TEKTRONIX®

CT 8100

CRT TERMINAL

USER'S

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077
070-2359-00

Serial Number _____

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WARRANTY

The 8002 μProcessor Lab System (including options) is warranted against defective materials and workmanship under normal use and service for a period of 90 days from date of initial shipment. CRTs found to be defective within 12 months from the date of shipment will be exchanged at no charge (this does not include installation).

On site warranty repair is provided during normal working hours (for the 90-day period). Travel to the site is confined to those areas in which Tektronix states it has service facilities available for this product.

Tektronix shall be under no obligation to furnish warranty service if:

a. Attempts to install, repair, or service the equipment are made by personnel other than Tektronix service representatives.

b. Modifications are made to the hardware or software by personnel other than Tektronix service representatives.

c. Damage results from connecting the 8002 μProcessor Lab System to incompatible equipment.

Specifications and price change privileges reserved.

Products of Tektronix, Inc. and its subsidiaries are covered by U.S. and foreign patents and/or pending patents.

PREFACE

GENERAL

The TEKTRONIX CT 8100 Crt Terminal permits an exchange of information and control between the user and the 8001/8002 μProcessor Labs. The CT 8100 Crt Terminal is manufactured by Tektronix, Inc. The CT 8100 is similar to the TEKTRONIX 4023 Computer Display Terminal. Therefore, most instrument references in this manual are to the TEKTRONIX 4023. In all correspondence with Tektronix, Inc., regarding the CT 8100 Crt Terminal, refer to the CT 8100 Crt Terminal.

WARRANTY SERVICE

Should the CT 8100 Crt Terminal require service during the warranty period, call the Tektronix Field Office or representative nearest you. Only Tektronix service personnel will perform repair or maintenance work under terms of the Tektronix, Inc. warranty.

THIS MANUAL

This manual is a guide to the procedures required to operate the TEKTRONIX CT 8100 Crt Terminal.

RELATED DOCUMENTS

CT 8100 Crt Terminal Service Manual
8001 or 8002 μProcessor Lab System User's Manual
8001 or 8002 μProcessor Lab System Service Manual

4023 Users

GENERAL INFORMATION

SECTION I
OPERATOR'S MANUAL

SECTION II
TECHNICAL USER'S MANUAL

APPENDICES

About This Manual

This manual will acquaint the operator and the technical user with the capabilities and operation of the Tektronix 4023 Computer Display Terminal.

Section I contains information important to the operator. It begins with an introduction to the 4023 including a basic description of 4023 operation in a data processing system, the purpose of the 4023, and layman's description of Terminal features. Section I also contains a description of Terminal controls, including Keyboard keys, console switches, console indicators, and special function keys. Short operational descriptions are provided to assist in control familiarization.

Section II contains information from a more technical point of view. Here the technical user will find programming information, strappable option information, installation information, etc.

Appendices at the rear of the manual contain additional information to aid the user in achieving maximum efficiency from the 4023.

A glossary is included listing the technical terms associated with the 4023.

A topical index follows the Table of Contents.

CONTENTS

TABLE OF CONTENTS

SECTION I

INDEX

CONTENTS

(cont.)

SECTION II

INDEX

A

B

C

D

E

F

INDEX
(cont.)

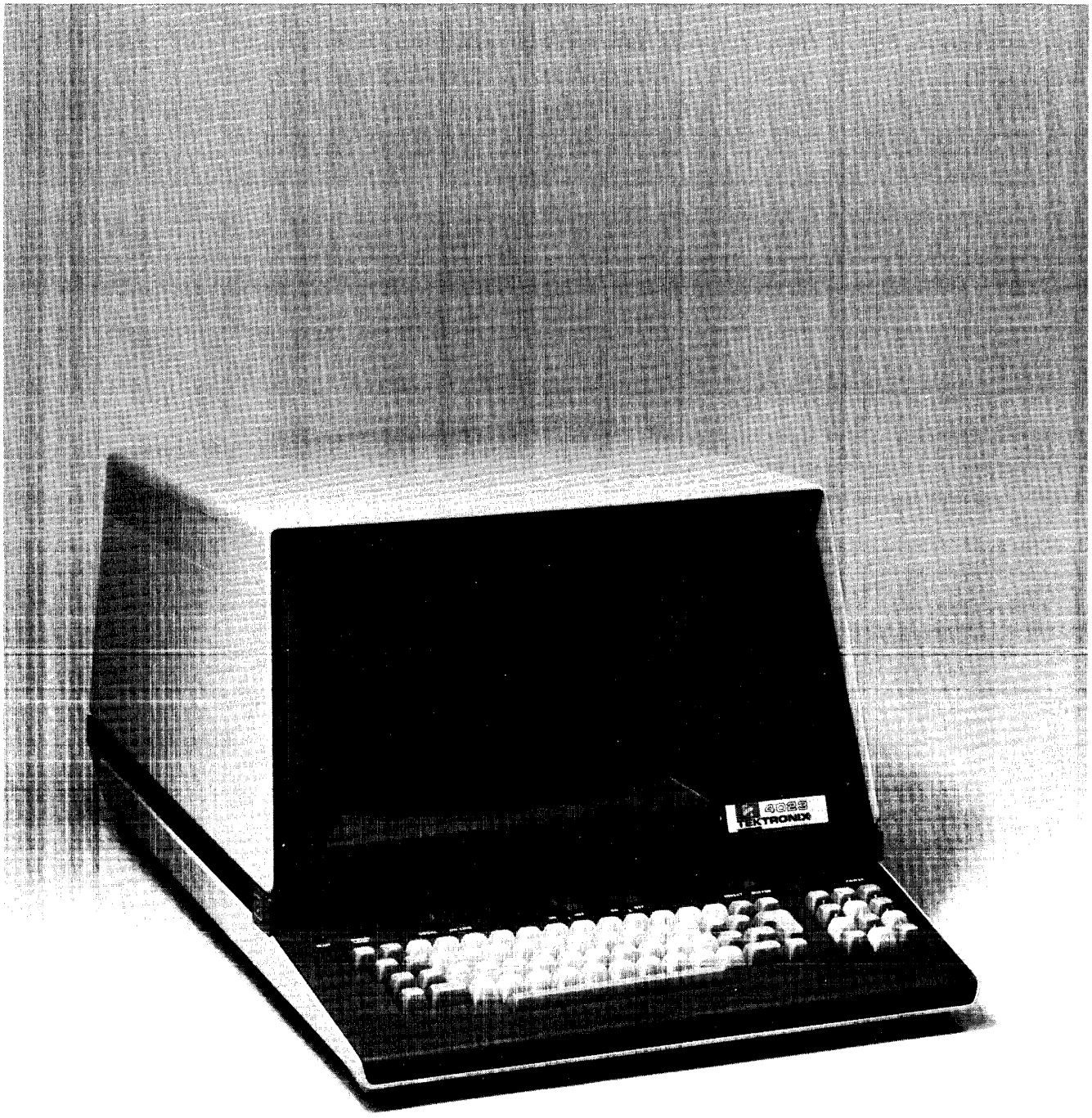


Fig. 1-1. The 4023 Computer Terminal

INTRODUCTION

SECTION I
PART 1

YOU AND THE 4023

General

This information will provide you with a basic understanding of the Tektronix 4023 Computer Display Terminal, and help in its operation. When, in reading the following, you come upon an unfamiliar term or phrase, refer to the Glossary. If more detailed information is desired on a subject, refer to the index. There you will find page references for additional information about the subject.

What The 4023 Is

The 4023 Computer Display Terminal is an instrument which enables exchange of information between people and computers. The 4023 is a "computer display terminal" because it is the starting and stopping point for information to and from the computer. As the Terminal operator, you will need to know how to use the 4023 effectively to obtain, input, or change the computer information.

Before we go into more detail about the 4023, it might be a good idea to review some of the basics of data processing. The following discussion briefly describes the part that you and the Tektronix 4023 perform in processing data.

Data Processing

"Data Processing" is the work involved in processing the information or records required by your company to conduct its business. There's the payroll, the inventory, the sales, engineering, and others – depending on the particular business your company is in. The data processing job is more rapidly and accurately performed by using the 4023 connected to a computer system.

First, all the data necessary to run your company's business is input to the computer system, where it is stored on a medium such as magnetic tape. This data can be input to the computer using the 4023 keyboard.

Data Processing (cont.)

Once the system has all the information, and the instructions describing how to manipulate the information, your assigned task can be performed. For example, depending on the instructions, inquiries, etc., that you type into the computer from the keyboard, the computer will call from storage the particular data required and use it by sorting, testing, and computing to arrive at the answer or information you want. The computer then transmits the results to the 4023, where they are displayed on the screen.

The 4023 can display information in response to operator or program selection; however, the Terminal's response is not restricted to writing on the screen. It can also perform a variety of functions in response to "control" commands. These functions include (but are not limited to) controlling the display format, switching Terminal operations from one mode to another, ringing the Terminal's bell, and controlling outputs from and inputs to the Terminal.

There are three basic types of data processing that the 4023 will perform; data retrieval, data entry, and inquiry-response.

Data Retrieval

As a data retrieval device, you will use the 4023 to obtain information on subjects such as bank balances, credit reports, inventory reserves, or motor vehicle registrations. Again, the information retrieved depends on your company's business. Keyboard entry is brief; usually there is just enough to identify the data you wish to retrieve. Once the data is identified, the computer responds with the specified data.

Data Entry

As a data entry device, the 4023 is used to enter new data to the computer, or to up-date data previously stored in the computer. The only outputs from the computer will be operational instructions for you, or data entry forms to aid in speeding up data entry. You will find that the excellent editing capabilities of the 4023, coupled with the ability of the display data to be "formatted," greatly simplify the data entry operation.

Inquiry-Response

This is a mode of operation in which the operator and computer carry on a "conversation". Here, the operator uses the keyboard to enter, to the computer, inquiries that are based on previous computer-calculated results. The "conversation" that results between the operator and the computer is displayed on the screen. Using the 4023 in this manner is helpful to programmers, engineers, designers, and others who create and use the computer program in a step-by-step fashion.

INTRODUCTION
(cont.)

Accessories

Accessory devices are offered for the 4023 to help you and your company more effectively use the Terminal in a computer system. Accessories for the 4023 include video monitors, digital magnetic storage units, and hard copy units. A hard copy unit is a device that, when connected to the 4023, can make paper (hard copy) reproductions of information displayed on the Terminal's screen.

The 4023 In A Data Processing System

With the preceding information in mind, Fig. 1-2 can be more readily understood. This figure illustrates the Terminal's position in a data processing system.

Data from a computer is sent to the Terminal via a communication link. The communication link may be a direct connection, or may be special equipment that connects the Terminal and computer using telephone lines. (Additional information on the Terminal and computer connections is provided in the Part 2 of Section II.) The Terminal's interface applies the received data to the Terminal Control circuits, which cause either display writing or control execution, depending on the coded content of the incoming signals.

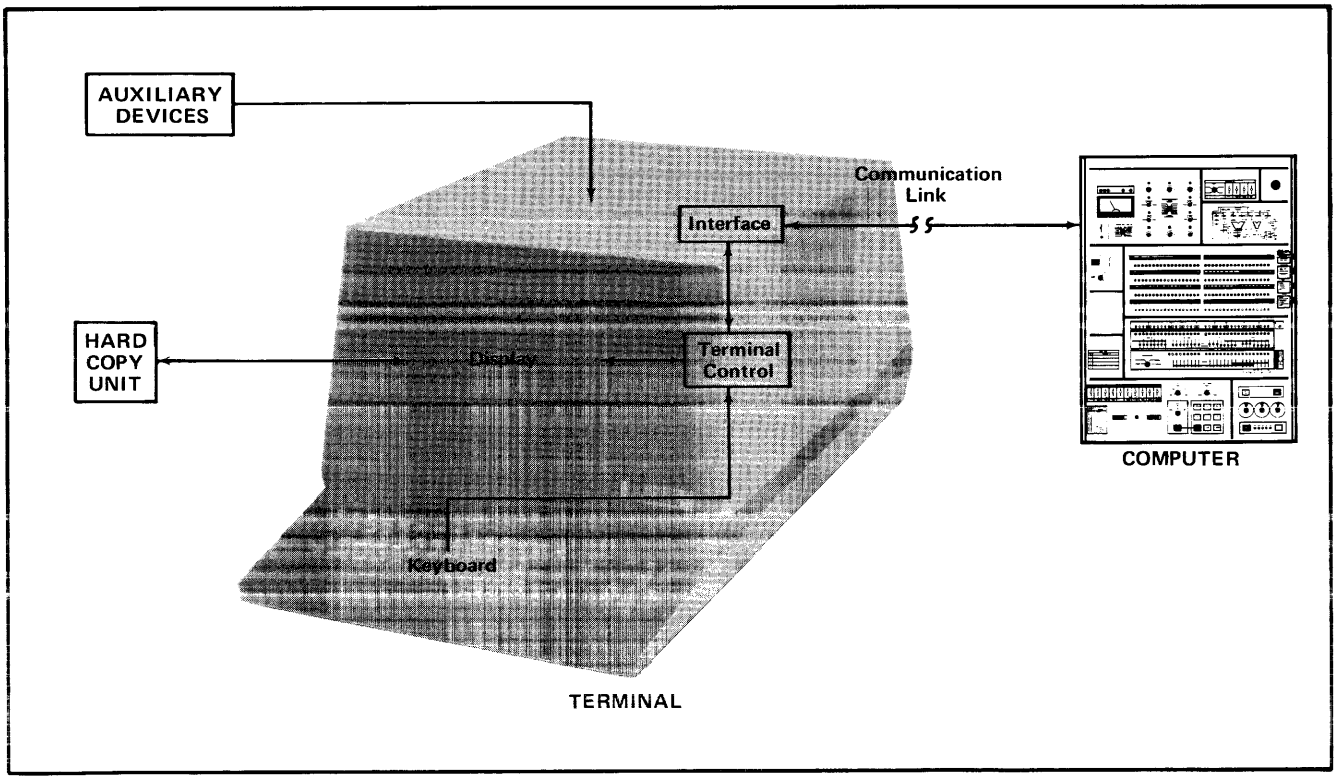


Fig. 1-2. 4023 position in a data processing system.

Data Processing System (cont.)

Data entered from the keyboard can be routed directly through the Terminal Control circuits, the Interface, and thence to the computer, by-passing the Terminal memory. If a data "echo" exists, the data is processed by the Terminal circuits and displayed. Data is not always sent directly to the computer from the keyboard. Keyboard data can be first stored in the Terminal memory, edited, then transmitted to the computer.

When a Make Copy command is given by any source (computer, Terminal, or at the Hard Copy Unit), the Hard Copy Unit takes control of the Terminal, extracts the display information, and reproduces the display on paper.

Operating Modes

You will normally operate the Terminal "on line" with the computer, as selected by the LOCAL/ON LINE switch (this switch can be placed in the LOCAL position for operator training, using the Terminal with auxiliary devices independent of the computer, repair, etc.). The basic On Line operations are Transmitting and Receiving. An introduction to these operations is given in the remainder of this section, along with a brief description of Local and Hard Copy Operation.

INTRODUCTION
TRANSMITTING

When transmitting, data entered at the keyboard is sent to the computer as indicated by this figure.

Data to the computer is encoded to indicate the specific character which is entered by the operator. Data may also be transmitted from auxiliary devices to the computer, or may be sent from the keyboard to the auxiliary devices.

With the DIRECT/BUFFER switch at DIRECT, no action is taken on the data by the Terminal unless an "echoing" condition exists, under which circumstance the 4023 accepts it as received data. With the DIRECT/BUFFER switch at BUFFER, data entered at the keyboard is stored in the Terminal memory and displayed; it is not transmitted until the operator activates an Enter or Send sequence using the SEND/ENTER key.

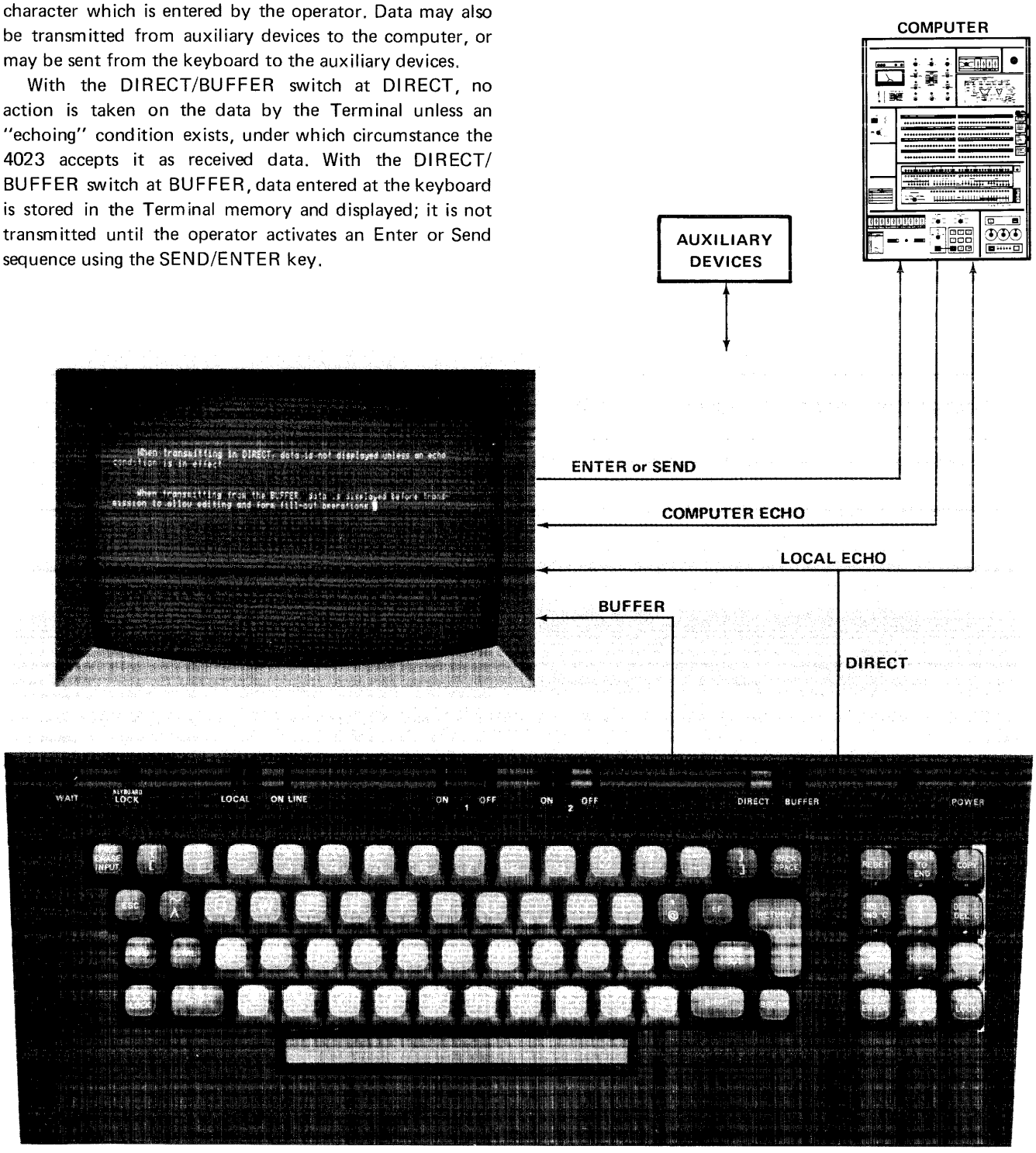
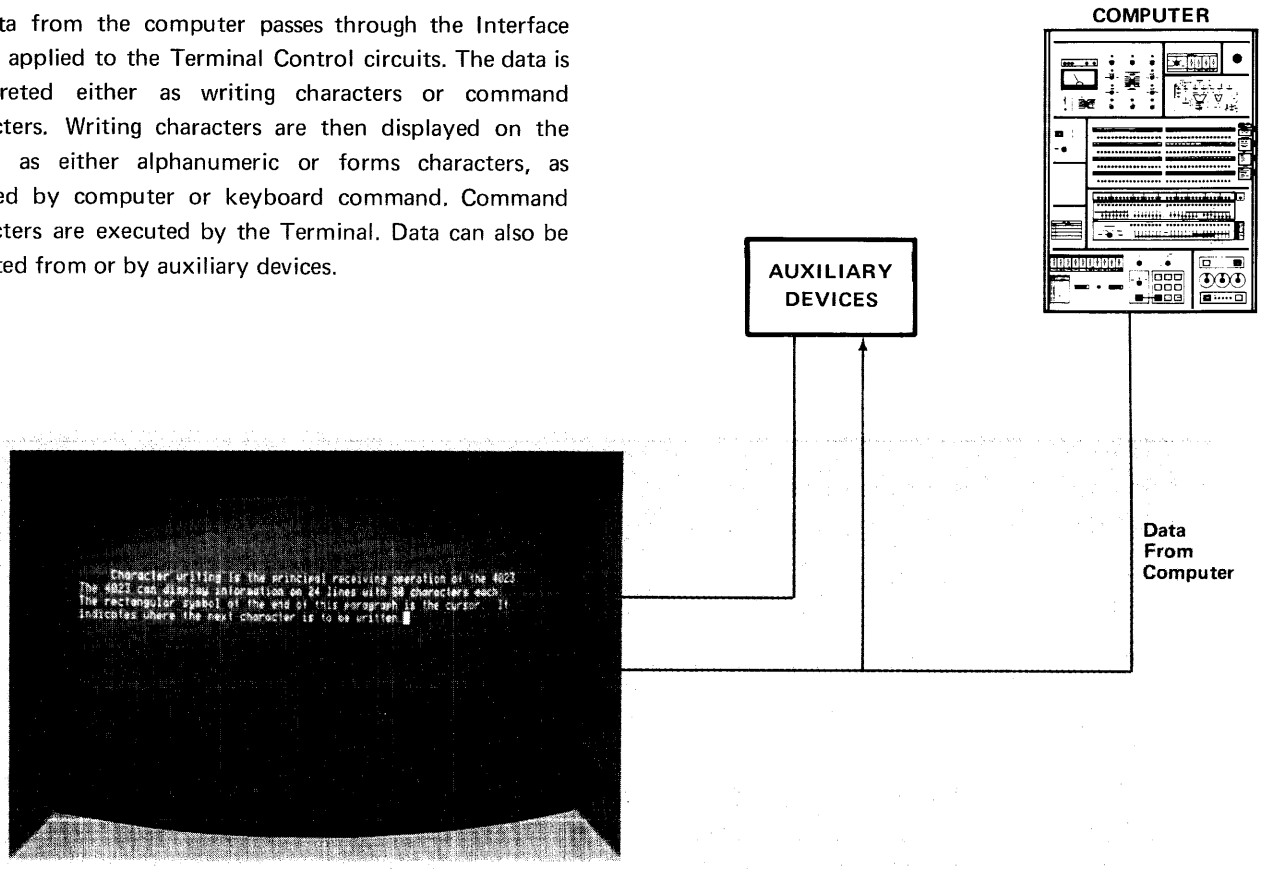


Fig. 1-3

INTRODUCTION
RECEIVING

The 4023's receiving operation consists basically of writing characters, drawing forms (if the Terminal is equipped with the optional rulings characters), or executing control commands.

Data from the computer passes through the Interface and is applied to the Terminal Control circuits. The data is interpreted either as writing characters or command characters. Writing characters are then displayed on the screen as either alphanumeric or forms characters, as selected by computer or keyboard command. Command characters are executed by the Terminal. Data can also be accepted from or by auxiliary devices.



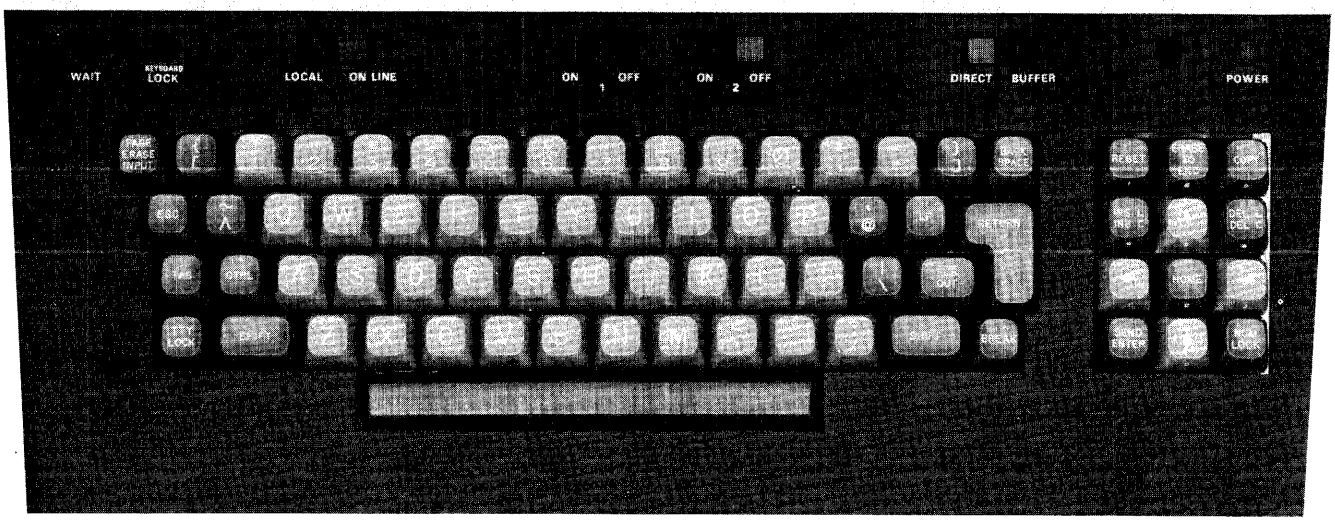


Fig. 1-4

INTRODUCTION
LOCAL OPERATION

In Local Operation the 4023 is isolated from the computer. Keyboard inputs are displayed or otherwise executed by the Terminal. The Terminal can interact with auxiliary devices while in Local.

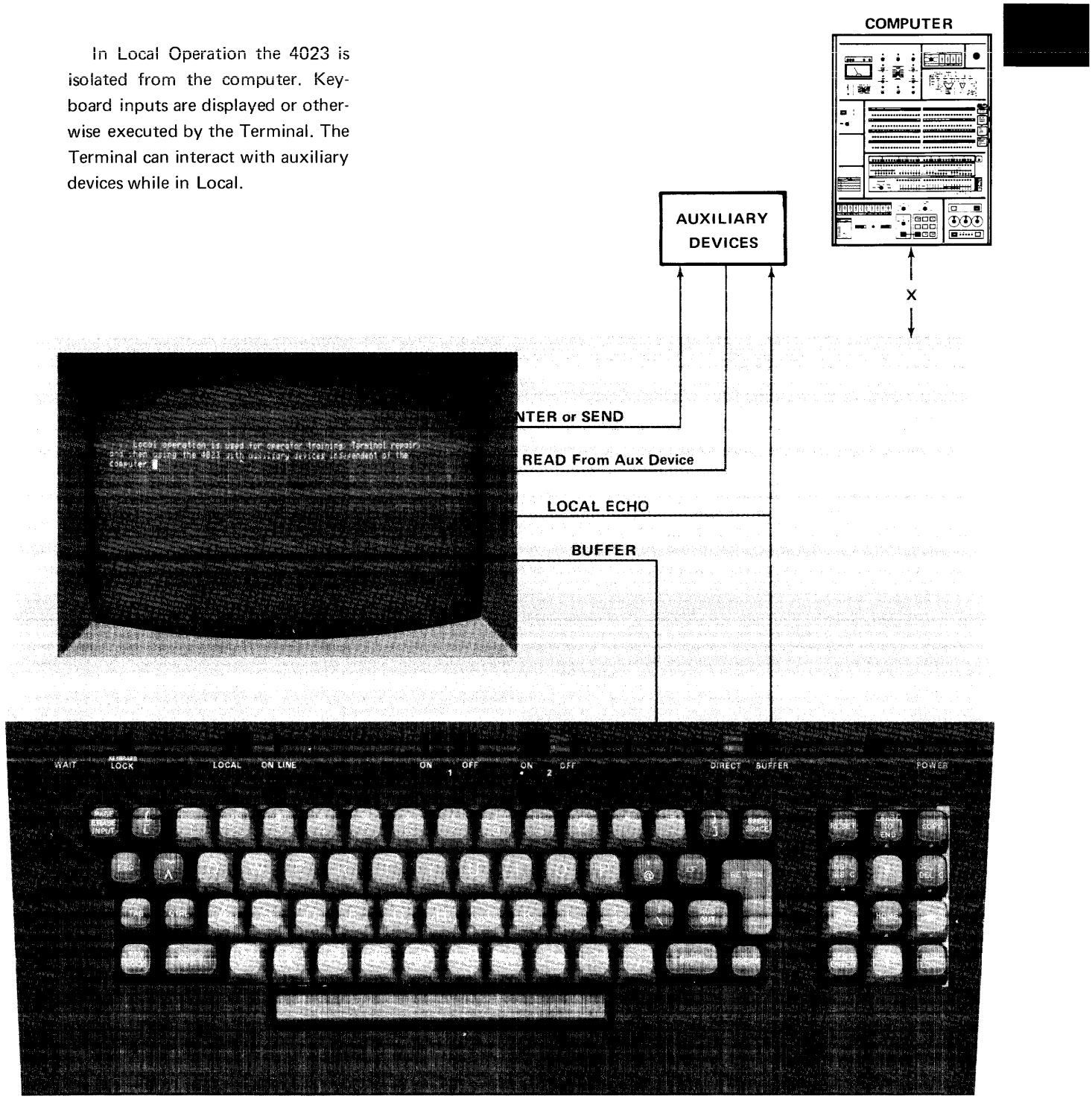
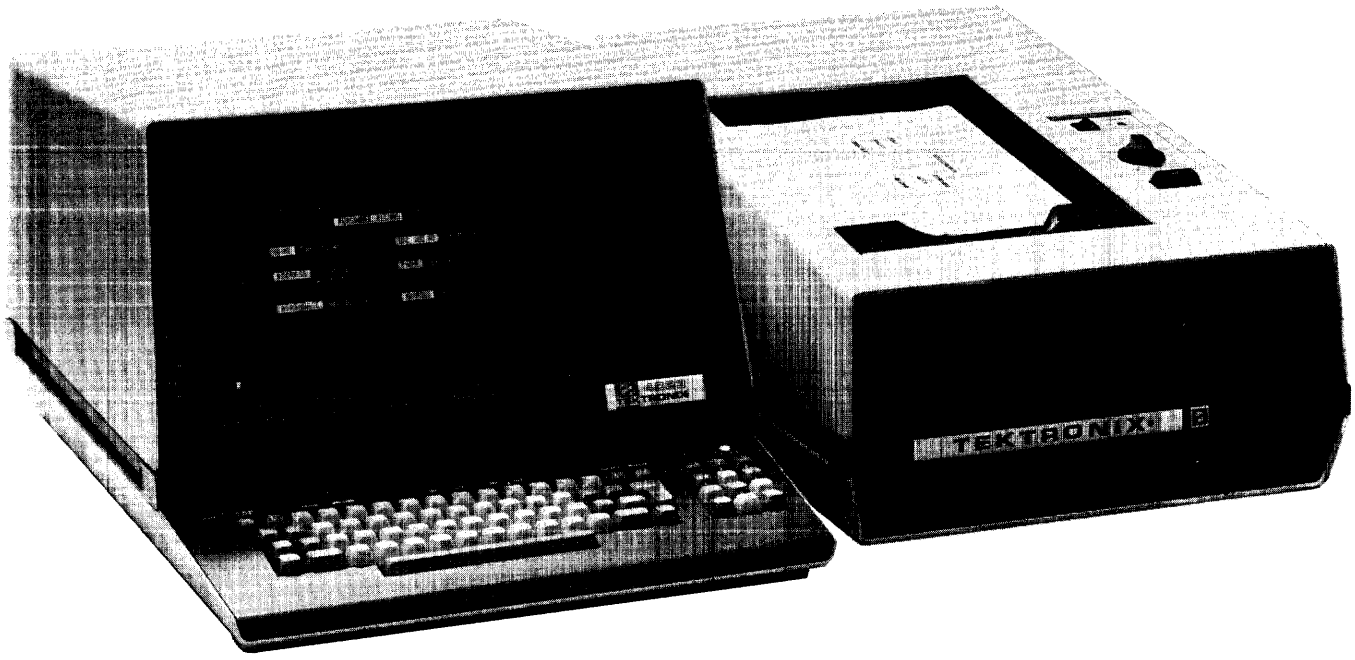


Fig. 1-5

INTRODUCTION
HARD COPY OPERATION



A Hard Copy Unit can produce a permanent copy of a Terminal display in response to a "make copy" command from the computer, keyboard, Hard Copy Unit, or from auxiliary devices.

Fig. 1-6

CONTROLS

SECTION I
PART 2

THE CONTROLS

General

As a Terminal operator, understanding the Terminal controls is an important part of your job. Of course, if you are not familiar with computer terminals, the purpose and usage of some of the controls may be unfamiliar at first. But, as you use the Terminal your understanding of Terminal controls and operation will increase proportionately.

NOTE

Because of the variety of systems, the purposes of some controls will vary from system to system.

Purpose of Controls

Even though the Terminal Keyboard looks like a typewriter keyboard, its use is quite different. Typewriter keys and controls provide a convenient means of writing, with functions designed toward outputting printed material on a piece of paper. The Terminal keyboard and controls are designed to manipulate computer-based data. THE KEYBOARD'S PRIMARY FUNCTION IS TO ACT AS A SOURCE OF DATA FOR THE COMPUTER. The screen (or display—both words are used interchangeably throughout this manual) is a convenient means of recording, for operator convenience, the Terminal/computer conversation. Editing functions and display formatting are simply Terminal features that provide more efficient Terminal/computer communications. So, even though for most operations the keyboard appears to be "talking" with only the screen, the result (or end result) of keyboard data manipulation is directed toward the computer. Keeping this in mind will help to better understand the use of the controls.

Purpose of Controls (cont.)

Terminal Controls can be divided into three basic groups; the Terminal Controls and Indicators, the Keyboard, and the Function Controls. A brief explanation of each group is provided in Fig. 1-7.

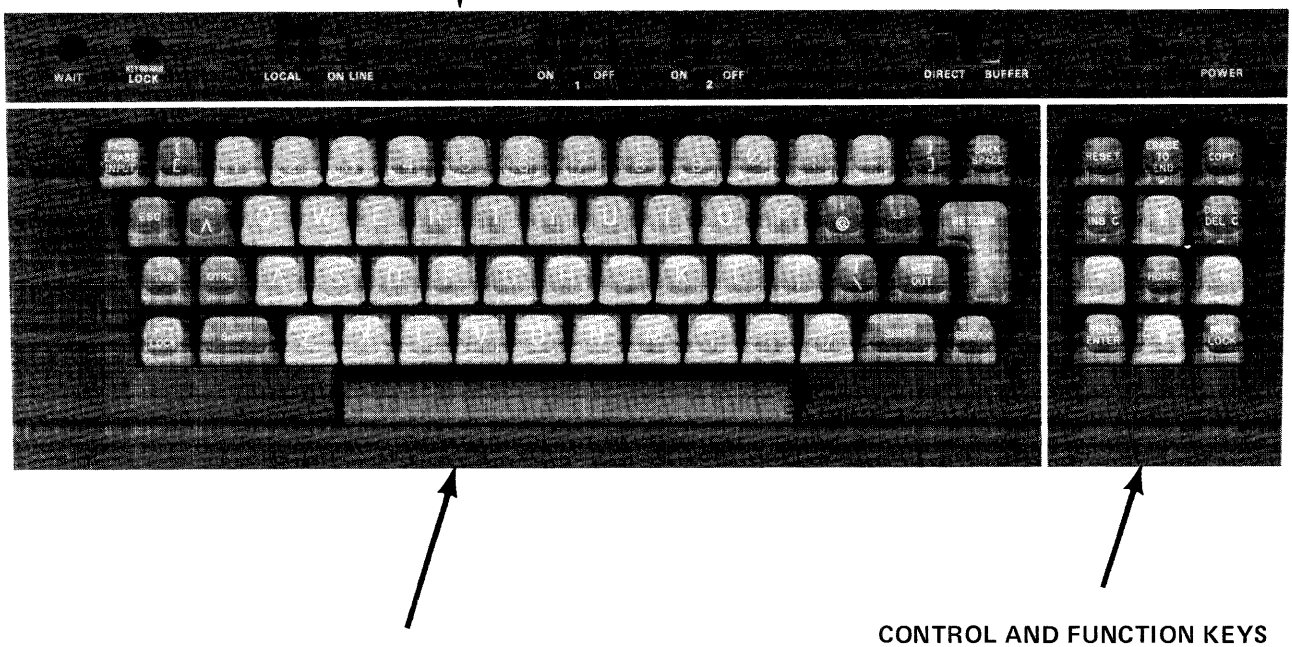
By understanding a few simple commands and the correct format, the operator at the Terminal runs programs that have already been stored in the computer. The keyboard enables you to "consult" with your "assistant" the computer; telling it what to do and when to do it. As the computer receives each instruction it "talks back" to you via the display.

With a typewriter typing on paper, you can tell where the next character will be typed by the mechanical position of the carriage. With the Terminal display, there is no mechanical relationship. To show where the next character is to be written a rectangular marker, called a cursor, is provided.

CONTROLS

CONSOLE CONTROLS AND INDICATORS

Two rocker-type switches provide control over the destination of data. Two spare switches can be used for control of auxiliary units. Console indicators provide data entry indications and a power on indication. Individual switch and indicator descriptions are given in Fig. 1-8.



THE KEYBOARD

The 4023 keyboard arrangement is similar to a typewriter keyboard. Both upper and lower case alphabetic characters can be generated. Non-shaded keys provide functions similar to a typewriter, and are used solely for entering data. Special keyboard keys that provide functions not normally related to a typewriter are shaded. Their functions are explained in Fig. 1-9.

CONTROL AND FUNCTION KEYS

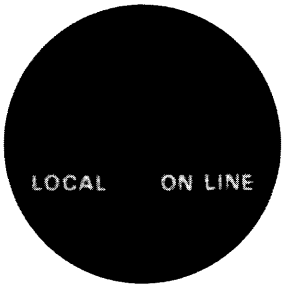
This group of keys provides a dual purpose:

1. Functions such as editing, cursor positioning, data transmitting, reset functions, etc., are controlled by these switches. A description of each switch is given in Fig. 1-10.

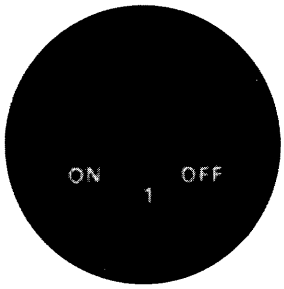
2. These keys can be made to function as a numeric keyboard by simply pressing the NUM LOCK key. Thus, those familiar with adding machine-type keyboards will find this a convenient means of entering numeric data.

Fig. 1-7

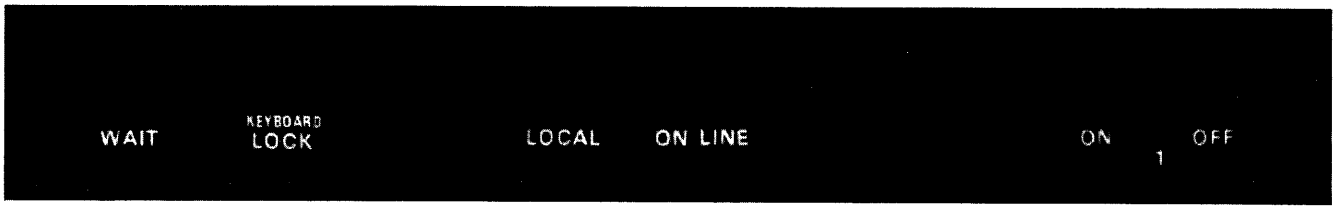
CONSOLE CONTROLS AND INDICATORS

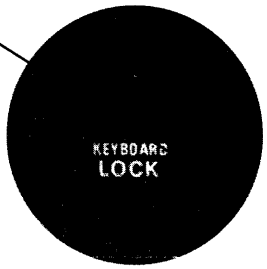


A two-position rocker switch that performs the following functions.
LOCAL – Logically disconnects the Terminal from the computer. However, the Terminal can still interact with other devices connected to it, such as a digital magnetic storage unit, etc. LOCAL is also used when practicing with the Terminal, using the 4023 with auxiliary devices independent of the computer, and when maintenance is performed.
ON LINE – Logically connects the Terminal to the computer, allowing the 4023 and computer to interact.



Spare rocker switch. Normally used to control auxiliary devices.



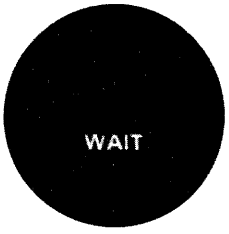


Indicates that keyboard entry is inhibited because one of the following is occurring:

1. The 4023 is transmitting a message or a message transmission is pending.

2. The cursor is located in a protected field in which data cannot be entered.

3. The cursor is positioned on a Field Attribute Code.



Indicates that the computer system will not accept data from the 4023. Operator must wait for light to extinguish before functions can occur.

Fig. 1-8 (A)

CONSOLE CONTROLS AND INDICATORS

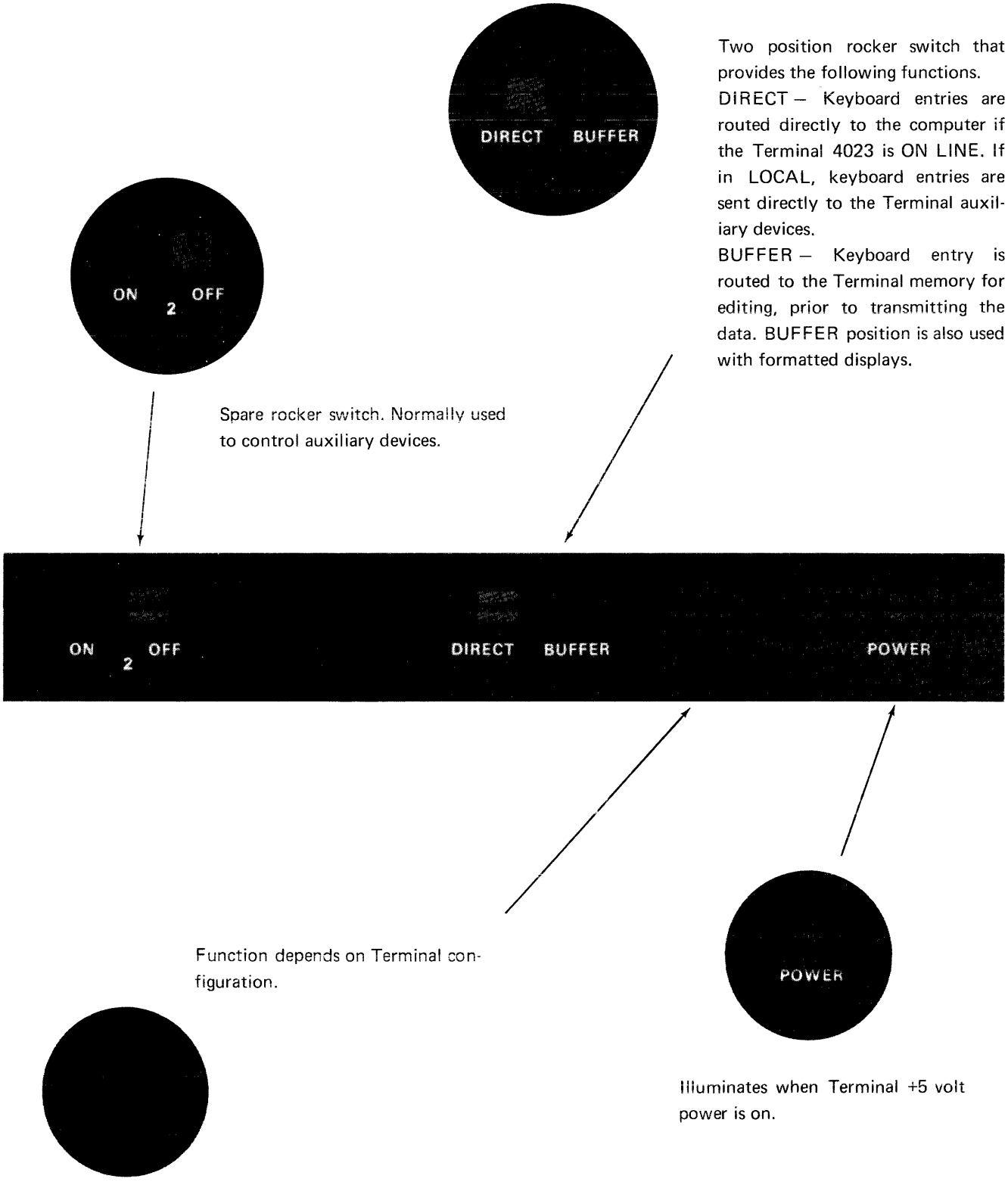


Fig. 1-8 (B)

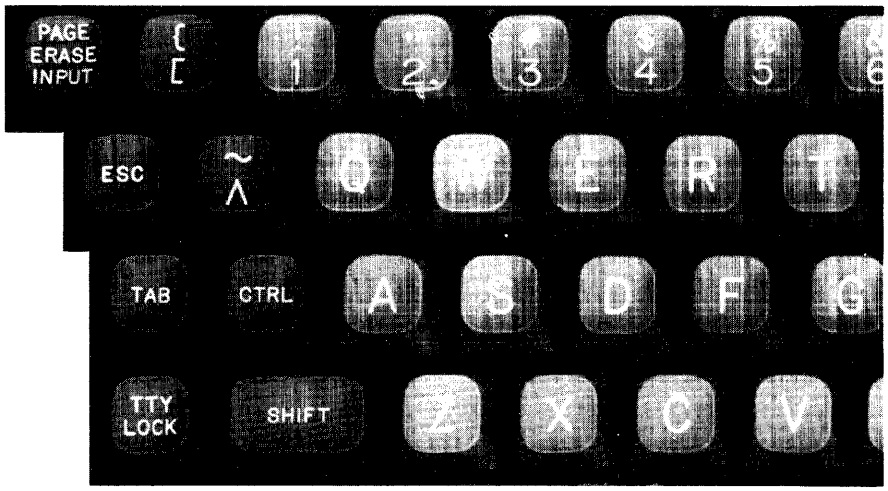
KEYBOARD CONTROLS

Used as a preparatory command key to notify the Terminal that the next character is to perform a function other than its normal function. For a keyboard example, pressing ESC then simultaneously pressing the SHIFT and L keys is the keyboard equivalent of the PAGE key. Works only in Buffer or with an Echo condition.

Used with formatted displays to tab the cursor to the first character position of the next unprotected (input) field. The first character position in an unprotected field serves as a tab stop. If no unprotected fields are found on the display, the cursor returns to the home position. In Direct with echo, TAB causes cursor to move one space right.

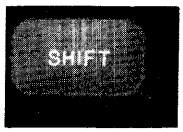
A dual function key whose function depends on whether the SHIFT key is pressed or not pressed.

Pressing without SHIFT causes all unprotected data on a formatted display to be erased. Protected data (form headings, etc.) is not erased. Pressing with SHIFT causes a clear page (erase) function. All displayed information is erased (including non-displayed information such as Field Attribute Codes), the Terminal logic is reset to the initial condition, and the cursor resides at the home position (upper left hand corner which corresponds to the first character position of the first line).



Causes character key inputs to be interpreted as control commands. Used with SHIFT and character keys to enter control commands. For example, simultaneously pressing the CTRL and K keys performs a "back tab" function.

Pressing key down causes TTY LOCK to be in effect. All lower case characters are then displayed and/or transmitted as upper case characters, regardless of condition of SHIFT key. Key must be pressed a second time to unlock.



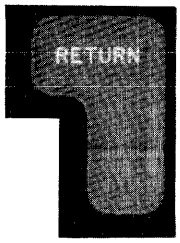
Used with character keys to shift them to upper case; used with CTRL and letter keys to enter control characters.

Fig. 1-9 (A)

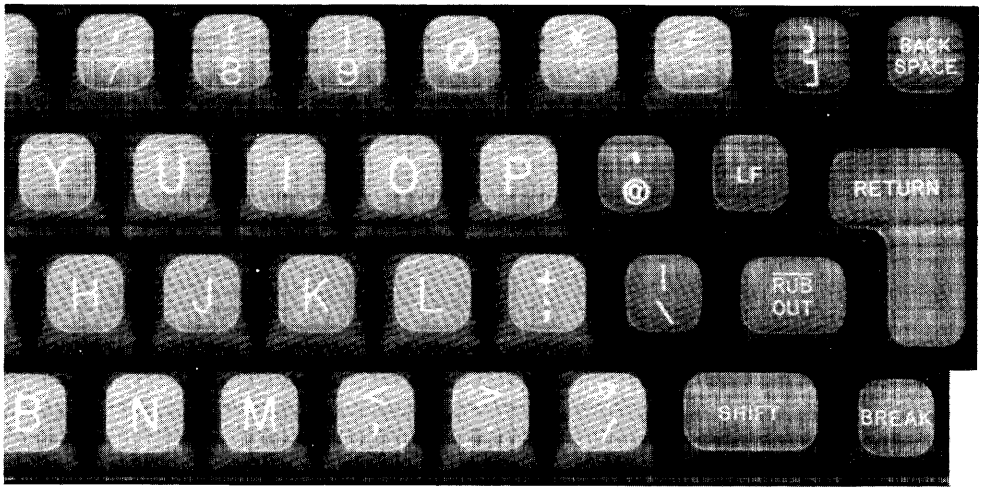
KEYBOARD CONTROLS

Moves the cursor one character space to the left. Does not destroy data.

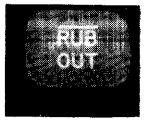
Positions the cursor to the start of a new line which is down one line and to the left side.



Moves the cursor down one line.



Use of this key depends on the particular Terminal/computer installation. Consult your programmer for its exact function.



The function of this key varies by computer system. Consult your programmer for its exact function.

Fig. 1-9 (B)

FUNCTION CONTROLS

Performs different functions depending on the operating configuration.

1. Pressing RESET causes the cursor to blink (unless a previously selected strap option has been set to make the cursor blink continuously).

2. Pressing RESET while simultaneously entering a control character will store that control character in Terminal memory when in Buffer.

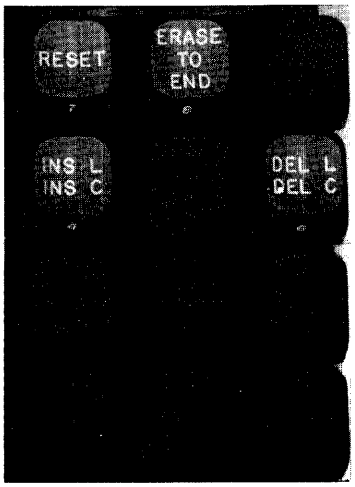
3. With formatted displays, pressing RESET enables data to be keyed into a protected field. Also, alpha data can be keyed into a numeric field and a Field Attribute Code can be keyed over.

4. Allows ERASE TO END key to erase a protected field.

5. Stops a buffer transmission sequence.

Plus

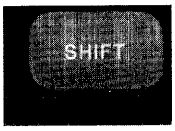
Pressing these keys when the cursor resides in an unprotected field erases all data from the cursor location to the end of that field. When no fields reside in a line, data is erased from the cursor position to the end of the line.



Causes a SPACE character to be entered at the cursor location. Data inside and to the right of the cursor shifts right with each activation. Data shifted past the right margin is lost.

Causes the character where the cursor resides to be deleted and replaced with the next character to the right. All characters to the right of the cursor move left one space.

Plus



Simultaneously pressing these two keys causes the line where the cursor resides to move down one line. All lines below roll down one line, leaving an empty line of SPACES at the cursor location.

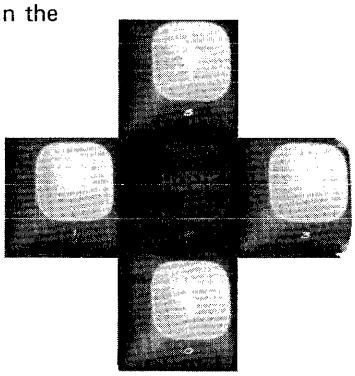
Plus

Simultaneously pressing these two keys causes the line where the cursor resides to be erased, and replaced with the line immediately below. All other lines below also move up one line.

Fig. 1-10 (A)

FUNCTION CONTROLS

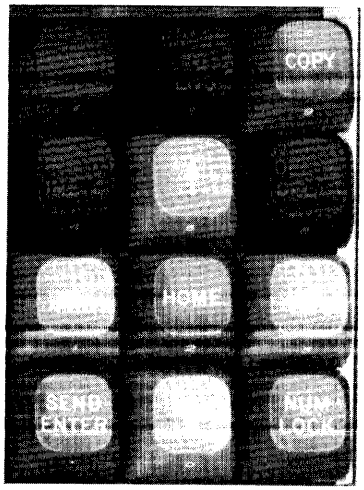
Provides directional movement for the cursor in the direction indicated.



With a Hard Copy Unit connected to the Terminal, pressing this key will activate the Hard Copy Unit to make a copy (on paper) of the displayed information.

Moves the cursor to the "home" position. Home corresponds to the first character position of the first line (also terminates Buffer transmission sequence).

With unformatted displays, pressing SEND-ENTER causes all data between the cursor location and the Home position, or preceding Message Separator, to be transmitted to the computer. When pressed, a Message Separator stores at the cursor location. With Formatted displays, SEND/ENTER causes only transmittable data to be transmitted to the computer. No Message Separator is displayed at the cursor location with formatted displays.



Plus

Causes all displayed data between existing Message Separators to be transmitted to the computer whether the display is formatted or unformatted. Does not display a Message Separator.

Causes the Function Keys to function as a numeric keyboard. This provides an adding machine-type key structure to facilitate entry of numeric data.

Fig. 1-10 (B)

POWER AND DISPLAY CONTROLS

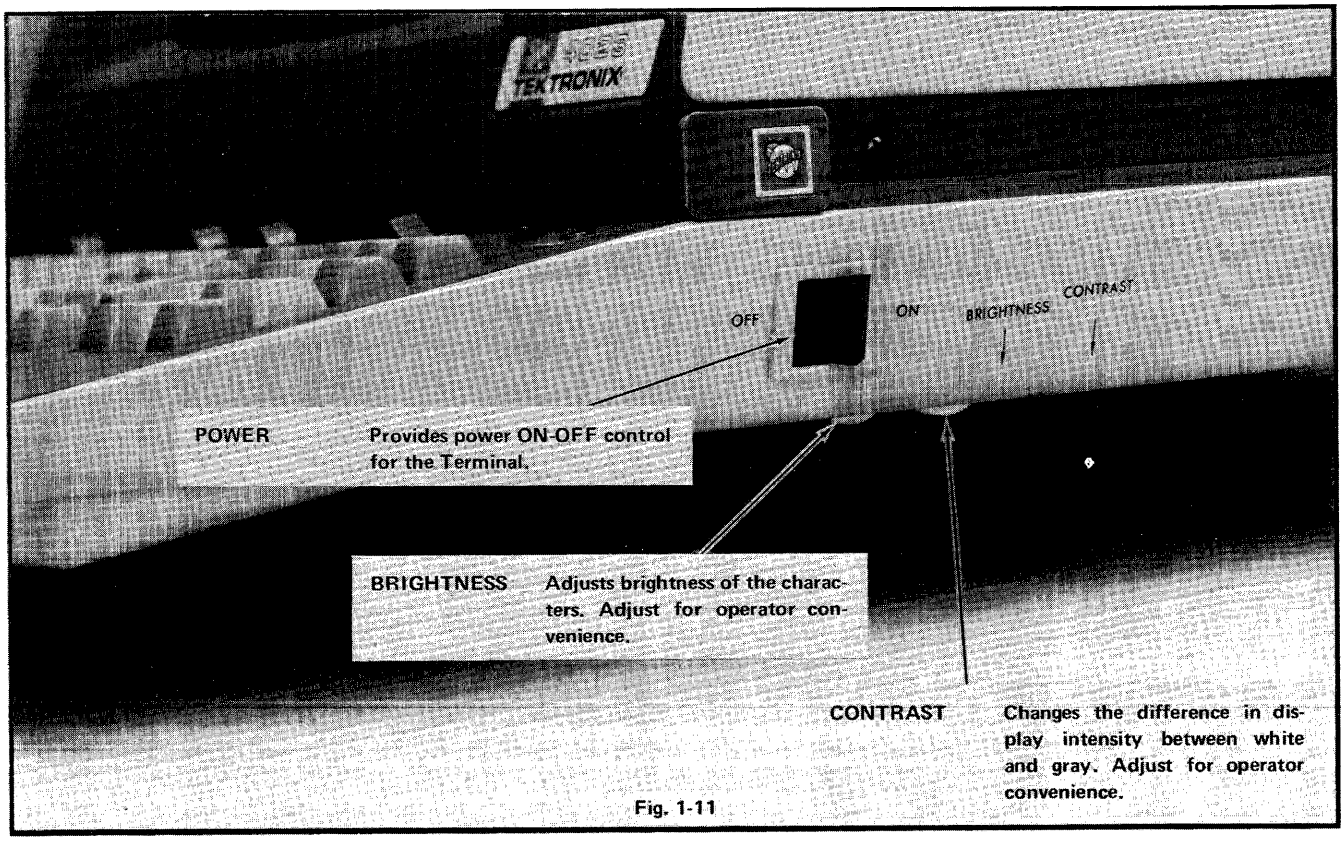


Fig. 1-11

REAR PANEL

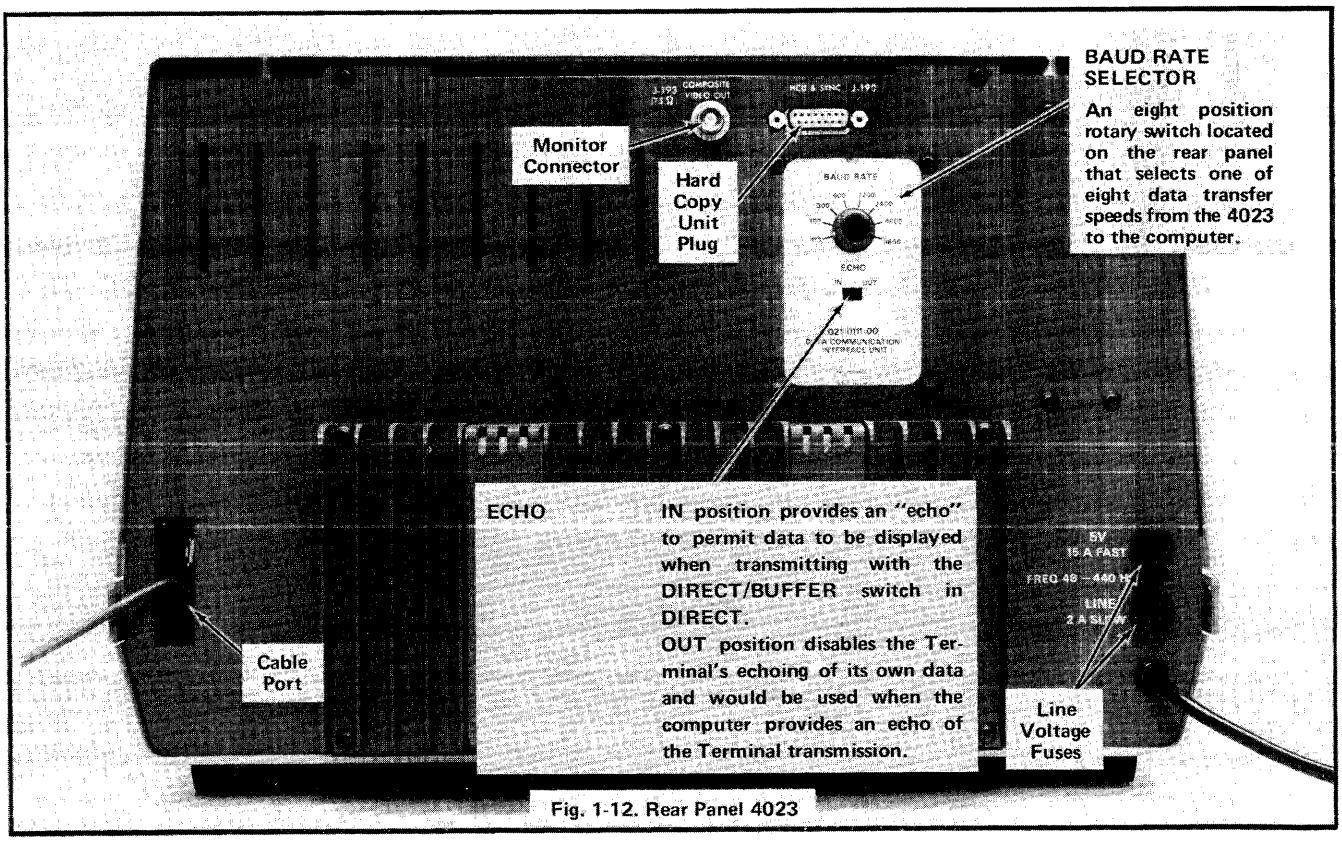


Fig. 1-12. Rear Panel 4023

OPERATION

SECTION 1
PART 3

USING THE 4023

INTRODUCTION

These operating procedures will more thoroughly acquaint you with the 4023 and its uses. Obtain a 4023 to use as you read through the following information.

Terminal/Computer Connection

In most cases, the Terminal you use will be connected to a computer. If the computer is in the same building as the 4023, the Terminal will probably be connected directly to the computer. If the computer is any great distance from the 4023, the computer connection will be made using a telephone and special electronic equipment. More detailed information on the Terminal/computer installation is provided in Part 2 of Section II.

In this portion of the manual, you will not be working with the computer. However, once you become familiar with 4023 operation, you will be shown how to go on line with the computer.

Set These Switches

Before turning the power on, set the LOCAL/ON LINE switch to LOCAL to isolate the 4023 from the computer. Set the DIRECT/BUFFER switch to BUFFER. Set both auxiliary switches 1 and 2 OFF to prevent typed data from accidentally being sent to any auxiliary units that may be connected to the Terminal. The above switch settings completely isolate the 4023 from the components of your company's data processing system. You are now ready to turn on the power.

Turning The Power On and Adjusting The Display

Turn the power on. Fig. 1-11 shows the location of the switch. Note the POWER indicator is lighted. After about 30 seconds, the cursor will appear in the upper left hand corner of the display. This is the first character position of the first line, and is called the HOME position. If the cursor does not appear after about one minute, turn up the BRIGHTNESS control (See Fig. 1-11) until most of the screen is dimly lit. Adjust the CONTRAST to make the cursor more clear, then turn down the brightness to your liking. With the cursor displayed, type in a few characters from the keyboard. Now, using the BRIGHTNESS and CONTRAST controls adjust the display for a viewing level that is most comfortable for you.

Becoming Familiar With The Keys

Fig. 1-13 highlights the keys you should first become familiar with. Note that the majority of these keys are standard typewriter keys. Check out the operation of these keys using the descriptions given in Figs. 1-9 and 1-10. Further control and operating familiarization is provided in the following material.

Erasing The Display

Type some characters onto the display, then simultaneously press the PAGE-ERASE INPUT key and the SHIFT key. Note that the displayed information is erased and the cursor positions to home. (The ERASE INPUT function will be described in the description of Formatted Displays.)

Cursor Movement

You have probably noticed by now that the LF key moves the cursor down one line. You may have also noticed that most of the keyboard keys when held down for more than about one half second, repeat their function. Keys that do not repeat their functions are; CTRL, TTY LOCK, SHIFT, BREAK, RESET, COPY, and NUM LOCK.

The Cursor Direction keys (keys with arrows on them) move the cursor in the direction of the arrow on the key. Note that when moving the cursor over displayed data, the data is not affected. These keys provide you with the ability to rapidly move the cursor to any character position on the display. You'll find them very useful.

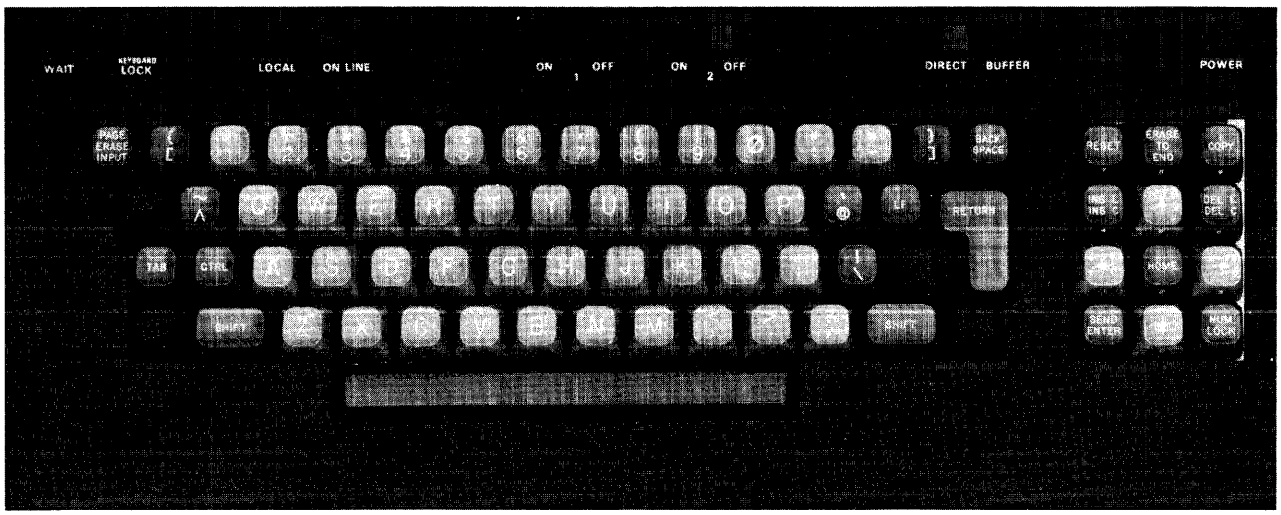


Fig. 1-13. Most often used keys.

Numeric Keyboard

Press the NUM LOCK key and note that it remains depressed. Press the keys on the Control Function Keyboard and you'll notice that numerals (the same as those in the top row of the keyboard) are displayed. A decimal point (SEND-ENTER) key permits a decimal point to be entered in the string of numerals. Press The NUM LOCK key once more to re-establish the Control Functions.

Home Cursor

Using the Cursor Direction controls, position the cursor to any position on the display. Now, press the HOME key and note that the cursor moves instantly to the first character position in the first line — the home position.

Dual Function Keys

Four control keys perform dual functions. The function that the key performs depends on whether the SHIFT key is pressed or not pressed. For example, the PAGE-ERASE INPUT key causes an erase page function to occur when pressed simultaneously with SHIFT. With SHIFT, this key causes erasure of only unprotected data on a formatted display (This key is explained in more detail in the Buffer Form Fill-Out description). The other three dual function keys are:

KEY	TYPE OF KEY	KEY OPERATION
INS L INS C	Edit	Press with SHIFT key to insert a line.
		Press without SHIFT key to insert a character.
DEL L DEL C	Edit	Press with SHIFT key to delete a line.
		Press without SHIFT key to delete a character.
SEND ENTER	Transmission Control	Press with SHIFT key to initiate the Send Sequence.
		Press without SHIFT key to initiate the Enter Sequence.

Editing Keys

A thorough understanding of the operator controlled editing features will help you to more effectively use your 4023.

Correcting Typing Errors

Fig. 1-14 shows an example of text that has been displayed. However, it needs to be edited before being entered to the computer (typing errors can be corrected by simply typing over the error). The Insert and Delete functions are performed as follows:

Inserting A Character

To insert a character, position the cursor where the character is to be inserted, then press the INS C key. Fig. 1-14 (A) illustrates this operation. Note that all data from the cursor location to the right margin shifts right one space, leaving a space at the cursor location.

Deleting A Character

To delete a character, position the cursor over the character to be deleted, then press the DEL C key. All data to the right of the cursor moves left to fill up the space left by the deleted character. Fig. 1-14 (B) illustrates this.

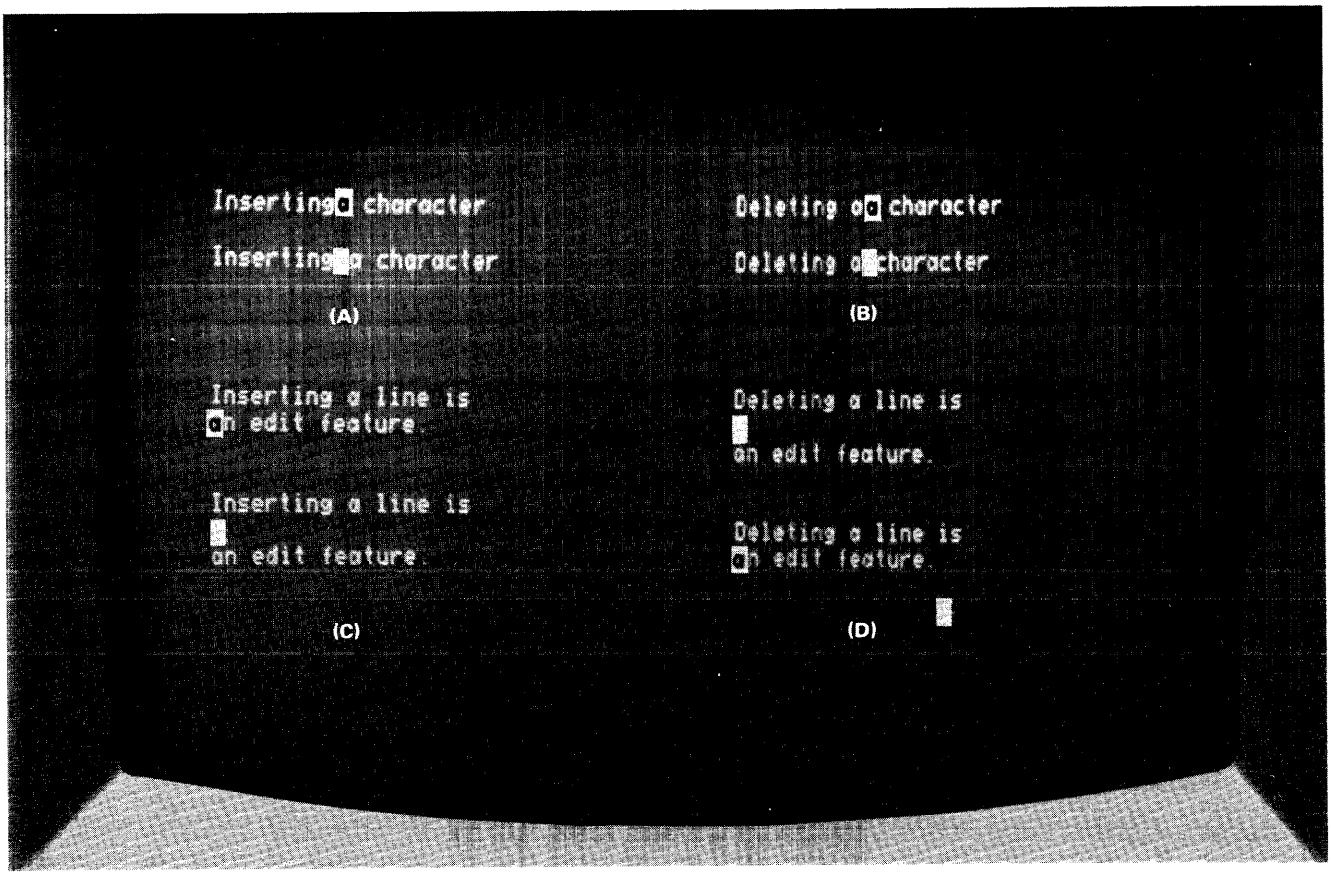


Fig. 1-14. Display mock-up of edit functions.

Inserting A Line

To insert a line, position the cursor to the position on the display where you wish the line to be inserted, then press the INS L and SHIFT keys. Note that the line where the cursor resides and all lines below the cursor move down one line. Fig. 1-14 (C) illustrates this.

Deleting A Line

To delete a line, position the cursor to the position on the display where you wish the line to be deleted, then press the DEL L and SHIFT keys. Note that the line where the cursor resides is erased and replaced with the line immediately below. All other lines below the cursor also move up one line. Fig. 1-14 (D) illustrates this.

Editing Summary

The editing features can be used to move entire lines or partial lines of text, such as would be done for centering form headings, etc. Practice and note the effects of the edit keys.

BECOMING FAMILIAR WITH OPERATION

General

The following is a summary of what to expect when you begin operating your 4023 on line with a computer. The 4023 communicates with a computer in three basic configurations, which can be summarized as Direct, Non-Formatted display (Buffer), and Formatted display (Buffer Form Fill-Out).

Direct Mode

In Direct communication, the DIRECT/BUFFER switch is set to DIRECT. If the LOCAL/ON LINE switch is set to ON LINE, data typed from the keyboard is sent directly to the computer. However, most systems provide an "echo" that allows the keyboard entries to be displayed for viewing by the operator. The echoing of transmitted data occurs so rapidly that it gives the impression of having occurred immediately when the key was pressed.

Editing the display from the keyboard serves no purpose in Direct communications, because the computer has already received the information. However, most systems provide some form of program editing. If you are working with such a system, consult your programmer for more information.

Roll-Up

Direct Entry is the only mode in which roll-up occurs. Roll-up occurs when a line feed from the keyboard or computer tries to position the cursor past the bottom line on the display. Note the effect of roll-up by switching to DIRECT and typing a few lines of text at the top and bottom of the display. Position the cursor to the bottom line, then press the LF (line feed) Key. Note that all lines of displayed data move up one line, leaving a new line at the bottom: note that the top line is lost. Switch back to BUFFER.

Buffer Mode

In Buffer communications, the keyboard entries are first stored in the Terminal memory, displayed, and edited by the operator before being transmitted to the computer. Buffered communications can be with or without a formatted display. Non-formatted displays are used for operations such as programming. Formatted displays (Buffer Form Fill-Out Entry) are used for those data entry operations requiring a form-type arrangement of data.

Buffer Operation

Fig. 1-15 shows a partial display illustration of a typical Buffer Transmission (non-formatted display) sequence. The first line is transmitted to the computer when the operator presses the SEND/ENTER key, initiating an Enter sequence. Pressing this key causes a rectangular marker about cursor size to be displayed at the cursor location. This display marker is called a Message Separator, and is used to bracket information transmitted to the computer. If no preceding Message Separator is displayed, data transmission occurs from the home position to the Message Separator caused by pressing the SEND-ENTER key. As the data is being transmitted, the KEYBOARD LOCK indicator becomes lighted as an indication that keyboard entry is inhibited until the transmission sequence is finished. Also, if a key is pressed during a buffer transmission sequence, the bell will ring. If the WAIT indicator is on, this is a signal that the transmission sequence cannot begin until the WAIT indication ends.

Visual indications that an On Line buffer sequence has been initiated are:

1. Message Separator stores at the cursor location when ENTER key is pressed.

2. Cursor moves back through text seeking the home position or a previously stored Message Separator.

Buffer Operation (cont.)

3. Data transmission begins and is indicated by cursor movement over the data. Speed of cursor movement is indicative of the Baud Rate Selector switch on the rear panel. The higher the baud rate selection, the faster the cursor moves.

4. When the cursor reaches the previously stored Message Separator, it positions to the left margin in the last line of data transmitted, waiting the computer reply.

NOTE

In Local, the Baud Rate Selector switch has no effect. The buffer transmission sequence occurs so fast that cursor movement cannot be visually monitored.

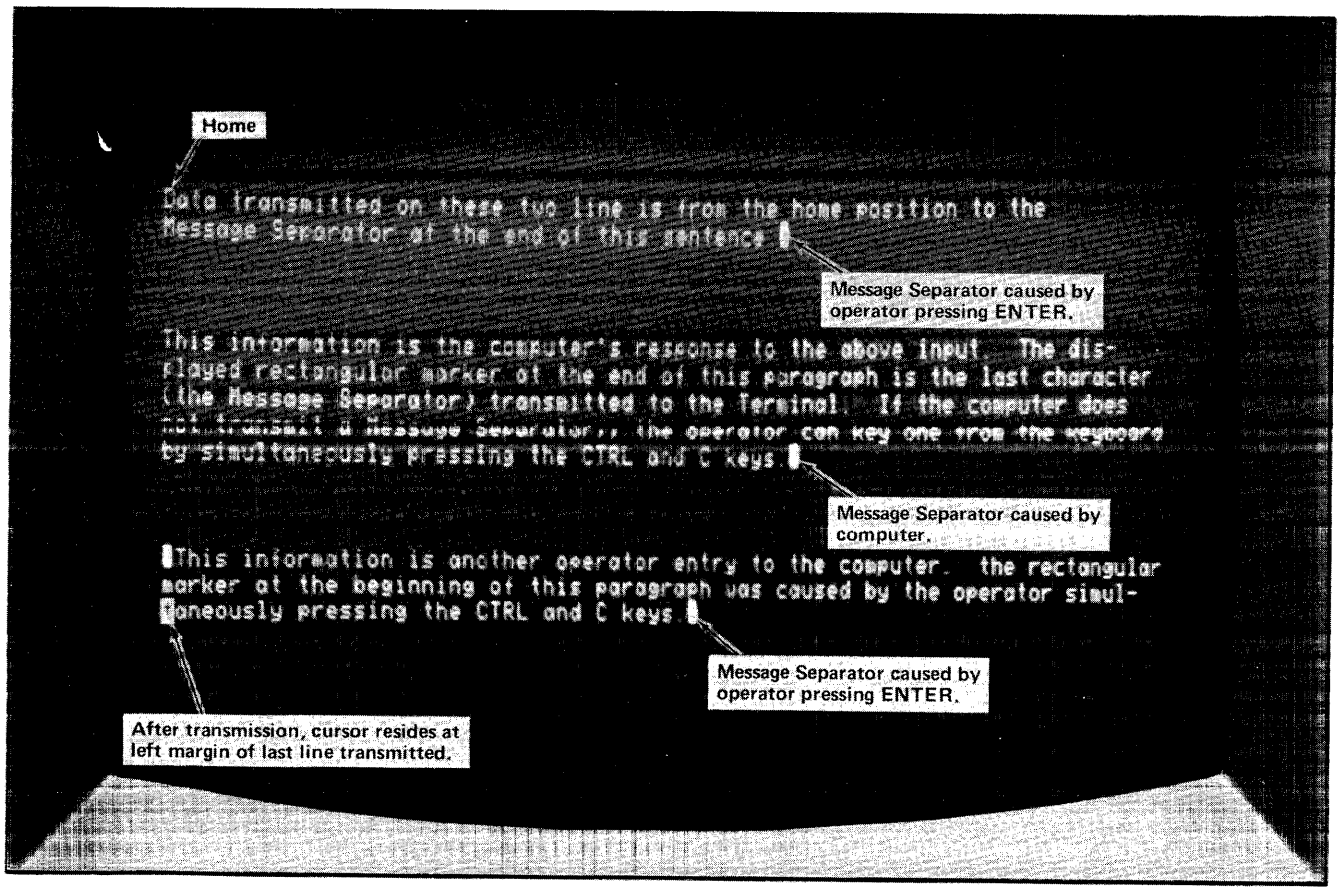


Fig. 1-15. A typical 4023/computer interchange using the terminal buffer.

Buffer Operation (cont.)

The second line in Fig. 1-15 is the computer response to the preceding buffer entry. Some computer systems cause a Message Separator to be displayed as the last character of the computer transmission. These computer generated Message Separators prevent computer originated data from being transmitted back to the computer on subsequent buffer transmissions. If the computer does not provide a Message Separator, the operator can provide one by simultaneously pressing the RESET and RETURN keys or by simultaneously pressing the CTRL and C keys.

Pressing the SEND/ENTER key simultaneously with SHIFT initiates the Send sequence. This transmission sequence does not store a Message Separator at the cursor location. However, existing Message Separators are honored. Thus, if no Message Separators are displayed, all screen data is transmitted to the computer.

You can gain an idea of the operation of both transmission sequences (Enter and Send) by exercising the 4023 in LOCAL. Of course, no computer responses are available in LOCAL, but enough can be learned from the information supplied in the preceding Buffer transmission descriptions that you will be prepared for on-line operation with a computer.

Buffer Form Fill-Out Operation

Buffer Form Fill-Out is the mode of operation that uses a "formatted" display to aid in data entry to a computer. Formatted displays are divided into fields that permit the displayed data to be arranged in a form configuration (the computer or auxiliary device will display the form as requested by the operator). (See Glossary for definition of a Field.) The computer program decides the type and amount of a specific information contained in a field. The operator types in or changes the necessary form information, then enters part of the form (or the entire form) to the computer.

Terminal features such as tabbing, editing, partial or entire form transmission, and others are directed toward Form Fill-Out operation. These features will be explained later. For the present, two types of data fields are important. These are "protected" fields and "unprotected" fields.

Protected Fields

Protected fields are data fields that cannot be changed by normal keyboard entry. These fields will contain form heading information, and other information, that the program sets as normally unchangeable from the keyboard. Protecting a field prevents accidentally typing into that field. When the cursor is in a protected field, the KEYBOARD LOCK indicator is lighted. As additional warning, pressing a key when the cursor is in a protected field causes the bell to ring.

NOTE

In isolated cases, it may be necessary to enter data into a protected field. Your programmer will tell you when such an entry is to be made. This can be done by pressing the RESET key simultaneously with the desired keyboard character.

Unprotected Fields

Unprotected fields are normally the fields in which you will be entering and changing data. Data in unprotected fields can be changed. Any unprotected field can be partially or completely erased (depending on cursor position in the field) by pressing the ERASE TO END key. Data in the unprotected fields can be erased by pressing the PAGE-ERASE INPUT key. The Erase Input function is used to leave a "blank form" for further entries that use the same heading information.

Non Alpha Fields

Some formatted displays may contain non alpha fields. Only the following characters can be entered into a non alpha field: SPACE ! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?. Attempting to enter an alpha character into a non alpha field will cause the bell to ring. In isolated cases it may be necessary to enter a character into a non alpha field. In this case, simultaneously press the RESET key with the character desired.

Field Identification

Field identification is accomplished by a variety of display backgrounds. For example, protected data can be displayed "dim", while unprotected data can be displayed at normal intensity. If the program requires the operator's attention to a specific field, that field can be made to blink. Other types of display backgrounds are available to the programmer. Fig. 1-16 is an example of the variety of displays available. When working with formatted displays, you will be told what type of background identifies specific fields.

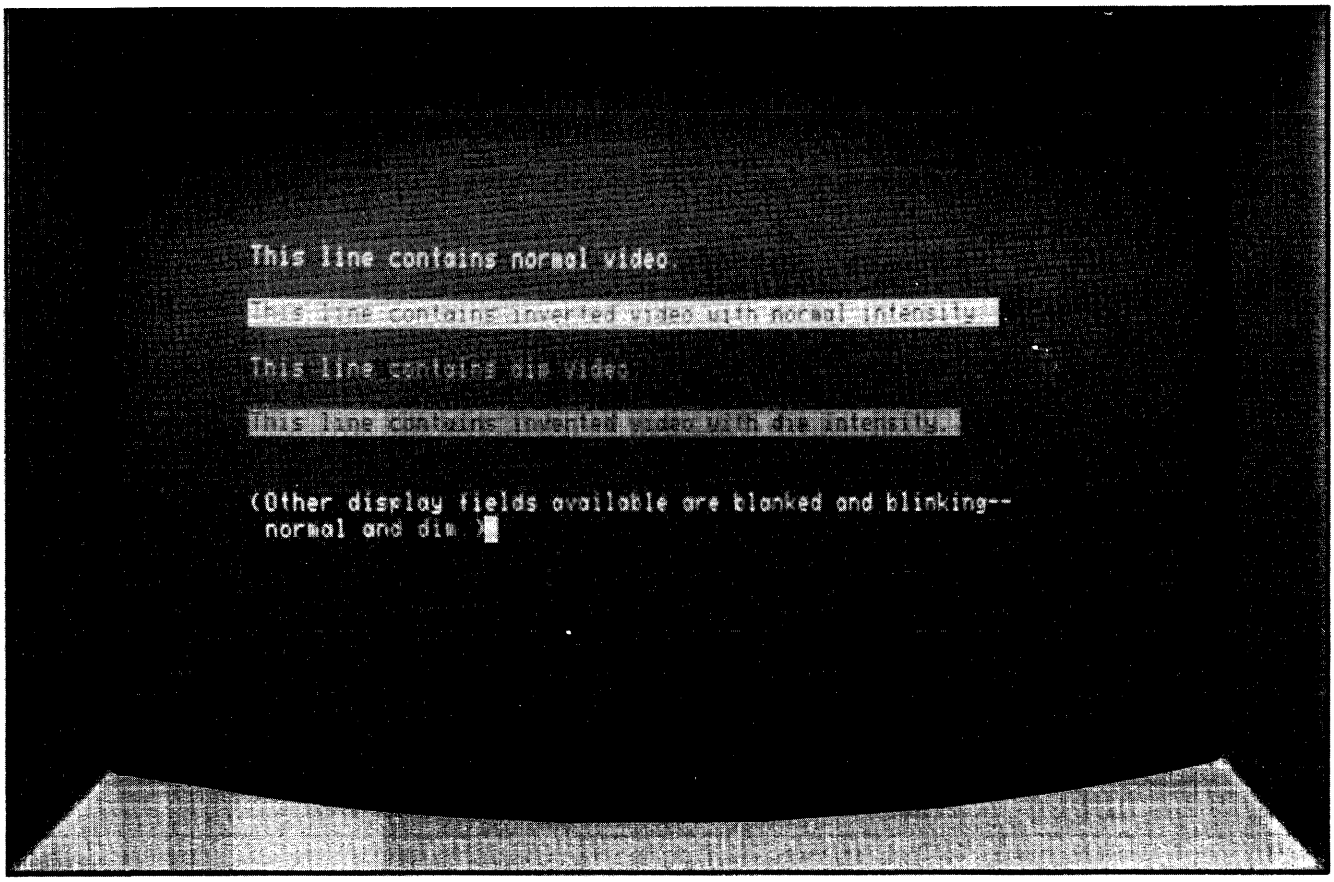


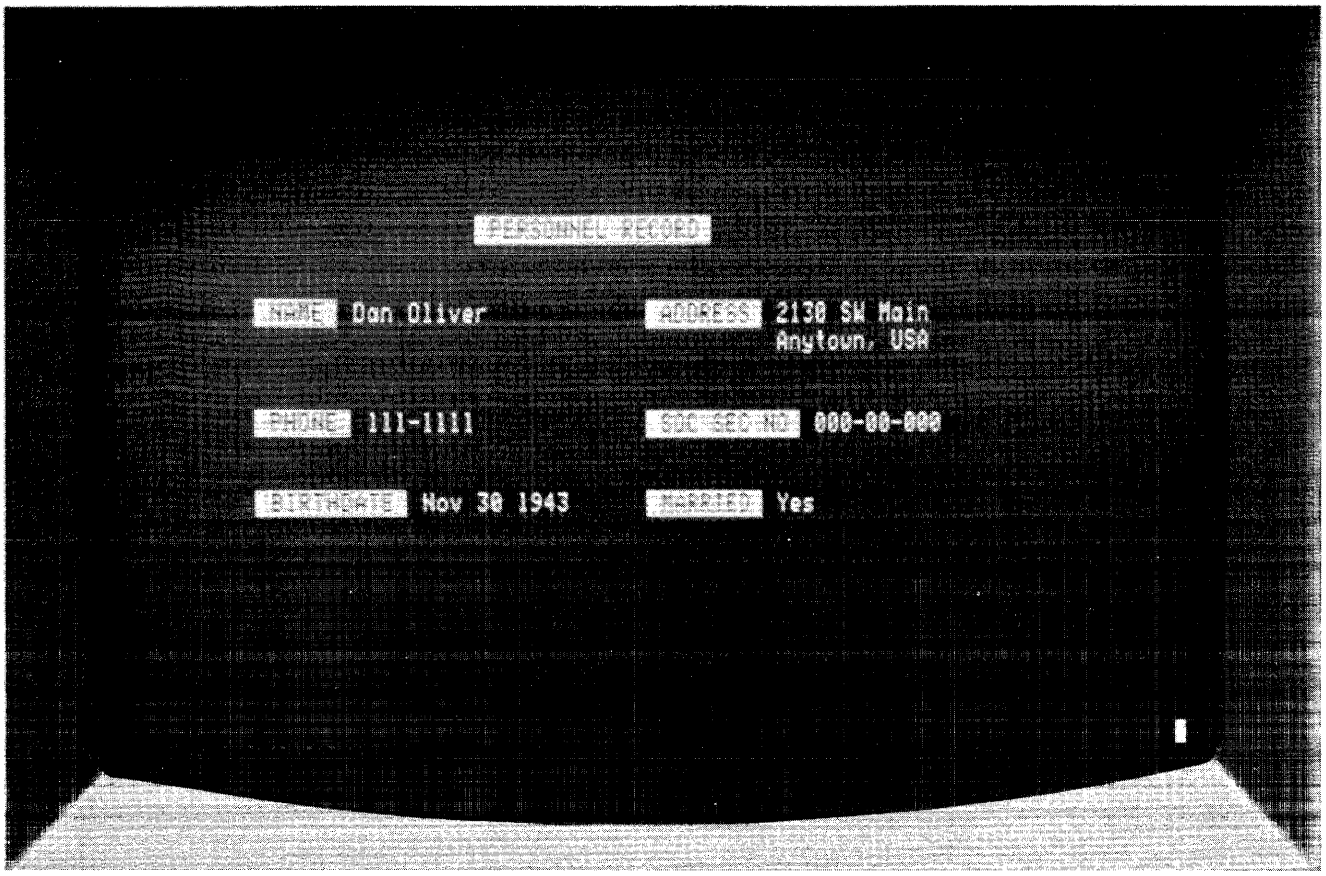
Fig. 1-16. Display fields available.

Example Of Form Fill-Out Operation

If your company uses formatted displays that contain protected and unprotected fields, have a more experienced 4023 Terminal operator retrieve a blank form from the computer system to use as you proceed through the following discussion. Find out which of the fields are protected and which are unprotected, then proceed with the following: Fig. 1-17 can also be referred to when reading the following. (Fig. 1-17 can be programmed from the keyboard by using the procedure outlined in Appendix D.) This figure illustrates a formatted display and related keyboard keys that are used in form fill-out operations.

1. Check that the LOCAL/ON LINE switch is in LOCAL, then position the cursor inside a protected field. Note that the KEYBOARD LOCK indicator comes on, and when any character key is pressed, the bell rings.

2. Note that protected data can be changed by entering a character when the RESET key is held down.



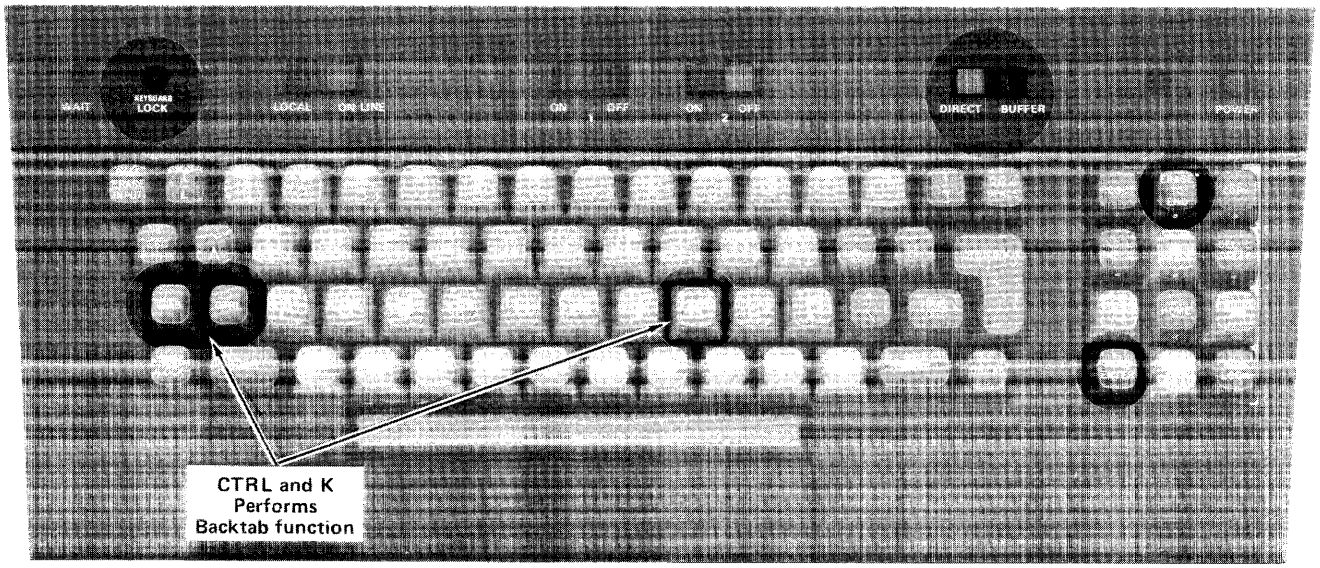


Fig. 1-17. Formatted display and related keys.

Example of Form Fill-Out Operation (cont.)

3. Press the HOME key, then quickly press and release the TAB key. The cursor is now positioned in the first character position of the first unprotected field. (In the case of Fig. 1-17, it is the field into which the person's name is entered.) Type in a few characters, then using the TAB key, move from one input field to the next, keying in a few characters in each.

NOTE

In Fig. 1-17, the unprotected fields for PHONE and SOC SEC NO are non alpha fields. When you wish to enter an alpha character, simultaneously press RESET with the character input desired.

4. Using the TAB key, position to an unprotected field. Press the ERASE TO END key and note that the information in that particular field is erased. The cursor positions to the first character position of the next field, whether it's protected or unprotected. Hold down the TAB key and note how it tabs from one unprotected field to the next.

5. Press the SEND-ENTER key. This starts the Buffer Enter transmission sequence. Note that the cursor automatically tabs from one unprotected field to the next, skipping the non transmittable data. After the cursor has scanned the entire form, it positions to the left margin on the last line. The KEYBOARD LOCK and WAIT indicators are lighted as described in the preceding Buffer Transmission description.

6. Simultaneously press the SEND/ENTER and SHIFT keys. This starts the Buffer Send transmission sequence. But note that the cursor automatically tabs from field to field, transmitting all data. The Send sequence for formatted displays is useful to programmers when it becomes necessary to update a form (change headings, etc.).

7. Press the ERASE INPUT key and note that all unprotected data is erased. This provides a clear form for further data entries that use the same form.

CONCLUSION

This concludes the operator familiarization portion of this manual. Because of the variety of systems with which the 4023 can operate, the presentation of material is very generalized. However, the information presented here should have acquainted you with the basics of 4023/computer communication.

PROGRAMMING

SECTION II
PART 1

INTRODUCTION

Input/Output Configuration

The 4023 is both a transmitting and a receiving device. Standard interface hardware provides full duplex only. Full or half duplex can be achieved by use of an Optional Interface. Data can be transmitted directly from the keyboard to the computer, from the Terminal memory (buffer), or from an optional auxiliary unit. Data received by the Terminal can be written on the display, can control other functions in the Terminal, or can control functions at auxiliary units.

The LOCAL/ON LINE switch must be in the ON LINE position to communicate with the computer.

Data transmitted to the computer can be echoed back to the Terminal's receiving circuits by either the computer, or by selecting Local Echo at the Interface Unit (if the Interface Unit is equipped with Local Echo capability). Under Local Echo conditions, data from the keyboard or auxiliary unit is simultaneously sent to the computer and the 4023 receiving circuits. All data from the computer enters the Terminal memory and is displayed.

The 4023 operates independent of the computer when the LOCAL/ON LINE switch is set to LOCAL. Local operation permits keyboard or auxiliary unit data to be written on the display or otherwise executed (to a degree) by the Terminal.

Summary of Terminal Configuration

The following describes the standard 4023 configuration. Where Strappable Options affect the Terminal configuration, special notation will be given (Strappable Options information can be found in Part 2 of this Section).

The 4023 displays information on 24 lines of 80 characters each. Display formatting capabilities are standard.

The 4023 communicates directly with a computer, or communicates with the computer via the Terminal buffer. In DIRECT, automatic roll-up occurs when the computer or operator attempts to give a line feed past the bottom line. This is known as "page full." In BUFFER, the Terminal goes busy when the computer or operator attempts to enter a line feed past the bottom line. With flagged interfaces, this will stop data flowing to the 4023 without loss. With unflagged systems (such as RS-232), further received data will be confined to the bottom line.

Pressing the RETURN key also performs a line feed. A computer-generated CR does not perform a simultaneous line feed. The effect of CR on line feed can be changed by strap placement (CR DOES LF strap) on the Keyboard Interface Card.

The LF (line feed) code from either the LF key or the program, performs a line feed function only. It can be strapped to also perform a carriage return. See the LF DOES CR strap on the Keyboard Interface Card.

When ON LINE and entering buffer data to the computer, carriage returns are transmitted at the end of a line, line feeds are not transmitted. Line feeds can also be transmitted by placement of the EOL LF GEN Strap on the Control Card. When no data resides in a line, CR (and LF if strapped) transmission is suppressed.

The standard 4023 transmits an End of Message character as the last character in an enter sequence. The standard End of Message character is CR. However, the MESSAGE END straps on the Control Card can be strapped to enable any ASCII control character to be used as the Message End Character.

The 4023 always performs a carriage return after the last character transmitted. A CR is transmitted only if the Message End Character is Strapped to be CR.

Buffered data from the standard 4023 is entered by page, and not by line. Once an enter sequence is activated, transmission continues until the entire message is transmitted. However, for those computer systems that can handle only a line of data at a time, the Terminal can be configured to meet their needs by placement of the PROMPT Mode strap on the Control Card. This strap causes buffer contents to be transmitted a line at a time. After a line is transmitted, cursor movement stops, awaiting the

"prompt" character from the computer. With the receipt of the prompt character, another line is transmitted to the computer. Standard prompt character is the code for the ASCII upper-case "P" (80_{10}).

The standard 4023 does not blink the cursor unless the RESET key is pressed. The BLINK CURSOR strap on the Timing Card can be placed to make the cursor blink continuously.

Features such as Position Cursor and Read Cursor are standard.

CODE EFFECT

General

In order to offer specialized functions and features to the programmer, several character codes or code sequences are designated as controls. Specialized features such as the definition of fields, clearing the screen, positioning the cursor, ringing the bell, and triggering hard copies allow the programmer to set up the Terminal in the desired manner.

Code Set

The standard ASCII code set is used to provide control for data transmission, operational configuration, and control over the specialized functions mentioned in the above paragraph.

Control Codes

Some of the control characters used in the Terminal are simply designated as controls. The ASCII Code Chart in Appendix B shows those controls. However, to expand the number of possible controls, two-character control sequences are used. The first character of the control sequence is ESC (27_{10}). It signals the Terminal that the next character, regardless of its normal function, is to perform a different function.

NOTE

Table 2-2 provides a description of the code controls and the effects they have on Terminal operation. The 4023 responds to or otherwise uses, only those listed.

Control Character Performance

Storage. Control characters typed by the keyboard or sent by the computer are usually not stored in Terminal memory, but are simply performed. For example, a CR (13_{10}) typed on the keyboard will normally not alter Terminal memory, but will cause the cursor to position itself at the beginning of the next line. The operator may enter the CR character (or any control character) into memory, by holding down the RESET key while typing the control character desired. The screen will show a block character (all dots written) to signal that the memory position contains an otherwise invisible control character. (Only half the control characters are displayed as blocks. If BIT 1 of the control character is true, then that control character can be displayed.) However, for normal usage, control characters need not be stored in memory. Stored control characters (excluding CR, NUL, and ETX) can be transmitted.

Two control characters, NUL and ETX are normally stored in Terminal memory independent of the RESET key, as explained by the following:

NUL A NUL is entered into the memory on Clear Page, Erase to End, Erase Input, Delete Line, and Delete Character functions. Nothing is displayed in a character position if a NUL occupies that position in Terminal memory. NULs are not transmitted. Thus the data string is compacted to include only the information displayed (or otherwise identified as being transmittable).

ETX When no Field Attribute Codes are stored in memory, pressing the ENTER key causes an ETX code to store in memory at the cursor location. ETX is also known as the Message Separator Code. It marks the beginning or end of text in conjunction with the Enter Function. With any Field Attribute Code stored, the ENTER key does not store an ETX unless RESET is pressed.

The computer equivalent of the ENTER key is the ETX code. By sending the Terminal an ETX (3_{10}) as the last character of the computer transmission, the displayed computer data is prevented from being transmitted back to the computer on subsequent buffer entries. The computer originated ETX stores regardless of Field Attribute Codes.

Message End Character. This is the last character transmitted from the 4023 in a buffer transmission sequence. The standard End character is CR (13_{10}). However, strap options on the Control Board permit any ASCII control

character to be selected. (See Strappable Options in the Installation procedures.)

Edit Key Effects

NULs are entered into memory on Delete Line and Delete Character functions. SPACEs are entered into memory on Insert Line and Insert Character functions. Erase Input and Erase to End (used with formatted displays) functions also place NUL characters into applicable positions in memory.

Computer Controlled Editing Functions

Format Effectors. The 4023 uses six ASCII control characters designated Format Effectors by the American National Standards Institutes. These six characters are CR (13_{10}), LF (10_{10}), BS (8_{10}), HT (9_{10}), VT (11_{10}), and FF (12_{10}).

CR (carriage return) moves the cursor to the first position of the line it is in. The standard Terminal can be strapped to also perform a line feed upon receipt of the CR code. See Strappable Options in the Installation Appendix.

LF (line feed) performs a line feed by moving the cursor down one line. It does not affect the horizontal position of the cursor unless strapped to do so (see Strappable Options in the Installation Appendix). If in DIRECT, attempting to enter a line feed past the bottom line on the display will cause the screen to roll-up one line. If in BUFFER, a line feed cannot be entered past the bottom line on the display.

BS (backspace) moves the cursor to the left one character. If the cursor is already at the left margin, the BS command is ignored.

HT (horizontal tabulate) tabs the cursor one space beyond the Field Attribute Code that describes an unprotected field (in Buffer Form Fill-Out). If no unprotected field is found, the cursor returns to the home position (upper left corner). In DIRECT, HT moves the cursor one space to the right.

VT (vertical tabulate) performs a back tab function; the reverse of the HT function. Again, if no unprotected field is found, the cursor returns to the home position.

FF (form feed) performs a clear page function when preceded by ESC (27_{10}).

Display Formatting

General. The display formatting feature is used to divide the display into fields. Codes called Field Attribute Codes (FACs) arrange the displayed data as to its appearance, its protection, and its transmission. A variety of FAC's provide programming versatility.

The Field Attribute Code. The FAC is stored in the first character position of the field it defines. It is protected from keyboard replacement. The field extends from the location of the FAC to another FAC in the same line or the end of the line (80th character position).

Setting the Field Attribute Code. Sending the US (31_{10}) control character sets the Terminal logic to interpret the next character as a FAC. Table 2-1 provides a quick reference for locating a specific FAC.

Once the FAC is chosen, it needs to be placed in Terminal memory at the desired location.

NOTE

Do not enter a FAC in the 80th character position of any line.

First, position the cursor to the start of the field being defined (see Position Cursor description, this section), then send the US (31_{10}) control character. US causes the next character to be interpreted as a FAC. Once the FAC is stored in memory, the field is completely defined. The FAC is protected from keyboard replacement, regardless of the field it defines.

NOTE

Since the computer can enter data anywhere on the screen regardless of fields, it is free to write the FAC's in any order. However, when a display is being formatted from the keyboard, it is convenient to enter the codes from right to left, beginning with the right-most FAC. Because the keyboard is not free to enter data anywhere on the screen, entering a FAC that sets up a protected field to the left, first, prevents other FAC's from being entered on the same line. However, protected Fields can be overridden from the keyboard by pressing the RESET key, while simultaneously keying in another FAC. The US control character from the keyboard is entered by simultaneously pressing the CTRL and SHIFT and O keys (^{cs}O).

TABLE 2-1

FIELD ATTRIBUTE CODES

LOGIC EFFECT / DISPLAY EFFECT	TRANSMITTABLE				NON TRANSMITTABLE			
	UNPROTECTED		PROTECTED		UNPROTECTED		PROTECTED	
	ALPHA-NUMERIC	NON ALPHA	NORMAL	DIM	ALPHA-NUMERIC	NON ALPHA	NORMAL	DIM
White on Black	@ (64_{10})	A (65_{10})	B (66_{10})	C (67_{10})	D (68_{10})	E (69_{10})	F (70_{10})	G (71_{10})
Black on White	H (72_{10})	I (73_{10})	J (74_{10})	K (75_{10})	L (76_{10})	M (77_{10})	N (78_{10})	O (79_{10})
Blinking	P (80_{10})	Q (81_{10})	R (82_{10})	S (83_{10})	T (84_{10})	U (85_{10})	V (86_{10})	W (87_{10})
Blanked	X (88_{10})	Y (89_{10})	Z (90_{10})	[(91_{10})	\ (92_{10})	] (93_{10})	^ (94_{10})	$\overline{(95_{10})}$

NOTE (cont)

Edit keys are operational with formatted displays. Although a Field Attribute Code cannot be keyed over from the keyboard, it can be deleted by using the Delete Character function. Also, lines that contain Field Attribute Codes can be deleted by using the Delete Line function (whether the code defines the data as being protected or unprotected is immaterial).

Non Alpha Fields. Non alpha fields are limited to those characters in columns 2 and 3 of the ASCII Code Chart (see Appendix B).

Sample Input String. Fig. 2-1 shows a formatted display. The input string as seen by the computer is:

With ENTER Sequence:

US@John SmithUS@2130 S W MainCRLFUS@Beaverton, Or.CR

With SEND Sequence:
USNNAMEUS@John SmithUSNADDRESSUS@2130 SW MainCRLFUS@Beaverton, Or.CR

Code explanation is:

US – Field Segregator that precedes each FAC.

@ – FAC

N – FAC

CR
LF – Carriage return and line feed

CR – End character (can be strapped to be any ASCII control character).

NOTE

The above input strings show that two character spaces must be allotted in the computer core for the FAC sequence; one for the US and one for the FAC.

Position Cursor

Each of the 1920 character positions can be individually addressed. Sending the FS (28_{10}) control character sets the 4023 to recognize the next two characters received as

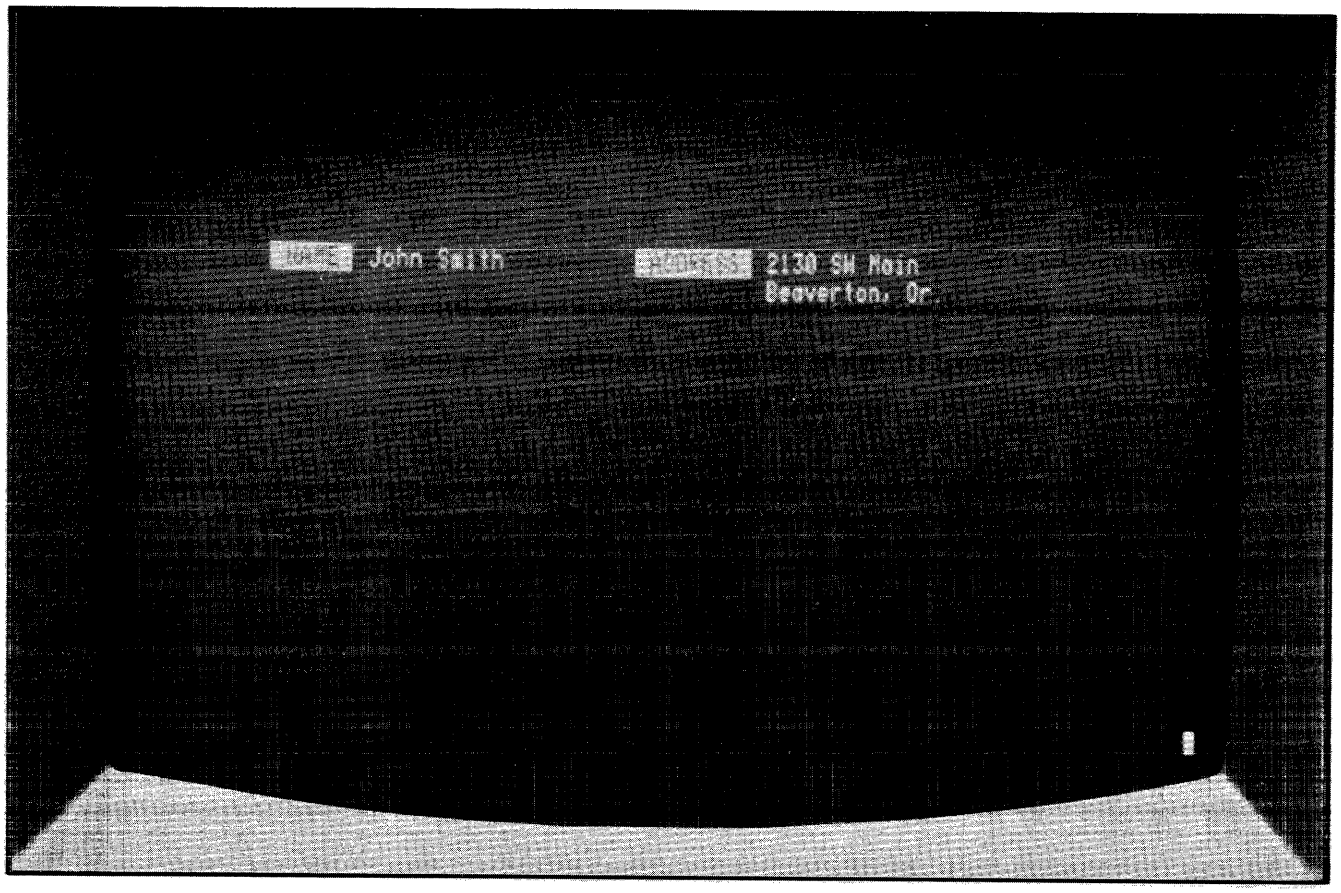


Fig. 2-1. A Formatted Display.

position cursor information. To find the specific horizontal (X) and vertical (Y) codes necessary to position the cursor, you must add 32_{10} to both the X address and the Y address. The X address is the specific character position in a line, and the Y address is the specific line.

For example, assume that you wish to position the cursor to the 18th character position of the 10th line.

Horizontal address = 18 + 32 = 50_{10}

Vertical address = 10 + 32 = 42_{10}

Referring to the ASCII Code Chart, you find that the numeral 2 and the asterisk codes are the respective X and Y codes needed to position the cursor to the above address. The complete sequence would be:

Set Cursor Position	Send FS (28_{10})
Set Horizontal Address	Send 2 (50_{10})
Set Vertical Address	Send * (42_{10})

Read Cursor

To read (send) the cursor position to the computer, the two-character control sequence of ESC followed by] (93_{10}) is used. Receiving this sequence causes the 4023 to send GS, X, Y, END to the computer. GS (29_{10}) identifies the next two characters as cursor position information. X is the code for the character position in a line; Y is the line number; and END is the character that marks the end of the message and is usually CR (The End character can be strapped to be any control character).

NOTE

To obtain the actual character and line position number, the program must subtract 32 from both the X and Y values received.

4023 Program Time Delays

FUNCTION	TIME DELAY REQUIRED
Erase Input, Clear Page, Roll up, Insert Line, Delete Line	3.75 ms
Erase to End	5 ms maximum. 63.6 μs for each character erased, up to 80 characters.
Tab	64 μs per character scanned; e.g., for full scan – 1920 X 64 μs = 12.5 ms.
Prompt Character Delay	
Receipt of Prompt Character causes . . .	Prevents terminal from transmitting to the computer for about 0.5 sec (250-750 msec) with timeshare systems
ESC Character Delay	
Same as Prompt Character Delay	

Fill Characters

The following shows the number of fill (pad) characters required at various baud rates, after an erase command or LF that produces a roll-up is received by the Terminal. Acceptable fill characters are NUL, SPACE RUB-OUT, or any non-functioning control character.

BAUD RATE		Typical		FILL CHARACTERS NEEDED
up to 2.93 k	–	up to 2400 baud	–	0
2.93 k to 5.86 k	–	4800 baud	–	2
5.86 k to 8.799 k				3
8.799 k to 11.73 k	–	9600 baud	–	4

Terminal functions that include new line (LF with CR), backspace (BS), and NUL, do not interrupt the 15720 character-per-second rate; except in roll-up as noted above.

Summary of ASCII Code Effect on the 4023

Code translation is (Refer to ASCII Code Chart):

$0\text{-}31_{10}$ ($0\text{-}36_8$)

Control characters. Specific control characters used by the 4023 are indicated in Table 2-2, as well as on the ASCII Code Chart.

32_{10} (37_8)

Non-displayable SPACE character.

$33\text{-}126_{10}$ ($40\text{-}176_8$)

Printing characters which occupy a character space in Terminal memory.

127_{10} (177_8)

Does not write or space.

The following table summarizes the ASCII code effect on the 4023. The terminal uses, or otherwise acts, on only those listed.

NOTE

Keying control characters from the keyboard requires two (and in some cases, 3) key closures. In the following table, a superscript C followed by a letter character indicates that the control character is formed by simultaneously pressing the CTRL and indicated letter key. A superscript C and S, e.g. ^{cs}O, indicates the control character (in this case, US) is formed by simultaneously pressing the CTRL and SHIFT and O keys.

TABLE 2-2

ASCII CODE EFFECT

Single Character Commands

ASCII CONTROL CHARACTER	KEYBOARD KEY COMBINATION	RESPONSE
ETX (3_{10})	^{c}C (normally not keyed from keyboard)	END OF TEXT. Functions as a Message Separator when stored in the buffer. It is stored when the computer outputs the ETX to the Terminal as the last character of the computer transmission, or when the operator types ^{c}C or presses the ENTER key. Storage is suppressed from the keyboard if there are any Field Attribute codes in memory.
BEL (7_{10})	^{c}G	Activates the bell-like tone from the speaker.
BS (8_{10}) Backspace	^{c}H	Backspace – a format effector. Moves the cursor to the left one character. If the cursor is already at the left margin, the BS command has no effect.
HT (9_{10}) Tab	^{c}I or TAB key	Horizontal Tabulate – a format effector. In Buffer mode with formatted displays, HT tabs the cursor one character space beyond the FAC that describes an unprotected field. Used to tab the cursor from one field (any field) into the next input field. If no input field is available, the cursor returns to the Home position. In DIRECT, HT performs a non-destructive direct space, i.e. moves cursor right one space.

TABLE 2-2 (cont)

ASCII CONTROL CHARACTER	KEYBOARD KEY COMBINATION	RESPONSE
LF (10_{10}) Line Feed	^{c}J or LF key	Linefeed – a format effector. In Buffer operations, LF performs a line feed by moving the cursor down one line. It does not affect the horizontal position of the cursor unless strapped to give a CR with LF (see Strappable Options). An LF past the 24th line will cause the screen to roll up one line, if in DIRECT. Linefeed's are generated as set by the EOL LF GEN strap on the Control Board (see Strappable Options).
VT (11_{10}) Back Tab	^{c}K	Vertical Tab – a format effector. Performs a "back tab" function – the reverse of the HT function. If no input field is found, the cursor goes to the home position. Does not work in DIRECT.
CR (13_{10}) Carriage Return	^{c}M	Carriage Return – a format effector. Moves the cursor to the first character position at the left margin. Can be strapped to provide a line feed with carriage return, thus establishing a new line at the left margin. Various effects to and from a CR are provided by Strappable Options. Can also be stored in memory for use as a Message Separator by having the operator simultaneously press RESET with CR.
SO (14_{10}) Rulings Set Select	^{c}N	Shift Out. Selects the optional (rulings) character set.
SI (15_{10}) Standard Set Select	^{c}O	Shift In. Selects the standard character set if the optional (rulings) character set has previously been selected.
ESC (27_{10}) Arming Command	ESC key or ^{cs}K	First character of a special two-character sequence. ESC "arms" the Terminal to interpret the next character received (regardless of its normal function) as a special control or function. (See ESC BEL, ESC FF, ESC SO, ESC SI, ESC O, and ESC].) The character following ESC causes CBUSY to go active for 0.5 sec. (See ESC Character Delay in Programming Considerations.)
FS (28_{10}) Set Cursor Addressing Mode	^{cs}L	Sets the Cursor Addressing Mode. When followed by the proper address codes, the cursor can be positioned to any position on screen.

TABLE 2-2 (cont)

ASCII CONTROL CHARACTER	KEYBOARD KEY COMBINATION	RESPONSE
US (31_{10}) Field Separator (Field Attribute Code Substitute)	$^{cs}0$	Performs two functions: 1) Used in Buffer Form Fill-Out Entry Sequences as a Field Segregator. The US code precedes the Field Attribute Code on the data string to identify the input data that follows as having been preceded by a FAC in Terminal memory. 2) When the Terminal receives a US code, Terminal logic is set to interpret the next character received as a Field Attribute Code.

Two Character Commands

ESC BEL	ESC ^{c}G	Used to trigger a hard copy of the displayed data when using a Hard Copy Unit. ESC BEL is the computer addressed equivalent of the COPY button on the Terminal or Hard Copy Unit. The Hard Copy Unit can receive and print video (except for blink) on paper. Multiple copies can be obtained under program control by commanding a copy to be made and immediately following it with the Read cursor command (ESC]). The action of making a copy delays the reading of the cursor until the copy is completed. When the Terminal responds with the cursor location, the program can use this as signifying that the copier is ready for another command.
ESC FF Clear Page	ESC ^{c}L	Clear screen command. Performs same function as PAGE. The screen is cleared, cursor positions to HOME and all Terminal logic is initialized.
ESC SO Send Page	ESC ^{c}N	Initiates a send function. Causes all fields, normally transmittable or not, from the beginning to end of text, to be transmitted to the computer. If fields are contained on the display, the Field Attribute Codes are preceded by the US (31_{10}) character. When transmission of all data is completed, the cursor resides in the left-most character position on the last line of the message.
ESC SI ENTER i.e. Send Transmittable Only	ESC ^{c}O	Performs the same function as ESC SO with the exception that only transmittable fields are transmitted. (Rulings are not transmittable.)
ESC O (79_{10}) ESC o (111_{10}) ESC / (47_{10}) (Clear Input)	ESC O	Initiates the clear input sequence. Sets all unprotected data fields to NUL characters. Used in the Buffer Form Fill-Out Mode when it becomes necessary to clear the input data only (does not clear rulings). Do not confuse with the Clear Page Function.

TABLE 2-2 (cont)

ASCII CONTROL CHARACTER	KEYBOARD KEY COMBINATION	RESPONSE
ESC] Set Read Cursor Mode	ESC] (] = 93_{10})	Initiates the Read Cursor Mode. Causes cursor coordinates to be transmitted to the computer.

RULINGS CHARACTER SET (Optional)

Introduction

An optional rulings character set can be provided with the 4023 to develop rulings for forms, charts, and bar graphs. To address the rulings character set, send SO (14_{10}). Use SI (15_{10}) to select the normal character set.

Rulings Character Set Organization

The optional Rulings Character set (Fig. 2-2 shows ruling characters available) is organized to make it possible for the program to compute the address of a character from the character description. This facilitates the designing of a subroutine package to compute the type and location of the ruling character by simply defining the rulings. The rulings are divided into two types:

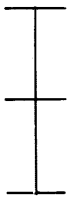
Type Ø single lines

Type 1 double lines

Each of the ruling types have six join types; three for horizontal and 3 for vertical.

Horizontal Join

Vertical Join



Thus, a horizontal type join of "Ø" is a horizontal line where the vertical element (line) crosses at or meets its left end. A vertical type join of "1" means the horizontal element passes through or meets the center of the vertical line.

There are four classes of characters that are used to make the horizontal and vertical lines.

1. SIMPLE JOIN CHARACTERS – Joins that exist between a horizontal and vertical element of the same ruling type.

2. COMPLEX JOIN CHARACTERS – Joins where the two elements have a differing ruling type.

3. SINGLE ELEMENT CHARACTERS – Straight lines with no join.

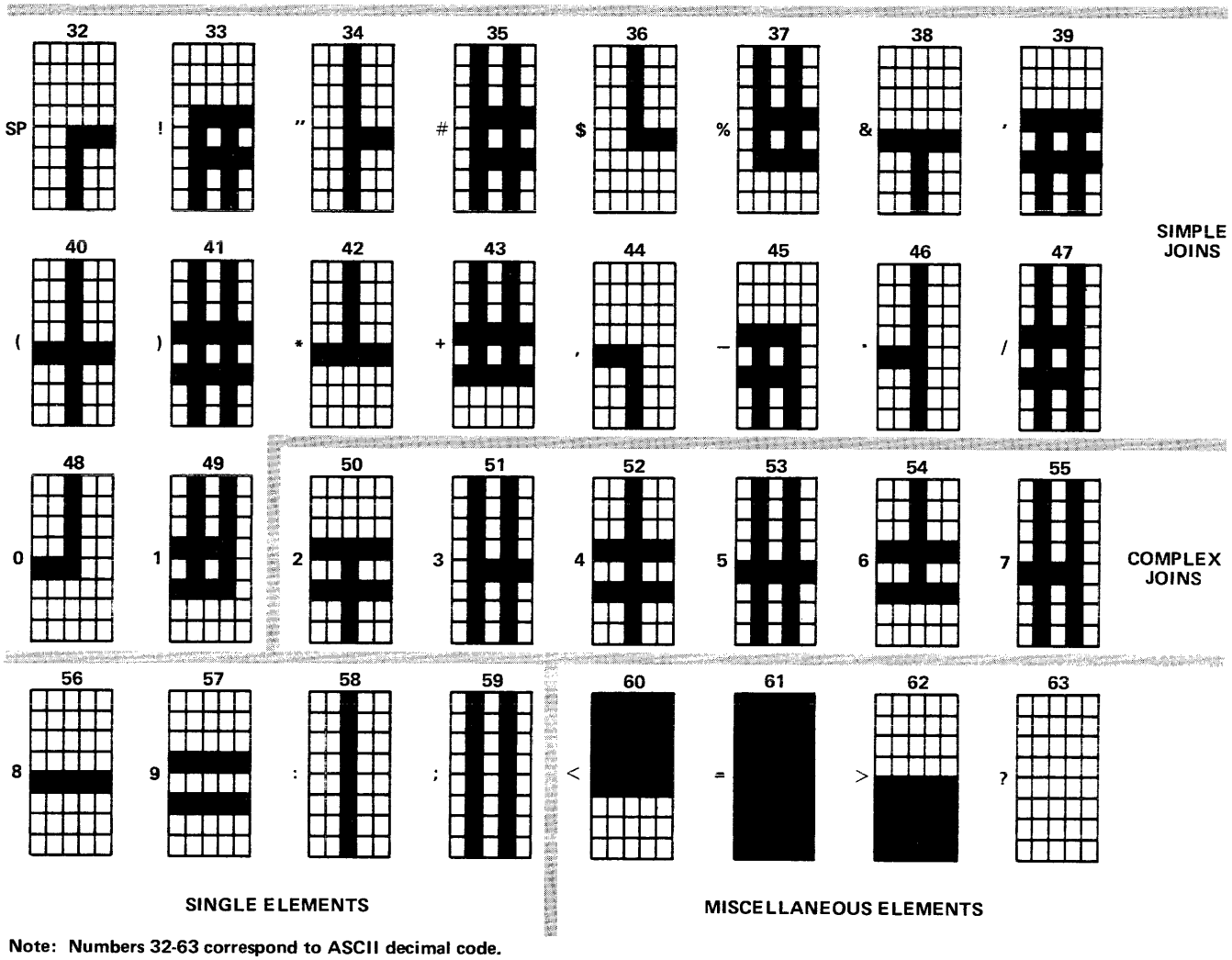
4. MISCELLANEOUS CHARACTERS – Use depends on program.

Finding the Character

A formula can be used to compute the specific character desired for three classes of characters (the formula will not work for the Miscellaneous Characters). The formula for computing a specific character is:

Ruling Character = (6 X P) + (2 X S) + T + 32

Where P = Primary Element (horizontal join)
S = Secondary Element (vertical join)
T = Tertiary Element (ruling type Ø or 1)



Note: Numbers 32-63 correspond to ASCII decimal code.

Fig. 2-2. Ruling characters provided by the optional rulings character set.

Simple Join Characters. As an example in using the formula to compute simple joins, assume that you wish to display the following simple join:

$= (6 \times 0) + (2 \times 1) + 1 + 32$

$= (\ 0\ ) + (\ 2\ ) + 1 + 32$

$= 35_{10}$

Referring to the ASCII code chart, you will see that sending the ASCII code for the # (35_{10}) character will display the ruling character shown in the example.

Complex Join Characters. For complex joins, the computing system is slightly modified, in that the ruling type codes are modified, and the types of joins are limited. The following are examples of those types of complex joins NOT present.

The rule for whether a specific join exists or not is: A HIGHER RULING TYPE MAY NOT TERMINATE IN A LOWER RULING TYPE.

For complex joins, the P element of the formula is always given the value of three (3), the S element states the join type of the inferior element, and the T element is the orientation of the superior element.

T = Ø (when superior element is horizontal)

T = 1 (when superior element is vertical)

NOTE

To obtain the correct T element for the ruling type, remember that the element with the lowest ruling type is the inferior element, and the element with the highest ruling type is the superior element.

The following is an example of computing the ASCII code for a complex join.

= (6 X 3) + (3 X 0) + 0 + 32

= (18) + (0) + 0 + 32

= 50_{10}

Refering to the ASCII Code Chart, you will find that sending the numeral 2 (50_{10}) will display the complex join shown in the example.

Single Element Characters. To use the formula for single elements, the P element is automatically set to 4. The S element tells the orientation of the ruling:

Horizontal = Ø

Vertical = 1

The T element is the ruling type

Single = Ø

Double = 1

An example of using the formula for single rulings:

= (6 X 4) + (3 X 0) + 1 + 32

= (24) + (0) + 1 + 32

= 57_{10}

The ASCII Code Chart shows that sending the code for the numeral 9 (57_{10}) will display the ruling character shown in the above example.

Miscellaneous Characters. The remaining four elements do not fit the formula, therefore, they are not considered here.

Summary

Table 2-3 summarizes the values that can be used in computing the specific ruling characters. The numbers in

TABLE 2-3

VALUES FOR COMPUTING RULING CHARACTERS

ELEMENT IN FORMULA / ELEMENT CLASS	P (X 6)	S (X 2)	T
Simple Join	Horizontal Join Type (0, 1, 2)	Vertical Join Type (0, 1, 2)	Ruling Type (0, 1)
Complex Join	3	Inferior Element Join Type (0, 1, 2)	Superior Element Orientation (0, 1)
Single	4	Ruling Orientation (0, 1)	Ruling Type (0, 1)

PROGRAMMING
(cont.)

parentheses are the legal values that may be used in that space . . . any others will yield unpredictable results.

Figure 2-3 is an example of the rulings capability. Arrows show keyboard characters used to generate the form.

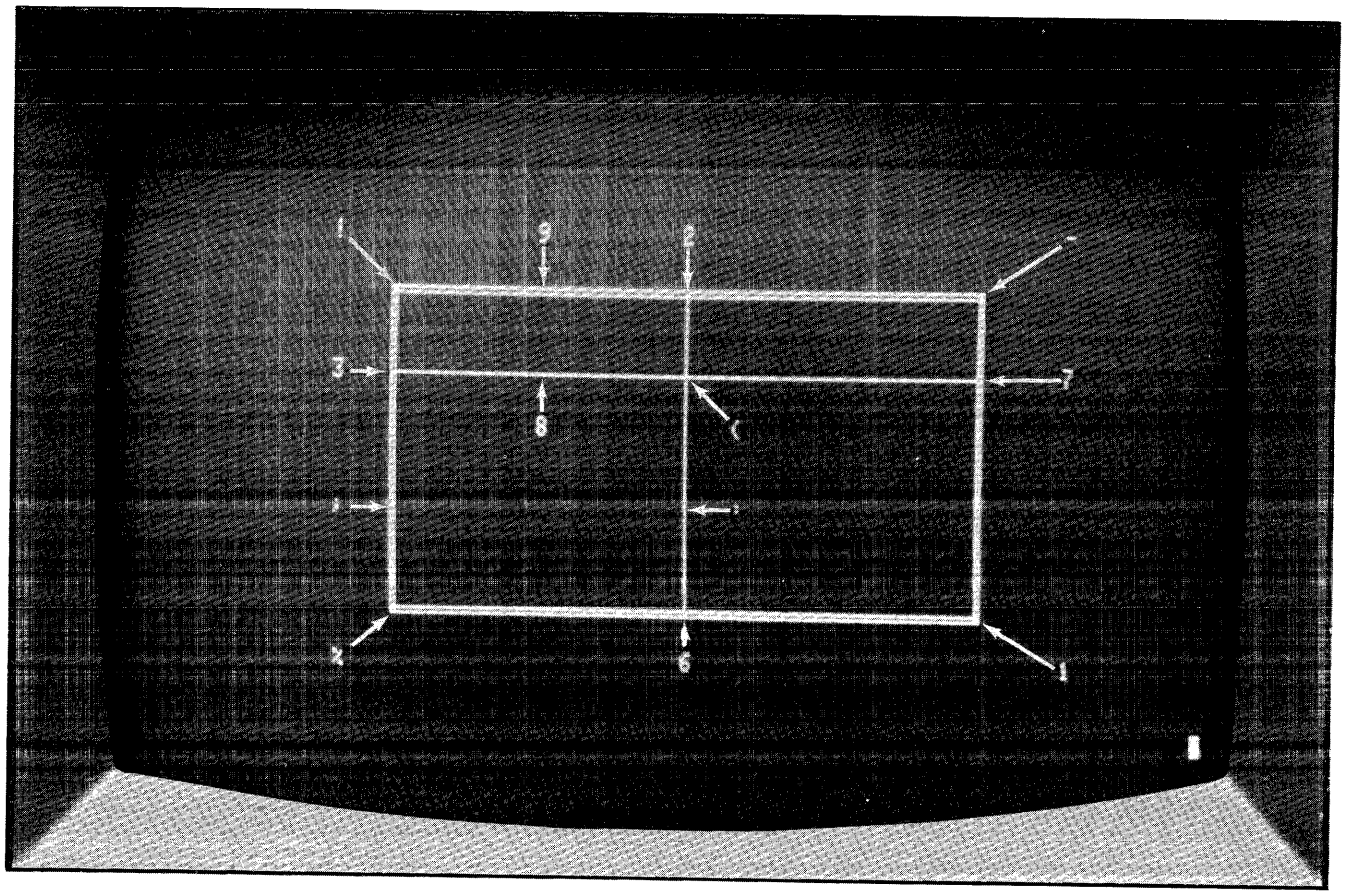


Fig. 2-3. Example of 4023 ruling capability. Numbers & symbols correspond to ruling cores. Fig. 2-2 shows the Ruling Characters provided by each of the above ruling codes.

INSTALLATION

SECTION II
PART 2

General

Installation consists of desk-mounting the Terminal, selecting the proper operating voltage and fuse size, setting the desired strap options, and connecting the Terminal to the computer. These steps are discussed in the following paragraphs.

Mounting the Terminal

Desk-Mounting consists of simply setting the Terminal on a desk or other surface. The air vents on the bottom and sides should be kept free of obstructions to permit air flow through the unit.

A dimensional drawing is provided in Fig. 2-4 as an installation aid.

AC Power Sources and Requirements

CAUTION

This Terminal is intended to be operated from a single phase, earth, referenced power source having one current carrying conductor (neutral) at ground (earth) potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase-to-phase on a multiphase system, or across the legs of a 117-234 single phase three-wire system) is not recommended because only the line conductor has overcurrent (fuse) protection within the instrument.

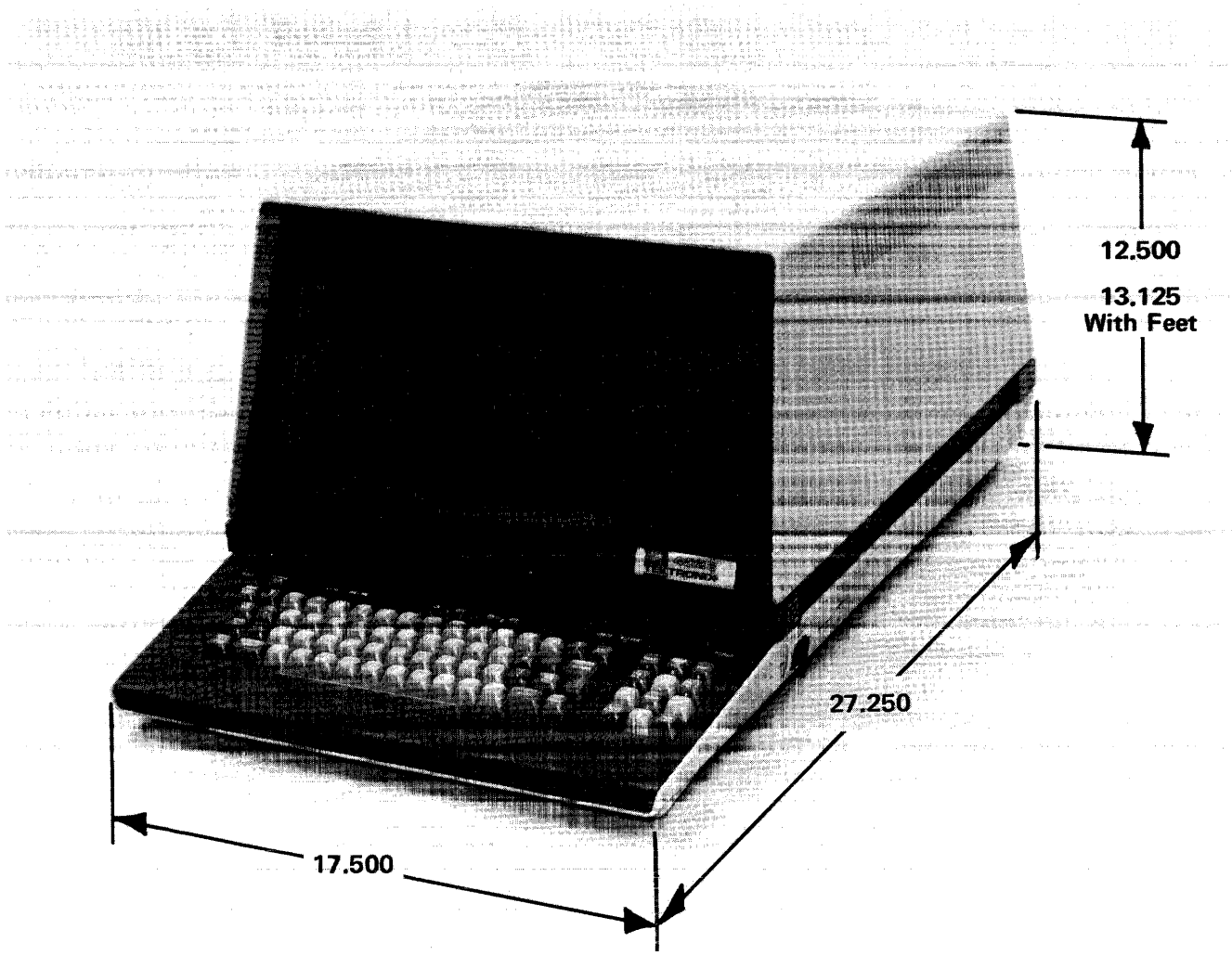


Fig. 2-4. Physical Dimensions.

This Terminal is designed to operate from either a 110 or 220 volt nominal line voltage source that has a frequency of 48 to 440 Hz. In addition, any of three voltage ranges for 100 Vac or four voltage ranges for 220 Vac may be selected. Voltage, current and power requirements are listed below.

VOLTAGE, CURRENT, AND POWER REQUIREMENTS

VOLTAGE RANGE	FREQUENCY	LINE FUSE (slow blow)	INPUT POWER
100, 115, 120	48 Hz	2 A	220 W Max
	or		
200, 220, 230, 240	440 Hz	1.25 A	

A fuse and a transformer jumper arrangement permit the Terminal to be modified to suit the voltage supply. A tag on the back panel of the Terminal identifies the internal voltage setting for which the Terminal is wired when shipped from the factory. If, for any reason, the jumper arrangement is changed, changing the internal voltage setting, cross out the old setting and write the new voltage setting on a tag. Attach the tag to the rear panel or the line cord.

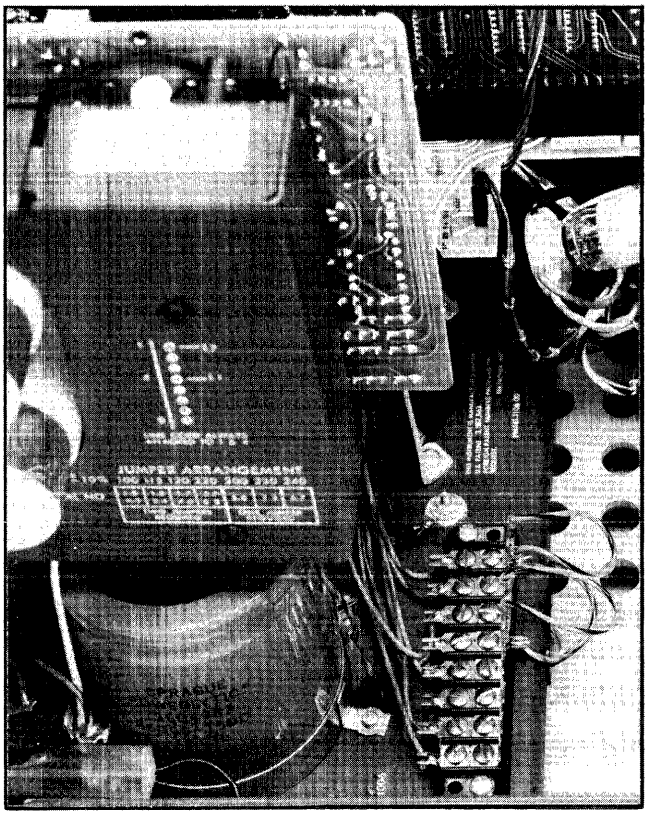


Fig. 2-5. Location of Transformer wiring connectors.

The fuse is located in the bottom-left corner of the back panel. The Transformer and jumper arrangement are located inside the display unit in the left rear corner (see Fig. 2-5). Removing the display unit provides access to the jumper arrangement. This consists of removing two screws at the top of the rear panel. The display unit cover can be removed. Wiring instructions are shown on the metal protection cover directly above the transformer wiring connectors. See Fig. 2-5.

WARNING

Dangerous voltages exist at several places inside the display unit. Disconnect the Terminal from the power source before changing transformer connections. (In the event the power was on when the cover was removed, a safety interlock switch disables the power supply. Pulling the switch up allows the Terminal to be operated with the cover off.)

AC Power Cord and Grounding Requirements

This instrument has a three-wire power cord with a three-wire terminal polarized plug for connection to the power source and safety earth. See Fig. 2-6 for USA

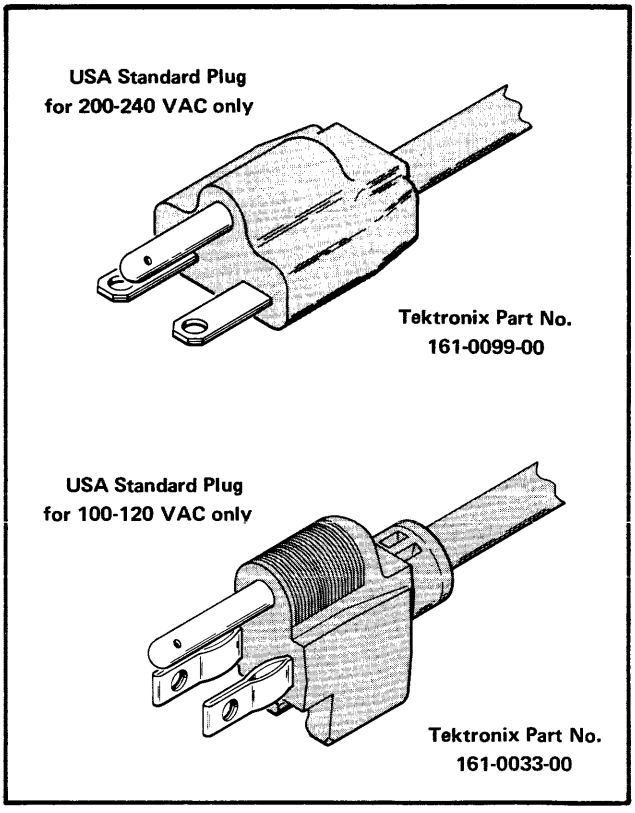


Fig. 2-6 USA Standard Power Cord Plugs.

standard plugs. The Safety Earth terminal of the plug is directly connected to the instrument frame for electric-shock protection. Insert this plug only in a mating outlet with a safety earth contact or otherwise connect the frame of the Terminal to a safety earth system. The color coding of the cord conductors is in accordance with recognized standards as shown below. In other jurisdictions, replace the USA standard plug with a plug that satisfies local authorities.

Power Cord Conductor Identification

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

Selecting Strappable Options

Strappable Options are movable wire straps located on circuit cards inside the display unit. These straps provide options for the operator and programmer and can be set at the user site by qualified technical personnel. The circuit cards (seven of them) plug into the Motherboard. See Fig. 2-7 for card locations on the Motherboard.

CAUTION

Even though identical signal lines are provided at corresponding points for each of the Motherboard card connectors, adequate heat dissipation requires that the cards be installed in the order shown in Fig. 2-7.

WARNING

Do not remove or install circuit cards while the Terminal Power is on.

The positions of the straps are dependent upon computer and program requirements, and in some cases, upon user preference. Strap locations and descriptions for the Keyboard Interface, Control, Timing, and Basic Data Communications Interface cards are shown in Fig. 2-8A-B and Fig. 2-9A-B. The Optional Data Communications Interface (021-0112-02) may be installed in place of the Basic Data Communications Interface (021-0111-00). Detailed Strappable Option information for these two interfaces can be found in their respective manuals.

Spare Switch (SW1 and SW2) Connections

Connection to SWITCH 1 and SWITCH 2 is provided at pin Z and X, respectively. Fig. 2-10 shows a complete listing of the Motherboard connector pin assignments. Depressing the right side of a switch provides a ground connection for the respective switch; the other position of the switch results in an open circuit.

Spare Indicator Connection

Connections to spare Indicator 3 are provided at pin 2 of the card-edge connector in the display unit.

Connectors and Wiring

Rear Panel Connectors provide connection for the 4023 Hard Copy Unit and video monitors.

Hard Copy Connector – J 190. 15-pin Cannon female connector with signals for sending video out of the 4023 or into the 4023. It can be used by the Hard Copy Unit or other devices for connections of up to 15 feet.

Video Connector – J 193. The Monitor connection is a 75 ohm BNC connector for composite video. The number of video monitors to which the 4023 can provide acceptable video depends on the type of monitor, the cable distance to the furthest monitor, and the type of connecting cable used. For example, using RG 59/U cable, the 4023 can drive up to 8 Conrac monitors if the string of monitors does not exceed 400 feet.

Connecting the Terminal to a Computer

The two basic methods of connecting the Terminal to a computer are direct connection and telephone line connection. A direct connection is used when the Terminal and the computer are located close to each other, permitting hook-up without additional equipment. A telephone line connection can be made regardless of the distance which separates the Terminal and the computer.

Direct Connection (not to be confused with DIRECT/BUFFER switch). When the Terminal has its standard interface (021-0111-00 Data Communication Interface) installed, a direction connection can be made by connecting the output plug to the interface card so that the plug index mark is matched with the "DIRECT TO CPU" index mark on the card. This is shown in Fig. 2-8D. The plug on the other end of the interface cable can then be inserted into the jack at the computer. The signal lines available to the computer are shown in Table 2-4.

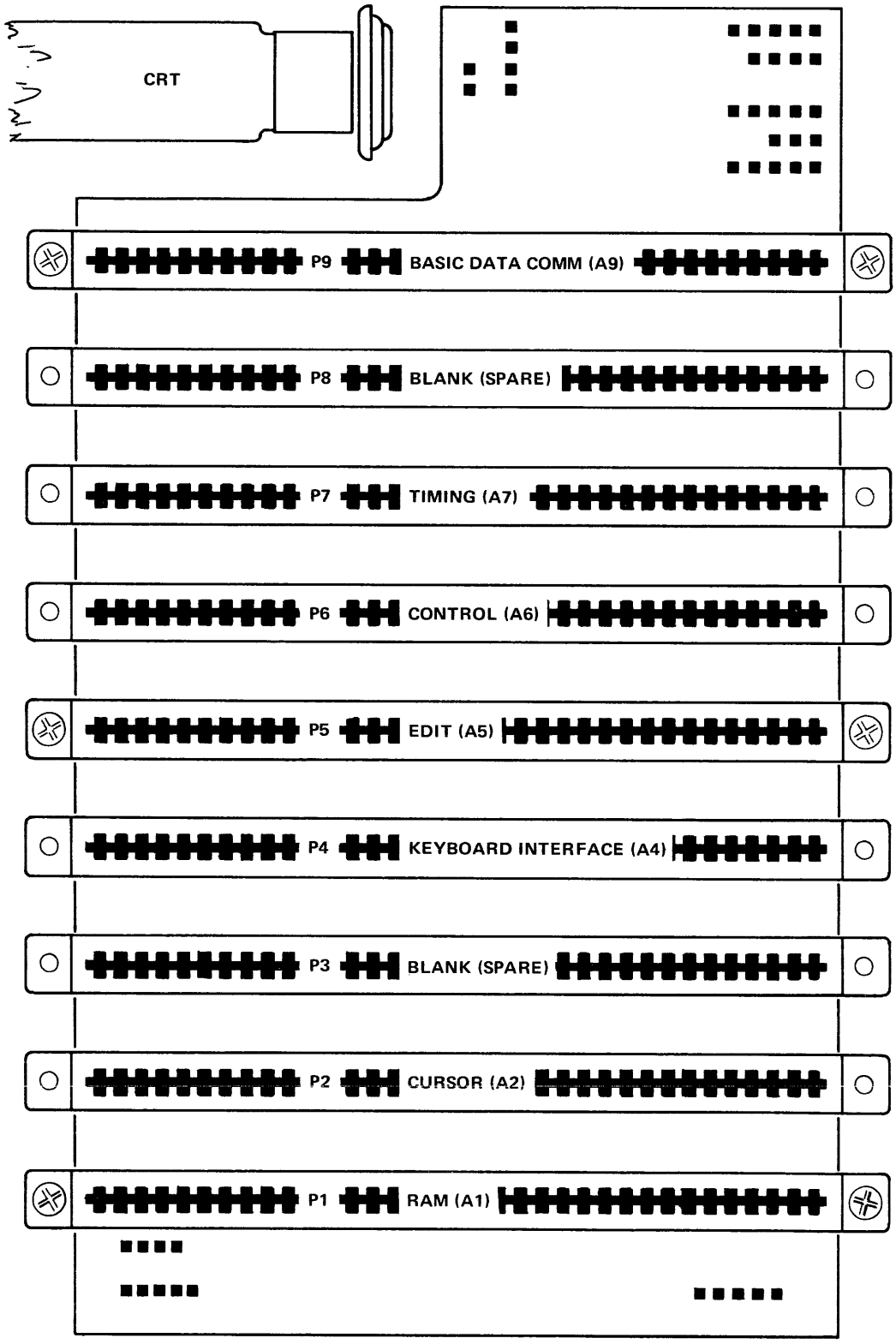
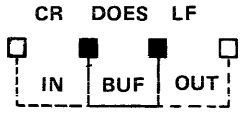
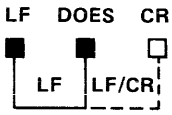


Fig. 2-7. Motherboard card connector assignment.

INSTALLATION
(cont.)

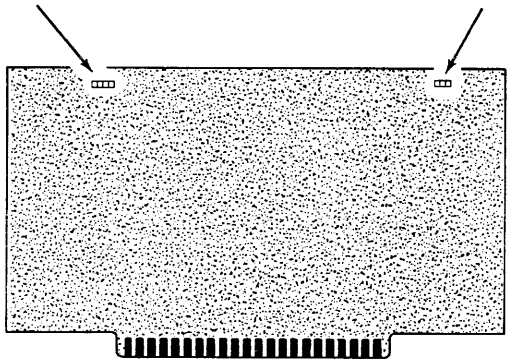




BUF—position with BUFFER selection permits a keyboard CR to also generate a linefeed.

IN position permits either a keyboard or computer generated CR to generate a simultaneous linefeed.

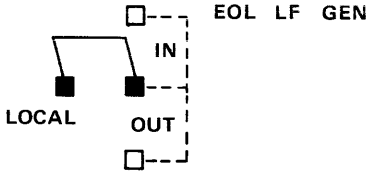
OUT position inhibits simultaneous linefeeds with CR, regardless of CR origin.



LF position performs a linefeed only upon receipt of a linefeed command.

LF/CR position causes a simultaneous carriage return function upon receipt of a linefeed command.

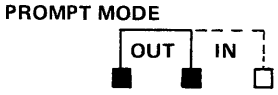
Fig. 2-8A. Keyboard Interface Card.

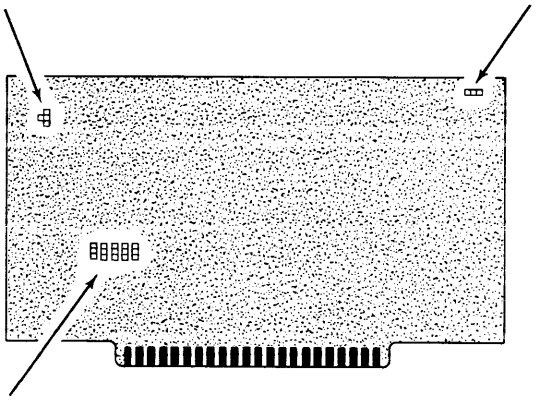


LOCAL enables line feeds to be generated in LOCAL when displaying data that originates from an aux. device. Linefeeds are not transmitted to the computer if on line.

IN enables linefeeds to be generated by transmit circuits when operating in LOCAL or ON LINE with BUFFER selected.

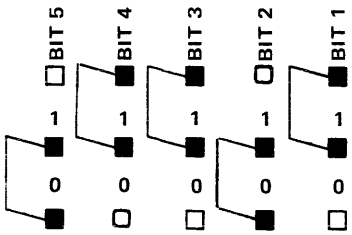
OUT prevents linefeeds from being generated at end of a line.





OUT is used when 4023 does not require a prompt character for data transmission from buffer.

IN is used when 4023 is to receive a prompt character for data transmission from buffer.



MESSAGE END

The Message End character is the last character sent in a buffer transmission. The standard Message End character is strapped to be CR; however, any ASCII control character can be strapped.

Fig. 2-8B. Control Card.

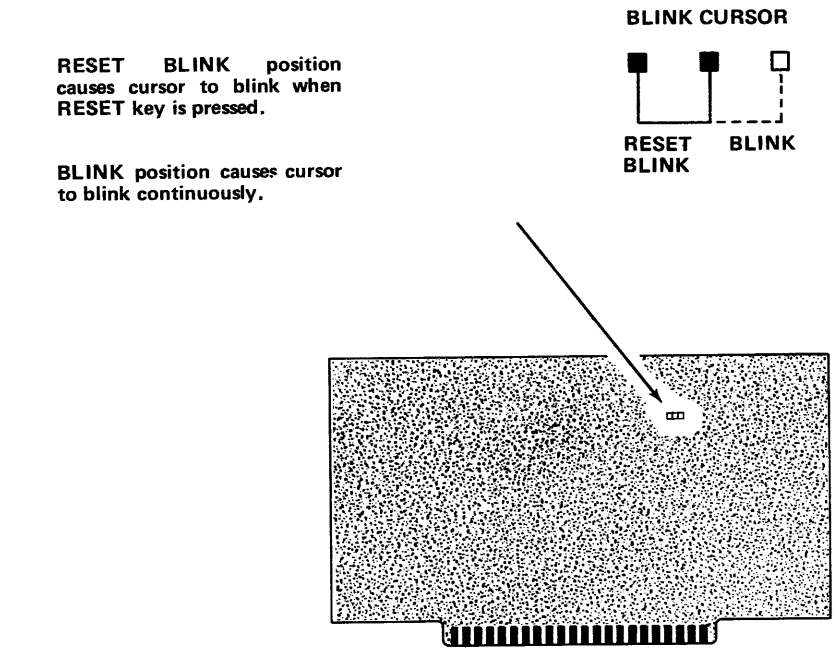


Fig. 2-9A. Timing Card.

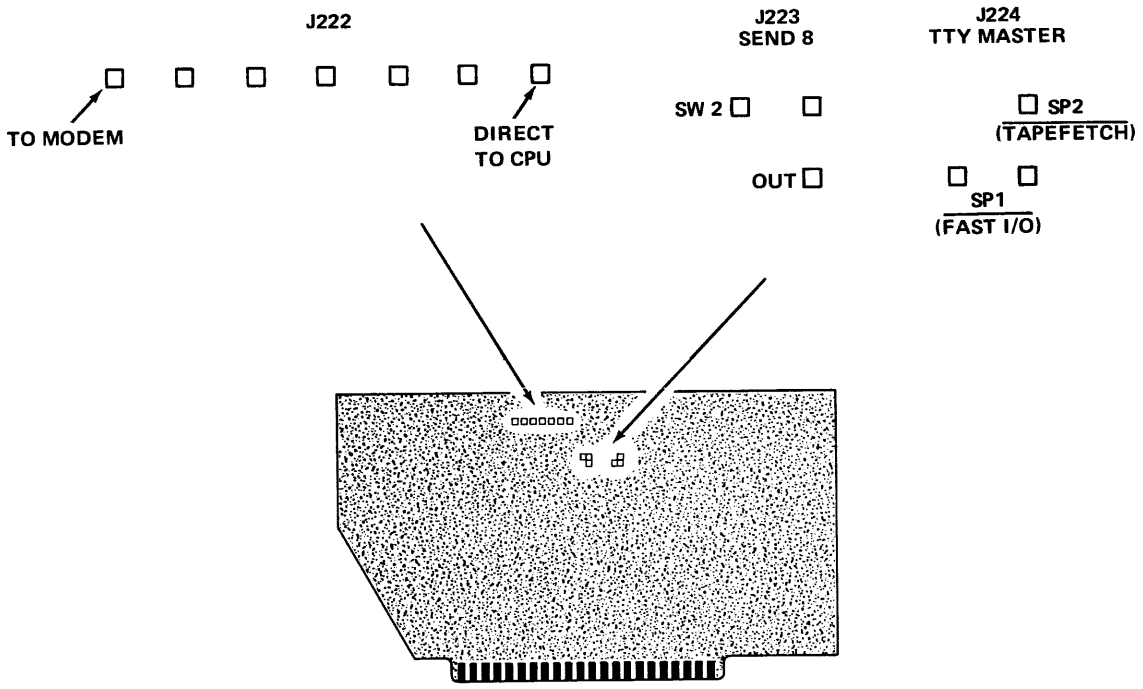


Fig. 2-9 B. Standard Data Communications Interface Card. Strap descriptions are given in Interface manual.

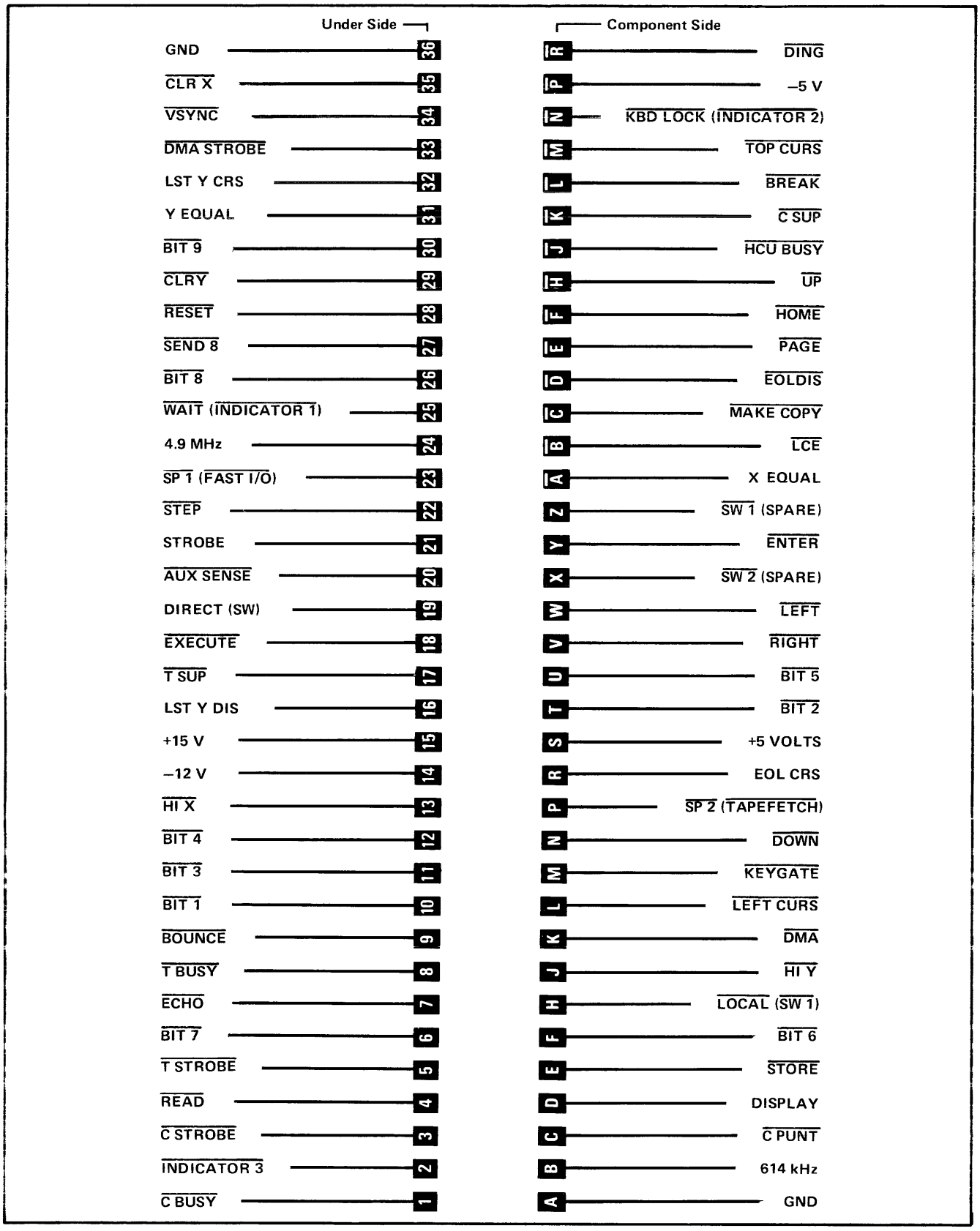


Fig. 2-10. Motherboard connector pin assignments.

Telephone Line Connection. A modulator-demodulator (modem) is required to establish telephone line connection. Telephone companies rent these modems (also called data sets or data phones). There are a number of specialized modems available; the type required depends upon the specific needs of the installation.

When a standard interface (021-0111-00 Data Communication Interface) is installed in the Terminal, the plug on the interface card must be connected so that the plug index mark aligns with the "TO MODEM" index mark on the card. Then the other end of the interface cable must be plugged into the modem set. Signal names remain as listed in Table 2-4.

Once connected to the modem, computer connection is achieved as follows: 1) Energize the equipment; 2) Dial the number of the computer installation; 3) When the computer responds with an audible tone, place the telephone headset on the cradle provided on the modem; or push the button marked DATA, and hang up the headset; or perform such other function as required by the specific modem in use; 4) Perform the sign-on procedure, which varies with the computer installation.

TABLE 2-4

021-0111-00 Data Communication Interface Output Connector Signals

Modem Connector Pin No.	RS-232C Circuit	CCITT Equiv.	Description
1	AA	101	Protective Ground
2	BA	103	Transmitted Data
3	BB	104	Received Data
4	CA	105	Request to Send (on while Terminal is on)
5	CB	106	Clear to Send
7	AB	102	Signal Ground (Common Return)
8	CF	109	Received Line Signal Detector
20	CD	108.2	Data Terminal Ready (on while Terminal is on)

APPENDIX A

CHARACTERISTICS

Summary of Hardware Characteristics

CRT	– 12 inch diagonal
Display Size	– 8.5 inches wide by 4.5 inches high
Phosphor Type	– P-4 (white)
Video	– Composite Video, compatible with standard interlaced 525 monitor
Frame Rate	– 50 Hz or 60 Hz
Cursor Type	– 7 by 10 dot matrix, non-destructive, remote or local control
Character Generator	– 5 by 7 dot matrix
Character Size	– 80 mils by 120 mils (0.08 inches wide by 0.12 inches high)
Character Code	– 128 ASCII, 94 printing (including space) upper and lower case characters. Optional Rulings Character Set provides 32 ruling characters.
Characters per Line	– 80
Lines per Display	– 24
Characters per Display	– 1920
Refresh Buffer	– MOS RAM
Intensity	– Normal 30 foot lamberts Dim 15 foot lamberts for background identification
Keyboard	– 64/96 ASCII upper and lower case 2 key rollover auto-repeat for any keys depressed over one-half second
Input/Output	– Standard Data Communications Interface is RS-232C compatible, Full Duplex, Serial Asynchronous, Start/Stop, LSB first, Baud rate Transmit/Receive selectable 110-9600 with backpanel switch, Transmission code is 128 ASCII upper/lower case.
Power Requirements	– 115/230 (Hi, Medium, Lo) VAC, 50 to 400 Hz, nominal 220 watts
Physical Dimensions	– Height – 13 inches Width – 18 inches Depth – 27 inches Weight net – 46 lbs shipping – 67 lbs

Summary of Control Characteristics

Cursor Positioning	– Up, down, left, right, or Home (upper left corner)
Clear Page	– Deletes all data and positions the cursor to home.
Insert Character	– A space is entered at the cursor position. All data from the cursor position moves right, leaving a space at the cursor position. Only the line where the cursor resides is affected.
Delete Character	– The character where the cursor resides is deleted or replaced by a new character typed from the keyboard. When a character is deleted, all characters to the right of the cursor move left one space.
Insert Line	– The line where the cursor resides and all lines below move down one line for each key depression. The bottom line is lost.
Delete Line	– The line where the cursor resides is deleted and all lines below move up one line for each key depression.
Erase Input	– Erases all unprotected information on the screen and positions the cursor to home.
Erase to End	– Erases information from cursor to end of line or unprotected field.
Copy	– Activates the Hard Copy Unit.

CHARACTERISTICS
(cont.)

Enter	– Transmittable information on the screen is transmitted to the computer when on line, or to auxiliary devices when in local.
Send	– Everything on the screen is transmitted to the computer when on line, or to auxiliary devices when in local.
Number Lock	– Shifts the Function Pad into a Numeric Pad; thus, those keys when depressed generate their respective numbers 0 through 9, plus a decimal point.

Summary of Buffer Operation Characteristics

An important benefit of the 4023 is that the contents of the buffer can be sent to the computer as a message. Instead of conversing character-by-character, the data can be sent as one complete block. The number of input errors is therefore almost eliminated because the user can see and edit the entire input before it is transmitted. If an error is detected, the buffer can be re-transmitted by the operator or on a command from the computer.

Buffer operation not only reduces the amount of "on-line" time needed, but also makes more efficient use of the "on-line" time that is used. CPU time is also reduced for two reasons; the editing function is done locally and the input is in a block mode, rather than a character at a time. This makes for more efficient use of the computing system, and equates directly to lower cost for the user.

ASCII CODE CHART

BITS B_7 B_6 B_5				ø ø ø	ø ø 1	ø 1 ø	ø 1 1	1 ø ø	1 ø 1	1 1 ø	1 1 1
				CONTROL		NON ALPHA		FIELD CODES		LOWER CASE	
B_4	B_3	B_2	B_1	0	1	2	3	4	5	6	7
ø	ø	ø	ø	NUL ø	DLE 16	SP 32	ø 48	@ 64	P 8ø STANDARD PROMPT	` 96	p 112
ø	ø	ø	1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
ø	ø	1	ø	STX 2	DC2 18	" 34	2 5ø	B 66	R 82	b 98	r 114
ø	ø	1	1	ETX 3 MESSAGE SEPARATOR	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
ø	1	ø	ø	EOT 4	DC4 2ø	$ 36	4 52	D 68	T 84	d 1øø	t 116
ø	1	ø	1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 1ø1	u 117
ø	1	1	ø	ACK 6	SYN 22	& 38	6 54	F 7ø	V 86	f 1ø2	v 118
ø	1	1	1	BEL 7 BELL; * HARD COPY	ETB 23	' 39	7 55	G 71	W 87	g 1ø3	w 119
1	ø	ø	ø	BS 8 BACK SPACE	CAN 24	(4ø	8 56	H 72	X 88	h 1ø4	x 12ø
1	ø	ø	1	HT 9 HORIZ TAB	EM 25	) 41	9 57	I 73	Y 89	i 1ø5	y 121
1	ø	1	ø	LF 1ø LINE FEED	SUB 26	* 42	: 58	J 74	Z 9ø	j 1ø6	z 122
1	ø	1	1	VT 11 BACK TAB	ESC 27	+ 43	; 59	K 75	[91	k 1ø7	{ 123
1	1	ø	ø	FF 12 * CLEAR PAGE	FS 28 MOVE CURSOR	, 44	< 6ø	L 76	\ 92	l 1ø8	¦ 124
1	1	ø	1	CR 13 RETURN	GS 29	- 45	= 61	M 77	] 93 * READ CURSOR	m 1ø9	} 125 ALT MODE
1	1	1	ø	SO 14 RULINGS SET; * XMIT ALL	RS 3ø	. 46	> 62	N 78	^ 94	n 11ø	~ 126
1	1	1	1	SI 15 RULINGS RESET; * XMIT UNPROTECTED	US ** 31	/ 47	? 63	* O 79 CLEAR INPUT	_ 95	o 111	127 RUBOUT

* CHAR IS PRECEDED BY ESC CHAR TO PERFORM FUNCTION

** When received by Terminal, the next character is interpreted as a FAC. When transmitting buffer contents, US is transmitted instead of the FAC.

APPENDIX C

ACCESSORIES

Refer to Tektronix, Inc. advertising information or contact a Tektronix Field Office for up-to-date listing of accessory devices.

Standard Accessories

Data Communication Interface	021-0111-00
Data Communication Interface Instruction Manual	070-1613-00
4023 Terminal Users Manual	070-1621-00
Cabinet Colors	
Red	390-0340-02
Green	390-0340-03
Gold	390-0340-04

Optional Accessories

4023 Service Manual 070-1617-00

Provides the technician with all the information needed to service and maintain the 4023. Documentation includes schematics, mechanical and electrical parts lists, wiring lists, component locations, theory of operation, and testing and adjustment procedures.

Optional Data Communication Interface 021-0112-00

This interface offers increased data communications control over that provided by the Data Communication Interface. Provides operation in full-duplex or either of two half-duplex modes. Baud rate selection from 110 to 9600 can be controlled by back panel switches for independent transmit and receive baud rates (plus two field programmable rates). Mode control, parity generation, and transmission rate are controlled by 4023 back panel switches. Includes a user manual and 15 feet connecting cable.

Rulings Character Set 020-0085-00

This is an additional character set that allows the 4023 to print 32 special "ruling" characters. These characters are orthogonal patterns and lines that are placed together to form contiguous lines. These lines are very useful in borders and rulings of forms and can also be used for simple chart plotting. The rulings character set is factory installed when the 4023 is ordered.

Logic Extender Card 067-0659-00
(Includes Extender Cable kit)

A design and maintenance device which can be independently inserted into the Motherboard to monitor signal lines or to inject signals into them. It can be used as a circuit card extender to perform those same functions, plus a signal interrupt function.

72-Pin Extender Card 067-0696-00
(Includes Extender Cable kit)

Used to extend the 4023 motherboard cards away from the bus for component access when troubleshooting. Each of the 72 bus lines are labeled and have a test point.

Audio Recorder Card 018-0086-00

This plug-in card is used in conjunction with the 4023 and an audio type tape recorder to provide low cost off-line storage. Several recording and playback modes are available including, tape to computer, tape to terminal, terminal to tape and computer to tape. Input and output characteristics can be varied to match a wide variety of tape recorders but for information on compatability with specific recorders, contact your Tektronix Field Office. Includes hook-up cables and operators manuals.

Pedestal 016-0568-00

The pedestal is a convenient support module for the 4023 Terminal.

Data Form Software Package 062-1573-02

This 4023 software system allows the user to manipulate data, enter and view forms, and easily access the various features of the Terminal. The package is developed as a set of FORTRAN subroutines that are grouped into two areas of usage; Utility support and Forms support. The utility support allows program control of screen erase, hard copy activation, cursor addressing and buffer transmission while the forms support group is used to design, edit and recall forms and formatting combinations to the screen. This also includes support for the hardware RULINGS CHARACTER SET (020-0085-00) when the 4023 is

ACCESSORIES
(cont.)

equipped with this feature. Includes user manual and installation procedure.

Auxiliary Devices

4623 Hard Copy Unit

The 4623 Hard Copy Unit is offered as a companion unit to the 4023. The 4623 produces an 8½ X 11 hard copy of the 4023 display in about 15 seconds and subsequent copies every 7 seconds. The standard 4623 can interface with up to four 4023's at distances up to 200 feet. A four color choice is also available to match the 4023 color selection of TAN, RED, GOLD, or GREEN.

633 Video Monitor

The 633 Video Monitor displays data that is being processed by the Terminal.

APPENDIX D

FORMATTING A DISPLAY

Displayed data can be field formatted from the keyboard. Table 2-1 in Section II shows 32 characters designated as Field Attribute Codes (FACs). When preceded by simultaneously pressing the CTRL and SHIFT and O keys (^{cs}O), keying in one of these FACs causes data from the cursor location to the end of the line (or the next FAC) to be identified as indicated. For example, assume you want a field with inverted video to contain data that is non-transmittable, protected, with dim intensity. Table 2-1 shows the O (79_{10}) character will set up the desired field.

Try it out. Turn on the Terminal power and after warm-up, move the cursor away from the home position; then type $^{cs}0$ followed by 0. Note that the field extends from the cursor position to the end of the line. Note its appearance and that keyboard data cannot be keyed into the field. Now you can begin formatting the display shown in Fig. D-1.

Type the headings in the approximate screen positions as shown in Fig. D-1. Fig. D-1 also shows the particular FACs and their respective positions. Next, enter the FACs. Do this by positioning the cursor over the FAC positions (as shown in Fig. D-1), and pressing the ^{cs}O keys followed by the particular FAC.

NOTE

When formatting displays from the keyboard and more than one FAC resides in a line, enter the FACs from right to left. Note also, that ^{cs}O must precede each FAC.

With the headings and all FACs set up as shown, enter the unprotected data (you can enter your name, address, etc.) in the appropriate positions. Formatted display operation can be checked out by following the "Example of Form Fill-Out Operation" procedure provided in Section I Part 3.

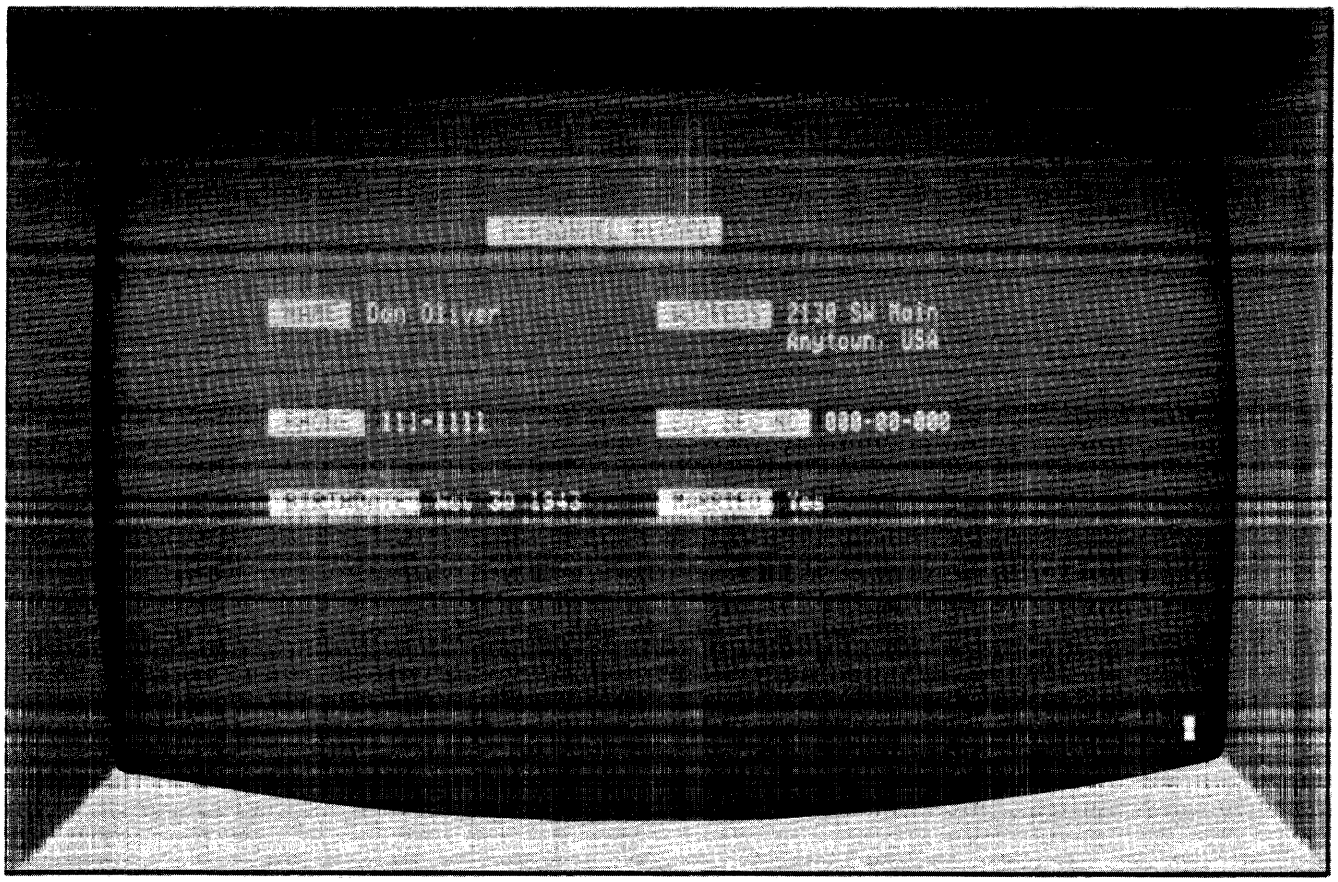


Fig. D-1. Example of formatted display.

APPENDIX E

GLOSSARY

This glossary pertains to this manual and is not intended to be a universal reference. It excludes definitions of most control characters which are defined by referring to pages listed in the index.

Accessory—See standard accessory or option accessory.

Address—A character location within the display memory (buffer) that is within the 80X by 24Y coordinate capability of the Terminal's registers.

Alpha—Refers to letter characters.

Alphanumeric—Refers to letters and numbers.

Arming—Preparing the Terminal so that the next-received character performs a function other than what it would cause if the Terminal were not "armed". The ESC control character normally is used to "arm" the Terminal.

ASCII character—Any one of 128 characters contained in the character set used by "American Standard Code for Information Interchange". See the ASCII code chart in the appendix.

ASCII Code—Seven-digit binary numbers which express any of the 128 ASCII characters. See the ASCII Code Chart in the appendix.

Auxiliary/Auxiliary Unit—A device which is designed for use with the Terminal, but which is not required for Terminal operation.

Backtab—A feature used to position the cursor back to the preceding unprotected field when using the buffer with formatted displays. The backtab command is the VT control character. The cursor will backtab upon receipt of the VT command from either the keyboard (CTRL K) or from the computer. Will not work in DIRECT.

Baud—Signalling units per second; an expression of serial data transmission bit rate.

Beam—The element (within the cathode-ray tube) which causes displays to appear on the screen.

Binary—Referring to a number system which uses two as its base. Only the digits 0 and 1 appear in binary expressions.

Binary equivalent—A number expressed in binary form to represent a number which has a different base or to represent a character from the ASCII code.

Bit—A binary digit.

Blanked—The non-writing status of the display beam.

Board, circuit—See circuit board.

Break—A signal sent from the Terminal to the computer to interrupt computer transmission in some installations. Also the command which initiates the signal.

Buffer—The memory of the 4023 which has the capability to remember the display location of 1920 individual characters (80 characters per line, times 24 lines, equals 1920 characters).

Bus—A wire which conveys electrical information between two or more points.

Byte—A group of bits operated on as a unit.

Card, circuit—See circuit card.

Carriage return—Movement of the writing beam to the left margin. Also the command which causes this movement.

Cathode-ray tube (CRT)—An evacuated glass envelope similar to a television display tube. The CRT face is the Terminal's display screen.

Character generator—An electronic circuit within the Terminal, which provides the positioning and writing information required for displaying characters on the screen.

Character—A symbol within a set of symbols; also the encoded form of that symbol. Also see control character.

GLOSSARY
(cont.)

Character keys—The keys located on the Terminal's keyboard.

Character set—Characters which make up a defined group, such as ASCII.

Character space—The horizontal area alotted to writing of one character on the screen.

Character writing—Moving the beam through a 7 by 9 dot matrix and unblanking the beam in the positions required for constructing the character.

Circuit board—A bolt-in circuit assembly, as opposed to a plug-in circuit card assembly.

Circuit card—A plug-in circuit assembly, as opposed to a bolt-in circuit board assembly.

Clock—An oscillator or other signal-producing device which provides signals for circuit timing.

Code Set—The individual binary bit sequence patterns that comprise the character set.

Command sequence—A sequence of characters, the first of which arms the Terminal so that the subsequent character(s) produce a result other than what they would produce alone.

Communication link—The connection between the Terminal and computer. It may be a wire cable, or may be a telephone line and modems.

Control character—A character which normally causes a function other than writing to occur, controlling the operation of equipment.

Control character command sequence—See command sequence.

Copy making—Generating a paper reproduction of a display.

CPU—Central processing unit; a term used interchangeably with computer in this manual.

CRT—See cathode-ray tube.

CTRL key—A keyboard key which, when held down, causes letter key entries to result in transmission of control characters.

Cursor—A rectangular symbol which indicates the next character writing position.

Data—Basic elements of information which can be produced or processed by devices such as computers, Terminals, teletypewriters and associated devices.

Data communication interface—A device which provides compatibility between the Terminal and a computer, usually via a modem.

Data communication standards—A statement of particulars regarding interfacing between data terminal equipment and data communication equipment employing serial binary data interchange. Typified by documents such as EIA RS-232C.

Data lines—Wires which carry data between or within devices.

Data Processing—Systematic computer oriented functions in classifying, sorting, and calculating of data that are necessary to obtain a desired result from that data.

Direct connection—In computer interfacing, a direct connection infers connecting the Terminal to the computer without benefit of modems.

Display—Information written on the Terminal screen; sometimes also used to denote the screen itself.

Display Format—The arrangement of data on the display. Usually synonomous with formatted displays.

Display beam—See beam.

APPENDIX E

GLOSSARY
(cont.)

Display Screen—See screen.

Display Unit—That section of the Terminal which includes the screen, keyboard, and associated circuits.

Dual key entry—Pressing a character key while holding the CTRL or SHIFT key down.

Echoing—The return of transmitted data to the transmitting device.

Enter—Synonomous with ENTER key actuated transmission of buffer contents. Also can refer to keyboard entry directly to the computer or to the buffer.

Erasing—Removing displayed data from the screen.

Form Fill-Out—Function used with formatted displays where the operator fills in the blank spaces or otherwise changes the information displayed.

Formatted Display—A display that is arranged to resemble a form or other source document through use of Field Attribute Codes.

Field Attribute Codes—Codes used by the 4023 that arrange the display into fields. Data residing in the fields is identified by the code as to appearance, transmittability, and protection.

Fields—Specific portions of the display that contain data identified by Field Attribute Codes as to the data's appearance, transmittability, and protection. The size of a field can be from one to seventy-nine characters (one line maximum).

Full Duplex—In data communications, full duplex refers to the ability of data transmissions between the Terminal and computer to occur in both directions simultaneously; both stations can transmit and receive at the same time.

Half Duplex—Data communications proceeds in only one direction at a time. The Terminal or computer can either transmit or receive, but never both at the same time.

Hard copy—A reproduction (on paper) of a Terminal display.

Hard Copy Mode—The operating status achieved by the Terminal during copy making.

Hard Copy Unit—An instrument which generates paper copies of Terminal displays.

Hardware—The mechanical, magnetic, electrical, and electronic devices and components of data processing equipment.

Home—The first line, first character position. Exists at top-left of the screen.

Initial Condition—Logic condition of the Terminal when power is turned on or the screen is erased.

Initializing—Turning the Terminal power on, or returning the Terminal to its initial condition.

Interface—The unit which permits two devices to interact with each other. Specifically, the unit which makes the Terminal compatible with a computer, modem, or peripheral equipment.

Jack—The least-portable of two mating connectors.

Keyboard Entry—The manual insertion of data into a data processing system using the Terminal keyboard. Keyboard data can be entered directly to the system, or entered first to the Terminal buffer, edited, then transmitted to the system using the Enter or Send function.

Letter keys—Commonly used to denote the keys which generate the code for Roman (conventional English) letters.

Line—A display consisting of 80 horizontally adjacent characters; also the space allocated to such a display.

Line feed—Movement of the writing beam from a line to the next lower line; also the command which causes such movement.

GLOSSARY
(cont.)

Line voltage—The force of the supply at an electrical outlet. In the United States, it is usually 115V or 230V or some slight variation of those values.

Lines, signal—See signal lines.

Local Echo—Simulating echoing within the Terminal, so that the Terminal executes the data it transmits, without having it echoed by the receiving device.

Local operation—An operating status which isolates the Terminal from the computer and sets up an echoplexing condition.

LSB (least significant bit)—The bit in the position of least magnitude in a binary expression; usually written as the last bit on the right.

Magnetic Storage Medium—An auxiliary device used with the Terminal on which system related information can be stored for future data processing applications.

Memory—See Buffer.

Message Separator—A control code (ETX) that is stored in Terminal memory at the cursor location. Message Separators can be either keyboard or computer initiated, and are used to limit the data transmitted to the computer to the data bracketed by two Message Separators. The Home and last character position of the last line perform Message Separator functions.

Motherboard—A wiring arrangement which makes all signal lines in the Terminal's pedestal available to all installed circuit cards.

Mode—A Terminal operating configuration.

Modem (Modulator/demodulator)—A device which can convert digital data to a signal (in a process called modulation) which can be conveyed over telephone lines, and can perform the reverse function in a process called demodulation. A modem is required on each end of the telephone line.

Monitor—As associated with the Terminal, monitor refers to a device which provides a copy of the Terminal display, or otherwise displays data which is processed by the Terminal.

MSB (most significant bit)—The bit in the position of greatest magnitude in a binary expression; usually written as the bit on the left.

Nul Suppression—The feature of the Terminal that suppresses transmission of NUL characters.

Non-Alpha—Fields into which only those characters contained in columns 2 and 3 of the ASCII Code Chart can be entered from the keyboard.

Non-Transmittable Data—Data that is identified by a Field Attribute Code as being non-transmittable.

On Line operation—Communicating with the computer.

Optional accessory—A device which can be purchased from Tektronix for use with the Terminal, but is not supplied as part of the standard Terminal package.

Options—See Strappable Options.

PAGE—A command which erases a display, sets initial condition Mode, and homes the cursor. Also a completed display.

Page full break—A signal generated when a page full of information has caused the display to line feed past the last (24th) line. Also an option contained on the Data Communication Interface circuit card.

Page full busy—A busy signal which can be generated in response to a page full of information.

Parallel transmission—simultaneous transmission of more than one data bit.

Pedestal—An optional accessory on which the 4023 may be mounted.

APPENDIX E

GLOSSARY
(cont.)

Peripheral devices—Generally refers to the equipment used in support of, or under control of, the computer. Used in this manual to mean equipment other than the computer or Terminal.

Plug—The most portable of two mating connectors.

Program—A pre-defined course of action which controls computer or other equipment operation. May be written on paper, punched on tape, stored on a magnetic storage device, or stored in computer or other equipment memory.

Program command—A command sent from the computer to the Terminal or to peripheral equipment as a result of a program decision.

Protected Data—Data identified by a Field Attribute Code that cannot be changed by a keyboard entry.

Receiving—Receiving data from another device.

Reset—Can refer to the RESET switch or one of many functions it controls. See RESET switch description.

Return—See carriage return. Also the keyboard name for control character CR.

Roll-up—The Terminal feature that when communicating in DIRECT, enables the displayed data to roll-up one line when attempting to perform a line feed past the bottom line.

Ruling Characters—An optional display package that can be ordered to permit the Terminal to draw lines for forms, charts, etc.

Screen—That area of the Terminal's display unit on which data is displayed. The face of the cathode-ray storage tube.

Send Function—A transmission function initiated by simultaneously pressing the SEND-ENTER and SHIFT keys. This function permits all data that resides between Message Separators to be transmitted.

Serialization—The process of converting simultaneously-occurring (parallel) data bits into sequentially-occurring (serial) data bits.

Serial Transmission—Sequential transmission of single data bits.

SHIFT key—A key on the Terminal keyboard whose function is comparable to that of a typewriter shift key.

Shifted character—A character resulting from pressing a symbol key while the SHIFT key is held down.

Signal lines—Wires which are used to send command signals between or within devices.

Software—Programs, procedures and techniques for directing the hardware (computer, Terminal, etc.) to perform desired functions.

Space—The horizontal area allocated to writing a character. Also, the movement from a character writing area to the next writing area. Also, the command which causes such movement without causing character writing.

Standard accessory—A device which is supplied with the basic Terminal.

Standards, data communication—See data communication standards.

Store—Synonomous with Terminal memory. The placement in memory of computer and keyboard data.

Strappable options—Operating features which can be changed by moving a friction-held wire from one point to another.

Telephone line connection—A communication link between the Terminal and computer. Sometimes generalized to include the associated modems.

Timing—The control of operations between and within devices with respect to time.

GLOSSARY
(cont.)

Transmittable Data—Data identified by a Field Attribute Code as being able to be transmitted.

Transmitting—Sending data to another device.

Triple key entry—Pressing a character key while holding down both the CTRL and SHIFT keys to generate the code for a control character.

Unblanked—The beam writing condition which produces the display on the screen.

Unprotected Data—Data identified by a Field Attribute Code that can be altered from the keyboard.

Unshifted character—A character resulting from pressing a symbol key while the SHIFT and CTRL keys are both released.

Voltage, data transfer—The voltage levels required to denote the status of data being transmitted.

Voltage, operating—See line voltage.

Writing—Displaying information on the screen as a result of unblanking the display beam.

Writing character—Any of the numerous characters in the ASCII code which can be written by the Terminal's character generator.

X—The horizontal axis of the screen.

Y—The vertical axis of the screen.

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committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT 4023 Users
070-1621-00

CHANGE REFERENCE C5/1176
DATE 11-8-76

CHANGE:	DESCRIPTION

TEXT CORRECTION

Page C-2

CHANGE: 4623 Hard Copy Unit to read 4632 in four places.

4632 Hard Copy Unit

The 4632 Hard Copy Unit is offered as a companion unit to the 4023. The 4632 produces an 8 1/2 x 11 hard copy of the 4023 display in about 15 seconds and subsequent copies every 7 seconds. The standard 4632 can interface with up to four 4023's at distances up to 200 feet. A four color.....

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MANUAL CHANGE INFORMATION

PRODUCT 4023 Users
070-1621-00

CHANGE REFERENCE C6/377
DATE 3-8-77

CHANGE:	DESCRIPTION

TEXT CORRECTION

Page 1-14, Paragraph 1, Line 7

CHANGE TO READ:

pressing the CTRL and L keys is.....