



Model Z19
VIDEO TERMINAL

595-2414-01

Operation Manual

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INTRODUCTION

The Zenith Data Systems Model Z19 Video Terminal is a professional, 25-line, video terminal. Not only does it have the features commonly found in other high-quality video terminals, but it also has many exclusive features. The terminal will connect to other equipment that uses an EIA RS-232C serial interface, and the high-quality keyboard, video display, and state-of-the-art logic circuitry make this Video Terminal an outstanding peripheral for your computer or MODEM.

The information is displayed on a 12" (diagonal), high-quality, cathode-ray tube (CRT) that is capable of displaying 2000 characters at one time (25 rows of 80 characters). The P4 phosphor used in the CRT provides superb character definition. Upper-case characters are formed by a 5×7 dot matrix. Lower-case characters that have descenders use a 5×9 dot matrix. The Terminal can also display 33 special graphic characters that can be arranged and grouped to form any number of graphic displays and effects. The graphic symbols are formed on an 8×10 dot matrix.

Special local and software controllable escape sequences allow you to select and use many special functions. These include:

- Using either ZDS or ANSI escape sequences.
- Eight user-defined special function keys.
- Alternate keypad output (for sending more user-defined special codes to your computer).
- Shifted keypad (so you can obtain the shifted keypad functions without using the SHIFT key).

- Keyboard enable/disable.
- Keyclick enable/disable.
- Cursor type select (underline or block).
- Auto LF, auto CR.
- Hold screen mode (for scrolling lines and pages).
- Cursor control (left, right, up, down, home).
- Direct cursor addressing.

and you can also:

- Transmit page.
- Transmit 25th line.
- Insert and delete characters and lines.
- Enter and exit the graphics and reverse video modes.
- Erase lines or page of text.
- Modify baud rates.

The highly reliable, standard-size electronic keyboard uses the universally accepted, standard typewriter format. Each key stroke is affirmed by an audible key click.

A 12-key keypad duplicates the numeric keys in a calculator format. This lets you rapidly enter numbers in programs that call for just numbers. In addition, the shifted keypad functions allow you to insert and delete lines and characters, and move the cursor. Plus, an alternate mode allows you to interchange the shifted and unshifted function and send special codes to your computer.

These features, along with the stylish molded cabinet, make the Video Terminal a versatile peripheral for your computer system.

SPECIFICATIONS

CRT	12" diagonal, P4 phosphor.
Display Format	25 lines of 80 characters.
Display Size	6.5" high × 8.5" wide.
Character Size	0.2" high × 0.1" wide (approximate).
Character Set	128 characters (95 ASCII and 33 graphic).
Character Type	5 × 7 dot matrix (upper case), 5 × 9 dot matrix (lower case with descenders).
Keyboard	84 keys (60 alphanumeric, 12 function/control) plus a 12-key numeric pad.
Cursor	Blinking nondestructive underline, or block.
Cursor Controls	Up, down, left, right, home, CR, LF, back space, and tab.
Cursor Addressing	Relative and direct.
Tab	Standard 8-column tab.
Refresh Rate	60 Hz at 60 Hz line frequency. 50 Hz at 50 Hz line frequency.
Edit Functions	Insert and delete character or line.
Erase Functions	Erase page, erase to end of line, erase to end of page, erase to beginning of line, erase to beginning of page, and erase line.

Scroll	Auto or line/page freeze.
Bell	Audible alarm on receipt of ASCII BEL.
Video	Normal and reverse, by character.
Interface	EIA RS-232C at 110 to 9600 baud.
Communications Mode	Full or half duplex.
Parity	Even, odd, stick, or none.
Operating Temperature	0-40° C ambient.
Power Requirements	120 VAC (105-135 VAC), 50/60 Hz, 45 watts. 240 VAC (210-270 VAC), 50/60 Hz, 45 watts.
Dimensions	13" high × 17" wide × 20" deep. (33 × 43.2 × 50.8 cm.)
Weight	45 lbs. (20.4 kg).

The Zenith Data Systems reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

SET-UP

POWER LINE CONSIDERATIONS

If you need to change the position of the 120/240 switch (located on the bottom of the Terminal), be sure you change rear panel fuse F1 to the proper value as follows:

For 120 VAC, use a 1-ampere, 125 volt, slow-blow fuse.

For 240 VAC, use a 1/2-ampere, 250-volt, slow-blow fuse (not supplied).

The plug on the power cord is for standard 120 VAC outlets. For 240 VAC operation in the U.S.A., cut off and replace the plug in a manner such that your power connection conforms with section 210-21 (b) of the National Electric Code, which reads, in part:

"Receptacles connected to circuits having different voltages, frequencies, or types of current (AC or DC) on the same premises shall be of such design that attachment plugs used on such circuits are not interchangeable."

When you install the new plug, make sure it is connected according to your local electrical code. Units with three-wire line cords must always have the green wire connected to chassis ground.

Be sure the NOR/LOW switch (on the bottom of the Terminal) is set in its proper position to match your line voltage as follows:

NOR range — 115 V to 135 V rms or 230 V to 270 V rms.

LOW range — 100 V to 120 V rms or 200 V to 240 V rms.

NOTE: If you do not know the value of the line voltage in your area, set the NOR/LOW switch to NOR.

CAUTION: Whenever you turn the power on, make sure you wait at least 30 seconds, or until you get a cursor or light raster on the screen, before you turn the power off again. A quick turn-on and turn-off can damage the CRT.

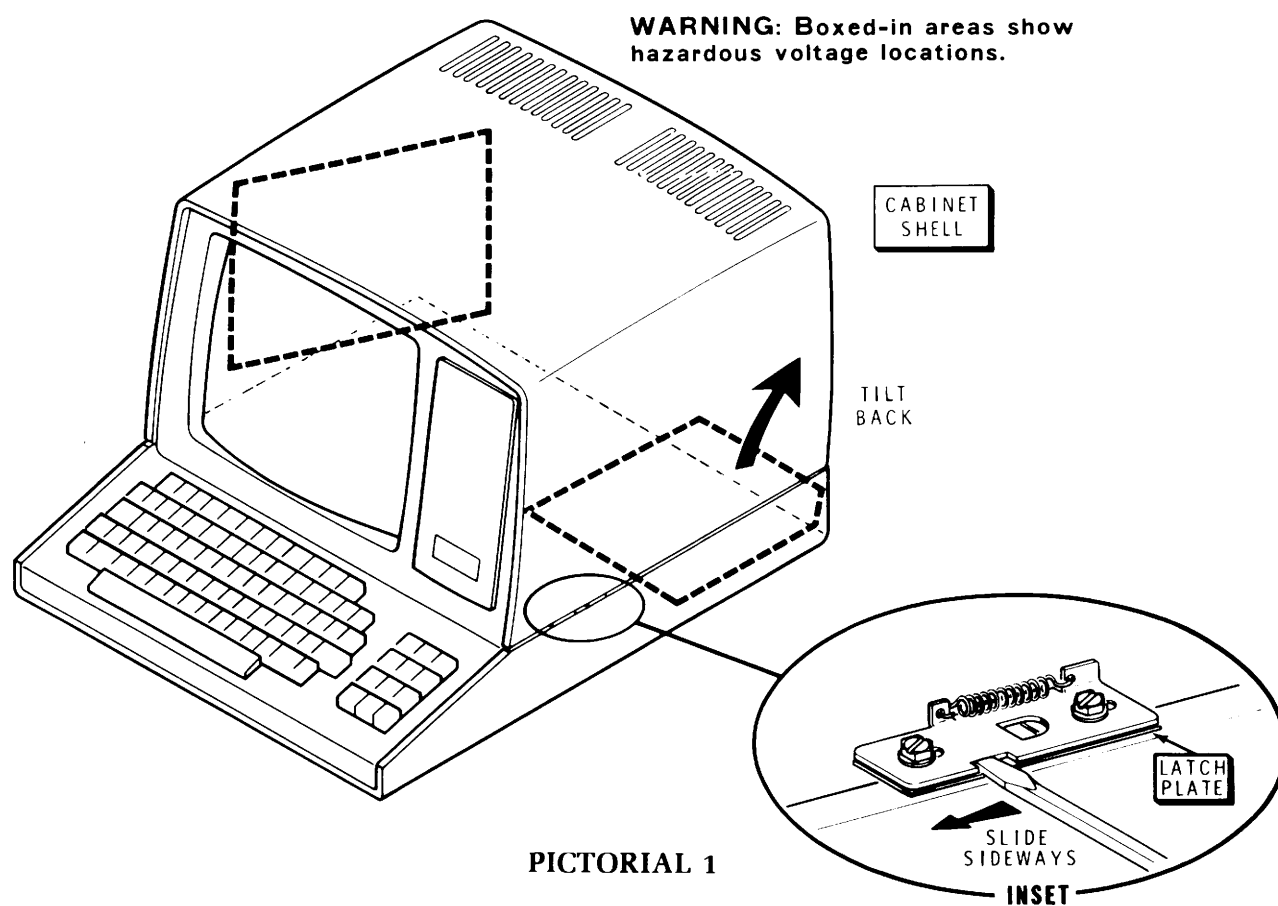
CABINET REMOVAL

Whenever you need to remove the cabinet shell:

- Refer to the inset drawing on Pictorial 1, insert the blade of a small screwdriver into the notch in the latch plate, and then slide the latch plate toward the back of the Terminal about 1/2".
- Likewise, open the latch plate on the other side of the Terminal.

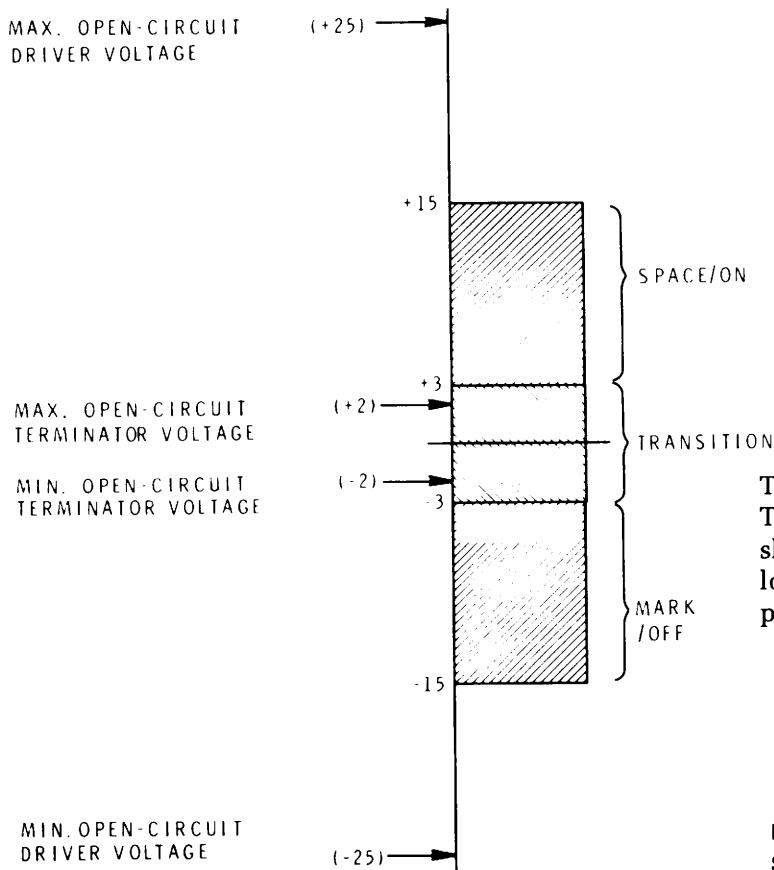
- **WARNING:** When the line cord is connected to an AC outlet, hazardous voltages can be present inside your Terminal. See Pictorial 1.
- Carefully tilt the cabinet shell back. **NOTE:** The hinges are designed so you can easily remove the cabinet shell from the chassis by lifting the cabinet shell straight up once you have opened it completely. **NOTE:** Never allow the cabinet shell to hang open and unsupported.

Simply reverse this procedure to close and lock the cabinet shell back on the Terminal.



SYSTEM CONFIGURATION

This Terminal is designed to interface with serial I/O modules that use the RS-232C standards of the Electronic Industries Association (EIA). This standard defines an asynchronous serial interface, its voltages (see Pictorial 2), its impedances, and its physical connectors.



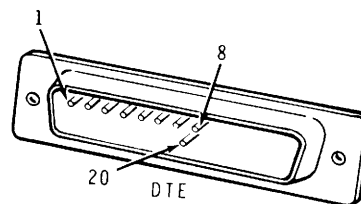
PICTORIAL 2

RS-232C places all equipment into one of two general categories:

DTE — Data Terminal Equipment

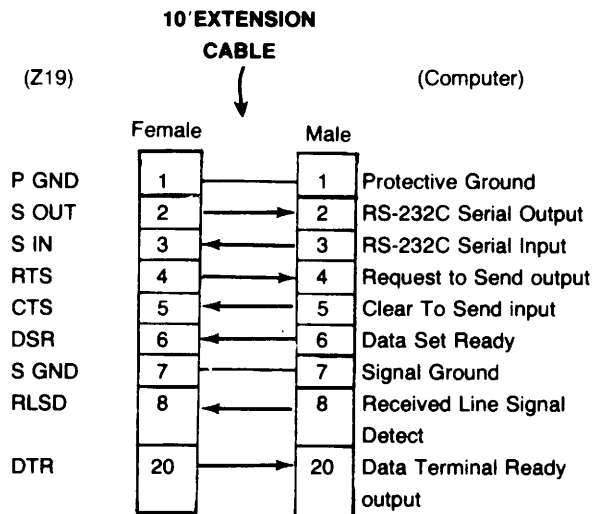
DCE — Data Communication Equipment

Computers and MODEMS are two types of DCE; while terminals, printers, and most peripherals are DTE. Always connect a DTE to a DCE. Never connect two like types together.



PICTORIAL 3

The 25-pin "D" connector on the back panel of the Terminal is a DTE (DB-25P) connector. Pictorial 3 shows the pin numbering of this connector. The following chart describes the DTE outputs of the rear panel connector.



Make sure your Serial I/O card is configured as required by your computer manual and operates at RS-232C signal levels. The baud rates of the Terminal and computer must be the same.

Video Terminal Configuration

Before you can use the Terminal, you must configure it to operate with your computer.

To gain access to the internal switches and controls, tilt back or remove the cabinet shell.

The particular configuration that you select is initialized when you power-up the Terminal or when you perform a Terminal Reset.

SWITCH S402

Push all of the switch sections on S402 (located on the terminal logic circuit board) up (0) as shown in Pictorial 4.

If you ever want to change these switch positions, they are defined as follows:

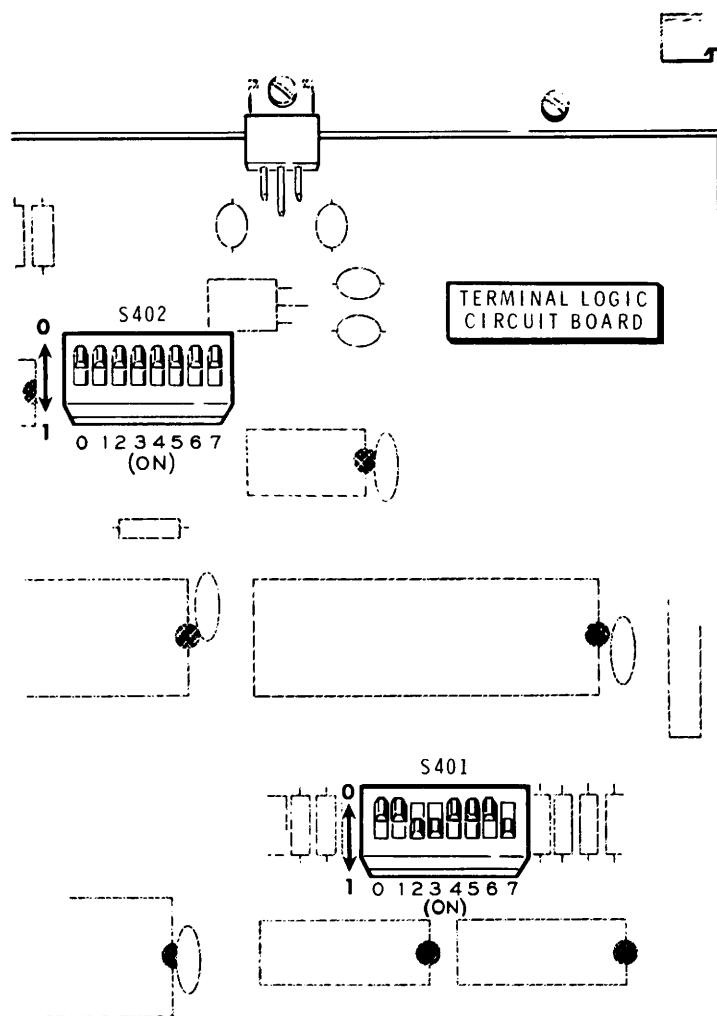
SECTION	DESCRIPTION
0	0 = underscore cursor; 1 = block cursor
1	0 = key click; 1 = no key click
2	0 = discard past end of line; 1 = wrap around
3	0 = no auto LF on CR; 1 = auto LF on CR
4	0 = no auto CR on LF; 1 = auto CR on LF
5	0 = ZDS mode; 1 = ANSI mode
6	0 = keypad normal; 1 = keypad shifted
7	0 = 60 Hz refresh; 1 = 50 Hz refresh

SWITCH S401

Refer to Pictorial 4 for the following steps.

This switch (located on the terminal logic circuit board) sets the following power-up and reset modes:

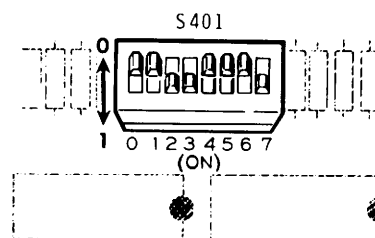
SWITCH SECTION	DESCRIPTION
0-3	Baud Rate
4	Parity Enable
5	Odd/Even Parity
6	Normal/Sticky Parity
7	Half/Full Duplex



PICTORIAL 4

Pictorial 4 shows the location of switch S401. This drawing shows switch S401 set for:

MODE	SWITCH SECTION							
	0	1	2	3	4	5	6	7
9600 Baud	0	0	1	1				
No Parity					0			
Even Parity						0		
Normal Parity							0	
Full Duplex								1



PICTORIAL 5

Remember that, as you look at switch S401 from the front of the Terminal, you select the one (1) positions of the switch by pushing the switches down, and you select the zero (0) positions by pushing the switches up.

Pictorial 5 shows the normal switch settings for switch S401. Each function is explained in the following text.

You can program the ACE (Asynchronous Communication Element) to either generate or eliminate the parity bit. Section 4 of switch S401 selects the parity bit.

Down (1) = Parity
Up (0) = No Parity

Baud Rate

You can select any of 12 different baud rates (110-9600). To do this, place sections 0, 1, 2, and 3 of switch S401 to the proper positions as shown below. The baud rate will be initialized (or updated) during power-up, or upon Terminal Reset.

BAUD RATE	SWITCH SECTION			
	0	1	2	3
N/A	0	0	0	0
110	1	0	0	0
150	0	1	0	0
300	1	1	0	0
600	0	0	1	0
1200	1	0	1	0
1800	0	1	1	0
2000	1	1	1	0
2400	0	0	0	1
3600	1	0	0	1
4800	0	1	0	1
7200	1	1	0	1
9600	0	0	1	1

Parity

When no parity is selected, you can set the even and normal parity switch sections to either position since they will be ignored.

Odd/Even Parity

If section 4 = 1, then section 5 of switch S401 selects odd or even parity.

Down (1) = Even Parity
Up (0) = Odd Parity

Normal/Stick Parity

If section 4 = 1, then section 6 of switch S401 sets the ACE to transmit and receive either stick or normal parity.

Down (1) = Stick Parity
Up (0) = Normal Parity

Half/Full Duplex

Section 7 of switch S401 selects either full or half duplex communications between the computer and the Video Terminal.

Down (1) = Full Duplex
Up (0) = Half Duplex

OPERATION

Pictorial 6 (Illustration Booklet, Page 1) shows the front of the Terminal. The power ON/OFF switch is located on the right rear corner of the back panel. Whenever you turn on the Terminal, allow the tube about 30 seconds to warm up. You should then see a flashing line (cursor) or block cursor (if it was selected) in the upper left-hand corner of the screen.

The keyboard allows you to send data to the computer or the screen. Most of the keys are the same as they are on most typewriters; they type the same alphanumeric characters. A clicking sound tells you that each keystroke has been processed by the Terminal. You cannot electrically damage the Terminal by typing on the keys.

The screen contains 2000 character positions; 25 lines of 80 characters. (Only 24 lines are normally used, 1920 character positions.) Only one character can occupy a character position at any given time and it will remain there until it is erased or replaced.

When the Terminal is initially turned on, it clears the screen by placing spaces in all character positions. The cursor is the blinking horizontal line that appears at the home position. It underlines the character position where the next character will be written. (The block cursor will fill the character position).

As shown in Pictorial 7 (Illustration Booklet, Page 2), the Terminal can be used in any one of three different modes; full duplex, off line, or half duplex.

When the Terminal is on line, the keyboard can transmit any one of the 128₁₀ ASCII characters (see the "ASCII Characters" chart on Page 65) to the computer. However, some of these characters will not be displayed if the computer sends them back to the Terminal. (See the chart.)

In the off line mode, the keyboard is effectively disconnected from the computer and controls the screen directly. This way, you can position the cursor (↑, ↓, →, ←, and HOME), insert or delete characters or lines (IC, DC, IL, and DL), or erase (ERASE), without sending the codes through the computer — which could otherwise disrupt a program, etc.

Another way of controlling the screen without sending code to the computer is to use the CTRL key. Example: you want to erase the screen, but you do **not** want to transmit a code to the computer. Press and hold the CTRL key and then type SHIFT ERASE. This tells the Terminal to erase the screen, but not to send the code to the computer. Again, you can use this procedure with the cursor keys (↑, ↓, →, ←, and home), the insert line, delete line, insert character, and delete character keys, and erase.

Whenever you use the special escape codes to enter and exit the special modes, make sure you enter the lower-case and upper-case letters just as they are called for in this Manual. For instance, type ESC p, not ESC P to enter the reverse video mode.

The "ASCII Characters" and the "Escape Sequences" (see the "Appendix," Page 37) show the commands and special escape sequences that the Terminal sends and responds to. Your computer **must** contain the proper software for it to respond to and generate the codes that use these special features. Different versions of software may support different features.

The Terminal has a 128 character input FIFO for receiving and holding characters until the Terminal can process them. In some cases (such as when the Terminal is operating at 9600 baud in the "insert character" mode), the FIFO can be filled faster than the Terminal can process the characters. In this case, the

Terminal will send X OFF (control S) when the FIFO has received 112 characters. After the Terminal has processed enough characters so that only 96 characters remain in FIFO, it will send X ON, (control Q) to the host computer to indicate that it is ready to accept more characters.

When the Terminal sends X OFF, this is only an indication that the buffer is nearly full. Characters will not be lost until after the FIFO has received a full 128 characters. At this point, more incoming characters will be lost and the bell will sound.

NORMAL MODES AND KEYS

ALPHABETIC KEYS

The Terminal has the standard 26 letters of the alphabet. These keys can transmit either lower-case or upper-case codes as well as display them on the screen. You can hold either SHIFT key down or you can push the CAPS LOCK key to obtain upper-case letters.

NONALPHABETIC KEYS

The nonalphabetic keys are those with double markings. These include the numbers 0 through 9, punctuation marks, and special characters. The lower marking is generated when both of the SHIFT keys are released, while the upper marking is generated when either or both SHIFT keys are held down. The CAPS LOCK key will not shift these keys.

MISCELLANEOUS

RETURN — Moves the cursor to the first character position of the line that it is currently in. If the cursor is already at the first character position, it remains there. RETURN is a nondisplayable character.

LINE FEED — Moves the cursor down one line. LINE FEED is a nondisplayable character. If the cursor is at the bottom line, a LINE FEED causes it to remain there, but all of the data on the screen moves up one line. Data on the top line is lost as it is shifted up and off the screen.

SPACE BAR — Causes the cursor to move one character position to the right. A Space is a nondisplayable character. If you type the Space Bar when the cursor is positioned below a displayed character, the character is replaced by a space and the cursor moves one character position to the right. If you type the Space Bar when the cursor is at the right end of a line, the cursor will remain there since neither a carriage return nor a line feed is generated.

BACK SPACE — Moves the cursor one space to the left. If the cursor is at the start (left end) of a line, it will not move when you type a BACK SPACE.

DELETE — Transmits the ASCII code 177. It is a nondisplayable character.

TAB — Software controlled to move the cursor to the next tab stop (eight character spaces) to the right. The tab stops are fixed at 9, 17, 25, 33, 41, 49, 57, 65, and 73. If the cursor is at character position 73 through 79, it will only move one character position to the right each time you type the TAB key. If the cursor is at character position 80, it will not move when you type the TAB key (unless the wrap-around feature has been selected).

ESC (Escape) — A nondisplayable character that transmits the ASCII code 033. This key is used in combination with other keys to enter and exit special modes. See "Special Keys and Modes" on Page 14.

For a complete listing of ZDS and ANSI codes using escape sequences and their definitions, refer to the "Appendix."

(REPEAT) — When you hold this key in, along with another key, it will repeat the function of the other key as long as both keys are held down. The repeat rate is approximately 15-characters per second. However, if the baud rate that has been selected is less than the repeat rate, the repeat function will operate at the slower rate.

SHIFT — When you use this key in conjunction with another key, the character printed on the upper portion of that key will be displayed. When you use the SHIFT keys in conjunction with the alphabetic keys, the upper-case character is displayed.

CAPS LOCK — When this latching key is down, the Terminal will transmit the ASCII code for, and display, upper-case (capital) alphabetic letters. It does not shift the keys with the double markings.

OFF LINE — When this latching key is down, the Terminal is inhibited from transmitting or receiving data. However, any displayable characters that you type on the keyboard will appear on the screen and any control codes that the Terminal can process will be processed.

BREAK — When you type this key, it generates a continuous "space level" at the serial RS-232 output of the Terminal. It is generally used to tell the computer that you wish to interrupt execution.

RESET — Allows you to reset the Terminal to its preset condition; it exits all escape modes and resets the baud rate to the rate selected by the switches on the logic circuit board. To use this key, you must press only the right-hand SHIFT key and the RESET key at the same time. This two-key combination prevents you from inadvertently resetting the Terminal.

SCROLL — When this is used with some software, in the Hold Screen Mode, you can type the SCROLL key to instruct the Terminal to display another line of information onto the screen. You can type SHIFT SCROLL to display another 24 lines of information onto the screen.

CONTROL KEY

The CTRL key is held down in conjunction with other keys to send the 32 ASCII control codes to the computer. Refer to the "ASCII Characters" chart in the "Appendix" of this Manual for a listing of the control keys. These are non-displayable characters. The Terminal responds to only seven of the control characters from the keyboard or from the serial input port. These seven characters are:

Bell (BEL or CTRL G) — Causes the Terminal to sound an audible tone through an internal speaker.

Back Space (BS or CTRL H) — Duplicates the BACK SPACE key.

Horizontal Tab (HT or CTRL I) — Duplicates the TAB key.

Line Feed (LF or CTRL J) — Duplicates the LINE FEED key.

Carriage Return (CR or CTRL M) — Duplicates the RETURN key.

Escape (ESC or CTRL [) — Duplicates the ESC key.

Cancel (CTRL X) — Cancels the current escape sequence.

SPECIAL MODES AND KEYS

NOTE, The following descriptions give ZDS mode escape sequences. For ANSI escape sequences, refer to the "Appendix."

CURSOR FUNCTIONS

Cursor Home — ESC H — [Shift 5 (HOME) of keypad]

Moves the cursor to the first character position on the first line (home).

Cursor Forward — ESC C — [Shift 6 (→) of keypad]

Moves the cursor one character position to the right. If the cursor is at the end of the line, it will remain there.

Cursor Backward — ESC D — [Shift 4 (←) of keypad]

Moves the cursor one character position to the left (backspaces). If the cursor is at the start (left end) of a line, it will remain there.

Cursor Down — ESC B — [Shift 2 (↓) of keypad]

Moves the cursor down one line. If the cursor is at the bottom line, it will remain there; however, a scroll will not occur.

Cursor Up — ESC A — [Shift 8 (↑) of keypad]

Moves the cursor up one line. If the cursor is at the top line, it will remain there; however, a scroll will not occur.

Reverse Index — ESC I — This is a reverse line feed. It causes the cursor to move upward one line. If the cursor is at the top line it will remain there. However, any text on the screen will be scrolled downward one line.

Cursor Position Report — ESC n — Reports the position of the cursor in the form of ESC Y line# column#.

Save Cursor Position — ESC j — The present cursor position is saved so the cursor can be returned there later on the “Set to previously saved position” command.

Set to Previously Saved Position — ESC k — Returns the cursor to the position where it was when it received the “Save cursor position” command.

Direct Cursor Addressing — ESC Y — Allows the computer to control the position of the cursor on the screen by entering the escape code, the ASCII character which represents the line number, and the ASCII character which represents the column number.

The first line and the left column are both 32_{10} and increase from there. The number 32_{10} is used because it is the smallest value of the printing characters. All values less than 32_{10} are control codes, which can interfere with operating sequences of some computers.

Since the lines are numbered from 1 to 24 (from top to bottom) and the columns from 1 to 80 (from left to right), you must add the proper line and column numbers to 31_{10} . Then convert these decimal numbers to their equivalent ASCII characters and enter them in the following order:

ESC Y line # (ASCII character) column # (ASCII character)

For example, to place the cursor at line 20, column 40, you will first have to add 31_{10} to the line number to find the value of the line #.

$$31 + 20 = 51_{10}$$

Then use the “ASCII Characters” chart (in the “Appendix”) to find the ASCII character that corresponds to 51_{10} . In this case, it is the number 3. Next, add 31_{10} to the column number to find the actual value of the column #.

$$31 + 40 = 71_{10}$$

Again, use the ASCII chart to find the ASCII character that corresponds to 71_{10} , which is the symbol G.

To demonstrate this example, make sure the OFF LINE key is down. Then type ESC Y 3 G. The cursor should move to line 20, column 40.

If you specify a line # that does not exist on the screen, the cursor will remain in the line it is presently in. If you specify a column # that does not exist on the screen, the cursor will move to the right-most column.

ERASING AND EDITING

Clear Display (SHIFT ERASE) — ESC E — Erases all the information on the screen. The screen is filled with spaces and the cursor is placed in the home position.

Erase Beginning of Display — ESC b — Erases the display from the start of the screen to the cursor position, and includes the cursor position.

Erase to End of Page (ERASE Key) — ESC J — Erases all the information from the cursor (including the cursor position) to the end of the page.

Erase Entire Line — ESC l — Erases the entire line, including the cursor position.

Erase Beginning of Line — ESC o — Erases from the beginning of the line to the cursor position, and includes the cursor position.

Erase to End of Line — ESC K — Erases from the cursor (including the cursor position) to the end of the line.

Insert Line — ESC L — [Shift 1 (IL) of keypad]

Inserts a new blank line by moving the line that the cursor is on, and all following lines, down one line. Then the cursor is moved to the beginning of the blank line.

Delete Line — ESC M — [Shift 3 (DL) of keypad]

Deletes the contents of the line that the cursor is on, places the cursor at the beginning of the line, moves all the following lines up one line, and adds a blank line at line 24.

Delete Character — ESC N — [Shift 9 (DC) of keypad]

Deletes the character at the cursor position and shifts any existing text that is to the right of the cursor, and on the same line, one character position to the left.

Enter Insert Character Mode — ESC @ — [shift 7 (IC) of keypad]

Lets you insert characters or words into text already displayed on the screen. The first time you type IC, the Terminal enters the Insert Character Mode. You can then use the cursor controls to place the cursor at the point where you want to insert characters. As you type in the desired characters, any existing text directly above and to the right of the cursor is shifted to the right. This feature lets you add letters or words to existing text without having to re-type the whole text. When you finish inserting characters, type IC again to exit the Insert Character Mode. The Terminal transmits an ESC@ to enter, and an ESC O to exit the Insert Character Mode.

Exit Insert Character Mode — ESC O — Exits the Insert Character Mode. See "Enter Insert Character Mode" above.

CONFIGURATION

Reset to Power-Up Configuration — ESC z — Nullifies all previously set escape modes and returns to the power-up configuration set by switches S401 and S402 on the terminal logic circuit board.

NOTE: If characters are sent to the Terminal during this "reset" time, several characters may be lost while the Terminal is resetting.

Modify The Baud Rate — ESC r — Initially, the baud rate is set by the switches on the terminal logic circuit board. However, you can change the baud rate from the keyboard. To do this, type ESC r followed by the appropriate letter given below:

A=110	G=2000
B=150	H=2400
C=300	I=3600
D=600	J=4800
E=1200	K=7200
F=1800	L=9600

Example: If the baud rate switches on the terminal logic circuit board are set to 4800 baud and you want to communicate with the computer at 9600 baud, just type ESC r L.

The baud rate reverts back to the baud rate set by the switches on the circuit board when you RESET the Terminal (RESET and right-hand SHIFT keys) or when you turn the Terminal off and then back on.

Set Mode — ESC x — Certain operating modes can be enabled and disabled from the keyboard. To enable the functions, type ESC x followed by the appropriate number given below:

- 1 = Enable 25th line. The 25th line is available as a line that is totally separate from the normally-used 24 lines. You might use this line, for example, to identify the user functions keys with labels which correspond to the function that your computer provides when it receives these function key escape codes. Or you might use it to display information concerning the status of your computer while a program is running.

The only way to place the cursor on the 25th line is to enable the 25th line and then use "Cursor Addressing." Once on the 25th line, the terminal acts like a 1-line terminal ("erase in display" commands only operate on the 25th line) until you use cursor addressing to place the cursor on one of the other 24 lines of the Terminal. This is a good place to use the "Save Cursor Position" and the "Set Cursor To Previously Saved Position" routines. With these routines, the current cursor position can be saved, your routine can address the 25th line, write information on the 25th line, and return to the "remembered" cursor location without your program having to remember that location.

- 2 = No key click. This function turns off the key click.
- 3 = Hold screen mode. See "Enter Hold Screen Mode" for a description of this function.
- 4 = Block cursor. Produces a cursor that fills the entire character position.
- 5 = Cursor off. Turns off the cursor so there is no cursor at all.
- 6 = Keypad shifted. See "Enter Keypad Shifted Mode" for a description of this function.

- 7 = Alternate keypad mode. See "Enter Alternate Keypad Mode" for a description of this function.
- 8 = Auto line feed on receipt of CR. A line feed is automatically performed (in addition to a carriage return) when a carriage return is received.
- 9 = Auto CR on receipt of line feed. A carriage return is automatically performed (in addition to a line feed) when a line feed is received.

Example: If you want to turn off the cursor, type ESC x 5.

These functions default back to their initial states (as set by switches S401 and S402 on the terminal logic circuit board) when the Terminal is reset (RESET and right-hand SHIFT keys) or when you turn the Terminal off and then back on again. You can also reset these functions using the Reset Mode escape codes (ESC y). See below.

Reset Mode — ESC y — Resets the "Set Mode" functions to their initial states. To reset a function, type ESC y followed by the appropriate number given below.

- 1 = Disable 25th line
- 2 = Enable key click
- 3 = Exit hold screen mode
- 4 = Underscore cursor
- 5 = Cursor on
- 6 = Keypad unshifted
- 7 = Exit alternate keypad mode
- 8 = No auto line feed
- 9 = No auto CR

See "Set Modes" above.

Enter ANSI Mode — ESC < — Enters the ANSI mode. See the "Appendix" in the rear of this Manual for the definition and descriptions of the ANSI mode escape codes.

MODES OF OPERATION

Enter Hold Screen Mode — ESC [— The Hold Screen Mode allows you to control when new information is printed on the screen. This is especially useful when you are reading lists or looking for a particular part of a program. Push the OFF LINE key to its down position and then type ESC [to enter the Hold Screen Mode. Then, after you release the OFF LINE key, each time you type the SCROLL key a new line of text will appear on the bottom line and the top line of text will scroll up and off the screen. If you type SHIFT SCROLL, a whole new page (24 lines) of text will be scrolled onto the screen. Press the OFF LINE key to its down position and type ESC \ to exit the Hold Screen Mode. Remember; in this mode, when the cursor is at the start of a line of text, the Terminal is probably waiting for a scroll command.

This mode requires that the host computer respond to XON and XOFF.

Exit Hold Screen Mode — ESC \ — Exits the Hold Screen Mode. See "Enter Hold Screen Mode" above.

Enter Reverse Video Mode — ESC p — The characters displayed on the screen can also be displayed in reverse video, a black character on a white background. Type ESC p to enter the Reverse Video Mode, and ESC q to exit the Reverse Video Mode.

Exit Reverse Video Mode — ESC q — Exits the Reverse Video Mode. See "Enter Reverse Video Mode" above.

Enter Graphics Mode — ESC F — The graphics mode lets you display 33 special symbols. Refer to the "Graphic Mode Symbols" in the "Appendix" of this Manual. Type ESC F to enter the Graphics Mode. Then type any of the 26 lower-case keys or the seven other symbol keys that correspond to the graphic symbols. Type ESC G to exit the Graphics Mode. You can place the Terminal in the Reverse Video Mode while it is in the Graphics Mode to increase the number of graphic symbols.

Exit Graphics Mode — ESC G — Exits the Graphics Mode. See "Enter Graphics Mode" above.

Enter Keypad Shifted Mode — ESC t — The shifted functions that the keypad transmits normally require you to press and hold the SHIFT key when you type one of the keys. You can type ESC t to enter the Shifted Keypad Mode so that you do not need to hold the SHIFT key to obtain the unshifted functions. However, if you place the Terminal in the Shifted Keypad Mode and you need to use the unshifted functions (numbers), you will have to press and hold the SHIFT key to obtain them. Type ESC u to exit the Shifted Keypad Mode.

Exit Keypad Shifted Mode — ESC u — Exits the Keypad Shifted Mode. See "Enter Keypad Shifted Mode" above.

Enter Alternate Keypad Mode — ESC = — The codes sent to the computer from the Terminal Keypad normally include the numbers, period, ENTER, and (when shifted) some special cursor movement and editing functions. You can change these keypad codes using the Alternate Keypad Mode to transmit specific escape codes that your computer may respond to.

Type ESC = to enter and ESC > to exit the Alternate Keypad Mode.

The following chart lists the escape codes sent by the Terminal in the Alternate Keypad Mode.

KEY	ZDS ESCAPE CODE	ANSI ESCAPE CODE
0	ESC ? p	ESC O p
1	ESC ? q	ESC O q
2	ESC ? r	ESC O r
3	ESC ? s	ESC O s
4	ESC ? t	ESC O t
5	ESC ? u	ESC O u
6	ESC ? v	ESC O v
7	ESC ? w	ESC O w
8	ESC ? x	ESC O x
9	ESC ? y	ESC O y
.	ESC ? n	ESC O n
ENTER	ESC ? M	ESC O M

Exit Alternate Keypad Mode — ESC > — Exits the Alternate Keypad Mode. See "Enter Alternate Keypad Mode" above.

ADDITIONAL FUNCTIONS

Keyboard Disabled — ESC } — Inhibits the output of the keyboard.

Keyboard Enabled — ESC { — A computer-sent code that enables the keyboard after it was inhibited by a "Keyboard Disabled" command.

Wrap Around at End of Line — ESC v — 31st character on a line is automatically placed in the first character position on the next line. The page scrolls up if necessary.

Discard at End of Line — ESC w — After the 80th character in a line, the characters overprint. Therefore, only the last character received will be displayed in position 80.

Identify as VT52* (ESC / K) — ESC Z — The Terminal responds to interrogation with ESC / K to indicate that it can perform as a VT52.

Transmit 25th Line — ESC]**Transmit Page — ESC #**

The transmit functions (Transmit 25th Line and Transmit Page) are the same except for the source of the data transmitted. Your computer may have a special routine (which is required for this function to work) so it can accept the transmitted codes.

Basically (assuming that the mode has not changed), the data is transmitted the same as it appears on the CRT. This includes all 1920 characters (24 lines of 80 characters), or the 80 characters of the 25th line. However, it is possible that the actual number of characters transmitted will be more than 1920. If graphic characters, reverse video characters, or both are encountered, the proper escape sequence for entering the respective modes will be transmitted. When one or both of these parameters no longer apply, the appropriate escape sequence will then be sent to exit the mode.

The escape sequence which is sent is determined by whether the Terminal is in the ZDS mode or the ANSI mode. The sequence will be the same as that which was sent to the Terminal (or entered from the keyboard) to cause the Terminal to enter and/or exit the reverse video and graphic character modes.

Following the transmission of the last character, a carriage return is sent and the bell will sound.

If a transmit page is executed (ESC #), only lines 1 through 24 are transmitted. If you want to transmit the 25th line, you must ask for that specifically (ESC]). This operates the same as the transmit page except that only the 80 characters of the 25th line (and any necessary escape sequences) are transmitted and followed by a carriage return. In the event that the 25th line is not enabled, only a carriage return will be transmitted.

Special Function Keys

The eight special function keys (f1, f2, f3, f4, f5, Blue, Red, and Gray) on the top row of the keyboard transmit two-character escape codes to the computer. You can define the meanings of each of these keys to suit your particular application (your software program must recognize the particular escape codes associated with the keys). See the "Appendix."

SUMMARY OF KEYPAD FUNCTIONS

The keypad can operate in any one of four modes: normal unshifted, normal shifted, alternate unshifted, and alternate shifted. Then, within each of these modes, you can use the SHIFT key shifted or unshifted. (See "Enter Keypad Shifted Mode" and "Enter Alternate Keypad Mode.")

Normal Unshifted — This is the normal operating mode.

Example:	TYPE	TERMINAL TRANSMITS
	3	3
	SHIFT 3	DL (Delete Line)

Normal Shifted — ESC t to enter; ESC u to exit — The normal functions are inverted.

Example:	TYPE	TERMINAL TRANSMITS
	_____	_____
	3	DL (Delete Line)
	SHIFT 3	3

Alternate Unshifted — ESC = to enter; ESC > to exit — This is the normal alternate mode.

Example:	TYPE	TERMINAL TRANSMITS
	_____	_____
	3	ESC ? s (ZDS escape code)
	SHIFT 3	DL (Delete Line)

Alternate Shifted — ESC t ESC = to enter; ESC u ESC > to exit — The normal alternate functions are now inverted.

Example:	TYPE	TERMINAL TRANSMITS
	_____	_____
	3	DL (Delete Line)
	SHIFT 3	ESC ? s (ZDS escape code)

See the "Appendix" for actual codes sent and for ANSI codes.

READJUSTMENT

This section contains several adjustments that you may need to make to properly maintain your Video Terminal. You will have to remove or tilt back the cabinet shell in order to reach the controls, coils, and adjustments called for in this section. To do this, refer to the inset drawing on Pictorial 1 and carefully remove the cabinet shell back.

- () On the terminal logic circuit board (see Pictorial 4), set section 2 of switch S402 down to its 1 position to enable the "wrap around" mode.

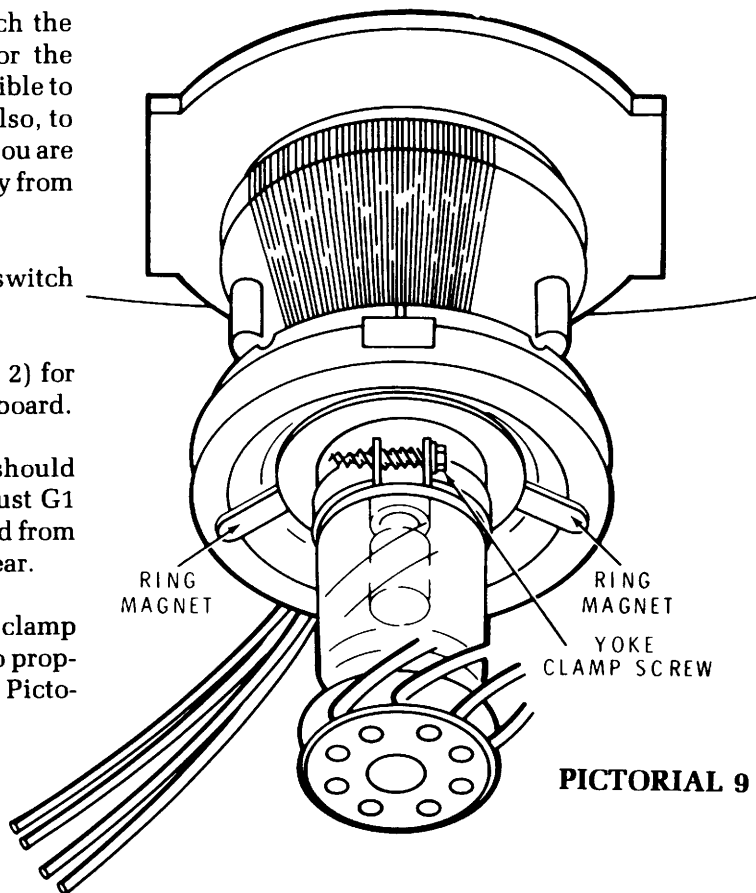
NOTE: When power is turned on, do not touch the flyback transformer, the high voltage lead, or the anode socket at the back of the CRT, as it is possible to receive an electrical shock from these areas. Also, to lessen the chances of an electrical shock while you are making adjustments, keep your other hand away from this unit and all other metallic objects.

- () Plug in the line cord and set the POWER switch to ON.

Refer to Pictorial 8 (Illustration Booklet, Page 2) for the locations of controls on the video circuit board.

- () After a short warm-up time, a light raster should appear on the screen. If it does not, adjust G1 control R268 counterclockwise (as viewed from the left side), to cause the raster to appear.
- () If the display is slanted, loosen the yoke clamp screw slightly and slowly turn the yoke to properly line up the raster on the screen. See Pictorial 9.

- () Adjust the VERT SIZE control R226 (on the video circuit board) so the display is approximately 6" high.
- () Refer to Pictorial 9 and rotate the ring magnets on the back of the yoke to center the display on the screen.
- () Adjust the BRIGHTNESS control (on the rear panel) until a blinking cursor (underline) appears at the top left corner of the screen.



- () Set the OFF LINE and CAPS LOCK keys to their down positions.
- () Hold the "Z" key and the REPEAT key down and fill the screen with characters.
- () Adjust HORIZ CENTERING control R253 to center the display horizontally within the raster.
- () Adjust VERT LINEARITY control R228 so that the top and bottom rows of characters are of uniform size.

NOTE: You should make the next adjustment in a darkened room.

- () Turn G1 control R268 clockwise (as viewed from the left) until the raster just disappears.
- () If the display width is not approximately 8-1/2", adjust WIDTH coil L204 to correct the width size.
- () Adjust the BRIGHTNESS control (on the rear panel) to obtain the brightness that is most suitable to you.
- () Adjust FOCUS control R271 for the best focus.
- () Recheck the display for proper alignment of the screen. If necessary, rotate the yoke a small amount. Then tighten the yoke clamp screw only enough to hold the yoke from turning.
- () Set the POWER switch to OFF and disconnect the line cord.
- () Set section 2 of switch S402 (on the terminal logic circuit board) up to its 0 position.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram and the Block Diagram while you read this "Circuit Description."

To help you locate parts in the Terminal or on the Schematic, the circuit component numbers (R1, C101, L301, etc.) for resistors, capacitors, coils, transistors, and integrated circuits are in the following groups:

0-99 Parts mounted on the molded chassis base or bezel.

100-199 Parts mounted on the power supply circuit board.

200-299 Parts mounted on the video circuit board.

300-399 Parts mounted on the keyboard circuit board.

400-499 Parts mounted on the logic circuit board.

POWER SUPPLY CIRCUIT BOARD

The primary circuit of the power supply consists of slow-blow fuse F1, ON/OFF switch SW1, 120 V/240 V switch SW2, HIGH/LOW line switch SW3, and the primary windings of transformer T1.

The red secondary windings of transformer T1 supply AC to diode bridge rectifier D109-D112. The 65-volt rectified output of the bridge is filtered by capacitor C1. It is used to power the video circuits.

The yellow secondary winding of T1 supplies AC to the diode bridge rectifier D105-D108. The rectified output of the bridge (8.5 VDC) is filtered by capacitor C103 and is used on the logic circuit board.

The green-yellow secondary windings supply center-tapped 30 VAC to diode bridge rectifier D101-D104. The rectified outputs of the bridge (± 16 VDC) are filtered by capacitors C102 and C104. These outputs are used on the logic circuit board.

INTERCONNECTION AND GROUNDING

The three power supplies (+65, +8.5, and ± 16) are not interconnected on the power supply circuit board. Instead, they pick up their appropriate grounds at the circuit boards they power. The +65-volt video supply connects to + and ground points on the video circuit board. The external conductive coating of the CRT and the CRT socket arc-ring both connect directly to the video circuit board ground.

The +9-volt and ± 16 -volt supplies connect directly to the logic circuit board with no common grounds until they meet at the terminal logic circuit board.

This grounding method produces two independent operating systems that do not interact with each other except through the signal ground and sync/video inputs. In the event of a CRT arc, the arc discharge current is confined to the video circuit board and it

does not induce transients into the logic circuits.

The logic/video system is also floating with respect to the ground wire of the power cord. The protective ground input (pin 1) of the EIA RS232 connector

connects to the power cord ground, along with all the exposed metal surfaces.

The signal ground input (pin 7) of the EIA RS232 connector connects to the logic circuit board ground.

VIDEO CIRCUIT BOARD

POWER SUPPLY

The unregulated 65-volts DC from the power supply circuit board enters the video circuit board at plug P202, pins 2 and 3. Assume that the Terminal has just been turned on and the output of the +53-volt regulator is at zero volts. The base current of Q209 is supplied through resistors R201, R202, and R203. The collector current of Q209 causes Q211 to turn on and supply current to the base of Q213. As the output voltage at the emitter of Q213 rises, D204 begins to supply current to zener diode D203 through resistor R202. D203 stabilizes at 12.8 volts and provides a reference for the output voltage. The divider formed by resistors R207 and R208 samples the output voltage as it continues to rise, and applies a fraction of the voltage to the emitter of Q209. When the emitter voltage of Q209 reaches 12.15 volts ($12.8 - .65$), its collector current is reduced to a value that keeps the output voltage stabilized at +53 volts.

Resistor R211 samples the current supplied to the load by Q213, and generates a voltage that is applied to the base of Q212. If the current exceeds about 1.1 amperes, Q212 turns on and shunts current from the base of Q211, which, in turn, prevents the output current from exceeding 1.1 amperes.

D205 and R212 form another zener regulator that supplied 6.2 volts DC to the video amplifier and 6 volts DC to the horizontal section through R213.

VIDEO AMPLIFIER

The video amplifier is a conventional cascode amplifier. The video signal enters the circuit board at plug P202, pin 4. The level of this video signal is set by Brightness control R216. It is then applied through R217 to the base of Q215. The base of Q214 is biased by the 6.2-volt supply. The signal at the collector of Q214 is coupled through resistor R1 to the cathode of the CRT. L201, which is in series with collector load resistor R215 provides high frequency compensation.

VERTICAL SECTION

The vertical portion of the video circuit board consists of two sections, a sweep generator and an amplifier.

The sweep (or ramp) generator consists of C211, C212, R227, and Q201. Capacitors C211 and C212 charge to +53 volts through resistor R227 to generate the ramp. This ramp voltage is applied to the anode of Q201, a programmable unijunction transistor. The gate of the unijunction is biased at a voltage determined by R222, R223, D201, and R224. When the anode voltage charges to the gate voltage, Q201 conducts and discharges C211 to ground through L202. As the discharge current decreases to zero volts, the unijunction stops conducting and the capacitors start to charge again through R227.

The ramp voltage is applied to the base of Darlington voltage follower Q202. The emitter voltage of Q202 is fed back to the junction of C211 and C212 to linearize the exponential ramp. Resistor R229 and Vert Linearity control R228 determine the amount of correction applied to the ramp. The amplitude of the ramp is determined by R225 and the Vert Size control, R226.

The free-running frequency of the oscillator is slightly less than 60 Hz, the normal sweep rate. Vertical sync pulses, which enter the circuit board at plug P202, pin 6, are coupled through R221, C208, and D201 to the gate of transistor Q201. The negative-going pulse lowers the gate voltage below the anode voltage and Q201 immediately conducts, discharging C211 and C212 before the free-running trip point is reached. Each succeeding sync pulse keeps the oscillator synchronized with the vertical sync signal generated by the CRT controller on the logic circuit board.

The amplifier portion of the vertical circuitry is composed of Q203, Q204, Q205, Q206, Q207, and Q208.

Under steady-state conditions, with no ramp signal

applied to the base of transistor Q204, the collector currents of Q203 and Q204 are determined by bias string R232, R233, R234, R235, and emitter resistors R236 and R241. The collector current of Q203 is nominally 3 milliamperes, and the collector current of Q204 is nominally 2 milliamperes. The difference (1 milliamperes) between the two, supplies base current to driver transistor Q205, which drives output transistors Q207 and Q208. Diode D202 and resistor R244 bias transistors Q207 and Q208 so that there is enough idle current to eliminate crossover distortion. Transistor Q206 is a current source that provides base current for Q208 and the bias network, D202 and R244. The output voltage at the junction of R246 and R247 is fed back to the bias string through R239 to keep the output stable at about 25 volts.

When the ramp signal is applied to the input of the amplifier through C213, the collector current of Q204 is varied as a function of the amplitude of the ramp voltage. The difference between the currents of Q203 and Q204 drives the outputs through Q205. The output voltage is fed through C217 to the vertical deflection yoke. Resistor R248, which is in series with the yoke, generates a voltage proportional to the yoke current. This voltage is fed back to the base of Q203 (negative feedback), which changes its collector current to keep the yoke current directly proportional to the input ramp voltage.

HORIZONTAL SECTION

The horizontal portion of the video circuit board consists of three sections:

Time delay and pulse shaping.

Horizontal deflection.

High voltage supplies.

The time delay and pulse shaping circuits are triggered by the horizontal sync pulses that come from the logic circuit board. They generate a time delay that provides horizontal centering and a pulse of the proper width to drive the horizontal sweep system.

The horizontal deflection system transfers energy from the power supply to the yoke in order to sweep the beam across the face of the CRT. The high voltage supplies generate the anode and grid voltages that operate the CRT.

TIME DELAY AND PULSE SHAPING

The horizontal sync pulses enter the circuit board at plug P202, pin 1. These pulses are then coupled through R249, C218, and D207 to U201. The trailing edge of each pulse triggers U201, a monostable multivibrator, causing the output (pin 3) to go high. The width of the output pulse is determined by C221, R254 and Horizontal Centering control R253. When the output pulse from U201 goes low, it triggers monostable U202. The 20 microsecond output pulse of Q202 (pin 3) is determined by C224 and R256. This pulse drives horizontal driver transistor Q216.

HORIZONTAL DEFLECTION

Transistor Q216 and driver transformer T201 drive horizontal output transistor Q217, which, in turn, drives the horizontal output transformer (flyback transformer) and the yoke. The positive-going pulse from U202 is coupled through the parallel combination of R257 and C225 to the base of Q216. During the time the pulse is high, the collector current of Q216 flows through the primary of T201. The phasing of the transformer is such that the secondary output voltage during this time is negative and keeps Q217 turned off. While Q216 is turned on and current flows through the primary, energy is stored in T201.

When the output pulse from U202 returns to zero volts, Q216 turns off, its collector current decreases to zero volts, the secondary voltage of T201 goes positive, and Q217 starts to conduct. The energy stored in the transformer is converted to base current and keeps Q217 turned on for the rest of the cycle. The transformer inductance, R261, R262, C227, and L203 control the base current decay and insure the best efficiency of the output transistor.

Transistor Q217 is a switch that controls the flow of energy through the deflection components. When Q217 is turned on, current flows from the power supply through the primary of horizontal output transformer T2 and through the horizontal yoke, L204, L205, and C233 to ground. During this time, the yoke current increases linearly and the beam is deflected to the right of the screen. When it reaches the right edge, driver transistor Q216 turns on and output transistor Q217 turns off. The energy that was stored in the yoke (along with the energy stored in the primary of T2) is transferred to C229 in the form of a half-wave voltage pulse with an amplitude of 550 volts. During this cycle, the current through the yoke goes to zero and the beam returns to the center of the screen.

Capacitor C229 now discharges into the yoke, inducing a current in the opposite direction, deflecting the beam to the left side of the screen. As the voltage across C229 decreases to zero volts, the resonant circuit of C229, the yoke, and the primary of T2 tries to oscillate in a negative direction. The energy transferred to the yoke by C229 now provides the sweep current for the first half of the scan and charges C233 through damper diode, D208.

Shortly before the beam reaches the center (before the yoke current reaches zero), transistor Q216 is turned off by U202 and Q217 is turned on. For a brief period, both D208 and Q217 are conducting in opposite directions. D208 is conducting the yoke current and Q217 is conducting the primary current of T2. Transistor Q217 turns on early to guarantee a smooth transition from negative to positive yoke current.

The value of C233 is chosen to provide "S" shaping of the current waveform through the yoke. This compensates for stretching at the left and right edges of the screen. Since the deflected beam sweeps a wider area at the edges than it does at the center for a given deflection angle, the current is decreased slightly at the left and right edges.

Width coil L204 is in series with the yoke and its reactance can be adjusted to change the total current through the yoke. If its reactance is high, the yoke current is slightly decreased and the scan width is reduced. If its reactance is low, the scan width is increased.

Vertical linearity coil L205 is a nonlinear inductor that provides further linearity correction that cannot be provided by C233 alone.

HIGH VOLTAGE SUPPLIES

The flyback voltage pulse developed at the collector of Q217 during the horizontal retrace is rectified by D211 and C232 to provide approximately 500 volts DC. This voltage, which is filtered further by R276, C236, C237, and C238 is coupled through R4 to the CRT grid 2 (G2).

The same flyback pulse is transformer coupled to the secondary of T2 and rectified by D209 and C231 to generate a -100-volt DC supply.

Resistor R272 and Focus control R271 form a voltage divider between the +500-volt and the -100-volt supplies to provide a bias voltage for grid 4 (the focus grid). This voltage is coupled through R275 and R3 to the CRT.

Another voltage divider consisting of D212, R267, and G1 control R268, between the +55-volt and -100-volt supplies, provides a bias voltage for grid 1 of the CRT.

The flyback pulse is also coupled to another secondary of transformer T2, the high voltage winding. The output pulse from this winding is about +15,000 volts. It is rectified by D1 (in the anode lead) and filtered by the internal capacitance of the CRT to provide the anode (or accelerator) voltage for the CRT.

Occasionally, the voltage stored in the internal capacitance of the CRT arcs over to the other electrodes. An arc ring built into the tube socket, and C234 (a capacitor with a parallel spark gap), in conjunction with series resistors R1, R2, R3, and R4, limit the amount of arc energy on the video circuit board to a safe value.

The video circuit board also has a discharge circuit that shorts the -100-volt supply to ground when the Terminal is turned off. This increases the beam current and discharges the high voltage so that a spot does not appear after the Terminal is turned off. A spot at the center of the tube could damage the phosphor.

When the Terminal is turned on, C235 charges through R274 and D213 to +53 volts. When the Terminal is turned off and the +53-volt supply starts to decrease, C235 applies a negative voltage to the base of Q218. This turns Q218 on and discharges the -100-volt supply.

Flyback transformer T2 also has a filament winding that supplies 6.3 volts AC at 450 milliamperes to power the CRT filament.

TERMINAL LOGIC CIRCUIT BOARD

The Terminal logic board consists of seven functional blocks:

1. Power supplies.
2. Keyboard encoder and configuration logic.
3. Processor/CPU.
4. Master clock and system logic.
5. Communications.
6. CRT and memory control.
7. Display memory, character generator, and video control logic.

The integrated circuits in each block are numbered as follows:

U401-U405	Power supplies.
U411-U419	Master clock and system logic.
U421-U429	Processor, ROM, RAM, processor control logic.
U430-U437	Keyboard encoder and configuration logic.
U451-U453	Communications and I/O drivers.
U461-U466	CRT and memory control.
U467-U479	Display memory, character generator, and video control logic.

POWER SUPPLIES

Integrated circuits U401 and U402 provide two regulated 5-volt supplies. U401 supplies 5-volts DC for the left half of the circuit board, while U402 supplies the right half of the circuit board. U403 supplies +12 volts DC, U404 supplies -12 volts DC, and U405

supplies -5.2 volts DC. These integrated circuits are internally protected against short circuits, overloads, and high temperatures. Capacitors C401, C403, C405, and C407 at the inputs of the regulators stabilize the supplies, while capacitors C402, C404, C406, C408, C409, and C440 improve the transient response of the regulators. C408 serves as the input stability capacitor for U405 and as the output capacitor for U404.

MASTER CLOCK AND SYSTEM LOGIC

Clock And Scalars

The master clock is a 12.288 MHz crystal-controlled oscillator. Crystal Y401, with C411, C413, and U411E form the oscillator. The series combination of C411 and C413 serve as the load capacitance for the crystal. U411E is the gain stage. Resistors R404 and R405 bias U411E into its linear region, while C412 bypasses any AC feedback through the two resistors. The output of the oscillator is buffered by U411D to prevent loading on the output from changing the oscillator frequency. This output is the "dot clock" and it is used by the shift register to shift dot information to the screen.

The dot clock also drives divide-by-eight scaler U412, which generates 1.536 MHz pulses. This is called the character clock. Each pulse corresponds to one character on the screen. U412 is a synchronous presettable counter that is loaded with a binary eight (1000). It counts dot clock pulses until its output reaches binary fifteen (1111). During the fifteenth count, the ripple carry output (pin 15) goes low. This pulse, which is inverted by U411F, puts a logic one on the load input (pin 9). The next positive-going clock cycle reloads a binary eight back into the counter and the cycle repeats. The Q_C output (pin 12) generates a 1.536 MHz pulse that serves as the clock for the CRT controller. It is inverted by U466D. These two signals are referred to on the Schematic as C and $\bar{C}$. The Q_B output generates a 3.072 MHz signal that drives the clock input (pin 16) of the ACE (U451).

The dot clock also drives U413 through U475C. U413 is a divide-by-six and divide-by-two scaler. The clock drives the B input (pin 1), and the Q_B output (pin 8) generates a 2.048 MHz clock signal for CPU U421. The Q_B output (pin 11) also drives the A input. The Q_A output in turn drives the input of binary scaler U414.

The output of U414 provides a 128 kHz clock (pin 6) for the keyboard encoder, U431, and a 1 kHz signal (pin 14) for the audible bell signal.

System Control Logic

The system control logic consists of I/O and memory decoding, power-up and manual reset circuits, and the bell and key click circuits.

I/O and memory decoding are accomplished by three-to-eight line decoders U418 and U419, respectively. U418 decodes address bits 5, 6, and 7 to generate eight I/O addresses:

1. Keyboard encoder 200
(80_H)
2. Keyboard status 240
(A0_H)
3. CRT controller 140
(60_H)
4. Power-up configuration (primary) 000
(00_H)
5. Power-up configuration (secondary) 040
(20_H)
6. ACE (communications) 100
(40_H)
7. Bell enable 340
(E0_H)
8. Key click enable 300
(C0_H)

Decoder U418 is enabled only during an I/O read or write operation to eliminate the possibility of false decoding on a refresh address coming from the Z80.

U419 decodes address bits 14 and 15 to generate three memory addresses:

1. Program ROM 000.000
(00 00_H)
2. Scratchpad RAM 100.000
(40 00_H)
3. Display memory 370.000
(F8 00_H)

Whenever the Z80 performs a read or a write operation it will either write to or read from one of these memory or I/O addresses.

When the Terminal is first turned on, the CPU, CRT controller, ACE, and keyboard control logic are cleared by the master reset signal. U415A, R407, C414, and D401 form the power-up reset circuit. When power is first turned on, C414 has no charge and temporarily holds pin 2 of U415A at logic zero. The output of U415 goes high and is inverted by U415B. The two outputs are the true and the complemented reset pulses. As C414 charges through R407, it pulls the input of U415 high, turning off the reset pulses.

A manual reset can also be accomplished if you simultaneously press the Reset and right-hand Shift keys on the keyboard. U435E and U435B are connected to those keys and they drive the inputs of U415D. The output of U415D (pin 11) is coupled through R408 to pin 1 of U415A. R408 and C415 form a de-bounce circuit for the Shift and Reset keys. When the output of U415D goes low, the input of U415A is also pulled low. This generates a reset pulse.

The CPU, under the control of the ROM program, can cause a bell tone or a key click to sound through the speaker. When the CPU addresses I/O port 340, pin 7 of U418 triggers one-half of monostable U417. Its output goes low for about 200 milliseconds, causing the output of U415C to go high. This logic 1 is NANDed in U416C with the 1000 Hz signal coming from U414. The output of U416C drives speaker SP1. Diode D402 keeps the output of U416C from being driven above 5-volts at turn-off by the inductive reactance of the speaker.

When the CPU addresses I/O port 300, pin 9 of U418 triggers the other half of U417. Its output (pin 7) goes low for about six milliseconds and turns on the 1000 Hz tone. This short duration causes the tone to sound like a click.

PROCESSOR

The processor section of the Terminal consists of the Z80 processor (U421), or CPU (central processing unit), ROM (read only memory), RAM (random access memory), and processor control logic.

Processor/CPU

The heart of the Terminal logic circuit board is the Z80 CPU. It acts as a scheduling or dispatching service for the data coming into or originating from the Terminal. It examines the data it receives and determines what, if anything, it should do with it. If the data comes from the ACE (U451), for example, the Z80 will compare the ASCII word with a set of conditions determined by the ROM program, and then write the word into the appropriate memory or I/O port. If the ASCII word is a bell signal, the CPU addresses I/O port 340, and the bell tone sounds through the speaker. If the word is the letter "B", the CPU performs a memory write to the current cursor position in the display memory. If the data from the ACE is a nonvalid character or a string of characters, the CPU simply ignores the data and does nothing.

The ROM program that directs the CPU is rather long and complex, but the mechanics of the process are easy to follow. The 2.048 MHz clock signal drives the clock input (pin 6) of the CPU through U411A. This steps the CPU through an internal "machine" cycle that starts with a fetch instruction. It executes the remainder of its instructions by stepping through a precise set of a few basic instructions. These include memory read, memory write, I/O read, I/O write, and interrupt acknowledge. The basic thing to remember is that the ROM program directs the Z80 to make decisions and move data from place to place within the circuit board. Without the CPU and ROM, the decisions and data movement would have to be accomplished with hard-wired logic packages.

ROM

The read only memory, U422 and U423, is made up of a pair of 2 K by 8-bit (16384 bit) ROMs. Its eleven address inputs connect to A0 through A10 of the address bus and its eight data outputs connect to D0 through D7 of the data bus. U429A, U429B, and U416D decode the ROM select line coming from memory decoder U419 and address A11 for the CPU to generate a new address for either a 2K or a 4K ROM.

RAM

The random access memory for the Z80 scratchpad consists of U424 and U425, 256 × 4-bit RAMs. This scratchpad RAM provides temporary data storage for the Z80. The address inputs to each IC connect to A0 through A7 on the address bus. The lower four bits of data (D0-D3) are provided by U424; the upper four bits (D4-D7) are provided by U425. The select signal comes from U419.

Processor Control Logic

The processor for the Terminal requires some additional circuitry to control the interrupt process, and to provide a wait cycle for the keyboard encoder, which is slow in responding to a read cycle.

U427C is a 2-input NOR gate that monitors the INTRPT output of the ACE and pin 4 of U436B (the keyboard INTRPT). When either INTRPT output goes high, the output of U427C goes low and signals the INT input (pin 16) of the Z80 that data is available from the ACE or keyboard.

U426, U427A, and U427B form a counter that drives the WAIT input (pin 24) of the Z80. Whenever the Z80 performs an I/O read at the keyboard encoder, pin 11 of U418 drives the "reset to zero" inputs (pins 12 and 13) of U426. The A and B outputs (pins 9 and 5) of U426 drive the inputs of U427B, a 2-input NOR gate. The output of U427B holds the Z80 WAIT input low whenever the A or B outputs of the counter are high. This generates a total wait of four clock cycles (one wait cycle is automatically inserted by the Z80 on an I/O instruction) to allow the output buffer of U431 to turn on. When the C output (pin 4) of counter U426 goes high, it drives the input of U427A high. This forces the output low and turns on the clock input (pin 10) of U426. The A and B outputs now go low and the wait signal is no longer present. The Z80 then finishes up the I/O read cycle (pin 11 of U418 goes high) and the counter is reset to zero and held there until the next keyboard read.

U428 provides a nonmaskable-interrupt ($\overline{\text{NMI}}$) that operates under the control of the ROM program. The NMI routine is used when the program wants to read something into the CRT Controller (or) CRTC during the vertical blanking period. The data input of U428A is driven by A2 of the address bus. The T, or clock, input is driven by the complemented CRT controller I/O select that comes from pin 12 of I/O decoder U418. U466C provides the complemented signal. When the

program wants to write during vertical retrace, it addresses the CRT controller while holding A2 high. The Q output of U428A is clocked high and drives the reset input of U428B high. The vertical sync signal drives the T input of U428B and clocks the $\overline{Q}$ output low as soon as the sync signal begins. The $\overline{NMI}$ input of the Z80 goes low and the program immediately jumps to the "update CRTIC" routine. Part of that routine will write a zero to the data input of U428A to clear the NMI signal.

KEYBOARD ENCODER AND CONFIGURATION LOGIC

Keyboard Encoder

The keyboard of the Terminal consists of single-pole, single-throw switches in a matrix that is scanned by keyboard encoder U431. Outputs X1 through X9 go high, in sequence, and drive one of the Y1 through Y10 inputs if one of the switches is depressed. The encoder uses the X and Y information to generate a unique binary code for each matrix intersection, and this code is latched internally when a key is depressed. The encoder generates a data strobe (DS), which comes from pin 13 of U431, for each key closure. It also clocks the T input (pin 3) of U432A and the $\overline{Q}$ output of U432A goes low. The $\overline{Q}$ output drives an input of U436B. The output of U436B generates an $\overline{INT}$ signal, which is coupled to the Z80. When the Z80 services the interrupt at I/O port 200, pin 11 of U418 clears U432A (through U436C and U435A) and the $\overline{INT}$ signal is defeated. Pin 36 of U431 is also a binary data output and it is latched in U432B by the I/O read at 200. The keyboard interrupt routine also checks the keyboard status in another I/O read operation. The keyboard status check reads the state of the following:

1. Control key.
2. Shift keys.
3. Repeat key.
4. Break key.
5. Off-line key.
6. Caps Lock key.
7. Data Strobe.
8. Data bit latched in U432B.

The ROM program uses this information in conjunction with the encoder data to determine the routing of the data within the Terminal. Pin 10 of I/O decoder U418 drives enable inputs (pin 19) of buffers U433 and U434 to put the status information on the bus. The Caps Lock, Break, Off Line, Control, Repeat, and Shift (left) keys are connected directly to the inputs of these buffers. The outputs of U432A and U432B are also connected to the inputs of the buffers.

The binary data outputs of the keyboard encoder drive the address inputs (A0-A7) of ROM U430. U430 converts the binary data from the keyboard encoder to ASCII data. The data outputs of U430 drive the D0-D7 bits of the data bus. The chip select input (pin 18) of U430 is driven by pin 11 of U418 (the I/O decoder).

When the Repeat key is held down, the input of U435D is low and its output is high. This enables the repeat rate oscillator, U436A, R414, C418, and Q402. The repeat frequency, which is approximately 15 Hz, is determined by R414 and C418. When the Repeat key is released, the output of U435D goes low, forcing the output of U436A high and disabling the repeat function.

The two shift keys are ORed together in U436D. Its output drives the shift input (pin 21) of U431. When the Control key is typed, it forces the output of U435F high, which drives the control input (pin 19) of keyboard encoder U431.

Configuration (Power-up) Logic

When the system is first turned on, the ROM program must program the ACE for the baud rate and parity that you selected on switches S401 and S402. The program addresses I/O port 000 and pin 15 of I/O decoder U418 drives enable inputs of U433 and U434 to put the information selected by the switches on the bus. The program then interprets the data and configures the ACE accordingly. I/O address 040 is used in a similar manner. Pin 14 of the I/O decoder (U418) enables buffer U437 and puts the data from S402 on the bus.

COMMUNICATIONS AND I/O DRIVERS

The Terminal talks to the outside world through an Asynchronous Communications Element (ACE) and EIA RS-232C compatible line drivers and receivers. The ACE (U451) converts parallel ASCII data to serial data and drives the communications line through line

driver U452. The ACE also converts serial data coming from line receiver U453 into parallel ASCII data. The ACE puts this data on the bus when the ROM program requests it.

ACE/UART

U451 is an Asynchronous Communications Element that performs the following functions:

1. Converts data from parallel to serial and vice versa.
2. Divides a master clock frequency by a programmable divisor to generate a desired baud rate.
3. Programs the data characteristics, parity, stop bits, and character length.

The characteristics of the ACE must be programmed into the internal registers of U451 by the ROM program through the address and data busses. Bidirectional data bits (pins 1-8) of U451 connect to the system data bus. The address inputs (pins 28, 27, and 26) connect to the system address bits A0, A1, and A2. When the ROM program addresses I/O port 100, pin 13 of I/O decoder U418 selects the $\overline{CS2}$ input (pin 14) of the ACE. The Z80 can then read or write data by enabling the data input and data output strobes at pins 21 and 18 ($\overline{DISTR}$ and $\overline{DOSTR}$).

When the ACE receives a complete serial word from the EIA interface, it signals the Z80 that there is data available by pulling the Z80 $\overline{INT}$ input (pin 16) low. The Z80 then examines the internal status and data registers of the ACE, reads the data word, and routes it to the proper device within the Terminal.

I/O Drivers

The standard EIA interface communicates by means of a serial stream of voltage levels that correspond to logic ones and zeros. A logic one (or mark) on the data lines is a voltage between -5 and -15 volts. A logic zero on the data lines is a voltage between +5 and +15 volts. On the control lines ($\overline{DTR}$, $\overline{RTS}$, $\overline{RLSD}$, $\overline{DSR}$, CTS), a voltage between +5 and +15 volts is considered to be ON, and a voltage between -5 and -15 volts is considered to be OFF.

U452 is a standard EIA line driver. A logic one on the input of U452C drives the serial data outline to an EIA logic one, or "mark". A zero on the input forces the line to an EIA zero, or "space." U452B and U452D drive control lines DTR (Data Terminal Ready) and RTS (Ready To Send) in a similar manner.

U453 is a standard EIA line receiver. The serial data in line drives the input of U453A, which converts the EIA voltages to TTL levels and drives the serial input of the ACE. Likewise, the RLSD, DSR, and CRS line signals drive the inputs of U453B, U453D, and U453C, respectively. The outputs drive the appropriate control inputs of the ACE.

The I/O connector on the back panel of the Terminal is a standard 25-pin D-type plug with the data and signal line connected as follows:

1. Protective or chassis ground.
2. Serial Data Out.
3. Serial Data In.
4. Request To Send (RTS).
5. Clear To Send (CTS).
6. Data Set Ready (DSR).
7. Signal ground.
8. Received Line Signal Detector In (RLSD).
20. Data Terminal Ready (DTR).

CRT AND DISPLAY MEMORY CONTROL

The heart of the Z19 video logic system is the CRT controller. This device generates all of the sync and blanking signals and display memory addresses for the video system. The memory control is used to select either the address coming from the CRT controller or the address bus, and to synchronize read and write pulses.

CRT Controller

The CRT controller, U461, is a fully programmable device that is set up by the ROM program during power-up. Its bidirectional data bits (pins 33-26) connect to system data bits D0-D7. Its address or programming inputs come from the following four input pins:

- Pin 22. Read/Write ($R/\overline{W}$) — Determines whether the controller's internal register file is to be written to or read from. A write is a logic zero.
- Pin 24. Register Select (RS) — Selects either the address register (RS=0) or one of the data registers (RS=1) of the internal register file.
- Pin 25. Chip Select ($\overline{CS}$) — A zero sets the CRT controller to read or write the internal memory file.
- Pin 23. Enable (E) — Enables the I/O buffers and clocks data to and from the CRT controller. Data is clocked on the falling edge of the enable signal.

The internal registers are written to or from by means of the address register. The Z80 sets up the programmable registers by first writing a register number into the address register when the register select input is low. It then performs a write operation when the Register Select input goes high.

Each of the CRT controller's registers is programmed at power-up with appropriate data to generate the SYNC, timing, and refresh signals. The memory address outputs (MA0-MA10) drive the address of the display RAM through multiplexers U463, U464, and U465. The scan row address outputs (RA0-RA3) drive the address inputs of character generator U473. The display enable output (EN) is a logic one whenever the CRT controller, U461, is addressing a port of the RAM during the time it should be displayed. This serves as a blanking output whenever it is a logic zero. The cursor output goes to a logic one when the RAM location being addressed is equal to the address stored in the cursor address registers.

Controller Read/Write Logic

The $\overline{CS}$ and EN inputs of the CRT controller must be selected in a particular sequence to perform read and write operations to and from the controller. The enable input pulse (pin 18) must always be inside the $\overline{CS}$ pulse. When the I/O request for address 140 appears at pin 12 of U418, the clear input of U462A goes low, and the $\overline{Q}$ output immediately drives the $\overline{CS}$ input low. The $\overline{Q}$ output drives the data input of U462B to a logic one. At the same time, U466C puts the Clear input of U462B at a logic one.

The next CPU clock pulse at pin 11 of U462B clocks the logic one at the data input through to the Q output. This delays the leading edge of the enable pulse until approximately one clock cycle after the leading edge of the $\overline{CS}$ pulse. When the I/O request at address 140 goes away (returns to logic one), the output of U466C immediately clears U462B and its Q output drives the EN input of the CRT controller to zero. The clear input of U462A goes high at the same time, but the Q output remains low until the next CPU clock pulse at pin 3 clocks the logic one at the data input through to the output, terminating the $\overline{CS}$. This delays the trailing edge of the $\overline{CS}$ pulse until after the trailing edge of the EN pulse.

Display Memory Control

The display memory control consists of an address bus multiplexer, a bidirectional bus buffer, and some gates that control the display memory write enable (WE) and chip select ($\overline{CS}$) inputs.

The address bus multiplexer consists of quad 2-input multiplexers U463, U464, and U465. Their select inputs are tied together and controlled by memory decoder U419. When no read or write operations are being performed on the display memory, the select inputs are at a logic one, and the memory addresses (MA0-MA9) generated by the CRT controller drive the address inputs (A0-A9) of RAMs U467-U470. When the Z80 addresses the memory, pin 9 of U419 pulls the select input to a logic zero, CRT controller memory addresses MA0-MA9 are disconnected from the display RAM, and address bus bits A0-A9 are connected to the RAM address inputs. The Z80 can then read from or write into the display RAM.

Bus buffer U471 isolates the main data bus from the secondary or refresh, bus. During the screen refresh period, the data outputs of the display RAM drive the data inputs of the character generator continuously. This would prevent the processor from having access to the bus except during retrace times. However, by isolating the refresh bus from the main bus, the Z80 can have continuous access to the main bus and the display RAM and character generator can have continuous access to the secondary bus (refresh bus). When the Z80 needs access to the display RAM, it addresses the memory, which enables U471 through pin 9 of U419, and connects the main bus directly to the secondary bus.

U466A and U466B provide the $\overline{CS}$ signals for the display RAMs. During the screen refresh cycle, pin 11 of U465 is driven by MA10 and pins 1 and 4 of U466 are logic one. The output of U466A provides the $\overline{CS}$ for RAMs U469 and U470, and drives input pin 5 of U466B. The output of U466B is the complement of the $\overline{CS}$ signal and it drives the $\overline{CS}$ input of RAMs U467 and U468. During a display RAM read or write cycle, pins 1 and 4 of U466 are driven by the RD+WR signal coming from pin 3 of U416A. This eliminates the possibility of a contention problem on the secondary (refresh) bus between the display RAMs and buffer U471.

The write (WE) inputs of the RAMs are connected together and they are controlled by U429C. The WE (pin 8 of U429C) cannot go low unless pin 9 of U419 is low (memory is selected) and the Z80 WR output is low.

DISPLAY MEMORY, CHARACTER GENERATOR, AND VIDEO CONTROL LOGIC

This section of the Terminal logic circuit board essentially runs by itself (in conjunction with the CRT controller) after being programmed by the Z80. The CRT controller continually provides refresh addresses for the display RAM, while the output of the RAM continually provides data for the character generator and the video shift register.

Character Generator

Character generator U473 is a 2048×8 (16384 bit) read only memory that converts the ASCII data stored

in the display memory into dot information for the video shift register. Address inputs A0-A3 (pins 5-8) are driven by the scan row address outputs of the CRT controller (RA0-RA3) to select a particular row of dots within a character space. Address inputs A4-A10 connect to the secondary data bus through 8-bit latch U472. These inputs use ASCII data to address the dot data stored in the ROM. The data outputs (01-08) of U473 supply video dot data to the parallel inputs of video shift register U474.

The inputs of 8-bit latch U472 connect to the secondary data bus. Data bits D0-D6 are latched into U472A and drive the character generator. Data bit D7 is the reverse video bit. It is latched in U472H and drives an input of U479A.

Video shift register U474 latches parallel dot data from the character generator at inputs A-H and shifts it out of output Q_H in synchronism with the dot clock (the dot clock drives the clock input, pin 7). The shift register is loaded (the dot data is latched) on a positive-going transition of the dot clock while the shift/load input is held low by the character clock coming from pin 12 of U411F. The dot data at input H appears immediately at output Q_H . The next leading edge of the dot clock shifts the data that was latched at Q_C . The next edge of the dot clock will shift the data that was latched in Q_F , and so on. After the data from Q_A is shifted to the Q_H output, the load input goes low, and the next character cycle begins.

Video Control Logic

The video control logic consists of two sections: a series, or chain, of gates and latches associated with video, cursor, and reverse video data; and a chain of gates and latches associated with blanking data.

The display enable (blanking) and cursor data from pins 18 and 19 of the CRT controller is coincident with MA0-MA10, which address the display RAM. The display enable bit is latched in U476D (after passing through AND gate U477C) by the complemented character clock pulse coming from pin 11 of U466D. The cursor bit is latched in U476F. This delays the two signals by one character time. They are delayed for one more character time by being latched in U476E and U476G, respectively. The two character delays are necessary to compensate for the delays in the display RAM/character generator "pipeline".

When MA0-MA10 address the RAM, it takes approximately 450 nS for the data to be valid at the outputs. Once it settles down, the next character clock latches it in U472. The data at the output of U472 then addresses character generator U473. The data at the output takes another 450 nS to settle, and it is latched in the shift register by the following clock pulse. (Since the character clock pulses are 650 nS apart, the RAM and character generator outputs have plenty of time to settle.) This two-character delay matches the delays for the cursor and display enable, so that everything is synchronized.

The reverse video bit (D7) in the display RAM is latched first in U472, and then in U476H (after passing through AND gate U477A), so that it too arrives coincident with the video, blanking, and cursor data.

The video dot data from pin 13 of the video shift register and the cursor data coming from pin 16 of U476G are exclusive-ORed in U475A. This causes the cursor dots to reverse when the cursor happens to be coincident with video information, and keeps the cursor from disappearing when it occupies the same space as a character.

The video/cursor information coming from pin 3 of U475A is then exclusive-ORed in U475B with the reverse video data coming from pin 19 of U476H. When pin 19 is logic zero, the video/cursor data passes through U475B just as it is entered. If pin 19 of U476H is logic one, the data is reversed, and the character appears on the screen as black dots on a white background. The reverse video function can be disabled under the control of the ROM program when a logic zero is written into latch U478B via the address bus. Address bit A3 drives the data input of U478B, and its clock input is clocked when the CRT controller is addressed (I/O address 140). If the reverse video is to be defeated, the Q output (pin 9) of U478B puts pin 1 of AND gate U477A at a logic 0 and disables the reverse video bit coming from pin 19 of latch U472.

The video/cursor/reverse data coming from pin 6 of U475B is ANDed in U477D with the display enable

data coming from pin 12 of U476E. If the display enable is logic 1, the video data goes to the video circuit board; if it is a logic zero, the video is blanked.

When the Z80 performs a read or write operation on the display RAM, it disturbs the pipeline, and the data on the secondary (refresh) bus does not coincide with what should be written on the screen. Consequently, the video is blanked during a read or write. When pin 9 of memory decoder U419 goes low to select the display RAM, it also drives the clear input (pin 1) of U476. The Q output (pin 6) of U476C drives pin 9 of AND gate U477C to a logic zero and disables the display enable. At the same time, the Q output (pin 12) of U476E drives pin 12 of AND gate U477D to a logic zero, blanking the video information coming from the video chain. The screen will blank as long as the RAM is selected.

When pin 9 of U419 goes high to deselect the RAM, U476 is no longer held cleared. The logic one at the D input of U476C is clocked through to its Q output on the next character clock pulse, and it is clocked through U476D and U476E on the next two pulses. This three-character delay gives the pipeline time to reload with valid information before the video is enabled.

The propagation delays through the various gates and latches (U474, U475A, U475B, and U476) from the edge of the character and dot clocks to their various outputs is not always constant, so another delay is used. Latch U478A acts as a mini-pipeline, clocked at the dot rate. The data input to U478A is the composite video/cursor/reverse/blanking data, and its T input is clocked by the dot clock. This 80 nS delay lets all data settle to valid states before it is sent to the video circuit board.

The sync and video signals are buffered before they leave the Terminal logic circuit board. U479A inverts and buffers the video data. U479B inverts and buffers the vertical sync signal coming from pin 40 of the CRT controller. U479B buffers the horizontal sync signal coming from pin 39 of the CRT controller.

APPENDIX

ASCII CHARACTERS

The characters in the shaded areas are not processed by the Terminal.

7-BIT OCTAL CODE	DECIMAL CODE	HEX CODE	CHARACTERS	CONTROL KEYS	DESCRIPTION
000	0	0	NUL	@	Null, tape feed.
001	1	1	SOH	A	Start of heading.
002	2	2	STX	B	Start of text.
003	3	3	ETX	C	End of text.
004	4	4	EOT	D	End of transmission.
005	5	5	ENQ	E	Enquiry; also WRU.
006	6	6	ACK	F	Acknowledge; also RU.
007	7	7	BEL	G	Rings the bell.
010	8	8	BS	H	Backspace; also FEB, format effector backspace.
011	9	9	HT	I	Horizontal tab.
012	10	A	LF	J	Line feed; advances cursor to next line.
013	11	B	VT	K	Vertical tab (VTAB).
014	12	C	FF	L	Form feed to top of next page.
015	13	D	CR	M	Carriage return to beginning of line.
016	14	E	SO	N	Shift out.
017	15	F	SI	O	Shift in.
020	16	10'	DLE	P	Data line escape.
021	17	11	DC1	Q	Device control 1: turns transmitter on (XON).
022	18	12	DC2	R	Device control 2.
023	19	13	DC3	S	Device control 3: turns transmitter off (XOFF).
024	20	14	DC4	T	Device control 4.
025	21	15	NAK	U	Negative acknowledge; also ERR (error).
026	22	16	SYN	V	Synchronous idle (SYNC).
027	23	17	ETB	W	End of transmission block.
030	24	18	CAN	X	Cancel (CANCL). Cancels current escape sequence.
031	25	19	EM	Y	End of medium.
032	26	1A	SUB	Z	Substitute.
033	27	1B	ESC	[	Escape.
034	28	1C	FS	\	File separator.
035	29	1D	GS	]	Group separator.
036	30	1E	RS	.	Record separator.
037	31	1F	US	-	Unit separator.

7-BIT OCTAL CODE	DECIMAL CODE	HEX CODE	CHARACTERS	DESCRIPTION
040	32	20	SP	Space.
041	33	21	!	Exclamation point.
042	34	22	"	Quotation mark.
043	35	23	#	Number sign.
044	36	24	\$	Dollar sign.
045	37	25	%	Percent sign.
046	38	26	&	Ampersand.
047	39	27	'	Acute accent or apostrophe.
050	40	28	(	Open parenthesis.
051	41	29	)	Close parenthesis.
052	42	2A	*	Asterisk.
053	43	2B	+	Plus sign.
054	44	2C	,	Comma.
055	45	2D	-	Hyphen or minus sign.
056	46	2E	.	Period.
057	47	2F	/	Slash.
060	48	30	0	Number 0.
061	49	31	1	Number 1.
062	50	32	2	Number 2.
063	51	33	3	Number 3.
064	52	34	4	Number 4.
065	53	35	5	Number 5.
066	54	36	6	Number 6.
067	55	37	7	Number 7.
070	56	38	8	Number 8.
071	57	39	9	Number 9.
072	58	3A	:	Colon.
073	59	3B	;	Semicolon.
074	60	3C	<	Less than.
075	61	3D	=	Equal sign.
076	62	3E	>	Greater than.
077	63	3F	?	Question mark.

7-BIT OCTAL CODE	DECIMAL CODE	HEX CODE	CHARACTERS	DESCRIPTION	GRAPHIC SYMBOLS
100	64	40	@	At sign.	
101	65	41	A	Letter A.	
102	66	42	B	Letter B.	
103	67	43	C	Letter C.	
104	68	44	D	Letter D.	
105	69	45	E	Letter E.	
106	70	46	F	Letter F.	
107	71	47	G	Letter G.	
110	72	48	H	Letter H.	
111	73	49	I	Letter I.	
112	74	4A	J	Letter J.	
113	75	4B	K	Letter K.	
114	76	4C	L	Letter L.	
115	77	4D	M	Letter M.	
116	78	4E	N	Letter N.	
117	79	4F	O	Letter O.	
120	80	50	P	Letter P.	
121	81	51	Q	Letter Q.	
122	82	52	R	Letter R.	
123	83	53	S	Letter S.	
124	84	54	T	Letter T.	
125	85	55	U	Letter U.	
126	86	56	V	Letter V.	
127	87	57	W	Letter W.	
130	88	58	X	Letter X.	
131	89	59	Y	Letter Y.	
132	90	5A	Z	Letter Z.	
133	91	5B	[	Open brackets.	
134	92	5C	\	Reverse slash.	
135	93	5D	]	Close brackets.	
136	94	5E	↑	Up arrow/caret.	
137	95	5F	—	Underscore.	

7-BIT OCTAL CODE	DECIMAL CODE	HEX CODE	CHARACTERS	DESCRIPTION	GRAPHIC SYMBOLS
140	96	60	\	Grave accent.	
141	97	61	a	Letter a.	
142	98	62	b	Letter b.	
143	99	63	c	Letter c.	
144	100	64	d	Letter d.	
145	101	65	e	Letter e.	
146	102	66	f	Letter f.	
147	103	67	g	Letter g.	
150	104	68	h	Letter h.	
151	105	69	i	Letter i.	
152	106	6A	j	Letter j.	
153	107	6B	k	Letter k.	
154	108	6C	l	Letter l.	
155	109	6D	m	Letter m.	
156	110	6E	n	Letter n.	
157	111	6F	o	Letter o.	
160	112	70	p	Letter p.	
161	113	71	q	Letter q.	
162	114	72	r	Letter r.	
163	115	73	s	Letter s.	
164	116	74	t	Letter t.	
165	117	75	u	Letter u.	
166	118	76	v	Letter v.	
167	119	77	w	Letter w.	
170	120	78	x	Letter x.	
171	121	79	y	Letter y.	
172	122	7A	z	Letter z.	
173	123	7B	{	Left brace.	
174	124	7C		Vertical bar (broken).	
175	125	7D	}	Right brace.	
176	126	7E	~	Tilde.	
177	127	7F	DEL	Delete (rubout).	

GRAPHIC SYMBOLS

KEY (OCTAL) [DECIMAL]	SYMBOL	KEY (OCTAL) [DECIMAL]	SYMBOL	KEY (OCTAL) [DECIMAL]	SYMBOL	KEY (OCTAL) [DECIMAL]	SYMBOL
^ (136) [94]	*** ***** ***** ***** ***	c (143) [99]	***** ***** ** ** ** **	h (150) [104]	* * ***** * *	m (155) [109]	**** **** **** **** ****
- (137) [95]	***** ***** ***** ***** ***** **** *** ** * *	d (144) [100]	** ** ** ** ***** *****	i (151) [105]	* *	**** **** **** **** ****	
(140) [96]	** ** ** ** ** ** ** ** ** **	e (145) [101]	** ** ** ** ***** *****	j (152) [106]	* ***** *	o (157) [111]	**** **** **** **** ****
a (141) [97]	***** *****	f (146) [102]	***** ***** ** ** ** **	k (153) [107]	* * * * * *** *	p (160) [112]	***** ***** ***** ***** *****
b (142) [98]	** ** ** ** ***** ***** ** ** ** **	g (147) [103]	* * ***** * * *****	l (154) [108]	**** **** **** **** ****	q (161) [113]	**** **** **** **** **** **** **** ****

Graphic Symbols (cont'd.)

KEY (OCTAL) [DECIMAL]	SYMBOL	KEY (OCTAL) [DECIMAL]	SYMBOL	KEY (OCTAL) [DECIMAL]	SYMBOL
r (162) [114]	***** ***** ***** ***** ***** ***** ***** *** ** *	w (167) [119]	* * ** ** ** ** **** ** ** **** ** ** ** ** * *	i (174) [124]	: ** : ** : ** : ** : ** : ** : ** : ** : ** : **
s (163) [115]	***** ***** ** ** ** **	x (170) [120]	* ** ** ** ** ** ** ** ** **	} (175) [125]	** ** ** ** ** ** ** ** ** **
t (164) [116]	** ** ** ** ***** ***** ** ** ** **	y (171) [121]	* ** ** ** ** ** ** ** ** ** **	~ (176) [126]	***** ***** ***** ***** ** ** **
u (185) [117]	** ** ** ** ***** *****	z (172) [122]	***** *****		
v (166) [118]	** ** ** ** ***** ***** ** ** ** **	{ (173) [123]	***** *****		

TRANSMITTED CODES

The following tables list the octal code or codes transmitted by the Terminal when the indicated keyboard keys are pressed.

KEY	LOWER CASE	UPPER CASE
A	141	101
B	142	102
C	143	103
D	144	104
E	145	105
F	146	106
G	147	107
H	150	110
I	151	111
J	152	112
K	153	113
L	154	114
M	155	115
N	156	116
O	157	117
P	160	120
Q	161	121
R	162	122
S	163	123
T	164	124
U	165	125
V	166	126
W	167	127
X	170	130
Y	171	131
Z	172	132

ALPHABETIC KEYS

KEY	UNSHIFTED	SHIFTED
0	060	051)
1	061	041 !
2	062	100 @
3	063	043 #
4	064	044 \$
5	065	045 %
6	066	136 ↑
7	067	046 &
8	070	052 *
9	071	050 (
-	055	137 _
=	075	053 +
[	133	135]
;	073	072 :
'	047	042 "
,	054	074 <
.	056	076 >
/	057	077 ?
`	140	176 ~
\	134	174 !
{	173	175 }

NONALPHABETIC KEYS

KEYPAD KEYS	UNSHIFTED	ZDS UNSHIFTED ALTERNATE	ANSI UNSHIFTED ALTERNATE	SHIFTED
Ø	Ø	ESC ? p	ESC O p	Ø
1\IL	1	ESC ? q	ESC O q	ESC L (Insert Line)
2\	2	ESC ? r	ESC O r	ESC B (Down arrow)
3\DL	3	ESC ? s	ESC O s	ESC M (Delete Line)
4\←	4	ESC ? t	ESC O t	ESC D (Left arrow)
5\HOME	5	ESC ? u	ESC O u	ESC H (Home)
6\→	6	ESC ? v	ESC O v	ESC C (Right arrow)
7\IC	7	ESC ? w	ESC O w	ESC @ (Enter Insert Character Mode)
				ESC O (Exit Insert Character Mode)
8\↑	8	ESC ? x	ESC O x	ESC A (Up arrow)
9\DC	9	ESC ? y	ESC O y	ESC N (Delete Character)
.	.	ESC ? n	ESC O n	.
ENTER	RETURN	ESC ? M	ESC O M	RETURN

KEYPAD KEYS

NOTE: The shifted mode and the unshifted (or alternate) mode (if the alternate mode was selected) can be interchanged by entering ESC t or ESC u.

KEY	ZDS ESCAPE CODE	ANSI ESCAPE CODE
Ø	ESC ? p	ESC O p
1	ESC ? q	ESC O q
2	ESC ? r	ESC O r
3	ESC ? s	ESC O s
4	ESC ? t	ESC O t
5	ESC ? u	ESC O u
6	ESC ? v	ESC O v
7	ESC ? w	ESC O w
8	ESC ? x	ESC O x
9	ESC ? y	ESC O y
•	ESC ? n	ESC O n
ENTER	ESC ? M	ESC O M

ALTERNATE KEYPAD MODE

KEY	ZDS ESCAPE CODE	ANSI ESCAPE CODE
F1	ESC S	ESC O S
F2	ESC T	ESC O T
F3	ESC U	ESC O U
F4	ESC V	ESC O V
F5	ESC W	ESC O W
BLUE	ESC P	ESC O P
RED	ESC Q	ESC O Q
GRAY	ESC R	ESC O R

SPECIAL FUNCTION KEYS

KEY	OCTAL CODE	ANSI CODE
RETURN	015	015
LINE FEED	012	012
BACKSPACE	010	010
SPACE BAR	040	040
TAB	011	011
DELETE	177	177
ESC	033	033

CONTROL KEYS

ZDS ESCAPE SEQUENCES

Summary of Sequences

CURSOR FUNCTIONS

<u>Escape Sequence</u>	<u>Mnemonic</u>	<u>Definition</u>
ESC H	ZCUH	Cursor Home
ESC C	ZCUF	Cursor Forward
ESC D	ZCUB	Cursor Backward
ESC B	ZCUD	Cursor Down
ESC A	ZCUU	Cursor Up
ESC I	ZRI	Reverse Index
ESC n	ZCPR	Cursor Position Report
ESC j	ZSCP	Save Cursor Position
ESC k	ZRCP	Set Cursor to Previously Saved Position
ESC Y	ZDCA	Direct Cursor Addressing (Same as VT52)

ERASING AND EDITING

ESC E	ZCD	Clear Display (Shift Erase)
ESC b	ZBD	Erase Beginning of Display
ESC J	ZEOP	Erase to End of Page (Erase Key)
ESC l	ZEL	Erase Entire Line
ESC o	ZEBL	Erase Beginning of Line
ESC K	ZEOL	Erase to End of Line
ESC L	ZIL	Insert Line
ESC M	ZDL	Delete Line
ESC N	ZDCH	Delete Character
ESC @	ZEIM	Enter Insert Character Mode
ESC O	ZERM	Exit Insert Character Mode

CONFIGURATION

ESC z	ZRAM	Reset to Power-Up Configuration
ESC r B _n	ZMBR	Modify Baud Rate (B _n =; A=110, B=150, C=300, D=600, E=1200, F=1800, G=2000, H=2400, I=3600, J=4800, K=7200, L=9600)
ESC x P _s	ZSM	Set Mode(s): P _s = 1 = Enable 25th line 2 = No key click 3 = Hold screen mode 4 = Block cursor 5 = Cursor off 6 = Keypad shifted 7 = Alternate keypad mode 8 = Auto line feed on receipt of CR 9 = Auto CR on receipt of line feed

ESC y P,	ZRM	Reset Mode(s): P, = 1 = Disable 25th line 2 = Enable key click 3 = Exit hold screen mode 4 = Underscore cursor 5 = Cursor on 6 = Keypad unshifted 7 = Exit alternate keypad mode 8 = No auto line feed 9 = No auto CR
ESC <	ZEAM	Enter ANSI Mode

MODES OF OPERATION

ESC [	ZEHS	Enter Hold Screen Mode
ESC \	ZXHS	Exit Hold Screen Mode
ESC p	ZERV	Enter Reverse Video Mode
ESC q	ZXRV	Exit Reverse Video Mode
ESC F	ZEGM	Enter Graphics Mode
ESC G	ZXGM	Exit Graphics Mode
ESC t	ZEKS	Enter Keypad Shifted Mode
ESC u	ZXKS	Exit Keypad Shifted Mode
ESC =	ZAKM	Enter Alternate Keypad Mode
ESC >	ZXAM	Exit Alternate Keypad Mode

ADDITIONAL FUNCTIONS

ESC }	ZDK	Keyboard Disabled
ESC {	ZEK	Keyboard Enabled
ESC v	ZEWA	Wrap Around at End of Line
ESC w	ZXWA	Discard at End of Line
ESC Z	ZID	Identify as VT52 (ESC / K)
ESC]	ZX25	Transmit 25th Line
ESC #	ZXMP	Transmit Page

NOTE: The Terminal will transmit the following sequences, but it will not respond to them if they are received by the Terminal.

ESC S	ZF1	Function Key #1 (f1)
ESC T	ZF2	Function Key #2 (f2)
ESC U	ZF3	Function Key #3 (f3)
ESC V	ZF4	Function Key #4 (f4)
ESC W	ZF5	Function Key #5 (f5)
ESC P	ZF7	Function Key (BLUE)
ESC Q	ZF8	Function Key (RED)
ESC R	ZF9	Function Key (GRAY)

ZDS Escape Sequences Defined

CURSOR FUNCTIONS

ZCUH Cursor Home ESC H

Moves the cursor to the first character position on the first line (home).

ZCUF Cursor Forward ESC C

Moves the cursor one character position to the right. If the cursor is at the right end of the line, it will remain there.

ZCUB Cursor Backward ESC D

Moves the cursor one character position to the left (backspaces). If the cursor is at the start (left end) of a line, it will remain there.

ZCUD Cursor Down ESC B

Moves the cursor down one line without changing columns. The cursor will not move past the bottom (24th) line and no scrolling will take place. Use HDCA (Direct Cursor Addressing) to move the cursor to line 25 — when line 25 is active.

ZCUU Cursor Up ESC A

Moves the cursor up one line. If the cursor reaches the top line, it remains there and no scrolling occurs.

ZRI Reverse Index ESC I

Moves the cursor to the same horizontal position on the preceding line. If the cursor is on the top line, a scroll down is performed.

ZCPR Cursor Position Report ESC n

The Terminal reports the cursor position in the form of ESC Y line# column#.

ZSCP Save Cursor Position ESC j

The present cursor position is saved so the cursor can be returned here later when given the HRCF (Set Cursor to Previously Saved Position) command.

ZRCP Set Cursor to Previously Saved Position ESC k

Returns the cursor to the position where it was when it received the HSCP (Save Cursor Position) command.

ZDCA Direct Cursor Addressing ESC Y

Moves the cursor to a position on the screen by entering the escape code, the ASCII character which represents the line number, and the ASCII character which represents the column number.

The first line and the left column are both 32_{10} (the smallest value of the printing characters) and increase from there. Since the lines are numbered from 1 to 25 (from top to bottom) and the columns from 1 to 80 (from left to right), you must add the proper line and column numbers to 31_{10} . Then convert these decimal numbers to their equivalent ASCII characters and enter them in the following order:

ESC Y line # (ASCII character) column # (ASCII character)

If the line number entered is too high, the cursor will not move. If the column number is too high, the cursor will move to the end of the line.

This is the only way to move the cursor to the 25th line, but the 25th line must first be enabled.

ERASING AND EDITING

ZCD Clear Display (Shift Erase) ESC F

Erases the entire screen, fills the screen with spaces, and places the cursor in the home position.

ZBD Erase Beginning of Display ESC b

Erases from the start of the screen to the cursor, and includes the cursor position.

ZEOP Erase to End of Page (Erase Key) ESC J

Erases all the information from the cursor (including the cursor position) to the end of the page.

ZEL ERASE Entire Line ESC I

Erases all of the line, including the cursor position.

ZEBL Erase Beginning of Line ESC o

Erases from the beginning of the line to the cursor, and includes the cursor position.

ZEOL Erase to End of Line ESC K

Erases from the cursor (including the cursor position) to the end of the line.

ZIL Insert Line ESC L

Inserts a new blank line by moving the line that the cursor is on, and all following lines, down one line. Then the cursor is moved to the beginning of the new blank line.

ZDL Delete Line ESC M

Deletes the contents of the line that the cursor is on, places the cursor at the beginning of the line, moves all the following lines up one line, and adds a blank line at line 24.

ZDCH Delete Character ESC N

Deletes the character at the cursor position and shifts any existing text that is to the right of the cursor one character position to the left.

ZEIM Enter Insert Character Mode ESC @

Lets you insert characters or words into text already displayed on the screen. As you type in new characters, existing text to the right of the cursor shifts to the right. As each new character is inserted, the character at the end of the line is lost.

ZERM Exit Insert Character Mode ESC O

Exits from the insert character mode.

CONFIGURATION

ZRAM Reset to Power-up Configuration ESC z

Nullifies all previously set escape modes and returns to the power-up configuration.

ZMBR Modify Baud Rate ESC r B_n

Modifies the baud rate, where B_n equals:

A=110, B=150, C=300, D=600,
E=1200, F=1800, G=2000, H=2400,
I=3600, J=4800, K=7200, L=9600

ZSM Set Mode(s) ESC x P_s

Sets the following modes, where P_s equals:

1=enable 25th line
2=no key click
3=hold screen mode
4=block cursor
5=cursor off
6=keypad shifted
7=alternate keypad mode
8=auto line feed on receipt of CR
9=auto CR on receipt of line feed

ZRM Reset Mode(s) ESC y P_s

Resets special modes, where P_s equals:

1=disable 25th line
2=enable key click
3=exit hold screen mode
4=underscore cursor
5=cursor on
6=keypad unshifted
7=exit alternate keypad mode
8=no auto line feed
9=no auto CR

ZEAM Enter ANSI Mode ESC <

Enters the ANSI mode.

MODES OF OPERATION

ZEHS Enter Hold Screen Mode ESC [

Controls when new information is printed on the screen.

- Type the SCROLL key and a new line of information will be printed on the bottom line. The top line will scroll off.
- Type SHIFT SCROLL and a whole new page of text will scroll onto the screen and stop as the old page scrolls up and off the screen.

**ZXHS Exit Hold Screen Mode ESC **

Exits the hold screen mode.

ZERV Enter Reverse Video Mode ESC p

Enters the reverse video mode so that characters are displayed as black characters on a white background.

ZXRV Exit Reverse Video Mode ESC q

Exits the reverse video mode.

ZEGM Enter Graphics Mode ESC F

Enters the graphics mode to display any of the 33 special symbols (26 lower-case keys and seven other keys) that correspond to the graphic symbols.

ZXGM Exit Graphics Mode ESC G

Exits the graphics mode and returns to the display of normal characters.

ZEKS Enter Keypad Shifted Mode ESC 1

Inverts the normal and shifted functions of the keypad. Now, if you hold down the SHIFT key, you will get a normally unshifted character.

ZXKS Exit Keypad Shifted Mode ESC u

Exits the keypad shifted mode.

ZAKM Enter Alternate Keypad Mode ESC =

Enters the alternate keypad mode, which will then allow the keyboard keys to transmit the following escape codes instead of the normal ones.

<u>KEY</u>	<u>ESCAPE CODE</u>
0	ESC ? p
1	ESC ? q
2	ESC ? r
3	ESC ? s
4	ESC ? t
5	ESC ? u
6	ESC ? v
7	ESC ? w
8	ESC ? x
9	ESC ? y
.	ESC ? n
ENTER	ESC ? M

These special escape codes are user defined and must be recognized by your software.

ZXAM Exit Alternate Keypad Mode ESC >

Exits the alternate keypad mode and returns to the transmission of normal character codes.

ADDITIONAL FUNCTIONS**ZDK Keyboard Disabled ESC }**

Inhibits the output of the keyboard.

ZEK Keyboard Enabled ESC {

Enables the keyboard after it was inhibited by an HDK (Keyboard Disabled) command.

ZEWA Wrap Around at End of Line ESC v

The 81st character on a line is automatically placed in the first character position on the next line. The page scrolls up if necessary.

ZXWA Discard at End of Line ESC w

After the 80th character in a line, the characters overprint. Therefore, only the last character received will be displayed in position 80.

ZID Identify as VT52 (ESC/K) ESC Z

The Terminal responds to the interrogation with ESC / K to indicate that it can perform as a VT52.

ZX25 Transmit 25th Line ESC]

Transmits the 25th line. (The computer requires a special routine to use this feature.)

ZXMP Transmit Page ESC #

Transmits lines 1 through 24. (The computer requires a special routine to use this feature.)

ZF1 Function Key #1 (F1) ESC S

Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code if it is received.

ZF2 Function Key #2 (F2) ESC T

Same as above.

ZF3 Function Key #3 (F3) ESC U

Same as above.

ZF4 Function Key #4 (F4) ESC V

Same as above.

ZF5 Function Key #5 (F5) ESC W

Same as above.

ZF7 Function Key Blue ESC P

Same as above.

ZF8 Function Key Red ESC Q

Same as above.

ZF9 Function Key Gray ESC R

Same as above.

ANSI ESCAPE SEQUENCES

Summary of Sequences

NOTES:

1. In the ANSI mode, the Terminal recognizes and responds only to escape sequences whose syntax and semantics are in accordance with ANSI specifications.
2. "Default" is a value that is assumed when no explicit value, or a value of zero, is specified.
3. P_n — Numeric Parameter. Any decimal value may be substituted for P_n .
4. P_s — Selective Parameter. Any decimal number that is taken from a list and used to select a subfunction. You can select several subfunctions at once by putting one number after another but separating them with delimiters (semicolons).

Example: To turn off the key click (ESC [> 2 h) and turn on the block cursor (ESC [> 4 h), type:

ESC [> 2;4 h

Escape Sequence	Mnemonic	Definition
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CURSOR FUNCTIONS

ESC [H or ESC [0;0 H or ESC [1;1 H	CUP or HUP	Cursor Home
ESC [f or ESC [0;0 f or ESC [1;1 f		
ESC [P_n C	CUF	Cursor Forward
ESC [P_n D	CUB	Cursor Backward
ESC [P_n B	CUD	Cursor Down
ESC [P_n A	CUU	Cursor Up
ESC M	RI	Reverse Index
ESC [6n	CPR	Cursor Position Report
ESC [s	PSCP	Save Cursor Position
ESC [u	PRCP	Set Cursor Position
ESC [P_t ; P_c H or ESC [P_t ; P_c f	CUP	Direct Cursor Addressing

ERASING AND EDITING

ESC [2 J	ED	Clear Display (Shift Erase)
ESC [1 J	ED	Erase Beginning of Display
ESC [J or ESC [0 J	ED	Erase to End of Page (Erase Key)
ESC [2 K	EL	Erase Entire Line
ESC [1 K	EL	Erase Beginning of Line
ESC [K or ESC [0 K	EL	Erase to End of Line
ESC [P _n L	IL	Insert Line
ESC [P _n M	DL	Delete Line
ESC [P _n P	DCH	Delete Character
ESC [4 h	IRM	Insert/Replacement (Insert character) Mode On
ESC [4 l	IRM	Insert/Replacement (Insert Character) Mode Off

CONFIGURATION

ESC [z	PRAM	Reset to Power-Up Configuration
ESC [P _n r	PMBR	Modify Baud Rate (P _n =; 1=110, 2=150, 3=300, 4=600, 5=1200, 6=1800, 7=2000, 8=2400, 9=3600, 10=4800, 11=7200, 12=9600)
ESC [> P _s h	SM	Set Mode(s): P _n = 1 = Enable 25th line 2 = No key click 3 = Hold screen mode 4 = Block cursor 5 = Cursor off 6 = Keypad shifted 7 = Alternate Keypad mode 8 = Auto line feed on receipt of CR 9 = Auto CR on receipt of line feed
ESC [> P _s l	RM	Reset Mode(s): P _n = 1 = Disable 25th line 2 = Enable key click 3 = Exit hold screen mode 4 = Underscore cursor 5 = Cursor on 6 = Keypad unshifted 7 = Exit alternate keypad mode 8 = No auto line feed 9 = No auto CR
ESC [? 2 h	PEZM	Enter ZDS Mode

MODES OF OPERATION

ESC [7 m	SGR	Enter Reverse Video Mode
ESC [m or ESC [0 m	SGR	Exit Reverse Video Mode
ESC [> 7 h	SM	Enter Alternate Keypad Mode (ESC =)*
ESC [> 7 l	RM	Exit Alternate Keypad Mode (ESC >)*
ESC [10 m	SGR	Enter Graphics Mode
ESC [11 m	SGR	Exit Graphics Mode

*These escape codes may be used, but are not recommended.

ADDITIONAL FUNCTIONS

ESC [2 h	SM	Keyboard Disabled
ESC [2 l	RM	Keyboard Enabled
ESC [? 7 h	SM	Wrap Around at End of Line
ESC [? 7 l	RM	Discard at End of Line
ESC [q	PX25	Transmit 25th Line
ESC [p	PXMT	Transmit Page

NOTE: The Terminal will transmit the following functions, but it will not respond to them if they are received by the Terminal.

ESC O S	SS3	Function Key #1 (F1)
ESC O T	SS3	Function Key #2 (F2)
ESC O U	SS3	Function Key #3 (F3)
ESC O V	SS3	Function Key #4 (F4)
ESC O W	SS3	Function Key #5 (F5)
ESC O P	SS3	Function Key (BLUE)
ESC O Q	SS3	Function Key (RED)
ESC O R	SS3	Function Key (GRAY)

ANSI Mode Summary

The ANSI controls SET MODE (SM) and RESET MODE (RM) are shown on the previous page. The following table shows all parameters which may be set or reset using the SM and RM control sequences.

The control sequence for SET MODE is: ESC [P, h.

The control sequence for RESET MODE is: ESC [P, l.

	<u>MODE</u>	<u>P_s</u>	<u>SET (SM)</u>	<u>RESET (RM)</u>
ANSI	KAM	2	Keyboard Disabled	Keyboard Enabled
	IRM	4	Insert Character Mode on	Insert Character Mode Off
	LNM	20	New Line Mode (Auto Line Feed on CR)	New Line Mode Off
ZDS	L25	>1	Display 25th Line	Disable 25th Line
	KCL	>2	Disable Key Click	Enable Key Click
	HSM	>3	Enable Hold Screen Mode	Disable Hold Screen Mode
	CBL	>4	Blinking Block Cursor	Blinking Underscore Cursor
	CDE	>5	Cursor Off	Cursor on
	KSH	>6	Keypad Shifted	Keypad Unshifted
	KAM	>7	Keypad Alternate Mode	Keypad Normal Mode
	ALF	>8	Auto Line Feed on Return	No Auto Line Feed
	ACR	>9	Auto CR on Line Feed	No Auto CR on Line Feed
	ZMD	?2	Enter ZDS Mode	N/A
	WAR	?7	Wrap Around at End of Line	Discard Past End of Line

ANSI modes which are always considered to be in either the SET or the RESET state, and those which do not apply to this product are as follows:

CRM	Control Representation Mode	RESET
EBM	Editing Boundary Mode	RESET
ERM	Erase Mode	SET
FEAM	Format Effector Action Mode	RESET
FETM	Format Effector Transfer Mode	RESET
GATM	Guarded Area Transfer Mode	RESET
HEM	Horizontal Editing Mode	RESET
MATM	Multiple Area Transfer Mode	N/A
PUM	Positioning Unit Mode	RESET
SATM	Selected Area Transfer Mode	SET
SRTM	Status Reporting Transfer Mode	N/A
TSM	Tabulation Stop Mode	N/A
TTM	Transfer Termination Mode	SET
VEM	Vertical Editing Mode	RESET
SEM	Set Editing Extent Mode	Edit in Line

ANSI Escape Sequences Defined

NOTES:

1. In the ANSI mode, the Terminal recognizes and responds only to escape sequences whose syntax and semantics are in accordance with ANSI specifications.
2. "Default" is a value that is assumed when no explicit value, or a value of zero, is specified.
3. P_n — Numeric Parameter. Any decimal number that is substituted for P_n .
4. P_s — Selective Parameter. Any decimal number that is taken from a list and used to select a subfunction. You can select several subfunctions at once by putting one number after another but separating them with delimiters (semicolons).

CURSOR FUNCTIONS

CUP Cursor Position ESC [H or ESC [$\emptyset$; $\emptyset$ H or
or ESC [1;1 H
HVP Horizontal & Vertical Position ESC [f or ESC [$\emptyset$; $\emptyset$ f) or
 ESC [1;1 f

Moves the cursor to the position specified by the parameters. The first parameter specifies the line number and the second parameter specifies the column number. A parameter of zero is considered to be one. If no parameter is given, the cursor is placed in the home position.

Default Value: 1

CUF Cursor Forward ESC [P_n C

Moves the cursor to the right the number of characters determined by the value of P_n . If this number is zero or one, the cursor moves one position. The cursor stops at the right margin.

Default Value: 1

CUB Cursor Backward ESC [P_n D

Moves the cursor to the left the number of characters determined by the value of P_n . If this number is zero or one, the cursor moves one position. The cursor stops at the left margin.

Default Value: 1

CUD Cursor Down ESC [P_n B

Moves the cursor downward without changing columns. The number of lines moved is determined by the value of P_n . If this number is zero or one, the cursor moves down one line. The cursor will stop at line 24. Direct Cursor Addressing must be used to move to line 25.

Default Value: 1

CUU Cursor Up ESC [P_n A

Moves the cursor upward without changing columns. The number of lines moved is determined by the value of P_n . If this number is zero or one, the cursor moves up one line. The cursor will stop at the top line.

Default Value: 1

RI Reverse Index ESC M

Moves the cursor to the same position on the preceding line.

CPR Cursor Position Report ESC [6n

The Terminal reports the cursor position in the form of ESC [P_i;P_c R.

PSCP Save Cursor Position ESC [s

The present cursor position is remembered so the cursor can be returned here later when given the PRCP (Return to Previously Saved Position) command.

PRCP Set Cursor to Previously Saved Position ESC [u

Returns the cursor to the position where it was when it received the PSCP (Save Cursor Position) command.

CUP Direct Cursor Addressing ESC [P_i;P_c H or ESC [P_i;P_c f

Same as CUP and HVP above. If the line number (P_i) entered is too high, the cursor will not move. If the column number (P_c) is too high, the cursor will move to the end of the line.

This is the only way to move the cursor to the 25th line, but the 25th line must first be enabled.

To move the cursor home, enter Ø;Ø or l;l or do not enter any values.

Default Values: 1

ERASING AND EDITING**ED Erase in Display ESC [P, J**

Erases some or all of the characters in the display according to the value of P_s.

<u>P_s</u>	<u>Means</u>
Ø	Erases from the cursor to the end of the screen and includes the cursor position.
1	Erases from the start of the screen to the cursor and includes the cursor position.
2	Erases all of the screen and the cursor goes to home position.

Default Value: Ø

EL Erase in Line ESC [P, K

Erases some or all of the characters in the cursor line according to the value of P_s.

<u>P_s</u>	<u>Means</u>
Ø	Erases from the cursor to the end of the line and includes the cursor position.
1	Erases from the start of the line to the cursor and includes the cursor position.
2	Erases all of the line including the cursor position.

Default Value: Ø

IL Insert Line ESC [P_n L

Inserts one or more blank lines (depending on the value of P_n) by moving the line that the cursor is on and all the following lines down P_n lines. Then the cursor is moved to the beginning of the new blank line.

DL Delete Line ESC [P_n M

Deletes the line of characters that the cursor is in, and other following lines if P_n is greater than one. The remaining lines below the deleted area then move up the number of lines that were deleted. The cursor is placed at the beginning of the next line.

Default Value: 1

DCH Delete Character ESC [P_n P

Deletes the characters at the cursor position, and other positions on the cursor line to the right of the cursor if P_n is greater than one. Any remaining character to the right of the deleted characters then move left the number of characters that were deleted.

Default Value: 1

IRM Insert/Replacement Mode ON ESC [4 h

Lets you insert characters or words into text already displayed on the screen. As new characters are entered, existing text to the right of the cursor shifts to the right. As each character is inserted, the character at the end of the line is lost.

IRM Insert/Replacement Mode OFF ESC [4 l

Exits from the IRM ON mode.

CONFIGURATION

PRAM Reset to Power-Up Configuration ESC [z

Nullifies all previously set escape modes and returns to the power-up configuration.

PMBR Modify Baud Rate ESC [P_n r

Modifies the baud rate, where P_n equals:

1=110, 2=150, 3=300, 4=600, 5=1200,
6=1800, 7=2000, 8=2400, 9=3600, 10=4800,
11=7200, 12=9600

SM Set Mode(s), ESC [> P_s h

Sets the following modes, where P_n equals:

1=enable 25th line
2=no key click
3=hold screen mode
4=block cursor
5=cursor off
6=keypad shifted
7=alternate keypad mode
8=auto line feed or receipt of CR
9=auto CR on receipt of line feed

Can set one or more modes as determined by the parameter string P_s;P_s;P_s, etc.

Default Value: None

RM Reset Mode(s) ESC [> P, l

Resets special modes, where P_s equals:

- 1=disable 25th line
- 2=enable key click
- 3=exit hold screen mode
- 4=underscore cursor
- 5=cursor on
- 6=keypad unshifted
- 7=exit alternate keypad mode
- 8=no auto line feed
- 9=no auto CR

Can reset one or more modes as determined by the parameter string P_s;P_s;P_s, etc.

Default Value: None

PEZM Enter ZDS Mode ESC [? 2 l

Enters the ZDS mode.

MODES OF OPERATION

SM Enter Hold Screen Mode ESC [> 3 h

Controls when new information is printed onto the screen.

- Type the SCROLL key and a new line of information will be printed on the bottom line. The top line will scroll off.
- Type SHIFT SCROLL and a whole new page of text will scroll onto the screen and stop as the old page scrolls up and off the screen.

RM Exit Hold Screen Mode ESC [> 3 l

Exits the hold screen mode.

SGR Enter Reverse Video Mode ESC [7 m

Enters the reverse video mode so that characters are displayed as black characters on a white background.

SGR Exit Reverse Video Mode ESC [m or ESC [0 m

Exits the reverse video mode.

SGR Enter Graphics Mode ESC [10 m

Enters the graphics mode to display any of the 33 special symbols (26 lower-case keys and seven other keys) that correspond to the graphics symbols.

SGR Exit Graphics Mode ESC [11 m

Exits the graphics mode and returns to the display of normal characters.

SM Enter Keypad Shifted Mode ESC [> 6 h

Inverts the normal and shifted functions of the keypad. Now if you hold down the SHIFT key, you will get a normally unshifted character.

RM Exit Keypad Shifted Mode ESC [> 6 l

Exits the keypad shifted mode.

SM Enter Alternate Keypad Mode ESC = or ESC [> 7 h

Allows you to enter the alternate keypad mode, which will then transmit the following escape codes instead of the normal ones.

<u>KEY</u>	<u>ESCAPE CODE</u>
0	ESC O p
1	ESC O q
2	ESC O r
3	ESC O s
4	ESC O t
5	ESC O u
6	ESC O v
7	ESC O w
8	ESC O x
9	ESC O y
.	ESC O n
ENTER	ESC O M

These special escape codes are user defined and must be recognized by your software.

RM Exit Alternate Keypad Mode ESC > or ESC [> 7 l

Exits the alternate keypad mode and returns to the transmission of normal character codes.

ADDITIONAL FUNCTIONS**SM Keyboard Disabled ESC [2 h**

Inhibits the output of the keyboard. To activate the keyboard, send the "enable keyboard" escape sequence from the computer or reset the Terminal.

RM Keyboard Enabled ESC [2 l

Enables the keyboard after it was inhibited by an SM (Keyboard Disabled) command.

SM Wrap Around at End of Line ESC [? 7 h

81st character on a line is automatically placed in the first character position on the next line. The page scrolls up if necessary and permitted.

RM Discard at End of Line ESC [? 7 l

After the 80th character in a line, the characters overprint. Therefore, only the last character received will be displayed in position 80.

PX25 Transmit 25th Line ESC [q

Transmits the 25th line.

PXMT Transmit Page ESC [p

Transmits lines 1 through 24. (The computer requires a special routine to use this feature.)

SS3 Function Key #1 (F1) ESC O S

Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code if it is received.

SS3 Function Key #2 (F2) ESC O T
Same as above.

SS3 Function Key #3 (F3) ESC O U
Same as above.

SS3 Function Key #4 (F4) ESC O V
Same as above.

SS3 Function Key #5 (F5) ESC O W
Same as above.

SS3 Function Key (Blue) ESC O P
Same as above.

SS3 Function Key (Red) ESC O Q
Same as above.

SS3 Function Key (Gray) ESC O R
Same as above.

