For instance, if text from the keyboard goes to the monitor,

```
!HCOPY<CR> or !HCO<CR>
```

copies one page of the monitor. If the keyboard is typing into the workspace,

```
!HCOPY<CR> or !HCO<CR>
```

copies one page of the workspace.

(If the HCOPY command comes from the computer rather than the keyboard, the scroll into which the computer is typing is the one which is copied.)

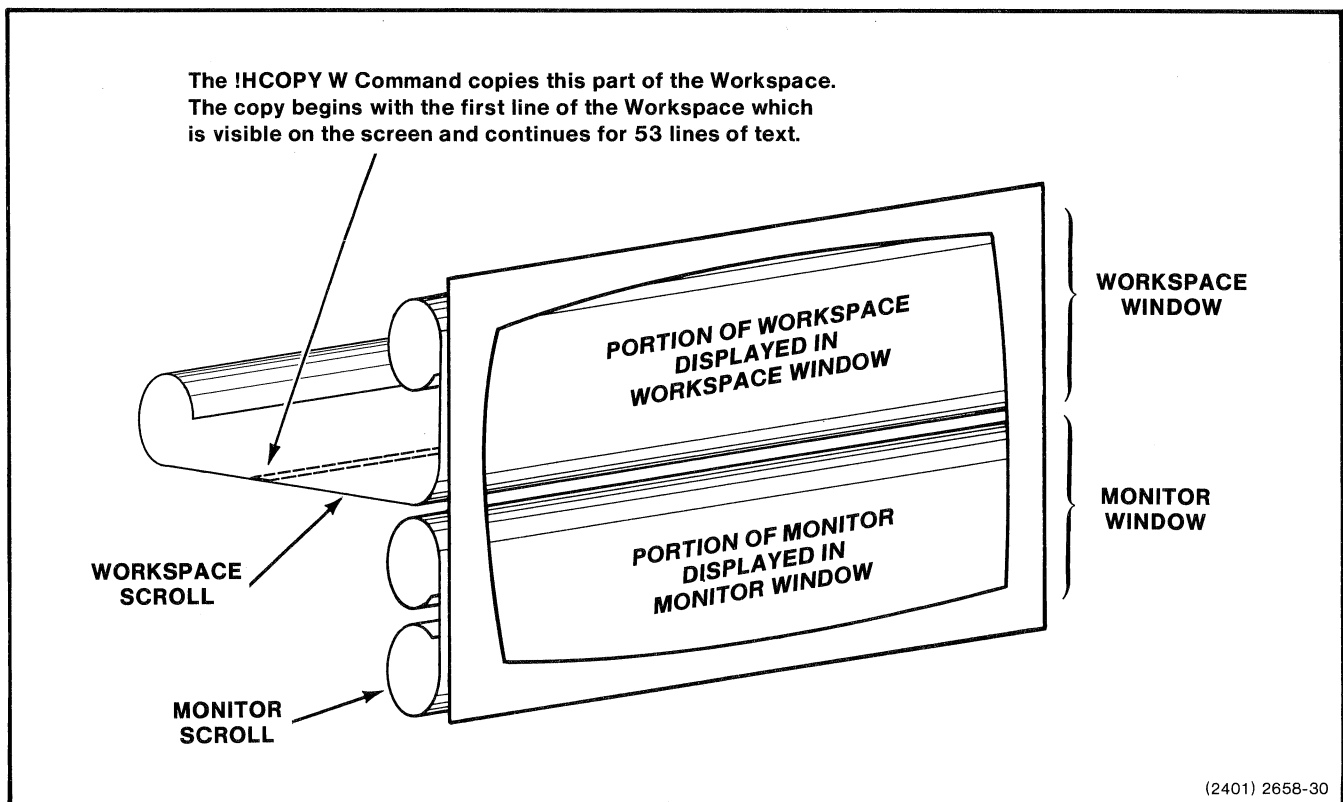


Figure 8-1. Making a Copy of Text in the Workspace.

CONNECTING THE 4632 HARD COPY UNIT TO THE 4027A

The 4632 Hard Copy Unit may be connected to the terminal by two different methods. The first method enables the user to make hard copies by pressing the "copy" button on the front of the hard copy unit. The second method provides for external COPY commands plus the use of the "copy" button.

In order to make copies by use of the "copy" button, one end of a 75 ohm BNC cable connects to the terminal Monochrome Output (J5300). The other end of the cable connects to the 4632 Video Loopthru (J701 or J703) on the back of the instrument. The "copy" button, when pressed, provides gray scale copies of color displays that are visible on the screen at that time. (See Figure 8-2, Connecting the Hard Copy Unit.)

In order to use the HCOPY commands or the "copy" button for gray scale copies, a 15 pin connector cable (hard copy cable) is necessary. One end of the 15 pin connector cable plugs into the terminal "To Video Hard Copy Unit" connector (J5200) while the other end of the 15 pin connector plugs into the 4632 (J790). This eliminates the need for the BNC connection previously described.

A 75 ohm terminator should be used to terminate the line by connecting to the "output" BNC connector which is electrically farthest from the source. The 75 ohm terminator may be attached to the other BNC connector, for impedance matching purposes.

The Video Background switch, "Invert" and "Norm" stipulates whether the gray scale copies will have the normal black background with white foreground, or be inverted displaying a white background with a black foreground.

For more information on the 4632 Video Hard Copy Unit, refer to the 4632 Service Manual.

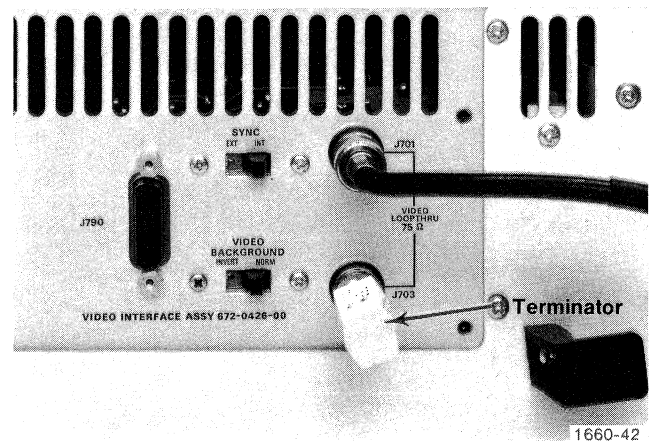


Figure 8-2. Connecting the Hard Copy Unit.

COPYING ON A PRINTER

If your terminal is equipped with Option 3 (RS-232 Peripheral Interface), and Option 36 (Peripheral ROM), you can print the contents of the workspace on a TEKTRONIX 4642 Line Printer or other RS-232 device. Also, you can have the 4642 print text coming from the host computer.

NOTE

The 4632 Printer will not copy graphics.

To print the workspace contents on the 4642, check that the pointer's SELECT light is on, and type this command:

!COPY W P<CR> or !COP W P<CR>

(If the 4642's SELECT light is off, press the SELECT key just below it to turn the light on.)

In the COPY command, W stands for workspace, and P for printer. The command tells the terminal to copy the contents of the workspace onto the printer.

To direct text coming from the host computer to the 4642 printer, type this command:

!COPY H P<CR> or !COP H P<CR>

(The "H" stands for "host computer;" this command tells the terminal to "copy text from the host computer onto the printer.")

The terminal will continue to copy data from the host computer onto the printer until one of three things happens:

- The computer sends an "end-of-file string" to tell the terminal to stop copying. (See the 4027A Programmer's Reference Manual for information on end-of-file strings.)
- The terminal, in buffered mode, receives a prompt string from the computer.
- You type on the keyboard with the terminal in unbuffered mode.

Section 9

PERIPHERAL DEVICES

This section tells how to use the terminal with its peripheral devices: the 4642 Printer, 4924 Digital Cartridge Tape Drive, and 4662 or 4663 Interactive Digital Plotter. Topics included are:

- Using the Printer: copying text from the workspace or the host computer on the printer.
- Considerations when using devices (4924 Tape Drives or 4662 or 4663 Plotter) which use the GPIB (General Purpose Interface Bus).
- Using the 4924 Tape Drive: installing it, copying files to and from it.
- Using the 4662 or 4663 Plotter.
- Copying to and from the host computer.

PRINTER

If Option 3 (RS-232 Peripheral Interface) is installed, you may attach an accessory printer, such as the TEKTRONIX 4642 Printer. You may print text from the terminal's workspace, the host computer, or a 4924 Tape Drive.

CONNECTING THE PRINTER TO THE TERMINAL

Figure 9-1 shows the terminal connected to a TEKTRONIX 4642 Printer. If Option 3 (RS-232 Peripheral Interface) is installed in the terminal, there is a cable with a female RS-232 connector emerging from the rear of the terminal's cabinet. Connect this cable to the male RS-232 connector on the cable coming from the 4642.

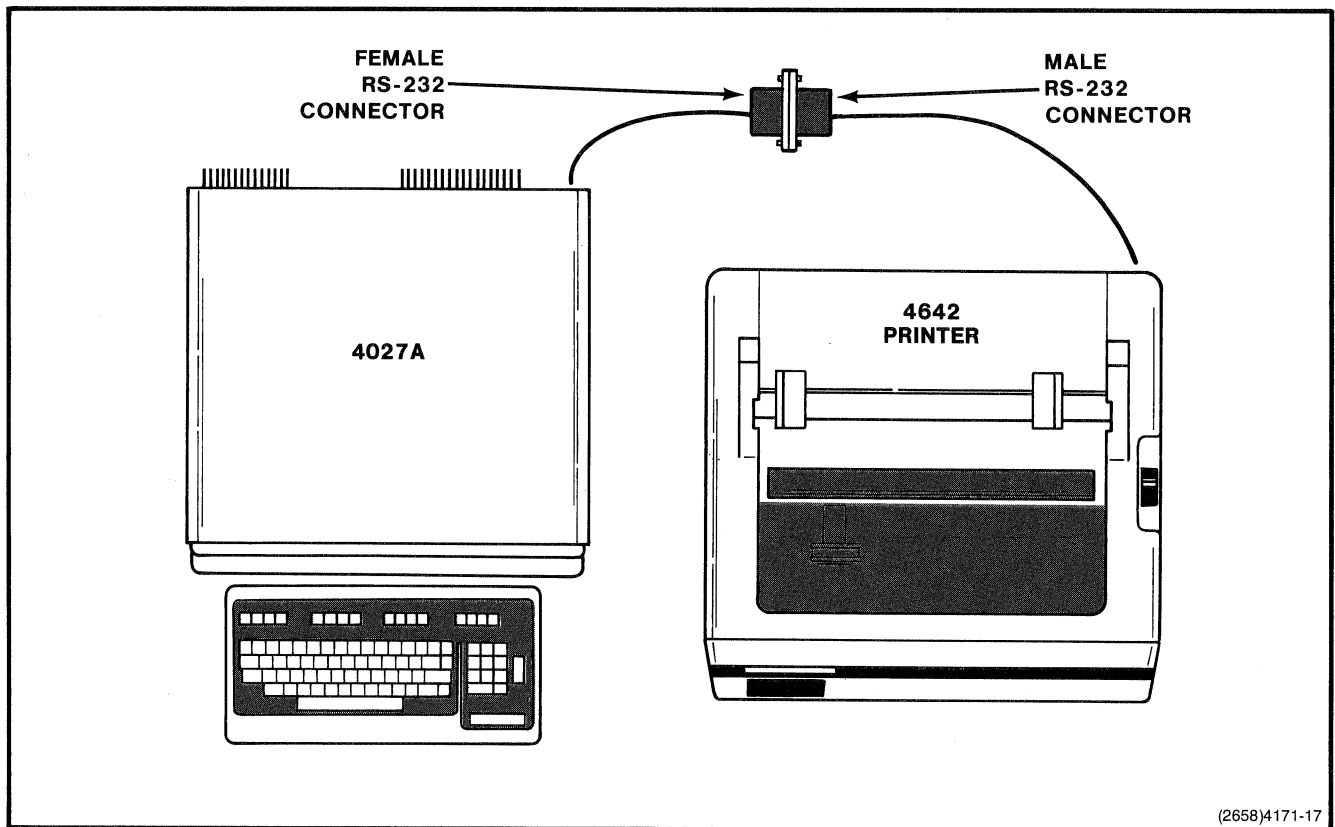


Figure 9-1. Connections to Printer.

SETTING SWITCHES ON THE 4642

Refer to Figure 9-2. Set the switches on the 4642 Printer as follows:

- POWER switch ON. (The POWER light above the LINE FEED switch should be on.)

- SELECT switch ON. (The SELECT light above the SELECT switch should be on.)
- To connect the terminal to a 4642 Printer, set the terminal to nonflagging mode, with a 2 msec. delay, and transmit a form feed when printing is to be concluded by typing:
!SET PR F 2 < CR >

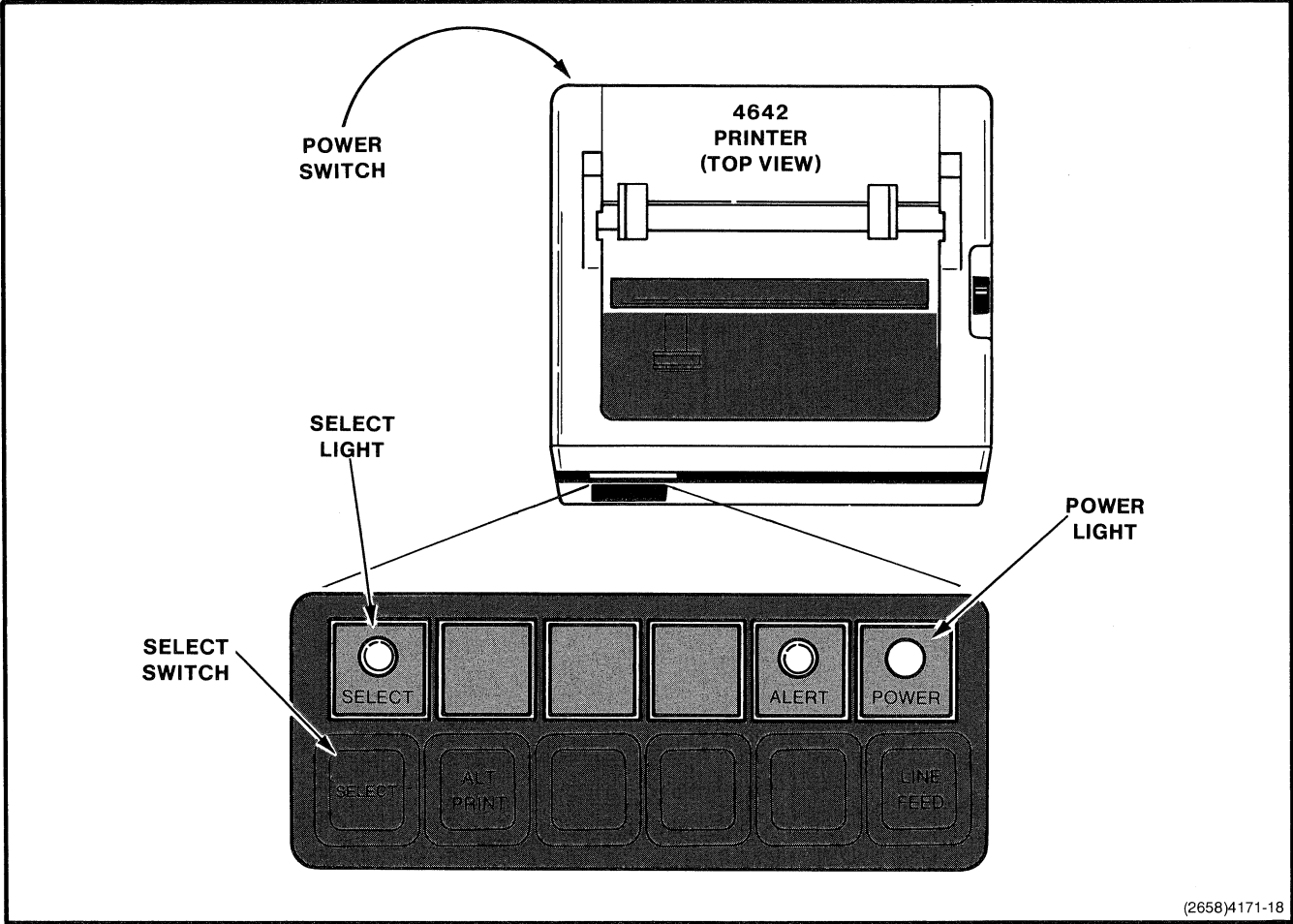


Figure 9-2. Switch Settings on 4642 Printer.

COPYING FROM THE WORKSPACE TO THE PRINTER

To copy text from the terminal's workspace to the printer, type a COPY command:

!COPY WO PR<CR> or !COP W P<CR>

NOTE

In the COPY command, unlike other commands, the parameters may not be spelled out completely. That is, you may not spell out the word WORKSPACE, but must abbreviate it to WO or W. Likewise, you may not spell out the word PRINTER, but must abbreviate it to PR or P.

The terminal sends the entire contents of the workspace to the printer. This includes any field attribute codes, which are sent as ATTRIBUTE commands. If you don't want the field attribute codes printed, you can suppress them by adding a "/N" immediately after the "WO," as follows:

!COPY WO/N PR<CR> or !COP W/N P<CR>

The "/N" is a "switch" which instructs the terminal not to send field attribute codes and to send any rulings characters as asterisks. You would use the "/N" switch if you were copying the contents of a form on the printer.

If the terminal is in form fillout mode, you may, if you wish, copy only the contents of the form's blanks (unprotected fields) onto the printer. To do this, add a "/U" immediately after the "WO" in the COPY command:

!COPY WO/U PR<CR> or !COP W/U P<CR>

COPYING FROM THE HOST TO THE PRINTER

End-of-File String

Before trying to copy text from a file in the host computer to the printer, you should check to be sure that the file's end is marked with an end-of-file string, and that the terminal is set to recognize the same end-of-file string.

The end-of-file string is a string of up to ten ASCII characters marking the end of the text to be copied. To examine the terminal's end-of-file string, type the PERIPHERALS command:

!PERIPHERALS<CR> or !PER<CR>

The terminal displays the PERIPHERALS list (Figure 9-3). The list's last line begins with the letters EOF: the characters shown after these letters comprise the current end-of-file string. (The 4027 comes from the factory with the end-of-file string set to fraction bar, asterisk as shown Figure 9-3.)

```

TA1 04 4051
PL1 01
PR L 00
EOF /*
    
```

(2658)4171-19

Figure 9-3. PERIPHERALS Message Showing End-of-File String.

Changing the End-of-File String

You can change the end-of-file string with an EOF command. In this command, you may enclose the new end-of-file string in quotes (or other delimiters described in the 4027A Programmer's Reference Manual). Alternatively, you may specify the characters of the string by their ASCII decimal equivalents:

```
!EOF "ABCDE"<CR> or !EOF
65,66,67,68,69<CR>
```

After changing the end-of-file string, be sure to check that you have set it correctly by typing the PERIPHERALS command.

The COPY Command

Once you have checked that the file to be copied has its end marked with the correct end-of-file string, you are ready for the "copy from host to printer" command. This command should be given from the host computer, and not typed on the keyboard. (For instance, the COPY command and the end-of-file string could be incorporated in the host file to be copied.)

Suppose, for instance, that you have the following text stored in a file in the host computer:

```
!COPY H PR
```

This is a test file to illustrate the terminal's "copy from host to printer" command (COPY HO PR or COP H P).

The file begins with the COPY command, on a line of its own. When the host computer sends that line to the terminal, it ends the line with "carriage return, line feed." The "carriage return" terminates the COPY command, causing the terminal to begin the copy operation.

As the host computer sends the text following the COPY command, the terminal copies that text on its printer. This continues until the end of the file, which is marked by the end-of-file string ("fraction bar, asterisk" in this example). The end-of-file string must be the very last thing in the file, as the terminal uses this string to mark the end of the file; it will not copy anything after the end-of-file string.

```
/*
```

At the end of the COPY operation, the terminal moves the printer's paper to the start of a new page. This it does by sending several line feed characters. (If the printer is one that responds to form feeds, it will send a form feed character instead.)

The copying continues until one of two things happens:

- The computer sends an end-of-file string to tell the terminal to stop copying.
- The terminal, in buffered mode, receives a prompt string from the computer. (See "Buffered Operation," in Section 3 of this manual.)

Copying from the tape drive to the printer is described later in this section.

SETTING PRINTER PARAMETERS

The terminal comes from the factory correctly set for communicating with a TEKTRONIX 4642 Printer. With the SET command, you can change settings to permit the terminal to use other printers. The settings you can change are:

- Whether the terminal causes the printer to move its paper to the start of a new page (a) by sending a series of ASCII line feed characters, or (b) by sending an ASCII form feed character.
- The length of the time that the terminal waits, after sending one line of text, before it sends the next line of text. (This delay is to give the printer's carriage time to return to the start of the next line.)

If the delay is set to "zero," the terminal examines one of the RS-232 circuits from the printer to see if the printer is ready to receive the next line of text. For instance, the 4642 Printer uses the RS-232 "Data Terminal Ready" circuit to signal its readiness for the next line of text.

The following examples show how to set these printer parameters:

!SET PR L<CR>

Makes the terminal use line feeds when signalling the printer to move to the start of a new page.

!SET PR F<CR>

Makes the terminal use the form feed character when signalling the printer to move to the start of a new page.

!SET PR 5<CR>

Sets the terminal to run in non-flagging mode and wait 5 tenths of a second after sending a line of text before sending the next line.

!SET PR 0<CR>

Sets the terminal not to wait a fixed period of time between lines of text, but to use "flag" signals (such as the RS-232 Data Terminal Ready signal) to determine when it may send the next line.

!SET PR L 0<CR>

Sets the terminal for use with a TEKTRONIX 4642 Printer — using line feeds rather than form feed to skip to the start of a new page, and using an RS-232 line to signal when a new line of text may be sent, rather than relying on a fixed delay between lines.

GPIB DEVICES (4924 TAPE DRIVE, 4662 AND 4663 PLOTTERS)

INTRODUCTION

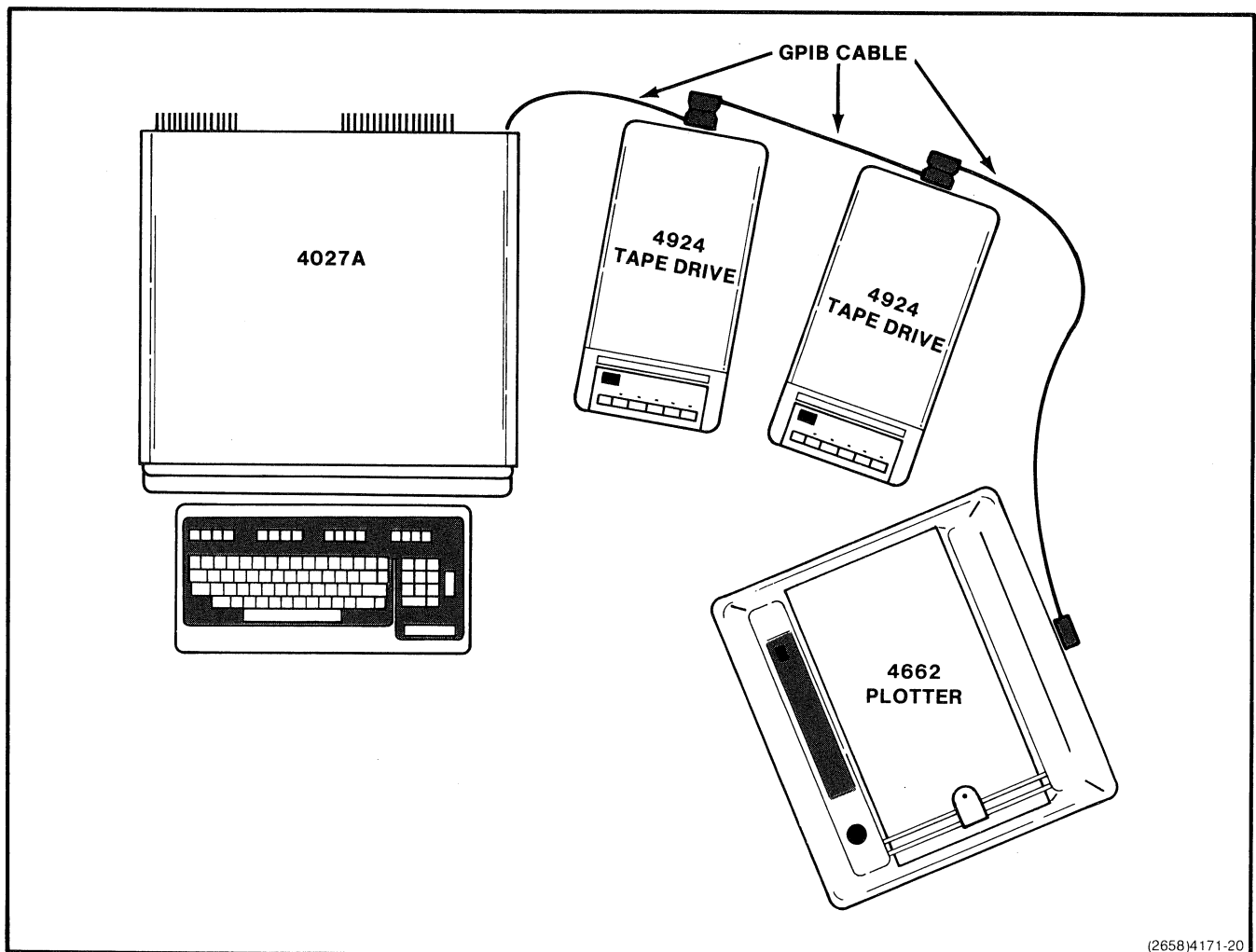
If the terminal has Option 4 (GPIB Peripheral Interface)¹ installed, it can be connected to up to four TEKTRONIX 4924 Digital Cartridge Tape Drives, and up to two TEKTRONIX 4662 or 4663 Interactive Digital Plotters. Figure 9-4 shows one possible arrangement.

¹The General Purpose Interface Bus (GPIB) is a standard way of connecting programmable instrumentation. It is described in IEEE Standard 488-1975; (copies of this standard may be obtained from the Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, N.Y. (The GPIB devices presently compatible with the 4027A are the 4924 and 4662 or 4663.)

CAUTION

When using GPIB devices (tape drives or plotters) with the terminal, be sure to turn them on before you start work with the terminal. That is turn all the GPIB devices on, and then turn on the terminal. (If the terminal is already on, press its MASTER RESET button.)

Leave all the tape drives and plotters turned on. (Turning them off and on can send spurious signals on the GPIB, — and that can interfere with the terminal's operation.)



(2658)4171-20

Figure 9-4. 4027A With GPIB Peripheral Devices.

POWER-ON PROCEDURE

If any GPIB devices are connected, use this procedure each time you turn on the terminal:

1. First turn on all the plotters and tape drives; then turn on the terminal. (If the plotters and tape drives are not turned on during the terminal's power-up sequence, the terminal will delete them from its memory of devices attached to it.)

2. Type the PERIPHERALS command:
!PERIPHERALS<CR> or !PER<CR>

The terminal displays its PERIPHERALS list in the monitor. (See Figure 9-5.) This list shows all the devices which the 4027 is aware are attached to it. In the list, "TA1," "TA2," etc. represent tape drives, "PL1" and "PL2" stand for plotters, "PR" denotes the printer, and "EOF" names the end-of-file string.

3. Check that the PERIPHERALS list includes all the tape drives and plotters connected to the terminal. If a device is missing from the list, the reason may be:

- You turned the terminal on before turning on the device. At power-up (or MASTER RESET) the terminal checked to see whether the device was there. When it got no response (because the device was then turned off), the terminal deleted that device from its PERIPHERALS list.

- The device is not turned on, or it has been disconnected from the terminal.
- The device's switches are set incorrectly.
- The terminal has not been informed of the device's presence. That is, the device has not been named in a SET command. (The SET command is described later in this section.)

NOTE

If the terminal has Option 3 (the RS-232 Peripheral Interface), then the PERIPHERALS message includes a "PR" entry for the printer – regardless of whether a printer actually is connected.

4. If any of the plotters and tape drives are missing from the PERIPHERALS message, perform the "Initialization Procedure," described later in this section.

```
TA1 04 4051
TA2 06 4051
TA3 08 4051
TA4 08 4051
PL1 01
PL2 15
PR L 00
EOF /*
```

(2658)4171-21

Figure 9-5. The PERIPHERALS List.

INITIALIZATION PROCEDURE

Whenever you connect a GPIB device (tape drive or plotter), perform the following installation procedure. The procedure serves these purposes:

- It gives the terminal details about the device you have connected, so that it can later send appropriate commands to that device.
- It checks that the terminal is, indeed, able to communicate with the device.

The procedure is as follows:

1. Connect all the GPIB devices to the terminal, using the special GPIB cables. Set each device's switches as described later in this section, under "Switch Settings" for the 4924 Tape Drive and the 4662 Plotter.

This includes choosing a "GPIB address" for each device, and setting the device's GPIB Address switches accordingly. In choosing the GPIB addresses, follow these rules:

- All addresses must be numbers between 1 and 30, inclusive. (Addresses of "0" and "31" are not allowed.)
- No two devices may have the same GPIB address.
- The GPIB address for a 4924 Tape Drive must be an even number in the range from 2 to 28. (Addresses 0 and 30 are not permitted.)
- The GPIB address for a 4662 or 4663 Plotter must not be the next higher address after a 4924 Tape Drive's GPIB address. (For instance, if a tape drive has GPIB address 6, you may not give GPIB address 7 to a plotter. The next available address is address 8.)

2. Turn on all the GPIB devices.
3. Turn on the terminal; if it is already turned on, press MASTER RESET.

4. Using SET commands, tell the terminal about each GPIB device that you have connected. The following are examples of SET commands, together with "translations" of what you tell the terminal when you type them:

```
!SET TA1 4 4051< CR>
```

"Tape Unit 1 is connected at GPIB address 4. It will record data on its tape in a format which is compatible with the TEKTRONIX 4051 Graphic System."

```
!SET TA2 6 4923< CR>
```

"Tape Unit 2 is connected at GPIB address 6. It uses a tape format compatible with the TEKTRONIX 4923 Digital Cartridge Tape Recorder."

```
!SET TA3 8< CR>
```

"Tape Unit 3 is connected at GPIB address 8." (If you omit "4051" or "4923" from the SET command for a tape drive, the terminal sets the tape drive to record data in "4051" format.)

```
!SET PL1 11< CR>
```

"Plotter Number One is connected at GPIB address 11."

5. Type the PERIPHERALS command:

```
!PERIPHERALS< CR> or !PER< CR>
```

Examine the list which appears; it should agree with the SET commands you have just typed.

6. Press MASTER RESET. (At this point, the terminal checks to be sure that it can communicate with all the devices in the PERIPHERALS list.)
7. Type the PERIPHERALS command again:

```
!PER< CR>
```

If a GPIB device is missing from the message, one of the following may be the reason:

- The device is not turned on, or it is not connected to the GPIB.
- The device's switches are set incorrectly.
- The device's SET command named the wrong GPIB address. (Or the SET command never was given.)

4924 TAPE DRIVE

If the terminal has Option 4 (GPIB Peripheral Interface), then up to four TEKTRONIX 4924 Digital Cartridge Tape Drives may be connected to it. These tape drives provide local storage for large amounts of data.

One way to use the tape drives is to store data entered when filling out forms in the 4027's workspace. The first file on a tape might hold commands to create the form; later files might hold the data entered in form fillout mode. Once all the data is entered, you may copy it from the tape drive to the host computer.

Another way to use the tape drive is to store pages of text which have been typed and edited in the workspace. Each page may be stored in a separate tape file, to be recalled for later editing if desired. At the end of a day's work, the text may be copied from the tape drive to the host computer.

In both these examples, the terminal's ability to store and edit data locally is used to save charges for computer connect time.

INSTALLING THE 4924

To install the 4924, you must connect it to the terminal by means of the special GPIB cable, set its switches correctly, and inform the terminal of its presence. Use this procedure:

1. Connect the special GPIB cable coming from the rear of the 4027 to the GPIB connector on the rear of the 4924, as shown in Figure 9-6. If this cable is already connected to another tape drive or plotter, use another GPIB cable, stacking one end of that cable on the other cable's connector. Up to four tape drives and two plotters may be connected in this way.

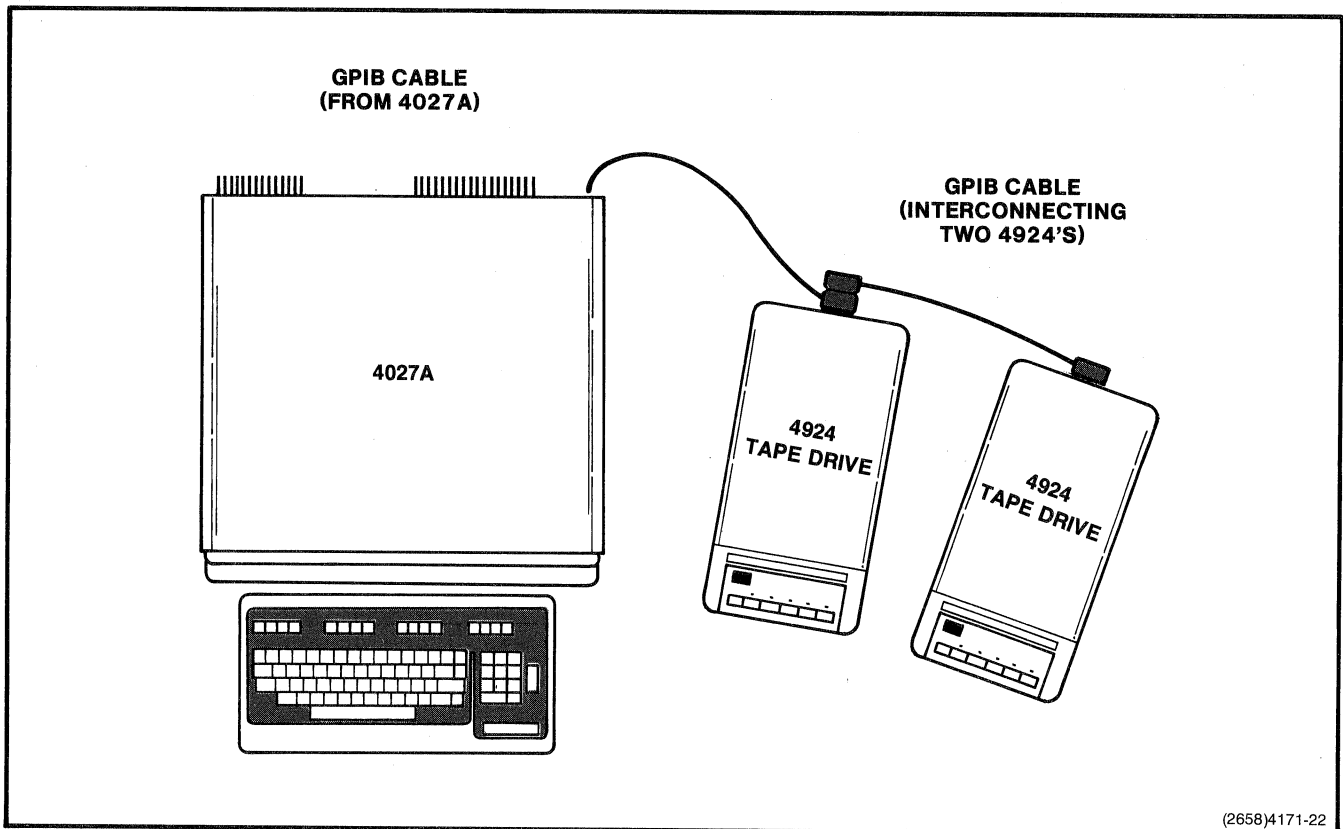


Figure 9-6. GPIB Interconnections.

2. Refer to Figure 9-7. Set the ALT-4051 switch on the 4924's rear panel to ALT.
3. Choose a GPIB address for the 4924. In choosing the address, follow these rules:

- The GPIB address must be an even number in the range from 2 to 28, inclusive. (Addresses 0 and 30 are not allowed.)
- The GPIB address must be different from that of any other GPIB device (tape drive or plotter) connected to the terminal.
- If any plotter has an odd number as its GPIB address, the 4924's GPIB address may not be the next lower-numbered address. For instance, if a plotter connected to the terminal has GPIB address 7, the 4924 Tape Drive may not have GPIB address 6. (It might, however, be given a GPIB address of 4 or 8.)

4. Encode the GPIB address you have selected on the 4924's GPIB ADDRESS switches (Figure 9-7), as follows:

GPIB Address	16	8	4	2	1
2	OFF	OFF	OFF	ON	OFF
4	OFF	OFF	ON	OFF	OFF
6	OFF	OFF	ON	ON	OFF
8	OFF	ON	OFF	OFF	OFF
10	OFF	ON	OFF	ON	OFF
12	OFF	ON	ON	OFF	OFF
14	OFF	ON	ON	ON	OFF
16	ON	OFF	OFF	OFF	OFF
18	ON	OFF	OFF	ON	OFF
20	ON	OFF	ON	OFF	OFF
22	ON	OFF	ON	ON	OFF
24	ON	ON	OFF	OFF	OFF
26	ON	ON	OFF	ON	OFF
28	ON	ON	ON	OFF	OFF

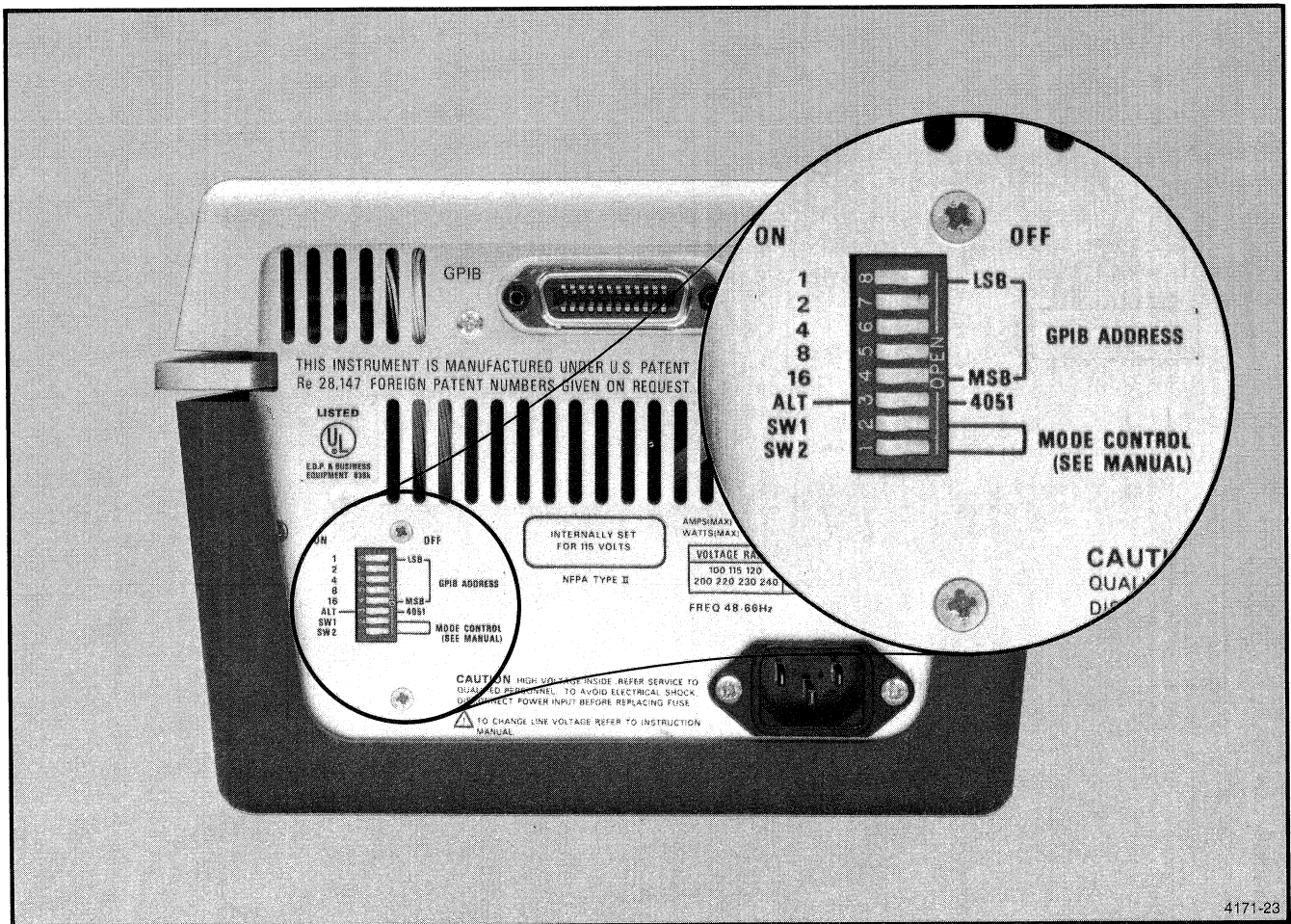


Figure 9-7. 4924 Rear Panel Switches.

PERIPHERAL DEVICES

5. Depress the red ON LINE switch on the 4924's front panel. Turn its POWER switch ON.
6. Turn the terminal on. If it is already on, press MASTER RESET.
7. When the cursor appears, type a SET command to inform the terminal of the tape drive's presence:

!SET TA1 4<CR>

or

!SET TA1 4 4051<CR>

"A 4924 has been connected as Tape Unit 1 at GPIB address 4. It will record data on its tape in a format compatible with the TEKTRONIX 4051 Graphic System's internal tape drive."

!SET TA2 6<CR>

"A 4924 is connected as Tape Unit 2 at GPIB address 6. It records data in 4051-compatible format."

!SET TA3 8 4923<CR>

"A 4924 is connected as Tape Unit 3 at GPIB address 8. It records data in a format compatible with the TEKTRONIX 4923 Digital Cartridge Tape Recorder."

NOTE

The 4923-compatible tape format is not recommended; the terminal's DIRECTORY command will not work for tapes recorded in this format. Use "4923" tape format only if you must exchange tape cartridges with a 4923 Tape Recorder.

8. Type a PERIPHERALS command:

!PER<CR>

Check the PERIPHERALS list that appears in the terminal's monitor. The information just entered (with the SET command) should be included. If that information is incorrect, type the SET command again.

9. Press MASTER RESET. When the cursor appears, type the PERIPHERALS command again. Check the PERIPHERALS message; if the information just entered with the SET command is missing, then you have not installed the 4924 correctly. (Try again!)

ALLOCATING FILES

Before you can record data on the 4924's tape cartridge, you must create files on that tape to hold the data. For this, use the ALLOCATE command. In the ALLOCATE command, you tell the terminal four things about the files to be created:

- On which tape unit to create the files.
- The file number of the first file to be created. (File number "zero" causes the 4924 to rewind to the start of the tape and number the first file created as "file number one.")
- How many files are to be created.
- How large the files are to be. (If you specify "5000 characters" in the ALLOCATE command, each file will be large enough to hold at least 5000 characters of data.)

Figure 9-8 illustrates an ALLOCATE command; the following exercise gives practice using that command, and also introduces the DIRECTORY command.

Exercise

1. Install a 4924 Tape Drive, if one is not already installed. Press MASTER RESET. When the cursor appears, type:

```
IPER<CR>
```
2. Check that the tape unit is listed in the PERIPHERALS list that appears. You should see a line in the PERIPHERALS message like this:

```
TA1 4 4051
```

(This says that Tape Unit 1 is at GPIB address 4, and that it writes data on its tape in "4051 format.")
3. If instead of "4051" the number "4923" appears in the PERIPHERALS message, type a SET command to change the tape unit to record in "4051 format." Be sure to use the same GPIB address in the SET command as the PERIPHERALS message currently shows for that tape unit.

For instance, if the PERIPHERALS message says

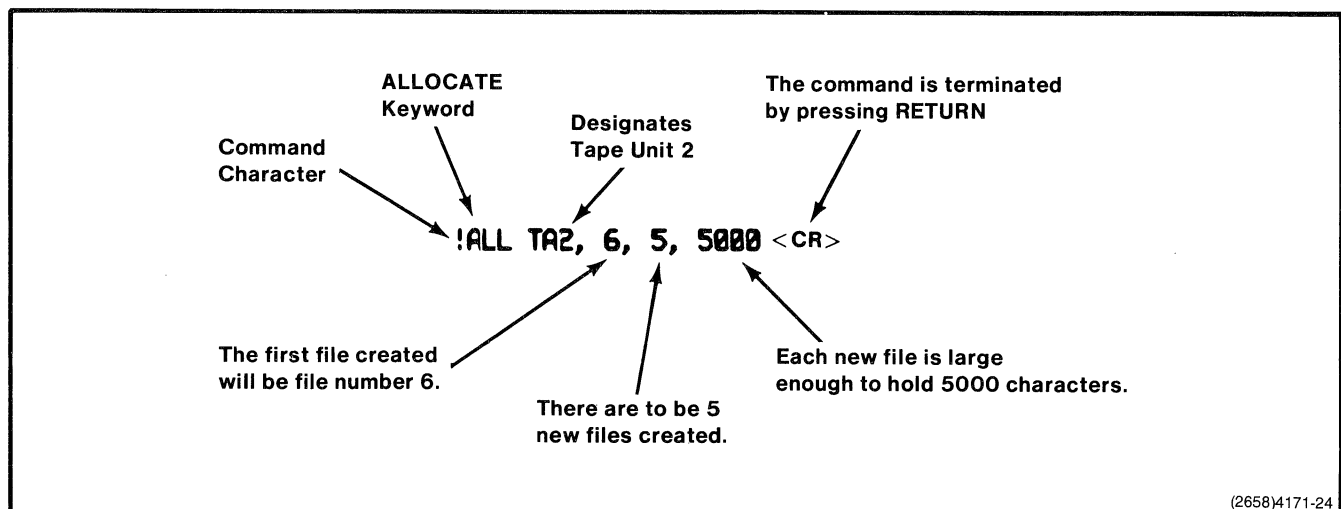
```
TA1 4 4923
```

you should type:

```
ISSET TA1 4 4051<CR>
```

Type the PERIPHERALS command again; you should now see:

```
TA1 4 4051
```



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Figure 9-8. ALLOCATE Command.

PERIPHERAL DEVICES

4. Insert an unused tape cartridge in the 4924. (Don't use a cartridge holding data you want to keep; you will destroy any data on the tape when you create new tape files.)

5. Type this command:

```
!ALLOCATE TA1 0,5,1000<CR>
```

The 4924 rewinds to the beginning of its tape, and then creates five files on the tape. It also creates a dummy file (file 6), to reserve a place for later ALLOCATE commands.

6. Type the following:

```
IDIRECTORY TA1<CR>
```

The terminal lists in its workspace a directory of the files on the tape:

1	NEW	4
2	NEW	4
3	NEW	4
4	NEW	4
5	NEW	4
6	LAST	3

In this exercise, you created five new tape files. Each file holds 4 "physical records" (indicated by the number 4 in the tape directory's rightmost column). Each of these records can hold 256 characters, so files 1 to 5 can each hold as many as 1024 characters — a little more than the 1000 characters specified in the ALLOCATE command.

In addition to the five files requested, file 6 was placed on the tape and labeled "LAST." You cannot record data in this file; its only purpose is to reserve a place where later ALLOCATE commands may create more new files.

To allocate an additional five files, each large enough to hold 2000 characters, you could type:

```
!ALL TA1 6,5,2000<CR>
```

The new files created would then start with file 6 (previously marked LAST), and would appear in a later DIRECTORY message as files 6 through 10. (File 11 would then be marked LAST to reserve a place for later ALLOCATE commands.)

NOTE

When you use an ALLOCATE command to create new files on a tape cartridge, any data on files at or after the files you create will be lost. For instance, if you create files 2 and 3 with an ALLOCATE TA1,2,2,100 command, any data at old files 2, 3, 4, 5, etc., is lost.

The following are examples of the ALLOCATE command:

```
!ALL TA1,0,5,5000<CR>
```

On Tape Unit 1, finds "file zero" (the beginning of the tape). Starting from there, creates 5 files, each large enough to hold at least 5000 characters of data. Also creates a dummy file (file 6) to reserve a place for a later ALLOCATE command to create more files.

```
!ALL TA1,6,2,100<CR>
```

On Tape Unit 1, finds file 6 and positions the tape head at the start of that file. Then creates files 6 and 7, each capable of holding at least 100 characters of data. Creates a dummy file (file 8) to reserve a place for a later ALLOCATE command to create more files.

THE DIRECTORY COMMAND

You have already used the DIRECTORY command:

IDIR TA1<CR>

Sends a tape directory for Tape Unit 1 to the terminal's monitor.

If you wish, you may specify in a DIRECTORY command that the tape directory is to go to the host computer or the 4642 Printer:

IDIR TA2 PR<CR>

Sends a tape directory for Tape Unit 2 to the printer.

IDIR TA3 HO<CR>

Sends a tape directory for Tape Unit 3 to the host computer.

Besides the monitor, the printer and the host computer are the only devices to which you can send a tape directory.

NOTE

The DIRECTORY command will only work if the tape unit uses "4051" format for recording data. If the tape unit is set for "4924" format, a DIRECTORY command produces this message:

TA1 DEV ERR 04

THE COPY COMMAND: COPYING TO AND FROM THE TAPE DRIVE

The COPY command transfers data to, from, or among the terminal's peripheral devices. This command takes the following form:

ICOPY <source> <destination> <CR>

Here, <source> and <destination> are abbreviations:

WO or W	The terminal's workspace.
HO or H	The host computer.
PR or P	The 4642 printer.
TA1 or TA or T	Tape Unit 1.
TA2, TA3, TA4	Tape Units 2, 3 and 4.
PL1 or PL	Plotter 1.
PL2	Plotter 2.

If the <source> or <destination> is a particular file on a 4924 Tape Drive, it is indicated by the abbreviation for that tape unit, followed immediately by a period and the file number:

TA1.1 Tape Unit 1, file 1.

TA2.16 Tape Unit 2, file 16.

If you have previously designated a particular tape file in a COPY command, you may, in a later COPY command, access the next file on the same tape unit without naming that particular tape file, but naming only the tape unit. For example, consider this sequence of commands:

ICOPY TA1.1 WO<CR>

ICOPY TA1 WO<CR>

ICOPY TA1 WO<CR>

ICOPY TA1 WO<CR>

The first command copies Tape Unit 1, file 1 to the workspace. The next command copies Tape Unit 1's next file (file 2) to the workspace. Likewise, the third and fourth commands copy Tape Unit 1, files 3 and 4 to the workspace.

PERIPHERAL DEVICES

This "automatic incrementing" feature permits you to access successive tape files by repeatedly pressing a function key which has been programmed to mean ! COPY TA1 WO (or !COPY WO TA1). For instance, the first file of a tape might contain a command file to (a) create a form in the workspace, (b) program the SEND key to mean "copy the contents of the workspace to next tape file," and (c) put the terminal in form fillout mode. You would invoke the form by typing "!COPY TA1.1 WO;" thereafter, each time you pressed the SEND key, a !COPY WOTA1 < CR> command would copy the contents of the form onto the next tape file.

The following examples show how to transfer data to and from a 4924 Tape Drive.

!COP WO TA1.1 < CR>

Copies the contents of the workspace to Tape Unit 1, file 1. The previous contents of that file are destroyed.

If no workspace is currently defined, copies an "empty workspace" into the file. This has the effect of erasing the file.

!COP TA1.1 W < CR>

Copies the contents of Tape Unit 1, file 1, to the terminal's workspace.

If no workspace is currently defined, the contents are displayed in the monitor.

!COP H TA2.3 < CR>

Copies data coming from the host computer to Tape Unit 2, file 3. Copy terminates when one of these things happens:

- An end-of-file string is received from the host computer.
- A prompt string is received, with the terminal in buffered mode.
- Break is pressed twice in quick succession.

NOTE

Because the copying ends when you press a keyboard key, this command should be given only by the host computer, not typed on the keyboard.

/N AND /U SWITCHES

When copying from the workspace to a tape file, the terminal sends the entire contents of the workspace, including field attribute codes, which are encoded as ATTRIBUTE commands. You may, however, suppress these field attribute codes by using the "/N" switch:

!COP WO/N TA1.5 < CR>

Copies the contents of the workspace to Tape Unit 1, file 5. Does not copy field attribute codes.

If the terminal is in form fillout mode, you may, if you wish, send only the contents of the form's blanks (unprotected fields). To do this, use "/U" switch:

!COP WO/U TA1.5 < CR>

Takes, from a form in the workspace, the contents of the form's blanks (unprotected fields), and records them on Tape Unit 1, file 5.

If a tape file contains commands for the terminal, then when you copy the tape file to the terminal's workspace, the terminal will execute the commands:

!COP TA1.1 WO < CR>

Retrieves the list of commands in Tape Unit 1, file 1, and causes the terminal to execute those commands.

You may, however, retrieve the contents of a command file without causing the terminal to execute the commands. (For instance, you might place the command file in the workspace for editing.) To copy a command file to the workspace without executing the commands in the file, use the "/N" switch:

!COP TA1.1 WO/N < CR>

Copies Tape Unit 1, file 1, to the workspace. Does not execute any commands in the file.

NOTE

The "WO/N" switch has different meanings according to whether it represents a COPY command's source or destination.

When copying from the workspace, "WO/N" means "don't copy any field attribute codes."

When copying to the workspace, "WO/N" means "don't execute any of the commands being copied."

THE KILL COMMAND

When the 4924 records data in "4051 format" (its normal data format), each tape file begins with a "header record." The header record holds the information about the file which you see when you ask for a tape directory (give the DIRECTORY command). When you first create a file, its header is marked "NEW;" it is changed to "ASCII DATA" when you record data in the file.

You can, if you wish, restore a file to its "NEW" status. To do this, use the KILL command. For instance,

```
!KILL TA1.6<CR>
```

"kills" Tape Unit 1, file 6. The header for that file is marked "NEW" and any data that was recorded there is lost.

4924 ERROR MESSAGES

If you command the terminal to do something impossible, it will usually display an error message. Table 9-1 lists the error messages you may encounter when using the terminal with a 4924 Tape Drive.

Table 9-1
4924 TAPE DRIVE ERROR MESSAGES

Message	Error
BUSY	The GPIB is busy; you may not use it just now.
TA1 NO DEV	You have tried to access TA1 (Tape Unit One), but it is not in the 4027's PERIPHERALS list.
TA1 FIL NAM ERR	You have made an error in naming the tape drive as the <source> or <destination> in a command. You may have attached an illegal switch to TA1 in command, or mistyped the file specification (TA1,6 instead of TA1.6).
TA1 DEV ERR 01	Domain Error or Invalid Argument.
TA1 DEV ERR 02	File Not Found.
TA1 DEV ERR 03	Magnetic Tape Format Error.
TA1 DEV ERR 04	Illegal Access.
TA1 DEV ERR 05	File Not Open.
TA1 DEV ERR 06	Read Error.
TA1 DEV ERR 07	No Tape Cartridge Inserted.
TA1 DEV ERR 08	Over-Read. (More than 256 characters in the 4924's buffer.)
TA1 DEV ERR 09	Tape is Write Protected.
TA1 DEV ERR 10	Read-After-Write Error.
TA1 DEV ERR 11	End of Tape.
TA1 DEV ERR 12	End of File.

4662 AND 4663 PLOTTERS

The Tektronix 4662 and 4663 Interactive Digital plotters may both be used with the terminal. There are two possible configurations:

- A "loop-through" configuration of the terminal and plotter can be made using the plotter SERIAL INTERFACE. The data communications line to the host computer is connected to the MODEM input of the plotter, and the terminal is connected to the TERMINAL output of the plotter. The plotter passes data from the host computer directly to the terminal until it recognizes a special sequence of characters that forms a DEVICE ON command. This command has the form:

```
< ATN> < ADR> E
```

where < ATN> is called the Attention Character. For the 4663 this can be either < ESC>, < !>, < >, or < SYN>. The 4662 uses only < ESC>. The second character < ADR> is the Address Character. The 4663 can be set to have an address of A,B,C,D,E,F,G, or H. The 4662 can use A,B,C, or D. When more than one plotter is used in a loop-through configuration, the address identifies a particular plotter. The last character E is the command character for a DEVICE ON command. Thus, a typical DEVICE ON command is:

```
< ESC> AE
```

After the plotter is ON, graphics and text can be drawn using the same commands as a Tektronix 4010-style terminal. The plotters also have additional commands and features. The plotters can also be turned logically off so that the host computer can communicate again with the terminal. The DEVICE OFF command is < ATN> < ADR> F.

In this configuration, the host computer, not the terminal, controls the plotter. Different commands are used for plotting on the plotter or on the terminal. A complete discussion of how to program the 4662 and 4663 plotter over the serial interface in this configuration can be found in the 4662 or 4663 Programmers Manuals.

The Tektronix PLOT-10 Interactive Graphics Library software package supports 4020 series terminals and 4662 and 4663 plotters. This package supports the configuration described here.

- The second configuration requires a 4025A, Option 4 GPIB Peripheral Interface. One or two plotters equipped with GPIB Interfaces can be connected to the terminal. In this configuration, the terminal controls the plotters. The plotter can be used in three ways:
 1. A plot can be made using the terminal graphic language (!VECTOR and !STRING). The terminal can be told to translate its language into plotter graphics language by COPYing to the plotter from the host with the /P switch. The same graph that appears in the terminal's workspace can then be drawn on the plotter. Only MOVE, DRAW, and PRINT plotter features can be used, however. (The /P switch can also be used to translate terminal language stored on a 4924 tape file to send it to a plotter.)
 2. A plot can be made using plotter commands only. This allows full use of the features available on the 4662 or 4663 plotters. The disadvantages of this method are that commands different from terminal commands must be used, and ASCII control characters may need to be sent (for example, the character < ETX> is needed to terminate a PRINT string). These commands can be typed into the terminal workspace and COPYed to the plotter.
 3. The third method is a combination of the above two. The special terminal PASS command can be used to send plotter commands intermixed with terminal commands. A plot can be displayed for preview on the terminal before being COPYed to a plotter.

NOTE

When displaying a plot on the terminal screen, arguments to the PASS command will be displayed. However, if host data is directed to the monitor by the use of the !MON H command, arguments will appear in the monitor and will not clutter the workspace.

INSTALLING THE 4662 PLOTTER

When installing a 4662 Interactive Digital Plotter, follow this procedure:

1. Set the plotter on the table where it will be used, and connect its power cord to the power mains. Do not turn on the plotter yet.
2. Choose a GPIB address for the plotter. In doing so, follow these rules:
 - No two GPIB devices (tape drives or plotters) may have the same GPIB address.
 - The plotter's GPIB address must be in the range from 1 to 30; addresses 0 and 31 are not allowed.
 - The plotter's GPIB address must not be the next address after a tape drive's address. For instance, if Tape Unit 1 is at GPIB address 4, you may not choose GPIB address 5 for the plotter.

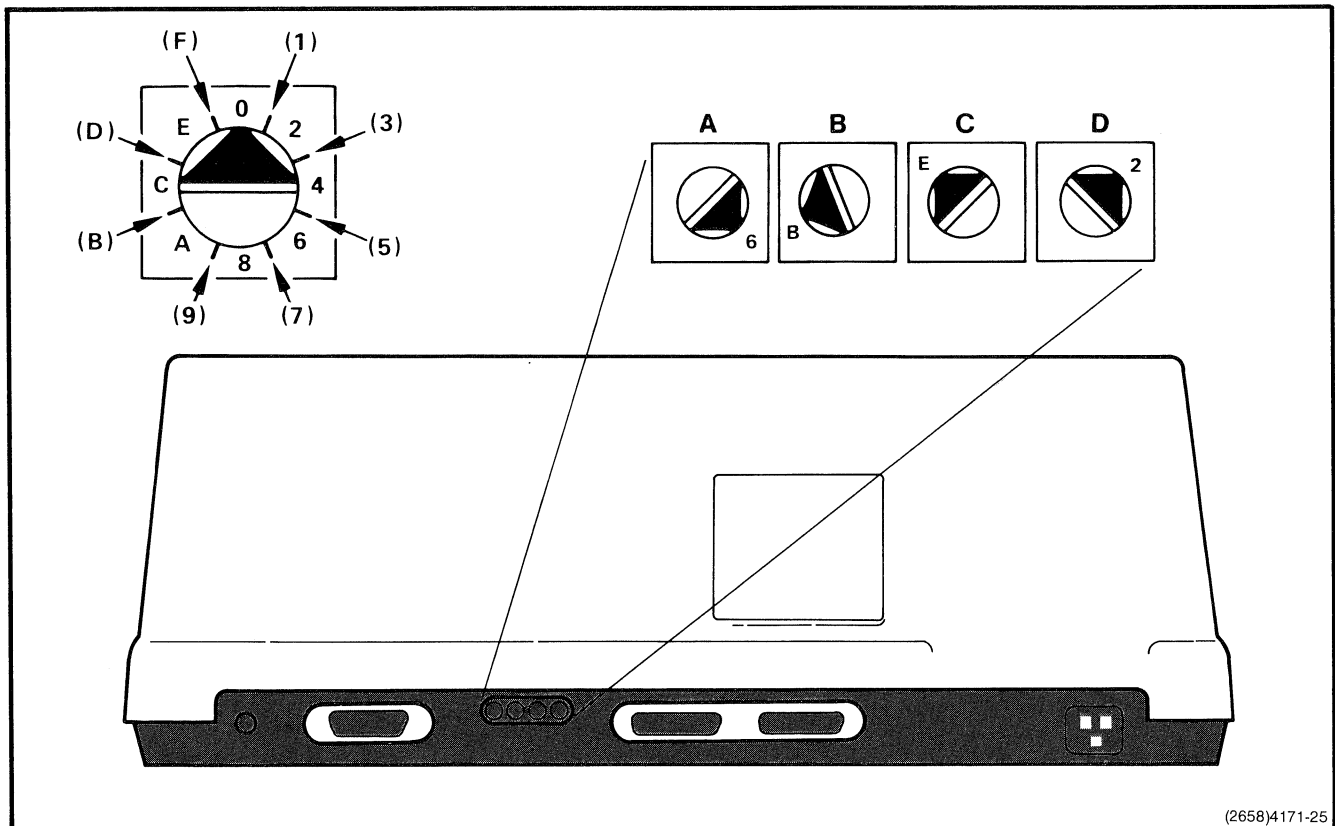
3. Set the plotter's rear-panel switches (Figure 9-9), as indicated in Table 9-2.

- Switch A determines these things:

Whether the plotter will draw at half its normal speed ("low plotting speed"). The low plotting speed is for use with pens whose ink does not flow rapidly enough to use the plotter's full speed.

Whether the plotter responds to "carriage return" characters by advancing to a new line (CR,LF), or only by moving the pen to the left end of the current line (CR).

- Switches C and D set the plotter's GPIB address.



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Figure 9-9. Plotter Switch Positions and Locations.

Table 9-2
SWITCH SETTINGS FOR
4662/4663 PLOTTER

Switch A	Low Plotting Speed?	CR Effect	Switch Setting	
	NO	CR	0 or 4	
	NO	CR,LF	1 or 5	
	YES	CR	8 or C	
	YES	CR,LF	9 or D	
Switch B	Set switch B to "4" or "5."			
Switch C	GIPIB Address	Switch Setting		
	1 to 15 16 to 30	0, 4, 8, or C 1, 5, 9, or D		
Switch D	GIPIB Address	Switch Setting	GIPIB Address	Switch Setting
	1	1	16	0
	2	2	17	1
	3	3	18	2
	4	4	19	3
	5	5	20	4
	6	6	21	5
	7	7	22	6
	8	8	23	7
	9	9	24	8
	10	A	25	9
	11	B	26	A
	12	C	27	B
	13	D	28	C
	14	E	29	D
15	F	30	E	

4. Attach the GPIB cable to the plotter, and be sure the plotter's LOCAL switch is not depressed. Turn on the plotter's POWER switch.
5. Turn the terminal on. If it is already on, press MASTER RESET. (This clears the GPIB bus of any spurious signals which may have occurred as you turned on the plotter.)
6. Type a SET command to inform the terminal that you have connected the plotter:
 !SET PL1 5< CR>
 "Plotter 1 has been connected to the terminal; it has GPIB address number 5."
 !SET PL2 6< CR>
 "Plotter 2 is connected at GPIB address 6."
7. Type the PERIPHERALS command and check that the information just entered with the SET command appears in the PERIPHERALS message:
 !PER< CR>
 If the information appears incorrectly, repeat step 6.
8. Press MASTER RESET. The terminal checks to be sure that it can access all the devices in its PERIPHERALS list. Any devices it cannot access, it deletes from the list.
9. Type the PERIPHERALS command again, to be sure the plotter still appears in the PERIPHERALS list.

INSTALLING THE 4663 PLOTTER

When installing a 4663 Interactive Digital Plotter:

1. Place the plotter on a table close enough to the terminal so that the GPIB cable from the terminal can be connected to the GPIB connector on the rear of the 4663. (Another GPIB cable can be used to extend the terminal cable.)
2. Choose a GPIB address for the 4663 using the rules given for the 4662 plotter. (Address values from 1 to 8 can be used.)
3. The 4663 Parameter Entry (PE) Card should be set according to the circled selections shown in Figure 8-10. The 4663 GPIB interface must be selected. (If the plotter is equipped only with a GPIB interface, this will be always active. If both a serial and GPIB interface are installed, the GPIB is Interface number 2. The GPIB interface should be selected before other parameters are changed. When changing from one interface to another, the Parameter Entry Card must be pushed all the way in before other parameters can be examined or changed.)

To make a selection, push the card all the way in, and turn the power on (if not already on). Then, slowly pull out the card. When a line on the card appears directly under the switches, this is the line indicating current selections. Lit switches indicated current selections. To make other selections, press the switch over the desired choice. The switch will light if a valid selection has been made. If the bell rings, the selection is not valid.

Enter the GPIB address chosen in step 2.

The INITIAL COMMAND/RESPONSE FORMAT line shows three choices (only one can be used at a time). Format 1 or 3 is recommended.

The INITIAL ASPECT RATIO line causes the plotter to create a viewport in the current page with the requested aspect ratio. The highlighted value of 3:2 is chosen to correspond to a terminal graphics area of 30 rows by 80 columns. This is recommended for use with the Tektronix PLOT-10 Easy Graphing software.

Consult the 4663 Operators Manual for information on the other selections of the Parameter Entry Card.

4. Be sure that both 4663 front panel INTERFACE switches are lit (labelled ON-LINE and REMOTE). This is the default at power-up or after pressing the front panel INITIALIZE switch.
5. The terminal must be informed that a plotter is connected. The terminal command to accomplish this is the SET command. For example, to use a 4663 as plotter number one with a GPIB address of 4, use the command:

```
ISSET PL1 4 < CR>
```

Note that two plotters may be used. A second plotter with a GPIB address of 6 can be connected by typing:

```
ISSET PL2 6 < CR>
```

6. To verify that the terminal has correctly understood the SET command, the PERIPHERAL command can be used. Type:

```
IPER < CR>
```

The terminal will respond with a message showing all PERipherals that are connected. For example:

```
TA1 02 4051
PL1 04
PL2 06
EOF /*
```

After a MASTER RESET, the terminal will check to see if all peripherals in its list are attached. Any that cannot be found will be deleted (and not appear in response to a subsequent PER command).

7. When using the GPIB, the terminal should always be the last device powered on. If not, it may be necessary to press the MASTER RESET button.

OPERATING CONSIDERATIONS USING THE 4662

When using the 4662 Plotter:

- Never use the CALL button. (It sends a signal to which the terminal is not prepared to respond.)
- Don't use the LOCAL button. (When it is pressed, the plotter is effectively disconnected from the terminal.)
- The LOAD button is used only when loading paper; be sure to release it when the paper is loaded. (With LOAD pressed, the plotter will not respond to commands.)
- Always turn on the plotter, and any other plotters and tape drives, before turning on the terminal or pressing MASTER RESET. (If the plotter is turned off when you press MASTER RESET or turn on the terminal, it will be deleted from the terminal's PERIPHERALS list.)

To learn how to install paper in the plotter, change its pen, position the boundaries of the plotting area, etc., see the 4662 Interactive Digital Plotter User's Manual.

OPERATING CONSIDERATIONS USING THE 4663

When using the 4663 Plotter:

- Do not press the DRAW POINT switch if the light is on. This sends a signal to which the terminal is not prepared to respond.
- Both 4663 front panel INTERFACE group switches must be lit. Otherwise the plotter will not accept commands from the terminal.
- The MEDIA and PAUSE switches can be used at any time. PAUSE can be used to interrupt a plot when replacing a pen or smoothing out the media. Pressing the PAUSE switch a second time causes plotting to resume where it left off.
- Always turn on all plotters and other peripherals before turning on the terminal or pressing MASTER RESET.
- When a plot is interrupted from the terminal, always use the 4663 front panel INITIALIZE function to reset the plotter. This ensures that when another plot is started, the 4663 will function correctly.

The 4663 Operators Manual should be consulted to learn how to load media, change pens, select page sizes, etc.

PASSING COMMANDS TO THE PLOTTER

Ultimately, the plotter takes its commands in "plotter language" — strings of ASCII characters. These plotter commands are in a different format from the terminal's commands; they do not use the command character, and they may include ASCII control characters (especially ETX, the End-of-Text character).

There are two ways you may send commands to the plotter:

- You can compose a list of plotter language commands and copy that list to the plotter.
- You can compose a list of "terminal language" graphics commands. The 4027 may then send that list from either a host file or the tape unit to the plotter, translating into plotter language as it does so. This causes the plotter to draw the graph specified by the commands in the list.

(Since the list is in terminal language, it can also be used to draw the same graph in the terminal's workspace.)

Plotter Language Commands

Table 9-3 gives examples of "plotter language" commands; the following exercise shows how to prepare a command file using these commands, and send that file to the plotter. For a more complete list of plotter commands, see Appendix F.

In the following examples, <ETX>, <CR>, and <LF> represent the ASCII End-of-Text, Carriage Return, and Line Feed characters.

Table 9-3
EXAMPLES OF 4662 AND
4663 PLOTTER COMMANDS

Command	Effect
PThis is a test.< ETX>	Prints on the plotter all characters after the P and before the < ETX> . In this case, prints "This is a test."
PThis is line 1.< CR> < LF> This is line 2.< ETX>	Prints two lines of text: This is line 1. This is line 2.
M50,63.537< CR> or M 50,63.537< CR>	Lifts the pen and moves it to the point X= 50, Y= 63.537 in the plotter's system coordinates. ^a
D100,100< CR> or D 100,100< CR>	Draws a line from the present pen position to the point X= 100, Y= 100 (plotter coordinates).
D50,50,125,75,0,0< CR> or D 50,50 125,75 0,0< CR>	Draws a line from the present pen position to the point (50,50); from there, to the point (125,750); and from there, to the point (0,0).
BP2 or BP 2	Selects pen number two. This is valid only for the 4663 or 4662 with Option 31.

^aIn its "move" and "draw" commands, the plotter uses a system of coordinates which runs from 0 to 150 in the horizontal direction (X-direction) and from 0 to 100 in the vertical direction (Y-direction).

Exercise

1. Create a workspace, and direct text from the keyboard to that workspace:

```
!WOR 20 K< CR>
```

2. Program Function Key 1 to mean: "Enter snoopy mode, type the End-of-Text character, and exit snoopy mode."² To do this, you may use the LEARN key, as described in Section 3, or the LEARN command, as follows:

```
!LEARN F1 "ISNOOPY;" ,3,"!SNOOPY  
NO" ,13< CR>
```

You will be entering plotter commands into the workspace, including ETX (End-of-Text) characters. To enter the ETX characters, the terminal must be in snoopy mode. (Control characters have no effect in the workspace unless the terminal is in snoopy mode.) The programmed key makes it easy to enter ETX characters: a single keystroke puts the terminal in snoopy mode, enters an ETX, and removes the terminal from snoopy mode.

3. Type the following plotter language commands into the workspace. (Wherever < ETX> occurs in this list, press Function Key 1.)

```
M 2,2  
PThis is the boundary of the plot.< ETX>  
M 0,0  
D 150,0 150,100 0,100 0,0  
M 55,40  
PThis is a triangle.< ETX>  
M 10,10  
D 140,10 75,90 10,10
```

You now have a "command file" of plotter language commands in the workspace.

²Snoopy mode, the SNOOPY command, and the LEARN command are described in the Programmer's Reference Manual. These commands are primarily of interest to the person who programs the host computer to communicate with the terminal. This particular example of the LEARN command is included here because it provides the easiest way to insert End-of-Text characters into the workspace. For more information on the SNOOPY and LEARN commands, see the Programmer's Reference Manual.

PERIPHERAL DEVICES

4. Load paper into the plotter, insert a pen, and uncap the pen. (These procedures are described in the 4662 or 4663 Interactive Digital Plotter User's Manual.)

5. Send your command file from the workspace to the plotter:

```
!COPY WO PL1<CR>
```

The plotter will execute the plotter language commands sent from the workspace. (Figure 9-10.)

6. If you have a 4924 tape drive installed, send the same command file to a file on the tape drive. For instance, if Tape Unit 1, file 1 is not holding data you want to keep, you may send the command file there:

```
!COPY WO TA1.1<CR>
```

7. Now copy the command file from the tape drive to the plotter:

```
!COPY TA1.1 WO<CR>
```

The plotter will execute the commands in the file, drawing the same diagram again.

4027A Language Commands for the Plotter

The preceding exercise shows how to create and use "plotter language" command files. However, plotter language has some disadvantages:

- The terminal does not understand plotter commands, and so cannot use a command file written in plotter language to draw graphs in its workspace.
- The "print" command in plotter language must end with an ASCII ETX (End-of-Text) character. However, it is not always feasible to send control characters like ETX to a host computer. (The computer may use the control characters for other purposes, and not permit them to occur in ordinary strings of text.)

You can overcome these limitations of plotter language by writing your command files in "terminal language," and letting the terminal translate them into plotter language when it sends them to the plotter. This has the following advantages:

- The terminal understands its own commands, so you can use a command file written in terminal language to draw a graph in the terminal's workspace as well as on the plotter.
- Files of terminal language commands can easily be sent to and from a host computer. (They do not have special control characters like ETX.)

The following exercise shows how to create and use terminal language command files.

Exercise

To do this exercise, you need a plotter ("PL1" in the PERIPHERALS list), and a tape drive ("TA1").

1. Create a workspace, and direct text from the keyboard to that workspace:

```
IWOR 20 K<CR>
```

2. Press the COMMAND LOCKOUT key; this turns off the COMMAND LOCKOUT light and stops the terminal from responding to commands. This lets you type a list of terminal commands into the workspace and edit them there.

3. Enter the following commands:

```
!WORKSPACE 20 K  
!GRAPHICS 1,35  
!VECTOR 23,14  
!STRING "This is the boundary of the plot."  
!VECTOR 0,0 639,0 639,479 0,479 0,0  
!VECTOR 235,192  
!STRING "This is a triangle."  
!VECTOR 43,48 598,48 320,432 43,48
```

4. Press COMMAND LOCKOUT again to remove the terminal from COMMAND LOCKOUT mode.

5. Tell the terminal to send the contents of the workspace to an unused tape file. For instance, if Tape Unit 1, file 6, is not being used, type:

```
!COPY WO TA1.6<CR>
```

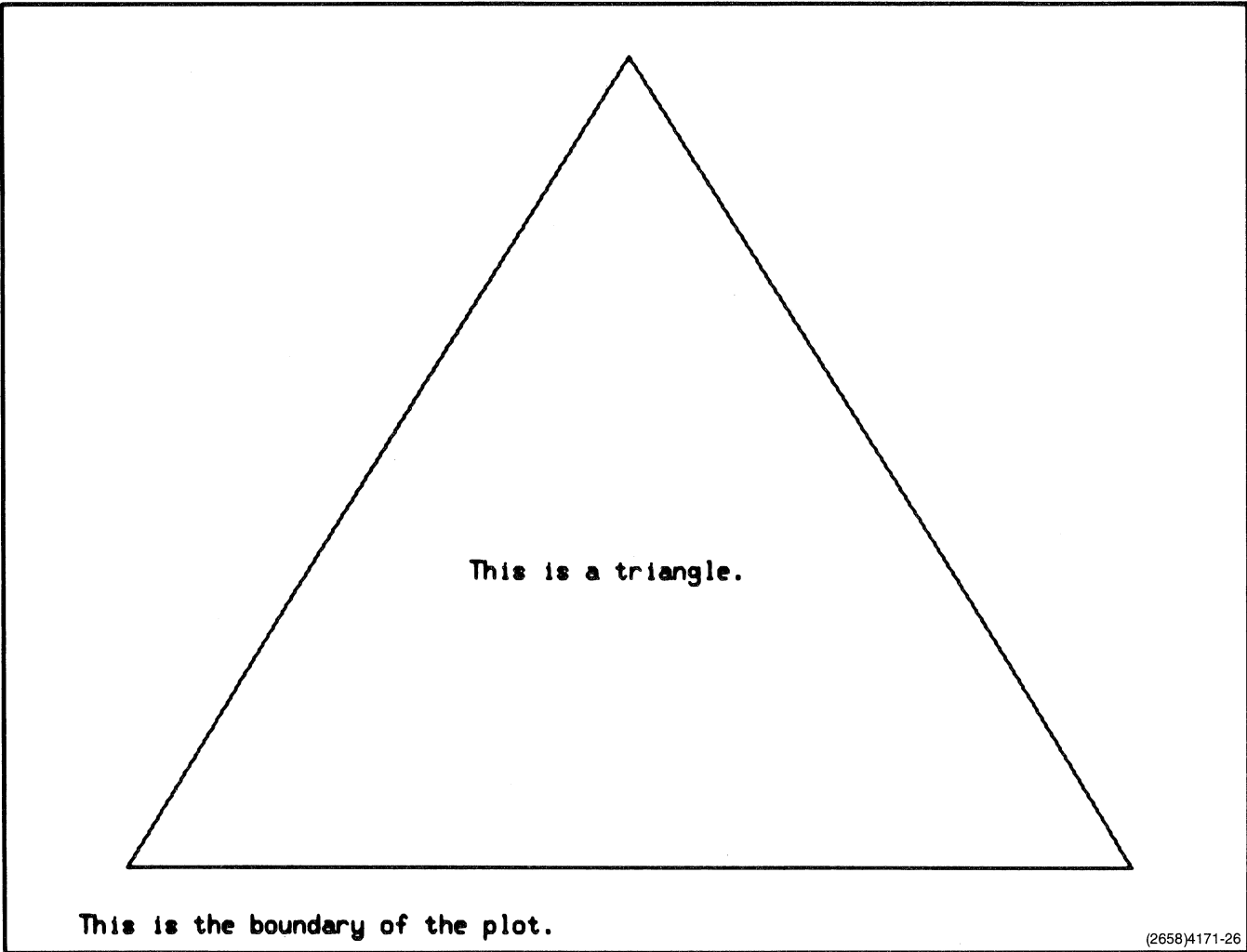


Figure 9-10. Example of a Plot in the Workspace.

6. Now copy the file back to the terminal:

!COPY TA1.6 WO< CR>

As the terminal receives the commands stored on the tape file, it executes them, drawing a diagram like that in Figure 9-10.

7. Erase the workspace (press the ERASE key), and copy the file again from the tape drive. This time, use the /N switch to suppress execution of the commands:

!COPY TA1.6 WO/N< CR>

This puts the file back in the workspace, where you may edit it with the editing keys. To do such editing, you would use this procedure:

- a. Press COMMAND LOCKOUT. With the terminal in COMMAND LOCKOUT mode, you can type new commands into the workspace without having them immediately executed.
- b. Edit the file: insert, change, delete commands as you wish.
- c. When you are finished, remove the terminal from COMMAND LOCKOUT mode. (Press the COMMAND LOCKOUT key again.)
- d. Send the file back to the tape drive with a COPY command.

8. Have the terminal copy the command file from the tape drive to the plotter, translating the commands into plotter language as it does so. To do this, type:

!COPY TA1.6/P PL1< CR>

(The "/P" is a switch instructing the terminal to take commands coming from TA1.6 and translate them to plotter language before sending them to the plotter.)

As the plotter receives the translated commands, it draws the figure they describe.

/P SWITCH

The preceding exercise introduced the /P switch. This switch tells the terminal to translate a file being copied into plotter language. These examples show how to use the /P switch:

!COPY TA1.6/P PL1< CR>

Copies a 4027A-language command file from Tape Unit 1, file 6, to the plotter, translating the file into plotter language.

!COPY TA1.6/P TA2.1< CR>

Copies the command file at Tape Unit 1, file 6, to Tape Unit 2, file 1. While copying, translates the file from 4027A language to plotter language.

!COPY HO/P PL1< CR>

Copies text coming from the host computer to Plotter 1, translating 4027A language commands to plotter commands. Copy continues until:

- The host sends an end-of-file string; or
- The host sends a prompt string with the terminal in buffered mode; or
- The operator presses a key on the keyboard.

This command should only be issued by the host computer; it should not be typed on the terminal's keyboard.

!COPY HO/P TA2.1< CR>

Copies a command file from the host computer to Tape Unit 2, file 1. While copying, translates 4027A language commands to plotter language. As in the example above, copy continues until the terminal receives an end-of-file or prompt string, or until the operator presses a key. This command should be issued by the host computer, not typed on the terminal's keyboard.

NOTE

The /P switch is always attached to the < source >, not the < destination >, in a COPY command. Also, the only "sources" to which "/P" may be attached are tape files and the host computer. That is,

*!COPY HO/P PL1< CR> and
!COPY TA1.6/P PL1< CR>*

are permitted, but

!COPY WO/P PL1< CR>

is not allowed.

The COPY command with the /P switch translates only VECTOR, RVECTOR, and STRING commands into plotter language. (It will send the outlines of POLYGON and RPOLYGON commands, but will not fill them in.)

- VECTOR and RVECTOR commands are translated into plotter "move" and "draw" commands. (For a description of the RVECTOR command, see the 4027A Programmer's Reference Manual.)
- STRING commands (used to insert text into a graphic region) are translated into plotter "print" commands. (The STRING command is described in the 4027A Programmer's Reference Manual.)
- All other 4027A commands in the file being translated are ignored. For instance, there are no plotter commands corresponding to the WORKSPACE and GRAPHICS commands used to set up a graphics region in the workspace. A command file for the 4027 might well include these commands, but when the file is translated into plotter commands, the WORKSPACE and GRAPHICS commands are ignored.

The terminal's LINE command is not translated into plotter language. You may use LINE commands to specify dashed lines in a command file, and those dashed lines will be displayed when you COPY the command file to the workspace; but when you COPY the file to the plotter using the /P switch, the dashed lines will be drawn as solid lines.

Using the !SHR or !SHR B commands tells the terminal to translate VECTOR or RVECTOR commands that may be passed to the plotter in 1024 X 1024 resolution information. In order to maintain the aspect ratio of the screen, an X VECTOR or RVECTOR of 1023 will, with the full area of the plotter defined, only draw or move to 0.867 of the maximum X dimension of the platen.

Using the !SHR R command tells the terminal to translate VECTOR or RVECTOR commands that may be passed to the plotter in 4096 X 4096 resolution information. In order to maintain the aspect ratio of the screen, an X VECTOR or RVECTOR of 4095 will, with the full area of the plotter defined, only draw or move to 0.867 of the maximum X dimension of the platen.

THE PASS COMMAND

There are many plotter commands which do not have corresponding 4027A-language commands: "Alpha Rotate" and "Alpha Size" are examples. (Appendix F lists these and other plotter language commands; for more complete descriptions of their functions, see the 4662 Interactive Digital Plotter User's Manual.)

The terminal's PASS command provides a way for the host to pass to the plotter such special plotter commands as "ALPHA ROTATE" or "ALPHA SIZE". This enables the host computer to transmit a 4027A-language command file which includes these commands through the plotter translator. Such a command file, being in 4027A language, can more easily be sent from the host computer than could a plotter-language file (which may include control characters like ETX).

A 4027A-language command file which includes PASS commands is intended to be sent to the plotter. If directed to the terminal screen, the PASS commands will be displayed. In cases where screen display is necessary, the host alphanumeric information may be directed to the monitor by use of the command, !MON H < CR>, to prevent the PASS commands from cluttering the graphic display.

In the PASS command, you specify a string of ASCII characters. Later, when the PASS command is translated into plotter language, the characters in the string are passed to the plotter. Table 9-4 illustrates the command:

Table 9-4
EXAMPLES OF THE PASS COMMAND

PASS Commands	Translations into Plotter Language
!PASS "abcde"<CR> or !PAS "abcde"<CR>	<a><c><d><e> — The string of text, "abcde".
!PASS 65,66,67,68<CR>	<A><C><D> — "ABCD"
!PASS "R10.3",3	<R><1><0> <.><3><ETX> — An "alpha rotate" command: "Set the plotter to print characters which follow as slanting upward at an angle of 10.3 degrees with respect to the X-axis."
!PASS "PHello",3<CR>	The characters <P><H><e> <l><l><o><ETX> — a "print" command: "Print 'hello' on the plotter."

COPYING DATA TO AND FROM THE HOST COMPUTER

The COPY command has special features, and special requirements, that apply COPYing to and from the host computer:

- When COPYing from the host computer, the data being copied must end with an end-of-file string.
- When COPYing to the host computer, the terminal inserts an end-of-file string at the end of the data.
- Whenever a COPY is to be from the host computer, the COPY command should be issued by that computer — not typed on the keyboard.
- In COPYing from the host computer to a peripheral device (printer, tape drive, or plotter), the data being copied may also be displayed on the terminal. A special switch ("D") is provided for this.

Each of these is discussed separately.

END-OF-FILE STRING

The end-of-file string was discussed earlier in this section, under "Copying from the Host to the Printer." The following is a summary of that discussion, which applies to all COPY operations with the host as the source of the data being copied:

- An end-of-file string is required at the end of the data being copied from the host computer.
- You can examine the terminal's current end-of-file string by means of the PERIPHERALS command.
- You can define a new end-of-file string with the EOF command.

When the COPY command has the host as destination, the terminal automatically inserts an end-of-file string at the end of the data being copied:

!COPY WO HO< CR>

Copies the data in the workspace to the host computer, appending an end-of-file string at the end of the data. The entire contents of the workspace is sent, including any field attribute codes. Functions like a SEND ALL command, except for appending the end-of-file string.

!COPY WO/U HO< CR>

With the terminal in form fillout mode, copies unprotected data in the workspace to the host computer, appending an end-of-file string at the end of the data being sent. Functions like a SEND MOD command, except for appending the end-of-file string.

!COPY WO/N HO< CR>

Copies the contents of the workspace to the host computer, suppressing any field attribute codes and sending rulings characters as asterisks. An end-of-file string is appended at the end of the data being copied.

!COPY TA1.6 HO< CR>

Sends the data in Tape Unit 1, file 6, to the host computer. Appends an end-of-file string at the end of the data being copied.

ISSUING A "COPY FROM HOST COMPUTER" COMMAND

When COPYing data from the host computer, the copy continues until one of the following occurs:

- The terminal receives its current end-of-file string in the data coming from the host.
- The terminal, in buffered mode, receives a prompt from the host computer.
- The operator types on the terminal's keyboard.

Because the copy ends when you type on the keyboard, "copy from host computer" commands should be issued by the host computer, not typed on the keyboard. To see what can go wrong if you type such a command on the keyboard, consider the following:

1. Suppose the operator types a "copy from host to workspace command," as follows:

!COPY H WO< CR>

As soon as he presses RETURN to terminate the command, the terminal begins looking for data coming from the host computer. It continues looking until one of the following happens: (a) it receives an end-of-file string, (b) it receives a prompt string if in buffered mode, or (c) the operator presses BREAK twice in quick succession.

2. At this point, the terminal is ready to copy data coming from the computer, but the computer is not sending it any data. For the computer to send the data, it must be given a command to do so. Unfortunately, since the keyboard is disabled, you cannot type the command.

The point is: do not try to issue a "copy from host computer" command from the keyboard. Let the host computer issue the command instead. One way to do this is to include the COPY command at the start of the text being copied. (An example of this is given earlier in this section, under "Copying from the Host to the Printer.")

THE /D SWITCH

In copying data from the host computer to one of the terminal's peripheral devices, you may have the terminal display the data at the time that it is copied. To do this, use the /D switch in the COPY command, as follows:

!COPY HO/D PR< CR>

Takes text coming from the host computer, and sends it to the printer. Displays the text on the terminal.

!COPY HO/D TA1,6< CR>

Takes text coming from the host computer, and sends it to Tape Unit 1, file 6. Displays the text on the terminal.

!COPY HO/D/P PL1< CR>

Takes the command file coming from the host computer, translates it into plotter language, and sends it to the plotter. Sends the same command file, untranslated, to its own display. The result is that the plotter draws the graph specified by the command file, and the terminal displays the same graph in its workspace.

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Appendix A

TEKTRONIX 4027A COLOR STANDARD

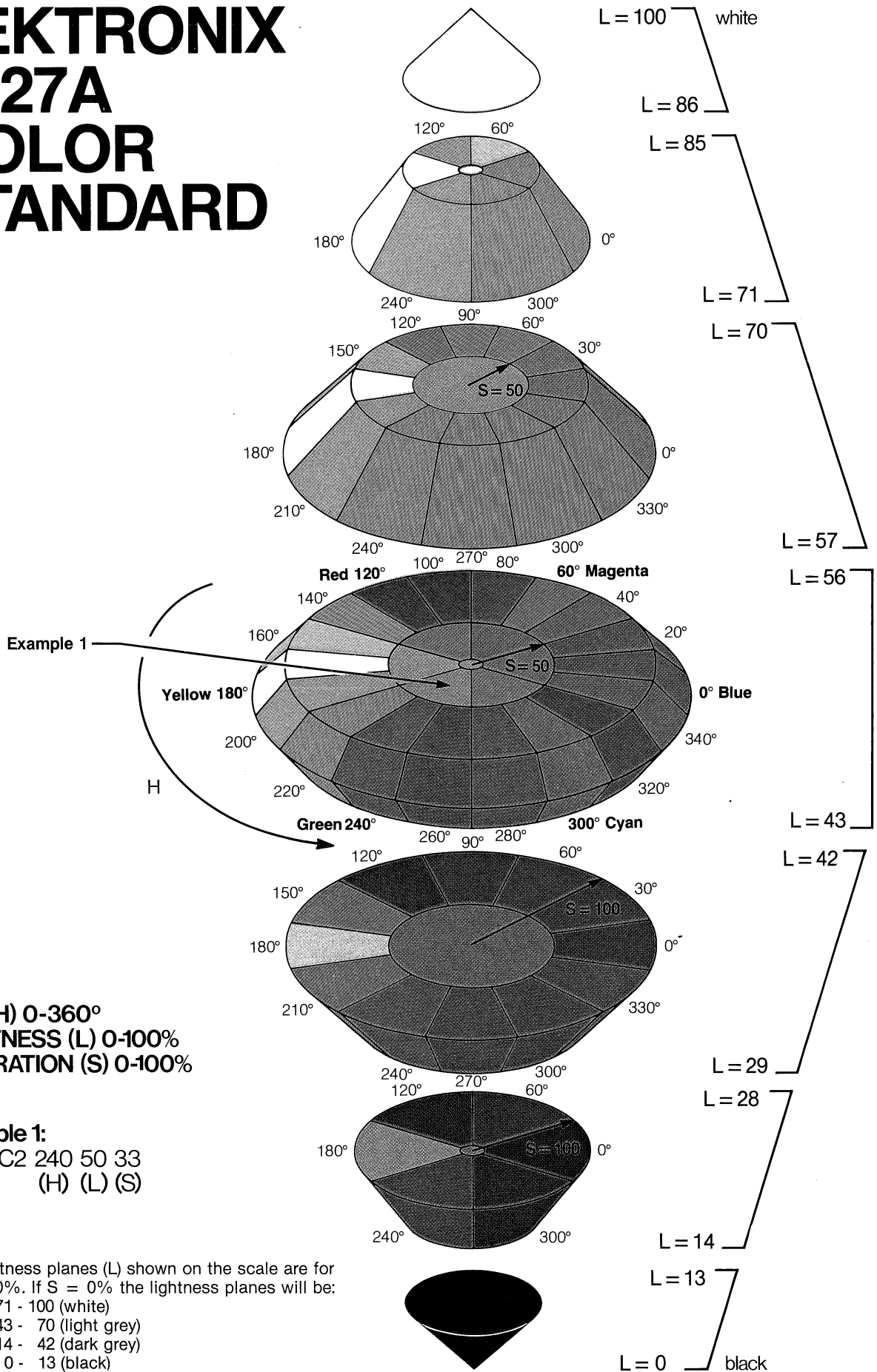


Figure A-1. 4027A Color Standard.

TEKTRONIX 4027A COLOR STANDARD

Overview:

The world of color is filled with ambiguous terminology, i.e. intensity, purity, value, etc. Many color users feel that "color theory" is a prerequisite to operating color systems; T.V., Videotaping, Photography, Computer Graphics.

In order to end this confusion, Tektronix has developed a color language and function based on human engineering, rather than machine engineering. Below is a description of this system, which will provide a clear and concise means for understanding how color is defined and how our syntax was derived.

4027A Color Concepts:

Color selection is specified by hue, lightness and saturation which is the HLS method. The definitions are as follows:

Hue: The characteristic associated with a color name such as red, yellow, green, blue, etc. Hue is a gradation of color advanced by degrees, thus represented as an angle from 0 to 360.

Lightness: The characteristic that allows the color to be ranked on a scale from dark to light. Lightness is expressed as a parameter ranging from 0 to 100% with black being 0 (bottom of cone) and white being 100% (top of cone).

Saturation: The characteristic which describes the extent to which a color differs from a gray of the same lightness. Saturation is expressed as percentage, ranging from 0% (maximum white content at that lightness level) to 100% (full saturated).

Geometrically, colors can be described in terms of a double cone (see Figure 1). Variations in lightness are represented along the axis, with white at the apex of the cone and black at the opposite apex. Variations in saturation are represented by radial distances from the lightness axis, in constant lightness planes. Hue is represented as an angular quantity from a known reference point.

The 64 colors available in the 4027A are discrete samples from this continuous color space. They are obtained by intersecting the cone into several planes of constant lightness.

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A better understanding of the color standard can be had by looking at a cross section of the double-ending cone (Figure A-2). There are four gray levels along the middle of the cone. At 0% saturation the four levels of gray are black, dark gray, light gray, and white. At any

other value of saturation, different hues (color mixtures) are obtained. Hue has no effect at 0% saturation. A maximum of seven different "planes" of color can be obtained at any value of saturation except 0%.

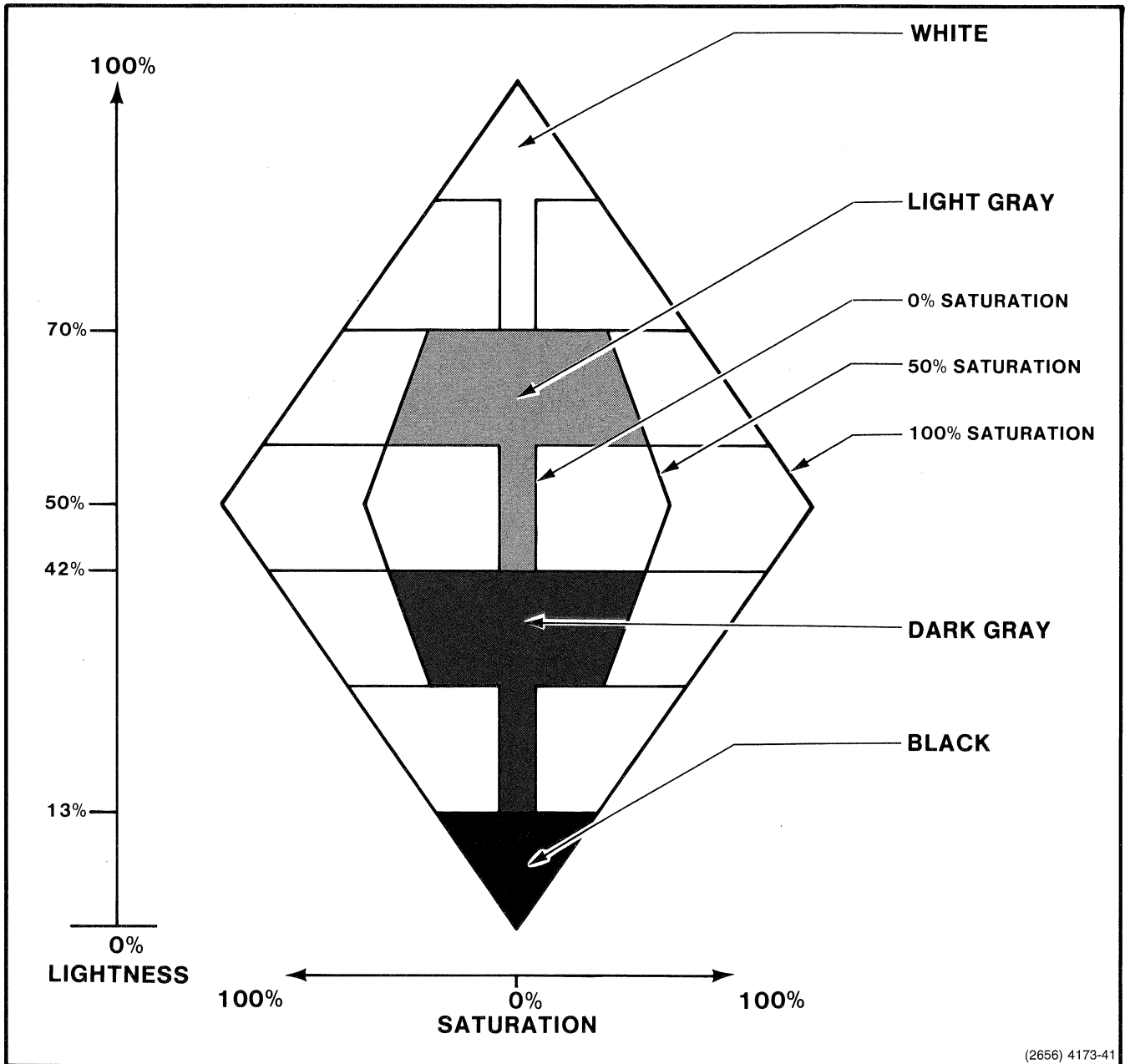


Figure A-2. Cross Section of the Color Standard.



Appendix B

EXAMPLES OF COMMANDS

The following examples of the terminal's commands all assume that the command character is the exclamation point. <CR> denotes the RETURN key. Commands are included which are not discussed in this manual; for information on those commands, see the 4027A Programmer's Reference Manual.

ALLOCATE (Requires Option 4 and 36)

Initializing an unmarked tape

!ALL TA1 0,2,5000<CR>

!ALL T 0,2,5000<CR>

Initializes the unmarked tape in tape unit 1, and creates two files (files 1 and 2) of 5000 bytes each. (If the tape has already been marked, this command destroys all old information on the tape.)

Allocating file space on a marked tape

!ALL TA1 1,2,5000<CR>

Creates two new files on tape unit 1, beginning with file 1. Each new file contains 5000 bytes.

!ALL TA1 7,4,8000<CR>

Creates four new files on tape unit 1, beginning with file 7. Each new file contains 8000 bytes.

ATTRIBUTE (Workspace)

Font Attributes

!ATT 0<CR>

!ATT<CR>

Defines a new field beginning at the cursor position; displays characters from Font 0 (the standard font) in this field.

!ATT 30 C4<CR>

Defines a new field beginning at the workspace cursor position: when characters are entered in this field, the terminal displays the corresponding characters in Color 4 from Font 30.

Logical Attributes

!ATT A<CR>

Defines an alphanumeric field beginning at the cursor position.

!ATT N<CR>

Defines a "numeric" unprotected field beginning at the cursor position. In form fillout mode, only characters with ADEs 32-63 can appear in this field.

!ATT P<CR>

Defines a protected field, beginning at the cursor position. In form fillout mode, this field cannot be typed into or erased.

!ATT PM<CR>

Defines a protected modified field beginning at cursor position. This field is transmitted to the computer with each subsequent SEND MOD command.

Visual Attributes

!ATT C5<CR>

Displays the field beginning at the cursor position with the (color) C5 visual attribute. (Characters are displayed in Color 5 on a background of Color 7.)

!ATT S<CR>

Displays the field beginning at the cursor position with the standard visual attribute. (Characters are displayed in Color 0 on a background of Color 7.)

!ATT E<CR>

Displays the field beginning at the cursor position with the enhanced visual attribute. (Color 2 on Color 7)

!ATT I<CR>

Displays the field beginning at the cursor position with the inverted visual attribute. (Color 7 on Color 0)

!ATT U<CR>

Displays the field beginning at the cursor position with the underscore visual attribute. (Color 4 on Color 7)

Combined Attributes (No spaces allowed between parameters)

!ATT C3-IC4<CR>

Displays the field beginning at the cursor position between C3 and inverted C4. The dash before the inverted attribute creates the blinking attribute. (Color 3 on Color 7 to Color 7 on Color 4)

!ATT 1 PS-C2<CR>

Defines a protected field beginning at the cursor position; blinks that field between the visual attributes of standard and C2. When characters are entered, this field displays the corresponding font 1 characters. (Requires Option 32)

BACKTAB

!BAC 5<CR>

Equivalent to pressing the BACKTAB key 5 times.

EXAMPLES OF COMMANDS

BAUD

!BAU 300,1200<CR>

Sets the transmitting baud rate to 300 baud, and the receiving rate to 1200 baud.

!BAU 9600<CR>

Sets both transmitting and receiving baud rates to 9600 baud.

!BAU O<CR>

Sets the terminal to external clock mode (requires Opt. 1)

BELL

!BEL<CR>

Sounds the terminal bell. (This is also done by sending the ASCII BEL character, CTRL G.)

BUFFERED

!BUF<CR>

!BUF Y<CR>

Places the terminal in buffered mode.

!BUF N<CR>

Removes the terminal from buffered mode.

CALIBRATE

!CAL<CR>

Displays the eight default colors and the crosshatch with the function keys labeled F1 through F10. The ESC (ESCAPE key) will exit the command and reset the terminal.

CIRCLE

!CIR 100<CR>

Draws the outline of a circle with a radius of 100 dots (screen units) centered at the current position of the graphic beam.

CLEAR

!CLE<CR>

Clears all learned key definitions including the 16 macros; all keys revert to their default definitions.

COLOR

!COL C1 C2<CR>

Sets the current vector and panel (polygon or pie) color. The second or optional color sets the outlining color. The eight default colors are labeled C0-C7.

COMMAND

!COM #<CR>

Changes the command character to the "number sign" (#).

!COM 19<CR>

Changes the command character to the ASCII character whose decimal equivalent is 19: the "DC3," or "device control #3" character.

COPY (Requires Options 3 and 36, and the 4642 Printer)

!COPY W/N P<CR>

Copies the contents of the workspace to the printer. All attribute codes are ignored and all ruling characters are converted to asterisks.

!COPY H P<CR>

Copies data from the host computer to the printer.

COPY (Requires Option 3 or 4, and 36)

Copying from the workspace

!COP WO TA1.3<CR>

!COP W T.3<CR>

Copies the workspace contents into file 3 of tape unit 1. If the workspace holds a form, this command copies the entire form (both protected and unprotected fields and their corresponding attribute codes). (Requires Option 4 and 36)

!COP W TA2<CR>

Copies the workspace contents into the next available file on tape unit 2. (Requires Option 4 and 36)

!COP W/U TA2<CR>

If the workspace holds a form, copies data from only the unprotected fields into the next available file on tape unit 2. (Requires Option 4 and 36)

!COP W/N P<CR>

Copies the workspace contents to the printer, ignoring attribute codes and converting all ruling characters to asterisks. (Requires Option 3 and 36)

Copying to the workspace

!COP T.1 W<CR>

!COP T.1<CR>

Copies file 1 of tape unit 1 into the workspace. (Requires Option 4 and 36)

!COP T.1/N W<CR>

Copies file 1 of tape unit 1 into the workspace, printing commands as text rather than executing them. (Requires Option 4 and 36)

Copying from the Host

!COP H TA1.3<CR>

Copies the host file into file 3 of tape unit 1. This file is not displayed on the terminal screen. (Requires Option 4 and 36)

!COP H/P TA1.3< CR>

Copies the host file into file 3 of tape unit 1, translating VEC, RVE, STR, AND PAS commands into plotter format. (Requires Option 4 and 36)

!COP H/D/P TA1< CR>

Copies data from the host computer into the next available file of tape unit 1. Displays this data on the screen and translates VEC, RVE, STR, POL and RPOL. (Requires Option 4 and 36)

Copying from a GPIB Device to a GPIB Device

!COP TA2.3/P PL1< CR>

Copies file 3 of tape unit 2 to plotter 1 translating it to plotter language. The file is not displayed on the terminal screen.

DCHAR

!DCH 5< CR>

Equivalent to pressing the DELETE CHAR key 5 times.

DELAY

!DEL 20< CR>

Sets (to at least 20 milliseconds) the length of time that the terminal delays before responding to a prompt from the host computer. Also sets the minimum interval to follow a prompt string.

DFONT

!DFO 21< CR>

Deletes character font number 21, so that the memory used for holding those characters may be used instead as graphics memory.

NOTE

Deleting Font 31 should not be used: patterns use this font and will be used for graphics if deleted.

DIRECTORY (Requires Option 4 and 36)

IDIR TA1 MO< CR>

IDIR T< CR>

Outputs tape unit 1 file headers to the monitor. Each file header lists the file number, file type, and length of the file (in blocks). (Output device may be any non-GPIB device.)

DISABLE

IDISA< CR>

Causes the terminal to leave GIN mode. The crosshair is removed from the graphic area and the crosshair control keys now control the alpha cursor.

DISCONNECT (Requires Option I)

IDISC< CR>

Tells the terminal to signal the modem to disconnect the data communications line.

DLINE

IDLI 6< CR>

Equivalent to pressing the DELETE LINE key 6 times; deletes 6 lines of text.

DOWN

IDOW 15< CR>

Moves the cursor down 15 lines; like pressing the "down" cursor movement key 15 times.

DUPLEX (Requires Option 1)

!DUP< CR>

!DUP F< CR>

Sets the terminal for full duplex.

!DUP H< CR>

!DUP H S< CR>

!DUP H S L< CR>

Sets the terminal for half duplex with supervisor. In buffered mode the prompt condition is line turnaround only.

!DUP H S P< CR>

Sets the terminal for half duplex with supervisor. In buffered mode the prompt condition is the prompt string plus line turnaround.

!DUP H N< CR>

!DUP H N L< CR>

Sets the terminal for half duplex normal. In buffered mode the prompt condition is line turnaround only.

!DUP H N P< CR>

Sets the terminal for half duplex normal. In buffered mode the prompt condition is the prompt string plus line turnaround.

ECHO

!ECH L< CR>

Sets the terminal for "local echo."

!ECH R< CR>

Sets the terminal for "remote echo."

ENABLE

IENA< CR>

Places the terminal in GIN mode and sets the crosshairs at the graphic cursor position.

ECF (Requires Options 3 or 4, and 36)

EXAMPLES OF COMMANDS

!EOF /abc/< CR>

Sets the end-of-file string to the ASCII characters <a> , ,<c> . This string is used in COPY commands to mark the end of a file being sent from the host computer for the terminal to copy on a 4642 line printer.

!EOF< CR>

Sets the end-of-file string to its default value, /*.

EOL

!EOL< CR>

Sets the end-of-line string to "carriage return."

!EOL 13 10< CR>

Sets the end-of-line string to the ASCII characters whose decimal equivalents are 13 and 10: < CR> , < LF> ("carriage return, line feed").

!EOL /abcDEF/ 13 10< CR>

Sets the end-of-line string to the ASCII characters <a> , ,<c> ,<D> ,<E> ,<F> ,< CR> ,< LF> .

ERASE

!ERA< CR>

If this command comes from the host computer or a peripheral device, the terminal erases the scroll (workspace or monitor) which receives text from the host computer.

If this command is typed on the keyboard, the terminal erases whichever scroll receives text from the keyboard.

!ERA W< CR>

Erases the workspace.

!ERA M< CR>

Erases the monitor.

!ERA G< CR>

Erases the contents of the graphic area.

!ERA G C1< CR>

Erases the contents of the graphic area with Color 1.

!ERA G P1< CR>

Erases the contents of the graphic area with pattern (P1).

EXPAND

!EXP M1< CR>

Causes the string assigned to the given macro (M1) to be inserted in the input queue in place of the EXPAND command. (Macro specifications are M1 to M16.)

FIELD

!FIE #< CR>

Sets (to "#") the character which is used to precede fields when they are transmitted to the host computer.

!FIE 02< CR>

Selects the ASCII character whose decimal equivalent is "2" as the character which precedes fields when they are transmitted to the host computer.

!FIE 2< CR>

Selects the numeral 2 as the character to precede fields when they are transmitted to the host computer.

FONT

!FONT 0,30,C7,C4< CR>

Copies the standard font (0) into Font 30 in C7 (background color) and C4 (foreground color). To avoid altering the graphics area, fonts should be defined before drawing graphics.

NOTE

Font 31 is reserved for storing user defined patterns. The use of 31 in the FONT command is illegal. If Font 31 is used in a FONT command an error condition will occur. The only way to recover from the error condition is to reset the terminal.

FORM

!FORM< CR>

!FORM Y< CR>

Puts the terminal in form fillout mode.

!FORM N< CR>

Removes the terminal from form fillout mode.

GRAPHIC

!GRA 5,9< CR>

Sets up a graphic area in the workspace, containing all 80 columns of rows 5 through 9.

!GRA 5,9,10,70< CR>

Sets up a graphic area in the workspace, starting at row 5 and ending at row 9, and containing columns 10 through 70 in those rows.

GTEST

!GTE< CR>

Tests each bit of graphic RAM (random access memory), including all three color planes. For each font, indicates whether ROM is installed, and, whether that ROM is OK. If faulty ROM or RAM is found, displays an error code for use by service personnel.

HCOPY (Requires Option 42)

!HCO W< CR>

Copies one 34-line page from the workspace onto a TEKTRONIX 4632 Hard Copy Unit, starting with the first line of the workspace which is in view on the screen.

IHCO 3 M< CR>

Copies three pages from the monitor onto a 4632 Hard Copy Unit. Copy begins with the first line of the monitor which is visible on the screen, and continues for three 34-line pages.

IHCO S< CR>

Copies the contents of the screen onto a 4632 Hard Copy Unit.

HRULE (Requires Option 32)

IHRU 3,5,15,2< CR>

Starts at row 3, column 5 in the workspace, and draws a horizontal ruling through 15 character positions. The ruling is a double line.

IHRU 3,5,15,1< CR>

Starts at row 3, column 5 in the workspace, and draws a horizontal ruling through 15 character positions. The ruling is a single line.

ICHAR

!ICH< CR>

Puts the terminal in insert mode. (The terminal leaves insert mode on receiving a cursor movement character or a command which moves the cursor.)

ILINE

!ILI 3< CR>

Inserts 3 lines in the text, starting at the current cursor location; equivalent to pressing INSERT LINE 3 times.

INK

!INK< CR>

!INK Y< CR>

Enables a line to be drawn in the current color from the previous location of the crosshair to the present location.

!INK N< CR>

Terminates the INK command.

JUMP (Workspace Only)

IJUM< CR>

Moves the cursor to the start of the first line of the workspace.

IJUM 15< CR>

Moves the cursor to the start of the 15th line of the workspace.

IJUM 15,26< CR>

Moves the cursor to row 15, column 26 in the workspace.

KILL (Requires Option 4 and 36)

IKIL TA1.5< CR>

Releases the space used to store file 5 on tape unit 1. This space may then be used to store new information.

LEARN

!LEA Q /abc/< CR>

Programs the shifted version of the Q key (uppercase Q) to mean the string of characters, < a> ,< b> ,< c> .

!LEA Q /abc/ 13< CR>

Programs the uppercase Q key to mean the string of characters, < a> ,< b> < c> ,< CR> . The < CR> ("carriage return") character is represented in the LEARN command by its ASCII decimal equivalent, the number 13.

!LEA F1 /abc/< CR>

Programs function key number 1 to mean the string, < a> ,< b> ,< c> .

!LEA S1 /abc/< CR>

Programs the shifted version of function key number 1 to mean the string < a> , < b> , < c> .

!LEA M2!/WOR 25!GRA 1,25!MON H; READY/13< CR>

Assigns the delimited command string, followed by a carriage return, to the Macro M2. (M1 to M16 are the allowed macro names.) The macro may be executed by using the EXPAND command.

LEFT

!LEF 5< CR>

Moves the alpha cursor five character positions to the left. If necessary, the cursor wraps around to the previous line. Equivalent to pressing the left cursor (←) key five times.

LINE

!LIN< CR>

!LIN 1< CR>

Sets the line type for subsequent VECTOR commands to "line type 1" — a solid line.

!LIN 5< CR>

Sets the line type to "line type 5."

!LIN E< CR>

Sets the line type to "line type E." Subsequent VECTOR commands will draw "background color vectors," which erase anything in their paths.

!LIN P< CR>

Sets the line type to "line type P." Subsequent VECTOR commands will plot points, rather than draw lines.

EXAMPLES OF COMMANDS

MAP

!MAP C1 0,50,100<CR>

Sets Color 1 to the specified color value (blue) with hue, lightness, and saturation parameters 0,50, and 100, respectively.

MARGINS (Workspace Only)

!MAR<CR>

Sets the left margin to column 1 of the workspace, and the right margin to column 80.

!MAR 5<CR>

Sets the left margin to column 5, and the right margin to column 80.

!MAR 10,70<CR>

Sets the left margin to column 10, and the right margin to column 70.

MIX

!MIX C2 25,0,100<CR>

Sets Color 2 to a given color value expressed in percentages (25,0,100) of red, green and blue, respectively.

MONITOR

!MON 5 H K<CR>

Creates a workspace. Reserves the bottom 5 lines of the screen for displaying the monitor, leaving the 29 lines above for displaying the workspace. Directs text from the host computer and the keyboard to the monitor.

!MON H<CR>

Directs text from the host computer to the monitor.

!MON K<CR>

Directs text from the keyboard to the monitor.

!MON <CR>

If this command is typed on the keyboard, it directs text from the keyboard to the monitor. If this command comes from the host computer, it directs text from the host computer to the monitor.

PAD

!PAD 205 <CR>

Places the terminal in keyboard lock mode (see Section 3).

!PAD 203<CR>

Removes the terminal from keyboard lock when given from the host computer. Keyboard lock may be exited from the terminal keyboard by pressing BREAK-BREAK.

!PAD 209<CR>

Places the terminal in delete ignore mode, to discard delete characters (ADE 127) as they are received (see Section 6).

!PAD 207<CR>

Places the terminal in full 128-character receive mode.

PARITY

!PAR E<CR>

Sets the terminal to even parity.

!PAR O<CR>

Sets the terminal to odd parity.

!PAR N<CR>

Sets parity to "none;" the terminal ignores the parity bit on input, and sets it to "0" on output.

!PAR D<CR>

Sets parity to "data;" the parity bit is available for use as a data bit.

!PAR H<CR>

Sets parity to "high;" the terminal ignores the parity bit on input, and sets it to "1" on output.

PASS

!PAS /S3.584 5.632/<CR>

Used during a COPY operation with plot translation in effect (/P switch set in COPY command). Passes the plotter-style command string S3.584 5.632, unmodified, to the output device specified in the COPY command.

PATTERN

!PAT P1 C1 C2 0,0,0,0,60,60,60,60,60,0,0,0,0<CR>

Defines a colored pattern in Color 1 and Color 2 for use in vector drawing, pie, and polygon filling. Up to 120 patterns (P0-P19) can be specified. The first color number is the background color while the second color number specifies the dots that are to be made that color by the numerical parameters which follow. (See SYMBOL command.)

PERIPHERALS (Requires Option 3 or 4 and 36)

!PER M<CR>

Prints a peripherals data list in the monitor. For each device attached to the terminal, this list displays the device mnemonic, the GPIB address, and the option data field. (GPIB address is blank for the printer.) Final entry in the list specifies the end-of-file string.

!PER P<CR>

Prints a peripherals data list on the printer.

TA1-TA4	Tape units 1-4
PL1,PL2	Plotters 1,2
P or PR	Printer

PIE

!PIE 100,90,360<CR>

Draws a pie with a radius of 100; fills in the area of the pie between 90 and 360 degrees in the current color.

POLYGON

!POL 0,0,200,0,200,200<CR>

!POL 0,0 200,0 200,200<CR>

!POL 0 0 200 0 200 200<CR>

Creates a polygon defined by the given vertices in the current color. The vertices are designated as in the VECTOR command.

PROMPT

!PRO /abc/<CR>

Sets the prompt string to <a>,,<c>. In buffered mode, the terminal must receive this string from the host before it sends each line of text from its transmit buffer.

!PRO 13 10<CR>

Sets the prompt string to the ASCII characters whose decimal equivalents are 13 and 10: <CR>,<LF>.

!PRO<CR>

Sets the prompt string to the single character, <LF> ("line feed").

REPORT (From the Host Computer Only)

!REP 00<CR>

Causes the terminal to send a report to the host computer; indicates the number of unused blocks of memory and the system status byte.

!REP 01<CR>

Reports to the host computer the status of the workspace cursor; gives the row and column location of the cursor and the character stored at that location.

!REP 02<CR>

Reports to the host computer the status of the graphic beam; gives the X and Y coordinate points, current color or pattern, and current SHRINK mode.

!REP 03<CR>

Reports to the host computer the status of the crosshair; indicates whether the crosshair is present and gives its X and Y coordinate points.

!REP 05<CR>

Reports to the host computer the status of device 5 (tape unit 2); indicates whether that device is present, the last tape error code, and whether the tape unit is SET to 4051 or 4923 compatibility.

!REP 12<CR>

Reports the status of plotter 1; indicates whether the plotter is present; if it is present, indicates the ASCII integer value of plotter status word O.

!REP 14<CR>

Reports the status of the printer; indicates whether the printer is present; if it is present, indicates the L/F option and the printer delay.

Peripheral device numbers:

- 00 — system status block
- 01 — workspace cursor
- 04-07 — tape units 1-4
- 12,13 — plotters 1,2
- 14 — printer

RDOWN

!RDO 5<CR>

Rolls the workspace or monitor scroll down 5 lines. (Equivalent to pressing the "down" scrolling key 5 times.) The action stops when the top of the scroll is in view on the screen.

RIGHT

!RIG 5<CR>

Moves the cursor 5 character positions to the right.

RMAP

!RMAP C1 0,-10,0<CR>

Changes Color 1 with hue, lightness and saturation parameters 0,-10,0, respectively.

RPOLYGON

!RPOL 0,0,100,0,0,100,-100,0<CR>

Creates a polygon with the vertices given in relative coordinates (as in the RVECTOR command) in the current color.

REMOTE START STOP

!RSS H 20 18<CR>

Sets the terminal to host control of data from the terminal to parameters of DC4 for stop and DC2 for start.

!RSS S<CR>

Displays RSS status.

EXAMPLES OF COMMANDS

RUP

IRUP 5<CR>

Rolls the workspace or monitor scroll up 5 lines. (Equivalent to pressing the "up" scrolling key 5 times.) The action stops when the last line of text already entered in the scroll comes into view on the screen.

RVECTOR

IRVE 5,5,10,10<CR>

"Relative vector" command. Same as a VECTOR command, except the coordinates are centered on the last beam position (end of the last line segment in a VEC or RVEC command), rather than being centered on the point (0,0).

SEND ALL

ISEN A<CR>

If not in form fillout mode, sends to the computer all the data in the workspace, including attribute codes, which are encoded as ATTRIBUTE commands.

If in form fillout mode, sends to the computer the contents of all the "blanks" of the form (the unprotected fields).

SEND MOD

ISEN M<CR>

ISEN<CR>

If not in form fillout mode, functions like SEND ALL; sends the entire contents of the workspace to the computer.

If in form fillout mode, sends to the computer the contents of those blanks ("unprotected fields") which have been modified since the last SEND MOD command. Sends also the contents of those protected fields which have been marked with the "modified" logical attribute.

SEND

ISEN<CR>

Same as SEND ALL.

SET (Requires Option 3 or 4, and 36)

!SET PL1 15<CR>

Instructs the terminal that plotter 1 is present at GPIB address 15. This must agree with the address switch settings on the plotter. GPIB addresses are specified for those and only those devices present and powered up on the bus. (Requires Option 4 and 36)

!SET TA1 8 4051<CR>

!SET T 8<CR>

Instructs the terminal that tape unit 1 is present at GPIB address 8, and instructs this tape unit to write data in 4051 compatible format. (GPIB address for a tape unit must be even.) (Requires Option 4 and 36)

!SET TA2 10 4923<CR>

Instructs the terminal that tape unit 2 is present at GPIB address 10, and instructs this tape unit to write data in 4923 compatible format. (Requires Option 4 and 36)

!SET PR F 3<CR>

Instructs the terminal to use a form feed character [<FF>] as the page separator; when the printer receives a <FF>, it will begin a new page. Also sets the printer delay to 0.3 seconds; after sending a <CR>, <LF>, or <FF> to the printer, the 4027 waits 0.3 seconds before sending another character. (Requires Option 3 and 36)

!SET PR L<CR>

Instructs the terminal that the printer does not treat a <FF> character as the page separator. The terminal will replace a <FF> with the number of <LF>'s required to begin a new page. (Requires Option 3 and 36)

!SET PR O<CR>

Instructs the terminal to communicate with the printer using flagged simplex protocol. (After sending a <CR>, <LF>, or <FF>, the terminal waits for a DTR (Data Terminal Ready) signal from the printer before sending another character.) (Requires Option 3 and 36)

SHRINK

!SHR<CR>

!SHR Y<CR>

Causes the terminal to "shrink" X- and Y-coordinates in subsequent graphic commands, by a factor of 5/8. This accommodates the terminal to the range of possible coordinates in 4010-style graphic commands.

!SHR H<CR>

Causes the terminal to "shrink" Y-coordinates (but not X-coordinates) in graphic commands, by 7/8. This predistorts graphs drawn on the terminal's screen.

!SHR B<CR>

Causes the terminal to perform both "ordinary" and "hard copy" shrink operations on coordinates in subsequent graphic commands. Multiplies X-coordinates by 5/8, and Y-coordinates by 35/64.

ISHR N<CR>

Removes the terminal from "shrink mode," so that X- and Y-coordinates in subsequent graphic commands are not altered.

NOTE

These commands (!SHR H and !SHR B) are present for 4025A compatibility. When the 4027A is used with the 4632 Hard Copy Unit, hard copies appear distorted.

SNOOPY

!SNO<CR>

!SNO Y<CR>

Puts the terminal in "snoopy mode." (In snoopy mode, the "non-printing" ASCII characters are represented on the display by two-letter abbreviations.)

!SNO N<CR>

Removes the terminal from snoopy mode.

STOPS

!STO 5,10,15<CR>

Puts tab stops in columns 5, 10, and 15.

STRING

!STR /EARNINGS/<CR>

Inserts the string EARNINGS in the graphics area. The first character in this string appears at the character position containing the graphic cursor.

SYMBOL

!SYM 8,30,C2,C3,0,0,0,0,2,52,72,72,52,2,0,255<CR>

Defines character 8 of Font 30. Each integer after the C3 parameter is converted to an 8-bit binary equivalent. The 0-1 pattern of this binary equivalent specifies which dots in a given row of the 8X14 dot matrix will be displayed in Color C3. C2 is the background color. Rows 13-14 are in the background color since no foreground dots are defined.

SYSTAT

!SYS<CR>

Displays the system status message in the monitor.

TAB

!TAB 2<CR>

Performs the same action as pressing the TAB key twice.

If not in form fillout mode, each tab advances the cursor one tab stop or to the beginning of the next line.

If in form fillout mode, each tab advances the cursor to the next blank (unprotected field) of the form.

TEST

!TES<CR>

Checks the terminal's memory, testing each character location and displaying each of the possible ROMs, OK if checksum is okay, BAD (with what checksum should be) if checksum doesn't match, or NO ROM if ROM not installed. In addition to the checksums, displays a sample of each character that may be displayed from 0 to 1, and rings the bell.

UP

!UP 5<CR>

Moves the cursor up 5 lines; similar to pressing the "up" cursor movement key 5 times.

VECTOR

!VEC 0,0,100,100,0,10<CR>

Draws a line in the graphic area of the workspace, starting at point (0,0) and continuing to (100,100); draws another line from there to the point (0,10).

VRULE (Requires Option 32)

!VRU 3,5,15,2<CR>

Starts at workspace row 3, column 5, and draws a vertical ruling downward through 15 character positions. The ruling is a double line.

!VRU 3,5,15,1<CR>

Starts at workspace row 3, column 5, and draws a vertical ruling downward through 15 character positions. The ruling is a single line.

WORKSPACE

!WOR 20 H K<CR>

Creates a workspace, and allots the top 20 lines of the screen for displaying it. Directs text from the host computer and the keyboard to that workspace.

!WOR H<CR>

Directs text from the host computer to the workspace.

!WOR K<CR>

Directs text from the keyboard to the workspace.

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Appendix C

THE ASCII CODE

When the terminal stores text in its memory, or sends and receives text from the computer, it represents that text as a collection of telegraph characters, using the ASCII telegraph code. ("ASCII" stands for "American Standard Code for Information Interchange." This code is known internationally as the "ISO-7" code.)

Bits. Each character of the ASCII code is a collection of seven "bits" ("binary digits"). (Often an eighth bit, the "parity bit" is added for error-detection purposes.) Each bit is either "1" or "0." With 7 bits, there are 128 possible combinations; these are the 128 ASCII characters.

ASCII Decimal Equivalents. Each character may be regarded as a binary numeral, representing a number in the range from 0 to 127. For instance, the ASCII character for "Z" is "1011010," which is the binary numeral for the number 90. We say that 90 is the "ASCII decimal equivalent" for the letter Z.

Printing and Non-Printing Characters. The 128 characters in the ASCII alphabet include many characters which can be printed on paper: upper- and lower-case letters of the alphabet, numerals, the "space" character, punctuation marks and special symbols. In addition, there are some "non-printing" characters, or "control characters." These have special meanings such as "carriage return" or "device control #1," and are used to control machines.

Using the ASCII Code Chart. Table C-1 is an "ASCII Code Chart;" it lists the 128 ASCII characters, and shows the binary bits and ASCII decimal equivalent for each character. The chart is a rectangular array of 8 columns, each containing 16 characters; this makes it more compact than a table with a single column of 128 characters.

NOTE

If you have Option 4A or 4C, refer to Appendix D for revised ASCII code chart.

The "high order bits" (B7,B6,B5) for the characters in each column are the same; they appear at the top of the column. Similarly, the "low-order bits" (B4,B3,B2,B1) for the characters in each row are the same, and are shown at the left of the row.

For instance, the letter "Z" is in the sixth column and eleventh row. At the top of the column, we see its high-order bits: "101;" and its low-order bits, "1010," appear at the left of the row. Hence, its seven binary bits are:

B7	B6	B5	B4	B3	B2	B1
1	0	1	1	0	1	0

The binary numeral "1011010" represents the number "90." This is the ASCII decimal equivalent for "Z," and appears next to it in the chart.

The "control characters" occupy the first two column in table C-1. There are keys on the keyboard for only a few of these characters: "escape" ("ESC"), "tab" ("HT"), "backspace" ("BS"), "carriage return" ("CR"), and "line feed" ("LF"). However, you can send any control character to the computer by using the CTRL key.

To send one of the control characters, you hold down the CTRL key and type one of the other ASCII characters. For instance, to type an "ENQ" character, you press CTRL-E; to type a "DC3," you press CTRL-S. Table C-2 lists the control characters, together with the two-letter mnemonics by which they are displayed when using the LEARN key, and the keys you press to type these characters.

Table C-1
ASCII CODE CHART

BITS				0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
B7	B6	B5	B4 B3 B2 B1	CONTROL		HIGH X & Y GRAPHIC INPUT		LOW X		LOW Y	
0	0	0	0	NUL 0	DLE 16	SP 32	0 48	@ 64	P 80	\ 96	p 112
0	0	0	1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
0	0	1	0	STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114
0	0	1	1	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
0	1	0	0	EOT 4	DC4 20	\$ 36	4 52	D 68	T 84	d 100	t 116
0	1	0	1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
0	1	1	0	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
0	1	1	1	BEL 7	ETB 23	/ 39	7 55	G 71	W 87	g 103	w 119
1	0	0	0	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
1	0	0	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	0	1	0	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	0	1	1	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123
1	1	0	0	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	l 124
1	1	0	1	CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125
1	1	1	0	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	- 95	o 111	RUBOUT (DEL) 127

Table C-2
CONTROL CHARACTERS

Mnemonic	Usual ASCII Abbrev.	Name of Character	Keys to Press
N	NUL	Null	CTRL- @
S	SOH	Start of Heading	CTRL-A
X	STX	Start of Text	CTRL-B
E	ETX	End of Text	CTRL-C
T	EOT	End of Transmission	CTRL-D
Q	ENQ	Enquiry	CTRL-E
A	ACK	Acknowledgement	CTRL-F
B	BEL	Bell	CTRL-G
S	BS	Backspace	CTRL-H
H	HT	Horizontal Tab	CTRL-I
L	LF	Line Feed	CTRL-J
V	VT	Vertical Tab	CTRL-K
F	FF	Form Feed	CTRL-L
C	CR	Carriage Return	CTRL-M
S	SO	Shift Out	CTRL-N
I	SI	Shift In	CTRL-O
D	DLE	Data Link Escape	CTRL-P
D	DC1	Device Control 1	CTRL-Q
2	DC2	Device Control 2	CTRL-R
D	DC3	Device Control 3	CTRL-S
3	DC4	Device Control 4	CTRL-T
N	NAK	Negative Acknowledgement	CTRL-U
S	SYN	Synchronization Character	CTRL-V
E	ETB	End of Transmission Block	CTRL-W
C	CAN	Cancel	CTRL-X
E	EM	End of Medium	CTRL-Y
S	SUB	Substitute	CTRL-Z
E	ESC	Escape	CTRL-[
F	FS	Field Separator	CTRL-\
S	GS	Group Separator	CTRL-]
R	RS	Record Separator	CTRL-↑
			CTRL- ^
			(CTRL-up arrow or CTRL-circumflex accent)
U	US	Unit Separator	CTRL- _
S			(CTRL-underscore)

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Appendix D

OPTIONS

The following options are available for the 4027A.

Option 1: Half Duplex

Permits half duplex data communications, in addition to the full duplex data communications provided as standard equipment.

Option 2: Current Loop

Permits the terminal to communicate with its host computer or another device by means of a 20 mA or 60 mA current loop rather than the standard RS-232 interface.

Option 3: RS-232 Peripheral Interface

Permits the terminal to transmit to RS-232 compatible peripheral devices such as the TEKTRONIX 4642 Line Printer. With this option, data from the host computer or the terminal's workspace can be printed on the 4642 Line Printer.

(Requires Option 36.)

Option 4: GPIB Peripheral Interface

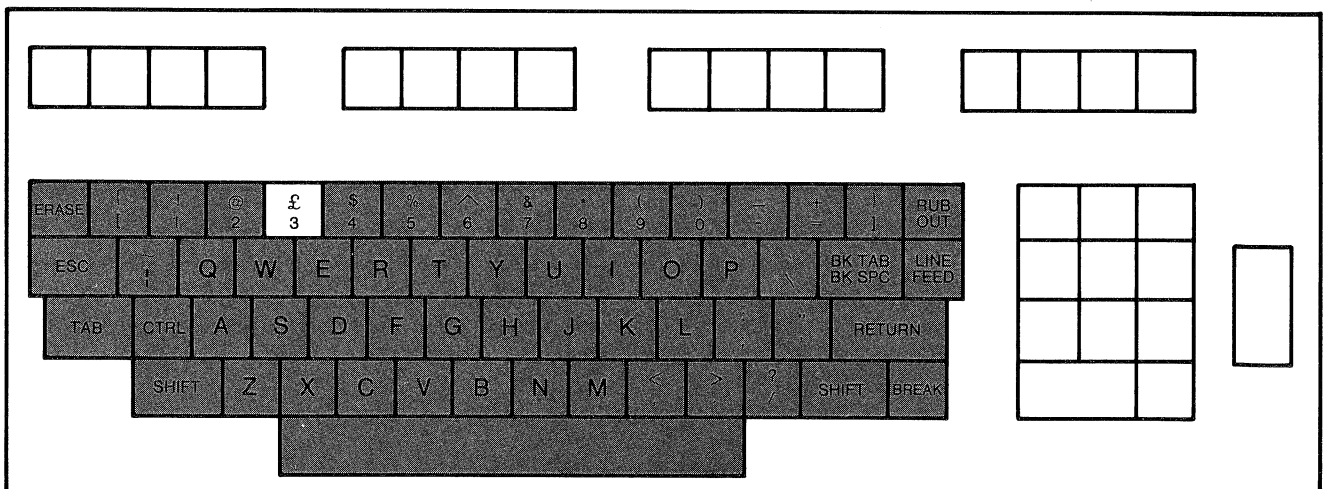
Permits the terminal to communicate with and control the TEKTRONIX 4924 Digital Cartridge Tape Drive and 4662 Interactive Digital Plotter. (These devices communicate with the 4027 over the General Purpose Interface Bus (GPIB), which is defined in IEEE Standard 488-1975.)

Allows the terminal to save data or command files on the 4924, and retrieve them later without the need for intervention by the host computer. Typical applications include storage and retrieval of forms, command lists, etc.

(Requires Option 36.)

Option 4A: United Kingdom Character Set

This option permits Tektronix 4020 Series terminals to change to a United Kingdom standard keyboard layout so that the United Kingdom characters are displayed. The only change is that the “#” sign is replaced by the English “£” sign. This is shown in the revised keyboard configuration (see Figure 1), and the revised ASCII Code Chart (see Table 1). When this key is pressed (or the appropriate code is received by the terminal), the “£” sign is displayed on the screen.



2943-1A

Figure D-1. United Kingdom Keyboard.

Table D-1

UNITED KINGDOM CHARACTER SET

BITS				0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
B7	B6	B5	B4	CONTROL		HIGH X & Y GRAPHIC INPUT		LOW X		LOW Y	
0	0	0	0								
0	0	0	0	NUL 0	DLE 16	SP 32	0 48	@ 64	P 80	\ 96	p 112
0	0	0	1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
0	0	1	0	STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114
0	0	1	1	ETX 3	DC3 19	£ 35	3 51	C 67	S 83	c 99	s 115
0	1	0	0	EOT 4	DC4 20	\$ 36	4 52	D 68	T 84	d 100	t 116
0	1	0	1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
0	1	1	0	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
0	1	1	1	BEL 7	ETB 23	/ 39	7 55	G 71	W 87	g 103	w 119
1	0	0	0	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
1	0	0	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	0	1	0	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	0	1	1	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123
1	1	0	0	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	l 124
1	1	0	1	CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125
1	1	1	0	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	RUBOUT (DEL) 127

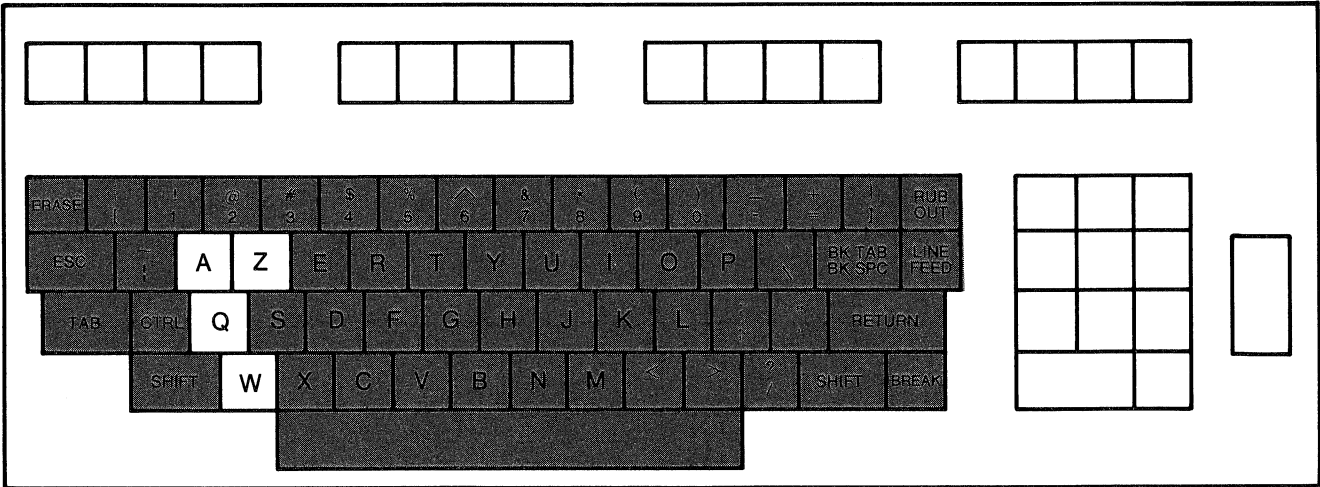
2943-2A

Option 4B: French Character Set

This option permits Tektronix 4020 terminals to change to the French "AZERTY" keyboard layout for the standard ASCII character set. All the characters are the same as on the 4020 standard keyboard. The only changes are that four keys are switched around. This is shown in the revised keyboard configuration (see Figure 2). There are no changes to the ASCII Code Chart. When these four keys are pressed (or the appropriate codes are received by the terminal), these characters are displayed on the screen.

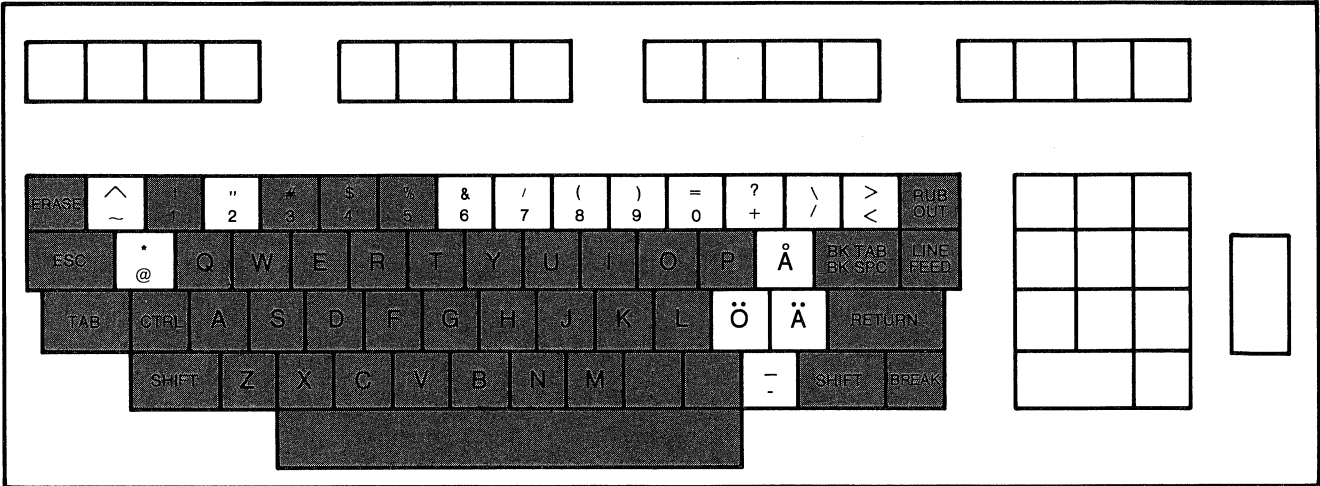
Option 4C: Swedish Character Set

This option permits Tektronix 4020 terminals to change to a Swedish standard layout so that the Swedish characters are displayed. There are seventeen changes to the keyboard, with three of these changes being new characters. These changes are shown in the revised keyboard configuration (see Figure D-3) and the revised ASCII Code Chart (see Table D-2). When these seventeen keys are pressed (or the appropriate codes are received by the terminal), the corresponding characters are displayed on the screen.



2944-1A

Figure D-2. French Keyboard.



2947-1A

Figure D-3. Swedish Keyboard.

Table D-2
SWEDISH CHARACTER SET

BITS B7 B6 B5 B4 B3 B2 B1				0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
				CONTROL	HIGH X & Y GRAPHIC INPUT			LOW X		LOW Y	
0	0	0	0	NUL 0	DLE 16	SP 32	0 48	@ 64	P 80	\ 96	p 112
0	0	0	1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
0	0	1	0	STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114
0	0	1	1	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
0	1	0	0	EOT 4	DC4 20	\$ 36	4 52	D 68	T 84	d 100	t 116
0	1	0	1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
0	1	1	0	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
0	1	1	1	BEL 7	ETB 23	/ 39	7 55	G 71	W 87	g 103	w 119
1	0	0	0	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
1	0	0	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1	0	1	0	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1	0	1	1	VT 11	ESC 27	+ 43	; 59	K 75	Å 91	k 107	ä 123
1	1	0	0	FF 12	FS 28	, 44	< 60	L 76	Ö 92	l 108	ö 124
1	1	0	1	CR 13	GS 29	- 45	= 61	M 77	Ä 93	m 109	å 125
1	1	1	0	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	— 95	o 111	RUBOUT (DEL) 127

2947-2A

Power Cord Options

- Option A1 220V/16A 50 Hz operation, universal European plug.
- Option A2 240V/13A 50 Hz operation, United Kingdom plug.
- Option A3 240V/10A 50 Hz operation, Australian plug.
- Option A4 240V/15A 60 Hz operation, North American plug.

Options 21, and 22: Added Display Memory

The standard terminal includes 16384 bytes of display memory. (Each byte is 8 binary bits, and can hold one ASCII character.) Option 22 expands this, permitting larger quantities of text to be stored in the terminal's workspace and monitor.

Option 22: 32,768 (32K) bytes.

Options 27, 28 and 29: Added Graphics Memory

These options differ only in the amount of "graphic memory" they include. Larger amounts of graphics memory permit the terminal to draw larger and more complex graphs in its workspace, and to create more alternate character sets.

Option 27: 98,304 (96K) bytes of graphics memory

Option 28: 147,456 (144K) bytes of graphics memory

Option 29: 196,608 (192K) bytes of graphics memory

Option 31: Character Expansion

Permits the addition of ROMs (Read-Only Memories) containing alternate character fonts.

Option 32: Ruling Characters

Adds "ruling" character font, permitting single and double lines to be drawn on forms in the workspace.

(Requires Option 31.)

Option 34: Math Characters

Adds a set of "math" characters to permit mathematical symbols to be displayed in the workspace. Includes standard mathematical symbols, Greek letters, etc.

(Requires Option 31.)

Option 36: Peripherals ROM

Provides instructions for the terminal's processor, allowing it to communicate with RS-232 or GPIB peripheral devices.

(Required for Option 3 or Option 4.)

Appendix E

SPECIFICATIONS

Table E-1
DISPLAY MECHANISM

Characteristic	Description
Display type	Color Video monitor.
Screen size	33.0 cm (13.0 in) diagonal.
Usable display area	19.1 cm x 25.4 cm (7.5 in x 10.0 in)
Phosphor type	Long persistence red, P-39 green, and P-22 blue
Video bandwidth	15 MHz
Raster lines	Standard 525 line scan, with 480 lines displayed.
Scan	30 Hz interlaced scan.
Refresh rate	
Dot	30 times/second
Frame	30 times/second
Field	60 times/second

Table E-2
DISPLAY CHARACTERISTICS

Characteristic	Description
Colors	Eight colors displayable at once selected by user from 64 possible color mixtures. 120 user defined patterns can be programmed.
Cursor type	Wide underscore
Character size Standard	7 X 9, in an 8 X 14 dot matrix. (Graphics cells are 8 X 14 matrix.)
Character sets Standard	64/96 upper and lower case ASCII. (A special "snoopy mode" is provided which displays all characters and commands. Snoopy mode enables the display of 128 characters.)
Optional	128 characters each, to a maximum of 8 character sets. Can include rulings or math characters, for example. Up to 31 character sets can be defined by user, in graphics memory.
Characters/line	80
Lines/display	34
Total characters/display	2720
Visual attributes	Characters can be displayed in color with colored background or inverted. In addition, the display can "blink" (alternate) between combinations of visual attributes.
Logical attributes	Fields can be protected, modified, alphanumeric, or numeric.

SPECIFICATIONS

**Table E-3
INTERFACE CHARACTERISTICS**

Characteristic	Description
Transmission speed	The transmitting and receiving baud rates may be independently selected up to 9600 baud. Baud rates can be entered from the keyboard or the host computer.
Interface with host computer	
Standard	RS-232 full duplex.
Optional Option 1	RS-232 half duplex and full duplex, with or without supervisory channel. External clocking, x 1.
Option 2	20 mA current loop.
Interfaces with peripheral devices	
Standard	Hard copy connector for 4632 Hard Copy Unit, and standard 75-ohm video output, for external video monitor.
Option 3	RS-232, transmit only, for 4642 Printer or other RS-232 device.
Option 4	IEEE 488-1975 GPIB (General Purpose Interface Bus), for TEKTRONIX 4924 Digital Cartridge Tape Drive or 4662/4663 Interactive Digital Plotters.
Video Signals	Generates 525 line interlaced 60 Hz composite video for red, green and blue. Conforms to EIA-RS-330 closed circuit television standard, 1 volt peak to peak.
Peripheral Devices	4642 Printer 4632 Hard Copy Unit (Option 6) 4924 Digital Cartridge Tape Drive 4662 Interactive Digital Plotter 4663 Interactive Digital Plotter

**Table E-4
BUFFERING AND EDITING CAPABILITIES**

Characteristic	Description
Size of display memory	16K bytes standard; may be expanded to 32K (Option 22.)
Parts of memory	
Monitor	Holds and displays conversational text, such as conversations between the user and the host computer, or commands to the terminal.
Workspace	Holds and displays text, forms, and graphics. One or several pages of text can be saved in the workspace, edited, and later sent to the host or to a peripheral.

Table E-5
KEYBOARD SPECIFICATIONS

Characteristic	Description
Number of keys	86
Lighted keys	4 (Insert Mode, TTY Lock, Numeric Lock, Command Lockout)
Programmable keys	81
Major keyboard functions	Typewriter keys, terminal function control, programmable function keys, numeric pad, cursor control, scrolling, crosshair cursor.
Tactile features	Curved profile, tactile feedback at typing "home" position.
Relationship to display	Detachable (flexible 8 foot cable)
Editing keys	Delete Character Delete Line Erase and Skip Insert Line Insert Mode

Table E-6
GRAPHICS SPECIFICATIONS
(For 4027A's with Option 27, 28, or 29.)

Characteristic	Description
Amount of Graphics Memory	
Standard	48K bytes (covers 1016 cells).
Option 27	96K bytes (covers 2040 cells).
Option 28	144K bytes (covers 3064 cells).
Option 29	192K bytes (covers 4088 cells).
Line types	Solid lines in one of eight colors.
	Seven styles of dashed lines.
	120 patterned lines.
	Single points.
	"Erase vectors", rewrite vectors in the current background color.
Type of display	Dot matrix; each graphics cell (character position) has 14 rows of 8 dots each.
Resolution	25 addressable points/cm (64/inch).

SPECIFICATIONS

**Table E-7
USER DEFINABLE CHARACTER SETS**

Characteristic	Description
Characters per font	128
Number of fonts available:	
Standard	7
Option 27	15
Option 28	23
Option 29	31

**Table E-8
PHYSICAL CHARACTERISTICS**

Characteristic	Description
Weight	220 kg (100 lb)
Dimensions	
Cabinet	Height 48.3 cm (19.0 in) Width 58.4 cm (23.0 in) Depth 58.4 cm (23.0 in)
Keyboard	Height 7.6 cm (3.0 in) Width 45.7 cm (18.0 in) Depth 23.5 cm (9.25 in)

**Table E-9
POWER REQUIREMENTS**

Characteristic	Description		
Line plug and power cord	15 ampere capability, detached.		
Input Line voltages:	Voltage	Range	Fuse
Standard	110 Vac 120 Vac	90-110 V 108-132 V	6A fast blow 6A fast blow
Options A1, A2, A3, A4	220 VAC 240 Vac	198-242 V 216-250 V	3A fast blow 3A fast blow
Line frequency	48 to 63 Hz		
Power consumption	550 W maximum at 125 Vac		

Appendix F

PLOTTER COMMANDS

This appendix gives examples of plotter commands, both in "plotter language" and in "4027A language." In these examples, ASCII control characters are included

in "angle brackets" — that is, <ETX> denotes the "end-of-text" character, <CR> denotes "carriage return," etc.

Table F-1
PLOTTER LANGUAGE COMMANDS

Command	Effect
H<CR> or H<ETX>	Home. Moves the pen to the upper left corner of the plotting area.
M 50,75<CR> or M50,75<ETX>	Move. Moves the pen to the point (50,75) in the plotter's system of coordinates. ^a
D 100,50<CR> or D100,50<ETX>	Draw. Draws a line from the current pen position to the point (100,50) in the plotter's system of coordinates.
D 100,50 0,0 50,10<CR> or D100,50,0,0,50,10<ETX>	Draws a line from the current pen position to the point (100,50); from there, to the point (0,0); and from there, to (50,10).
PThis is a test.<ETX>	Print. Prints on the plotter, starting at the current pen position, the message, "This is a test."
S 1.5,3.0<CR> or S1.5,3.0<ETX>	Alpha Scale. Sets the size of each character cell to 1.5 graphic display units in the X-direction, 3.0 graphic display units in the Y-direction. (The "graphic display unit" is a measure of length used by the Plotter. In the X-direction, it is 1/150 of the length of the plotting area; in Y-direction, it is 1/100 of the height of the plotting area.)
R10<CR> or R10<ETX>	Alpha Rotate. Sets the angle at which alphanumeric characters are printed on the plotting surface. Characters printed after this command is executed will slant upwards at ten degrees with respect to the positive X-axis.
F 2<CR> or F2<ETX>	Alpha Font. Selects printing font number 2 from among the plotter's seven fonts.
A<CR> or A<ETX>	Alpha Reset. Resets the alphanumeric printing parameters (Alpha Scale, Alpha Rotate, Alpha Font) to their default values.
T 0<CR> or T0<ETX>	Prompt Light. Turns off the PROMPT light on the plotter's front panel.
T 1<CR> or T1<ETX>	Turns on the plotter's PROMPT light.

^aThe plotter's coordinate system is not the same as the terminal's. The plotter's X-axis always runs from 0 to 150, and its Y-axis from 0 to 100.

PLOTTER COMMANDS

**Table F-2
TRANSLATIONS OF PLOTTER
COMMANDS INTO 4027A LANGUAGE**

Command Name	Plotter Language	4027 Language
HOME	H<CR>	IPASS "H",13
	H<ETX>	IPASS "H",3
MOVE	M 50,75<CR>	IPASS "M 50,75",13
	M50,75<ETX>	IPASS "M50,75",3
DRAW	D100,50<ETX>	IPASS "D100,50",3
	D100,50,0,0<ETX>	IPASS "D100,50,0,0",3
MOVE, followed by DRAW ^a	M50,75<ETX>D100,100<ETX>	IVEC 213,30,427,479
PRINT	PThis is a test.<ETX>	ISTRING "This is a test."
ALPHA SCALE	S1.5,3.0<ETX>	IPASS "S1.5,3.0",3
ALPHA ROTATE	R10<ETX>	IPASS "R10",3
ALPHA FONT	F2<ETX>	IPASS "F2",3
ALPHA RESET	A<ETX>	IPASS "A",3
PROMPT LIGHT	T0<ETX>	IPASS "T0",3
	T1<ETX>	IPASS "T1",3

^aThe coordinates in the 4027A-language VECTOR command differ from those in the plotter-language MOVE and DRAW commands. This is because the terminal's system of coordinates differs from that of the plotter. In translating VECTOR commands, the terminal assumes a graphics area with a maximum X-coordinate of 639 and maximum Y-coordinate of 500 is to be mapped onto a plotter work area with maximum X-coordinate of 127.80 and a maximum Y-coordinate of 100.

Appendix G

EXTERNAL CONVERGENCE ADJUSTMENTS

NOTE

Routine external convergence board adjustments should be performed by qualified personnel only.

The external convergence board may need to be adjusted occasionally. Convergence should be checked when the terminal is first installed or whenever it is relocated.

Proper convergence means that the red, green, and blue beams come to a point on the screen. If the convergence is not properly adjusted, the most noticeable indication is that red, green, and blue colors will appear on the perimeter of any white areas of the screen. An alignment grid is used for reference. If convergence appears to be out of adjustment, the procedure which follows should be used to adjust the external convergence board.

PROCEDURE FOR ROUTINE CONVERGENCE ADJUSTMENTS

1. Type the CAL command (ICAL<CR>)

This will cause a message to be displayed which assigns each of the function keys (F1 through F8) to a color and F9 to an alignment grid. Go through the function keys from F1 to F8 and check that the following colors appear: white, red, green, blue, cyan, magenta, yellow, and black.

2. Remove the two screws securing the external convergence board tray and slide out the tray (Figure G-1).

The external convergence board contains 27 adjustments arranged in groups of three. Looking at the board from the front of the terminal, there is a direct correspondence between each of these groups and an area on the screen. For example, upper left on the board corresponds to upper left on the screen. In addition, the adjustments are color coded. Thus, the red adjustments control the red beam, the green adjustments control the green beam, and the blue adjustments control the blue beam.

Refer to Figure G-1 to get an idea of the direction of beam movement produced by the convergence adjustments. For a particular area, the red and green are converged first, then the blue is converged with them.

3. After the terminal has warmed up for 30 minutes, press the "degauss" button on the rear panel for 2 or 3 seconds. Press function key F9 to display the alignment grid.
4. Begin adjusting in the center (first the red and green, then the blue) and continue in the following order: top center, bottom center, right center, left center, top right, bottom right, top left and bottom left.
5. Once satisfactory convergence has been obtained, restore the external convergence board to its compartment.

EXTERNAL CONVERGENCE ADJUSTMENTS

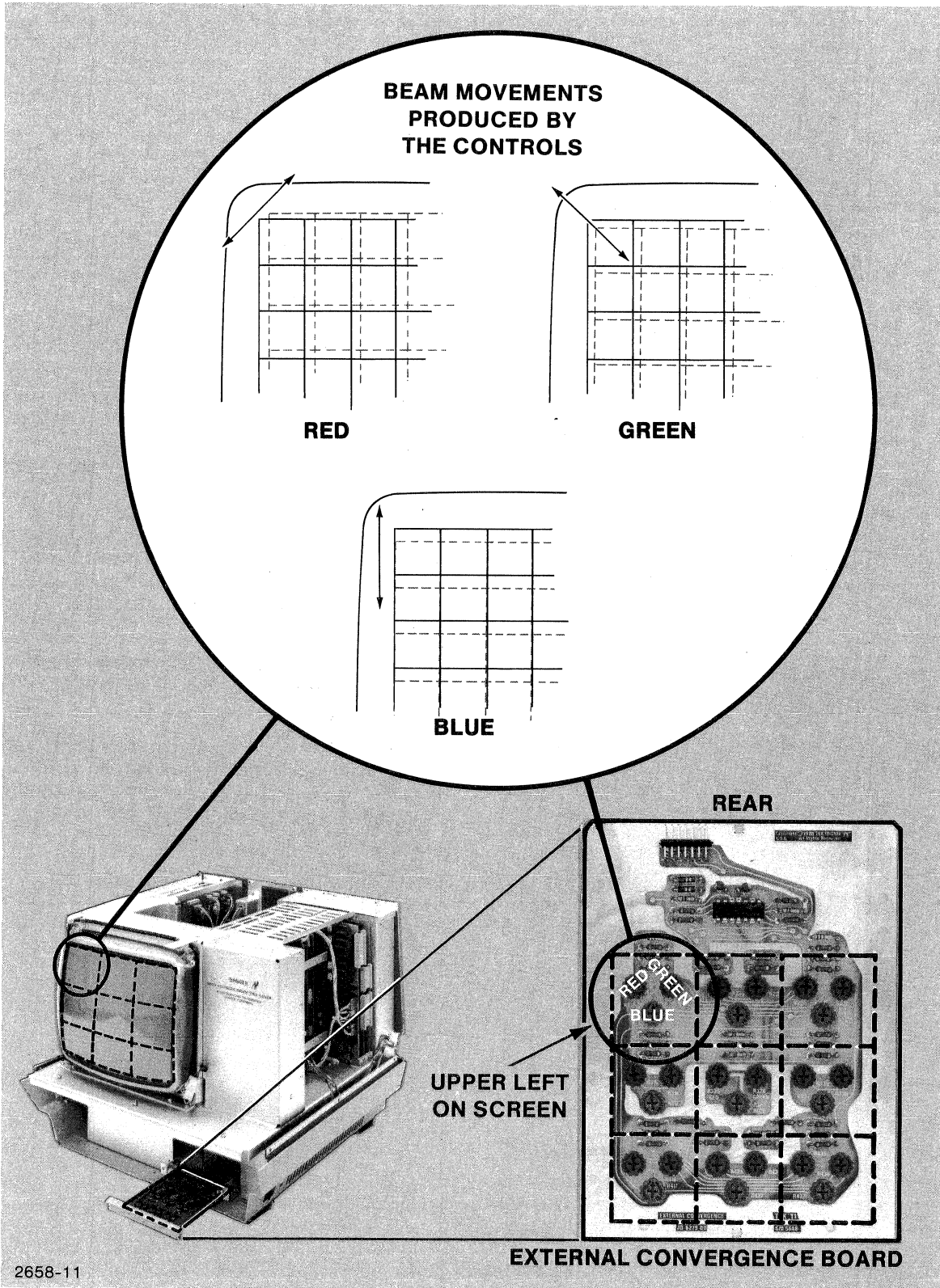


Figure G-1. External Convergence Adjustments.

OPERATOR'S REFERENCE TABLE

Please record the following settings for future reference:

Transmitting Baud Rate	TB=	Default Colors (Eight)	C0=
Receiving Baud Rate	RB=		C1=
Command Character	CC=		C2=
Prompt String	PR=		C3=
End-of-line String	EL=		C4=
Duplex (Full or Half)	DU=		C5=
Echo (Remote or Local)	EC=		C6=
Parity (None, Even, Odd, or Date)	PA=		C7=

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