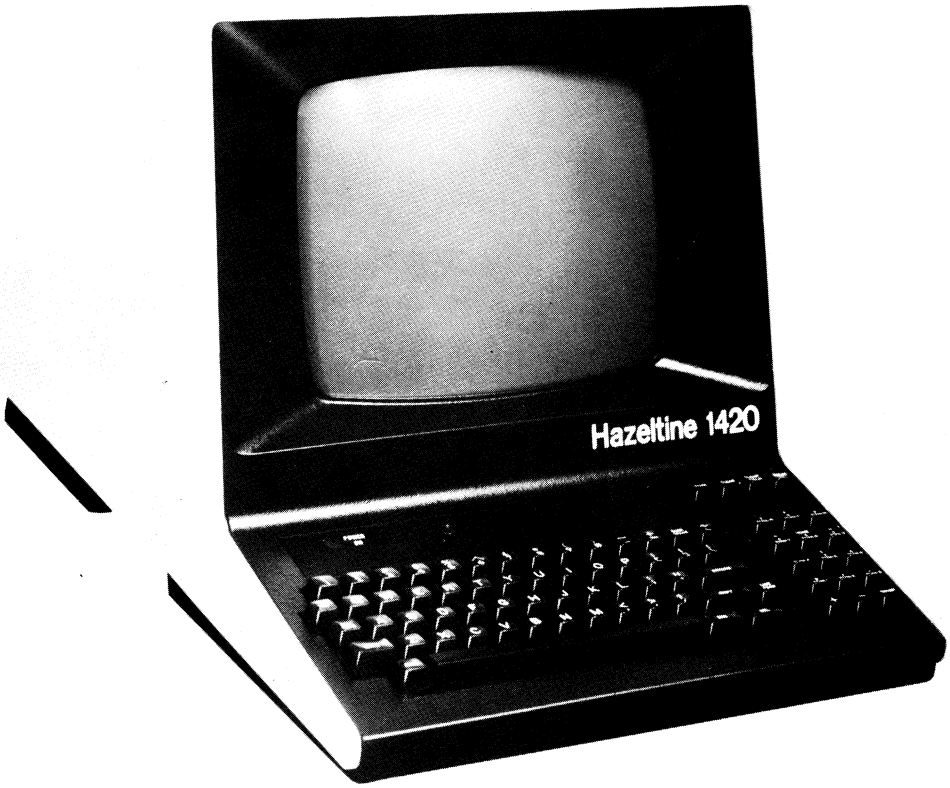
Hazeltine 1420

VIDEO DISPLAY TERMINAL REFERENCE MANUAL



Hazeltine Corporation

COMPUTER TERMINAL EQUIPMENT
GREENLAWN, N.Y. 11740
(516)549-8800 TELEX 96-1435

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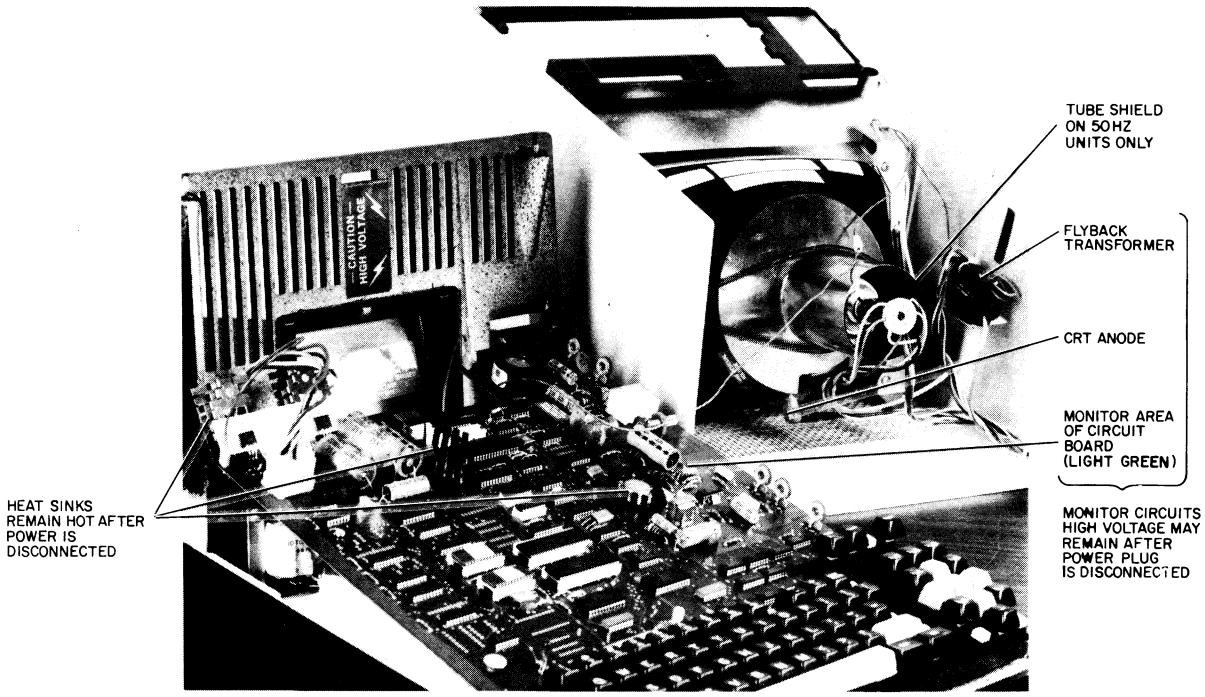
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SAFETY SUMMARY

WARNING

Dangerous voltages (12,000 vdc, 500 vdc and 100 to 240 vac) are present in the Video Display Terminal. Some voltage may remain present in monitor circuits after power is removed (see diagram below). Use caution when working on internal circuits. Do not work alone.

The terminal power cord should always be unplugged before the cover is removed. Use caution when handling the cathode-ray tube (eg, wear safety goggles) to avoid risk of implosion. The internal phosphor coating is toxic; if the tube breaks and skin or eyes are exposed to phosphor, rinse with water immediately and consult a physician.



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SECTION I

INTRODUCTION

The Hazeltine 1420 Video Display Terminal is a product of advanced microprocessor and large scale integrated circuit technology which offers quiet, reliable, and economical operation. The single circuit board design enhances reliability and ease of servicing. Speed, silence, and flexibility, combined with the operator oriented features of the terminal, summarized in table 1-1, improve the efficiency of both the software and programmer in data input/output applications.

This manual covers both the Domestic (115 v, 60 Hz) and International (100 to 240 v, 50 or 60 Hz) versions of the terminal. The terminal is also available in a European version compatible with CCITT-v.24 interfaces. A maintenance manual (HI-1082) for the terminal may be purchased from Hazeltine.

This manual describes the features and operation of the terminal, organized as follows:

- Installation and turn-on instructions are in Section 2.
- Data for operators, describing switch setting requirements and keyboard functions is in Section 3.
- Data for programmers, describing the modes of operation and use of the many remote commands is in Section 4.
- Interface details for installation planning are in Section 5.
- Servicing and adjustment instructions are in Section 6.

This manual is published and distributed by Hazeltine Corporation, Computer Terminal Equipment Product Line. The information presented herein may not reflect the latest changes in the product. Confirmation and any required clarification of this information can be obtained from Hazeltine.

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Table 1-1. Technical Summary

DISPLAY FORMAT	
Screen	12 inch (30.5 cm) diagonal, P4 phosphor, anti-glare contrast enhancement filter
Capacity	80 characters/line x 24 lines (1920 characters)
Character Format	5 x 8 dot matrix in 7 x 10 dot window, block cursor. Character shows through cursor in reverse video when superimposed.
Character Set	95 displayable ASCII. All 128 ASCII codes can be keyed and transmitted
Display	White on black background, two intensities, blink or blank
Refresh Rate	60 Hz, no interlace (50 Hz for International Model)
TV Line Standard	260 lines/frame, 240 lines displayed
Memory	2048 x 8 Random Access Memory
INTERFACE	
Input/Output	EIA RS-232C at 110, 300, 600, 1200, 1800, 2400, 4800, or 9600 baud (switch selected). Optional 20 mA current loop
Parity	Odd, Even, One or Zero (switch selected)
Character	Eleven bits (start, seven bit ASCII, parity, two stop bits) Received characters may have any number of stop bits
Modes	Half Duplex or Full Duplex (switch selected)
PHYSICAL/ENVIRONMENTAL DATA	
Size and Weight	15-1/2 inches (39.4 cm) wide, 13-1/2 inches (34.3 cm) high, 20-1/2 inches (52.2 cm) deep, 28 pounds (12.7 kg)
Power Required	104 to 125 v, 60 Hz ±1%,75 watts (100, 115, 220 or 240 v ± 10%, 50 Hz ±1% for International)
Temperature Range	10° to 40°C (50° to 104°F) operating; - 20° to 65°C (4° to 150°F) storage
Humidity Range	5% to 90%, non-condensing
REMOTE COMMANDS	
Cursor	Up down, right, left, home, direct cursor address, columnar tab, field tab, send cursor address
Display	Clear screen, clear foreground fields, high-intensity, blink, or blank foreground fields, low intensity follows, display test pattern, clear to end of line, clear to end of screen, insert line, delete line
Keyboard	Lock, unlock, sound alarm, enter/exit function mode
ADDITIONAL FEATURES	
Numeric Keypad and Function Mode	15 key numeric cluster. 12 Keys generate ESCape sequences in function mode
Typamatic Keyboard	Alphanumeric and incremental cursor control keys repeat at 15 char/second rate when held down for 3/4 second.
Break Key	Inserts 200 to 250 ms break in transmitted data
Tab Stops	Tab stops every eighth column
Auxiliary Input/ Output Port (Option)	RS-232C input/output with remote enable, enable without display, and disable commands.

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SECTION 2

INSTALLATION

2.1 SET-UP AND CONNECTIONS

Following unpacking, place the unit so that free air circulates around the rear, base and top. Ensure that cables are free of kinks or tight bends.

2.1.1 Interface Connection

The standard Electronic Industries Association (EIA) input/output connector (figure 2-1), located on the rear of the terminal, provides the connection to the data set or acoustic coupler. The interface is compatible with EIA Standard RS-232C.

2.1.2 Auxiliary Input/Output Connection

If the terminal is equipped with the optional auxiliary input/output feature, the auxiliary input/output connector (figure 2-1) may be used to connect a compatible RS-232 device such as a serial printer.

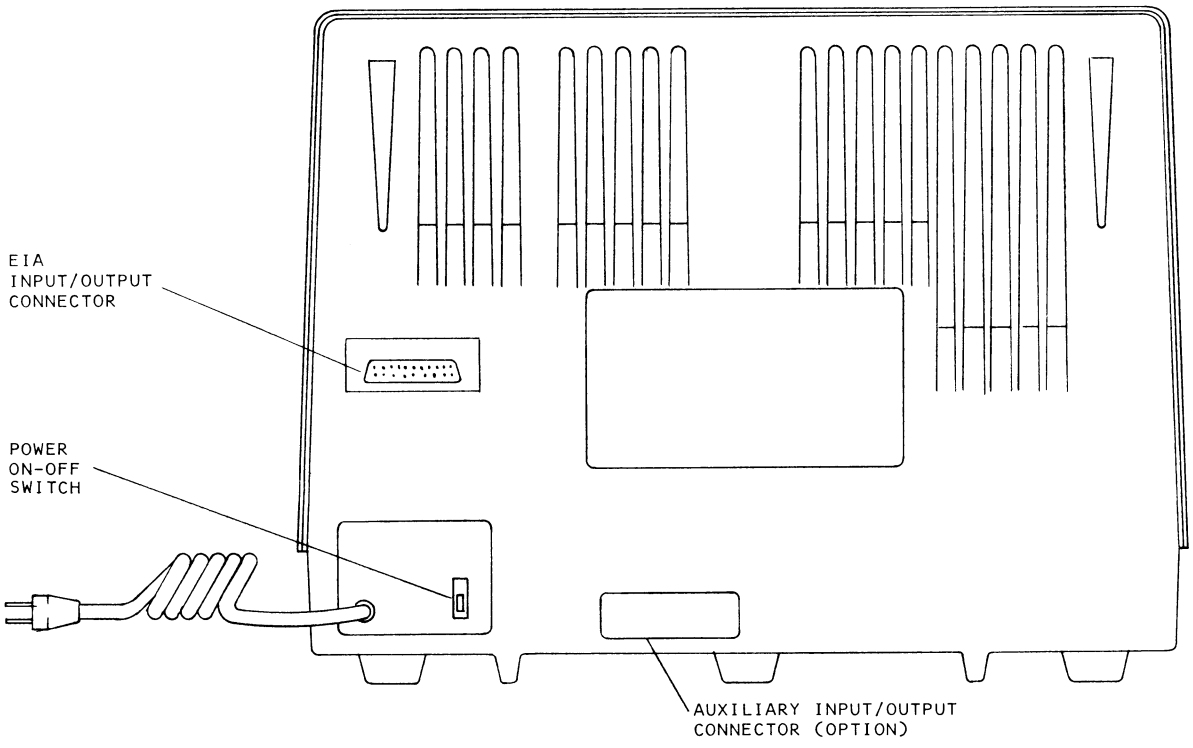


Figure 2-1. Terminal, Rear View

2.1.3 Power Cord

The power cord must be plugged into a properly grounded power outlet. Do not use adapters which would prevent the terminal unit from being properly grounded.

On international units, check the identification plate on the back of the terminal to ensure that the terminal is set for the appropriate voltage.

2.1.4 Cleaning

Dirt and smudges can be removed from the cabinet with common household spray cleaner and a soft cloth. The faceplate should be cleaned only with a soft, damp cloth or tissue to avoid scratching.

2.2 TURN-ON AND WARM-UP

A terminal brought in from a substantially colder environment should be allowed at least 1 hour to reach room temperature prior to power turn-on.

2.2.1 Power Turn-on

The power on/off switch is located at the rear of the terminal. When power is turned on, a cursor should appear on the display within 3 minutes.

a. If random characters appear on the screen and do not clear when the CLEAR key is depressed, or if there is no response to keyboard entries, switch power off, wait 15 seconds, and switch power on one more time. If the problem occurs a second time, refer to Section 6.

b. If there is no display after the unit has warmed up for a reasonable time (not more than 3 minutes), adjust the CONTRAST control located under the access panel above the keyboard. If there is still no display, refer to Section 6.

2.2.2 Warm-Up

Allow 30 seconds for display warm-up. At the end of this period the terminal is ready to operate.

SECTION 3

CONTROLS AND KEYBOARD

3.1 CONTROLS AND INDICATOR UNDER ACCESS PANEL

Switches used for selecting the input/output interface characteristics of the terminal are accessible to the operator without having to open the terminal. To gain access to these switches, remove the access panel above the keyboard by pulling up. The function of each control is described in the following paragraphs.

3.1.1 Baud Rate

The three BAUD RATE switches are used to select one of eight communication speeds from 110 to 9600 baud. The switch settings for each available speed are shown in figure 3-1.

3.1.2 Parity

The PARITY switches are used to select the parity compatible with the system. The switch settings for each parity condition are shown in figure 3-1. The four possibilities are:

Parity	Operation
Odd	Checks for odd parity on received data and generates odd parity on data sent.
Even	Checks for even parity on received data and generates even parity on data sent.
1	The parity bit of each transmitted character is set to a one. No parity check is made on data received.
0	The parity bit of each transmitted character is set to a zero. No parity check is made on data received.

NOTE

1. Baud rate and parity are determined by the switch settings at the time the terminal is turned on. To make a change after the terminal is turned on, reset the switches for the desired speed and parity and press the BREAK key (figure 3-2) to initiate the change.
2. If a character is received with a parity error when Even or Odd parity is selected, a ? symbol will be displayed at the cursor position.

3.1.3 Communication Mode

a. Full Duplex

The off position of this switch selects the full duplex mode of communication which is typically used when the communications system is capable of simultaneous two-way transmission. In this mode, data entered from the keyboard is sent directly to the computer system. Upon reaching the computer, the data is typically "echoed" back to the terminal at the discretion of the program (ie, it may not be desirable to echo back special codes, passwords, etc). If modems are used, they must

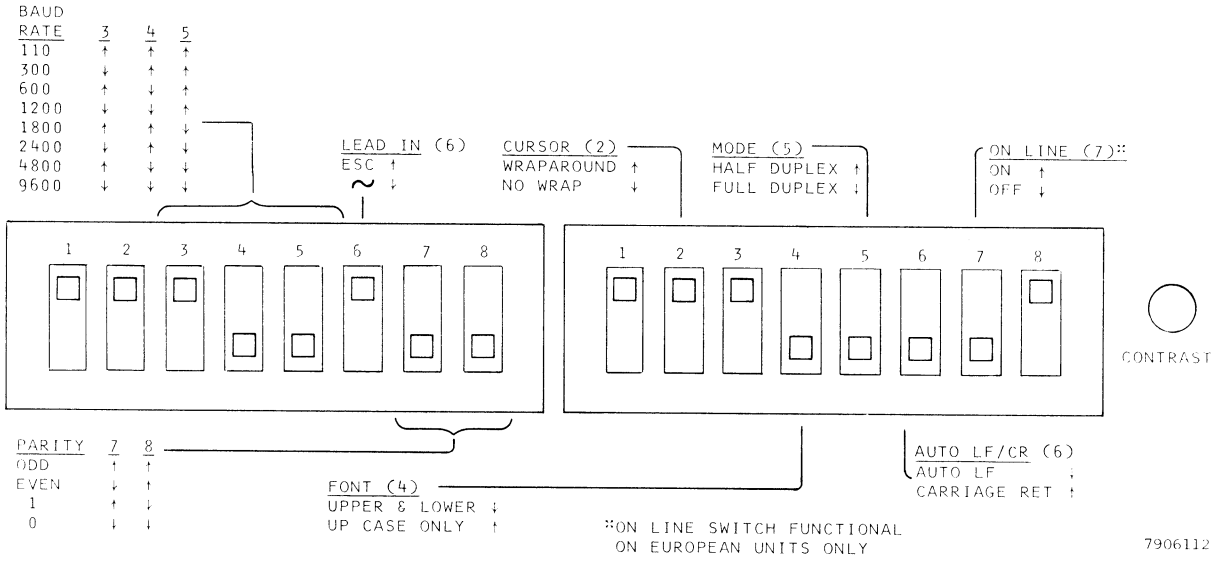


Figure 3-1. Controls Under Access Panel

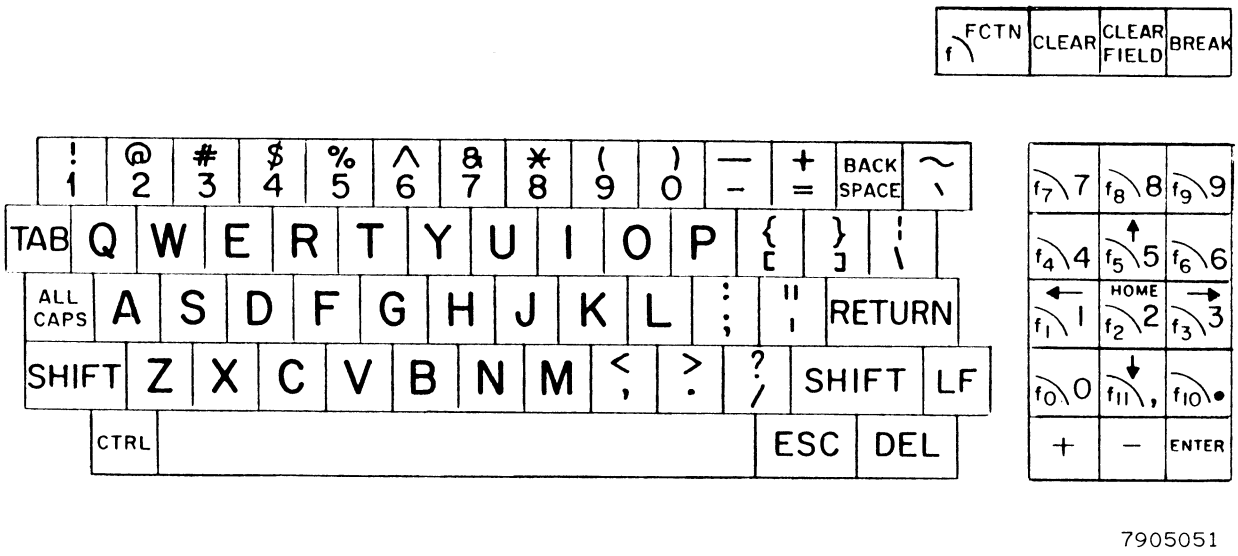


Figure 3-2. Keyboard

be set for full duplex operation. Only received or "echoed" data is displayed or acted upon by the terminal.

b. Half Duplex

The on position of this switch selects the half duplex mode of communication. In this mode, data entered from the keyboard is sent directly to the computer system and is treated as received data by the terminal via an internal connection. Echoing, as in full duplex mode, is not required; if used, it may cause each transmitted character to be displayed twice.

3.1.4 Automatic Line Feed or Carriage Return

a. AUTO LF (Automatic Line Feed)

When this switch is in the on position, all received carriage returns automatically cause the cursor to move to the first character position of the next line (new line function). The CR code is not stored in the display memory. If the cursor was on the last displayable character row, carriage returns will scroll the display (refer to section 4.4 for a description of scrolling). Received line feed characters are ignored.

b. CR (Carriage Return)

When this switch is in the off position all received carriage returns move the cursor to the first character position of the same line. The CR code is not stored in the display memory. Received line feed characters move the cursor down one line. If the cursor was on the last displayable character row, line feed characters cause the display to scroll (refer to section 4.4 for a description of scrolling). The LF code is not stored in the display memory.

3.1.5 Font

a. UP (Upper case)

The on position of this switch selects upper case only operation. All lower case alpha characters generated from the keyboard are converted to upper case for transmission and display. All received lower case alpha characters are displayed as upper case. In this position, the ALL CAPS key is logically disabled.

b. U/L CASE (Upper and lower case)

The off position of this switch selects the full 128 character ASCII codes for transmission and 95 character alpha/numeric character set for display. In this position, the ALL CAPS key in the down position may be used for upper case operation.

3.1.6 Lead-In

This switch must be set to match the lead-in code selected for remote commands, as described in paragraph 4-4. If ESCape is selected as the lead-in ~ will be displayed when received.

3.1.7 Wraparound

If wraparound mode is selected (on position), whenever a character is entered in the last (80th) column of a row, either from the keyboard or as received data, the cursor moves to the first column of the next row without requiring a carriage return or line feed. If the cursor was on the bottom row, the display scrolls up.

If no wraparound is selected (off position), when the cursor reaches the last (80th) column it remains there until a carriage return or line feed (or other cursor movement command) is received. If data continues to be entered, either from the keyboard or as received data, the

characters are entered in the 80th character position sequentially, each character replacing the previous one.

3.1.8 Contrast Control

This control, located to the right of the switchs, permits a wide range of contrast adjustment to facilitate viewing the display under a variety of lighting conditions.

3.1.9 Power On Indicator

The power on indicator lights (red) whenever the terminal is on. In addition, the indicator blinks if the keyboard is locked out or the terminal is in the function mode.

3.2. KEYBOARD

3.2.1 Alphanumeric (qwerty) Cluster

The alphanumeric keys operate in the same manner as a typewriter keyboard. The lower case letter, or lower symbol on the key, is transmitted when the key is struck. When either SHIFT key is held down while an alphanumeric key is struck, the upper case letter, or the upper symbol on the key is transmitted. The CTRL (control) key operates like the SHIFT key in that it must be held down while another key is typed to accomplish its function. The CTRL and SHIFT keys, used in conjunction with the alphanumeric keys, permit transmission of any one of the 128 ASCII codes (Appendix A). Appendix B lists the keystroke combination required for every ASCII code. If the ASCII code does not correspond to a displayable character (codes in columns 0 and 1 Appendix A, and DEL are not displayable) nothing will be displayed on the screen. Table 3-2 lists the character(s) transmitted and the function performed by the non-alphanumeric keys on the keyboard.

3.2.2 Numeric Cluster

In normal operation, the numeric pad keys duplicate the corresponding keys in the alphanumeric cluster (the ENTER key causing a carriage return), and are provided for convenience in entering numerical data. If the terminal is placed in the function mode by remote command or by pressing the FCTN key, keys 0 through 9, comma and period become user defined function keys and transmit the ESCape sequences described in paragraph 4.6.

3.2.3 Additional Keyboard Commands

Table 3-1 lists commands which can be entered from the keyboard, but for which no individual key is provided. In addition, any of the remote commands listed in Appendix C except Enable Auxiliary Output No Display, will be performed by the terminal if the appropriate character sequence is entered from the keyboard. If the keyboard lock sequence (Lead-in CTRL U) is entered, the keyboard will be locked out, and may be unlocked locally only by switching terminal power off and then on to reset the terminal.

Table 3-1. Additional Keyboard Commands

Keystrokes	Command	Description
Lead-in ^{C}Y	Background Follows	All subsequent data will be entered as a background field until cancelled by one of the three following "foreground" commands. Data in a background field will be displayed in low intensity, will not be cleared by a CLEAR FIELD entry, and will be tabbed over by a TAB entry.
Lead-in ^{C}B	Select Blank Foreground Field	All subsequent data will be entered as a foreground field until cancelled by a Background Follows command, and *all* foreground data will be blank on the display but retained in memory.
Lead-in ^{C}DEL	Select High Intensity Foreground Field	All subsequent data will be entered as a foreground field until cancelled by a Background Follows command, and *all* foreground data will be displayed at high intensity.
Lead-in ^{C}A	Select Blinking Foreground Field	All subsequent data will be entered as a foreground field until cancelled by a Background Follows command, and *all* foreground data will blink (2/3 second on, 1/3 second off).
Lead-in "	Display Test Pattern	A test pattern of all 0's will be displayed with the cursor in the home position.
Lead-in ^{C}Z	Insert Line	Row cursor is on and all rows below it scroll down one row. New row of all spaces appears on display with cursor in first column.
Lead-in ^{C}S	Delete Line	Row cursor is on is deleted and all rows below it scroll up on row. Cursor moves to first column of same row.
Lead-in ^{C}O	Clear to End of Line	All characters from cursor position to end of line, including character under cursor, are cleared to foreground spaces.
Lead-in ^{C}X	Clear to End of Screen	All characters from cursor position to end of screen, including character under cursor, are cleared to foreground spaces.
		NOTE
	The remaining commands are applicable only if the auxiliary input/output port is installed.	
Lead-in /	Enable Aux Output with Display	All subsequent data will be available at the auxiliary input/output port. The terminal defaults to this condition.
Lead-in ?	Disable Aux Output Port	Data will not be output at the auxiliary input/output port.

Lead-in = ESC or ∿ as selected

A superscript ^{C} or ^{S} indicates holding the CTRL and/or SHIFT key down while typing the character.

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Table 3-2. Keyboard Operations

Key Stroke	Transmitted Char(s)		Operation in half duplex or in full duplex when echoed
	Half Dupl	Full Dupl	
ALL CAPS	None	None	Alternate action key. When set (down) all alphabet keys generate upper case
SHIFT/TAB	SO	SO	Horizontal Tab to next tab stop
TAB	HT	HT	Tab to start of next foreground field
ESC	ESC	ESC	If ESC is selected as lead-in next character will be interpreted as a command (para. 3.1.6)
DEL	DEL	DEL	None
RETURN	CR	CR	Carriage return or carriage return and line feed
LINE FEED	LF	LF	Line feed or none
HOME	None	L-I DC2	Cursor moves to upper left corner
BACK SPACE	BS	BS	Cursor moves left one character
←	None	BS	
→	None	DLE	Cursor moves right one character
↑	None	L-I FF	Cursor moves up one row
↓	None	L-I VT	Cursor moves down one row
FCTN	None	None	Numeric pad keys labled f0 through f11 become user defined function keys
CLEAR	None	L-I FS	Clear screen and home cursor
CLEAR FIELD	None	L-I GS	Clear all foreground chars to spaces
BREAK	Break	Break	Break signal
SHIFT/ON LN	None	None	Alternate action key. Places terminal on line and takes it off line
Numeric Pad	See remarks	See remarks	Same as corresponding keys in alpha-numeric cluster except after FCTN key is struck

L-I = ESC or ~ as selected

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Table 3-2. Keyboard Operations (Cont)

Remarks
Only the alphabetic keys are affected. Received lower case characters will be displayed as lower case. If the Upper Case mode has been switch selected (para 3.1.5) ALL CAPS is overridden
Numbering columns 0 to 79, stops are at 0, 8, 16, 24 ... (steps of 8) ... 72
If these is no new foreground field down-screen from cursor position, search will resume at home position
If ESC is followed by one of the command codes listed in Appendix C the command will be executed. If followed by any other character both will be ignored
Operation depends on interpretation by host. Commonly used to cancel previous character
If AUTO LF is selected (para 3.1.4) CR is transmitted when RETURN is typed and the cursor moves to the start of the next line. LF will be sent if LINE FEED is typed but received LF's are ignored. If CR is selected, CR is sent and cursor moves to start of present line
Cursor Up, Down, Right and Left will not be executed if the result would put the cursor off the screen (CR or LF will be executed at the bottom of the screen, with the display scrolling up as necessary). Cursor right and left wrap around at edge of screen. Cursor right differs from space in that characters are not replaced by spaces for cursor right
ESCape sequence described in paragraph 4.6 is sent when f0 through f11 is typed following FCTN key. Function mode may be cancelled by typing FCTN a second time
Screen is cleared to foreground spaces in both cases
Terminal transmits all 0's for 200 to 250 milliseconds
Keyboard will be locked out when off line except for ON LN keystroke
ENTER key duplicates RETURN key in normal mode. There is no Function Mode sequence for + - or ENTER

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SECTION 4

OPERATION

4.1 OPERATION IN FULL DUPLEX

The full duplex mode of communication is used with systems capable of simultaneous two-way transmission, and permits more computer control of the display. Data and commands entered at the keyboard are transmitted directly to the computer without display. The display is affected only by data and commands received by or "echoed" back to the terminal. The cursor movement (HOME, ↑, etc) and CLEAR keys also generate codes which are transmitted to the computer, and performed only when echoed back to the terminal. In the full duplex mode, the terminal's "Request to Send" output is high (true) when the first character is entered and remains high until power is shut off.

4.2 OPERATION IN HALF DUPLEX

The half duplex mode of communication is used when the system is not capable of simultaneous two-way transmission, or "echoed" back operation is undesirable. Data keyed from the keyboard is transmitted and displayed simultaneously. The cursor movement (except BACK SPACE) and CLEAR keys do not generate codes for transmission in half duplex mode (see table 3-1). Half duplex transmission via a modem is accomplished by the following modem control sequence:

1. When a character is entered at the keyboard, the terminal outputs a "Request to Send" signal to the modem.

2. The terminal checks for a "Data Set Ready" signal from the modem.

3. Upon sensing the Data Set Ready signal, the terminal waits, if necessary, for a "Clear to Send" signal from the modem.

4. Upon sensing the "Clear to Send" signal, the terminal transmits the character via the modem. The terminal's "Request to Send" signal remains present, and entered characters are transmitted, until one of the following three "turn around" characters is entered: Carriage Return, End of Text (ASCII ETX, keystroke CTRL C) or End of Transmission (ASCII EOT, keystroke CTRL D).

5. After transmission of the "turn around" character, the terminal resets its "Request to Send" signal and the modem switches to the receive mode. The sequence begins again when the next character is typed.

Note that if the terminal does not sense a "Data Set Ready" signal in step 2 above, it transmits the character regardless of the presence or absence of "Clear to Send". This permits direct hard-wired connection to a computer or other device without simulation of modem control signals.

4.3 SCROLLING

If a displayable ASCII code is received at the last character position of the bottom row, and the WRAP-AROUND switch is in the on position (para 3.1.7), the display moves up one row, the top row of data is removed, and the cursor moves to the first character position (left margin) of the new bottom row. This operation is referred to hereafter as scrolling and requires no fill

characters at any baud rate for a minimum of 24 consecutive scrolls. Scrolling also occurs when the cursor is on the bottom row and a line feed (CR selected, para 3.1.4) or carriage return (AUTO LF selected) is received.

4.4 REMOTE COMMANDS

The remote command features of the terminal provide the user with the capability of controlling the terminal via the CPU software. For the terminal to execute a remote command, the command code must be preceded by a lead-in code (except as noted). The lead-in code may be either a tilde (ASCII ~, column 7, row 14; decimal 126) or an escape (ASCII ESC, column 1, row 11; decimal 27). The ~/ESC switch (para 3.1.6) must be set to agree with the lead-in code selected. The lead-in code is not displayed when received and does not advance the cursor. The command code must follow the lead-in without intervening characters (including DEL or NUL characters). If the code following the lead-in code is not one of the valid command codes requiring a lead-in (a second lead-in is invalid) both the lead-in character and the following character will be ignored. The remote commands are listed and described in detail below.

Command	Lead-In	ASCII	Description
Sound Alarm	No	BEL	On receipt of the Sound Alarm command the terminal sounds an audible alarm for approximately 1/4 second.
Horizontal Tab	No	SO	On receipt of the Horizontal Tab command, the cursor tabs to the next tab stop on the present row. Tab stops are located in columns 0, 8, 16, 24 ... (steps of 8) ... 72 (numbering columns from 0 to 79). If there are no more tab stops in the present row the cursor moves to the first column (no. 0) of the next row, or to the home position if it was on the bottom row.
Field Tab	No	HT	On receipt of the Field Tab command the cursor tabs to the first character position in the next foreground field. If there is no new foreground field down-screen from the present cursor position, the search is continued from the home position. If home position is foreground, it is considered a new foreground field. If there is no new field on the display, the cursor ends up in the original location.
Line Feed	No	LF	On receipt of the Line Feed command, the cursor moves down one row in the same column; if it was on the bottom row, the display scrolls up. If the AUTO LF/CR switch is set to AUTO LF (para 3.1.4), Line Feed commands are ignored.
Carriage Return	No	CR	On receipt of the Carriage Return command, the cursor moves to the first column position of the present row. If the AUTO LF/CR switch is set to AUTO LF (para 3.1.4) the cursor also moves down one row; if it was on the bottom row, the display scrolls up.
Home Cursor	Yes	DC2	On receipt of the Home Cursor command, the cursor moves to the upper left (home) character position. The display is unchanged.

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Command		Description
Lead-In	ASCII	
Cursor Up		On receipt of the Cursor Up command, the cursor moves up one row in the same column. If the cursor is on the top row it does not move.
Yes	FF	
Cursor Down		On receipt of the Cursor Down command, the cursor moves down one row in the same column. If the cursor is on the bottom row, it does not move.
Yes	VT	
Cursor Right		On receipt of the Cursor Right command, the cursor moves right one column in the same row. If the cursor is in the right hand column (no. 79), it moves to the first column of the next row unless it is on the bottom row.
No	DLE	
Cursor Left		On receipt of the Cursor Left (Backspace) command, the cursor moves left one column in the same row. If the cursor is in the left hand column (no. 0) it moves to the last column and up one row unless it is on the top row.
No	BS	
Direct Cursor Address		The Direct Cursor Address command is a four character sequence: Lead-in DCl Xcoordinate Ycoordinate. The 80 character columns are designated X and range from 0 to 79. The rows are designated Y, and range from 0 to 23.
Yes	DCl, X, Y	
Send Cursor Address		On receipt of the Send Cursor Address command, the terminal responds with the sequence: X coordinate, Y coordinate, Carriage Return. The coordinate system is the same as described for Direct Cursor Address above. The coordinates transmitted are listed in Appendix B. In the full duplex mode of operation the terminal is capable of receiving data while the coordinates are being transmitted. In half duplex operation, the terminal is capable of receiving data after the CR is transmitted. The keyboard is locked out during transmission.
Yes	ENQ	
Send Character at Cursor Position		On receipt of this command, the terminal transmits the character at the present cursor position followed by a Carriage Return. The cursor is not advanced. When used in conjunction with the cursor up, down, right, left, and direct cursor address commands, this permits reading any character previously entered on the display.
Yes	!	

Decimal Address	Column (X)	Decimal Address	Row (Y)
0 through 78	0 through 78	0 through 22	0 through 22
79 through 95	79	23 through 31	23
96 through 127	0 through 31 (dec -96)	32 through 54	0 through 22 (dec -32)
		55 through 63	23
		64 through 86	0 through 22 (dec -64)
		87 through 95	23
		96 through 118	0 through 22 (dec -96)
		119 through 127	23

The four characters in the sequence must be received without intervening characters, including NUL characters. Appendix A lists all possible addresses and the key strokes for generating them.

C79053

Command	Lead-In	ASCII	Description
Clear Screen	Yes	FS	On receipt of this command, the entire screen is cleared to foreground spaces and the cursor moves to the home position.
Clear Foreground	Yes	GS	On receipt of this command, all foreground characters on the display are replaced with foreground spaces and the cursor moves to the first position in the first foreground field.
Clear to End of Line	Yes	SI	On receipt of this command all characters from and including the present cursor position to the end of the cursor row are cleared to foreground spaces
Clear to End of Screen	Yes	CAN	On receipt of this command all characters from and including the present cursor position to the end of the screen are cleared to foreground spaces
Insert Line	Yes	SUB	On receipt of this command a new row of all foreground spaces is inserted at the present cursor position with the cursor in the first column. The row the cursor was on, and all rows below it scroll down one row.
Delete Line	Yes	DC3	On receipt of this command the row the cursor is on is deleted from the display and all rows below it scroll up one row. The cursor moves to the first column of the present row.
Background Follows	Yes	EM	On receipt of this command, all subsequent data is entered as a background field until cancelled by one of the three following "foreground" commands. Data entered as background is displayed at low intensity, is not cleared by a Clear Foreground command, and is tabbed over by a Field Tab command. The terminal defaults to this state at turn on.
Select Blinking Foreground Field	Yes	SOH	On receipt of this command, all subsequent data is entered as a foreground field until cancelled by a Background Follows command, and *all* foreground data blinks (2/3 second on, 1/3 second off) until superseded by a different "foreground" command.
Select High Intensity Foreground Field	Yes	US	On receipt of this command, all subsequent data is entered as a foreground field until cancelled by a Background Follows command; *all* foreground data is displayed at high intensity until superseded by a different "foreground" command.
Select Blank Foreground Field	Yes	STX	On receipt of this command, all subsequent data is entered as a foreground field until cancelled by a Background Follows command; *all* foreground data is blanked on the display. The foreground data already in display memory, plus any foreground data entered subsequently is retained in memory and displayed on receipt of a Select Blinking or Select High Intensity Foreground Field command.
Keyboard Lock	Yes	NAK	On receipt of the Keyboard Lock command, the keyboard is locked out and no operator entries may be made. The POWER ON indicator will blink, while the keyboard is locked out. This command may be cancelled by the Keyboard Unlock command or by turning power off and then on to reset the terminal.
Keyboard Unlock	Yes	ACK	On receipt of this command, the keyboard is enabled. The terminal defaults to this condition at turn on.
Display Test Pattern	Yes	"	On receipt of this command, a test pattern of all background 0 characters is displayed with the cursor in the home position
Enter Function Mode	Yes	>	On receipt of this command the function keys fØ through fll become enabled in the function mode as described in paragraph 4.6. The remote command differs from entering the function mode by typing FCTN at the keyboard in that the keyboard will remain in function mode after the remote command until cancelled by the exit command described below.
Exit from Function Mode	Yes	<	On receipt of this command the keyboard is restored to the normal mode. If the keyboard is not in the function mode nothing is changed.

C79054

Command		Description
Lead-In	ASCII	
		NOTE The following three commands apply only to terminals with the auxiliary input/output port option. These commands should be followed by a fill character (NUL or DEL) or equivalent time out to allow time for the output to be enabled or disabled when the next character is received.
Enable Auxiliary Output With Display Yes	/	On receipt of this command, all data received via the terminal Input/Output port is displayed and is output at the auxiliary input/output port. In half duplex operation, keyboard entries are transmitted via the terminal input/output port and are output via the auxiliary port. The terminal defaults to this condition at turn on.
Enable Auxiliary Output-No Display Yes	*	The Enable Auxiliary Output-No Display command permits transmission to an auxiliary device without affecting the display. On receipt of this command, data received via the terminal input/output port is output at the auxiliary input/output port without processing or display by the terminal. The keyboard is locked out while in this mode and the POWER ON indicator blinks. The only inputs to which the terminal responds are a Disable Auxiliary Port or an Enable Auxiliary Port with Display command.
Disable Auxiliary Output Yes	?	On receipt of this command the auxiliary output is disabled and no data is output at the auxiliary port. Input remains enabled.

C79046

4.5 FOREGROUND/BACKGROUND

All data is entered in display memory as either a foreground field or a background field, depending on the most recent command as described in paragraph 4-4. The terminal defaults to the background state at turn-on. Data in a background field is always displayed in low intensity, is tabbed over by a Field Tab command (TAB at keyboard) and is not cleared by a Clear Field command.

Data in a foreground field is displayed as high intensity, blinking, or blank, depending on the most recent command (para 4-4). All foreground data is cleared by a Clear Foreground command or by depressing the CLEAR FIELD key. These features may be used to highlight data, enhance graphics, or in form fill applications. The form fill application is best described by an example. Figure 4-1 shows a command sequence and the resulting display.

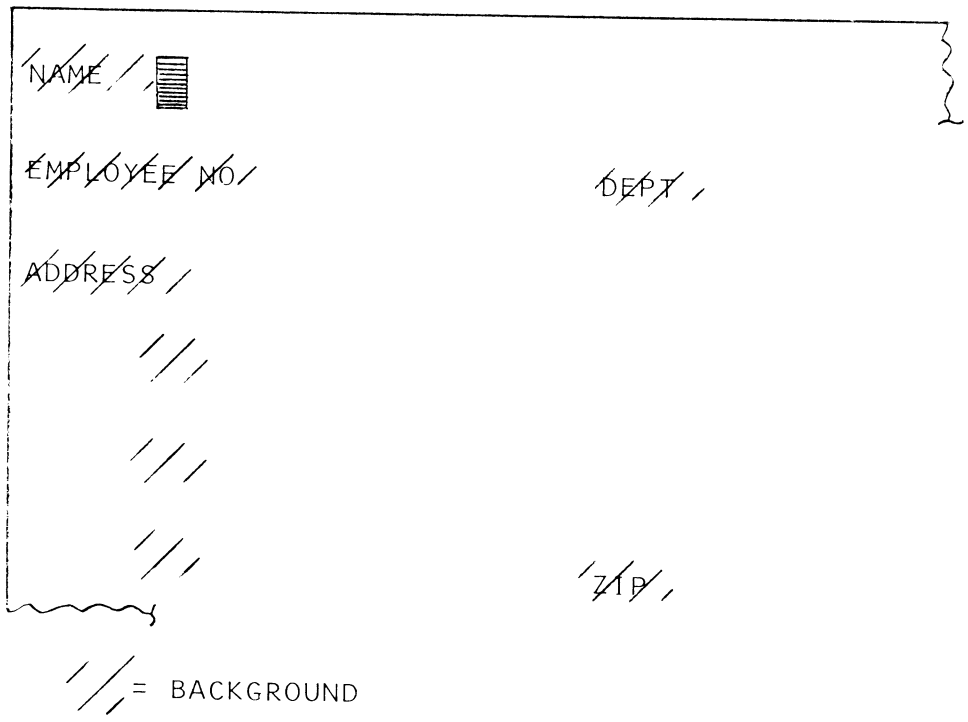
After the specified sequence is entered the cursor ends up in the first foreground position as shown. The operator may then enter the first field of data (name) and use the Field Tab (keystroke = TAB) which causes the cursor to tab over the next background field (employee no) and stop at the first foreground space following it, continuing until the form is completed. The form would appear in background (low) intensity, and operator entries in high intensity. A clear Foreground command (CLEAR FIELD at keyboard or Lead-in GS from computer) then clears the operator entries but leaves the form intact for another entry.

Alternatively, if multiple blocks of data sharing a common format are to be displayed, the same features may be used to transmit the form only once. If the sequence described

SEQUENCE ENTERED	OPERATION
ESC NAK ESC FS ESC DC1 b b ESC EM NAME space ESC DC1 B d EMPLOYEE NO Space ESC DC1 DEL d DEPT Space ESC DC1 b f ADDRESS Space ESC DC1 h h Space Space ESC DC1 h j Space Space ESC DC1 h l Space Space ESC DC1 DEL l ZIP Space ESC DC2 ESC US HT ESC ACK	Keyboard lock, clear screen, direct cursor address - col 2/row 2, background follows, "NAME", col 2/ row 4, "EMPLOYEE NO", col 31/row 4, "DEPT", col 2 /row 6, "ADDRESS", col 8/row 8, space space, col 8/row 10, space space, col 8/row 12, space space, col 31/row 12, "ZIP", Home, select high intensity foreground field, field tab, unlock keyboard

(The example assumes ESCape has been selected as remote command lead-in. Substitute ~ in all cases if selected as lead-in.)

RESULTING DISPLAY



7905055

Figure 4-1. Display Example

above were followed by: Jones, J. F. HT 1645 HT Personnel HT 145 Main Street HT HT HT Greenlawn, N. Y. HT 11743 the data would be displayed next to the appropriate form entries. A new block of data could then be transmitted to the same form by preceding it with Clear Foreground and Field Tab commands.

NOTE

1. Foreground and Background commands are not stored in display memory. Each character is coded as foreground or background when entered.

2. All character positions are cleared to foreground spaces at turn on and after a Clear command. A position can be changed to background field only by entering a background character (including space) in it. Commands which move the cursor over a field (Tab, Cursor Right, etc) do not change the nature of the field.

4.6 USER DEFINED FUNCTIONS

The terminal provides for transmission of twelve user-defined function codes without affecting the display. Pressing the FCTN key followed by one of the twelve numeric pad keys labled f0 through f11, causes the terminal to transmit a sequence of three ASCII characters: ESCape, the code for the normal key character (0 through 9, comma or period), Carriage Return. Any number of functions may be accommodated by using multiple codes. The FCTN key must be pressed before each function code; eg, to transmit function 3-2, type FCTN, f3, FCTN, f2. The cursor does not advance and nothing is displayed when the sequence is transmitted. If the sequence is echoed a carriage return is performed. Once the FCTN key is pressed, all keys except the twelve function keys are locked out and the POWER ON indicator blinks until one of the function keys is pressed. If the FCTN key is pressed in error, it may be cancelled by pressing it again.

4.7 TIMING CONSIDERATIONS

4.7.1 GENERAL. Characters received by the terminal are placed on a 54-character queue for processing, except NUL or DEL characters, which are ignored. At high baud rates it is possible to send more than 54 characters to the terminal while some time consuming commands are being processed. In order to prevent loss of data, fill characters or time out may be required after these commands.

NOTE

The symptom of a queue overrun will be the loss of 54 characters, or a multiple of 54 characters, immediately following a remote command. For example, at 9600 baud the sequence "Insert Line, Select Blinking Field, 80 data characters" could result in the loss of the Select Blinking Field command (2 chars) and the 52 characters following it.

The time consuming commands involved are those which require extensive reading and/or writing display memory characters, namely: Clear Foreground, Insert or Delete Line, Field Tab, Clear to End of Screen, and Clear Screen. Table 4-1 lists, for various baud rates, a) the maximum number of characters

Table 4-1. Weighted Character Values for Remote Commands, Fill Characters and Data Characters

FUNCTION	MAXIMUM CHARACTER VALUES				
Baud Rate	9600	4800	2400	1800	1200
Clear Foreground	+87	+44	+22	+17	+11
Insert or Delete Line	+65	+33	+17	+13	+8
Field Tab	+57	+29	+16	+11	+7
Clear to End of Screen	+15	+8	+4	+3	+2
Clear Screen	+8	+4	+2	+2	+1
Fill Char (NUL or DEL)	-1	-1	-1	-1	-1
Data Character	-0.2	-0.6	-0.8	-0.8	-0.9
Direct Cursor Address	0	-2	-3	-3	-3
Other Commands	0	-1	-1	-2	-2
Character Time (milliseconds)	1	2	4	6	8

Notes: All values except data characters are rounded to whole numbers.

Values are based on continuous transmission (no time between characters). If there is N bit space between transmitted characters the command values are multiplied by 10/(10 + N) and the character values are increased by N/10
For example, at 9600 baud with 5 bit space between characters:

$$\text{Value for Clear Foreground} = \left[+87\ \frac{10}{10+5}\right] = +58$$

$$\text{Value for data character} = -(0.2 + \frac{5}{10}) = -0.7$$

$$\text{Value for fill character} = -(1 + \frac{5}{10}) = -1.5$$

which can be transmitted while a command is being executed (+ values), b) the number of characters which will be worked off the queue in the time taken to transmit a character or command (- values), and c) the time corresponding to one character transmission. Table 4-2 provides minimum, maximum and methods of calculating approximate intermediate values for commands.

4.7.2 CALCULATION OF FILL REQUIREMENT. The number of fill characters (or time out) required is calculated as follows:

1. Tabulate the sequence of commands and data to be transmitted along with the character values from table 4-1 (or table 4-2 if use of maximum values is not desired).

2. Accumulate a running total of the character values (the total cannot be less than 0). At any point where the total exceeds +54, fill characters (or equivalent time out) must be inserted to reduce the total to 54 or less. For insurance and ease of calculation, a figure of +50 rather than +54 is recommended, as used in the example shown in table 4-3.

The following points about fill character calculations should be noted:

a. At all baud rates, no fill characters are required if the total transmission does not include more than 54 characters following one of the remote commands cited in paragraph 4.7.1.

b. At 4800 baud or below, no fill characters are required in any transmission which does not contain more than one remote command of the type cited.

c. At any point in a program where transmission is halted until a response is received from the terminal (operator entry, send cursor address command or send character command) the queue is emptied and the accumulated total (step 2, table 4-3) goes to zero.

d. Non-displayable characters, other than NUL or DEL, are counted the same as displayable characters.

4.8 AUXILIARY INPUT/OUTPUT PORT (OPTION)

A user installable auxiliary input/output (I/O) port is available for the terminal. It permits connection of an EIA RS-232 serial peripheral device to the terminal. Output to the peripheral device is controlled by remote command as described in paragraph 4.4. Input is controlled by the peripheral device via the Auxiliary Request to Send signal, and will be chanelled to the terminal I/O Transmitted Data (BA) line. The Clear to Send signal (CB) from a modem will be relayed to the peripheral device as Auxiliary Clear to Send. If no modem is present, Auxiliary Clear to Send will be held at a high level (true).

Table 4-2. Calculation of Character Values for Remote Commands

FUNCTION	MINIMUM, MAXIMUM AND INTERMEDIATE CHARACTER VALUES
Clear Foreground	Minimum (Full screen of FG): +21R Maximum (1 FG char at home position): +87R Mixed Screen: $\left[\frac{\text{No. of FG char}}{76} + \frac{\text{No. of BG char}}{23} + 4\right]R$ $\left[\frac{\text{No. of FG char}}{76} + (3.5 \times \text{No. of BG fields})\right]R$ whichever is greater
Insert or Delete Line	Minimum (line No. 0 or 23): +5.5R Maximum (line No. 11 or 12): +65R Other: $\frac{65(N+1)}{12}R$ where N = line No. (lines 0 to 11) $\frac{65(24 - N)}{12}R$ (lines 12 to 23)
Field Tab	Minimum (all FG): +17R Maximum (all BG): +57R Other: $\left[\frac{\text{No. of FG chars tabbed over}}{113} + \frac{\text{No. of BG chars tabbed over}}{34}\right]R$
Clear to End of Screen	Minimum (cursor on bottom row): +0.7R Maximum (cursor on top row): +15R Other: $\frac{15}{24}(24-N)R$ where N = line No. (0 to 23) of cursor position
Clear Screen	Minimum = Maximum = +8R
$R = \frac{\text{Baud Rate}}{9600}$	FG = Foreground BG = Background

Table 4-3. Sample Fill Character Calculation

(For 9600 baud - example limits queue to 50 characters)

	STEP 1	STEP 2
Start	0	0
Clear	+8	+8
Background Follows	0	+8
60 data chars (60 x -0.2)	-12	-4 = 0
Direct Cursor Address	0	0
Insert line (at line 11)	+65	+65 -Insert 15 fill chars (65-15) = 50
80 data chars (80 x -0.2)	-16	+34
Direct Cursor Address	0	+34
Insert line at No. $5(\frac{65 \times 6}{12})$	+33	+67 -Insert 17 fill chars (67-17) = 50
50 data chars (50 x -0.2)	-10	+40
-		-
-		-

SECTION 5

COMMUNICATIONS INTERFACE

5.1 ASCII

The Hazeltine 1420 terminal communicates via the ASCII code shown in Appendix A. A parity bit, as selected, is added to make an eight-bit code.

5.2 ASYNCHRONOUS DATA

The format for received and transmitted data is asynchronous serial ASCII. Each transmitted character is preceded by a start bit and followed by two stop bits. Received characters may have any number of stop bits. The parity bit can be selected (see Section 3) to be even, odd, always one, or always zero. If a character is received with incorrect parity (with odd or even parity selected), a question mark (?) is displayed on the screen at the cursor position. This indicates to the terminal operator that erroneous data was received. Switches are provided (see Section 3) to select one of eight transmission rates from 110 to 9600 baud.

5.3 FULL DUPLEX/HALF DUPLEX

Full duplex operation requires the ability to communicate in two directions simultaneously. For telecommunications, this means that the modem involved is capable of simultaneous bi-directional data transmission and reception. Half duplex operation requires that communications alternate between transmit and receive. For telecommunications, this means that the modem involved is switched between the transmit mode and receive mode by the terminal. Operation of the Hazeltine 1420 requires that communications take place at the same baud rate for both receive and transmit.

5.4 EIA INTERFACE

5.4.1 EIA Input/Output Connector

The standard EIA input/output connector located on the rear of the terminal (figure 2-1) provides the connection to the appropriate data set or acoustic coupler. The signals conform to EIA Standard RS-232C; these are listed below.

Pin Number	Direction of Signal	Designation	Function
1	--	AA	Protective Ground (Chassis)
2	From Terminal	BA	Transmitted Data
3	To Terminal	BB	Received Data*

*If the current loop option is installed, a small switch is added to the circuit board next to the input/output connector. If the switch is a toggle switch, it must be set toward the connector for EIA operation and away from the connector for current loop operation.

If the switch is a slide switch, it must be set toward the connector for current loop operation and away from the connector for EIA operation.

Start Bit	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Parity Bit	Stop Bit	Stop Bit

TRANSMITTED DATA FORMAT

Pin Number	Direction of Signal	Desig-nation	Function
4	From Ter-minal	CA	Request to Send
5	To Ter-minal	CB	Clear to Send
6	To Ter-minal	CC	Data Set Ready
7	--	AB	Signal Ground
8	To Ter-minal	CF	Data Car-rier Detect
13	From Ter-minal	--	16X Baud Rate Clock
18	To Ter-minal	--	+ Current Loop Input*
19	To Ter-minal	--	- Current Loop Input*
20	From Ter-minal	CD	Data Ter-minal Ready
21	From Ter-minal	--	Current Loop Output*
25	From Ter-minal	--	Current Loop Output*

*No connection if current loop option is not installed.

5.4.2 Auxiliary Input/Output Connector (Option)

The auxiliary input/output port is an option that can be installed by the user. It permits serial output of received and transmitted data, at the data I/O baud rate, to an RS-232C compatible auxiliary device such as a printer, recorder, or another terminal. It also permits display and transmission of serial data input from an auxiliary device. Output and display may be controlled by remote commands described in paragraph 4.4. Additional information is furnished with the modification instructions.

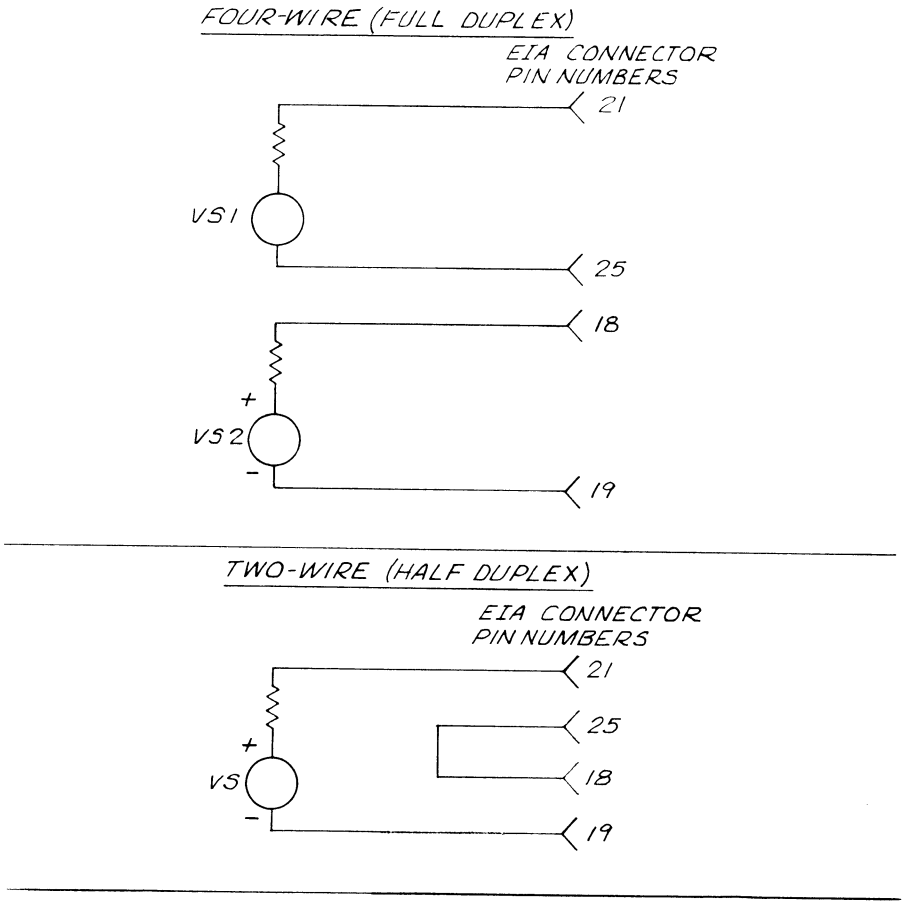
If installed, the auxiliary input/output connector is located on the lower rear of the terminal (figure 2-1). It provides the EIA RS-232C voltage level signals listed below:

Pin Number	Direction of Signal	Desig-nation	Function
1	--	AA	Protective Ground (Chassis)
2	To Terminal	Aux BB	Auxiliary Data In
3	From Ter-minal	Aux BA	Auxiliary Data Out
4	To Terminal	Aux CA	Auxiliary Request to Send
5	From Ter-minal	Aux CB	Clear to Send
6	From Ter-minal	Aux CC	See Note
7	--	AB	Signal Ground
8	From Ter-minal	Aux CF	See Note

NOTE: Aux CC and Aux CF are true (high) whenever the terminal is on.

5.5 CURRENT LOOP INTERFACE (OPTION)

The current loop interface converts the standard EIA RS232 voltage level interface to a 20 mA current switching interface. The current loop interface switching states are "mark" (current flow) or "space" (no current flow). The output data controls a circuit closure. In the "mark" condition, the circuit is closed while in the "space" condition the circuit is open. Figure 5-1 shows the external current loop configuration for either a four-wire (full duplex) facility or two-wire (half duplex) facility.



Note that the current loop connections must follow the polarities indicated and that there is a 50 volt open circuit limitation on voltages applied to the current loop interface. The current source must be external to the terminal.

7706024

Figure 5-1. Current Loop Interface

The maximum ratings are:

Current:	30 mA maximum
Open Loop Voltage:	50 V maximum
Cable Interface:	1000 ft maximum 9600 baud

5.6 HARDWIRE INTERFACE

The terminal can be connected directly to a computer by connecting pins 2, 3 and 7 from the EIA connector on the rear panel. Note that pins 2 and 3 may have to be crossed with the corresponding pins on the computer. No wiring changes are required at the terminal to simulate

the presence of a modem. Refer to your computer supplier for any special wiring at the computer interface.

5.7 DATA SETS

5.7.1 103A or 212A Modems

The terminal connects directly to a 103A or 212A modem through an optional interface cable which is available from Hazeltine.

5.7.2 202 Modem

The terminal connects to a 202 modem through an interface cable which is available from Hazeltine. The following procedure should be followed for proper operation with a half duplex 202 modem.

a. After the first key is depressed, the terminal conditions the modem for transmission. This can take up to 1/5 of a second. A very fast typist should take care to ensure that the first character reaches the screen before additional entries are mode.

b. To complete the transmission to the computer system, either a carriage return (RETURN), ETX (CTRL C) or EOT (CTRL D) must be entered as a termination character. The termination character used is determined by the computer software. Upon sending the termination character, the 202 modem switches into the receive mode.

c. Depressing the next character for transmission returns operation to step a.

SECTION 6

SERVICING

6.1 INTRODUCTION

Hazeltine will repair units returned to the factory under the conditions contained in the description of "Warranty Service" and "Non-Warranty Service" supplied with the terminal.

For customers who elect the alternative of troubleshooting to the circuit board level, this section provides instructions for gaining access to internal components, changing the fuse, removing and replacing the printed circuit board, and aligning the monitor. Some of the procedures require a second terminal or spare circuit board, without which accurate diagnosis may not be possible.

WARNING

Do not attempt to service the terminal until you have read and understood the procedures described herein and are prepared to adhere to them strictly.

Dangerous voltages (12,000 vdc, 500 vdc and 100 to 240 vac) are present in the Video Display Terminal. Some voltage may remain present in the monitor circuits (see figure 6-2) after power is disconnected. Use caution when working on internal circuits. Do not work alone.

The terminal power cord should always be unplugged before the cover is removed. Use caution when handling the cathode-ray tube (eg, wear safety goggles) to avoid risk of implosion. The internal phosphor coating is toxic; if the tube breaks and skin or eyes are exposed to phosphor, rinse with water immediately and consult a physician.

Any person who elects to use these procedures thereby agrees and acknowledges that Hazeltine Corporation will not be liable for any damages due to failure to follow exactly the instructions contained herein. Said customer also agrees to indemnify Hazeltine Corporation against any claim brought by an employee or subcontractor of customer as a result of the failure to follow, in whole or in part, the instructions contained herein.

The terminal is equipped with a safety interlock which interrupts power when the cover is removed. All diagnoses and adjustments which require power can be accomplished with the cover on and no attempt should be made to defeat the interlock.

6.2 TROUBLESHOOTING

In the unlikely event of a problem, the single circuit board design of the Hazeltine 1420 coupled with the instructions herein makes troubleshooting very simple. Almost all problems are corrected by realigning the monitor circuits or replacing the circuit board. These should be within the capability of the average user who understands and strictly follows the instructions herein. Servicing beyond this level should be performed only by a qualified technician. The following guidelines

are provided to help isolate problems and minimize unnecessary replacement of circuit boards.

6.2.1 Preliminary Steps

Before deciding that the terminal is malfunctioning, check the following:

- Power cord plugged into a working outlet, power switch ON and cover on.
- Check that input/output connector at rear of unit is tight.
- Check that CONTRAST control under access panel (paragraph 3.1) is properly adjusted and interface switches are set properly for the system (see notes for paragraph 3.1.2).
- If possible, substitute another terminal to confirm or absolve the terminal (versus interface) as the cause of the problem.

6.2.2 Troubleshooting Procedure

a. Disconnect the electric power, wait 5 minutes, and open the unit as described in paragraph 6.3.

b. Refer to table 6-1 and answer the questions about the symptoms. The chart leads through the appropriate troubleshooting steps.

6.3 ACCESS

To gain access to internal components proceed as follows:

a. Disconnect the power cord plug from the ac power socket.

b. Lay the terminal on its side and loosen two captive screws in the base (figure 6-1).

c. Set the terminal upright and loosen two captive screws at the top rear.

d. Carefully lift the cover (with the cathode-ray tube (crt)) off the base and set it immediately to the right of the base. There is enough slack in the wiring to lay the cover on its side alongside the base as shown in figure 6-2.

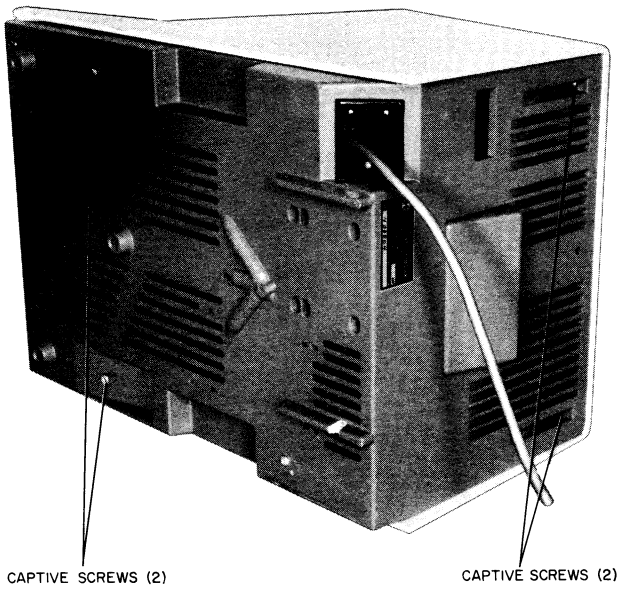
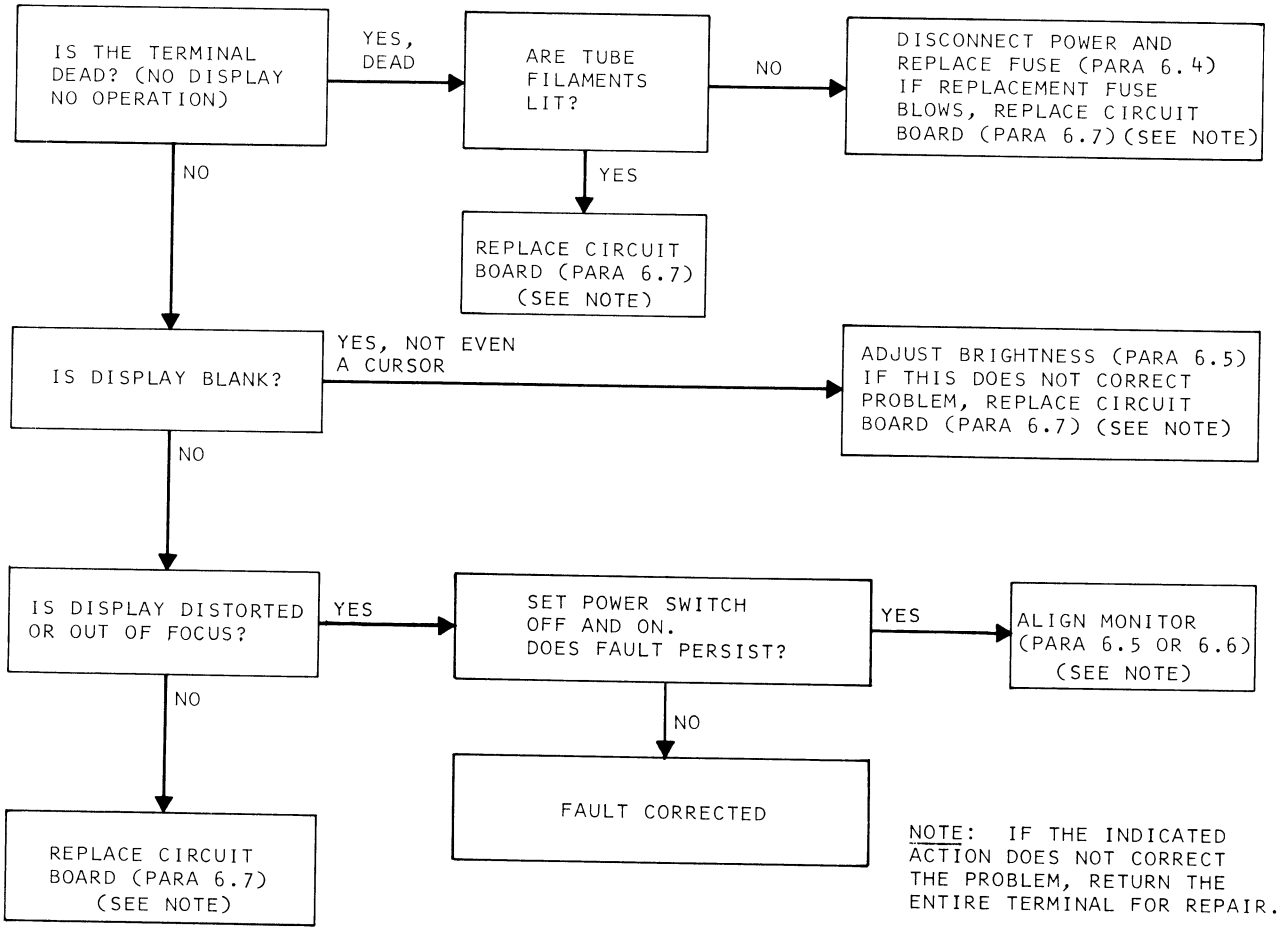


Figure 6-1. Rear and Bottom View of Terminal

Table 6-1. Troubleshooting Chart



7805095

6.4 CHANGING FUSE

NOTE

Prior to removing cover, look through the slots in the rear to see if the crt filaments are lit. If they are lit, the problem is not a blown fuse.

a. Open the unit as described in paragraph 6.3.

b. Loosen the two hold-down screws securing the circuit board to the base (figure 6-2).

c. Grasp the circuit board under the keyboard area and lift up about 1/2 inch; then slide the circuit board forward just enough for the keyhole slots to clear the hold-down screw heads, and lift the board gently from the base.

WARNING

Double check that the power cord is disconnected before changing fuse.

d. The fuse or fuses are located on a bracket assembly at the right

rear of the base (figure 6-3.) They may be removed by pulling up by hand, or with a fuse puller tool available in most automotive shops.

e. Install the new fuse by pressing into the clamps.

CAUTION

Use only type 3AG 1 ampere slo-blo fuses for 100 to 140 volt operation or 1/2 ampere slo-blo fuses for 200 to 240 volt operation. The use of a larger fuse may result in damage to the equipment.

f. Slide circuit board onto the base and seat the holes in the board over the bosses on the base.

g. Secure the two hold down screws loosened in step b.

h. Connect the power cable, place the cover on the base, and set the power switch to ON. If the replacement fuse blows, refer to paragraph 6-2.

i. If the replacement fuse has not blown, disconnect the power cord and reassemble the unit by reversing the procedure of paragraph 6.3.

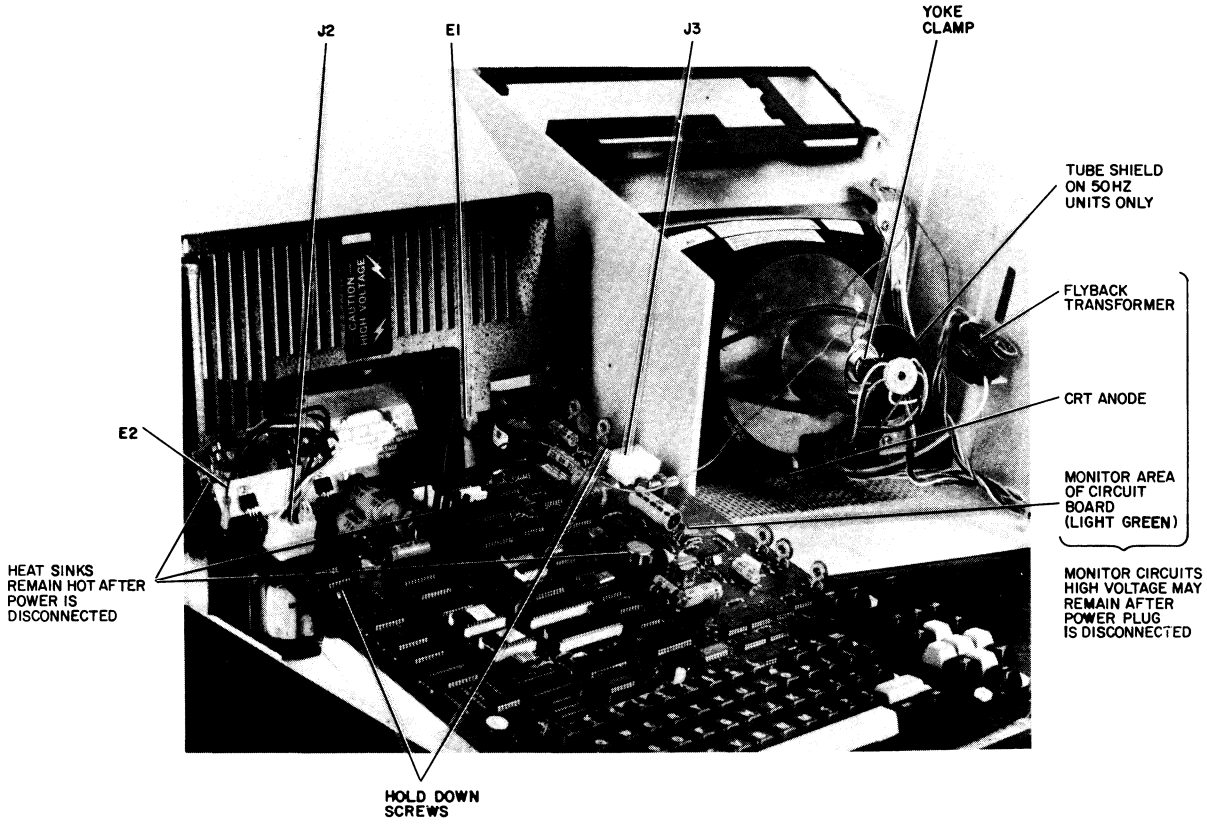


Figure 6-2. Terminal, Open, Ready for Servicing

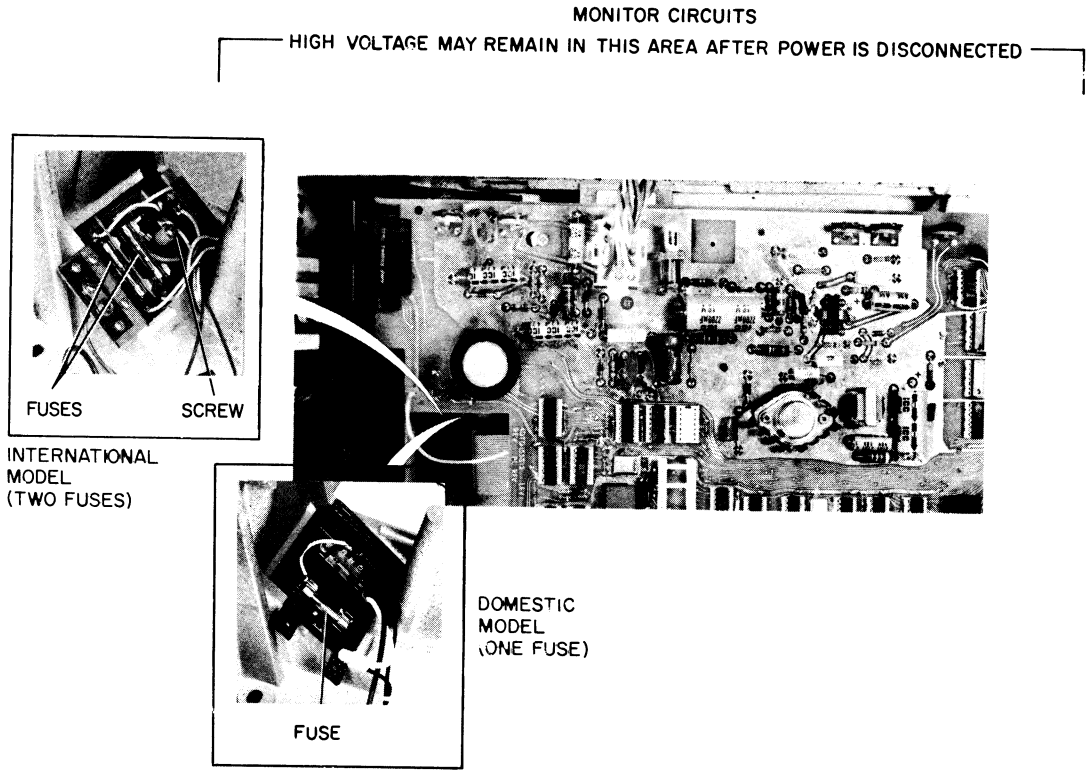


Figure 6-3. Location of Fuses

6.5 TOUCH UP ALIGNMENT

a. Connect the power cord and set the power switch to ON.

b. Set the HALF/FULL duplex switch for HALF duplex.

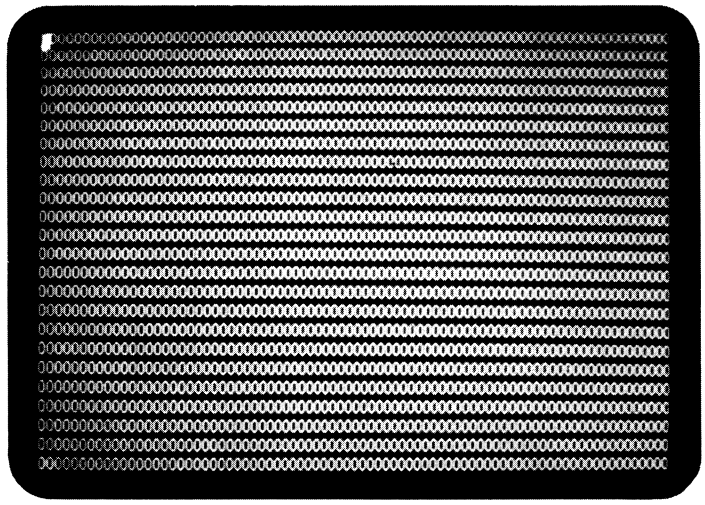
c. Type ∿ or ESC (whichever the ESC/∿ switch is set for) followed by ". A full screen of O's should be displayed.

d. Find the problem(s) in the left column below, and adjust the control listed in the right column to correct the problem.

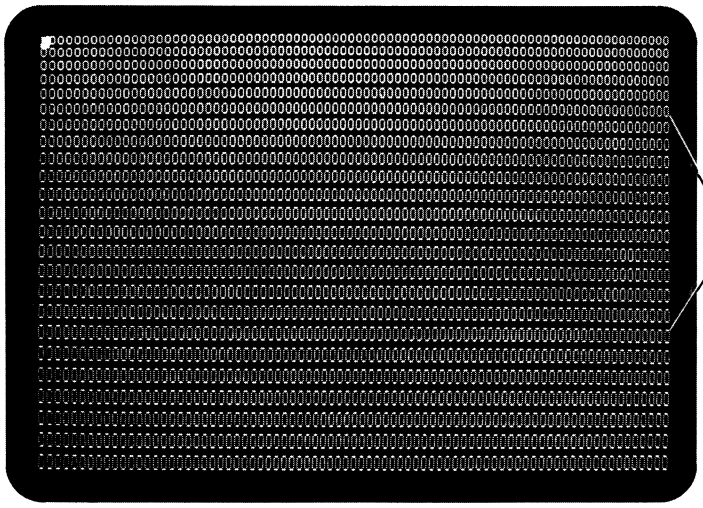
CAUTION

Do not use a metal tool to make adjustments. A plastic alignment tool such as General Electronic's part number GC8606 is recommended.

Problem (See figure 6-4)	Adjustment (See figure 6-5)
Display too dark or too bright	BRIGHTNESS
Display out of focus	FOCUS
Display too wide or too narrow	WIDTH (Norm is 8-1/2 in)
Display too high or not high enough	HEIGHT (Norn is 5-3/4 in)
Display rolls or part of top or bottom character row missing	V HOLD
Some character rows larger or smaller than others	V LIN

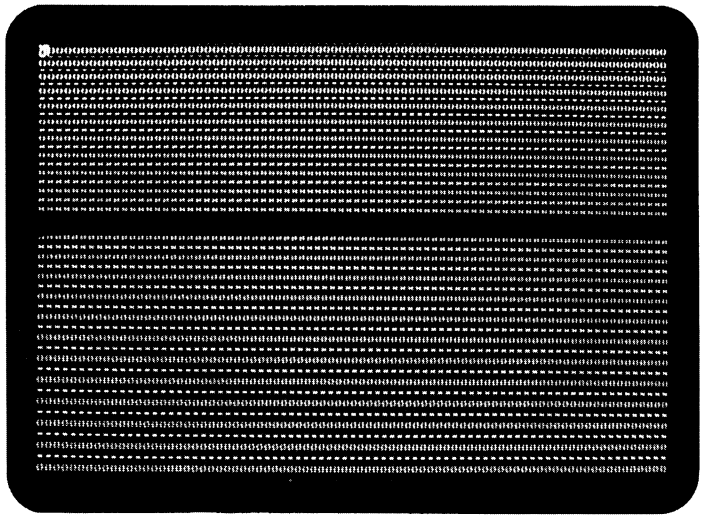


OUT OF FOCUS
ADJUST "FOCUS"



SOME ROWS
MUCH LARGER
OR SMALLER
THAN OTHERS

ADJUST
"VERT LIN"



DISPLAY ROLLS
UP OR DOWN
ADJUST "V HOLD"

Figure 6-4. Display Faults

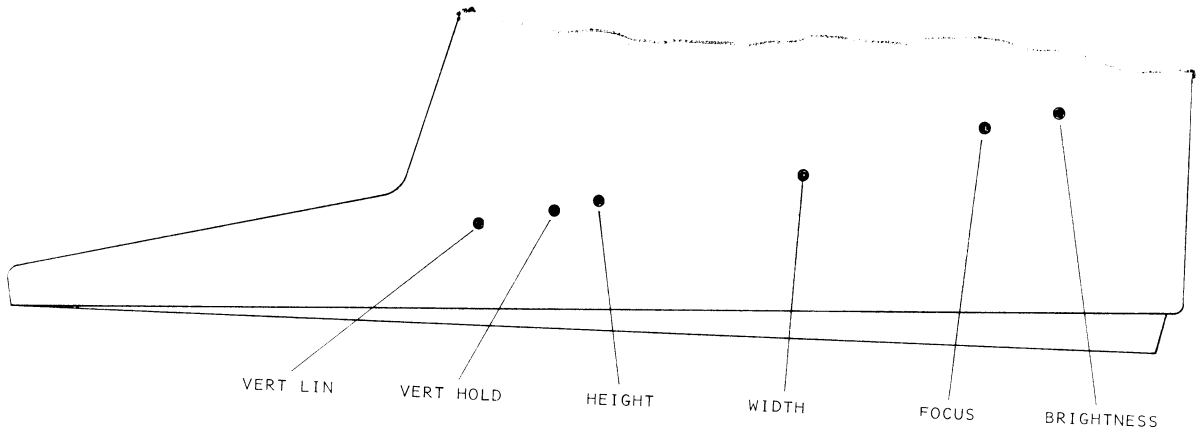


Figure 6-5. Location of Adjustments

6.6 COMPLETE ALIGNMENT

Only the touch up alignment procedure given in paragraph 6.5 should be needed in normal services. However, if a circuit board or crt is replaced and complete realignment is required, follow the procedure below:

a. Connect the power cord and set the power switch to ON.

b. Set the HALF/FULL duplex switch for HALF duplex.

c. Type ∿ or ESC (whichever the ESC/∿ switch is set for) followed by ".

d. Adjust BRIGHTNESS control (see figure 6-5 for locations) until a raster is just visible on the screen (fine horizontal lines just brighter than the background).

e. Adjust BRIGHTNESS control until the raster just disappears (background lines cannot be seen).

f. If the display is tilted, perform steps (1) through (5) below. Otherwise skip to step g.

WARNING

Dangerous voltages (12,000 vdc, 500 vdc and 100 to 240 vac) are present in the Video Display Terminal. Some voltage may remain present in monitor circuits after power is removed (see figure 6-2). Use caution when working on internal circuits. Do not work alone.

The terminal power cord should always be unplugged before the cover is removed. Use caution when handling the cathode-ray tube (eg, wear safety goggles) to avoid risk of implosion. The internal phosphor coating is toxic; if the tube breaks and skin or eyes are exposed to phosphor, rinse with water immediately and consult a physician.

(1) Note the direction and amount of tilt.

(2) Disconnect the power plug and open the unit as described in paragraph 6.3.

(3) Wait 5 minutes and then loosen the screw securing the clamp on the neck of the tube (figure 6-2).

(4) Rotate the yoke in the direction and distance necessary to correct the tilt noted in step (1) and tighten the screws. (The display will rotate the same distance and direction as the yoke is rotated.)

(5) Place the cover on the base, plug in the power plug, set the power switch to ON and check the display. Repeat steps (1) through (4) if necessary.

(6) Set the power switch to off and reassemble the unit by reversing the procedure of paragraph 6.3.

g. If display is rolling up or down, adjust vertical hold potentiometer until display is steady.

h. Adjust height control for a 5-3/4 inch (14-1/2 cm) high display.

i. Adjust width control for an 8-1/2 inch (21-1/2 cm) wide display.

j. Adjust contrast control for optimum display.

k. Adjust focus control for best overall focus.

l. Adjust vertical linearity control for best overall linearity (all character rows as close to equal height as possible).

6.7 REMOVAL AND REPLACEMENT OF CIRCUIT BOARD

WARNING

Double check that the power cord is disconnected before working on internal components. Do not touch any components on the light green area of the circuit board (right rear quarter). Sufficient voltage may remain in this area after power is disconnected to cause a shock.

6.7.1 Removal

a. Open the terminal as described in paragraph 6.3.

b. Disconnect connector P2 at the left rear of the circuit board (figure 6-2). This is done by squeezing the sides of the connector to release the latch and pulling straight up.

c. Disconnect P3 at the right rear of the circuit board in the same manner.

d. If auxiliary input/output connector J5 is installed disconnect it from the center rear of the circuit board by pulling straight back.

e. Disconnect the two single wires from terminals E1 and E2 at the rear of the circuit board by pulling straight up on the metal clips; do not pull on the wire itself.

f. Loosen the two hold-down screws securing the board to the base.

g. Grasp the circuit board under the keyboard area and lift about 1/2 inch, then remove the board by sliding straight forward.

6.7.2 Replacement

a. Set the HALF/FULL duplex switch to HALF (see Section 3).

CAUTION

The terminal must not be turned on unless P3 is connected to the terminal board or damage to the terminal may result.

b. Set connectors P2, and P3 (and J5 if option is installed) clear of the circuit board mounting area.

c. Set the circuit board in place and align the holes in the board with the bosses on the base.

d. Secure the board to the base with two hold-down screws.

e. Connect connector P2 to the circuit board connector at the left rear. The connectors are keyed so they cannot be installed backwards.

f. Connect connector P3 at the right rear of the terminal.

g. If the auxiliary input/output port option is installed connect J5 to the connector at the center rear edge of the circuit board.

h. Connect the two single wires to terminals E1 and E2 at the rear of the circuit board by pressing the clips onto the terminals.

i. Set the cover on the base, connect the power cord and set the power swtich to ON. Check that the cursor is displayed on the screen within 3 minutes.

NOTE

It may be necessary to adjust the BRIGHTNESS control (figure 6-5) in order to see the display.

j. Type ESC or ∿ (whichever the ESC/∿ switch is set to) and ". A full screen of O's should be displayed.

k. Check the display for focus and distortion. If minor distortion is present, refer to paragraph 6.5 and adjust as required. If major distortion is present, perform the alignment procedure described in paragraph 6.6.

l. When a satisfactory display is obtained, disconnect the power cord and tighten the four captive screws which secure the cover to the base (figure 6-1).

6.8 CHANGING VOLTAGE TAPS (International Model Only)

The international model terminal may be modified to operate with 100, 115, 220 or 240 volt ±10% mains as follows:

a. Disconnect the power cord and remove the circuit board as described in paragraphs 6.3 and 6.7.

b. Refer to the voltage tap decal on the back of the base (figure 6-6) for the tap for the desired voltage.

c. Loosen the screw securing the power lead to the terminal strip (figure 6-6) and move the wire to the terminal tap for the desired voltage.

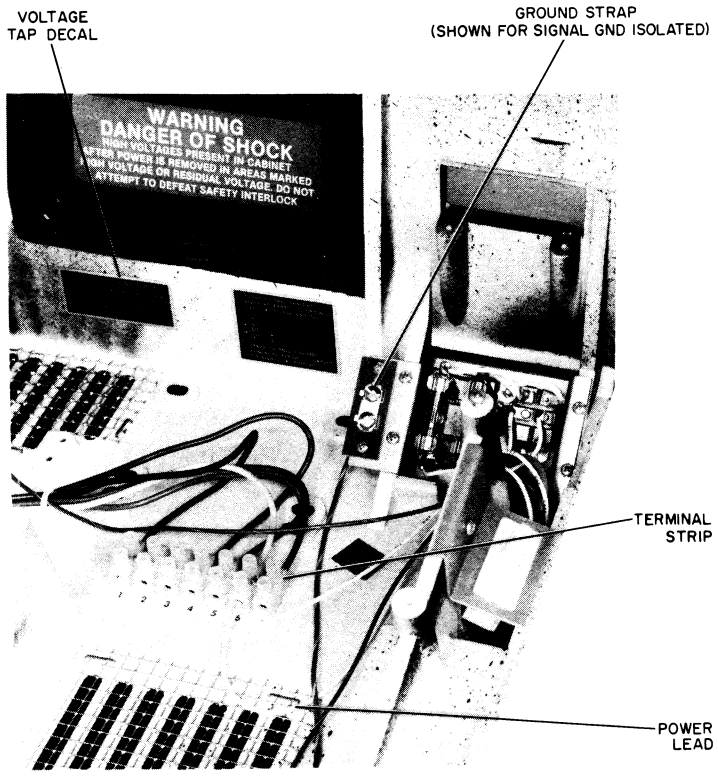


Figure 6-6. International Terminal Power Connections

CAUTION

The fuses must be 1/2 ampere slo-blo for 220 or 240 volt operation and 1 ampere slo-blo for 100 or 115 volt operation. Use of the wrong fuse rating may result in damage to the equipment.

d. Check the fuses for the proper rating and change them as necessary.

e. Replace the circuit board as described in paragraph 6.7.2.

f. Mark the new voltage rating on the nameplate at the rear of the terminal.

APPENDIX A

ASCII CHARACTER CODE CHART

ROW	b4	b3	b2	b1	COLUMN 0	1	2	3	4	5	6	7
	BITS			b8	p	p	p	p	p	p	p	p
				b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	1	0	1	0	1
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
1	0	0	0	1	SOH	DCI	!	1	A	Q	a	q
2	0	0	1	0	STX	DC2	"	2	B	R	b	r
3	0	0	1	1	ETX	DC3	#	3	C	S	c	s
4	0	1	0	0	EOT	DC4	$	4	D	T	d	t
5	0	1	0	1	ENQ	NAK	%	5	E	U	e	u
6	0	1	1	0	ACK	SYN	&	6	F	V	f	v
7	0	1	1	1	BEL	ETB	'	7	G	W	g	w
8	1	0	0	0	BS	CAN	(	8	H	X	h	x
9	1	0	0	1	HT	EM	)	9	I	Y	i	y
A	1	0	1	0	LF	SUB	*	:	J	Z	j	z
B	1	0	1	1	VT	ESC	+	;	K	[	k	{
C	1	1	0	0	FF	FS	,	<	L	\	l	¦
D	1	1	0	1	CR	GS	-	=	M	]	m	}
E	1	1	1	0	SO	RS	.	>	N	^	n	~
F	1	1	1	1	SI	US	/	?	O	_	o	DEL

p = PARITY BIT

NOTE: Some terminals, including other Hazeltine terminals, use different terminology, or different symbols for some codes. The listing to the right indicates the Hazeltine 1420 character which will probably produce the equivalent result.

Symbol	H1420
XON	DC1 (^{C}Q)
XOFF	DC3 (^{C}S)
↑	^
←	_
■	
RUB OUT	DEL

APPENDIX B

CURSOR ADDRESS CHART

This table provides row (Y) and column (X) coordinate information for direct cursor address and read cursor address. To address the cursor it is necessary to precede the X and Y coordinates by a lead in followed by a DC1 code. It is recommended that use of codes in column 0 and 1 of the ASCII Chart (Appendix I) be avoided. For read cursor address, the terminal will transmit the row and column coordinates indicated by the brackets.

Bit Pattern $b_7 \ldots b_1$	Dec. Value	ASCII Char.	Key Stroke	Coordinates Col. No. (X)	Line No. (Y)
0000000	0	NUL	cs_2	0	0
0000001	1	SOH	c_A	1	1
0000010	2	STX	c_B	2	2
0000011	3	ETX	c_C	3	3
0000100	4	EOT	c_D	4	4
0000101	5	ENQ	c_E	5	5
0000110	6	ACK	c_F	6	6
0000111	7	BEL	c_G	7	7
0001000	8	BS	BACKSPACE	8	8
0001001	9	HT	TAB	9	9
0001010	10	LF	LF	10	10
0001011	11	VT	c_K	11	11
0001100	12	FF	c_L	12	12
0001101	13	CR	RETURN	13	13
0001110	14	SO	c_N	14	14
0001111	15	SI	c_O	15	15
0010000	16	DLE	c_P	16	16
0010001	17	DC1	c_Q	17	17
0010010	18	DC2	c_R	18	18
0010011	19	DC3	c_S	19	19
0010100	20	DC4	c_T	20	20
0010101	21	NAK	c_U	21	21
0010110	22	SYN	c_V	22	22
0010111	23	ETB	c_W	23	23

Bit Pattern $b_7 \ldots b_1$	Dec. Value	ASCII Char.	Key Stroke	Coordinates Col. No. (X)		Line No. (Y)
0011000	24	CAN	c_X	24		23
0011001	25	EM	c_Y	25		23
0011010	26	SUB	c_Z	26		23
0011011	27	*ESC	ESC	27		23
0011100	28	FS	c\	28		23
0011101	29	GS	$c_]$	29		23
0011110	30	RS	cs\	30		23
0011111	31	US	c_{DEL}	31		23
0100000	32	SP	space	32		0
0100001	33	!	!	33		1
0100010	34	"	"	34		2
0100011	35	#	#	35		3
0100100	36	$	$	36		4
0100101	37	%	%	37		5
0100110	38	&	&	38		6
0100111	39	'	'	39		7
0101000	40	(	(	40		8
0101001	41	)	)	41		9
0101010	42	*	*	42		10
0101011	43	+	+	43		11
0101100	44	,	,	44		12
0101101	45	-	-	45		13
0101110	46	.	.	46		14
0101111	47	/	/	47		15
0110000	48	0	0	48		16
0110001	49	1	1	49	Output	17
0110010	50	2	2	50	Read	18
0110011	51	3	3	51	Cursor	19
0110100	52	4	4	52	Address	20
0110101	53	5	5	53		21
0110110	54	6	6	54		22
0110111	55	7	7	55		23
0111000	56	8	8	56		23

*Lead-in Code

Bit Pattern $b_7 \ldots b_1$	Dec. Value	ASCII Char.	Key Stroke	Coordinates Col. No. (X)		Line No. (Y)
0111001	57	9	9	57		23
0111010	58	:	:	58		23
0111011	59	;	;	59		23
0111100	60	<	<	60		23
0111101	61	=	=	61		23
0111110	62	>	>	62		23
0111111	63	?	?	63		23
1000000	64	@	@	64		0
1000001	65	A	A	65		1
1000010	66	B	B	66		2
1000011	67	C	C	67		3
1000100	68	D	D	68		4
1000101	69	E	E	69		5
1000110	70	F	F	70		6
1000111	71	G	G	71	Output	7
1001000	72	H	H	72	Read	8
1001001	73	I	I	73	Cursor	9
1001010	74	J	J	74	Address	10
1001011	75	K	K	75		11
1001100	76	L	L	76		12
1001101	77	M	M	77		13
1001110	78	N	N	78		14
1001111	79	O	O	79		15
1010000	80	P	P	79		16
1010001	81	Q	Q	79		17
1010010	82	R	R	79		18
1010011	83	S	S	79		19
1010100	84	T	T	79		20
1010101	85	U	U	79		21
1010110	86	V	V	79		22
1010111	87	W	W	79		23
1011000	88	X	X	79		23

Bit Pattern $b_7 \ldots b_1$	Dec. Value	ASCII Char.	Key Stroke	Coordinates Col. No. (X)		Coordinates Line No. (Y)	
1011001	89	Y	Y	79		23	
1011010	90	Z	Z	79		23	
1011011	91	[	[	79		23	
1011100	92	\	\	79		23	
1011101	93	]	]	79		23	
1011110	94	^	^	79		23	
1011111	95	_	_	79		23	
1100000	96	`	`	0		0	
1100001	97	a	a	1		1	
1100010	98	b	b	2		2	
1100011	99	c	c	3		3	
1100100	100	d	d	4		4	
1100101	101	e	e	5		5	
1100110	102	f	f	6		6	
1100111	103	g	g	7		7	
1101000	104	h	h	8		8	
1101001	105	i	i	9		9	
1101010	106	j	j	10		10	
1101011	107	k	k	11	Output	11	Output
1101100	108	l	l	12	Read	12	Read
1101101	109	m	m	13	Cursor	13	Cursor
1101110	110	n	n	14	Address	14	Address
1101111	111	o	o	15		15	
1110000	112	p	p	16		16	
1110001	113	q	q	17		17	
1110010	114	r	r	18		18	
1110011	115	s	s	19		19	
1110100	116	t	t	20		20	
1110101	117	u	u	21		21	
1110110	118	v	v	22		22	
1110111	119	w	w	23		23	
1111000	120	x	x	24		23	

Bit Pattern $b_7 \ldots b_1$	Dec. Value	ASCII Char.	Key Stroke	Coordinates Col. No. (X)	Coordinates Line No. (Y)
1111001	121	y	y	25	23
1111010	122	z	z	26	23
1111011	123	{	{	27	23
1111100	124	¦	¦	28	23
1111101	125	}	}	29	23
1111110	126	*~	~	30	23
1111111	127	DEL	DEL	31	23

*Lead-in Code

Lead-In	ASCII	Dec	Octal	Function
*	SOH	1	001	Select Blinking Field
*	STX	2	002	Select Blank Field
*	ENQ	5	005	Send Cursor Address
*	ACK	6	006	Keyboard Unlock**
	BEL	7	007	Sound Alarm
	BS	8	010	Cursor Left
	HT	9	011	Field Tab
	LF	10	012	Line Feed
*	VT	11	013	Cursor Down
*	FF	12	014	Cursor Up
	CR	13	015	Carriage Return
	SO	14	016	Horizontal Tab
*	SI	15	017	Clear to End of Line
	DLE	16	020	Cursor Right
*	DC1	17	021	Direct Cursor Address
*	DC2	18	022	Home Cursor
*	DC3	19	023	Delete Line
*	NAK	21	025	Keyboard Lock
*	CAN	24	030	Clear to End of Screen
*	EM	25	031	Background Follows **
*	SUB	26	032	Insert Line
*	FS	28	034	Clear Screen
*	GS	29	035	Clear Foreground
*	US	31	037	Select High Intensity Field
*	!	33	041	Send Character at Cursor Position
*	"	34	042	Display Test Pattern
*	*	42	052	Enable Aux Output No Display
*	/	47	057	Enable Aux Output with Display **
*	?	63	077	Disable Aux Output
*	<	60	074	Exit Function Mode
*	>	62	076	Enter Function Mode

*Lead-in required: ASCII ESCape (decimal 27, octal 033), or tilde (decimal 126, octal 176), as selected by switch (para 3.1.f).
**Default state at turn on

NOTES:

1. If a remote command lead-in is followed by any character not listed above, both the lead-in and the following character will be ignored.

2. Any ASCII control code (columns 0 and 1, Appendix A) which is not preceded by a remote command lead-in will be ignored, except for the seven listed above as not requiring a lead-in (and ESCape if selected as the lead-in code).

3. The Direct Cursor Address command must be followed immediately by the X and Y coordinates as listed in Appendix B.

4. Response to carriage return and line feed depends on the setting of the AUTO LF/CR switch **(para 3.1.4).**

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