2644A

Mini DataStation

Owner's Manual

HEWLETT hp PACKARD

Source and Destination I/O Device Selection

[ ] , [f2 FROM R TAPE] , [f7 TO DISPLAY] , [f8 TO PRINTER] . When keys pressed in this sequence would assign the right Mini Cartridge as source (input) device and both the display and printer as destination (output) devices. Pressing the [READ] key would then cause the next file on the right Mini Cartridge to be both displayed and printed. These assignments remain in effect until another Gold key selection sequence is made. One source and/or one or more destinations can be set up in the same sequence.

Copy All, Copy File, or Copy Line

[ ] , [FILE COPY f2] would copy one file from the source device (left Mini Cartridge, right Mini Cartridge or Display) to the destination device(s) (left Mini Cartridge, right Mini Cartridge, Display and/or Printer). Copy All (to copy all files) and Copy Line (to copy a single record) work the same way.

Edit

[ ] , [EDIT f4] turns on Edit Mode (or off if the Edit light is lit). In Edit Mode any information rolling off from the top of the terminal's memory will automatically be stored on the destination device/ devices.

Rewind

[ ] , [FUNCTION REWIND f5] , [DEVICE L TAPE f5] rewinds the left Mini Cartridge; DEVICE:R.TAPE (f_6) for the right Mini Cartidge.

Mark File

[ ] , [FUNCTION MARK FILE f6] , [DEVICE L TAPE f5] causes a file mark to be written on the left Mini Cartridge. A file mark is necessary after each file to separate each file from the next.

Skip n Line

[ ] , [FUNCTION SKIP n LINES f7] , [−] , [4] , [DEVICE L TAPE f5] causes the left Mini Cartridge to back up 4 records (skip n lines where n = −4). Any number (plus or minus) of records can be skipped on either the left or right Mini Cartridge.

Find File n

[ ] , [FUNCTION FIND FILE n f8] , [4] , [2] , [DEVICE R TAPE f6] causes the right Mini Cartridge to be positioned at the start of file #42. An absolute (to get a specific file) or a relative (plus or minus, to skip a number of files) file address can be used on either the left or right Mini Cartridge.

RETURN

[RETURN] cancels any uncompleted extended instruction, and clears displayed messages.

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Figure 1. 2644A Mini DataStation Keyboard

Congratulations!

You have chosen Hewlett-Packard's new 2644 Mini DataStation – another technological advance in reliable terminals. The 2644's flexibility, extensive features, and ease of operation should save you valuable user time and computer resources in filling a wide range of applications.

We have prepared this owner's manual to acquaint you with the 2644 and to serve as an aid to achieving many years of optimum use from your new Mini DataStation. This manual tells you the features of the 2644, how to install it, how to use the 2644 by itself (off-line operation), and how to control it by computer program (on-line operation). The manual also provides condensed reference information. It should answer any questions you have about the actual use of the 2644 Mini Data-Station. (The HP 2644 Service Manual – 02644-90002 is also available for information regarding troubleshooting, repair, and option/accessory installation.)

Introducing the 2644

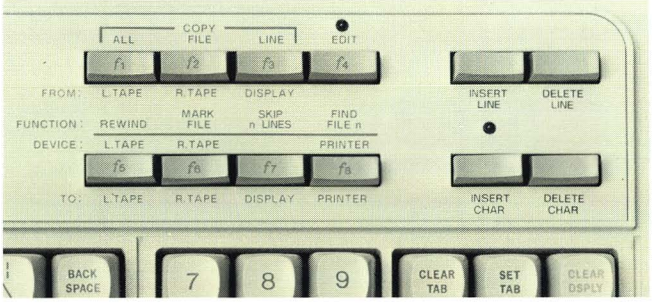
Enhanced High-Resolution Display

The 2644 has a 5-inch by 10-inch rectangular display providing a 1,920 character capacity in 24 lines of 80 characters per line. The characters are formed by a 7 x 9 dot matrix generated in a 9 x 15 dot character cell. The high resolution of the 7 x 9 dot matrix is enhanced by dot shifting for precise character definition, and by the use of the enlarged character cell for wide character and line separation. These display features are engineered to increase clarity and ease sessions at the terminal.

Full Editing Capability

Editing and computer time requirements can be significantly reduced by such features as:

- Programmable protected fields in any combination of display positions.
- 8 special function keys for calling user-defined routines in remote operation, such as forms entry or on-line automatic error correction.
- Character insert and delete, line insert and delete, display clear.
- Roll up, roll down, next page, previous page.
- Cursor sensing, addressability, tabulation, and positioning.

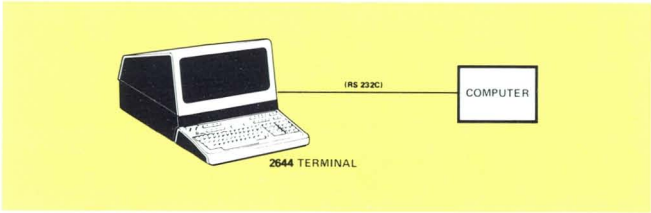


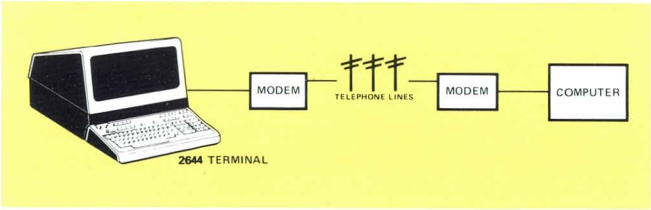
These capabilities can be controlled from either the keyboard or the computer.

Character Mode or Block Mode with Standard RS232C Compatibility

The 2644 will operate character-by-character as a completely interactive terminal or is capable of operating on a block at a time. Information can be composed and edited locally, thus allowing the terminal user to verify and correct data before transmission to the computer.

Transfer of information between the 2644 and the computer is by the EIA RS232C interface, a communications industry standard, with serial asynchronous operation and using ASCII code. Connection to the computer can be direct or via a 103 or 202 modem.





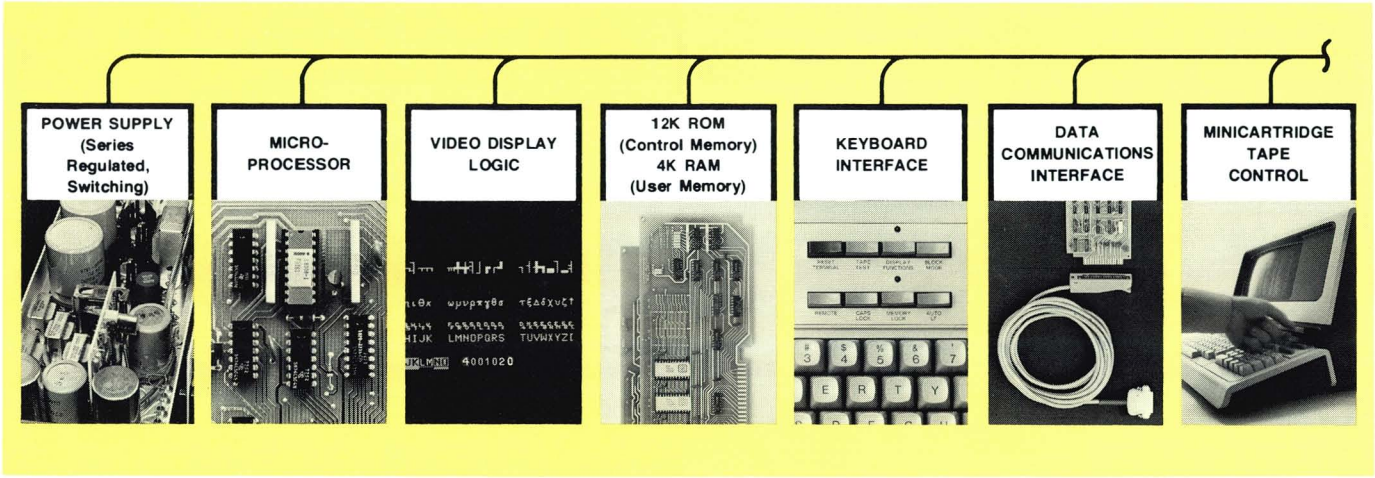
The switch selectable communication features of the 2644 are: Full or Half-Duplex; Even/Odd/No Parity; Data transfer rate (110, 150, 300, 1200, 2400 baud or from an external source). Option 020 to the 2644 permits transfers at any baud rate (between 37.5 and 2400 baud) as well as split baud rates by RS232C or 20mA current loop. For hard copy, the 2644 allows direct interface to the 9866 thermal line printer, or to an RS232C serial printer.

Fully Integrated, Dual Mini Cartridge Mass Storage

Two tape transports which utilize the unique Mini Cartridge provide local mass storage. This gives the 2644 Mini DataStation many powerful stand-alone capabilities. Shirt-pocket size, each cartridge contains precise tape guiding mechanics to assure high reliability and interchangeability. Up to 110,000 bytes (many hours worth of typing) can be stored per cartridge in variable length records and files. Fast access to files is provided by the high-speed search feature. In addition, the 4096 bytes of display memory are dynamically allocated, as used, to fit each application. Option 008 to the 2644 permits you to obtain a 2644 without the tape transports — the transports can be added later.

Microprocessor Control

The operating characteristics of the 2644 terminal are controlled through firmware. The terminal's microprocessor manages memory allocation, data communications, keyboard scanning, and display control. This microprocessor implementation and the use of a single common bus architecture yield a terminal with a wide range of capabilities.



Pop-In Modularity

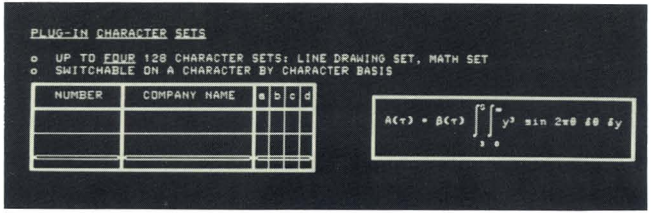
The modular computer-like construction of the 2644 is designed for ease of service. Digital electronics are contained on printed-circuit cards that can be exchanged within the terminal; up to 15 cards can be accommodated to allow a flexible choice of options both now and in the future.

Self-Test

The HP 2644 has been engineered for high reliability, ease of maintenance testing, and rapid repair when needed. By using the TEST button on the keyboard the user receives a Go/No-Go indication from results of an internal memory test, firmware test, tape transport test and display verification.

Plug-In Character Set

Recognizing the demand for terminals that speak many languages and fill diverse sets of needs, the HP 2644 has the capacity to include up to four 128-character sets resident concurrently in the terminal. Adjacent characters on the display may be from any of the four character sets. A Math Character Set and Line Drawing Set are available with the optional Underline, Blinking and Half-Bright feature.



Multi-Task Keyboard

The 2644 has a detachable, expanded ASCII keyboard which has been designed for ease of use and the flexibility to fill the needs of a wide variety of tasks. The Multi-Task Keyboard includes: a ten-key numeric group; cursor, tab and page control group; and 26 additional editing, tape control, and special function keys.

Your 2644

What You Get

Your new 2644 is delivered with the options and accessories that you reqested already installed and tested. "Identifying Options and Accessories" lists these features.

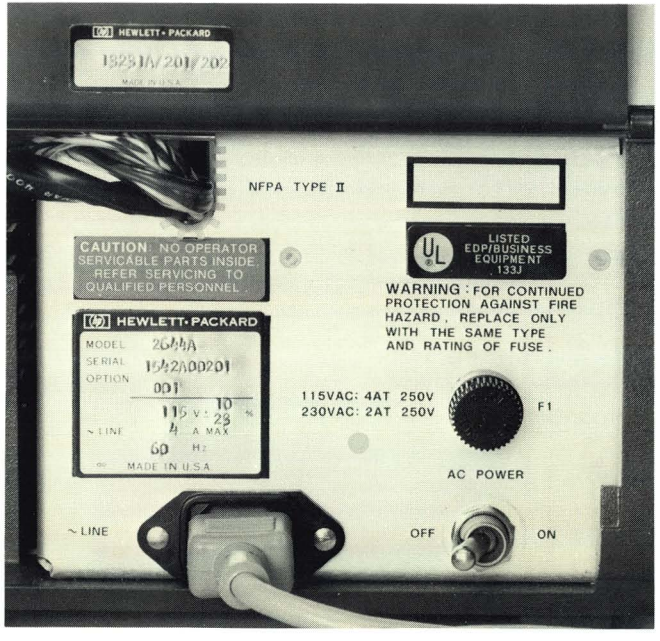
How To Identify

The options and accessories installed are specified on the Identification Labels found on the Mainframe Panel under the Rear Access Cover.

Who To Contact

When communicating with Hewlett-Packard regarding your 2644 unit, use the Model, Serial, and Option numbers to insure quick identification by HP. Hewlett-Packard Sales and Service Offices are listed on page 76.

Identifying Options And Accessories



PRODUCT NUMBER	DESCRIPTION/NOTES
2644A	Mini DataStation Block or character mode (switch selectable); 64 character upper case Roman set; 4096 bytes of RAM storage; 2 cartridge tape transports (includes 2 cartridges); inverse video; 110-2400 Baud; data communications; includes 5 option slots. (Does not include computer interface cable). **NOTE:** Order at least one of accessories 13232A or C.
opt. 001	128 Character Set — Roman. Adds lower case and control codes display.
opt. 008	Deletes cartridge tape transports and associated electronics.
opt. 012	Printer Subsystem Adds 9866A Line Printer, interface, and cable to 2644A.
opt. 013	Adds five Mini Cartridges
opt. 015	50 Hz
opt. 020	Extended Asynchronous Data Communicatons Interface — Operates either RS232C or 20mA current loop. Split speed, custom baud rates available.

PRODUCT NUMBER	DESCRIPTION/NOTES
	(Replaces standard Asynchronous Data Communications Interface board.) **NOTE:** For RS232C application, use accessory 13232A or 13232C. For current loop, use 30-pin connector (provided) or 13232F.
13231A	Display Enhancements Adds blinking, half-bright & underline and provides for addition of three 128-character sets (requires 1 option slot)
opt. 201	64-character mathematic symbol set. Adds display of integral signs, Greek letters, etc.
opt. 202	64-character line drawing set. Adds display of continuous horizontal and vertical line segments for forms, histograms, etc.
13232A	103/202 Modem Cable — for connection to 103/202 Modem, or hardwired to HP 3000, or hardwired to HP 2000 multiplexer. — 15 feet. Male RS232 connector.
13232C	RS232C Cable — 5 feet. Female RS232 connector

PRODUCT NUMBER	DESCRIPTION/NOTES
13232F	Current Loop Connector Kit — Connects and configures 2644 opt. 020 for current loop operation. Provides four lugs for connection to customer-provided barrier strip. 5-foot cable.
13232G	Male RS232C Printer Cable — 15 feet.
13232H	Female RS232C Printer Cable — 15 feet.
13245A	PROM Character Set Accessory — Aid to production of customer-defined character sets.
13246A	Printer Subsystem (add-on) — Includes 9866A Printer, interface and cable for connection to 2644.
13250A	Serial Printer Interface — For use with RS232C serial printers. (Requires one option slot.) Also permits field upgrade equivalent to 2644 opt. 020 (replaces existing Asynchronous Data Communications Interface board). **NOTE:** For RS232C printer application, use accessory 13232G or 13232H. For modem application, use accessory 13232A or 13232C. For current loop application, use accessory 13232F.
9162-0061	Mini Cartridge (1)
8500-1251	Tape Head Cleaning Solvent (4 ounces)
9300-0468	Tape Head Cleaning Swabs (10)

Installing the 2644

The 2644 Mini DataStation is designed to operate in a wide range of environments as indicated by the "Specifications" section. The 2644 is totally self-contained with easy access to all operator controls, so that normal installation does not require opening the unit.

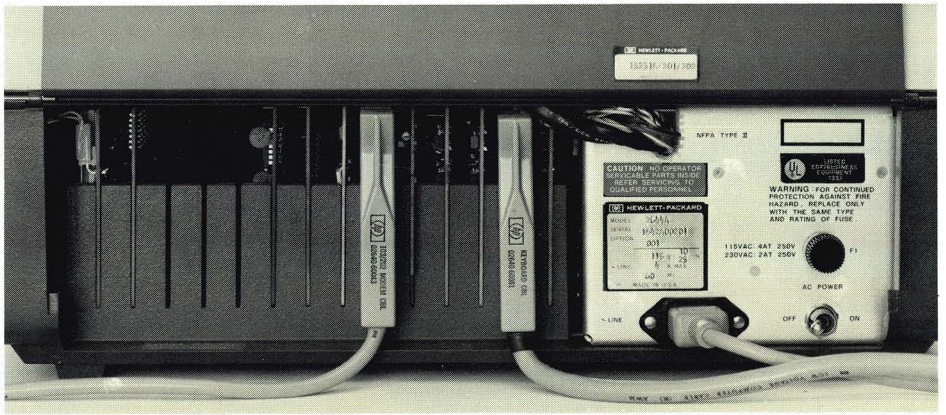
NOTE

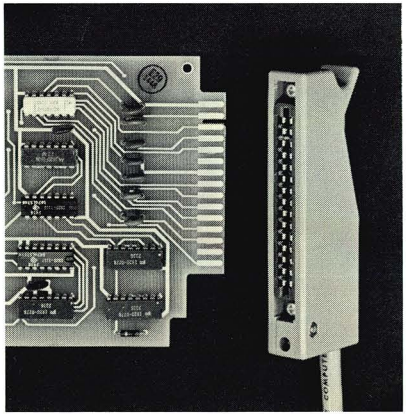
Should you later desire to open the unit for option/accessory add-ons, please refer to the HP 2644A Service Manual — 02644-90002.

Simply complete the following five steps to insure proper installation:

STEP 1. Place the terminal on any convenient surface, except plush or spongy surfaces that might restrict 2644 air flow through the bottom vents — do not use typewriter pads, for example.

STEP 2. Raise the unit's hinged rear access cover (two rotating latches hold it in place) and connect the keyboard cable hood connector to the printed-circuit card connector that has been appropriately notched to match the cable connector.





NOTE

Card connectors have been notch-keyed to prevent erroneous connection. Minimal pressure is needed to make the connection.

STEP 3. Connect the interface cable (accessory 13232A, C, or F) hood connector to the printed-circuit card connector that has been appropriately notched to match the interface hood connector. Connect the remaining end of the interface cable to your modem or computer connector interface. (Table 1 on page 84 contains a technical description of the Interface Standards.)

STEP 4. Put the AC Power Switch in the OFF position; connect the power cord to the AC Power Connector.

STEP 5. AFTER INSURING THAT YOUR A.C. MAIN VOLTAGE CORRESPONDS TO YOUR TERMINAL'S VOLTAGE REQUIREMENTS (either 115V or 230V as printed after "LINE" on the Identification Label on the rear panel), plug the 3-prong power connector into your A.C. power source outlet.

NOTE

For safety reasons a 3-prong grounded power outlet must be used.

Turning the 2644 On and Off

ON. After the 2644 Mini DataStation has been properly installed:

STEP 1. Assure that the REMOTE latching key is not depressed (i.e., the 2644 is set for off-line operation).

STEP 2. Set the A.C. Power Switch, located on the Mainframe Rear Panel, to the ON position. After a 15 second warm-up period, the station will be in its initial state: the display and memory are clear, the cursor appears in the upper left corner (Home position) of the display, all programmable functions are OFF, the left and right tape units are selected as the source and destination devices, respectively, for data transfer operations.

STEP 3. (Optional) It is also recommended that the 2644's Self-Test be performed — press the TAPE TEST key. Generally, if the station gives an audible beep and a test pattern similar to those presented in the "Self-Test" section (page 70) is displayed, then the station is working properly.

NOTE

If the cursor still does not appear and the TEST function does not work properly, set the A.C. Power Switch to OFF and do not attempt to operate the station until the malfunction has been corrected by a qualified service representative.

OFF. The station is turned Off by setting the A.C. Power Switch, located on the Mainframe Rear Panel, to OFF.

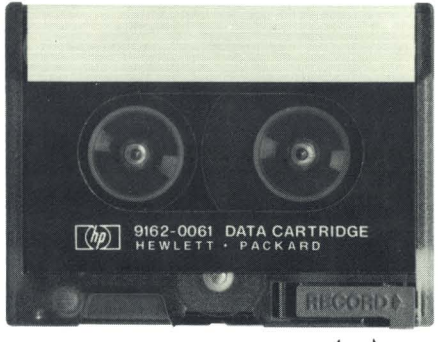
The Tape Cartridges

Inserting the Tape Cartridge

The tape cartridge is easily inserted through the tape unit doors of the 2644. The tape cartridge is inserted as shown on below. Before removing the cartridge, the tape should always be rewound as described on page 26. You can use the indicator in the eject button at the left of each door as a reminder — when the indicator is on, or blinking do not remove the cartridge. When you rewind the tape the indicator will go out, indicating that the tape has been rewound.

Protecting a Tape

If you have data on your tape cartridge and want to protect it from being inadvertently overwritten, move the tab marked RECORD ⇨ at the rear of the cartridge in the opposite direction of the arrow. You may permanently protect the data by removing the tab from the cartridge.



Using Your 2644 Off-Line

Introduction

This portion of the manual gives you information on how to operate the 2644 without the aid of a computer (that is, "off-line"). First, you can perform four quick demonstrations to familiarize yourself with the versatility of the 2644. Then, you can read further about the off-line capabilities by controlling the devices of the 2644 (display, tape units, and optional printer) from the keyboard.

Four Quick Demonstrations

Your 2644 is a Mini DataStation having powerful stand-alone capabilities. Its many functions allow you to manipulate data simply. After performing the following demonstrations, you will want to read on and learn how to completely utilize the 2644's off-line capability.

Here are some demonstrations that you can try:

DEMO 1. Display data on the screen and edit it, if necessary.

DEMO 2. Record data that you have entered on the screen onto one of the cartridge tapes.

DEMO 3. Display data recorded on the cartridge tape.

DEMO 4. Copy data directly from one cartridge tape to another.

Before you perform the four demonstrations, check that the 2644 is ready for operation by reading "Turning the 2644 On and Off" on page 9.

NOTE

A list of screen messages along with their meaning and recovery procedure is found on page 86. You may see one or more of these messages displayed while performing the demonstrations.

DEMO 1. Displaying and Editing Data. Sit down in front of the keyboard and type your name. Notice that the cursor moves across the screen as you type. This tells you where the next character will appear when you hit a key.

Changing a Character. If you wish to change a character displayed on the screen, position the cursor (using ← , → , ↑ , ↓ keys) under the character to be changed, then press the desired character key.

Further Editing. Editing text is further simplified by using INSERT LINE , DELETE LINE , INSERT CHAR , DELETE CHAR keys. Explanations of these keys are given on page 26.

DEMO 2. Recording Data On Cartridge Tape. By using the cartridge tape units in your 2644, you can store information for use at a later time. This can be done off-line thereby not requiring CPU time to store the information. Let's try storing some information now.

STEP 1. Press ↖ , CLEAR DSPLY , type your name, then press RETURN .

STEP 2. Insert a tape cartridge into the right tape slot at the front of the tape unit. The cartridge must be inserted as shown on page 10. Also, be sure that the tape is not protected.

STEP 3. The tape will automatically rewind to the "load point" (a location on the tape where you start to write data) when you insert it. Also, SEARCHING appears on the screen. The cartridge eject button at the left of the tape slot will light when the tape is at load point. Data may be recorded now.

STEP 4. Press [RECORD]. Your name is recorded on the right cartridge tape unit. The eject button blinks as the data is recorded.

STEP 5. Now rewind the right cartridge tape by pressing:

[ ], [FUNCTION: REWIND f5], [f6 TO: R. TAPE].

DEMO 3. Displaying Data From Cartridge Tape. Displaying the data from cartridge tape allows editing of data and debugging programs stored on cartridge tape. Also, it permits displaying pre-recorded forms for formatted data entry. Let's display your name that you recorded in **DEMO 2.**

STEP 1. Press the tape eject button, remove the tape cartridge from the right slot, and insert it into the left tape slot. SEARCHING message appears on the screen (replaces your name temporarily) as the tape is automatically rewound to "load point".

STEP 2. When the cartridge eject button lights, press [READ]. This sets the read mode which displays the recorded data (your name) on the next line of the display.

STEP 3. Now rewind the left cartridge tape by pressing:

[ ], [FUNCTION: REWIND f5], [DEVICE: L. TAPE f5].

STEP 4. Remove the tape cartridge from the left tape unit.

NOTE

Gold functions are shown in this manual as appearing below the key (as they appear on the keyboard) like this:

[f1 FROM: L. TAPE], [f8 TO: PRINTER], [f3 FROM: DISPLAY], [f6 TO: R. TAPE].

Green functions are shown as they appear above the key. Only the function being performed will be shown, like this:

[COPY ALL f1], [FUNCTION: REWIND f5], [DEVICE: R. TAPE f6], [FIND FUNCTION: FILE n f8], [DEVICE: PRINTER f8].

All other keys will be shown as follows:

[READ], [RECORD], [↖], [A], [3].

DEMO 4. Copying a Tape. Copying data from one tape to another provides a convenient means to furnish back-up data on tape, to supply additional data stations with duplicate data entry forms, etc. It's so easy and can be done completely off-line. For example:

STEP 1. Insert the tape to be copied (you could use the one with your name on it) into the left tape slot. Insert another tape into the right tape slot. Be sure the tape is not protected.

STEP 2. Select the left tape unit as the source of the information and the right tape unit as the destination by pressing:

STEP 3. Copy the information by pressing:

When both eject button indicators stop blinking, the copy function is complete.

STEP 4. Now rewind the right cartridge tape by pressing:

STEP 5. Rewind the left cartridge tape by pressing:

You can check the data on the new tape by performing **DEMO 3.**

Summary, What's Next? Now that you have demonstrated briefly some of the off-line capabilities of the 2644, read on and learn about controlling and transferring data between the display, tape units, and optional printer in detail. A brief glossary of terms that you should know is given on the following page. Being aware of these terms will help you understand the discussion that follows.

Terms Used In This Owner's Manual

BOT	"Beginning Of Tape" — The point to which the cartridge tape is rewound.
CURSOR	The blinking dash on the display that tells you where the next character, or space, will occur — acts as a pointer.
DATA TRANSFER OPERATION	The process of transferring (or copying) data from one device to another.
DEVICE	The display, left or right tape unit, or optional printer.
DEVICE CONTROL OPERATION	The process of rewinding tapes, finding files, marking files, skipping lines, moving printer paper, etc.
END OF DATA	The point on the cartridge tape where you last recorded data.
EOT	"End Of Tape" — The point on the cartridge tape beyond which data cannot be recorded.
FILE	Usually consists of more than one record, or lines. It may be thought of as a page in a book.
FILE MARK	A special record that you record on the cartridge tape to separate files.
FORM FEED	Move the printer paper to the top of the next page.
"FROM" DEVICE	The device that supplies the data in a data transfer. Also defined as the "source" device.
LINE	A group of characters, and may be thought of as a line of text in a book.
LOAD POINT	The point on the cartridge tape where you can start recording data.
LOCAL MODE	Operating the 2644 without the aid of a computer system (that is "off-line").
PAGE	24 lines.
RECORD	A line of data. Records may be from 1 to 256 characters long.
REMOTE MODE	Operating the 2644 with the aid of a computer system (that is, "on-line").
"TO" DEVICE	The device that receives the data in a data transfer. also defined as the "destination" device.

The Display

The display can show 24 lines of up to 80 characters each, which is called a "page". The display's memory can retain multiple pages depending upon the number of characters per line (that is, the 1 page shown on the display and the other pages that you don't see at the same time which are stored in the display's memory).

The block of 12 keys at the right of the keyboard are used to control the display and the information that you enter into the display's memory.

Moving the Cursor. You can position the cursor to any location on the display by pressing [←], [→], [↑], [↓]. [↖] homes the cursor to the upper left corner of the display.

Setting Tabs. To set a tab, move the cursor to the desired column, and press [SET TAB]. [CLEAR TAB] clears the tab position. The [TAB] key is located at the left side of the keyboard.

Clearing the Display. [CLEAR DSPLY] clears the display memory from the current cursor position to the end of display memory. To clear the entire display, simply press [↖] (cursor home), then press [CLEAR DSPLY].

Displaying Information. The information that you have typed is retained in the display memory. When you have entered 24 lines of information (even if you have only entered one character on each line), the display rolls up one line. As you continue to type information, the display continues to roll up for each line typed until display memory is filled. If additional lines are typed, a sufficient number of lines at the beginning of display memory are lost to allow space for the additional lines. (Memory Lock and Edit Mode decribed on pages 22 and 30, repectively, are two methods of preventing lines of information from being lost.)

The [ROLL UP] and [ROLL DOWN] keys permit you to display any part of display memory. They move the display a line at a time.

The [NEXT PAGE] and [PREV PAGE] keys move the display 24 lines at a time (a "page"). When you press these keys, the information presently displayed is replaced by the next "page" (24 lines), or the previous "page", in display memory.

Display Messages. Display messages appear in the upper left corner of the display and give certain types of status or error information. For example, SEARCHING and NO TAPE. A complete list and an explanation of display messages are presented in "Display Messages", page 86. [RETURN] will clear the message and restore the display.

The Keyboard

Before learning to control the devices and transfer data in detail, you should have a brief understanding of the various functions of the keyboard. Figure 1, inside the front cover shows the keyboard layout. The keyboard consists of six functional groups:

- CHARACTER SET GROUP — This group of keys is like a standard typewriter keyboard. It is used for entering data onto the display.
- NUMERIC AND DISPLAY CONTROL GROUP — The numeric portion with its ten-key adding machine layout can be used for entering large amounts of numeric data. The display control portion controls the various functions of the display.
- COMMUNICATIONS GROUP — These switches are used when the terminal is connected to a computer system.
- TERMINAL CONTROL GROUP — This group of keys initializes the terminal (RESET), establishes the operating mode, and performs the Self Test.
- EDIT GROUP — Text can be easily modified on the display through use of the insert/delete character and line keys of the edit group.
- MINI CARTRIDGE AND SPECIAL FUNCTIONS CONTROL GROUP — This group controls the devices, data transfer operations, and special functions which will be described later.

At this point, some further explanation is needed on the Mini Cartridge and Special Functions Control Group — Green Key and Gold Key Operations.

Green Key Operations. Green key operations are used to copy information from one device to another, to perform edit functions, to find files, and to control the tape units and optional printer. Green key operations are performed by pressing the [ ] prefix key followed by keys that are labeled with the corresponding green color coding. For example, pressing:

[ ] , FUNCTION REWIND f5 , DEVICE L TAPE f5 .

would cause the left tape to rewind.

RETURN Key. Pressing RETURN during a "green" key operation will cancel that operation. The return key will halt any tape operation except file search rewind, or record during edit mode. Also, RETURN will clear any error message displayed (see page 86) and restore the previous display. For example: if a rewind operation is attempted with no cartridge tape inserted, the NO TAPE message can be cleared by pressing RETURN .

Gold Key Operations. The gold key operations (device selection) are used to specify where information will come "from" and where it is going "to". Gold operations are performed by pressing the [ ] prefix key followed by keys that are labeled with the corresponding gold color coding. When the [ ] prefix key is pressed, the indicator above the [ ] key will light to indicate that the terminal is in the device selection mode. For example,

pressing [ ] , [f2 FROM: R TAPE] , [f7 TO: DISPLAY] .

specifies that the information will come from the right tape unit and will go to the display.

Once the device selection is made, it will remain in effect until you make another selection or press [RESET TERMINAL] .

When power is turned on, or when [RESET TERMINAL] is pressed, "preset", selections are made automatically, as shown below. These "preset" selections remain in effect until you select other devices by gold key operations.

PRESET DEVICE SELECTIONS

OPERATIONS	"FROM" DEVICE	"TO" DEVICE
Read	Left Tape	Display
Record	Display	Right Tape
Copy	Left Tape	Right Tape

If the [ ] key is pressed again while the device select indicator is on, device selection will not be changed. The device select mode will be terminated and the indicator will be turned off.

After you have selected where the information will come "from" and where it is going "to", pressing any key (other than the [ ] key) completes the device selection and performs the operation indicated by the key that was pressed.

Character Set Group

Alphabetical, Numerical, and Symbol Keys. This group of keys functions similarly to a standard teletypewriter keyboard. ASCII character codes are generated for upper and lower case letters, numbers, and symbols. (Any optional display characters that are not present in the 2644 unit are not displayed.)

ESC

Escape function generates the ASCII escape character, and can be used in creating any of the programmable 2644 functions associated with the escape code sequence (for instance, ESC U produces a NEXT PAGE command — see table 4 on the back cover).

TAB

The cursor is moved to the next tab position to the right; or if none, to the first column of the next line. In Format Mode, the cursor is moved to the start of the next unprotected field, disregarding normal horizontal Tab stops — thus any number of stop locations in any combination of positions can be created for use in Format Mode, up to memory capacity.

CNTL

Control function. When pressed in conjunction with any alphabetical key or @,[,\,],^,_,`,{,|,},–,DEL, the CNTL key converts the character code for that particular key into an ASCII control code. All of the ASCII control codes are shown in first two columns of Table 2. Also accesses alternate functions on certain keys, such as ↖, CLEAR DSPLY, f1 thru f8, and TAPE TEST (as indicated by the blue coding on these keys).

BACK SPACE

The cursor is moved left one character position. If the cursor is in the first column, it remains there.

RETURN

Returns the cursor to the beginning of its current line. An automatic local Carriage Return, Line Feed is generated when a character is placed in the last column (with standard strapping — see page 52). Aborts a green keystroke sequence. Halts any tape operation in progress except for REWIND, SEARCH, and CONDITIONING. Restores display and unlocks keyboard when a screen message is displayed.

Numeric and Display Control Group

Ten-Key Numeric Group. Functions as an adding machine format keyboard.

↑

Cursor Up. Moves the cursor up one line on the display. If the cursor is in the top line, it is wrapped around to the bottom line of the display.

↓

Cursor Down. Moves the cursor down one line on the display. If the cursor is in the bottom line, it is wrapped around to the top line of the display.

→

Cursor Right. Move the cursor right one column on the display. The cursor will wrap around the display from the last column to the first column of the next line; from the last display position to the first.

←

Cursor Left. Moves the cursor left one column on the display. The cursor will wrap around the display from the first column to the last column of the above line; from the first display position to the last.

↖ Cursor Home. Moves the cursor to the first character position of the first line. The first page of memory is displayed. In Format Mode, the Home position is the first unprotected location on the display. If CNTL is pressed simultaneously, the cursor moves to the first character position of the last line, and the last page of memory is displayed.

CLEAR DSPLY Clears memory (and display) from the current cursor position to the end of memory; or to the end of the current line if CNTL is pressed simultaneously. In Format Mode only unprotected fields are cleared.

ROLL UP Moves the entire display up one line by displaying the next line from memory (until the last line of memory is located at the top of the display). Cursor is stationary.

ROLL DOWN Moves the entire display down one line by displaying the line from memory above those currently displayed (until the first line of memory is located at the top of the display). Cursor is stationary.

NEXT PAGE Displays the next 24 lines of memory (until the last line of memory is located at the top of the display). The cursor is moved to the first unprotected location on the new page.

PREV PAGE Displays the previous 24 lines of memory (until the first line of memory is located at the top of the display). The cursor is moved to the first unprotected location on the new page.

SET TAB Sets a tab at the current cursor column. In Format Mode TAB settings are ignored, and the start of each unprotected field functions as a TAB position.

CLEAR TAB Clears a tab at the current cursor column.

Communications Group

DUPLEX Switch. HALF: Typed characters are processed by the terminal and transmitted to the computer. FULL: Typed characters are transmitted to the computer and not processed by the terminal until returned from the computer. (This function is ignored in Block Mode.)

PARITY Switch. When set to EVEN/ODD/NONE, even/odd/no parity is transmitted for each character. Incorrect parity: a "_" (or a "▤" with Option -001) is displayed.

BAUD RATE Switch. Selects data transmission rate of 110, 150, 300, 1200, 2400 baud. EXT: any rate between 110 and 2400 can be selected from an external source. The 110 baud rate uses 2 stop bits; all others use one stop bit to delimit each character transmitted.

Control Group

RESET TERMINAL

The terminal is set to the initial power-on state: display and memory clear, cursor home, programmable functions off. Cartridges are rewound and positioned at load point.

TAPE TEST

A diagnostic test of memory, ROM, and the display is performed. If a failure is detected, an indication of the appropriate error is displayed. If no error is detected, a standard test pattern is displayed. If the prefix key is pressed before pressing TAPE TEST a test of the tape units is also performed (see "Self Test", page 70). If CNTL is pressed simultaneously, the left tape will be conditioned (see "Tape Conditioning Procedure", page 74). To recover from an error in the Self Test, press the RESET TERMINAL key.

DISPLAY FUNCTION

All escape codes and control functions (typed or received) except Carriage Return are disabled and will not be executed. RETURN performs both a Carriage Return and a Line Feed. You can list programs which have escape or control codes in them without the terminal responding to the codes. All codes are displayed as blanks unless option -001 is installed. With the 128-character Roman Set option (-001) escape codes and control functions are also displayed. The "Self-Test" section (page 70) shows these characters. Being able to actually display these codes is a powerful program debugging aid.

Example:

Executing the escape sequences to move the cursor to the Home position, clear the display, turn on Memory Lock and type "Hello!" on the 2644 display in Inverse Video would appear on the display as:

With DISPLAY FUNCTIONS On, the same sequence would be displayed as:

BLOCK MODE

When the terminal is in Block Mode, typed data is displayed but not transmitted to the computer until requested by the computer or until after the ENTER key has been pressed and the computer has responded. Otherwise, the terminal is in Character Mode and data is transmitted as typed. (See "Block Mode", page 44.)

The terminal is in Remote (on-line) operation. Otherwise, the terminal is in local (off-line) operation.

Locks all alphabetical keys to upper-case characters; @, [,], \, ^ are locked in lower-case; other numerical/symbol keys operate normally.

Memory Lock has two independent modes of operation:

- Memory Overflow Protect. If Memory Lock is turned on when the cursor is in the top line of the display, the indicator is lighted and data is prevented from rolling off from the top of memory after display memory has been filled. The MEMORY LOCK indicator blinks and an audible "beep" is generated when memory is full. Additional data, typed or received is ignored.
- Display Lock. If the cursor is not in the top line of the display when Memory Lock is turned on, displayed data above the line with the cursor frozen on the screen. Once the display is full, the bottom lines on the display roll around the frozen data as additional data lines are typed or received. This is an important feature to freeze information on the display for use in forms headings, instructions or rules to the operator. Format Mode, Next Page, Previous Page, Cursor Home, and Tab are modified when Display Lock is used, and their use is not recommended for data entry applications in Format Mode.

Example:

To demonstrate these two modes of operation:

- Home the cursor 

, turn on Memory Lock, and then press 

key a number of times until the terminal's memory is full (the indicator will blink and the bell "beeps").
- Attempt to type in additional data below the last test pattern. No data should appear.
- Move the cursor up, press 

, move the cursor down to the line below the last test pattern, and then type in additional data until the limit of memory is again indicated. The data should appear.
- Now, Home the cursor, turn off Memory Lock, move the cursor down a few rows and turn on Memory Lock again.
- Depress the 

key (allowing it to Auto-Repeat), then depress the 

key. The top lines of the display should remain stationary while the lines below roll up and down.

Causes a Line Feed each time a Carriage Return is generated by the terminal.

Transmits a BREAK signal to interrupt computer operation. (Transmits a 200 ms space on the asynchronous data communication line and sets secondary channel low for 200 ms.)

The indicator will be lighted when a data link exists for transmission between the terminal and the computer during modem operation. The Clear to Send line of the RS232C interface is high.

On-Line Mode

- Character Mode, Format Off. The entire line containing the cursor is transmitted as a block.
- Character Mode, Format On. Unprotected characters from the cursor position to the end of the unprotected field are block transmitted. The cursor is left at the first character position after the end of the field.
- Block Mode, Format Off. After receiving a DC1 from the computer, informs the computer by transmitting a DC2 control character (or DC2 CR(LF) with Line Strapping — see "Strapping Options", page 52) that the terminal is ready to transmit characters from the cursor to the end of the line of memory (dependent on Line/Page strapping).
- Block Mode, Format On. After receiving a DC1 from the computer, informs the computer by transmitting a DC2 (or DC2 CR(LF) with Line Strapping) that the terminal is ready to transmit the current field, or all unprotected fields from the cursor to the end of memory, each delimited by a unit separator, US (dependent on Line/Page strapping).

(See Character Mode and Block Mode operation on page 44 for details and examples of ENTER operation.)

NOTE

All block transfers are terminated by a CR(LF), or a Record Separator, RS, in Block Mode with Page Strapping.

Off-Line Mode

In off-line mode, performs the same function as the 

key.

Mini Cartridge Control and Special Functions Group

thru 

Special Function Keys. These eight keys perform multiple functions, depending upon whether the terminal is in Local or Remote Mode, and whether 
, 
, 

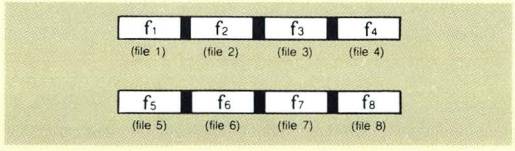
, or no key is previously pressed. The green and gold functions of these keys are discussed in "Cartridge Tape Operations" on page 31.

Special Function Keys f_1 through f_8

NO KEY PREVIOUSLY PRESSED

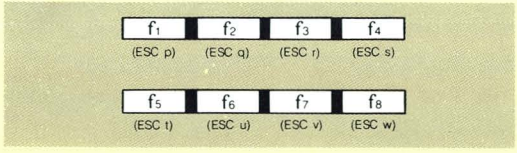
Local Mode

Locates and displays file 1 thru file 8 from the current "from" device depending upon which key is pressed. For example, [f_3] corresponds to file 3.

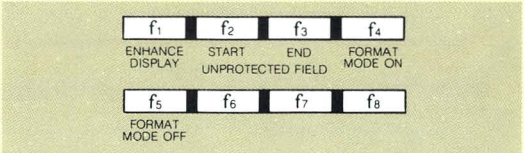


Remote Mode

Sends an escape code to the computer to call any subroutine you designate (with software support). Keys [f_1] thru [f_8] correspond to ESC p thru w. For example, [f_4] would be ESC s. (See "Special Function Keys", page 69).



[CNTL] PRESSED AND HELD DOWN



NOTE: The above labels do not appear on the keyboard.

[f_1] **(Enhance Display).** Precedes a single letter (@, A through O) indicating one of the 16 possible combinations of Half-Bright, Underline, Inverse Video (black characters on a white background), and Blinking is to be displayed (Half-Bright, Underline, and Blinking are provided by Option 13231A):

	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Half Bright									X	X	X	X	X	X	X	X
Underline					X	X	X	X					X	X	X	X
Inverse Video			X	X			X	X			X	X			X	X
Blinking		X		X		X		X		X		X		X		X

X indicates that the feature is on. For example, pressing the ENHANCE DISPLAY key followed by E would turn on the start of a field of Blinking-Underlined characters. These Enhanced Display features can be turned on and off on a character-by-character basis

and can be used in a wide variety of applications to accentuate the differences between various fields on a display.

Example
A user with a data entry application might wish to distinguish a protected form with Inverse Video from the fields into which data is to be entered. (Such a form is shown on page 50.) Also, the user might wish certain fields to be brought to the operator's attention by causing those fields to blink.

f2 **(Start Unprotected Field).** Characters from the cursor position to the end of the current line or the next End Unprotected field are unprotected in Format mode. Set while out of Format Mode.

f3 **(End Unprotected Field).** Characters from the cursor position to the end of the current line or the next Start Unprotected Field are protected. All lines are automatically protected in Format Mode unless otherwise specified by the use of Start Unprotected Field. Set while out of Format Mode.

f4 **(Format Mode On).** In FORMAT MODE only unprotected fields can be operated on. All locations in the terminal's memory which have not been specifically made unprotected by the use of the f2 (Start Unprotected Field) key remain protected (these locations cannot be altered from the keyboard or the computer). Attempting to type into a protected field will move the cursor to the next unprotected field for data entry. The cursor home position is the first unprotected field location. The cursor is automatically put in the home position when Format Mode is turned on.

Example
The form shown on page 50 was created with FORMAT MODE off. The START UNPROTECTED FIELD and END UNPROTECTED FIELD keys were used to start and end each of the fields for data entry within the Inverse Video form. With FORMAT MODE on, only unprotected data entry fields can be written into — the form cannot be altered, and the cursor automatically moves forward to the next unprotected field (the TAB key can also be used). See the data entry example presented on page 51.

f5 **(Format Mode Off).** Turns off FORMAT MODE.

f6 thru f8 (No function. Pressing one of these keys in local mode will perform a file search, same as no key previously pressed.)

Edit Group

INSERT LINE

The line containing the cursor and the remaining lines below the cursor are rolled down and a blank line is inserted. The cursor is moved to the first column of the new blank line. Disabled in Format Mode.

DELETE LINE

The line containing the cursor is deleted and the remaining lines below the cursor line are rolled up. The cursor is moved to the first column of the first line rolled up from below the deleted line. Disabled in Format Mode.

INSERT CHAR

Succeeding typed or received characters are inserted at the cursor position. As each character is inserted at the cursor position, the cursor and the characters to the right of the cursor are moved right one column. Control codes at the cursor position are not moved. Characters moved out of column 80 are lost. Operates on the current field in Format Mode.

DELETE CHAR

The character (including control codes) at the cursor position is deleted and all characters to the right of the deleted character are moved left one column. Operates on the current field in Format Mode.

Cartridge Tape Operations

Rewinding the Cartridge. You can rewind either tape as follows:

Press , FUNCTION: REWIND f5 , or DEVICE: L. TAPE f5 DEVICE: R. TAPE f6

If the previous operation was a record operation, an end-of-file mark and an end-of-data mark are recorded at the tape's present position before the tape is rewound. The end-of-data mark provides a reference point to append data at a later time, if desired.

Recording Data. Pressing RECORD copies data from the display onto the "to" devices (right tape, left tape, and/or printer) in local mode. The specific devices may be selected by gold key operations, or by "preset" selection (right tape unit). The RECORD key causes the entire contents of display memory to be recorded on the "to" device.

The RETURN key will halt the record operation, except during edit mode.

Another method of recording data on the tape units is explained in "Copy Operations", page 30.

Reading Data. Pressing [READ] in local mode copies data from either the left or right tape unit to the display. The specific tape unit may be selected by gold key operations, or by preset (left tape unit).

Data is read from the present position of the tape up to the point where a file mark is encountered. Data may be read from the beginning by first rewinding the tape, then pressing [READ]. Consecutive files may be read by pressing [READ] for each file. Any file may be accessed directly as described in "Finding Files". Pressing [RETURN] will halt the read operation.

Another method of reading data from the tape units is explained in "Copy Operations", page 30.

Marking Files. As you record data on the tape units, you may want to separate the data into files. This permits you to locate the data later (by file) easily after it is recorded on tape. "Marking a file" means to record a file mark at the end of a group of data. For example, after a record operation you could mark that file by pressing:

A file mark is recorded at the end of the file. You could record additional information after that point, and mark that file by the same process.

Finding Files. Files of information recorded on the tape units can be located by two methods. In Local Mode, the first eight files on the "from" tape can be located and displayed automatically by pressing the respective [f1] through [f8] key. In either Local or Remote Mode, any file can be located by "green" key operations (however, it will not be displayed automatically). The "green" key operations sequence is this:

STEP 1. Press

STEP 2. Enter the number of the file you want to locate. (For example, press [1] , [2] for file 12.)

STEP 3. Press [DEVICE: L. TAPE f5] or [DEVICE: R. TAPE f6] .

Had you performed the above sequence, file 12 would be located (if it exists). Pressing [READ] would display file 12. If file 12 did not exist, END OF DATA would be displayed.

Relative addressing of files can also be used.

pressing [ ] , [FUNCTION: FIND FILE n f8] , [−] , [3] , [DEVICE: L. TAPE f5] .

would cause the left tape to back up 3 files from its current tape position. A [+] instead of [−] would have caused the left tape to advance 3 files. If no number is included, the tape would move to the beginning of the current file.

Skipping Lines. A tape may be positioned to a specific line (record) by using the "green" SKIP n LINES operation. A tape may be moved forward, or backward, depending upon the sign (+ or −) of the integer in the keystroke sequence.

Example:

pressing [ ] , [FUNCTION: SKIP n LINES f7] , [+] , [6] , [DEVICE: L. TAPE f5] .

will move the left tape forward 6 lines.

pressing [ ] , [FUNCTION: SKIP n LINES f7] , [−] , [2] , [DEVICE: R. TAPE f6] .

will move the right tape backward 2 lines.

If the sign of the integer is omitted, a "+" is assumed. If no number is included, the tape will backspace one line.

If the last line skipped over during a backspace operation is a file mark; the tape will be moved forward so that the tape is positioned after the file mark. Thus to skip backwards over a file mark, a −2 should be used.

Appending Data. You can append data on the "to" tape unit by finding the end of data on that unit, then either record or copy data from the "from" device.

Example:

STEP 1. Press [gold], FUNCTION FIND FILE n [f8], [2], [5], [6], DEVICE L TAPE [f5] or DEVICE R TAPE [f6]

will locate the end of data on the selected tape unit. END OF DATA message will appear on the screen.

STEP 2. Press [RETURN] to clear the message.

STEP 3. Press [RECORD] if the display is the "from" device, or press [gold], then COPY ALL [f1], COPY FILE [f2], or COPY LINE [f3].

The Optional Printer

Controlling the Paper. The printer paper can be made to space lines and move to top-of-form by "green" key operations.

The printer can be made to space any number of lines that you specify by using the "green" SKIP n LINES operation.

Example:

STEP 1. Press [gold], FUNCTION SKIP n LINES [f7].

STEP 2. Enter the number of lines that you want to skip. (Press [3] for 3 lines, for example.)

STEP 3. Press DEVICE PRINTER [f8].

If you had performed the above example, the printer paper would have moved 3 lines.

Some printers can be made to skip to top-of-form (form feed) by using the "green" MARK FILE operation:

Press [gold], FUNCTION MARK FILE [f6], DEVICE PRINTER [f8].

Printing Data. If the printer has been selected as a "to" device by a gold key operation, information will be transferred to it for printing by RECORD or COPY operations.

Copy Operations

Three "green" COPY key operations permit you to copy a line, a file, or all data "from" and "to" the devices selected by gold key operations. The "preset" devices are left tape ("from") and right tape ("to").

Copy Line. Pressing [ ] , [COPY LINE f3] , will copy one line of data from the "from" device to the "to" device(s). If the display is the "from" device, the line containing the cursor is copied.

Copy File. Pressing [ ] , [COPY FILE f2] , will copy an entire file from the "from" device to the "to" device(s). File marks encountered will also be copied between "from" and "to" devices. If the display is the "from" device, all information from the line containing the cursor to the bottom of the display is copied.

Copy All. Pressing [ ] , [COPY ALL f1] , will transfer all information from the "from" device to the "to" device(s). File marks encountered will also be copied between "from" and "to" devices. If a tape is the "from" device, data from the present tape position to the end-of-data mark will be sent. If a tape is the "to" device, recording will begin at the tape's present position. If the display is the "from" device, all information from the line containing the cursor to the end of display memory is copied. This is a useful function for creating backup tapes.

Edit Mode

The Edit Mode (a local mode function only) allows you to read data from one device to the display, to edit the data, and record the edited data automatically on the "to" devise(s). If the tape units are selected, make sure that the tape cartridge is not protected (see page 11). To enter the edit mode, press [ ] , [EDIT f4] . The green EDIT indicator will light.

The [READ] and [RECORD] keys have special meaning in edit mode:

- The [READ] key performs the same function as in non-edit mode, except that any data that would be lost by rolling off the top of display memory is recorded automatically on the "to" device(s).
- The [RECORD] key transfers any information remaining in display memory to the "to" device(s) — the same as in non-edit mode. Also, any information remaining in the file of the "from" device will be transferred to the "to" device(s). Then the edit mode is terminated.

The edit mode may also be terminated at any time by pressing [ ] , [EDIT f4] . The EDIT indicator will go out.

Format Mode

In format mode only unprotected fields can be operated on. All locations in the display's memory which have not been specifically made unprotected cannot be overwritten. This is a very useful feature for displaying protected forms for data entry applications (see page 50). The data entry form on page 50 was constructed using the Start Unprotected Field function (CNTL held down while f2 is pressed) and the End Unprotected Field function (CNTL held down while f3 is pressed) to start and end each field for data entry within the form. Then format mode is turned on (CNTL held down while f4 is pressed). Format mode can be turned off at any time by CNTL held down while f5 is pressed.

When in format mode, the RECORD operation transfers only the information in the unprotected fields to the "to" device(s). Then it automatically homes the cursor and clears all of these fields. If the "to" device is a printer, the printing format (positioning of the information) will be identical to the format of the display. If the "to" device is a tape unit, formatting information will also be stored on the tape. A file mark will be appended automatically. When data transfers (READ or COPY operations) are made using this recorded data in format as appeared originally on the display. If the data is transferred while not in format mode, each unprotected field will be presented as a line.

Mini Cartridge Control Keys

Enables the "green" functions written above the f1 through f8 keys.

READ

When in Remote Mode, transfers information from the "from" device (specified by "gold" operation) to the computer system. In Local Mode, transfers one file from the "from" device to the display.

RECORD

When in Remote Mode, transfers up to 256 bytes to the "to" device (specified by "gold" key operations) from the computer system. When in Local Mode, homes the cursor and transfers all data in display memory to the "to" device (specified by "gold" key operations). Indicator remains lighted in Remote Mode until the record operation is terminated.

Enables the "gold" functions written below the f1 through f8 keys. This allows you to specify which devices will be used for source (from) and destination (to) in the data transfer. Indicator lights to indicate device selection mode. Indicator will go out when any key is pressed terminating the device selection mode.

GOLD KEY PRESSED

[gold] [f1] L. TAPE — Selects the left tape unit as the "from" device for READ, COPY ALL, COPY FILE, and COPY LINE functions.

[gold] [f2] R. TAPE — Selects the right tape unit as the "from" device for READ, COPY ALL, COPY FILE, and COPY LINE functions.

[gold] [f3] DISPLAY — Selects the display as the "from" device for RECORD, COPY ALL, COPY FILE, and COPY LINE functions.

[gold] [f4] — (No function. "BAD SELECT" message will be displayed if [dark], [READ], or [RECORD] is pressed after pressing [gold], [f4].)

[gold] [f5] L. TAPE — Selects the left tape unit as a "to" device for RECORD, COPY ALL, COPY FILE, and COPY LINE functions.

[gold] [f6] R. TAPE — Selects the right tape unit as a "to" device for RECORD, COPY ALL, COPY FILE, and COPY LINE functions.

[gold] [f7] DISPLAY — Selects the display as a "to" device for READ, COPY ALL, COPY FILE, and COPY LINE functions.

[gold] [f8] PRINTER — Selects the printer as a "to" device for RECORD, COPY ALL, COPY FILE, and COPY LINE functions.

GREEN KEY PRESSED

[dark] COPY ALL [f1] — Transfers all data on the selected "from" device to the selected "to" device(s). If a tape unit is the "from" device, data starts from the present position of the tape.

[dark] COPY FILE [f2] — Transfers one file on the selected "from" device to the selected "to" device(s).

[dark] COPY LINE [f3] — Transfer one line (record) of data on the selected "from" device to the selected "to" device(s).

[dark] ○ EDIT [f4] — Extends the function of the [READ] and [RECORD] keys. When [READ] is pressed, one file from the selected "from" device is displayed. Any data that rolls off of the top of the display memory is recorded on the "to" device. When [RECORD] is pressed, the data in display memory

is recorded on the "to" device. Also, data remaining on the "from" device is recorded on the "to" device. After all data is recorded, the edit mode is terminated. You may abort the edit mode at any time by pressing [ ], [EDIT f4].

REWIND / L. TAPE [ ] [f5]

REWIND. Rewinds the tape on the tape unit selected by the next key pressed (either [DEVICE: L. TAPE f5] or [DEVICE: R. TAPE f6]).

L. TAPE. Selects the left tape unit for REWIND, MARK FILE, SKIP n LINES, and FIND FILE n functions.

MARK FILE / R. TAPE [ ] [f6]

MARK FILE. Records a file mark on the tape unit selected by the next key pressed (either [DEVICE: L. TAPE f5] or [DEVICE: R. TAPE f6]). Performs a form feed if the printer is selected.

R. TAPE. Selects the right tape unit for REWIND, MARK FILE, SKIP n LINES, and FIND FILE n functions.

SKIP n LINES [ ] [f7]

SKIP n LINES. Causes the L. TAPE, R. TAPE, or PRINTER to skip the number of lines specified. If the number is positive, the selected tape will move forward. If the number is negative, the selected tape will move backward (reverse). File marks are counted as lines. The printer, if selected, will space the number of lines specified, ignoring the sign of the number.

Example

[ ], [SKIP FUNCTION: n LINES f7], [–], [5], [DEVICE: R. TAPE f6], If n is not specified, n = –1 is assumed.

FIND FILE n / PRINTER [ ] [f8]

FIND FILE n. Causes the designated tape unit to locate the file number that you specify. Pressing [READ] will display the located file. The tape is positioned immediately after the file mark when the file search is completed. If the number is larger than the number of files on the tape, then an end-of-data mark (which is recorded when you rewind after a record operation) is located.

Example

[ ], [FIND FUNCTION: FILE n f8], [1], [0], [DEVICE: L. TAPE f5]. Position the tape at the beginning of file 10 on the Left tape unit.

PRINTER. Selects the printer for MARK FILE and SKIP n LINES functions. MARK FILE causes a form feed; SKIP n LINES causes n line feeds.

Additional Functions

There are several additional control codes and escape code sequences which can be used by the 2644 terminal and represent additional capabilities.

Enquiry (ENQ; E^{C}). Enquiry signal from the computer to the terminal. (See "Operating at High Speeds", page 54.)

Acknowledge (ACK: F^{C}). Acknowledge signal from the terminal to the computer in answer to an Enquiry.

Bell (BEL: G^{C}). Causes terminal to emit an audible "beep". A "beep" is automatically generated at the end of each unprotected field in Format Mode and as the cursor passes column 72 to signal the approach of the end of a line.

Define Alternate Character Set (ESC)). Precedes a parameter (@,A,B,C) which indicates which of four character sets will be the Alternate Character Set. (See "Using Alternate Character Sets", page 36.)

Turn On Alternate Character Set (SO: N^{C}). Changes characters from the cursor position to the end of the line or the next O^{C} control code to the Alternate Character Set.

Turn Off Alternate Character Set (SI; O^{C}). Changes characters from the cursor position to the end of the line or the next N^{C} control code to the primary character set (normally the Roman set).

Block Transfer Trigger (DC1; Q^{C}). Triggers a block transfer. Note that no block transfer requested by the computer or the terminal begins until triggered with a DC1 control code or the Enter key in Character Mode. (See "Operating in Block Mode", page 48.)

Block Transfer Enable from the Terminal (DC2; R^{C}). Transmitted to inform the computer of a Block transfer request. (See "Operating in Block Mode", page 48.)

Block Transfer Enable from the Computer (ESC d). The computer informs the terminal to enable itself for information transfer to the computer.

Record Separator (RS; ^ ^{C}). Used as a terminator for Block transfers when the terminal is in Block Mode strapped for page.

Unit Separator (US: _^{C}). Used to separate unprotected fields for Block transfers with Page strapping in Format Mode.

Cursor Addressing (ESC &a). Precedes a parameter sequence used to set cursor location. (See "Cursor Addressing", page 55.)

Cursor Sensing (ESC a or ESC`). Causes the terminal to send the current address of the cursor position to the computer. (See "Cursor Sensing", page 55.)

Keyboard Enable (ESC b). Enables the terminal keyboard (used in conjunction with Keyboard Disable).

Keyboard Disable (ESC c). Disables all keyboard keys from issuing their codes except the RESET TERMINAL key.

Tab (ESC I). Performs the same functions as pressing the TAB key.

Cursor Return (ESC G). Moves the cursor to the first column of the current line.

Clear Line from Cursor (ESC K). Clears the line from the cursor position to the end of the current line or current unprotected field.

Down Loading (ESC &b). Precedes parameters making up a program which is loaded into the terminal and executed. This function can be used by HP diagnostics only.

Terminal Status (ESC ^). Transmits seven bytes of terminal status as a block transfer representing memory size, lower straps, upper straps, latching keys, transfer pending flags, error conditions flags, Device Transfer pending flags and ended by a terminator. (See "Station Status", page 65.)

Reset Terminal (ESC E). Performs complete reset of the terminal as if the RESET TERMINAL key had been pressed. Must be followed by a 200 ms delay before sending additional characters.

Modem Disconnect (ESC f). The computer causes the terminal to "hang-up" the modem. The terminal responds to the escape code by lowering the CD (Data Terminal Ready) line to the modem for one second.

I/O Device Control (ESC & p). Precedes a parameter sequence used to control functions, transfer data, and obtain status of the I/O devices (display, cartridge tape units, and optional printer). (See "How To Code I/O Device Control", page 56.)

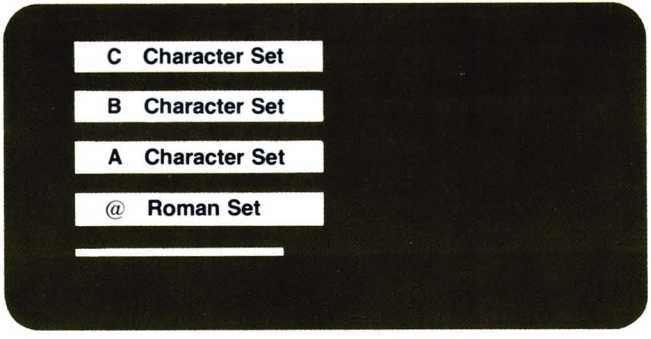
Fast Binary Read (ESC e). Permits entering binary data directly into a computer system without the normal handshake process. (See "How To Code I/O Device Control — Fast Binary Read," page 64.)

Using Alternate Character Sets

The 2644 has the capability to display up to four different 128-character sets. Because the 2644 uses Transparent Control Characters (control characters that are stored in the terminal's memory but do not take up locations on the display) switching from one character set to another or from one Display Enhancement feature to another can be done on a character-by-character basis. For example, a character from the alternate Math Symbol Set that has been made Underlined and Blinking can be displayed next to the start of a field of Half-Bright, Inverse Video characters from the Roman set.

To use optional character sets, the Alternate Character Set must first be defined. (With the terminal in its initial state, the A character set is defined to be the Alternate.) This is done by issuing an ESC) followed by an @, A, B, or C to specify which is to be the alternate set. To find which character set corresponds to @, A, B, or C, generate the test pattern (by pressing the TAPE TEST button). This displays the ordering of the additional character sets in each 2644.

TEST PATTERN

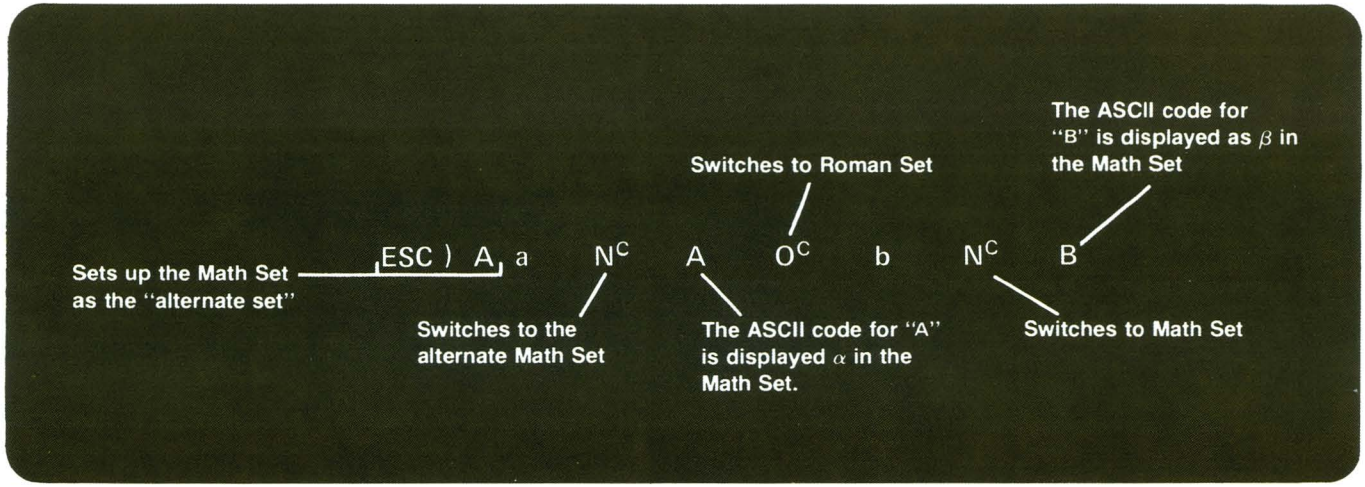


Once the Alternate Character Set is defined, switching from the Roman set to the Alternate set requires SO (N^C).

Example:

From the TEST pattern the Math Symbol Set is found to be the A Alternate Character Set.

To display aαbβ would require the following sequence:

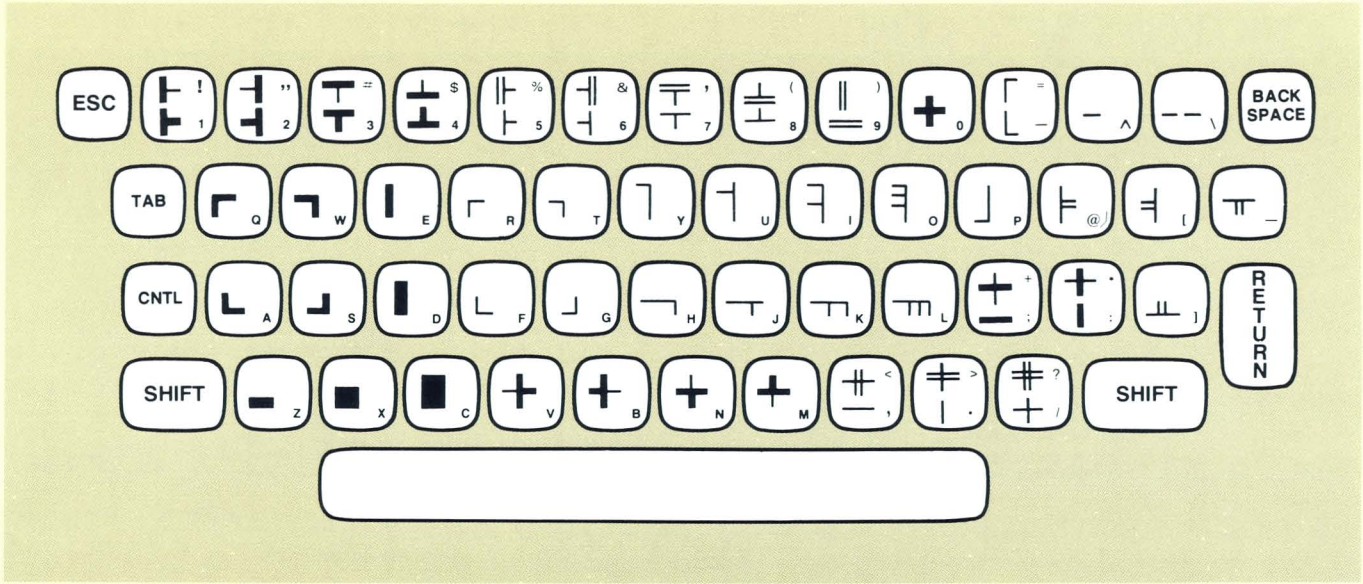


To change to a different Alternate Character Set another ESC) command can be issued. An SO (N^c) must be re-issued for each new line on which the Alternate Character Set is to be displayed.

The elements of the optional Math Symbol Set as associated with the keyboard as pictured below.

Note that only the Roman character set is actually printed on the keyboard.

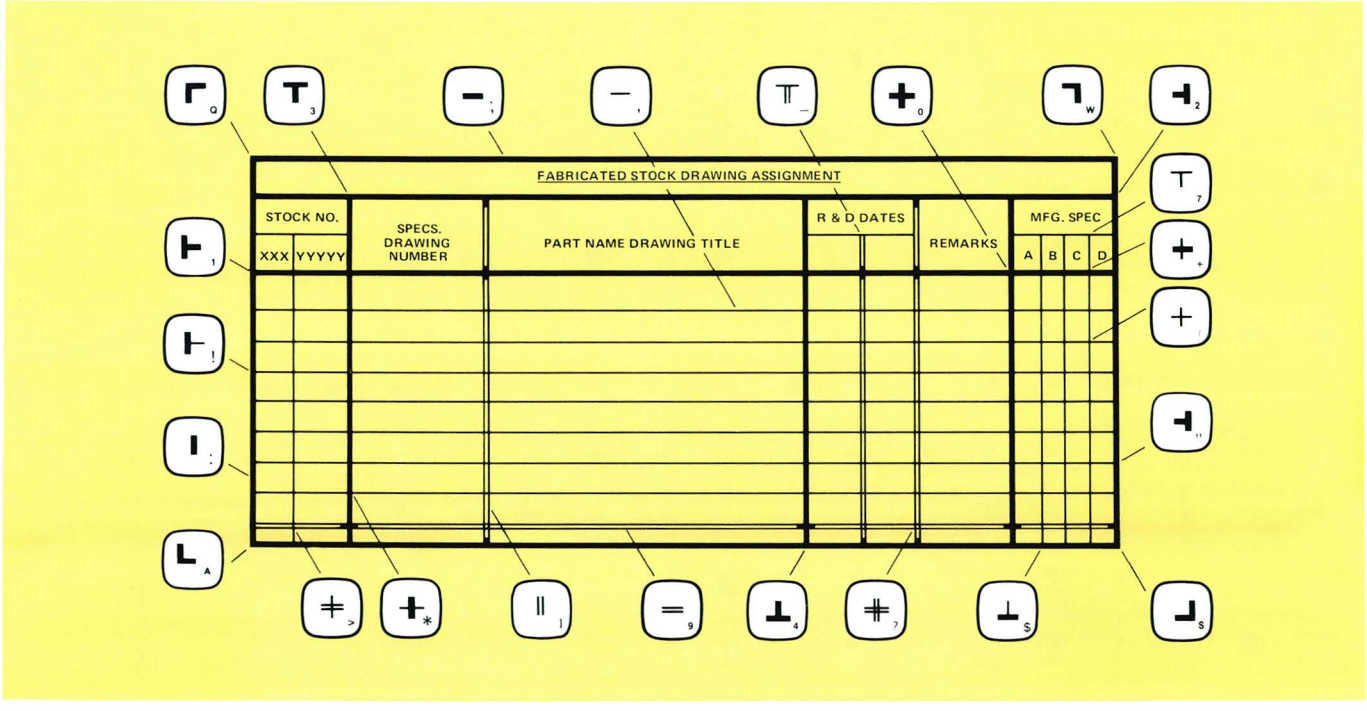
The elements of the optional Line Drawing Set are associated with the keyboard as pictured below:



Note that only the Roman character set is actually printed on the keyboard.

The Line Drawing Set gives the 2644 a limited graphics capability. Simple line drawings and fairly complex forms for data entry applications can be generated:

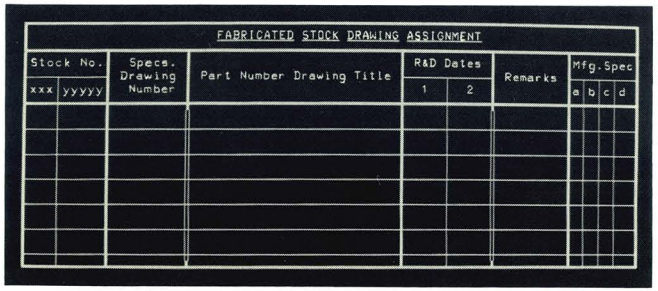
Example:



Off-Line Applications

Here are examples of three typical off-line applikations for which the 2644 Mini DataStation is ideally suited.

Forms Data Entry. Suppose that you had data which needed to be frequently formatted and entered into a computer system (such as, order processing or inventory control). You could simplify data entry by coding the necessary forms to be used, and storing them on a Mini Cartridge. The [f1] thru [f8] keys are used to display the forms. Then you enter the data into the displayed form and edit it, if necessary. The [ENTER] or [RECORD] key can be pressed to store the data on a second Mini Cartridge. All of these operations can be done totally off-line. Later, the contents of the cartridge can be batch transmitted on-line to a computer (with the proper software support).



Program Generation. Using the 2644's edit mode simplifies creating programs. By inserting a cartridge into the right tape slot (selected as the "to" device), and pressing [ ], [EDIT f4], you can generate your program line-by-line and not worry about losing previous entries as they roll off of the top of display memory — they are automatically recorded on the cartridge tape. The [INSERT LINE], [DELETE LINE], [INSERT CHAR], and [DELETE CHAR] keys aid you in editing your program on the display. Additional entries and modifications can be made after storage on the tape by inserting it into the left tape slot (selected as the "from" device) and placing another tape into the right tape slot. As the left tape is read, modifications can be made on the displayed data, and the new version automatically stored on the right tape, if additional modifications need to be made later, you simply repeat the edit mode process.

STEP 1. Insert the old version into the left tape slot and a blank tape into the right tape slot.

STEP 2. Select edit mode: [ ], [EDIT f4].

STEP 3. Press [READ] to display information from the left tape line-by-line (stopping the read process, as necessary, by briefly holding down [RETURN]).

STEP 4. Edit the information on the display, and resume the read process by pressing [READ].

STEP 5. Press [RECORD] when editing is complete, and you have a new version stored on the right tape.

STEP 6. Rewind the tape, or record a file mark and continue to add more data to the tape.

The final version of your program can be batch transmitted into the computer system (with the proper software support).

Text Entry. Letters, instruction manuals, and other types of text material can be conveniently composed and edited using the 2644. Again the [INSERT LINE], [DELETE LINE], [INSERT CHAR], [DELETE CHAR] keys are used to edit information on the display, while edit mode automatically records the information on the right tape. The text is easily updated by using the edit mode —

- reading the old version from the left tape slot,
- editing the text on the display,
- automatically recording the new version on the right tape.

Printed copy could be obtained by either the optional printer or by a line printer output from a computer system. You could select the printer as the "to" device to obtain a printed copy directly while editing.

Using Your 2644 On-Line

Introduction

This section of your Owner's Manual presents some of the details you'll want to become familiar with if you are planning to program the actual operations of the 2644 Mini Data-Station with a computer (that is, "on line" with the REMOTE key depressed).

Any function of the 2644 which has a corresponding escape code sequence (as presented in the "Programmer's Reference Table" at the back of this manual) can be executed from the computer or the keyboard. Thus either the keyboard or a computer that can transfer ASCII codes over an interface can completely control the operations of the 2644.

From the computer, escape code sequences can be programmed within PRINT or WRITE statements or within print files to be issued to the 2644. For example, the BASIC statement:

```
100 PRINT "EcHEcJEc1Ec&dBHELLO!"
```

which was coded by:

```
ESC H, ESC J, ESC 1, ESC &d B, HELLO!
```

would move the cursor to the home position, clear the display, turn on Memory Lock and type "HELLO!" on the 2644 display in Inverse Video. The same actions would happen if this group of characters within the PRINT statement were typed in from the keyboard.

NOTE

Any escape sequence initiated from the keyboard that enables a block transfer will lock up the keyboard until a DC1 is received from the computer.

Character Mode

In Character Mode operation (BLOCK MODE key not depressed), the terminal is on-line (REMOTE key depressed) and normally transmits characters to the computer as they are typed. This mode of operation is used during conversational exchange with a computer system.

Example:

Computer:	Please Type Your Company Name
2644 User Types:	HEWLETT-PACKARD
Computer:	What File Number Would You Like From The HEWLETT-PACKARD Library?
2644 User Types:	12345
and so on.	

Block Mode

In Block Mode Operation (BLOCK MODE key depressed, REMOTE key depressed), characters are not transmitted as they are typed. Instead, the user is able to input information to the 2644, then edit and correct the information before transmitting it to a computer (either in segments of groups of characters, or all at one time as one block of characters through the use of the ENTER key — see Strapping Option D, page 52). More efficient use of computer resources and the user's time at the terminal results from using the Block Mode.

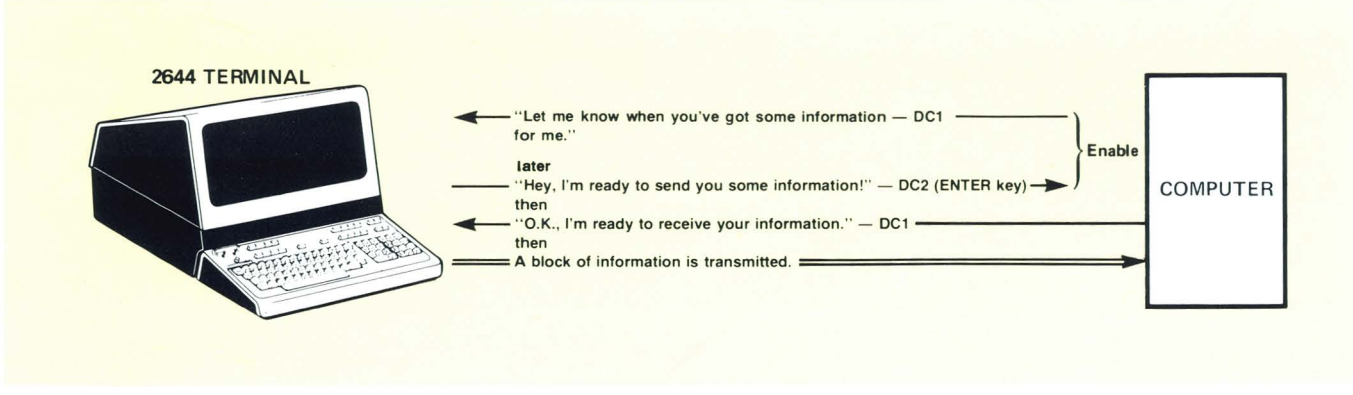
Block Transfers

There are certain functions of the 2644 Mini DataStation that always result in block transfers, regardless of whether the terminal is operating in Character mode or Block Mode. The following are always handled as block transfers:

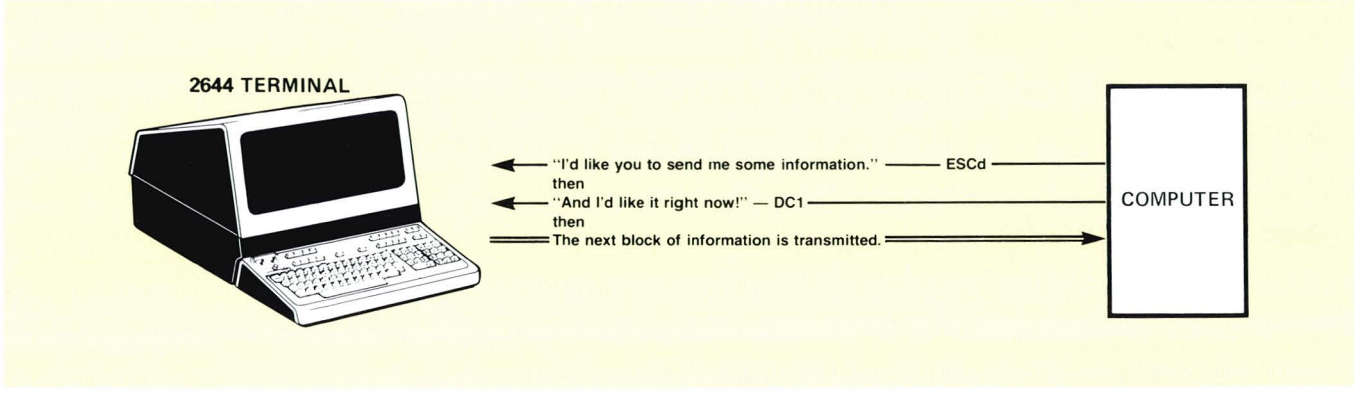
- all device input/output and control operations, including all tape transfers
- use of special function keys
- station and device status requests
- cursor sensing
- all transfers while operating in Block Mode

To have any of these types of block transfers occur, the 2644 must both be enabled (sets up the 2644 for a future transfer), and triggered (starts the actual information transfer) by the computer. Once a transfer has been enabled, it must be triggered before a block of data is actually transmitted to the computer; the keyboard is locked out until the transmission is triggered. Block transfer enabling escape sequences should not be invoked from the keyboard or the cartridge tape because it will cause the keyboard to lockup while waiting for the computer to send a DC1. Enabling and triggering can be viewed as a simple handshaking process as shown below. (See "Strapping Options", page 52, for this procedure.)

A transfer can be enabled from the terminal — pressing the ENTER key while in Block Mode enables a transfer once a DC1 control code has been received. (An initial DC1 is assumed by the 2644 when power is turned on, when Remote Mode is set, or when RESET TERMINAL is pressed.) The READ key (explained on page 31) and Special Function keys (page 69) can also enable a transfer from the terminal.



Or a transfer can be enabled directly from the computer ESC d for transfer from the display, ESC a for cursor sensing (see page 55), ESC ^ for station status (page 65), or the generalized escape code sequence (ESC & p . . ., page 56) for device input/output and control.



From these two examples, you can see that some software support for this handshaking process is necessary for block transfers — support for the DC1 control code enable and trigger, recognition of DC2, and set up of program buffers to receive incoming blocks of information. Other software support may also be needed, depending upon your specific application (cursor sensing, tape control, etc.)

NOTE

The computer should not be allowed to echo back information that is block transmitted by the terminal.

Read and Record On-Line

In Character Mode On-Line, the READ key causes the next record on the "from" device to be transmitted to the computer. (The terminal must be enabled by a DC1 before transmission begins.) Each subsequent DC1 triggers transmission of the next record from the "from" device. If the terminal is in half duplex, the data is also displayed. Line Feed (LF) characters contained within records are not transmitted. Each record is terminated by a Carriage Return (CR). If AUTO LF is on, an LF will be the first character of the next record (for teletypewriter compatibility — see strapping option E, page 53).

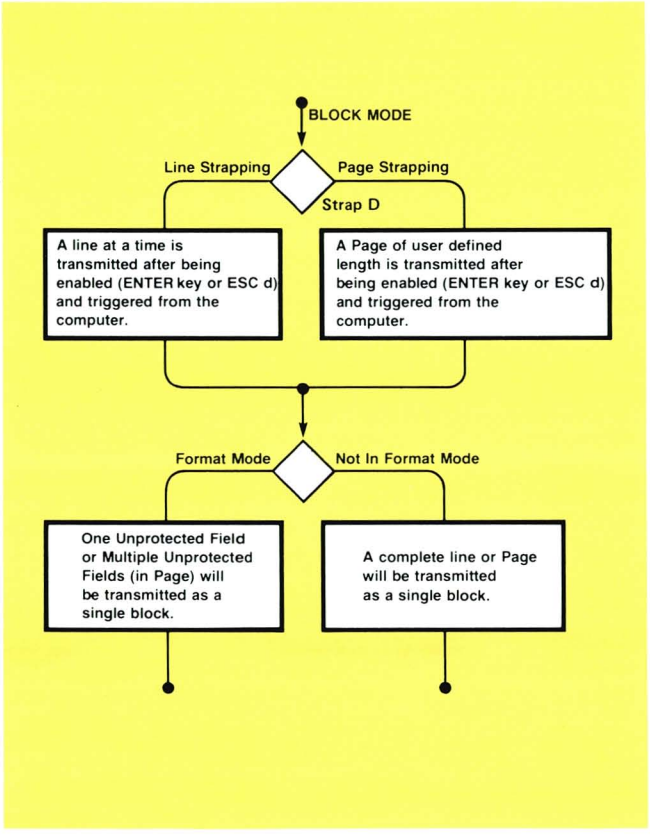
A record containing only a CR(LF), carriage return followed by line feed if AUTO LF is on, will be sent on the completion of the transfer from the terminal to the computer. Four conditions can cause the 2644 to send the CR(LF) during a READ operation:

- The last record of the file has been transmitted; READ operation complete.
- An Input/Output error has occurred; error message displayed.
- An end-of-data mark has been encountered; error message displayed.
- Memory Lock is on in overflow protect, and display memory is full; MEMORY LOCK indicator blinks.

In Block Mode, READ operates the same as it does in Off-Line operation.

On-line, the RECORD key causes all data received from the computer to be transferred to all "to" devices (except the display). Receiving a Line Feed will cause the current record to be ended. Receiving 256 consecutive characters (the maximum record size on tape) will also cause the current record to be ended. For high speed transfers of short records to tape, or printer, the ENQ/ACK sequence explained in "Operating at High Speeds", page 54, should be used.

Operating in Block Mode



The size of the block of information transferred in BLOCK MODE, and the control characters used to separate fields and to terminate blocks differ somewhat, depending on the Line/Page Strapping of the terminal and whether or not the terminal is operating in FORMAT MODE:

Strapped for Line, non-FORMAT MODE:

- data is transferred from the current cursor position to the end of the line or to a Record Separator (RS) control character, whichever occurs first.
- imbedded control characters are transmitted, including the RS if present.
- The Block is terminated by the transmission of a CR(LF), a Carriage Return and Line Feed if AUTO LF is depressed. (A local CR(LF) is executed to reposition the cursor; if no more information is present at or beyond the cursor the transmission consists of RS CR(LF)).

Strapped for Line, FORMAT MODE:

- only information in Unprotected Fields is transmitted. If the cursor is not in an Unprotected Field it will be forwarded to the next one or RS CR(LF) will be transmitted if no such field exist. Data is transmitted from the cursor position to the end of the Field or an RS, whichever occurs first. Thus the Unprotected Field to be transferred could be longer than one line in length.
- imbedded control characters are not transmitted, except for the RS if present.
- the Block is terminated by the transmission of a CR(LF) and the cursor is forwarded one character position.

Strapped for Page, non-FORMAT MODE:

- data is transferred from the current cursor position to the end of the terminal's allocated memory or to the next RS, whichever occurs first. Thus the Block to be transferred could be several full displays of information.
- imbedded control characters are transmitted, including the RS if present.
- if multiple lines are in the Block, they are separated by CR LF in the transfer. The Block is terminated by the transmission of an RS.

Strapped for Page, FORMAT MODE:

- only information in Unprotected Fields is transmitted. If the cursor is not in an Unprotected Field it will be forwarded to the next one or RS will be transmitted if no such fields exist. Data found in Unprotected Fields is transmitted from the cursor until an RS or the end of memory is encountered.
- imbedded control characters are not transmitted, except for the RS if present.
- a Unit Separator (US) control character is transmitted between each Unprotected Field. The Block is terminated by the transmission of an RS.

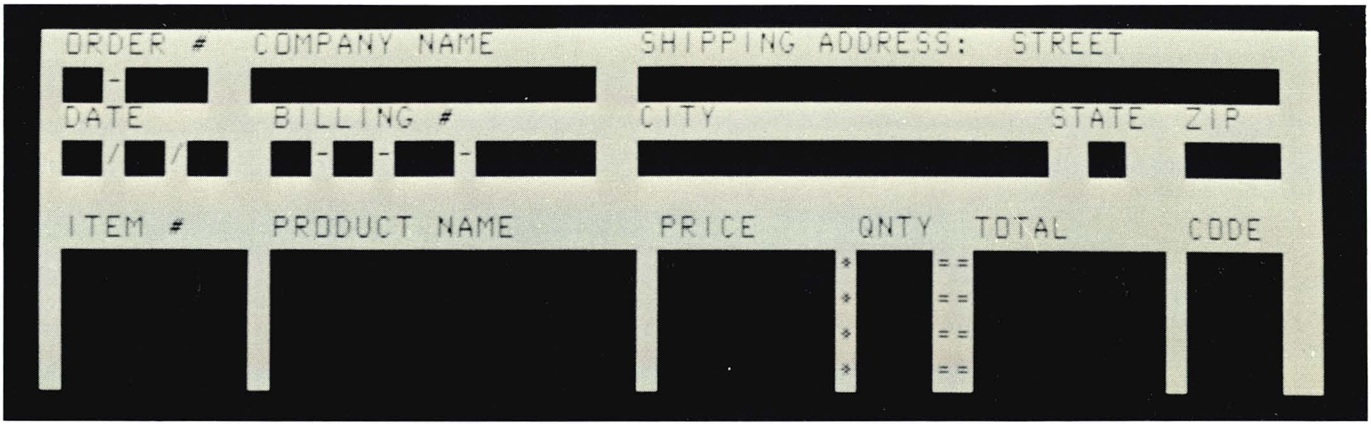
Example (Format Mode, Page Strapping)

In this example, the user has an application in which order data is to be entered in the same format as a standard company form.

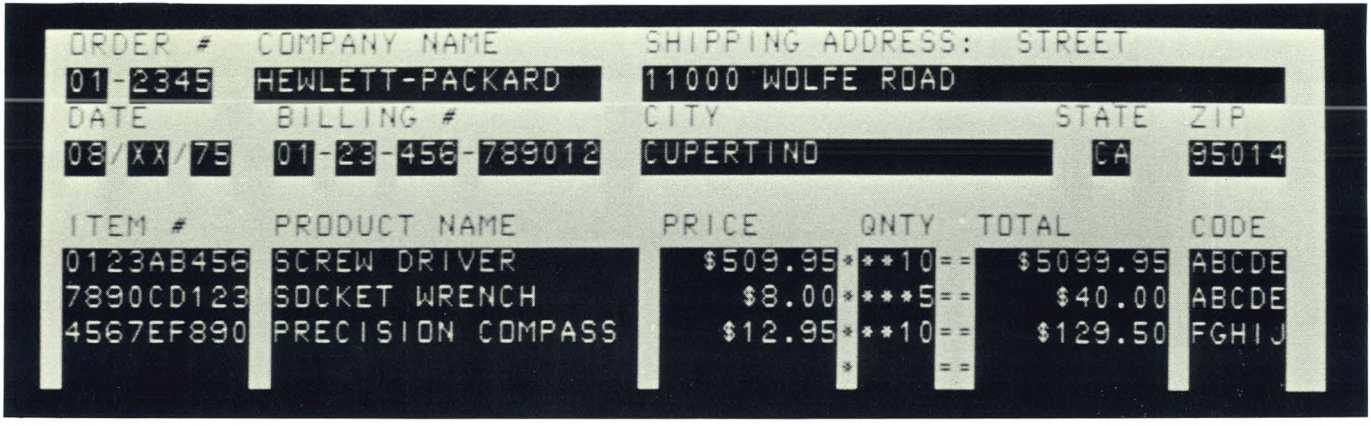
STEP 1. The user presses the Special Function key, which he has previously programmed in a remote computer routine to both automatically display on the 2644 the form pictured below and turn on FORMAT MODE. (REMOTE and BLOCK MODE are depressed.)

STEP 2. All areas of the display have been programmed to be protected except for the dark fields within the form itself. Thus, as data is typed at the keyboard only these dark areas can be written into. The cursor automatically will tab from one field to the next when a field boundary is encountered or by use of the TAB key. The user now inputs data from the keyboard:

```
                  T                T
012345HEWLETT-PACKARD A 11000 WOLFE RD A 081175 etc.
                  B                B
```



The complete form would look as follows:



STEP 3. After filling out the form and correcting any noticed errors, the ENTER key is pressed once. The following sequence of events would then occur:

- Having received a DC1 from the computer, the terminal transmits a DC2.
- Computer software recognizes the DC2 and responds with a second DC1.
- The terminal receives the DC1 and transmits all data as one Block, fields separated by US's and the Block terminated by an RS:

  $01^{US}2345^{US}$HEWLETT-PACKARD $^{US}11000$
  WOLFE ROAD ^{US}
  $08^{US}xx^{US}75^{US}$ . . . . . $^{US}\$129.50^{US}$FGHIJ^{RS}

STEP 4. The form full of data has been transmitted to the computer. The user could then Home the cursor, hit CLEAR DSPLY, to clear only the data from the form in FORMAT MODE, and enter a second set of data inputs — repeating the sequence and reusing the form.

Strapping Options

The standard 2644 can be optionally strapped to alter a number of the station's functions:

STRAP	STRAPPING OPTION	NORMAL OPERATION (STRAP IN)	OPERATION WITH STRAPPING OPTION (STRAP OUT)
A	Function Key Transmission	The escape code sequence generated by the major function keys (such as, ROLL UP, ROLL DOWN, etc.) are executed locally, but not transmitted to the computer.	The escape code sequences generated by all keys are transmitted to the computer. If operating in half duplex, the function is also executed locally.
B	Space Overwrite (SPOW) Latch Enable	Spaces typed will overwrite existing characters.	When the SPOW latch is off, overwriting occurs as normal. When the SPOW latch is on, spaces cause the cursor to forward but not overwrite any existing characters. The SPOW latch is turned on by a Carriage Return, and off by a Line Feed, Home or Tab.
C	Cursor End-of-Line Wrap Around	At the end of each line, a local Carriage Return and Line Feed are generated; the cursor moves to the beginning of the next line.	A Carriage Return and Line Feed are not generated at the end of each line. The cursor remains in and overwrites column 80.
D	Block Mode, Page	The 2644 is set to transfer a line at a time in Block Mode.	Entire pages of information are transferred in Block Mode. (See page 48.)
E	Paper Tape Mode	When the [READ] key is pressed with the [AUTO LF] key latched down, each tape record is terminated by a CR. The LF will be sent followed by the next tape record after a DC1 is received from the computer.	Each tape record is terminated by CR(LF).

STRAP	STRAPPING OPTION	NORMAL OPERATION (STRAP IN)	OPERATION WITH STRAPPING OPTION (STRAP OUT)
F	Fast Binary Read	The 2644 transmission rate is determined by the BAUD RATE switch on the keyboard.	When an ESC e (Fast Binary Read) is issued by the computer, the baud rate is switched automatically to 9600 baud.
G	Block Transfer Handshake	In Block Mode, all data transfers to the computer are sent upon receipt of a DC1 from the computer.	All Block Mode transfers (i.e., cursor sense, terminal and device status, device I/O responses, display memory, and function keys) are preceded by a DC2. The 2644 sends the DC2 upon receipt of a DC1 from the computer. After the CPU receives the DC2 from the 2644, another DC1 is required to trigger transmission of data from the 2644.
H	Inhibit DC2	During Block Mode Handshake transfers, the 2644 sends a DC2 in response to a DC1 prior to sending data. (See Block Transfer Handshake strapping above.)	A DC1 from the computer is not required to trigger data transfers to the computer. Also, the DC2 from the 2644 is not sent during Block Mode Transfer handshakes. (See Block Transfer Handshake strapping above.) Removal of both straps G and H eliminate the terminal's use of the Handshake protocol entirely. Additionally, when the ENTER key is pressed in Block Mode, the cursor will be placed in the first column before transmission occurs if operating in Line/Field Mode (strap D in) or Home'd if operating in Page Mode (strap D out).

Procedures to locate and change these straps are outlined in the HP 2644A Installation and Service Manual — 02644-90002.

Operating At High Speeds

If the number of characters transmitted to the terminal in one sequence exceeds 80, the required terminal processing time may cause some characters to be not recognized (this usually does not occur at rates of 1200 baud or less). There are two ways of assuring that this potential problem will not arise:

- It is possible to use a call-and-answer procedure between the 2644 and the computer: if the computer transmits an ENQ (E^c) after transmitting 80 characters, the 2644 will transmit an ACK to the computer after it has processed the 80 characters. The computer can then respond by issuing its next data transfer. This is the preferable technique.
- Alternatively, delays can be inserted in the user software or system software after each 80 character transfer from the computer to the terminal. Transmitting null characters ($@^c$) is one way of accomplishing this. Each null character has the effect of approximately an 8 ms (millisecond) delay at 1200 baud, and 4 ms at 2400 baud. As an aid for calculating needed time delays, a list of processing times for various terminal functions is provided in the table below. (Note that the listed times are typical times only. These times can vary greatly depending on such factors as the number of characters in the 2644's memory or on the display, and the current operating mode.)

The symptom of this problem is the appearance of the '_' or '▤' character.

TERMINAL FUNCTION	TYPICAL REQUIRED TIME
Cursor up/down	25 ms
Cursor left	8 ms
Home	200 ms (Format Mode only)
Erase-to-end-of-line	8 ms (Format Mode only)
Delete character	32 ms
Format on	200 ms
Line feed	38 ms
Insert character	44 ms
Horizontal tab	33 ms (Format Mode only)
Reset Terminal	200 ms (minimum)

Cursor Addressing

The 2644 cursor can be repositioned to any displayable location by the issuing of a relative or absolute address sequence from the computer.

The following are examples of the escape sequences that can be issued from the computer to reposition the 2644 cursor:

Absolute Addressing

ESC & a 23 r 60C	Move cursor to Row 23, Column 60.
ESC & a 30C	Move cursor to current row, column 30.

Cursor Relative Addressing

ESC & a +7c −11R	Move cursor from its current position 11 rows up, 7 columns right.
ESC & a −8R	Move cursor from its current position, 8 rows up.

Screen Relative Addressing

ESC & a 35c 15Y	Move cursor to relative screen Row 15 (relative to the present position of the display), Column 35. For example, if the first row of the first row of the display was Row 30, the cursor would move to Row 45.

Combinations of Absolute and Relative Addressing

ESC & a +8r 60C	Move cursor from its current row down 8 rows and to column 60.
EXC & a 4y −15C	Move cursor from its current position 15 columns left, and to relative screen row 4.

Note that the separating r, c, or y is lower case, and the terminating R, C, or Y is upper-case. Column addresses can range from 0 to 79, and row addresses can range from 0 to the maximum line capacity of the terminal's memory for absolute addressing, or from 0 to 23 for screen relative addressing.

Whenever addresses exceed these ranges, the maximum possible address will be used. Also, if the row address specified in the "ESC & a" sequence is located in off-screen storage, the display will roll up or down to bring the addressed position onto the display. The cursor is always displayed on the screen.

Cursor Sensing

The current position (absolute or relative) of the 2644 cursor can be determined from the computer.

Upon receipt of an "ESC a" or "ESC` " followed by a DC1 control code from the computer, the terminal transmits a standard sequence of characters containing the address of the current cursor position.

Absolute Sensing

An example of this sequence with the cursor at column 20, row 9 is:

ESC a	Computer to Terminal
DC1	
ESC & a 020c009R followed by a Carriage Return and Line Feed if AUTO LF is depressed — CR(LF); or an RS if the 2644 is operating in BLOCK MODE, strapped for page.	Terminal to Computer

Screen Relative Sensing

An example of this sequence with screen row 0 at absolute row 35, and the cursor at column 40, row 45 is:

ESC `	Computer to Terminal
DC1	
ESC & a 040c 010Y followed by CR(LF), or an RS.	Terminal to Computer

How to Code I/O Device Control

The 2644 I/O devices (display, cartridge tape units, and printer) can be program-controlled from a computer through use of the generalized escape sequences.

The following are examples of the escape sequence used to control a device and/or transfer information.

ESC & p 2s 3d M	Transfer all information stored on the right cartridge tape unit to the display.
ESC & p 1u C	Rewind the left cartridge tape unit.
ESC & p 1^	Fetch the status of the left cartridge tape unit.
ESC & p 2d 25W	Write the next 25 bytes sent from the computer on the right cartridge tape unit.

Using the Generalized Escape Sequence. The generalized escape sequence for I/O device control is as shown in the illustration at the right. Items in angle brackets (< >) are replaced by an appropriate numerical value. Items in square brackets [ ] are optional.

The I/O control escape sequence is initiated by the characters ESC & p and terminated by an upper case character (B, C, D, F, M, P, R, S, U, W, or ^).

The characters b, c, f, m, r, w, and ~ (lower case ^) indicate a command is to be performed. All other letters define parameters for the commands. For a given escape sequence, only one command character may be specified. Also, a device operation (other than a status request) should

not be initiated before the previous device operation has been completed. For example, after initiating a read command, the data record must be read by the CPU before another device operation is initiated. Otherwise, the read operation may not be executed properly.

Generally, the terminator used for responses from using the I/O control escape sequence is CR(LF), that is, a carriage return followed by an optional line feed if the AUTO LF key is depressed. The ASCII character RS (Record Separator — octal 36) is used for the terminator when the terminal is in BLOCK MODE strapped for page. Whenever the terminator is specified, the characters CR(LF)/RS will be used to denote the above conditions.

During the execution of a command, input from the data communications interface is ignored and the keyboard is locked out except for the RETURN key during device-to-device transfer operations. Pressing the RETURN key will terminate the operation in progress, set a flag to indicate user interrupt to the CPU, and unlock the keyboard.

Any errors in the escape sequence will cause the entire sequence to be ignored by the terminal. This may cause the CPU to hang if a response is expected from the escape sequence. A programmed time-out can be used to counteract this problem.

ESC & p [<"from" device code>s]
[<"to" device code>d]
[<control parameter>p] [<device code>u]
<control code>c
[<device code>]^
[<read control byte>]r
[<byte count>]w
b
f
m

where:

device codes (s,d,u) are:

1 = left cartridge tape unit
2 = right cartridge tape unit
3 = display
4 = printer

control code (c) is:

Control Code (c)	Default Device	Function
0	"from"	Rewind
1	"from"	Space "p" records
2	"from"	Space "p" files
3	"from"	Locate end-of-data mark
4	"from"	Condition tape
5	"to"	Record file mark
6	"to"	Record end-of-data mark
7	"to"	Test cartridge tape unit
8	"to"	Skip "p" records immediately without recording end-of-data mark

control parameter (p) is:

a positive (+n), negative (−n), or unsigned integer, specifying the number of records or files for (c) control codes 1 and 2.

read control byte (r) is:

0 = transmit next record
1 = retransmit last record only
2 = send byte count before sending next record
3 = send byte count before sending next record read

Indicating Successful Completion of a Program-Controlled Function. Completion of a device control or transfer of information should be tested by your program as follows:

- Issue a DC1 to the terminal (after issuing the controlling escape sequence).
- After the terminal has successfully completed the function, it responds to the computer program with an S character followed by a CR(LF)/RS. If the function was a data read operation, (ESC & p R) successful completion is the data.
- If the operation failed, or an error occurred in the process, the terminal responds with an F character followed by CR(LF)/RS. If the functions was a data read operation, an I/O failure or end-of-file is indicated by a response of RS, CR(LF).
- If a device-to-device operation was interrupted by you (by pressing RETURN), the terminal responds with a U character followed by CR(LF)/RS.

Selecting Input/Output Devices. The devices to be controlled are selected by the following escape sequence format:

ESC & p [<p "from" device code>s]
[<"to" device code>d]

where device codes are:

1 = left cartridge tape unit
2 = right cartridge tape unit
3 = display
4 = printer

Example:

ESC & p 2s 1d 4D

(Specifies the right cartridge tape unit as the source of the information, and the left cartridge tape unit and printer as destinations for the information).

Only one "from" device may be specified for a given escape sequence. Multiple "to" devices may be specified.

The "preset" assignments are left tape unit for "from" device and right tape unit for "to" device.

Device Control Functions. The device functions are controlled by escape sequences in the following format:

ESC & p [<"from" device code>u]
[<"to" device code>d]
[<control parameter>p] [<device code>u]
<control code>c

Example:

ESC & p 2u 0C	**Rewind** the right cartridge tape unit.
ESC & p 2u −1p 1C	Back**space** one **record** on the right cartridge tape unit.
ESC & p 1u +3p 2C	Forward **space** three **files** on the left cartridge tape unit.
ESC & p 1u 6p 2C	Find the sixth file on the left cartridge tape unit.
ESC & p 2u 3C	**Locate end-of-data mark** on the right cartridge tape unit.
ESC & p 1u 4C	**Condition** the **tape** on the left cartridge tape unit.
ESC & p 2u 5C	**Record a file mark** on the right cartridge tape unit.
ESC & p 2u 6C	**Record end-of-data mark** on the right cartridge tape unit.
ESC & p 1u 7C	Perform a cartridge **tape test** on the left cartridge tape unit.
ESC & p −5p 8C	Back**space** five **files immediately without recording end-of-data mark** on the "to" device.

If the (p) parameter is omitted (control code 1,2, or 8) or zero is specified, a default value of +1 is assumed.

For the skip record functions (1 or 8), all movements are relative. Backspacing is indicated with a minus (−) sign preceding the p parameter number, while forward spacing is indicated by a plus (+) sign or no sign preceding the number. If a file mark is the last record encountered while backspacing, the tape is spaced forward so that the tape is positioned immediately after the file mark (i.e., just before the first record of the file). Also, the end-of-file mark status bit is set (bit 4 of cartridge tape unit status byte 0). In order to backspace past a file mark, you must specify at least 2 records.

For the locate file function (2), the (p) parameter may be either an absolute file number, or a relative file count indicated by a plus (+) or minus (−) sign preceding the number. The tape is positioned before the first record of the specified file (i.e., after the file mark of the previous file). Files are numbered from 1 to 255.

Skip/locate functions (1,2,3, or 8) are limited to the bounds of load point and end-of-data (or end of tape). Any attempt to exceed these bounds will cause the command to be aborted, and the appropriate bits in the device status will be sent. To append a new file on a cartridge, first find the end-of-data mark (3), then record a file mark (5) to terminate the last file before starting a new file. If a file mark is not written, the new data will be appended to the end of the last file.

Unless the "skip p records immediately" function (8) is used, an end-of-data mark will be written before a skip, locate, rewind, or condition tape operation (0-4) is performed, if the last function performed on the cartridge was a record operation. "Skip p records immediately" inhibits the writing of the end-of-data mark and is intended primarily for write verification in a write-backspace-read operation sequence. After using the "skip p records immediately" function, a file mark must be written on the tape before rewinding the tape. This function should not be used to skip forward on a cartridge on which a record function was the last operation.

All other functions are applicable for cartridge tapes. The display ignores all control functions. Any control functions applied to the display will be flagged as executing successfully.

All functions, except the skip lines functions (1), cause one ASCII Form Feed character (octal 14) to be sent to the printer. The Form Feed character will cause some printers to skip to the top of the next page. The skip lines function will cause the printer to skip p lines using the absolute value of p.

While the control function is executing, the keyboard is locked out,and input from the computer is not read by the terminal. Upon successful completion of the control function, the terminal will respond with an S followed by CR(LF)/RS to the computer if a DC1 has been received from the computer.

A DC1 sent to the terminal during execution of the control function will not be lost. If the control function was aborted because of an error, the response is an F followed by CR(LF)/RS.

Transferring Data From Device to Computer. Data may be transferred from the cartridge tape units or display to the computer by the following escape sequence.

ESC & p [<"from" device code>s]
[read control byte]r

Examples:

ESC & p 2s 2R	Right tape unit is selected as the new "from" device; send byte count before sending next record
ESC & p 0R	Send next record from the "from" device

The read control byte has the following meanings:

0 = Transmit next record with no byte count
1 = Retransmit last record only
2 = Send byte count before sending next record
3 = Send byte count before sending last record read

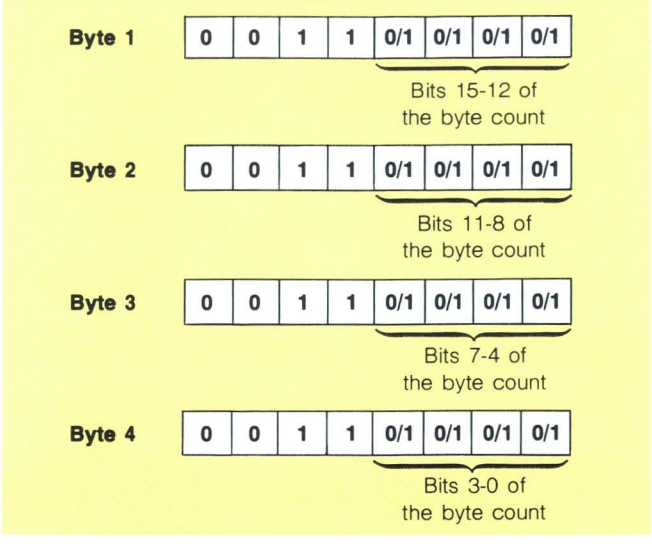
For reads without byte count (0R,1R), a DC1 from your program (following the escape sequence) causes one record to be read and transmitted to the computer. A CR(LF)/RS terminator is appended to the end of the record. Any Line Feed characters in a record will not be transmitted if the AUTO LF key is not latched down. When a file mark is read, the terminal send an RS (Record Separator) followed by CR(LF). If the terminal is in BLOCK MODE strapped for page, only RS is sent. The escape sequence must be repeated to read each record from a device.

If a byte count is specified in the escape sequence (2R or 3R), the information is sent in two steps:

STEP 1. When your program issues a DC1 (following the escape sequence), the byte count (the number of bytes in the record to be sent) will be transmitted to the computer.

STEP 2. When your program sends the next DC1 to the terminal, the record will be sent to the computer. All characters within the record will be sent (including LFs). No record terminator will be appended to the record. (After the record has been sent, the Request to Send (CA) line from the terminal will be dropped for about 5 milliseconds. This may be used as an interrupt condition for the computer.)

The byte count is sent in binary as four bytes followed by a CR(LF), or an RS if the terminal is in BLOCK MODE, strapped for page.



If retransmit is specified (1R or 3R), the previous record read is transmitted. Only the previous record can be retransmitted. Intervening read or write operations are not allowed.

To transfer binary data, the read control byte in the escape sequence must specify a byte count (2R or 3R), and the PARITY switch on the terminal must be set to NONE. If a non-recoverable error occurs, the terminal will send an RS as if a file mark were detected. The type of error can be determined by inspecting the device status.

Transferring Data From Computer to Device. A record of data may be transferred from the computer to the cartridge tape units, display, and optional printer by the following sequence:

ESC & p [<"to" device control>d]
[<byte count>]w

Example:

ESC & p 15W Send the next 15 data bytes from the computer to all "to" devices

The byte count must consist of ASCII numerals. The maximum value is 256. If no byte count is specified, data is accepted by the terminal until a Line Feed character is received or a maximum of 256 characters are received. If a byte count is specified, an ENQuiry character (octal 5) must be sent after the escape sequence, but before the data bytes. When the terminal responds with an ACKnowledge character (octal 6), then the data bytes may be sent.

During the transmission of the data byte, nulls and rubouts will not be stripped out of the data byte stream, and the terminal will not respond to an ENQuiry character from the computer with an ACKnowledge character.

To use all eight bits of each byte for binary data, no parity (NONE) should be selected for both terminal and the computer.

The keyboard will be locked out until the record has been transferred to all destination devices. Upon successful completion of the operation, the terminal will respond with an S followed by CR(LF)/RS after receiving a DC1. Any non-recoverable write errors terminate the escape sequence immediately, and the terminal will respond with an F followed by CR(LF)/RS instead.

Copying a Record. A record may be copied from one terminal device to another. The escape sequence format is as follows:

ESC & p [<p "from" device codes>s]
[<"to" device code>d]
b

Example:

ESC & p B — Copy one record from the "from" device to as all "to" devices.

Any file or end-of-data marks on the "from" device are copied to the "to" devices and count as one record each. (No file marks are transferred where the display is the from device.)

An error condition results if an attempt is made to copy a record beyond the available data space of a "to" device (for example, end of tape). Also an error condition results if the "from" device is located at end-of-data.

Upon successful completion of the transfer, the terminal sends an S followed by CR(LF)/RS after receiving a DC1. If an error occurred during the transfer, an F followed by CR(LF)/RS is sent instead.

Copying A File. A file may be copied from one terminal device to another. The escape sequence format is as follows:

ESC & p [<"from" device code>s]
[<"to" device code>d]
f

Example:

ESC & 2s 4d F — Copy one file from the right cartridge tape unit to the printer. The right cartridge tape unit is selected as the new "from" device; and the new "to" device.

The file copy operation starts from the current position on the from device and copies one record at a time until a file or end-of-data mark is detected. Upon completion, the mark is sent to all to devices. If the data space is exceeded on a to device (for example, end of tape), the transfer is terminated and an error condition results.

Upon successful completion of the transfer, the terminal sends an S followed by CR(LF)/RS after receiving a DC1. If an error occurred during the transfer, an F followed by CR(LF)/RS is sent instead.

The terminal operator may interrupt this operation by pressing the RETURN key. In this case, the termination response is U followed by CR(LF)/RS.

Copying to End of Medium. All files on a from device may be copied to one or more to devices by using the following escape sequence format:

ESC & p [<"from" device code>s]
[<"to" device code>d]
m

Example:

ESC & p 1s 4d M Copy all data from the left tape unit to the printer.

The end of medium copy operation starts from the current position on the "from" device to the end of medium (end-of-data mark on the cartridge tape unit, or end of display memory). If the data space is exceeded on the "to" device, the copy operation is terminated and an error condition results.

Upon successful completion of the transfer, the terminal sends an S followed by CR(LF)/RS after receiving a DC1. If an error occurred during the transfer, an F followed by CR(LF)/RS is sent instead. The terminal operator may interrupt this operation by pressing the RETURN key. In this case, the termination response is U followed by CR(LF)/RS.

Fast Binary Read (Program Loading). Binary data can be read directly into the computer without the normal handshake process by using:

ESC e

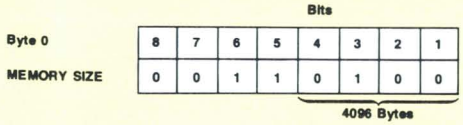
The principal use of this escape sequence is for loading of binary data. When the sequence is issued to the terminal, parity is turned off, and transmission begins immediately without waiting for a DC1 from the computer. Transmission continues until a file mark is read.

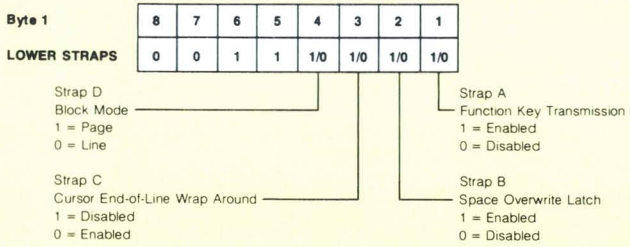
Data is transmitted as read from the source device. No terminators (that is, CR, LF or RS) are appended to the end of record. The mark does not cause an RS (Record Separator) to be transmitted; it serves only to terminate transmission. Instead, the reading of a file mark or end-of-data mark causes two null bytes (all zeros) to be transmitted. If an I/O error occurs, and the binary read operation is terminated. Two "all ones" bytes will be sent if the tape is already positioned past the end-of-data mark when the fast binary read operation is invoked. If the Fast Binary Read Strapping Option is set (see page 53), the band rate of the 2644 will automatically switch to 9600 baud. This is valid only if the CPU is capable of receiving at 9600 baud and and the CPU's interface is clocked by the 2644 (see Table 1, page 84).

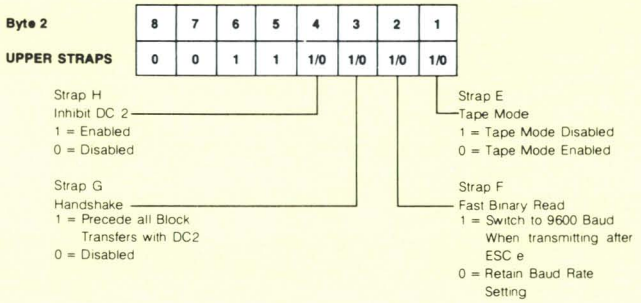
Station Status

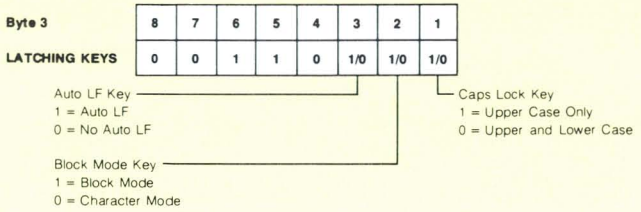
The computer can request information on the status of the overall station, or a specific device (tape units or printer).

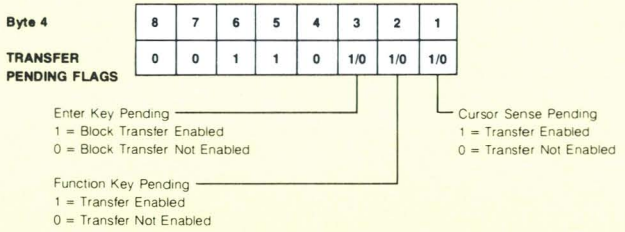
Overall Station Status. The overall station status is requested by issuing an ESC^ followed by a DC1 control character (Q^c^). The 2644 will respond by transmitting an ESC\ followed by the seven bytes of status information presented below and a CR(LF) (or an RS if operating in BLOCK MODE, strapped for page) to terminate the transfer.

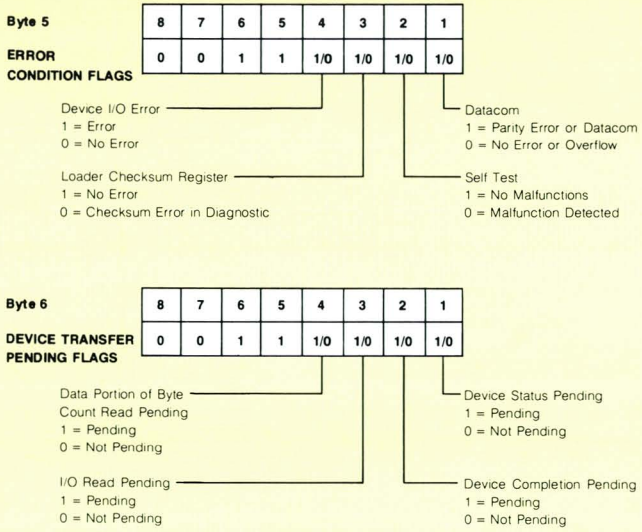












The ASCII characters in the status bytes can be translated by the table below:

ASCII CHARACTER	BINARY
0	0011 0000
1	0011 0001
2	0011 0010
3	0011 0011
4	0011 0100
5	0011 0101
6	0011 0110
7	0011 0111
8	0011 1000
9	0011 1001
:	0011 1010
;	0011 1011
<	0011 1100
=	0011 1101
>	0011 1110
?	0011 1111

Example:

In response to an ESC^ DC1 sent to the 2644, the computer has received:

ESC\407468CR(LF)

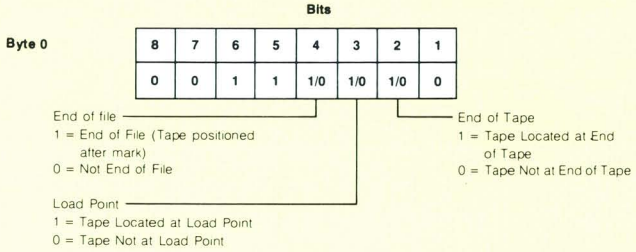
BYTE	ASCII	BINARY	STATUS
0	4	00110100	4096 Bytes of Memory
1	0	00110000	Strapped for Line; Cursor Wrap Around enabled; Function Key Transmission disabled; Space Overwrite Latch disabled.
2	0	00110000	Inhibit DC2 not enabled; Handshake disabled; Tape Mode enabled; retain Baud rate.
3	7	00110111	AUTO LF, BLOCK MODE, and CAPS LOCK are all engaged.
4	4	00110100	ENTER key has been hit, DC2 sent; a transfer has been enabled.
5	6	00110110	No errors have been recognized — last Self-Test was successful.
6	8	00111000	Data portion of a Byte Count Read is pending.
	CR(LF)		The termination is a CR(LF) because the terminal is not strapped for Page.

Device Status. The status of the left tape unit, right tape unit, or printer is requested by issuing an ESC & p <device code> , followed by a DC1. The device codes are:

1 = left tape unit
2 = right tape unit,
4 = printer.

The 2644 will respond by transmitting an ESC\p<device code> followed by the 3 bytes of device status information presented below and a CR(LF)/RS.

Cartridge Tape Unit Status Bytes



Byte 1

Bits	8	7	6	5	4	3	2	1
	0	0	1	1	1/0	1/0	1/0	0

Command Execution
1 = Last Command Performed
0 = Last Command Aborted

Write Protect
1 = Enabled
0 = Not Enabled

Read Error
1 = Error During Last Read
0 = No Error During Last Read

Byte 2

Bits	8	7	6	5	4	3	2	1
	0	0	1	1	1/0	1/0	1/0	1/0

Soft Error
1 = Soft Read Error (Recovered)
0 = No Soft Read Error

Hard Error
1 = Hard Read Error (3 read attempts failed)
0 = No Hard Read Error

Cartridge Inserted
1 = Cartridge Inserted in 2644
0 = Cartridge Not Inserted in 2644

End of Valid Data
1 = End of Valid Data
0 = Not End of Valid Data

Printer Status Bytes — (Not all printers will have *all* status bits available.)

Byte 0

Bits	8	7	6	5	4	3	2	1
	0	0	1	1	0	0	1/0	1/0

Print Error
1 = Print Error
0 = No Print Error

Paper Out
1 = No Paper in Printer
0 = Paper in Printer

Byte 1

Bits	8	7	6	5	4	3	2	1
	0	0	1	1	1/0	0	0	1/0

Command Execution
1 = Last Command Performed
0 = Last Command Aborted

Printer Availability
1 = Printer Busy
0 = Printer Ready

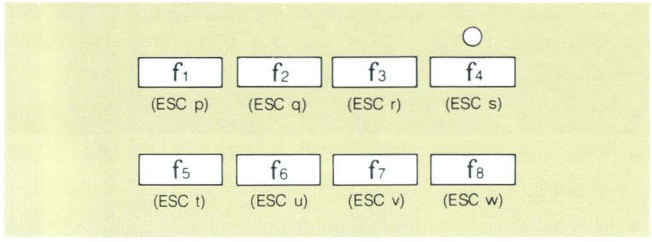
Byte 2

Bits	8	7	6	5	4	3	2	1
	0	0	1	1	1/0	1/0	1/0	1/0

Printer Baud Rate

Baud Rate	Bit 3	2	1
External	0	0	0
110	0	0	1
150	0	1	0
300	0	1	1
1200	1	0	0
2400	1	0	1
4800	1	1	0
9600	1	1	1

Printer On-Line
1 = Printer Connected to 2644
0 = Printer Not Connected to 2644



Special Function Keys

The 2644 has 8 user-definable Special Function keys. While operating in REMOTE (on-line), pressing any one of these eight keys, the user is able to call in and execute from a remote computer any routines might perform such tasks as:

- display a standard protected form for data entry.
- execute an on-line error checking routine on displayed data.
- call up and insert a commonly used subroutine into the program currently being coded.
- display a set of instructions to the operator.

and any other programmable routine that the user's application might demand. (Note that the user-defined routine is executed by a remote computer, not by the 2644 itself.)

Pressing a Special Function key in NON-BLOCK MODE, REMOTE causes ESC p-w CR(LF) to be transmitted to the computer after a DC1 has been received by the terminal (where p-w represents a single character corresponding to the particular key depressed [f1] thru [f8] ; [f2] would be ESC q CR(LF) for example).

If the terminal is operating in BLOCK MODE, REMOTE, strapped for Page, the 2644 instead generates a DC2 after receiving a DC1 to enable a transfer. (See "Operating in Block Mode", page 48.) Once triggered by a second DC1 response, the terminal transmits:

ESC p-w RS.

Self-Test

The 2644 tests itself.

In today's complex computer operating environment where any one of a large number of devices and interfaces between the computer and the terminal could malfunction, the 2644's Self-Test is an extremely important capability — by pressing a TAPE TEST key on the station's keyboard at any time, an internal diagnostic of the major areas of the 2644 is executed. This is a GO/NO-GO check on whether or not the terminal is functioning properly.

Two levels of self test are possible. One level (pressing the TAPE TEST key only) checks out the station excluding the two tape transports. The other level (pressing the key, then the TAPE TEST key) checks out the entire station including the tape transports

The following is performed when the TAPE TEST key is pressed:

- The light-emitting diodes (indicators) on the keyboard are turned on briefly as an indication that the power supply and microprocessor board are functioning.
- A checksum test is done on the read-only memory (ROM). This verifies that the firmware is working properly. An error here causes the message ROM TEST FAIL to be displayed.
- A checkerboard test is performed on the random access memory. An error here causes RAM TEST FAIL to be displayed.
- The bell is beeped indicating success up to this point.
- The entire character set contained in the 2644 is displayed.
- A line of characters, @ABCDEFGHIJKLMNO, is displayed. If the Display Enhancement option is installed, then Underline, Half-Bright, and Blinking will be displayed with Inverse Video in all of the possible Display Enhancement combinations by this line of characters.
- The seven bytes of status information are displayed. (See "Station Status", page 65.)

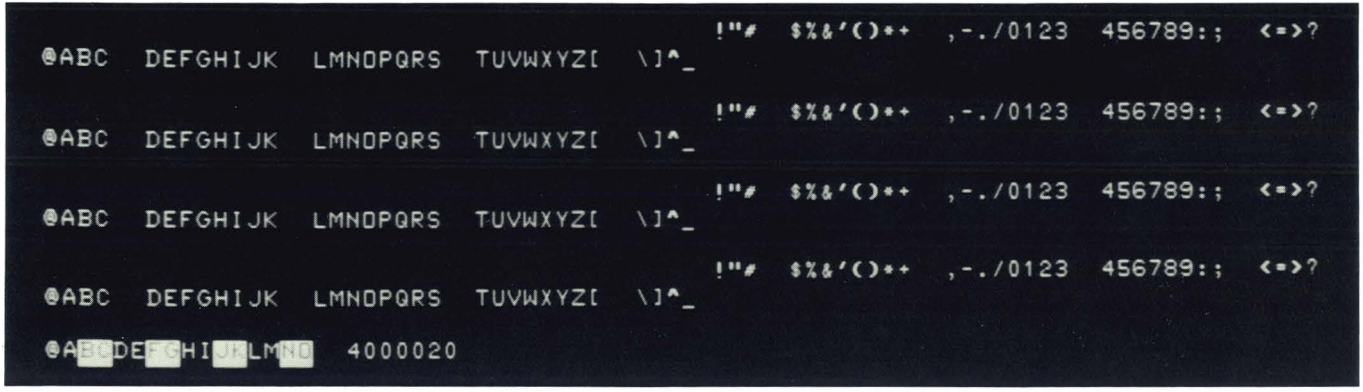
Generally, if the terminal beeps and the display shows a pattern similar to the ones below, then the 2644 is functioning properly (only those character sets actually present in the 2644 will be displayed in the test pattern and consequently the actual test pattern displayed will be dependent on which features are present in each terminal).

RESET TERMINAL must be pressed to resume operation if any error occurred. However, the station's operation will not be reliable if the Self Test failed.

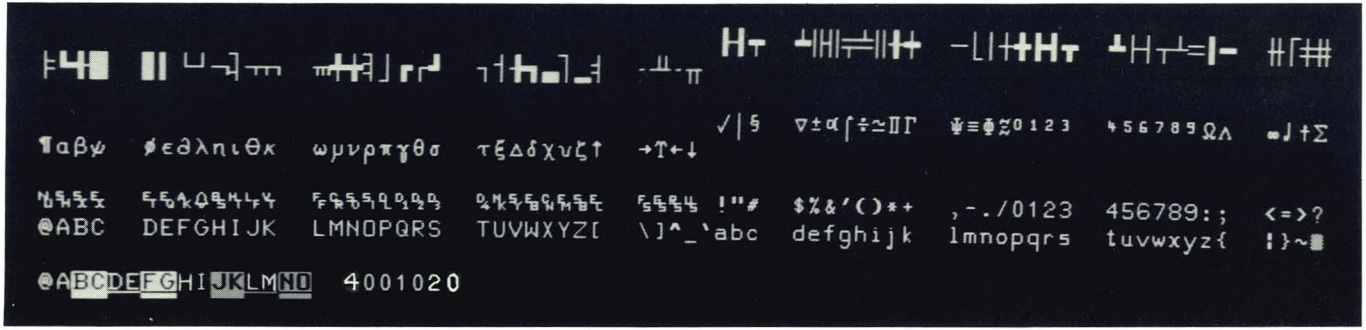
NOTE

The test pattern cannot be recorded because of imbedded Record Separators (RS).

Test Pattern for the standard 2644.



Test Pattern for the 2644 containing Display Enhancements, 128 Roman Character Set, Math Symbol Set, and Line Drawing Set



CAUTION

The following self-test is performed with two unprotected tape cartridges. Make sure that any data on these tapes need not be saved.

The following is performed when the [ ] key is pressed then the [TAPE TEST] key is pressed:

- A test is performed on the left tape unit:
  - A worst case data pattern ("%Z" repeated 128 times to form a 256 character record) is recorded on the tape cartridge.
  - The tape is backspaced over the record to the beginning of the test pattern.
  - The test pattern is read and verified.
  - A file mark is recorded.
- Two standard tests are performed as described previously.
- A test is performed on the right tape unit (same as the left tape unit).
- Another standard test is performed.

If a fault is detected during the tape transport test, the eject button will be lit on the transport being tested, the test will not proceed any further, and one of the error messages shown below will be displayed.

NO TAPE , RUNOFF , PROTECTED , READ FAIL

These messages are explained in "Display Messages", page 86.

If a hardware failure has occurred during the self-test, the reliability of the station cannot be assured. If any error occurred, press [RESET TERMINAL] to restore normal operation. Try replacing the tape cartridge and running the self-test again to make sure that the error is a hardware malfunction. Servicing procedures are contained in the 2644 Installation and Service manual.

You may verify that the tapes you record may be read by other terminals as follows:

- perform the tape transport test.
- Rewind the tapes.
- Exchange tape between the left and right transports.
- Read each tape, and check that a line of "%Z" appears on the screen. If this does not happen, a hardware malfunction may exist in one of the transports.

The tape transports may be tested from your program by coding:

```
ESC & p 1u 7C    (for the left tape transport)
ESC & p 2u 7C    (for the right tape transport)
```

After the test is performed, the 2644 will respond with an "S" CR(LF) if the test was successful or an "F" CR(LF) if the test failed. The status of the tested page unit may be interrogated to determine the reason for the failure. (See "Station Status", page 65.)

Tape Transport Head Cleaning Procedure

The read-record heads on the tape transports should be cleaned every 50 hours of cartridge tape operation or when read problems occur. The head cleaning kit provided with the 2644 contains all the necessary items. The procedure is as follows:

STEP 1. Dip one of the swabs into the bottle of head cleaning solvent to satuate the swab.

STEP 2. Hold the tape unit door open with your finger and clean the head with a back-and-forth motion of the swab (not an up-and-down motion). The head is the shiny surface at the back of the transport.

STEP 3. Take a dry swab, and wipe the head clean with a back-and-forth motion (not an up-and-down motion).

STEP 4. Clean the other tape transport head in the same manner.

Tape Conditioning Procedure

"Conditioning" a tape means to run the tape forward to the limits of the tape, reverse it, and run the tape backward to the beginning limit of the tape. This is done by inserting the tape cartridge to be conditioned in the left tape slot, and pressing and holding CNTL while pressing TAPE TEST. The SEARCHING message appears on the screen and the eject button light remains out as the tape is wound fast-forward to end-of-tape. Then the eject button light comes on and the SEARCHING message remains on the screen until the tape is rewound to load point. When the SEARCHING message disappears, conditioning is complete.

Conditioning is necessary to ensure smooth, continuous operation of the cartridge. Whenever a cartridge has been subjected to sudden environmental changes (such as being transported by air), you should condition the tape before use. Also, if the READ FAIL message occurs while reading a particular cartridge, it may be due to uneven tensioning on the tape. Conditioning restores proper tensioning, and the tape will operate smoothly. If READ FAIL messages still occur after conditioning, try cleaning the tape transport read-record head.

Specifications

GENERAL

Screen Size: 5 inches (127 mm) x 10 inches (254 mm)
Screen Capacity: 24 lines x 80 columns (1,920 characters)
Character Generation: 7 x 9 enhanced dot matrix; 9 x 15 dot character cell; non-interlaced raster scan
Character Size: .097 inches (2.46 mm) x .125 inches (3.175 mm)
Character Set: 64 upper-case Roman
Cursor: Blinking-Underline
Display Modes: White on Black; Black on White (Inverse Video)
Refresh Rate: 60 Hz (50 Hz optional)
Tube Phosphor: P4
Implosion Protection: Bonded implosion panel
Memory: MOS; ROM (control memory) — 12K bytes; RAM (user memory) — 4096 bytes
Keyboard: Full ASCII Code Keyboard, 8 special function keys, and 16 additional control and editing keys; Ten-key numeric pad; Cursor pad; Multi speed auto-repeat; N-key roll-over; detachable on a 4 foot cable.
Cartridge Tape: Two mechanisms
Read/Write speed: 10 ips
Search/rewind speed: 60 ips
Recording: 800 bpi
Mini Cartridge: HP part no. 9162-0061
110 kilobyte capacity (maximum) per cartridge

DATA COMMUNICATIONS

Data Rate: ASCII Mode: 110, 150, 300, 1200, 2400 baud, and external source — switch selectable. (110 baud selects 2 stop bits.)
Fast Binary Read: 9600 baud output from terminal
Communications Interface: EIA standard RS232C; 103-type and 202-type modem compatible
Transmission Modes: Full or half duplex, asynchronous
Operating Modes: On-line; Off-line; Character or Block Mode
Parity: Switch selectable; Even, Odd or None

POWER REQUIREMENTS

Input Voltage: 115V (+10%, −23%) at 60 Hz
230V (+10%, −23%) at Hz
Power Consumption: 85W to 125W max.

ENVIRONMENTAL CONDITIONS

Temperature (Free Space Ambient):
Non-Operating: −10 to +65°C (−15 to +150°F)
Operating: 5 to +40°C (+41 to 104°F)
Humidity: 20 to 80% (non-condensing)
Heat Dissipation: 483 BTU/hour
Altitude:
Non-Operating: Sea level to 25,000 feet (7620 meters)
Operating: Sea level to 15,000 feet (4572 meters)
Vibration and Shock (Type tested to qualify for normal shipping and handling):
Vibration: .010 inches (25 mm) pp, 10 to 55 Hz, 3 axis
Shock: 30G, 11 Ms, 1/2 sine

PHYSICAL SPECIFICATIONS

Display Monitor Weight: 44.1 pounds (20.0 kg)
Keyboard Weight: 7 pounds (3.2 kg)
Display Monitor Dimensions:
17.5" W x 18" D x 13.5" H
(445 mmW x 457 mmD x 343 mmH)
(Including Keyboard: 25.5" D (648 mmD))
Keyboard Dimensions: 17.5" W x 8.5" D x 3.5" H
(445 mmW x 216 mmD x 89 mmH)

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08/75

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2644/2640 Differences

Status Request

Seven data bytes are returned on the 2644. The seventh data byte contains Device Transfer Pending Flags which were not required on the 2640. Minor changes in the other bytes have also been made. (See "Station Status", page 65.)

Cursor Sensing

Screen Relative Sensing has been added to the 2644. (See "Cursor Sensing", page 55.) Sending ESC to the 2644 returns the following string:

ESC & a lllcnnnY where: lll is the column number.
nnn is the relative screen row.

Cursor Addressing

Cursor Addressing in the 2644 accepts an additional parameter, "y", which is the relative screen row. (See "Cursor Addressing", page 55.)

Block Mode Protocol

When the 2644 is strapped in a configuration which most closely matches the 2644 (all straps in), there is still a minor difference in the Block Mode protocol. When the [ENTER] key or one of the Special Function keys ([f1] thru [f8]) is pressed on the 2640, its code (DC2 for Enter or ESC p-w for the function keys) is transmitted to the computer without waiting for DC1. In the 2644, the code is not sent until a DC1 is received from the computer. In Character Mode, the [ENTER] key code is transmitted from the 2644 to the computer without waiting for a DC1. (See "Strapping Options", page 52.)

Print Escape Sequence

Control of all peripheral I/O devices (tape units and optional printer) in the 2644 is handled by generalized escape sequences. (See "How to Code I/O Device Control", page 56.) The print escape sequence of the 2640 (ESC 0) is not implemented in the 2644.

Speed

Due to the additional complexity of the 2644, the overall speed is slightly slower. This will not affect applications where ENQuiry and ACKnowledge is used, but it may have some impact on those user applications which make use of time delays or fill characters.

Terminal Reset

A terminal reset in the 2644 (initiated by an ESC F) exactly duplicates the function of the

key. This includes rewinding cartridge tapes and clearing the datacom buffers. This requires considerable time (many seconds if the cartridge tapes are some distance from load point) and may cause a large number of datacom characters to be dropped. It may also cause the computer to "hang" while waiting for an ACKnowledge if an ENQuiry were sent after the ESC E. A 200 milli-second delay should follow ESC E.

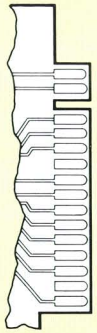
Cursor Home Down

On the 2644, pressing CNTL , ↖ (cursor home) generates an ESC F which causes the cursor to move to the first character position of the last line, and the last page of memory is displayed. (See page 20.)

Keyboard

No Line Feed key. To obtain a Line Feed, use CNTL , J (J^C). The keyboard is locked out whenever a block transfer to the computer is pending. Therefore, any block transfer enabling escape sequence issued from the keyboard to the Cartridge Tape Units will cause the keyboard to lock up until a DC1 is received from the computer.

Table 1. Interface Standards



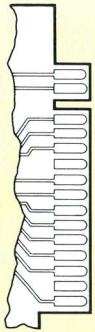
		Standard Data Communications Board	PIN NUMBERS: 13232C CABLE (RS232) CONNECTOR	PIN NUMBERS: 13232A CABLE (103/202 MODEM) CONNECTOR
A			—	—
B	BA	DATA OUT	2	2
C	BB	DATA IN	3	3
D	CA	REQUEST TO SEND	4	4
E	CB	CLEAR TO SEND	5	5
F			—	—
H	AB	GROUND	7	7
J	CE	RECEIVE CARRIER	8	8
K	EXT	CLOCK OUT (X8) } (Note 1)	16	—
L	EXT	CLOCK OUT (X16) } (Note 1)	24	—
M	SA	SECONDARY TRANSMITTED DATA } (Note 2)	11	11
N	SB	SECONDARY RECEIVED DATA } (Note 2)	12	12
P	CD	DATA TERMINAL READY	20	20
R			—	—
S	EXT	CLOCK IN (X16) (not RS232 level)	25	—

ASYNCHRONOUS DATA COMMUNICATIONS LOGIC BOARD (NOTCHED TO MATCH THE 13232A, C MODEM CABLE HOOD CONNECTORS)

NOTE:

1. External clocks always reflect the transmit baud rate. These are TTL (non-RS232C) levels.
2. 202 Modem operation requires that the Bell 202C Modem, or equivalent, should have the Secondary Channel options installed and that the remote computer implement a line turn-around protocol using reverse channel signals.
   These lines correspond to RS232C SCA (SA) and SCV (SB).
3. When using the 13250A in place of the Standard Data Communications Interface; the 13232A or C cables are used (see Table 1).
4. When using the 13250A for an RS232C printer interface, the 2644 functions as RS232 Data Communications Terminal.
5. Hood connector pins A and 1 are jumpered together.
6. All cable connections and signal names associated with the alphabetical pin designations are in **BOLD** type. All cable connections and signal names associated with numeric pin designations are in LIGHT type.

13250A



		SIGNAL NAMES FOR PINS A THRU S	SIGNAL NAMES FOR PINS 1 THRU 14	13232G AND 13232H CABLES (RS232C PRINTER) (See Notes 3 and 4) CONNECTOR	13232G AND 13232H CABLES (RS232C PRINTER) (See Notes 3 and 4) SIGNAL NAME	13232F CURRENT LOOP CABLE LUGS
A	1	**GRD GROUND**	NECL $\overline{\text{ENABLE CURRENT LOOP}}$	—	—	(Note 5)
B	2	**BA DATA OUT**		**3**	**BB DATA IN**	—
C	3	**BB DATA IN**		—	—	—
D	4	**CA REQUEST TO SEND**	CL+ CURRENT LOOP REC'R POS INPUT	**8**	**CF RECEIVE CARRIER**	Red
E	5	**CB CLEAR TO SEND**	CL− CURRENT LOOP REC'R NEG INPUT	**20**	**CD DATA TERMINAL READY**	Brown
F	6		CLA CURRENT LOOP XMIT SOURCING OUTPUT	—	—	Green
H	7	**AB GROUND**	**CURRENT LOOP XMIT RETURN**	**7**	**AB GROUND**	**Yellow**
J	8	**CE RECEIVE CARRIER**		—	—	—
K	9	**EXT CLOCK OUT (X8)** } (Note 1)		—	—	—
L	10	**EXT CLOCK OUT (X16)** } (Note 1)		11	NISB $\overline{\text{INVERT SB}}$	—
M	11	**SA SECONDARY TRANSMITTED DATA** } (Note 2)		—	—	—
N	12	**SB SECONDARY RECEIVED DATA** } (Note 2)		**14**	**SA SECONDARY TRANSMITTED DATA**	—
P	13	**CD DATA TERMINAL READY**		**6**	**CC DATA SET READY**	—
R	14			—	—	—
S	15	**EXT CLOCK IN (X16)** (not RS232 level)		—	—	—

NUMERICAL PIN NOS. REPRESENT OTHER SIDE OF BOARD (SEE NOTE 6)

GENERAL PURPOSE ASYNCHRONOUS DATA COMMUNICATIONS LOGIC BOARD (NOTCHED TO MATCH ALL 13232 CABLE HOOD CONNECTORS)

Table 2. ASCII Code Chart

BIT 7 6 5 / 4 3 2 1	CONTROL (CNTL) CHARACTERS		DISPLAYABLE CHARACTERS						ESCAPE KEY PRESSED FIRST					
	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0000	NUL (N_U)	DLE (D_L)	SP	0	@	P	\	p	SP	0	@	P DELETE CHAR	CURSOR RELATIVE SENSE \	p f_1
0001	SOH (S_H)	DC1 (D_1)	!	1	A	Q	a	q	!	1 SET TAB	A ↑ CURSOR UP	Q INSERT CHAR ON	a CURSOR ABSOLUTE SENSE	q f_2
0010	STX (S_X)	DC2 (D_2)	"	2	B	R	b	r	"	2 CLEAR TAB	B ↓ CURSOR DOWN	R INSERT CHAR OFF	b KEYBOARD ENABLE	r f_3
0011	ETX (E_X)	DC3 (D_3)	#	3	C	S	c	s	#	3	C →CURSOR RIGHT	S ROLL UP	c KEYBOARD DISABLE	s f_4
0100	EOT (E_T)	DC4 (D_4)	$	4	D	T	d	t	$	4	D ←CURSOR LEFT	T ROLL DOWN	d ENTER	t f_5
0101	ENQ (E_Q)	NAK (N_K)	%	5	E	U	e	u	%	5	E RESET TERMINAL	U NEXT PAGE	e BINARY READ	u f_6
0110	ACK (A_K)	SYN (S_Y)	&	6	F	V	f	v	& PARA-METER SEQUENCE	6	F CURSOR HOME DOWN	V PREV PAGE	f MODEM DIS-CONNECT	v f_7
0111	BEL (🔔)	ETB (E_B)	'	7	G	W	g	w	'	7	G CURSOR RETURN	W FORMAT MODE ON	g	w f_8
1000	BS (B_S)	CAN (C_N)	(	8	H	X	h	x	(	8	H ↖ CURSOR HOME UP	X FORMAT MODE OFF	h	x
1001	HT (H_T)	EM (E_M)	)	9	I	Y	i	y	) DEFINE SET	9	I HORI-ZONTAL TAB	Y DISPLAY FUNCTIONS ON	i	y
1010	LF (L_F)	SUB (S_B)	*	:	J	Z	j	z	*	:	J CLEAR DSPLY	Z DISPLAY FUNCTIONS OFF	j	z TEST
1011	VT (V_T)	ESC (E_C)	+	;	K	[	k	{	+	;	K ERASE TO END OF LINE	[START UNPROTECT FIELD	k	{
1100	FF (F_F)	FS (F_S)	,	<	L	\	l	¦	,	<	L INSERT LINE	\	l MEMORY LOCK ON	¦
1101	CR (C_R)	GS (G_S)	—	=	M	]	m	}	—	=	M DELETE LINE	] END UNPROTECT FIELD	m MEMORY LOCK OFF	}
1110	SO (S_O)	RS (R_S)	.	>	N	^	n	~	.	>	N	^ STATUS	n	~
1111	SI (S_I)	US (U_S)	/	?	O	—	o	DEL	/	?	O	—	o	DEL

Example: J is bits 1001010; Control J is LF line feed; Escape (ESC) followed by J is CLEAR DISPLAY

LEGEND

AK — ACKNOWLEDGE	EM — END OF MEDIUM	NK — NEGATIVE ACKNOWLEDGE
— BELL	EQ — ENQUIRY	RS — RECORD SEPARATOR
BS — BACKSPACE	ET — END OF TRANSMISSION	SI — SHIFT IN
CN — CANCEL LINE	EC — ESCAPE	SO — SHIFT OUT
CR — CARRIAGE RETURN	EB — END OF TRANSMISSION BLOCK	SP — SPACE
D1 — DEVICE CONTROL 1	EX — END OF TEXT	SH — START OF HEADING
D2 — DEVICE CONTROL 2	FF — FORM FEED	SX — START OF TEXT
D3 — DEVICE CONTROL 3	FS — FILE SEPARATOR	SB — SUBSTITUTE
D4 — DEVICE CONTROL 4	GS — GROUP SEPARATOR	SY — SYNCHRONOUS IDLE
DEL — DELETE	HT — HORIZONTAL TABULATION	US — UNIT SEPARATOR
DL — DATA LINK ESCAPE	LF — LINE FEED	VT — VERTICAL TABULATION

NOTES: 1. LOWER CASE LETTER, LOWER CASE SYMBOL, AND CONTROL CHARACTER CODES ARE GENERATED BY STANDARD TERMINAL, BUT ASSOCIATED CHARACTERS ARE NOT DISPLAYED ON THE SCREEN. REFER TO PAGE 71 FOR DISPLAYABLE CHARACTER SET.

2. SINGLE CHARACTER ESCAPE SEQUENCES AND CONTROL CODES NOT LISTED WITH A FUNCTION ARE NEITHER ACTED UPON NOR DISPLAYED.

Table 3. Display Messages

MESSAGE	MEANING	RECOVERY
SEARCHING	Tape unit is locating "load point", rewinding or locating a file.	Not applicable.
BAD SELECT	Two FROM devices have been selected, or the PRINTER has been selected as a FROM device.	Press RETURN, then re-select devices.
FROM=TO	The same device has been selected as a FROM device and a TO device.	Press RETURN, then re-select devices.
PROTECTED TAPE	A record operation was attempted while the RECORD ⇨ tab at the back of the cartridge is in the "protected" position.	Press RETURN. Remove tape cartridge, and move RECORD ⇨ tab in the direction of the arrow. If it is in the "record" position, a hardware malfunction has occurred.
NO TAPE	Tape cartridge is not inserted in the selected tape unit.	Press RETURN. Insert tape cartridge in the selected tape unit. If it is inserted, re-select the unit and try again. If NO TAPE still appears, a hardware malfunction has occurred.
END OF DATA	While READING you have reached the end of recorded data.	Press RETURN, then REWIND the tape.
	While RECORDING you have reached end-of-tape.	Press RETURN, REWIND the tape, and insert another tape cartridge to continue RECORDING data.
RETRY	The station is automatically re-reading a record because of misread.	If several RETRY's have occurred while reading data, consider "conditioning" the tape and cleaning the tape heads (refer to page 73), or copy the data to another tape.

MESSAGE	MEANING	RECOVERY
READ FAIL	The station has tried to read a record 3 times.	Press RETURN . Try "conditioning" the tape (page 74), then read the record again. If you get another READ FAIL , try replacing the tape cartridge and running the Self Test (page 70). If you still get a READ FAIL , try cleaning the magnetic tape heads (page 73). If READ FAIL still exists, a hardware malfunction has occurred.
PRINT FAIL	The printer did not produce the expected results. Either the printer is not connected properly, printer power is off, or printer is out of paper.	Press RETURN . Check that the printer power is on; check that it is properly connected and is loaded with paper.
RUNOFF	One of two conditions has occurred: 1. Tape has run off one of the spools in the cartridge. You can check this by opening the cartridge head door to see if the tape is present (no runoff). (See illustration on page 88.)	Remove the cartridge and use another tape cartridge (without data on it). If the data recorded on the runoff tape must be recovered, you can respool the tape by the procedure given in the 2644 Installation and Service Manual.
	2. One of the holes in the tape is present in the prism area.	Remove the cartridge, and move the drive wheel to position the hole past the prism surface (see illustration on page 88). Then, re-insert the cartridge.
ROM TEST FAIL	Hardware malfunction.	See "Self Test", page 70).
RAM TEST FAIL	Hardware malfunction.	See "Self Test", page 70).
LOADER	The binary loader for loading diagnostics is being executed.	Not applicable.

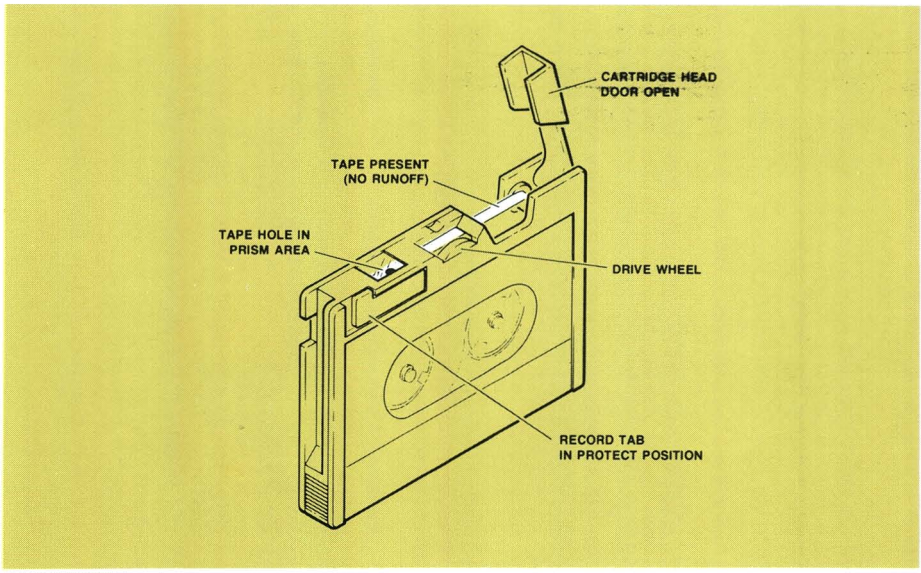


Table 4. Programmer Reference Table

KEY	REMOTE	LOCAL	PAGE REF
f1	ESC p to computer	Finds and displays file 1 from source device (local). Calls a user-defined routine (remote).	24
f2	ESC q to computer	Finds and displays file 2 from source device (Local). Calls a user-defined routine (remote).	24
f3	ESC r to computer	Finds and displays file 3 from source device (local). Calls a user-defined routine (remote).	24
f4	ESC s to computer	Finds and displays file 4 from source device (local) Calls a user-defined routine (remote).	24
f5	ESC t to computer	Finds and displays file 5 from source device (local). Calls a user-defined routine (remote).	24
f6	ESC u to computer	Finds and displays file 6 from source device (local). Calls a user-defined routine (remote).	24
f7	ESC v to computer	Finds and displays file 7 from source device (local). Calls a user-defined routine (remote).	24
f8	ESC w to computer	Finds and displays file 8 from source device (local). Calls a user-defined routine (remote).	24
READ	Transfers data from source device to computer.	Transfers one file from source device to DISPLAY.	31, 47
RECORD	Transfers data from computer to destination device.	Transfers one file from DISPLAY to destination device.	31, 47
ENTER	Enables block transfers.	Operates same as RECORD	23, 44

KEYSTROKE SEQUENCE	ESCAPE SEQUENCE	FUNCTION	PAGE REF
[f1] FROM: L. TAPE	ESC &p 1S	Assigns LEFT TAPE as source device	32, 58
[f2] FROM: R. TAPE	ESC &p 2S	Assigns RIGHT TAPE as source device	32, 58
[f3] FROM: DISPLAY	ESC &p 3S	Assigns DISPLAY as source device	32, 58
[f5] TO: L. TAPE	ESC &p 1D	Assigns LEFT TAPE as destination device	32, 58
[f6] TO: R. TAPE	ESC &p 2D	Assigns RIGHT TAPE as destination device	32, 58
[f7] TO: DISPLAY	ESC &p 3D	Assigns DISPLAY as destination device	32, 58
[f8] TO: PRINTER	ESC &p 4D	Assigns PRINTER as destination device	32, 58
NOTE: One source and multiple destinations can be set up with the same sequence. Example: [ ] [f5] TO: L. TAPE [f7] TO: DISPLAY [f8] TO: PRINTER			
COPY ALL [f1]	ESC &p xs xd M	All files (current position) from source device are transferred to destination device.	32, 64
COPY FILE [f2]	ESC &p xs xd F	One File (current position) from source device is transferred to destination device.	32, 63
COPY LINE [f3]	ESC &p xs xd B	One line (current position) from source device is transferred to destination device.	32, 62
EDIT [f4]	— — —	Toggles EDIT mode.	33
FUNCTION: REWIND [f5] — DEVICE: L. TAPE [f5] Or DEVICE: R. TAPE [f6]	ESC &p 1u 0C or ESC &p 2u 0C	Rewinds LEFT TAPE. Rewinds RIGHT TAPE.	33, 58 33, 57
FUNCTION: MARK FILE [f6] — DEVICE: L. TAPE [f5] Or DEVICE: R. TAPE [f6]	ESC &p 1u 5C or ESC &p 2u 5C	Write a FILE MARK on LEFT TAPE Write a FILE MARK on RIGHT TAPE	33, 57 33, 57
TAPE TEST	ESC &p 1u 7C ESC &p 2u 7C	Tests left tape unit Tests right tape unit	70, 73
NOTE: x is variable to indicate source and destination device codes. 1 = Left Tape, 2 = Right Tape, 3 = Display, 4 = Printer *Example: ESC &p 2s 1d 3d M*			
FUNCTION: SKIP n LINES [f7] — DEVICE: L. TAPE [f5] Or DEVICE: R. TAPE [f6]	ESC &p (±n)p 1u 1C or ESC &p (±n)p 2u 1C	Positions LEFT TAPE to a relative (±n) LINE Positions RIGHT TAPE to a relative (±n) LINE	33, 57 33, 57
FUNCTION: FIND FILE n [f8] — DEVICE: L. TAPE [f5] Or DEVICE: R. TAPE [f6]	ESC &p (±n)p 1u 2C or ESC &p (±n)p 2u 2C	Positions LEFT TAPE to a relative (±n) or absolute (n) FILE Positions RIGHT TAPE to a relative (±n) or absolute (n) FILE	33, 57 33, 57

Table 4. Programmer's Reference Table (Continued)

KEY OR SWITCH	CODE	FUNCTION	PAGE
	CHARACTER SET GROUP		
Alphabetical, numerical & symbol keys	— — —	Similar to typewriter keyboard	18
ESC (escape) key	ESC ($[^C$)	Leads off an ASCII escape sequence	19
TAB key	HT (I^C)	Forwards cursor to next tab position	19
CNTL (control) key	— — —	Used to generate ASCII control codes	19
BACK SPACE key	BS (H^C)	Cursor left one space	19
RETURN key	CR (M^C)	Returns cursor to start of line	19
	NUMERIC AND DISPLAY CONTROL GROUP		
↑ key	ESC A	Cursor Up	19
↓ key	ESC B	Cursor Down	19
→ key	ESC C	Cursor Right	19
← key	ESC D	Cursor Left	19
↖ key	ESC H	Cursor Home	20
CLEAR DSPLY key	ESC J	Clears memory from cursor position	20
ROLL UP key	ESC S	Scroll the display up one line	20
ROLL DOWN key	ESC T	Scroll the display down one line	20
NEXT PAGE key	ESC U	Displays the next 24 lines of memory	20
PREV PAGE key	ESC V	Displays the previous 24 lines of memory	20
SET TAB key	ESC 1	Sets the tab at the current cursor column	20
CLEAR TAB key	ESC 2	Clears the tab at the current cursor column	20
Ten-Key Numeric Group	— — —	Adding machine format keyboard	19
	CONTROL GROUP		
RESET TERMINAL key	ESC E	Sets the terminal to power-on state	21
TEST key	ESC z	Self-Test (no tape test)	21
DISPLAY FUNCTIONS key & indicator	ESC Y (on) ESC Z (off)	Control functions disabled and displayed	21
BLOCK MODE latching key	— — —	Block Mode: data displayed but not transmitted until requested; otherwise, terminal is in Character Mode and data transmitted as typed.	21
REMOTE latching key	— — —	Remote (on-line) operations; otherwise, off-line operation	22
CAPS LOCK latching key	— — —	Upper-case alphabetical lock	22
MEMORY LOCK latching key & indicator	ESC l (on) ESC m (off)	Memory overflow protect; display lock	22
AUTO LF latching key	— — —	Line Feed with each terminal carriage return	23
ENTER key	— — —	Enables block transfers	23
BREAK key	— — —	Transmits BREAK signal to interrupt computer	23
TRANSMIT indicator	— — —	Data link exists	23

KEY OR SWITCH	CODE	FUNCTION	PAGE
	SPECIAL FUNCTIONS GROUP		
ENHANCE DISPLAY key (f_1^C)	ESC & d	Turns on Display Enhancement	24

	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Half Bright									X	X	X	X	X	X	X	X
Underline					X	X	X	X					X	X	X	X
Inverse Video			X	X			X	X			X	X			X	X
Blinking		X		X		X		X		X		X		X		X

KEY OR SWITCH	CODE	FUNCTION	PAGE
START UNPROTECTED FIELD key (f_2^C)	ESC [	Starts an Unprotected Field	25
END UNPROTECTED FIELD key (f_3^C)	ESC]	Ends an Unprotected Field	25
FORMAT MODE ON key (f_4^C) FORMAT MODE OFF key (f_5^C)	ESC W (on) ESC X (off)	Only unprotected fields can be modified	25
	EDIT GROUP		
INSERT LINE key	ESC L	Blank line is inserted	26
DELETE LINE key	ESC M	Line containing cursor is deleted	26
INSERT CHAR key & indicator	ESC Q (on)	Succeeding inputs inserted at cursor	26
DELETE CHAR key	ESC P	Character at cursor deleted	26
	ADDITIONAL FUNCTIONS		
— — —	ENQ (E^C)	Enquiry from the computer	34
— — —	ACK (F^C)	Acknowledge — response to ENQ	34
— — —	BEL (G^C)	Bell	34
— — —	ESC)	Define Alternate Character Set: @, A, B, C	34
— — —	SO (N^C)	Turn on Alternate Character Set	34
— — —	SI (O^C)	Turn off Alternate Character Set	34
— — —	DC1 (Q^C)	Block Transfer Trigger	34
— — —	DC2 (R^C)	Block Transfer Enable from Terminal	34
— — —	ESC d	Block Transfer Enable from Computer	34
— — —	RS ($\wedge^C$)	Record Separator	34
— — —	US ($-^C$)	Unit Separator	34
— — —	ESC & a	Cursor Addressing	35
— — —	ESC a	Cursor Sensing (Absolute)	35
— — —	ESC `	Cursor Sensing (Screen Relative)	35
— — —	ESC b	Keyboard Enable	35
— — —	ESC c	Keyboard Disable	35
— — —	ESC I	TAB	35
— — —	ESC G	Cursor Return	35
— — —	ESC F	Cursor Home Down	35
— — —	ESC K	Clear Line from the Cursor	35
— — —	ESC & b	HP diagnostics ONLY	35
— — —	ESC ^	Terminal Status	35
— — —	ESC e	Fast Binary Read	35
— — —	ESC f	Modem Hang-up	35

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