2640A

Interactive Display Terminal

Owner's Manual

HEWLETT **hp** *PACKARD*

Contents

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Congratulations!

You have chosen Hewlett-Packard's new 2640 Interactive Display Terminal-the technological advance in reliable terminals. The 2640'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 2640 and to serve as an aid to achieving many years of optimum use from your new terminal. This manual contains installation, operating, programming and reference information covering the 2640 and its options and accessories. It should answer any questions you have about the actual use of the 2640 Interactive Display Terminal. (The HP 2640A Service Manual-02640-90012 is also available for information regarding trouble-shooting, repair and option/accessory installation.)

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Features of the 2640

Enhanced High-Resolution Display

The 2640 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 × 9 dot matrix generated in a 9 × 15 dot character cell. The high resolution of the 7 × 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.
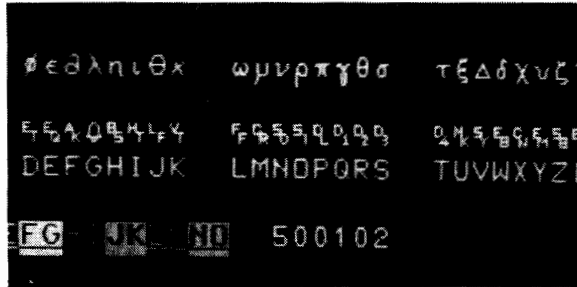
Full Editing Capability

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 user-defined routines, such as forms entry or on-line automatic error correction.
- Character insert and delete, line insert and delete, display clear.
- Scroll up, scroll down, next page, previous page.
- Cursor sensing, addressability, tabulation, and positioning.
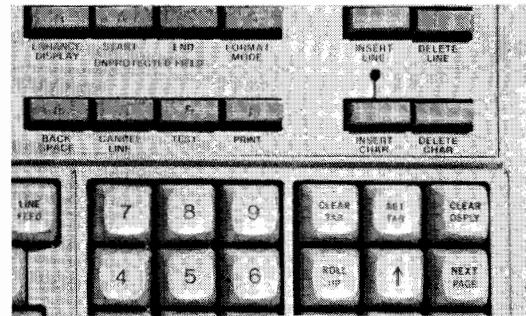
These capabilities can be controlled from either the keyboard or the computer.

Character Mode or Block Mode with Standard RS232C Compatibility

The 2640 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 2640 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.
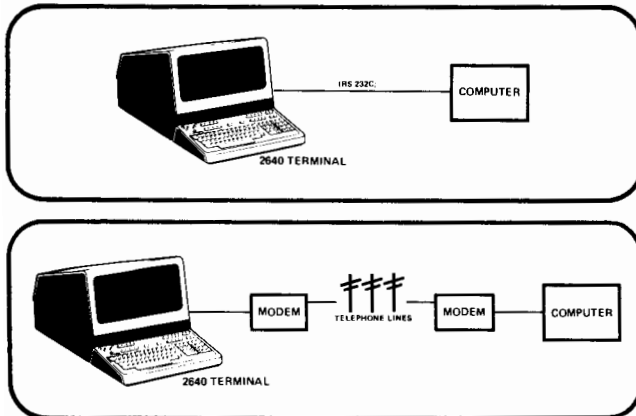
The switch selectable communications features of the 2640 are: Full or Half-Duplex; Even/Odd/No Parity; Data transfer rate (110, 150, 300, 1200, 2400 baud or from an external source). For hard-copy, the 2640 allows direct interface to the 9866 thermal line printer.

Dynamically Allocated Memory

Because of an efficient memory linking organization (transparent to the user), spaces to the right of the last character typed on a line are normally not stored in memory—the memory configures itself dynamically to fit the application. Consequently, the basic 2640 terminal equipped with 1024 characters of display memory can store from 8 to 50 lines of information depending on line length. Memory options of +2048 and +4096 bytes expand this line capacity to a maximum of from 83 lines to over 400 lines of information. Lines are viewed 24 at a time by using the roll up, roll down, next page, and previous page keys.

3

Microprocessor Control

The operating characteristics of the 2640 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 and potential for future enhancements.

| POWER SUPPLY (Series Regulated, Switching) | MICRO-PROCESSOR | VIDEO DISPLAY LOGIC | ROM (Control Memory) 1K RAM (User Memory) | KEYBOARD INTERFACE | DATA COMMUNICATIONS INTERFACE |
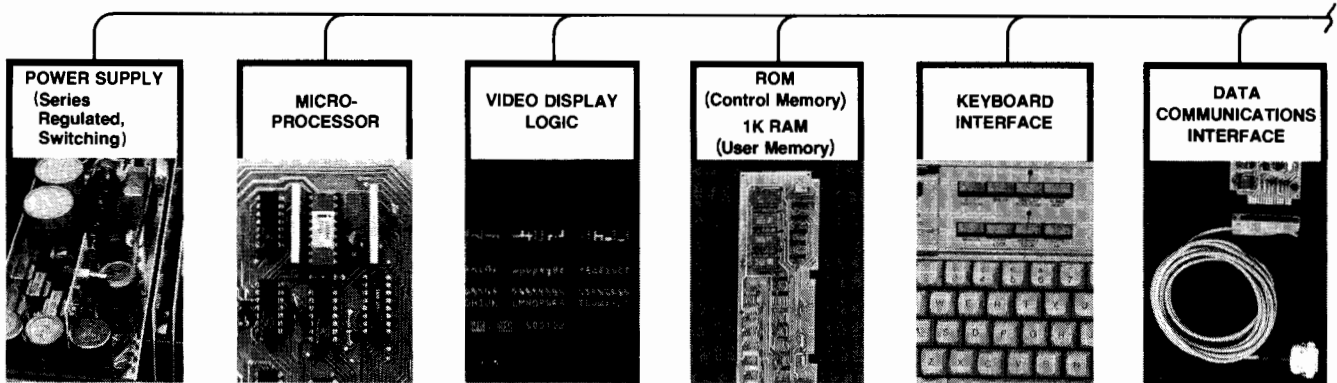
Pop-In Modularity

The modular computer-like construction of the 2640 is designed for ease of service. Digital electronics are contained on printed-circuit cards that can be exchanged within the terminal; up to 14 cards can be accommodated to allow a flexible choice of options both now and in the future.

Self-Test

The HP 2640 has been engineered for high reliability, ease of maintenance testing, and rapid repair when needed. By depressing the TEST button on the keyboard the user receives a Go/No-Go indication from results of an internal memory test, firmware test, and display verification.

4

Plug-In Character Set

Recognizing the demand for terminals that speak many languages and fill diverse sets of needs, the HP 2640 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.
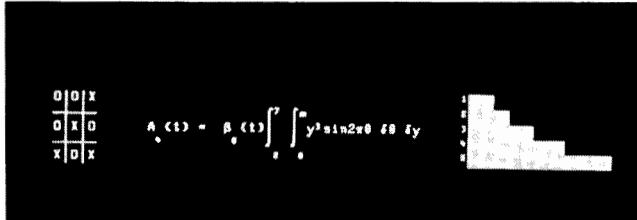
Multi-Task Keyboard

The 2640 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 22 additional editing, control and special function keys. An optional simplified keyboard is also available.

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Equipment Supplied

Your new 2640 is pre-configured to include the options and accessories which you requested. Options are fully specified on the Identification Label found on the Main-frame Panel under the Rear Access Cover.

When communicating with Hewlett-Packard regarding your 2640 unit, use these numbers to insure quick and correct identification by HP. See "Options and Accessories" for an enumeration of these features.

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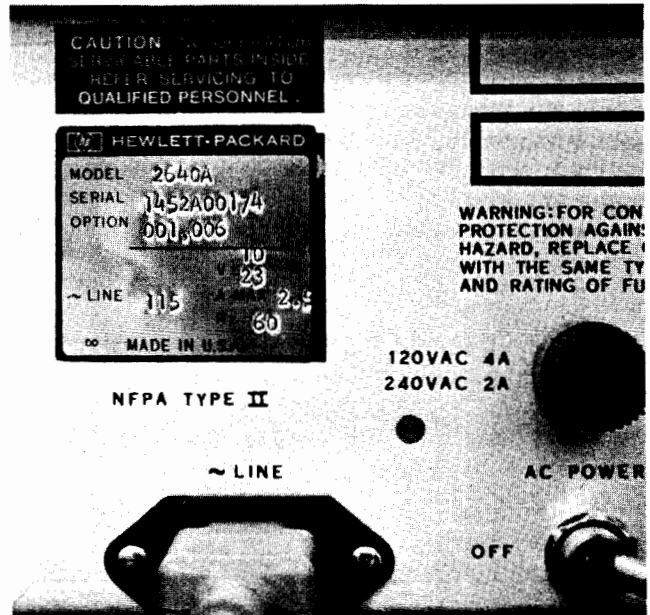
Options and Accessories

PRODUCT NO.	DESCRIPTION/NOTES
2640A	**Interactive Display Terminal** Block or character mode (switch selectable); 64 character upper case Roman set; 1024 bytes of storage, expandable to 8192 bytes maximum; inverse video; 110-2400 Baud; RS232; includes 2 option slots. (Does not include computer interface cable). NOTE: Order at least one of opt. 005/006.
opt. 001	128 Character Set — Roman Adds lower case and displayable control codes.
opt. 005	103/202 Modem Cable — for connection to 103/202 modem or hard-wired to HP 2000/3000. Male RS232 connector
opt. 006	RS232C Cable Female RS232 connector
opt. 010	Simplified Keyboard Replaces standard multitask keyboard with a simpler keyboard (including numeric pad).
opt. 015	50 Hz

PRODUCT NO.	DESCRIPTION/NOTES
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.
13233A	**Terminal Memory Module (+2K)** 2048 bytes of additional storage for 2640A. (requires 1 option slot).
13234A	**Terminal Memory Module (+4K)** 4096 bytes of additional storage for 2640A. (requires 1 option slot).
13238A	**Terminal Duplex Register** For use with HP 9866 (requires 1 option slot).
opt. 001	HP 9866 Cable Cable to connect to 9866 printer.
13240A	**2640 Option Slot Extender** Adds 5 option slots (with fan)

Specifications

GENERAL

Screen Size: 5 inches (127 mm) × 10 inches (254 mm)
Screen Capacity: 24 lines × 80 columns (1,920 characters)
Character Generation: 7 × 9 enhanced dot matrix; 9 × 15 dot character cell; non-interlaced raster scan
Character Size: .097 inches (2.46 mm) × .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)—8K bytes; RAM (user memory)—std. 1024 bytes, 8192 bytes max.
Keyboard: Full ASCII Code Keyboard, 8 special function keys, and 14 additional control and editing keys; Ten-key numeric group; Cursor group; Multi speed auto-repeat; N-key roll-over; detachable on a 4 foot cable.

DATA COMMUNICATIONS

Data Rate: 110, 150, 300, 1200, 2400 baud, and external source —switch selectable.
Communications Interface: EIA standard RS232C; 103 and 202 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 No Parity

POWER REQUIREMENTS

Input Voltage: 115V (+10%, −23%) at 60 Hz or 230V (+10%, −23%) at 60 Hz
Power Consumption: 75W to 125W max.

ENVIRONMENTAL CONDITIONS

Temperature (Free Space Ambient):
Non-Operating: −40 to +75°C (−40 to +167°F)
Operating: 0 to +55°C (+32 to +131°F)
Humidity: 5 to 95% (non-condensing)
Heat Dissipation: 426 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: .012 inches (30 mm) pp, 10 to 55 Hz, 3 axis
Shock: 30G, 11 Ms, 1/2 sine

PHYSICAL SPECIFICATIONS

Display Monitor Weight: 37 pounds (16.8 kg)
Keyboard Weight: 7 pounds (3.2 kg)
Display Monitor Dimensions:
17.5″ W × 18″ D × 13.5″ H
(444.5 mmW × 457.2 mmD × 342.9 mmH)
(Including Keyboard: 25.5″ D (647.7 mmD))
Keyboard Dimensions: 17.5″ W × 8.5″ D × 3.5″ H
(444.5 mmW × 215.9 mmD × 88.9 mmH)

Installing the 2640

The 2640 Interactive Display Terminal is designed to operate in a wide range of environments as indicated by the "Specifications" section. The 2640 terminal 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 2640A Service Manual—02640-90012.)

Simply complete the following five steps to insure proper installation:

1. Place the terminal on any convenient surface, except plush or spongy surfaces that might restrict 2640 air flow through the bottom vents—do not use typewriter pads, for example.
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.
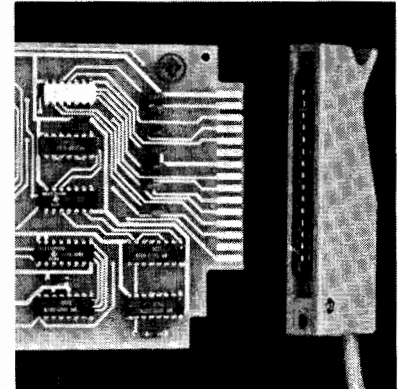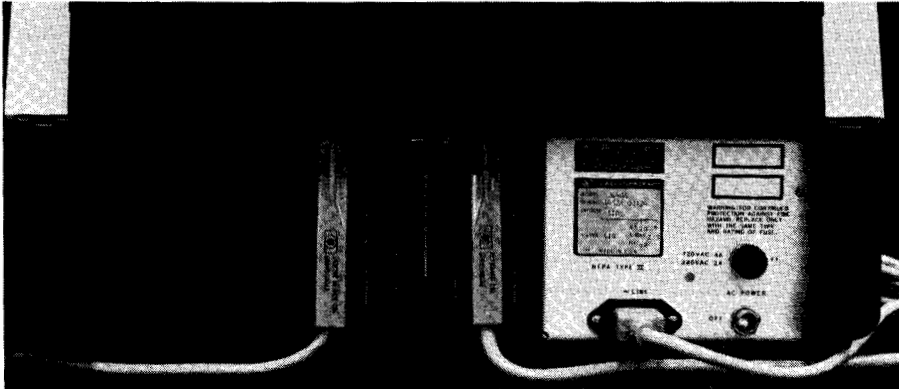
(Continued on next page)

3. Connect the interface cable (option -005 or -006) 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 contains a technical description of the Interface Standards.)
4. Put the AC Power Switch in the OFF position; connect the power cord to the AC Power Connector.
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.

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Turning the 2640 On and Off

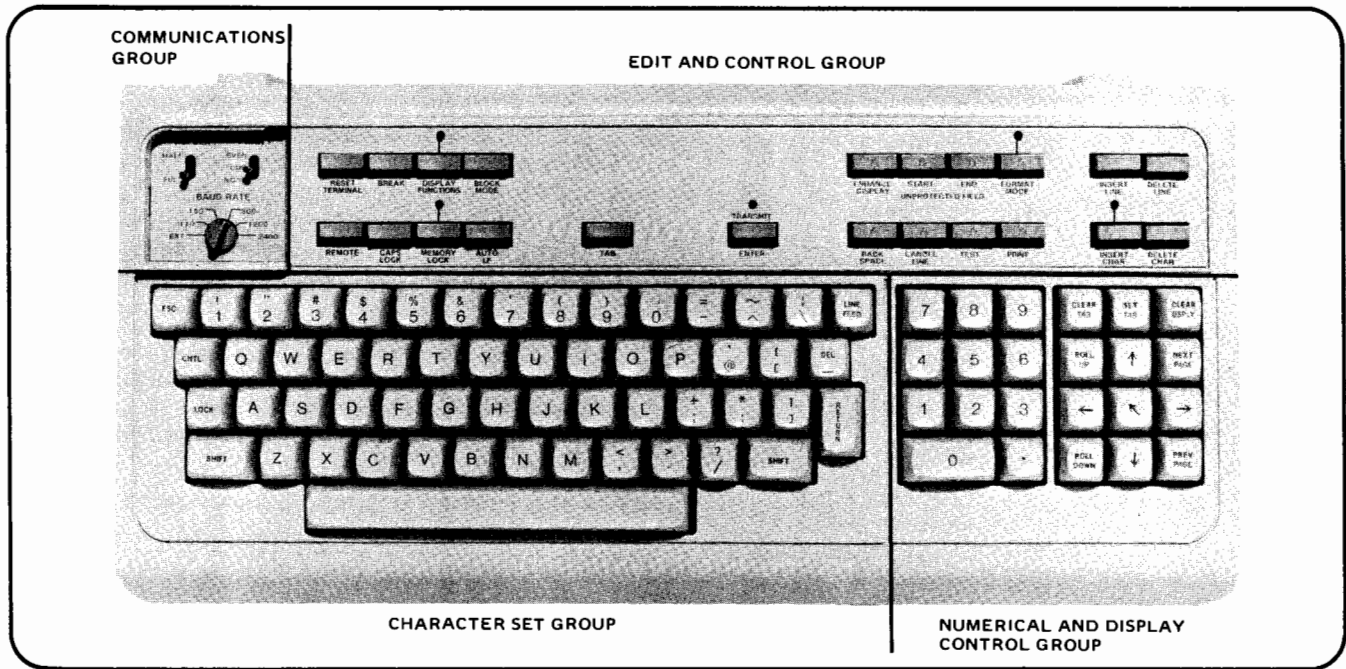ON. After the 2640 Interactive Display Terminal has been properly installed:

1. Assure that the REMOTE latching key is not depressed (i.e., the 2640 is set for off-line operation).

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 terminal 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.

3. (Optional) It is also recommended that the 2640's Self-Test be performed—press the TEST key. Generally, if the terminal gives an audible beep and a test pattern similar to those presented in the "Self-Test" section (page 38) is displayed then the terminal 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 terminal until the malfunction has been corrected by a qualified service representative.

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

2640 Operation

The 2640 terminal's detachable keyboard has been designed for ease of use and for the flexibility to fill the needs of a wide variety of applications. All keys, indicators and switches needed to operate with the 2640 at full capability are located on this keyboard and are grouped for convenient usage.

COMMUNICATIONS GROUP

EDIT AND CONTROL GROUP

CHARACTER SET GROUP

NUMERICAL AND DISPLAY CONTROL GROUP

12 All 2640 keyboard functions are described in this section.

Note: The information in parentheses following each function is the function's equivalent escape code sequence, or ASCII symbol and control character. For example, ESC is the ASCII symbol for an escape character and the equivalent control character, [^{c}, is generated by depressing the CNTL key and pressing the [key.

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 2640 unit are not displayed.)

ESC key. (ESC; [^{c}**).** Escape function generates the ASCII escape character, and can be used in creating any of the programmable 2640 functions associated with an escape code sequence (for instance, ESC U produces a NEXT PAGE command).

CNTL key. 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 the first two columns of Table 2.

LINE FEED key (LF; J^c). Moves the cursor down one line. If the cursor is in the last line displayed on the monitor, a roll up is performed.

RETURN (CR:M^c). 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).

NUMERICAL AND DISPLAY CONTROL GROUP

↑ **key (ESC A).** 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.

↓ **key (ESC B).** 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.

→ **key (ESC C).** Cursor Right. Moves 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.

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← **key (ESC D).** 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.

↖ **key (ESC H).** 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.

CLEAR DSPLY key (ESC J). 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 simultaneously pressed (ESC K). In FORMAT Mode only unprotected fields are cleared.

ROLL UP key (ESC S). 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 key (ESC T). 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 key (ESC U). 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 key (ESC V). 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 key (ESC 1). 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 key (ESC 2). Clears a tab at the current cursor column.

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

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EDIT AND CONTROL GROUP

RESET TERMINAL key (ESC E). The terminal is set to the initial power-on state: display and memory clear, cursor home, programmable functions off.

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

DISPLAY FUNCTIONS key and indicator (on- ESC Y; off- ESC Z). 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 with standard strapping. With the 128-character Roman Set option (−001) escape codes and control functions are also displayed. The "Self-Test" section shows these characters. Being able to actually display these codes is a powerful program de-bugging 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 2640 display in Inverse Video would appear on the display as:


```
HELLO!
```

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


```
ᴇcHᴇcJᴇcIᴇc&dBHELLO!
```

Any error in the escape or control coding can quickly be detected with the DISPLAY FUNCTIONS feature and the 128-character Roman Set.

BLOCK MODE latching key. 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 "Operating in Block Mode")

REMOTE latching key. The terminal is in Remote (on-line) operation. Otherwise, the terminal is in Local (off-line).

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

MEMORY LOCK key and indicator (on- ESC L ; off-ESC m). 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 user 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 is 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 of the display for use in forms headings, instructions or rules to the operator.

Example: To demonstrate these two modes of operation:

- Home the cursor (↖ key), turn on MEMORY LOCK, and then hit the TEST 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, hit DELETE LINE, 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 ROLL UP key (allowing it to Auto-Repeat), then depress the ROLL DOWN key. The top lines of the display should remain stationary while the lines below roll up and down.

AUTO LF latching key. Causes a Line Feed each time a Carriage Return is generated by the terminal.

TAB key (HT, I^c). The TAB key moves the cursor to the next tab position to the right; or if none, 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.

TRANSMIT indicator. 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.

ENTER key. (See "Operating in Character Mode"; "Operating in Block Mode" for details and examples of ENTER operation.)

- 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. Informs the computer by transmitting a DC2 control character (or DC2 CR with Line strapping—see "Strapping Options") that the terminal is ready to transmit characters from the cursor to the end of the line or of memory (dependent on Line/Page strapping).
- Block Mode, Format On. Informs the computer by transmitting a DC2 (or DC2 CR 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, U8 (dependent on Line/Page strapping).

Note: All block transfers are followed by a terminator—a CR(LF), or a Record Separator, RS, in Block Mode with Page Strapping.

f₁ key (ESC p); f₂ key (ESC q); f₃ key (ESC r); f₄ key (ESC s); f₅ key (ESC t); f₆ key (ESC u); f₇ key (ESC v); f₈ key (ESC w). Special Function Keys. These are alternate control action keys. If these keys are pressed in conjunction with the CNTL key, the terminal transmits the corresponding escape code sequence. In Block Mode with Page strapping, the terminal informs the computer that the key has been pressed by transmitting a DC2. The escape sequence is then transmitted in response to a DC1. These escape code sequences can be used to perform user-defined special functions by a remote computer (See "Special Function Keys"). If these keys are pressed without using the CNTL key, the functions printed below the keys are performed.

ENHANCE DISPLAY key (ESC &d). 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 in "Operating in Block Mode".) Also, the user might wish certain fields to be brought to the operator's attention by causing those fields to blink.

START UNPROTECTED FIELD key (ESC [ ). 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.

END UNPROTECTED FIELD key (ESC]). 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.

FORMAT MODE key and indicator (on- ESC W; off-ESC X). 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 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 in "Operating in Block Mode" was created with FORMAT MODE off. The START UNPRO-TECTED 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 in "Operating in Block Mode".

BACK SPACE key (BS; H^c). The cursor is moved left one character position. If the cursor is in the first column, it remains there.

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CANCEL LINE key (CAN; X^c). A code is sent to the computer to cancel the current line.

TEST key (ESC z). 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. (See "Self-Test".)

PRINT key (ESC 0). If the optional printer is present, the contents of the terminal's memory are printed.

INSERT LINE key (ESC L). The line containing the cursor and the remaining lines below the cursor line 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 key (ESC M). 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 key (on- ESC Q; off- ESC R). 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 a field-by-field basis in Format Mode.

DELETE CHAR key (ESC P). 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 a field-by-field basis in Format Mode.

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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.

ADDITIONAL FUNCTIONS

There are several additional control codes and escape code sequences which can be used by the 2640 terminal and represent additional feature capabilities.

Enquiry (ENQ; E^c). Enquiry signal from the computer to the terminal. (See "Operating at High Speeds".)

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 "Alternate Character Sets".)

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 tne 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".)

Block Transfer Enable from the Terminal (DC2; R^c). Transmitted to inform the computer of a Block transfer request. (See "Operating in Block Mode.")

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;$^{\wedge c}$). Used as a terminator for Block transfers.

Unit Separator (US:$\underline{c}$). 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 "Programming and the 2640 - Cursor Addressing".)

Cursor Sensing (ESC a). Causes the terminal to send the current address of the cursor position to the computer. (See "Programming and the 2640 - Cursor Sensing".)

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 a horizontal TAB.

**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 six bytes of terminal status as a block transfer representing memory size, lower straps, upper straps, latching keys, transfer pending flags, error conditions flags, and ended by a terminator. (See "Programming and the 2640 - Terminal Status".)

OPERATING WITH THE SIMPLIFIED KEYBOARD

The 2640's Optional Simplified Keyboard has been designed to make operating with the 2640 in Character Mode as easy for the user as possible. All keys, indicators and switches needed to operate the 2640 Interactive Display Terminal in Character Mode are located on this keyboard.
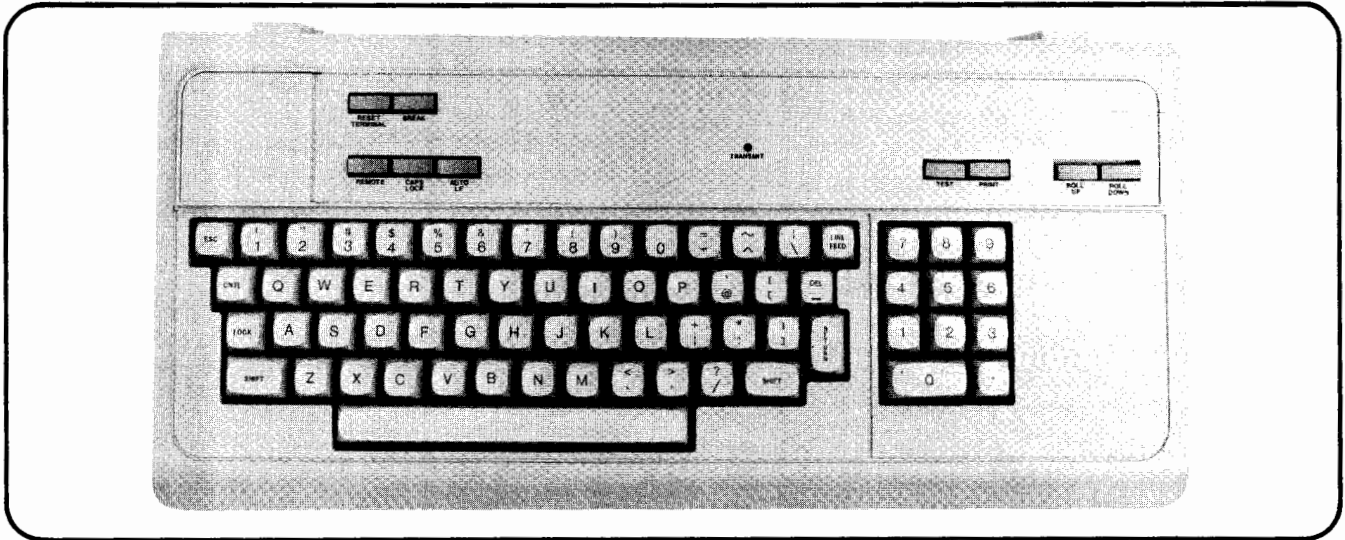
The functions of the keys on the Simplified Keyboard are identical to the functions indicated in "2640 Operation":

Alphabetical, Numerical and Symbol keys	Ten-Key Numeric Group keys	TRANSMIT indicator
CNTL key	RESET TERMINAL key	TEST key
ESC key	BREAK key	PRINT key
LINE FEED key	REMOTE key	ROLL UP key
RETURN key	CAPS LOCK key	ROLL DOWN key
	AUTO LF key	

Note that the ESC and CNTL keys can be used even with the Simplified Keyboard to generate any of the powerful editing and formatting functions supported by escape sequences and control characters on the 2640 as presented in "2640 Operation".

Programming and the 2640

GENERAL OPERATION

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 2640 Interactive Display Terminal with a computer.

Any function of the 2640 terminal which has a corresponding escape code sequence (as presented in "2640 Operation") can be executed from the computer or from the keyboard. Thus either the keyboard or any computer that can transfer ASCII codes over an RS-232C interface can completely control the operations of the 2640 terminal.

From the computer, escape code sequences can be programmed within PRINT or WRITE statements or within print files to be issued to the 2640. For example,

100 PRINT "ᴱcHᴱcJᴱcLᴱc&dBHELLO!"

would move the cursor to the Home position, clear the display, turn on Memory Lock and type "Hello!" on the 2640 display in Inverse Video. The same actions would happen if this group of characters within the Print statement were typed in from the keyboard.

OPERATING IN CHARACTER MODE
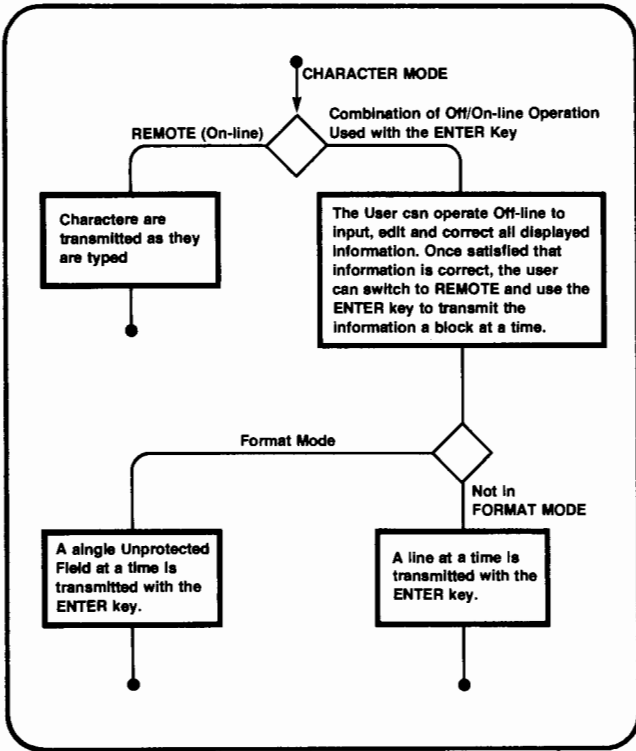
In normal Character Mode operation (BLOCK MODE key not depressed) the terminal is On-Line (REMOTE key depressed) and transmits characters to the computer as they are typed.

Example:

Please Type Your Company Name	Computer
HEWLETT-PACKARD	2640 User
Which file number would you like from the HEWLETT-PACKARD library?	Computer
12345	2640 User

and so on.

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A CR(LF), a Carriage Return and optional Line Feed (if AUTO LF is depressed), usually terminates each line of information transmitted to the computer.

There is also the capability with the 2640 to transmit Blocks of information in Character Mode by using the ENTER key (in the proper operating system environment).

Example:
1. After logging on to a computer system and calling in a data entry program, the user puts the 2640 Off-Line (REMOTE button not depressed).

2. The user then inputs several lines of data from the keyboard to the display.

3. When the user is satisfied that the data is as he wants it (after editing, correcting, adding lines, etc.), the user then hits the Cursor Home key to position the cursor at the beginning of the program, and goes On-Line by depressing the REMOTE key.

4. The ENTER key is then pressed until all lines have been transmitted. Each line is sent to the computer as a block terminated by a CR(LF). The cursor forwards as the lines are transmitted.

This example is just one of a wide variety of applications for the ENTER function in Character Mode. In addition to data entry, program statements and other information can be block transmitted (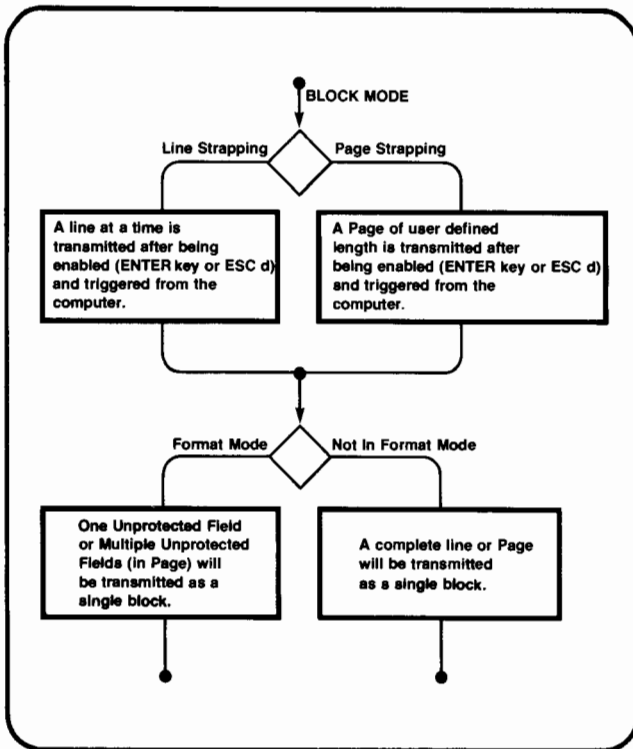in the proper operating system environment). The application given in "Operating in Block Mode" is analogous to what could be done with the ENTER function in Character Mode. (Note that the computer should not be allowed to echo back the information block transmitted by the terminal.)

In Format Mode, rather than the entire line containing the cursor being transmitted when the ENTER key is pressed, only a single unprotected field from the current cursor position to the end of the unprotected field is transmitted. The cursor is automatically forwarded to the beginning of the next unprotected file before transmitting the next field. (Control characters imbedded in the fields are not transmitted in Format Mode.) The transfer of each field is terminated by the transmission of a CR(LF).

The ENTER key used in Character Mode both <u>enables</u> (sets up the 2640 terminal for a future transfer) and <u>triggers</u> (starts the actual transfer) the 2640 for information transmission to the computer. Alternatively, the computer can enable the transfer by sending an ESC d to the 2640, and then trigger the transfer with a DC1(Q^c).

Thus either the terminal or the computer can enable and trigger an information transfer. Both enabling and triggering are necessary for the transfer to occur.
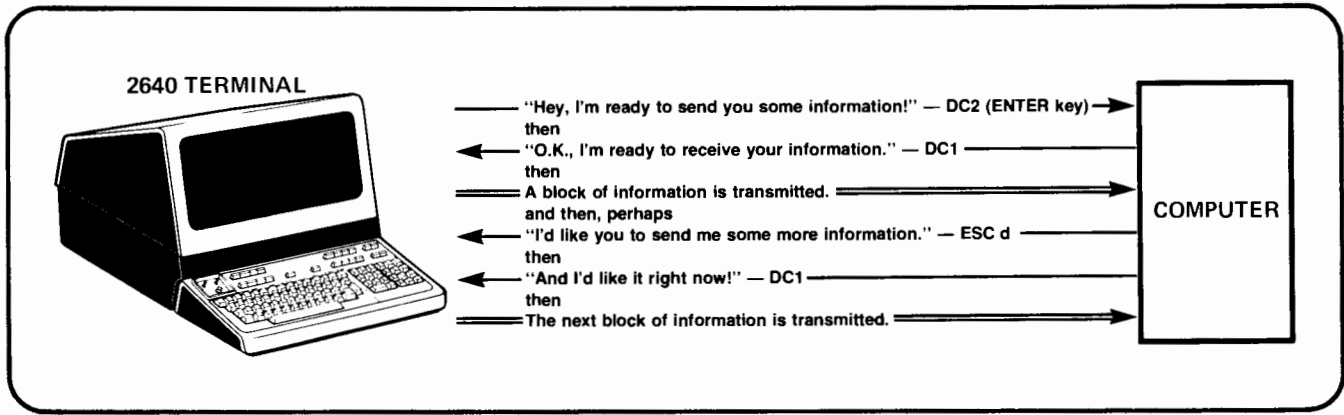
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OPERATION IN BLOCK MODE

```
                        ┃
                  BLOCK MODE
                        ┃
                        ▼
   Line Strapping    ◇◇◇◇    Page Strapping
          ┌──────────◇    ◇──────────┐
          │           ◇◇◇◇           │
   ┌──────┴─────────┐      ┌──────────┴──────┐
   │ A line at a time is │  │ A Page of user defined │
   │ transmitted after being │ │ length is transmitted after │
   │ enabled (ENTER key or ESC d) │ │ being enabled (ENTER key or ESC d) │
   │ and triggered from the │ │ and triggered from the │
   │ computer.       │      │ computer.       │
   └──────┬─────────┘      └──────────┬──────┘
          └────────────┬─────────────┘
                       ▼
   Format Mode      ◇◇◇◇   Not In Format Mode
          ┌──────────◇    ◇──────────┐
          │           ◇◇◇◇           │
   ┌──────┴─────────┐      ┌──────────┴──────┐
   │ One Unprotected Field │  │ A complete line or Page │
   │ or Multiple Unprotected │ │ will be transmitted │
   │ Fields (in Page) will │   │ as a single block. │
   │ be transmitted as a │    │                 │
   │ single block.    │      │                 │
   └──────┬─────────┘      └──────────┬──────┘
          ●                           ●
```

In BLOCK MODE characters are not transmitted as they are typed. Instead the user is able to input information to the 2640 terminal, and edit and correct the information before transmitting it to the computer (either in segments or all at one time as one block, through the use of the ENTER key). Both more efficient use of computer resources and the user's time at the terminal normally results from the use of BLOCK MODE.

To have a transfer of information in BLOCK MODE from the 2640 terminal to the computer the transfer must be both enabled (sets up the 2640 terminal for a future transfer) and triggered (starts the actual transfer). The 2640 can be enabled in either of two ways:

- From the terminal—pressing the ENTER key enables a transfer (a DC2(R^c) control code is issued by the terminal to the computer).
- From the computer—an ESC d is issued by the computer to the 2640 to enable a transfer.

Once a transfer has been enabled it must be triggered before any of the displayed information is actually transmitted to the computer. Triggering occurs when a DC1(Q^c), is sent to the 2640 by the computer. Note that the ENTER key does not automatically trigger a transfer when the terminal is in Block Mode.

Enabling and triggering can be viewed as a simple hand-shaking process:

2640 TERMINAL

"Hey, I'm ready to send you some information!" — DC2 (ENTER key) →
then
← "O.K., I'm ready to receive your information." — DC1
then
A block of information is transmitted.
and then, perhaps
← "I'd like you to send me some more information." — ESC d
then
← "And I'd like it right now!" — DC1
then
The next block of information is transmitted.

COMPUTER

From this example it can be seen that some software support for this hand-shaking process in BLOCK MODE is necessary: the software must recognize a DC2 interrupt, it must also be capable of generating a DC1 and perhaps an ESC d. Some cursor sensing and positioning and other software support might also be needed depending on your specific application. (Note also that the computer should not be allowed to echo back information block transmitted by the terminal.)

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, dependent on the Line/Page Strapping of the terminal and whether or not the terminal is operating in FORMAT MODE:

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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 fields 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 transfered 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.

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Example:

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.

1. The user presses down the CNTL key and at the same time hits the f₃ Special Function key, which he has previously programmed in a remote computer routine to both automatically display on the 2640 the form pictured below and turn on FORMAT MODE. (REMOTE and BLOCK MODE are depressed.)

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:

$$012345HEWLETT\text{-}PACKARD \overset{T}{\underset{B}{A}} 11000 \ WOLFE \ RD \overset{T}{\underset{B}{A}} 081175 \ etc.$$

The completed form would look as follows:

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:
   - Terminal transmits a DC2.
   - Computer software recognizes the DC2 and responds with a 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:

   $01^u_s2345^u_s$HEWLETT-PACKARD ^u_s11000
   WOLFE ROAD ^u_s
   08^u_sxx$^u_s75^u_s$ . . . .^u_s129.50^u_sFGHIJ^R_s

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.
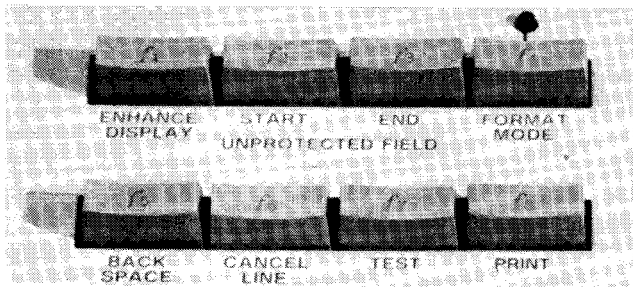
Special Function Keys

The 2640 has 8 user-definable Special Function keys. By depressing the CNTL key and simultaneously pressing any one of these eight keys, the user is able to call in and execute from a remote computer any routine which he has previously defined. These user defined 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 2640 itself.)

Normally, pressing a Special Function key with CNTL depressed causes ESC p-w CR(LF) to be transmitted to the computer (where p-w represents a single character corresponding to the particular key depressed f_1-f_8; f_2 would be ESC q CR(LF) for example).

If the terminal is operating in BLOCK MODE, strapped for Page, the 2640 instead generates a DC2 to enable a transfer (See "Operating in Block Mode"). Once triggered by a DC1 response, the terminal transmits:

ESC p-w RS.

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CURSOR ADDRESSING

The 2640 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 2640 cursor:

Absolute Addressing:

ESC & a 23 r 60C	Move cursor to Row 23, Column 60
ESC & a 60 c 23R	Move cursor to Row 23, Column 60
ESC & a 15 R	Move cursor to Row 15, current column
ESC & a 30 C	Move cursor to current row, column 30

Relative Addressing:

ESC &a+8r−10C	Move cursor from its current position 8 rows down, 10 columns left
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
ESC &a + 10C	Move cursor from its current position 10 columns right

Combinations of Absolute and Relative Addressing:

ESC &a+8 r 60C	Move cursor from its current row down 8 rows and to column 60.

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Note that the separating r or c is lower case, and the terminating R or C 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. 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 of the 2640 cursor can be determined from the computer.

Upon receipt from the computer of an "ESC a" followed by a DC1 control code, the terminal transmits a standard sequence of characters containing the address of the current cursor position. An example of this sequence with the cursor at column 20, row 9 is:

ESC a	Computer to Terminal
DC1	
ESC & a 020c009R	Terminal to Computer
followed by a Carriage Return and line feed if AUTO LF is depressed −CR(LF); or an RS if the 2640 is operating in BLOCK MODE, strapped for page.)	

ALTERNATE CHARACTER SETS

The 2640 has the capability to display up to four different 128-character sets. Because the 2640 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. The test pattern (generated by pressing the TEST button) displays the ordering of the additional character sets in each 2640 terminal.

TEST PATTERN
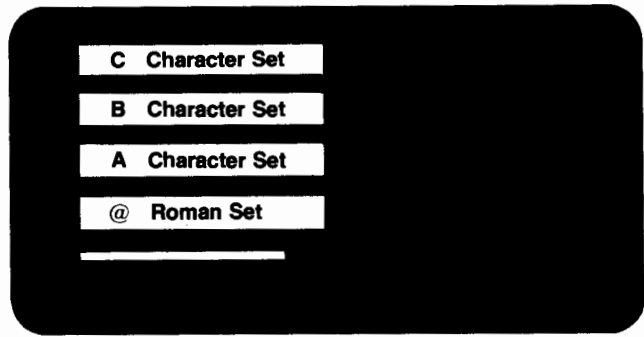
Once the Alternate Character Set is defined, switching from the Roman set to the Alternate set requires a SO (N^C) control character. And to switch back to the Roman set requires a SI (O^C).

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:

The ASCII code for
"B" is displayed as β in
the Math Set

Switches to Roman Set

Sets up the Math Set ——— ESC) A, a N^C A O^C b N^C B
as the "alternate set"

Switches to the
alternate Math Set

The ASCII code for "A"
is displayed α in the
Math Set.

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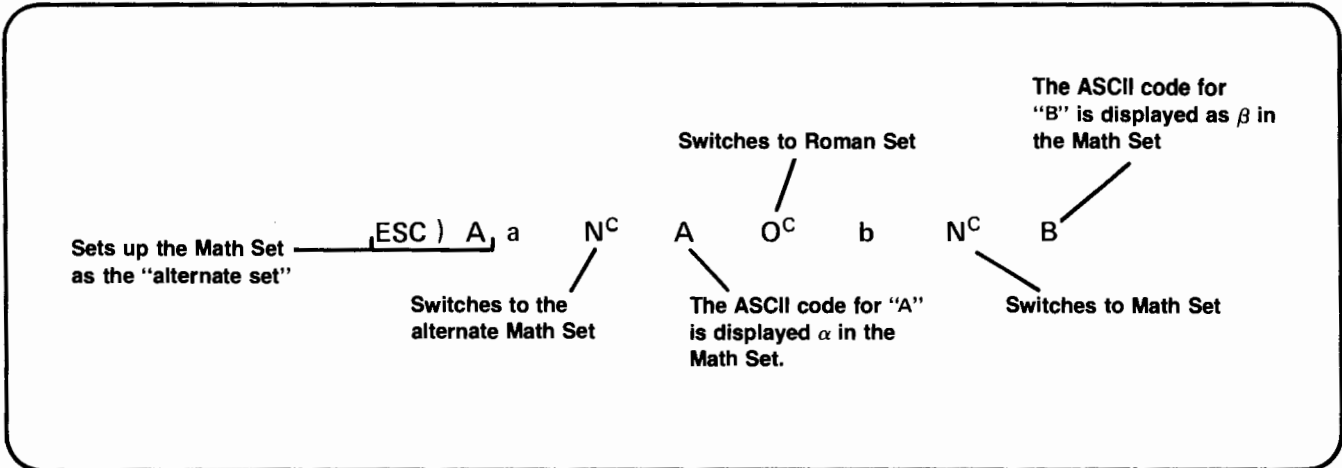
To change to a different Alternate Character Set another ESC) command can be issued. An SO(N^c) must be reissued for each new line on which the Alternate Character Set is to be displayed.

The elements of the optional Math Symbol Set are associated with the keyboard as pictured below.
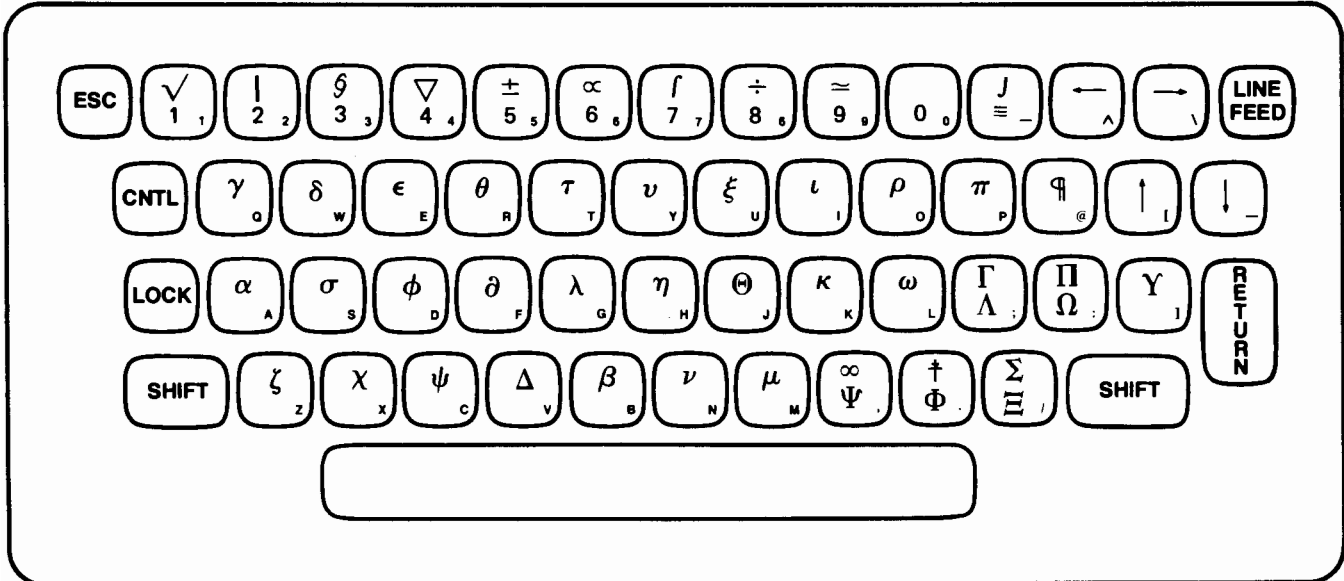
Note that only the Roman character set is actually printed on the keyboard.

The elements of the optional Line Drawing Set are as-
sociated with the keyboard as pictured below:
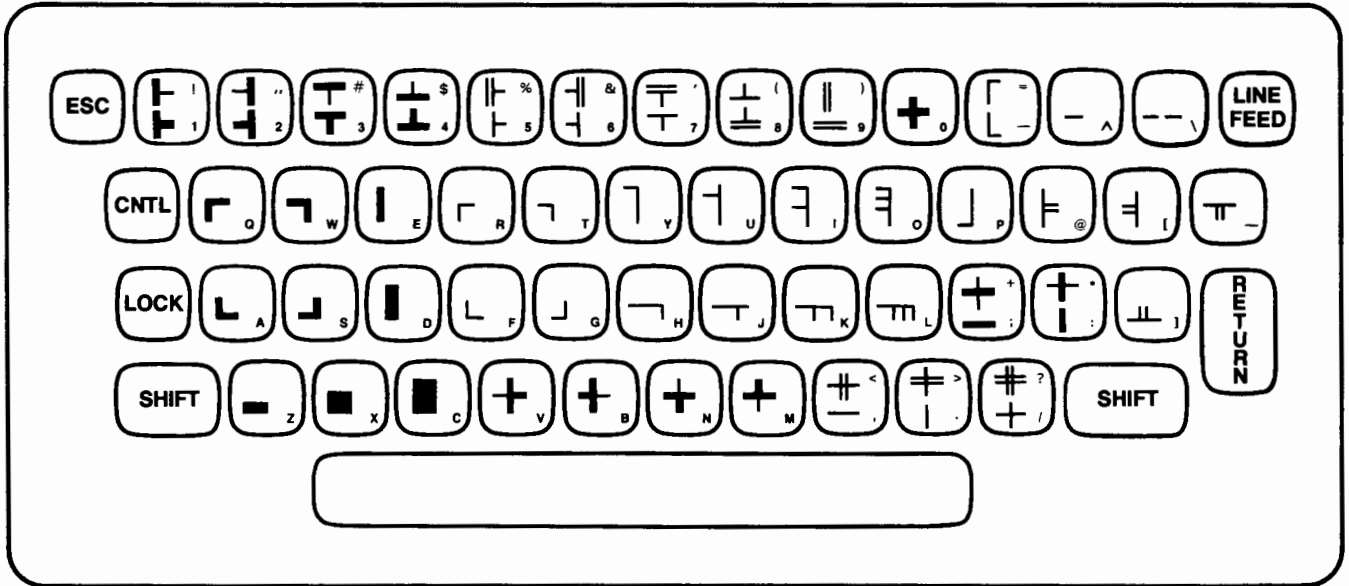
36   Note that only the Roman character set is actually printed on the keyboard.

The Line Drawing Set gives the 2640 a limited graphics capability. Simple line drawings and fairly complex forms for data entry applications can be generated:

Example:

	STOCK NO.		SPECS. DRAWING NUMBER	PART NAME DRAWING TITLE	R & D DATES			REMARKS	MFG. SPEC			
	XXX	YYYYY							A	B	C	D

FABRICATED STOCK DRAWING ASSIGNMENT

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SELF-TEST

The 2640 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 2640's Self-Test is an extremely important capability—by pressing a single TEST key on the terminal's keyboard at any time, an internal diagnostic of the major areas of the 2640 is executed. This is a GO/NO-GO check on whether or not the terminal is functioning properly. The following is performed when the TEST key is depressed:

- The light-emitting diodes 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 that 2640 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 six bytes of status information are displayed. (See "Terminal status".)

Generally, if the terminal beeps and the display shows a pattern similar to the ones below then the 2640 is functioning properly (*only* those character sets actually present in the 2640 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).

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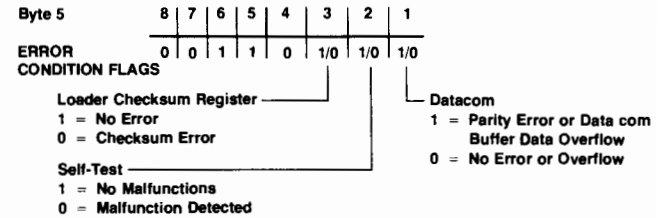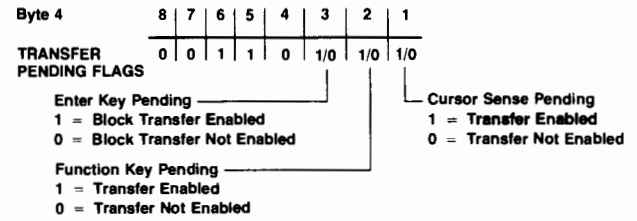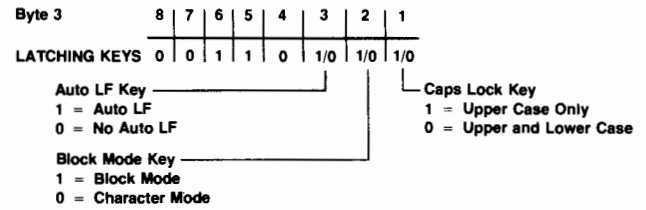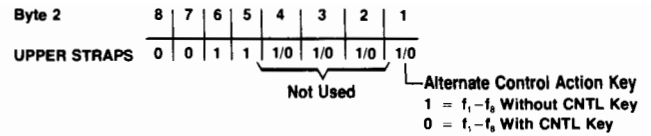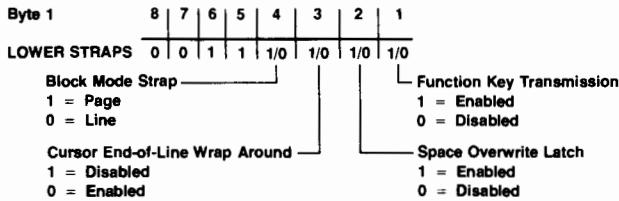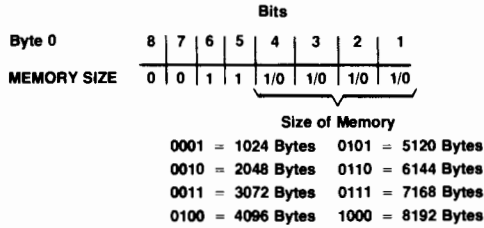Test Pattern for the standard 2640 with 128 Roman Character Set option
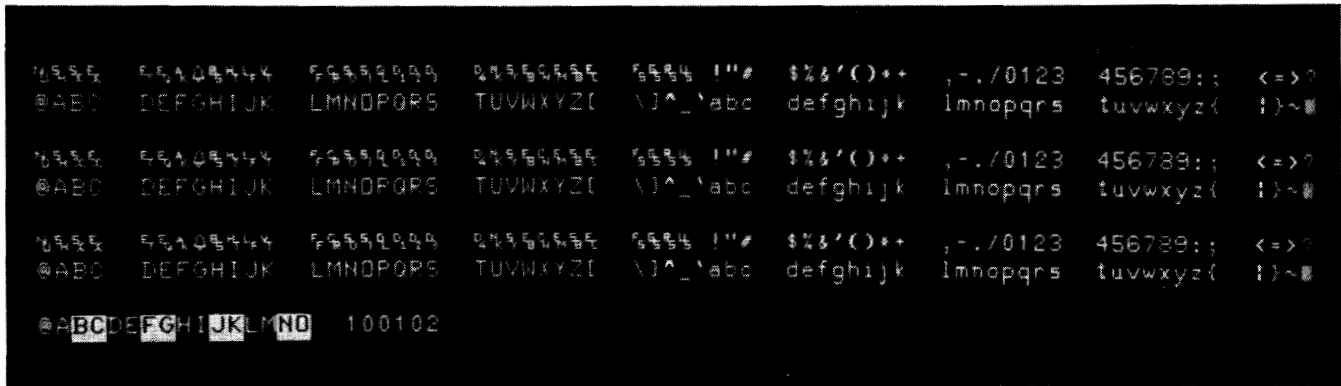
Test Pattern for the 2640 containing Display Enhancements, 128 Roman Character Set, Math Symbol Set, and Line Drawing Set
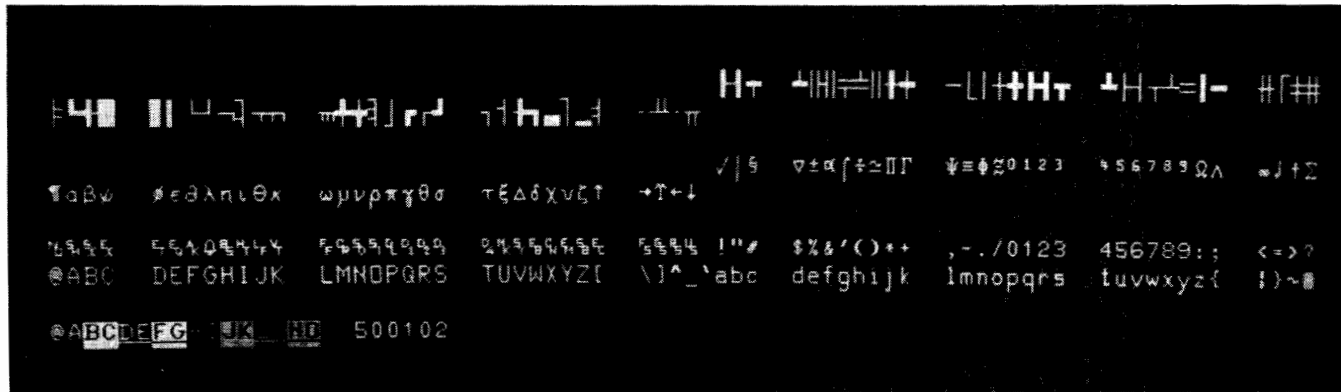
TERMINAL STATUS

The computer can request information on the status of the terminal by issuing an ESC ∧ followed by a DC1 control character. The 2640 terminal will respond by transmitting an ESC \ followed by the six 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.

Bits

Byte 0 — MEMORY SIZE

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

Size of Memory

```
0001 = 1024 Bytes    0101 = 5120 Bytes
0010 = 2048 Bytes    0110 = 6144 Bytes
0011 = 3072 Bytes    0111 = 7168 Bytes
0100 = 4096 Bytes    1000 = 8192 Bytes
```

Byte 1 — LOWER STRAPS

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

Block Mode Strap
1 = Page
0 = Line

Cursor End-of-Line Wrap Around
1 = Disabled
0 = Enabled

Function Key Transmission
1 = Enabled
0 = Disabled

Space Overwrite Latch
1 = Enabled
0 = Disabled

Byte 2 — UPPER STRAPS

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

Not Used

Alternate Control Action Key
1 = f₁-f₈ Without CNTL Key
0 = f₁-f₈ With CNTL Key

Byte 3 — LATCHING KEYS

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

Auto LF Key
1 = Auto LF
0 = No Auto LF

Block Mode Key
1 = Block Mode
0 = Character Mode

Caps Lock Key
1 = Upper Case Only
0 = Upper and Lower Case

Byte 4 — TRANSFER PENDING FLAGS

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

Enter Key Pending
1 = Block Transfer Enabled
0 = Block Transfer Not Enabled

Function Key Pending
1 = Transfer Enabled
0 = Transfer Not Enabled

Cursor Sense Pending
1 = Transfer Enabled
0 = Transfer Not Enabled

Byte 5 — ERROR CONDITION FLAGS

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

Loader Checksum Register
1 = No Error
0 = Checksum Error

Self-Test
1 = No Malfunctions
0 = Malfunction Detected

Datacom
1 = Parity Error or Data com Buffer Data Overflow
0 = No Error or Overflow

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For example:

In response to an ESC∧ DC1 sent to the 2640, the computer has received

ESC\5:0742RS

Table 2, the ASCII Code Chart can be used to translate these six bytes of status:

Byte	ASCII	Binary	Status
0	5	00110101	5120 Bytes of Memory
1	:	00111010	Strapped for Page; Space Overwrite Latch enabled; other indicators are standard.
2	0	00110000	CNTL is necessary to generate f_1-f_8
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	2	00110010	No errors have been recog-nized—last Self-Test was successful.
	RS		The termination is an RS because the terminal is in BLOCK MODE, strapped for Page.

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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 not be 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 2640 and the computer: if the computer transmits an ENQ (E^c) after transmitting 80 characters, the 2640 will transmit to the computer an ACK (F^c) 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. (This procedure must be used with the Type 202 Modem.) 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 2640's memory or on the display, and 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)

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STRAPPING OPTIONS

The standard 2640 terminal can be optionally strapped to alter a number of the terminal's functions:

STRAPPING OPTION	NORMAL OPERATION	OPERATION WITH STRAPPING OPTION
Function Key Transmission	The escape code sequence generated by the major editing function keys are executed locally, but not transmitted to the computer.	The escape code sequences generated by the major editing function keys are transmitted to the computer.
Space Overwrite (SPOW) Latch	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.
Cursor End-of-Line Wrap Around	At the end of each line, an automatic Carriage Return and Line Feed are generated.	A Carriage Return and Line Feed are not automatically generated at the end of each line. The cursor remains in and overwrites column 80.
Block Mode, Page	The 2640 is set to transfer a line at a time in Block Mode.	Entire pages of information are transferred in Block Mode. (See "Operating in Block Mode").
Alternate Control Action Keys	The CNTL key must be pressed along with the Alternate Control Action Keys to generate the Special Function escape codes.	The effect of the CNTL key associated with the eight Special Function keys is reversed—the Special Function escape code sequences are generated with the Alternate Control Action keys without the use of the CNTL key.

Procedures to change these straps are outlined in the HP2640A Service Manual—02640-90012.

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Table 1: Interface Standards

		Pin Numbers	
		RS232 Cable Connector (Option −006)	103/202 Modem Cable Connector (Option −005)
A	GROUND	—	—
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	GROUND	7	7
J	CF RECEIVE CARRIER	8	8
K	EXT CLOCK OUT (X8)	16	—
L	EXT CLOCK OUT (X16)	24	—
M	SA SECONDARY TRANSMITTED DATA	—	11
N	SB SECONDARY RECEIVED DATA *	12	12
P	CD DATA TERMINAL READY	20	20
R		—	—
S	EXT CLOCK IN (X16)	—	—

(Bell 202 Equivalent)

Data Communications Logic Board
(Notched to Match the RS232 or 103/202 Modem
Cable Hood Connector)

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Table 2: ASCII Code Chart

	CONTROL CHARACTERS		DISPLAYABLE CHARACTERS						ESCAPE SEQUENCES					
BIT 765 →	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
4321 ↓														
0000	NUL	DLE (D_L)	SP	0	@	P	`	p	SPACE	PRINT	@	P DELETE CHAR	`	p
0001	SOH (S_H)	DC1 (D_1)	!	1	A	Q	a	q	!	1 SET TAB	A ↑	Q INSERT CHAR ON	a CURSOR SENSE	q f_1
0010	STX (S_x)	DC2 (D_2)	"	2	B	R	b	r	"	2 CLEAR TAB	B →	R INSERT CHAR OFF	b KEYBOARD ENABLE	r f_2
0011	ETX (E_x)	DC3 (D_3)	#	3	C	S	c	s	#	3	C ↑	S ROLL UP	c KEYBOARD DISABLE	s f_3
0100	EOT (E_T)	DC4 (D_4)	$	4	D	T	d	t	$	4	D ↓	T ROLL DOWN	d ENTER	t f_4
0101	ENQ (E_Q)	NAK (N_K)	%	5	E	U	e	u	%	5	E RESET TERMINAL	U NEXT PAGE	e	u f_5
0110	ACK (A_K)	SYN (S_Y)	&	6	F	V	f	v	& PARAMETER SEQUENCE	6	F	V PREV PAGE	f	v f_6
0111	BEL	ETB (E_B)	'	7	G	W	g	w	'	7	G CURSOR RETURN	W FORMAT MODE ON	g	w f_7
1000	BS (B_S)	CAN (C_N)	(	8	H	X	h	x	(	8	H ↖	X FORMAT MODE OFF	h	x f_8
1001	HT (H_T)	EM (E_M)	)	9	I	Y	i	y	)	9	I HORIZONTAL TAB	Y DISPLAY FUNCTIONS ON	i	y
1010	LF (L_F)	SUB (S_B)	*	:	J	Z	j	z	* DEFINE SET	:	J CLEAR DSPLY	Z DISPLAY FUNCTIONS OFF	j	z
1011	VT (V_T)	ESC (E_C)	+	;	K	[	k	{	+	;	K ERASE TO END OF LINE	[START UNPROTECT FIELD	k	{ TEST
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

Table 3: Programmer's Reference Table

KEY OR SWITCH	ESCAPE OR CONTROL CODE	FUNCTION
CHARACTER SET GROUP		
Alphabetical, numerical & symbol keys	—	Similar to typewriter keyboard
ESC (escape) key	ESC ([^{c})	Leads off an ASCII escape sequence
CNTL (control) key	—	Used to generate ASCII control codes
LINE FEED key	LF (J^c)	Moves cursor down one line
RETURN key	CR (M^c)	Returns cursor to start of line.
NUMERICAL AND DISPLAY CONTROL GROUP		
↑ key	ESC A	Cursor Up
↓ key	ESC B	Cursor Down
→ key	ESC C	Cursor Right
← key	ESC D	Cursor Left
↖ key	ESC H	Cursor Home
CLEAR DSPLY key	ESC J	Clears memory from cursor position
ROLL UP key	ESC S	Scroll the display up one line
ROLL DOWN key	ESC T	Scroll the display down one line
NEXT PAGE key	ESC U	Displays the next 24 lines of memory
PREV PAGE key	ESC V	Displays the previous 24 lines of memory
SET TAB key	ESC 1	Sets a tab at the current cursor column
CLEAR TAB key	ESC 2	Clears a tab at the current cursor column
Ten-Key Numeric Group	—	Adding machine format keyboard
EDIT AND CONTROL GROUP		
RESET TERMINAL key	ESC E	Sets the terminal to initial state
BREAK key	—	Transmits BREAK signal to interrupt computer
DISPLAY FUNCTIONS key & indicator	ESC Y (on) ESC Z (off)	Control functions disabled and displayed
BLOCK MODE latching key	—	Block Mode: data displayed but not transmitted until requested; otherwise, terminal is in Character Mode and data transmitted as typed.
REMOTE latching key	—	Remote (on-line) operations; otherwise, off-line operation
CAPS LOCK latching key	—	Upper-case alphabetical lock
MEMORY LOCK key & indicator	ESC l (on) ESC m (off)	Memory overflow protect; display lock
AUTO LF latching key	—	Line Feed with each terminal carriage return
TAB key	HT (l^c)	Forwards cursor to next TAB position
TRANSMIT indicator	—	Deta link exists
ENTER key	—	Enables block transfers
f₁ key	ESC p	User-definable special function keys
f₂ key	ESC q	
f₃ key	ESC r	
f₄ key	ESC s	
f₅ key	ESC t	
f₆ key	ESC u	
f₇ key	ESC v	
f₈ key	ESC w	

KEY OR SWITCH	ESCAPE OR CONTROL CODE	FUNCTION
ENHANCE DISPLAY key	ESC &d	Turns on Display Enhancement:
START UNPROTECTED FIELD key	ESC [	Starts an Unprotected Field
END UNPROTECTED FIELD Key	ESC]	Ends an Unprotected Field
FORMAT MODE key & indicator	ESC W (on) ESC X (off)	Only unprotected fields can be operated on
BACK SPACE key	BS (H^c)	Cursor left one space
CANCEL LINE key	CAN (X^c)	Cancel line code transmitted
TEST key	ESC z	2640 Self-Test
PRINT key	ESC 0	Dump terminals memory to printer.
INSERT LINE key	ESC L	Blank line is inserted
DELETE LINE key	ESC M	Line containing cursor is deleted
INSERT CHAR key	ESC Q (on) ESC R (off)	Succeeding inputs inserted at cursor
DELETE CHAR key	ESC P	Character at cursor deleted
COMMUNICATIONS GROUP		
DUPLEX switch	—	Half/Full
PARITY switch	—	Even/Off/None
BAUD RATE switch	—	110, 150, 300, 1200, 2400, external
ADDITIONAL FUNCTIONS		
—	ENQ (E^c)	Enquiry from the computer
—	ACK (F^c)	Acknowledge—response to ENQ
—	BEL (G^c)	Bell
—	ESC)	Define Alternate Character Set: @,A,B,C
—	SO (N^c)	Turn on Alternate Character Set
—	SI (O^c)	Turn off Alternate Character Set
—	DC1 (Q^c)	Block Transfer Trigger
—	DC2 (R^c)	Block Transfer Enable from Terminal
—	ESC d	Block Transfer Enable from Computer
—	RS (∧^{c})	Record Separator
—	US (_^{c})	Unit Separator
—	ESC & a	Cursor Addressing
—	ESC a	Cursor Sensing
—	ESC b	Keyboard Enable
—	ESC c	Keyboard Disable
—	ESC l	TAB
—	ESC G	Cursor Return
—	ESC k	Clear Line from Cursor
—	ESC & b	HP diagnostics ONLY
—	ESC∧	Terminal Status
MAINFRAME REAR PANEL SWITCHES		
PWR ON/OFF switch	—	Primary power to terminal.