Heathkit® Manual

for the

VIDEO DISPLAY TERMINAL

Model H-29

OPERATION 595-2992-02

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

FCC WARNING

This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of FCC Rules. Only computers certified to comply with the Class B limits may be attached to this equipment. Operation with non-certified computers is likely to result in interference to radio and TV reception.

This equipment uses radio frequency energy for its operation and if not installed and used properly, that is, in strict accordance with the instruction manual, may cause interference to radio and television reception. It has been type tested and found to comply with the RF emission limits for a Class B computing device which is intended to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio and television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Move the computing device away from the receiver being interfered with.
- Relocate the computing device with respect to the receiver.
- Reorient the receiving antenna.
- Plug the computing device into a different AC outlet so that the computing device and receiver are on different branch circuits.
- Be certain that the computing device is plugged into grounded outlet receptacles. (Avoid using A/C cheater plugs. Lifting of the power cord ground may increase RF emission levels and may also present a lethal shock hazard to the user.)

If additional help is needed, consult the dealer or ask for assistance from the manufacturer. · Customer service information may be found on the inside back cover of this Manual. The user may also find the following booklet helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the US Government Printing Office, Washington, D.C. 20402 — Stock No. 004-000-00345-4.

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INTRODUCTION

Advanced technology and truly state-of-the-art design have made this Model H-29 Terminal an easy-to-use and versatile tool for your local or remote computer, or other device, in both business and personal applications.

Features of the H-29 Terminal include:

- Built-in power-up diagnostics.
- Four terminal emulation modes (in additon to a Monitor Mode):
  Heath, ANSI, Lear Seigler ADM-3A, and Hazeltine 1500.
- Programmable character attributes and scrolling regions.
- Detached keyboard with 8-foot coiled cord.
- Advanced keyboard features include:
  Automatic key repeat, "N" key rollover, Status indicators, User function keys, and Full cursor control.
- No switches to set; all features accessible through the keyboard, and a non-volatile memory saves the settings.
- Professional screen with 24 lines of 80 characters, plus a 25th (status) line. Special attribute capabilities include reverse video, half-intensity, blinking, and underlining.

Other features and characteristics of the H-29 Terminal are detailed in the "Specifications" section of this Manual.

The structure and content of this Operation Manual is designed to help you achieve the utmost use and satisfaction from your Terminal. The "Installation" section describes the connections used in a typical setup with peripherals such as a computer and modem. It also describes interfacing with the RS-232C and connector pinouts.

The "Operation" section describes the alphabetic, numeric, and special character keys, and the command and function keys. It also describes the setup and operation menus and presents operational examples to quickly familiarize you with the operation of the Terminal. For the advanced user or computer programmer, "Programming" contains valuable information on the special control codes and functions.

A "Theory of Operation" section is presented in Block Diagram form for the student of computer electronics, while a more detailed "Circuit Description" relates to the Schematic Diagrams, for the technician or one who might be interested.

If your Terminal ever fails to operate properly, the "In Case of Difficulty" section, with its Troubleshooting Chart, will help you locate (and correct) a problem. The Semiconductor Identification Chart, and Circuit Board X-Ray Views, will also help you trace the problem to a faulty connection or part. The Parts List in the "Assembly Manual" will help you identify parts in case you must order one.

Large, readable Schematics are provided for the electronics technician, and will aid in following the Theory of Operation and Circuit Description, and in troubleshooting the Terminal. Your Heath Warranty is printed on the inside front cover of this Manual, and Service Information on the inside rear cover.

Every effort has been made to produce a manual of the same high quality and usefulness as the H-29 Terminal it describes.

SPECIFICATIONS

DISPLAY

CRT	12″ (30.5 cm), double-enhanced contrast non-glare, P31 green screen.
Display Format	25 rows of 80 characters.
Display Size	6.0″ high × 8.5″ wide.
Character Type	80 × 10 character cell.
Character Size	0.2″ (5 mm) high × 0.1″ (2.5 mm) wide (approximate).
Character Set	Normal: 128 characters; 95 ASCII, upper and lower case, numerics and punctuation, and 33 graphic characters. Alternate: 128 characters; 95 ASCII, superscript and subscript, scientific notation, and 33 graphic characters.
Video Attributes	Normal or reverse character, normal or underlined character, normal or half-intensity character, and normal or blinking.
Refresh Rate	60 Hz.

CURSOR

Type	Underline or reverse (solid) video block.
Attributes	On, off, or blinking.
Controls	Up, down, left, right, backspace, tab, back tab, home, carriage return (CR), and line feed (LF).
Addressing	Direct or relative.

KEYBOARD

Unit	91-key, detached keyboard unit with 8-foot (1.9 M), coiled cable.
Layout	Split; 77-key standard typewriter style with special function keys and 14-key numeric keypad.
Indicators	Visual: Power, locked keyboard, off-line, and caps lock (LED). Audible: Key click with each key entry (programmable on/off) with each key entry. Beep tone, 1 kHz for 200 msec.

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EDITING AND ERASING FUNCTIONS

Editing	Insert or delete character. Insert or delete line.
Erasing	Erase page, erase to end of line, erase to beginning of line, erase to beginning of page and erase line.

COMMUNICATIONS

Type	EIA RS-232C, asynchronous.
Baud Rates	75, 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600, or 19200 baud.
Mode	Half or full duplex.
Code	ASCII.
Format	Serial asynchronous.
Word Length	7 data bits, one parity bit.
Stop bits	2 at 75 and 110 baud rates; 1 at all other baud rates.
Parity	Even, odd, mark, or space.

ENVIRONMENT

Operation	Temperature: 32- to 105-degrees Fahrenheit (0- to 40-degrees Celsius). Humidity: 10 to 90% (relative) non-condensing.
Storage	Temperature: −40- to +150-degrees (F) or −40- to +66-degrees (C). Humidity: 0 to 95% (relative) non-condensing.

POWER

Voltage Range	105 to 127 volts AC.
Frequency	60 Hz.
Fuse	3/4-ampere, slow-blow.
Consumption	45 watts.

DIMENSIONS

Monitor	13-5/8″ high × 15-3/8″ wide × 14-1/2″ deep (34.6 × 39 × 36.8 cm).
Keyboard	3″ high × 18″ wide × 7-1/4″ deep (7.6 × 45.7 × 18.4 cm).

Heath Company 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.

INSTALLATION

Your particular use of the H-29 Terminal will determine the best location for the components. Because the Terminal will operate satisfactorily over a wide range of temperature and humidity, you may select an environment that is comfortable to work in.

As you plan your installation, be sure to consider whether you will use the Terminal with a local (or remote) computer, disk drives, modem (modulator/demodulator), or other equipment. Allow sufficient room to keep the components within easy reach for operating convenience.

You will need a sturdy table or bench about 27" high, and large enough to hold your Terminal and other equipment. You will also need a number of AC power receptacles with sufficient current for your equipment. If you cannot place your table or bench close to enough wall outlets, construct or purchase a multiple outlet extension with at least number 16 wire with ground. You will also want your telephone handy if you plan to communicate with a remote terminal or computer over the telephone lines. Figure 1 shows a typical installation.

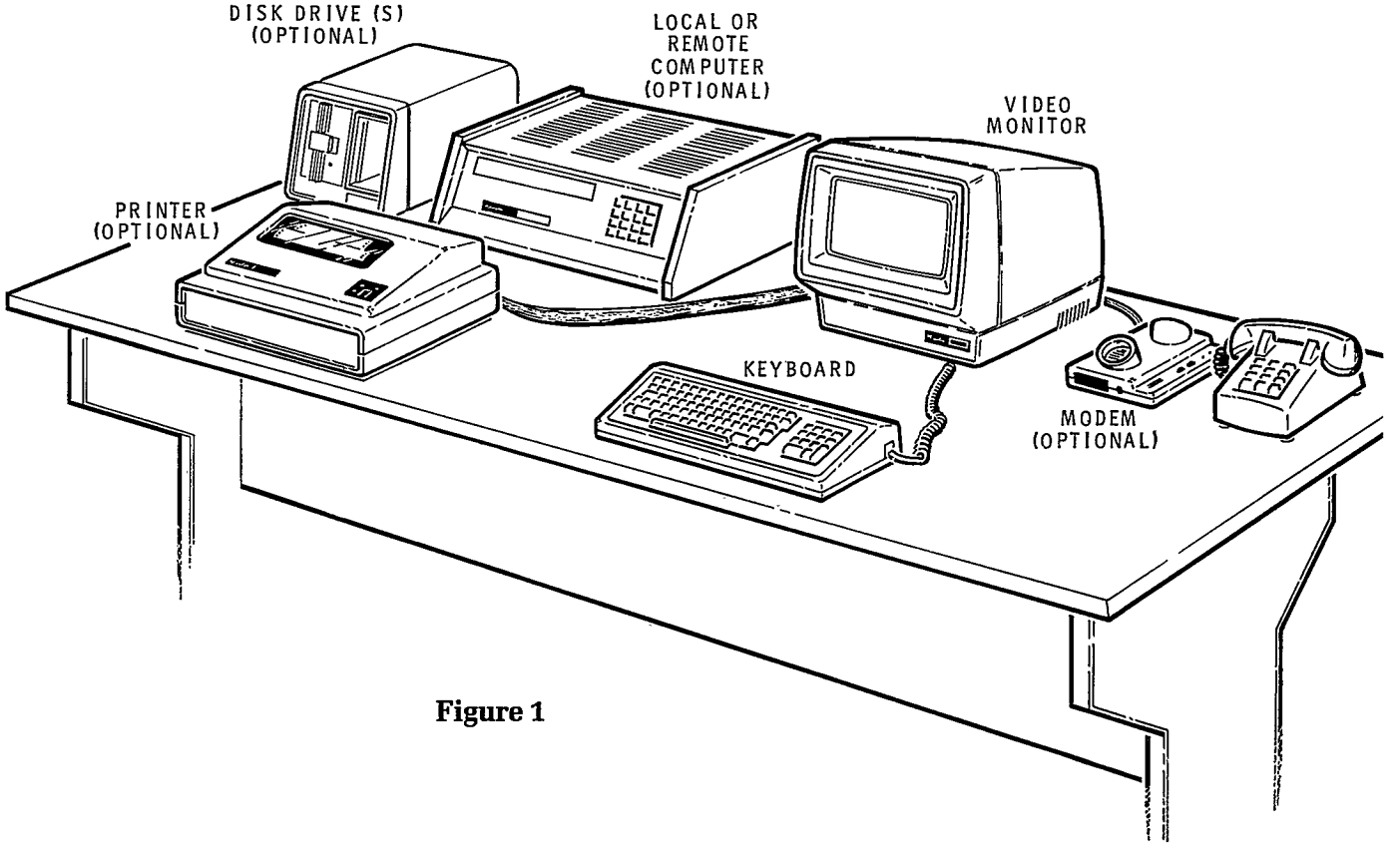


Figure 1

CONNECTIONS

Your H-29 Terminal consists of a keyboard and a video monitor. You can place the keyboard anywhere within eight feet of the monitor. Perform the following steps to make the connections.

1. Position the monitor on your work surface so you can see its rear panel as shown in Figure 2 (Illustration Booklet, Page 1).

2. Note that one end of the coiled cable has a longer straight portion, so you can route it under the monitor. Plug this end of the cable into the KEYBOARD CONNECTOR on the rear of the monitor.

3. Plug the free end of the coiled cable into the connector on the side of the keyboard.

4. Be sure the Power switch is in the OFF position, then connect the line cord plug to a 120 VAC receptacle.

INTERFACING

You can connect this Terminal directly, or via a modem over telephone lines, to any size computer or to another terminal that has compatible RS-232C asynchronous ports.

CAUTION: Never connect your Terminal or its coiled cable directly to a telephone line. It will damage your Terminal or telephone company equipment, and it will **void your warranty.** Always use a modem for telephone line communication.

DCE AND DTE DEVICES

Two connectors on the rear panel of the video monitor, labeled "DCE" and "DTE", match the standards set for RS-232C Input/Output (I/O) ports. DCE (Data Communications Equipment) devices are computers and modems or similar devices, while DTE (Data Terminal Equipment) devices include terminals, and most other peripheral devices.

The major difference between the DTE and DCE connectors is in the connection of receive and transmit (Input/Output) signal lines (pins 2 and 3), and the "Clear To Send" and "Data Terminal Ready" lines. Table 1 shows the connector pin numbers and their signals for the DCE and DTE ports. Whenever you connect any device to this Terminal, be sure its connector signals correspond with those in the Table.

Table 1

CONNECTOR PIN SIGNALS

PIN NO. DTE (P401)	PIN NO. DCE (P402)	SIGNAL	DESCRIPTION
1 GND	1	PGND	Protective Ground.
2 OUT	3 OUT	XMT	RS-232C serial output—data.
3 IN	2 IN	REC	RS-232C serial input—data.
4 OUT	4 IN	RTS	Request to Send. Tells other device there is data to send.
5 IN	—	CTS	Clear to Send. Tells other device it is ready to receive.
7 GND	7 GND	SGND	Signal Ground.
20 OUT	20 IN	DTR	Data Terminal Ready.
—	5 OUT	CTS	Tied to line 20.
—	6 OUT	DSR	Tied to line 20.
—	8 OUT	CD	Tied to line 20.

Always connect the DTE driver port on your Terminal to a DCE device, and vice versa. Never connect DTE to DTE, or DCE to DCE. Use the DTE connector on the rear panel of your monitor to connect to a computer, either directly or through a modem. Use the DCE connector for other DTE devices.

The computer or modem that you use with this Terminal must meet the RS-232C standards. If it does not, proper operation may be inhibited.

- If you use this Terminal with a computer in a local installation (wired directly to the computer), plug the RS-232 cable into the **lower** of the two RS-232 connectors (DTE) on the monitor, and the other end into the computer's terminal connector (see your computer hardware manual for the proper connector).

- If you use this Terminal with a computer in a remote installation (not wired directly to the computer), plug the RS-232 cable into the **lower** of the two RS-232 connectors (DTE) on the monitor, and the other end into a telephone modem.

- Make sure the POWER switch on the monitor is off. Then plug the line cord into a 120-volt AC, 60 Hz power source.

- Position the monitor so the screen is facing you.

- Position the keyboard in front of the monitor. Be sure the keyboard is connected to the monitor as described earlier.

- Turn the POWER switch to ON.

CAUTION: Whenever you turn the Power on, be sure to wait at least 10 seconds before you turn the Power off again. If you turn the Power on and off rapidly, you could damage the power supply circuits.

BUILT-IN DIAGNOSTICS

As soon as you turn this Terminal on, it quickly performs a series of diagnostic tests to ensure proper operation. If it finds any faults, it displays an appropriate error message. If it does not find any faults, a short beep is sounded. The tests performed and the possible error messages are as follows. Refer to "In Case of Difficulty" in this Manual for information on correcting a problem.

TEST	ERROR MESSAGE IF FAULT IS DETECTED
ROM	ROM Checksum
RAM	RAM Fault
CRT Controller	CRTC Error
Keyboard	Keyboard
Non-volatile RAM	NVRAM Checksum

These same diagnostic tests are repeated each time you reset the Terminal. To reset the Terminal, simultaneously press the SHIFT and RESET/BREAK keys.

POWER-ON INDICATION

When you turn the POWER switch on, the POWER-ON LED (light-emitting diode) on the keyboard should light. If it does not, either the keyboard is not properly connected to the monitor, or the Terminal is not properly connected to an acceptable AC outlet.

After a few seconds, a cursor will appear in the upper left corner of the screen. A display may also appear on the 25th line of the screen. If this display does appear, it will show time (beginning at 0:00:00) and/or one or more other messages, such as CAPS LOCK, OFF LINE, or INSERT MODE.

This completes the "Installation" of your Terminal. Proceed to the "Operation" section.

OPERATION

This section of the Manual describes the controls and indicators on your Terminal, and then explains the operation of the keyboard and its keys. If you have not connected your computer, modem, printer, or other devices to the Terminal, refer back to the "Installation" section and connect them now.

CAUTION: Do not connect or disconnect any plugs or connectors to the Terminal without first turning off the POWER switch on the rear panel.

CONTROLS AND INDICATORS

The following paragraphs describe the function of the controls and indicators to prepare you for operating your Terminal. You can connect the line cord plug to an AC receptacle and try each function as it is described, to better familiarize yourself with the Terminal operation. Figure 3 (Illustration Booklet, Page 2) shows the rear panel of the monitor and the status indicators on the keyboard.

POWER ON/OFF — On the rear of the monitor, controls the AC power to both the monitor and keyboard.

BRIGHTNESS — Also on the rear of the monitor, allows you to adjust the video display for the brightness you prefer.

NOTE: There are two unused locations on the rear of the monitor. These are provided for possible future options.

The following indicators are located on the keyboard.

POWER ON (indicator) — glows when the Power switch is ON, with the line cord plug connected to an AC outlet and the keyboard connected.

KEYBOARD LOCK (indicator) — glows when the Terminal is under computer control, rendering the keyboard inoperative. You should wait for the computer to complete its function. However, you could reset the terminal to exit the mode.

OFF LINE (indicator) — glows when the Terminal is off-line with host equipment. Normal operation is on-line, with the lamp not lit.

CAPS LOCK (indicator) — glows to indicate that all capital letters will be produced by the alphabet keys Numeric keys are not affected.

THE KEYBOARD

Figure 4 is an overall view of the 91-key keyboard. Besides the normal 26 letter alphabet and 10 numeral keys, there are 11 punctuation and other character keys, control and command keys, and programmed function keys.

ALPHABET KEYS

Standard "QWERTY" typewriter layout is used for the alphabet keys, which produce lower case letters when unshifted and upper case (capital) letters when either SHIFT key is pressed or CAPS LOCK is active. Note that the CAPS LOCK indicator glows and the status line on the monitor (when activated) displays a CAPS LOCK message.

NUMERALS AND OTHER CHARACTERS

Non-alphabetic (punctuation and other character) keys have two characters printed on their key tops. The characters on the upper half of the key tops (shown shaded in Figure 5) are produced **only** when you simultaneously press either SHIFT key.

OTHER TYPING KEYS

The Space Bar, Back Space, Tab, Return, and Line Feed, function the same as with a standard typewriter. See Figure 6.

SPACE BAR — produces one blank space each time it is pressed.

BACK SPACE — moves the cursor one space to the left each time it is pressed, except from the "home" position.

DELETE — sends the ASCII character for delete to the host computer.

RETURN (Carriage Return) — moves the cursor to the left margin and (if so programmed in "Setup") performs a Line Feed.

LINE FEED — moves the cursor down one line and (if programmed in "Setup") also causes a carriage return.

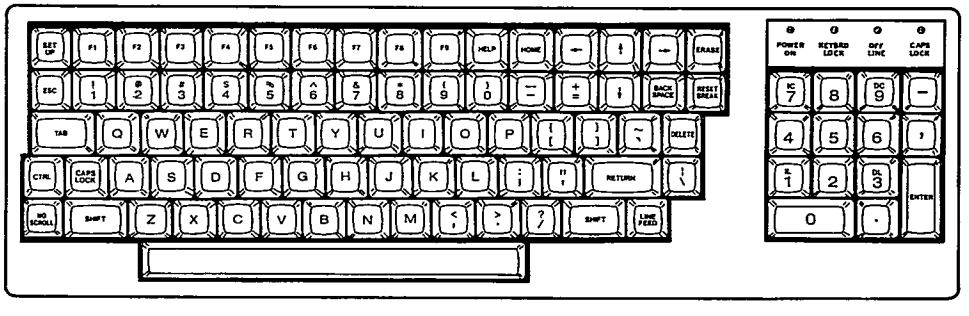


Figure 4

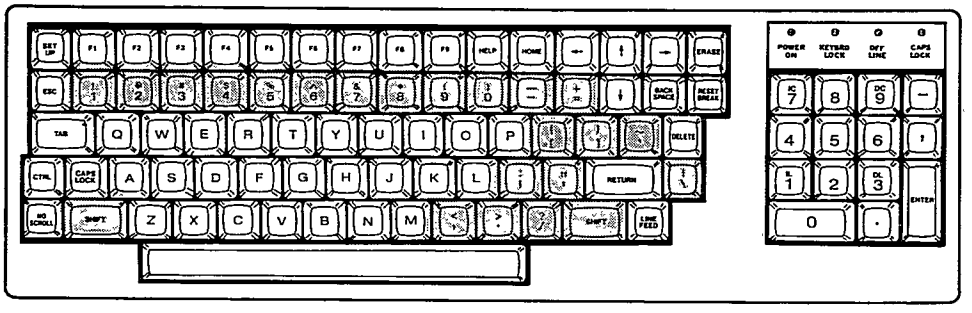


Figure 5

TAB — moves the cursor to the next tab column as set in the "Setup" mode or by software. If you press either SHIFT key and TAB, the cursor will move to the previous tab column. This will be explained in more detail later.

CURSOR CONTROL

HOME — moves the cursor to the "home" position at the upper left corner of the screen.

← — moves the cursor one character to the left except when it is at the left margin.

→ — moves the cursor one character to the right until it reaches the right margin.

↑ — moves the cursor one line upward until it reaches the top of the screen.

↓ — moves the cursor one line downward until it reaches the bottom of the screen.

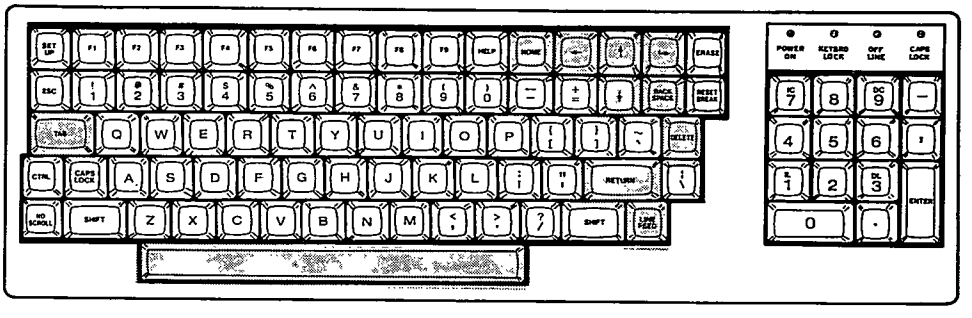


Figure 6

SPECIAL FUNCTION KEYS (See Figure 7)

ERASE — erases all unprotected information from the screen by filling the erased area with spaces. By pressing either SHIFT key and ERASE, the entire screen is cleared.

RESET/BREAK — may be used by software in the normal (unshifted) mode to interrupt program execution. When pressed with the SHIFT key, it resets the Terminal to the power-up state.

HELP — used by some programs to summon aid in the form of special "prompts" or "helps."

F1 – F9 — are special function keys, defined by software.

NO SCROLL — displays as "Hold Screen" on the monitor in the Setup mode. If the screen is full, this prevents a host computer from transmitting more data. Each press of the NO SCROLL key will scroll one line at a time. Pressed with either SHIFT key causes the Terminal to accept and display the next twenty-four lines of text.

ESC — The ESCape key generates the ASCII ESCape code. When you press it before you press another key it creates an "Escape Sequence." These escape sequences are special functions that command the Terminal. When you use an escape sequence, press and release the ESC key and then type the character **exactly**. For example, ESC E is a different code than ESC e. A complete listing of the ESCape Sequences is presented in the Appendix section of this Manual.

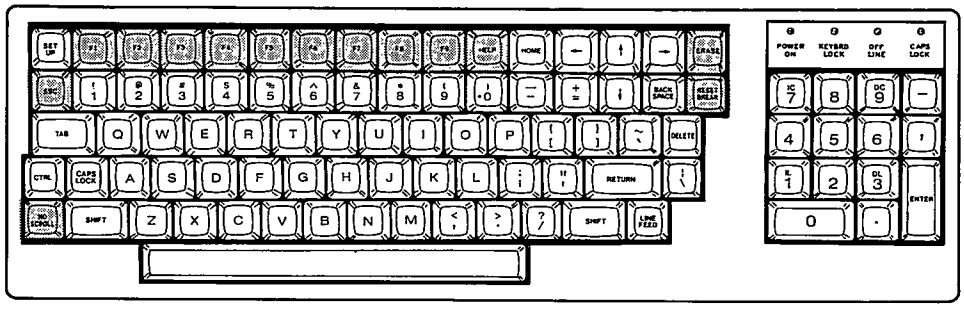


Figure 7

CTRL — (Control) is also a special function key used with another key to produce a command.

SETUP — is used to enter or exit the "Setup" mode which will be explained later.

Calculator-Style Keypad — at the right of the keyboard has the numbers 0 through 9, a decimal point, a comma for data entry, a minus sign, and ENTER to signal the computer that the entry is complete. For compatibility with other Heath terminals, the 2, 4, 5, 6, and 8 keys operate as cursor control keys when pressed with a SHIFT. Keys 1, 3, 7, and 9 (marked IL, DL, IC, and DC, respectively) are used to INSERT or DELETE lines or characters when pressed with a SHIFT key.

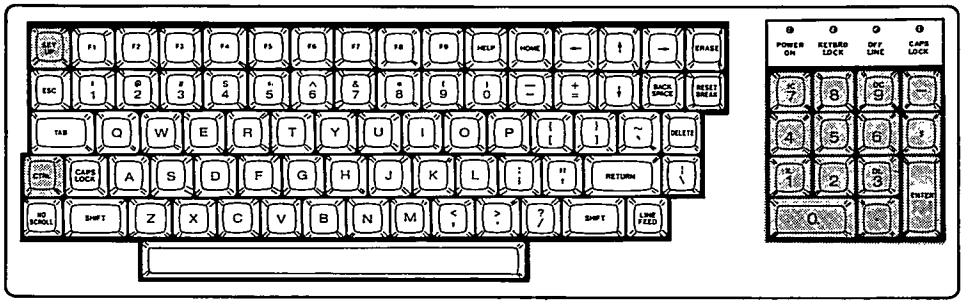


Figure 8

SETUP MODES AND MENUS

The starting point for selecting the various modes is the "Setup" mode, activated by the SET UP key. With a Setup Menu displayed on the monitor, you can select other menus to perform the setup function you desire.

This Terminal uses the latest in solid-state technology for setting up and maintaining vital communication parameters. A non-volatile memory IC allows you to quickly and easily enter all of the parameters through the keyboard. This section explains all of the features you may establish in this manner.

When you want to program the Terminal's parameters, press the SETUP key to enter the Setup mode and perform the instructions that follow in this section. After you have established the desired parameters, you can choose to either use them on a temporary basis or store them in the Terminal's non-volatile memory. If they are not stored, the parameters will return to default values (those last stored) whenever the Terminal is reset, loses AC power, or is turned off.

To save (store) parameters that you set, hold down either SHIFT key and press SETUP. All parameters will then be saved until you reenter the Setup mode and change them, even after the terminal is reset or is turned off. If you only desire a temporary change of parameters, simply press SETUP without a SHIFT key after you select the parameters.

NOTE: You can permanently protect your Setup parameters by changing a jumper wire inside your Terminal. After you enter your desired parameters, refer to "Setup Protection" on Page 23.

NOTE: When you place the Terminal in the Setup Mode, it is in an "off line" state. It does not communicate with a host computer until you exit the Setup Mode.

The Setup Mode has eight different displays that are shown in reverse video (black on green) on the 25th line of your screen. The displays are referred to as Setup Menu A through Setup Menu G and T. Each of these displays show the status of various features.

Chart 1 is a quick summary of the setup functions, where they are used, and which Setup Mode they are found in.

Chart 1

FEATURE	SETUP MENU
Automatic Carriage Return	F
Automatic Line Feed	F
Automatic Repeat	E
Baud Rate Selection	B
Character Sets	G
Clock	D
Communications Mode	B
Cursor Selection	F
Fill Screen	G
Hold Key	C
Key Click	E
Keypad Alternate/Shifted	E
Line Frequency Selection	F
Monitor Mode	C
Off Line/On Line	A
Parity Selection	B
Port Selection	C
Screen Saver	D
Status Line	D
Tabs	T
Video Attributes	G
Wraparound	D

ENTERING THE SETUP MODE

To enter the Setup Mode, press the SET UP key. The bottom line of the screen will show Setup Menu A's display.

MENU SELECTION

To select any of the eight different Setup Menu presentations, Setup A through Setup G, and Setup T, press the corresponding alphabetic key. You can access any of these menus from any other setup presentation by simply pressing the alphabetic key associated with that particular menu. Each function in the menu is accessed by its associated numeral. Once you establish your particular setup configuration, you may save this menu in non-volatile memory; just exit the Setup Mode by pressing either SHIFT key and the SETUP key.

SETUP MENU A

To enter Setup Menu A, simply press the A key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key. The bottom line of the screen will produce a display similar to this:

```
**SETUP MENU A** (Ver 1.XX) 1. on line Menus -A-
to -G- or -T- for TABS (XX = latest version)
```

NOTE: The bottom line display on your screen may differ slightly from those printed in this Manual, depending on the version of the ROM installed.

On/Off Line

Whenever the Terminal is "on line," it is an input/output device for a host computer. If the Terminal is "off line," it can not transmit to or receive information from the host computer, but is controlled through its own keyboard.

When the mode selected is off line, and the Status Line is enabled, the OFF LINE is displayed on the bottom line of the screen.

You can change the state of the on/off line status by pressing the 1 key on the main keyboard.

TAB MENU

To enter the Tab Mode, simply press the T key if the Terminal is already in the Setup Mode. If the Terminal is not in the Setup Mode, press the SET UP key and then the T key. The bottom line of the screen will display:

```
#234|678901|3456789012|456789012345678901234567890
12345678901234567890|234567890
```

In this example, the vertical lines represent tab locations at the 5th, 12th, 23rd, and 71st character positions. You can set and reset tabs by moving the graphics block left or right with the appropriate arrow keys.

Cursor Movement

To move the cursor to the right, press the right arrow (→) key. Once the cursor reaches the right side of the display, it will not move any further.

To move the cursor to the left, press the left arrow (←) key. Once the cursor reaches the left side of the display, it will not move any further.

Set Tab

To set a tab, position the cursor to the desired location and press the up arrow (↑) key.

Clear Tab

To reset (clear) a tab, position the cursor to the desired location and press the down arrow (↓) key.

Exit

To exit the Tab Mode without storing the tab settings, just press the SET UP key. When the Terminal is reset, or turned off and then on again, the tab stops will return to the settings that existed before you made any changes.

To exit and store the tab stop settings in non-volatile memory, press and hold the SHIFT key and then press the SET UP key. The tab stops will remain set until you change them again in the Setup Mode.

SETUP MENU B

To enter Setup Menu B, simply press the B key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key and then the B key. The bottom line of the screen will display:

```
*MENU B*  1. BAUD 9600  2. PARITY Space
3. DUPLEX full  4. HANDSHAKE software
```

Baud Rate

This Terminal can use a wide number of baud rates to communicate with its host computer: 75, 110, 150,

300, 600, 1200, 1800, 2400, 4800, 9600, and 19200 baud. The sample menu above shows that 9600 baud is selected.

You can change the baud rate by pressing the 1 key. The current baud rate will step to the next available baud rate. If you do not want that rate, continue pressing the 1 key until you obtain the baud rate that you desire. When the Terminal reaches 19200 baud, the next rate is 75 baud.

IMPORTANT: The number of data bits and the number of stop bits are **not** programmable at the Terminal. This Terminal uses seven data bits and one stop bit at all baud rates **except** 75 and 110 baud. These last two utilize two stop bits.

Parity

The available parity options are: space, odd, even, or mark (continuously on). You can change the parity (shown as a space in the above example) by pressing the 2 key, which changes the parity to the next selection and displays it. If you do not want that selection, continue pressing the 2 key until you obtain the selection that you desire.

NOTE: Heath/Zenith operating systems on the Models H-8, H/Z-89, and Z-90 computers do not check parity with the Terminal. The Terminal ignores parity on all incoming data.

Duplex Mode

This Terminal can communicate in either full or half duplex. You can change the mode of operation by pressing the 3 key.

Handshaking

Two methods of "handshaking" are used in this Terminal. These methods are described separately below.

In the software handshake mode, the Terminal automatically generates the XON or XOFF codes. XOFF signals that data transmission from the computer to the Terminal should cease. XON signals that transmission may resume. This Terminal automatically generates the XOFF code when its internal buffer is almost full.

The hardware handshake is performed via the RS-232 interface in conjunction with the CTS, RTS, and DTR lines. The DTE connector makes use of all three lines, while the DCE connector can utilize the RTS line only.

You can use the 4 key to change the mode of handshaking.

SETUP MODE C

To enter Setup Menu C, simply press the C key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key and then the C key. The bottom line on the screen will display:

```
*MENU C*  1. PORT normal  2. MODE Zenith
3. HOLD SCRN off  4. MONITOR off
```

Port Assignment

In normal operation, this Terminal uses the DTE port to communicate with the computer. The DCE port could be connected to an optional printer. Occasionally, you may want to exchange ports. Or, you may wish to connect the Terminal to two different computers and selectively use one or the other without making any wiring changes. This feature allows you to send the signals to one port or the other. Be aware, however, that there are limitations between the two ports for handshaking arrangements, and the baud rate used by one port must be the same for the other port.

You can change the routing of the signals to the DTE and DCE ports by pressing the 1 key. When these signals are swapped, the display will show:

```
1. PORT auxil
```

Terminal Modes

This Terminal can emulate four common terminal types: The Heath/Zenith H/Z-19, the Lear Siegler ADM 3A, the Hazeltine 1500, or the ANSI (American National Standards Institute) standard X3.64-1979 (similar to the VT100). Each of the four modes responds differently to codes it receives. For more information, refer to the "Programming" section of this Manual.

You can change the Terminal Mode by pressing the 2 key on the main keyboard. The Terminal emulated is displayed. If you do not want to use that mode, continue pressing the 2 key until you obtain the mode you desire.

Hold Screen

The HOLD SCRN (Hold Screen) function offers the operator control over the scrolling of the display. When this is activated, you must press the NO SCROLL key to allow each new line to be displayed. To display an entire new page of information, simultaneously press either SHIFT key and the NO SCROLL key.

You can enable or disable the Hold Screen function by pressing the 3 key on the main keyboard.

Monitor Mode

The MONITOR function puts the screen of the Terminal into a state where it will display all control characters in reverse video. The Monitor mode is useful for monitoring data communications.

Normally, control characters (such as Escape) are not displayed even though they are received and processed. Be aware, however, that the screen formatting is not possible when this feature is enabled.

You can enable or disable the Monitor function by pressing the 4 key on the main keyboard.

SETUP MENU D

To enter Setup Menu D, simply press the D key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key and then the D key. The bottom line of the screen will display:

```
*MENU D*  1. SET CLOCK  2. STATUS LINE on
3. WRAP on  4. SCRN SAVER on
```

Clock

This Terminal has a 24-hour clock, which is displayed on the status line. To set the clock, press the 1 key. The bottom line of the screen will display:

```
Enter hours >
```

Use the main keyboard to enter a 1- or a 2-digit number that is between 0 and 23. Then press the RETURN key. The bottom line of the screen will display:

```
Enter minutes >
```

Use the main keyboard to enter a 1- or a 2-digit number that is between 0 and 59. Then press the RETURN key. The clock will be set to the time you entered, the moment you complete the entry.

NOTE: Any illegal entry causes the display to return to the menu with no changes. Also, the clock will rest to 00:00:00 if the power switch is turned off or the line cord is disconnected.

Status Line

The Status Line on the CRT displays the following information for operator convenience: 24-hour clock; CAPS LOCK if the caps lock is on; OFF LINE if the Terminal is in the Off Line mode; and INSERT MODE if the Terminal is in the Insert Mode (activated by Insert Line or Insert Character key).

The clock is always displayed unless the status line is turned off, or the 25th line is turned on by a software command in a program. If the status line is enabled, it always appears as long as the 25th line is disabled.

You can turn the Status Line display on or off by pressing the 2 key on the main keyboard.

Wrap On/Off

When the wraparound feature is enabled and you enter the 81st character of any line, it is automatically printed at the first character postion of the next line. If the line is the last line of the designated scrolling region, the screen is "scrolled" up one line and a new bottom line is started with your character in the first position. If this feature is disabled, any characters you type after the 80th character replaces the 80th character on that line.

You can enable or disable the wraparound feature by pressing the 3 key on the main keyboard.

Screen Saver

The screen is automatically blanked out if no key is pressed or the Terminal receives no data from the computer for 15 minutes. This feature helps increase the life of the CRT. You can restore the screen by pressing the CAPS LOCK key or typing any character. However, if you type a character, it will be sent ot the host computer.

You can enable or disable the screen saver feature by pressing the 4 key on the main keyboard.

SETUP MENU E

To enter Setup Menu E, simply press the E key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key and then the E key. The bottom line of the screen will display:

```
*MENU E*  1. KEYPAD SHFT off  2. KEYPAD ALT off
3. REPEAT on  4. CLICK on
```

Keypad Shift

In normal operation, shifted characters on the numeric keypad may be transmitted only when you press the SHIFT key along with the corresponding key. This function reverses the operation, requiring you to use the SHIFT key to transmit unshifted characters.

You can enable or disable the shifted keypad function by pressing the 1 key on the main keyboard.

Alternate Keypad

Normally, the codes generated on the numeric keypad are the ASCII numerals for 0 through 9, the comma, the dash (hyphen, or minus sign), the period (or decimal point), and ENTER. In the Alternate Keypad Mode, other codes are transmitted. Refer to "Programming" for the codes that are transmitted in the Alternate Keypad Mode.

You can enable or disable the alternate keypad function by pressing the 2 key on the main keyboard.

Key Repeat

When the Key Repeat feature is enabled, holding any key except the SHIFT, CAPS LOCK, CTRL, SET UP, and RESET BREAK keys for more than about 1/2-second causes that key to be repeated. The longer you hold the key down, the faster the repeat rate. The key continues to repeat until you release it.

You can enable or disable the Key Repeat function by pressing the 3 key on the main keyboard.

Key Click

As an audible "click" is provided to let you know that a key entry has been made. Some keys, such as the SHIFT and CTRL keys, do not sound the key "click" when you press them, as they modify other keys when pressed in conjunction with them.

You can enable or disable the Key Click function by pressing the 4 key on the main keyboard.

SETUP MENU F

To enter Setup Mode F, simply press the F key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key and then the F key. The bottom line of the screen will display:

```
*MENU F*  1. AUTO CR off  2. AUTO LF off
3. CURSOR blnk line  4. FREQ 60 Hz
```

Auto CR

When this feature is enabled, a carriage return (CR) is also generated whenever a line feed is received.

You can enable or disable this feature by pressing the 1 key on the main keyboard.

Auto LF

When this feature is enabled, a line feed (LF) is generated whenever a CR is received.

You can enable or disable this feature by pressing the 2 key on the main keyboard.

Cursor Selection

The cursor shows you where the next information or key will appear on the screen. You can change the characteristics of this indicator with this setup feature.

You may select any one of four different cursor formats by pressing the 3 key on the main keyboard. The cursor type and display are as follows:

CURSOR TYPE	DISPLAY
block (reverse space)	block
underline	underline
blinking block	blnk blck
blinking underline	blnk line

Line Frequency

The display scan rate of the display depends upon your local AC line frequency: 60 Hz in areas served by 60 Hz AC lines and 50 Hz in areas served by 50 Hz AC lines. The normal line freqeuncy in the United States is 60 Hz. If you have any doubts, or if you plan to use your Terminal in a foreign (other than US) location, consult your local power company.

You can change the scan rate frequency by pressing the 4 key on the main keyboard.

SETUP MENU G

To enter Setup Menu G, simply press the G key if the Terminal is already in the Setup Mode. If the Terminal is not already in the Setup Mode, press the SET UP key and then the G key. The bottom line of the screen will display:

```
*MENU G*  1. CHAR SET normal  2. FILL SCREEN
3. ATTRIBUTES  4. TEST
```

Character Sets

This Terminal is supplied with two character sets. Both sets are illustrated in the "Programming" section of this Manual. In most instances, you will use the normal character set. There may be times, however, when you will want to access some of the special characters available in the alternate set.

You can enable or disable the alternate character set by pressing the 1 key on the main keyboard.

Fill Screen

The Fill Screen function allows you to fill the entire screen with any one character. This function is used primarily for service of the video monitor and character generator within the Terminal.

After you press the 2 key on the main keyboard, you can fill the entire screen with any character you select by pressing the appropriate key. You may change the displayed character as many times as you desire. To return to Setup Menu G, press the RETURN key.

Video Attributes

There are sixteen different attributes available on a full screen or character-by-character basis through software. For programming information, refer to the "Programming" section of this Manual.

You may step through the attributes of the entire screen by pressing the 3 key on the main keyboard. The sixteen attributes are as follows:

1. Normal display at normal intensity.
2. Reverse video at normal intensity.
3. Normal video underlined at normal intensity.
4. Reverse video underlined at normal intensity.
5. Same as number 1 but blinking.
6. Same as number 2 but blinking.
7. Same as number 3 but blinking.
8. Same as number 4 but blinking.
9. Same as number 1 but half intensity.
10. Same as number 2 but half intensity.
11. Same as number 3 but half intensity.
12. Same as number 4 but half intensity.
13. Same as number 5 but half intensity.
14. Same as number 6 but half intensity.
15. Same as number 7 but half intensity.
16. Same as number 8 but half intensity.

Test

This Terminal has tests built-in for servicing. This specific test checks the ROM, RAM, and fills the screen with all characters from the character set and sounds a beep if the test is successful. The test automatically repeats until it detects a failure, or you press any key to exit from the test.

To activate this test function (of Setup Menu G), press the 4 key. To exit from the test, press any key.

NOTE: If you experience a failure during the "test", refer to the "In Case of Difficulty" section of this Manual.

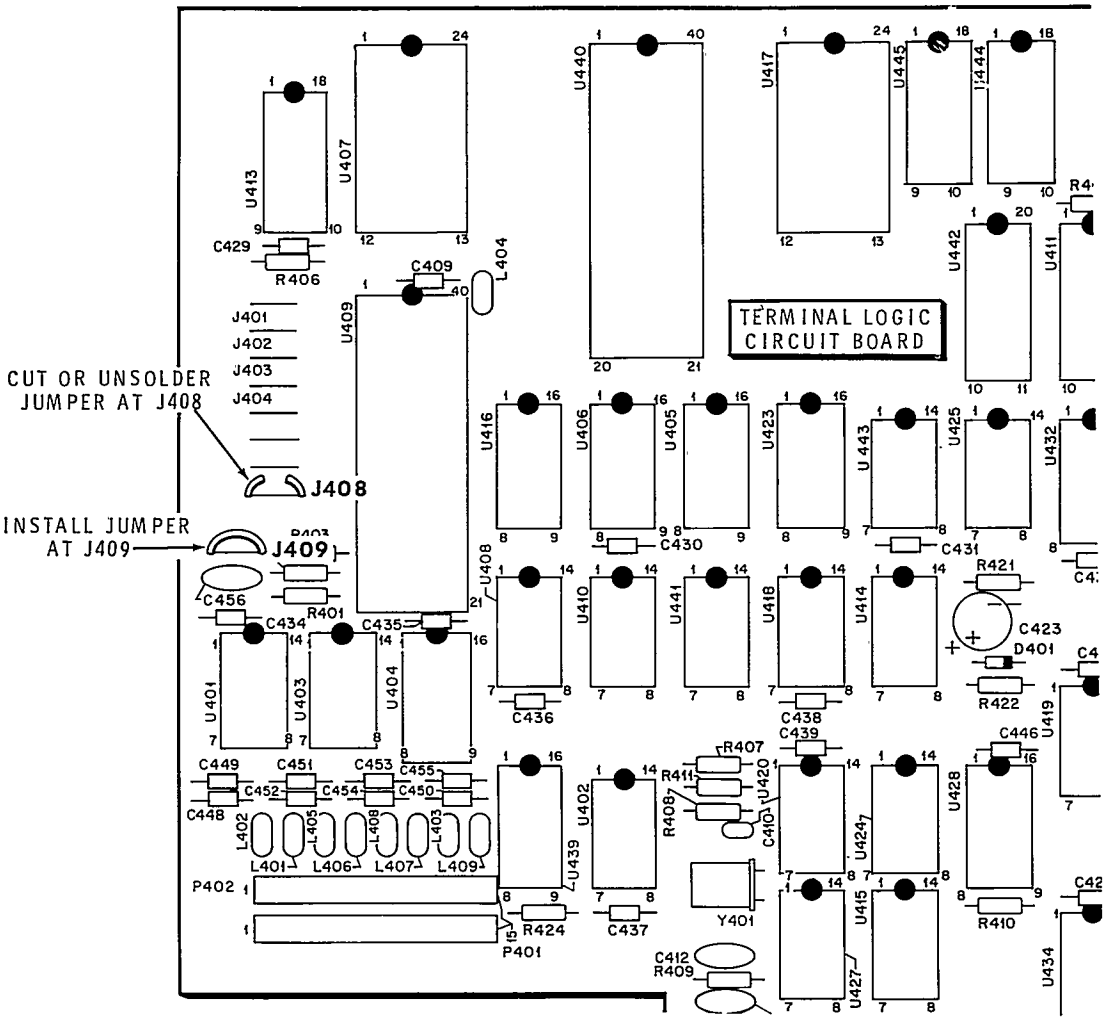


Figure 9

SETUP PROTECTION

There is an optional hardware modification that prevents the Terminal operator from entering the Setup Mode. If you desire to add this protection, refer to Figure 10 and perform the following steps:

1. Remove the three screws from the rear panel (two in the upper corners and one in the lower center). Then tilt the panel outward so the terminal logic circuit board is accessible.

2. Locate jumper J408 in the terminal logic circuit board (TLB) and carefully cut or unsolder this jumper wire.

3. Install a jumper wire at location J409 on the terminal logic circuit board.

4. Close the rear panel and reinstall the three screws.

NOTE: You will have to move this jumper back to location J408 before you can again perform the Setup function.

PROGRAMMING

Information that you may find useful in establishing programs for use with this Terminal is included in "Appendixes A through E" at the rear of this Manual. This information is arranged as follows:

Appendix A	ASCII Code Information
Appendix B	Heath/Zenith Mode Code Information
Appendix C	ANSI Mode Code Information (Std.X3.64-1979)
Appendix D	Lear Siegler ADM 3A Mode Code Information
Appendix E	Hazeltine 1500 Mode Code Information

THEORY OF OPERATION

The following description is a brief summary of how the Terminal operates. The Block Diagram in Figure 10 (Illustration Booklet, Page 3) shows the major component relationships. A more detailed description is provided in the "Circuit Description."

A keyboard and a monitor form the Terminal and are connected together by a coiled cable. The monitor contains four circuit boards. Their various circuits are shown in Block Diagram form.

An RF filter is connected between the AC line input and the power supply. This filter blocks out any line-conducted RF interference, both into and out of the monitor. The power supply provides all of the DC voltages required to operate the entire Terminal.

The terminal logic circuit accepts input from the keyboard and other RS232 computer equipment. This circuit processes the information into and out of the Terminal and controls the operation of the Terminal.

A video driver circuit creates the raster on the CRT. Then it takes the information from the terminal logic circuit and processes it for viewing.

POWER SUPPLY

When you turn the power on for your H-29 Terminal, an AC (Alternating Current) line voltage is applied to the power supply where it is converted into several DC (Direct Current) voltage levels. These voltages are then fed to the various circuits of the Terminal for operation.

CPU and ROM

The CPU (Central Processor Unit) contains a portion of memory ROM (Read Only Memory) which instructs the Terminal to perform proper operation. Initial operation at power-up is a series of tests and checks of the various circuits. At the successful completion of these tests, all circuitry is reset (including a built-in time clock) and the system is initialized according to programming held in the CPU ROM and expansion ROM(s) (read only memory) and non-volatile memories (these are programmed while the Terminal is in the setup mode). Communication is established with a host computer (if present) through the DTE or DCE ports.

TIMING AND CLOCK FUNCTIONS

In addition to maintaining a time clock function, the system uses various timing signals (clocking frequencies) to maintain synchronization within the Terminal and for establishing the communication channel's baud rates.

CHARACTER AND COMMAND SOURCES

Characters and Terminal commands (single or multiple byte) may be received from any of three sources: keyboard, host computer, or internal memory.

- The keyboard source involves the translated code created by the keyboard encoder, in conjunction with the characteristics established either by control codes or during setup. If commands are involved, the CPU will process them in accordance with the programming established during the setup of the Terminal or the instructions contained in the program ROM(s).

- Codes received from host equipment are passed through the CPU, which strips the data from the transmitted signal. The resulting code can be acted upon if it is a command or stored in your Terminal's memory if it is a character.

- The internal memory source includes the time clock and the characteristics established during setup or initialization. These may or may not involve characters to be placed on the CRT display.

Regardless of the source of the character or command sequence, the CPU receives and processes the code and then either acts upon it (if it is a command) or routes it to the appropriate memory for use by the Terminal.

CHARACTER GENERATION

A complex interrelationship is maintained between the CPU, Video Character and Attribute RAM (memory), the controllers, and display synchronization logic. The speed of this relationship is obtained through DMA (Direct Memory Access) logic.

When a new character is to be generated on the screen, the CPU will route (handled by the Bus Control Circuitry) the character code into the appropriate memory location (which corresponds to a screen location) in the Video Character RAM and the attribute code into the corresponding location in the Video Attribute RAM.

The CPU, under timing control of the clocking signals, and in conjunction with the DMA logic, directs the Video and Attribute Controllers to access the Video Character and Attribute memories in sequential order with respect to placement on the screen.

The codes for the individual characters are sent through the Video Controller to the Character Generator, where they are translated into the proper pattern for display. From there, the bit pattern is sent to a Shift Register where the information is sent in a serial fashion through synchronization logic where it is mixed with the attribute for that character. The resulting signal is then routed into the Video Drive Circuitry and reproduced on the screen of the Terminal.

COMMUNICATION

The CPU, in addition to controlling placement of generated characters, following instructions generated by control codes, and placing data into the appropriate memory location, also handles communication with external devices. The instructions are stored in the program ROM(s) and executed as a result of keyboard entry or a command sequence. Routing of transmitted and received code is handled by the CPU in a manner similar to storing a new character.

If one or more stored characters are to be sent to either a host computer or auxiliary printer, the CPU will make use of the Bus Control Circuitry to locate and retrieve data on a character-by-character basis from the Video Character and Attribute memories. Each character is then converted to serial data and transmitted with the established protocols (baud rate, handshaking, and parity characteristics) to the appropriate port.

CIRCUIT DESCRIPTION

This Circuit Description serves two purposes. If you are a trained technician or serviceperson, it will help you to quickly understand any unfamiliar circuitry. If you are not a technician or serviceperson, it will NOT help you service your Terminal, but will help you gain a basic understanding of how the basic component blocks work together.

Refer to the Block Diagram (Illustration Booklet, Page 3) and to the Schematic Diagram (Fold-in) while you read this Circuit Description. This description deals with groups of components by addressing each group as a functional block.

POWER SUPPLY

The primary circuit of the power supply (see Figure 11) consists of the line filter circuit board, fuse F1, On/Off switch SW1, and the primary winding of transformer T1.

Components L51, C51, C52, and C53 form the line filter. This trap circuit filters out any line-conducted RF interference both in and out of the Terminal. Fuse F1 disconnects the Terminal from the power source in the event of a Terminal power supply failure.

The secondary circuit of the power supply (see Figure 14, Illustration Booklet, Page 4) consists of three secondary power transformer windings and the power supply circuit board.

The red secondary winding of transformer T1 supplies AC to the full-wave bridge rectifier circuit formed by diodes D101 through D104. This circuit produces approximately 9.6 volts DC, which is filtered by capacitor C101. The resultant DC is passed to the terminal logic circuit board where it is split into three separate supplies for use by the circuits there.

Another secondary winding of the transformer (blue wires) supplies AC to the full-wave bridge rectifier formed by diodes D105 through D108. This circuit produces approximately 18 volts DC, which is filtered by capacitor C102. This voltage source is passed to the terminal logic circuit board where it is used to produce the +12-volt supply needed there. This voltage source is also applied to adjustable regulator integrated circuit U101. Resistors R101 and R102 set the current on U101 so that it produces a regulated 12 volts DC, which is filtered by capacitor C103. The regulated +12 volt source is provided to the video board via connectors through the terminal logic board.

A third secondary winding of the transformer (yellow wires) supplies AC to the full-wave bridge rectifier formed by diodes D109 through D112. This produces approximately –18 volts DC, which is filtered by capacitor C104 and is provided to the terminal logic circuit board for use there.

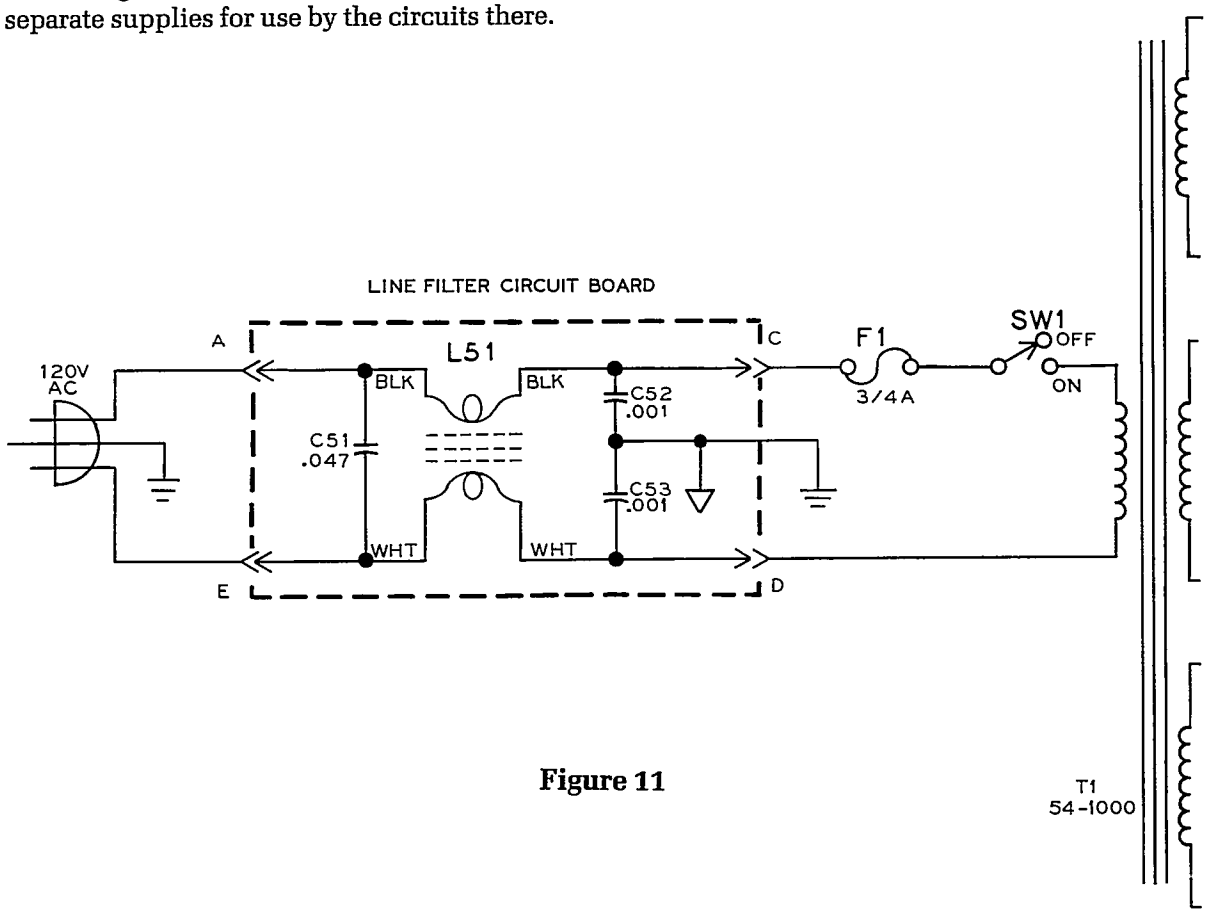


Figure 11

TERMINAL LOGIC CIRCUIT BOARD

This circuit board contains the microprocessor integrated circuit and controls the operation of the entire Terminal. Each circuit on this circuit board is described separately below.

REGULATOR CIRCUITS

Four on-board regulators are included on the terminal logic circuit board (see Figure 13, Illustration Booklet, Page 4). These regulators accept voltage from the power supply circuit board and convert it into the +12-volt (U435), –12-volt (U436), and +5-volt (U437 and U438) supplies needed for the circuits on this circuit board. Capacitors C415 through C422 help stabilize the regulators and improve their transient response. Capacitors C442 through C445 filter RFI (radio frequency interference) noise from the logic board.

POWER-UP and RESET CIRCUIT

To set this Terminal back to its original operating mode when it has been changed by software escape sequences, the microcomputer must be reset. A reset can be accomplished by a power-up, by simultaneously pressing the Escape and Reset keys on the keyboard, or by receiving a Reset command from the host.

The power-up reset circuit (Figure 14) consists of diode D401, resistors R421 and R422, capacitor C423, and integrated circuit U414C. Each time the Terminal is turned on, capacitor C423 is in a discharged condition. This holds one input (pin 10) of NAND gate U414C low and the output (pin 8) high. Resistor R422 pulls this output voltage to a level that insures that microcomputer U409 resets. After this initial reset, capacitor C423 charges through resistor R421, causing both inputs of U414C to be high. The resulting low at its output allows the microprocessor to exit the reset condition.

Simultaneously pressing the Shift and Reset keys on the keyboard also resets the microcomputer. Since two keys must be pressed to reset the Terminal in this manner, the chances of accidental reset are reduced. At power up, capacitor C424 is in a discharged condition, but immediately begins to charge through resistor R423. This performs the same function as the capacitor and resistor on the other input to U414C. Capacitor C424 finally charges to a level that is sufficient to override the reset condition and allows the microcomputer to operate properly. When the Shift and Reset keys are simultaneously pressed, a logic low from the keyboard (pin 2 of plug P403) causes capacitor C424 to discharge. Once this capacitor discharges to a TTL low, the output (pin 8) of U414C goes

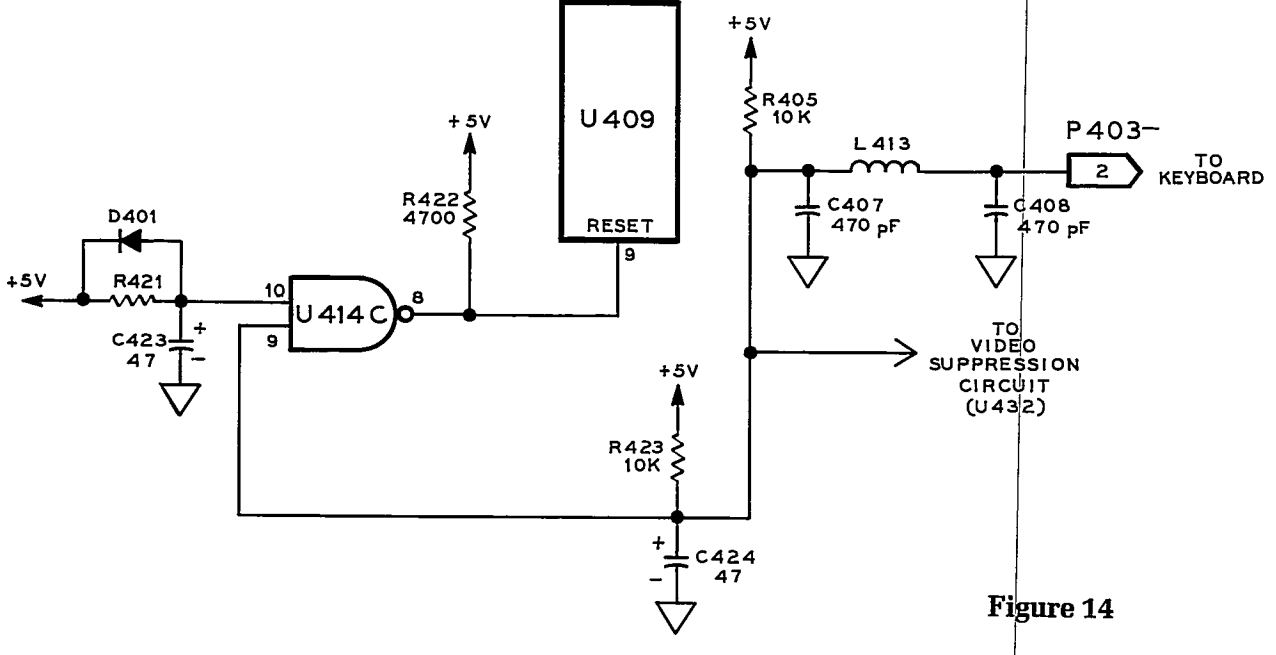


Figure 14

high and resets the Terminal. Because the reset line will float high, the Terminal is protected from becoming reset if the keyboard is unplugged from the monitor.

The low that is sent to the reset circuit from the keyboard is also applied to the clear input to the video suppression circuit (U432). The video enable input to this integrated circuit is pulled high during reset (and inverted by U412D before it is applied to the data input) and the clear input (pin 15) is pulled low. This insures that the screen is blanked during the reset. Resistors R423 and R405, together with capacitor C424, integrate out any noise pulses that could otherwise reset the Terminal by forming a time constant. The time constant chosen is longer than the transients but shorter than the time it takes to actually press the Shift and Reset keys. Therefore, it is not necessary to "hold" the keys down to cause a reset.

After a reset is complete, firmware causes the microcomputer to begin the initialization routine. This clears the scratchpad and display memory RAM, and initializes the CRT controllers and the ports. Initialization is done according to the characteristics chosen and saved in the Setup mode.

SERIAL PORTS

There are two user-available ports on this Terminal (see Figure 15, Illustration Booklet, Page 5), the computer port and the auxiliary port. The computer port is a standard RS-232 DTE connector, and the auxiliary port is a standard RS-232 DCE connector. The pinouts for these connectors are shown in Table 2 below.

TABLE 2

DTE Computer Port		DCE Auxiliary Port	
PIN#	FUNCTION	PIN #	FUNCTION
1	Ground	1	Ground
2	Transmit data	2	Receive data
3	Receive data	3	Transmit data
4	Request to send data	4	Request to send data
5	Clear to send data	7	Signal ground
7	Signal ground	20	Data terminal ready
20	Data terminal ready	5	Clear to send*
		6	Data set ready*
		8	Received line signal detect*

* tied to pin 20

Microcomputer U409 controls the operation of the serial ports. This integrated circuit contains a serial port that enables the Terminal to communicate with other peripherals, without the need for a seperate asynchronous communications element. This serial port is useful for serial linking peripheral devices through standard asynchronous protocols, with full duplex operations.

The microcomputer responds to a serial port interrupt request by either reading or writing to the serial port's buffer. This full duplex serial I/O port provides asynchronous modes to facilitate communications with standard UART/USART devices, such as other terminals, printers, or computers. The receiver input to this port contains two buffers to eliminate the possibility of overrun, which could occur if the CPU fails to respond to the receiver's interrupt before the beginning of the next frame. Since the microcomputer (U409) can maintain the serial link without a double buffer, a single buffer is used at the transmitter output.

In asynchronous communication, false start bit rejection is provided on the received frames. For noise rejection, a majority of two-out-of-three samples taken near the center of each received bit must agree.

The I/O ports may be programmed to function in any of the four operation modes shown below:

Mode 0 — Synchronous I/O expansion using TTL or CMOS shift registers.

Mode 1 — UART interface with 10-bit frame and variable transmission rate.

Mode 2 — UART interface with 11-bit frame and fixed transmission rate.

Mode 3 — UART interface with 11-bit frame and variable transmission rate.

Proper timing for the serial I/O data is provided by a transmission rate generator inside microcomputer U409. Three different methods of transmission rate generation are possible, and the achievable rate depends on the operating mode of the serial port. Since this Terminal uses transmission mode 1, the transmission rate is generated from the microcomputer clock frequency. In this mode, the oscillator frequency is divided by 12 (or the T1 input is divided by

256, minus the value in TH1 if counter 1 is configured in the auto-reload mode by firmware). This frequency is then divided by 32 to provide the transmission rate. The baud rates that the ports will support are 75, 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 baud.

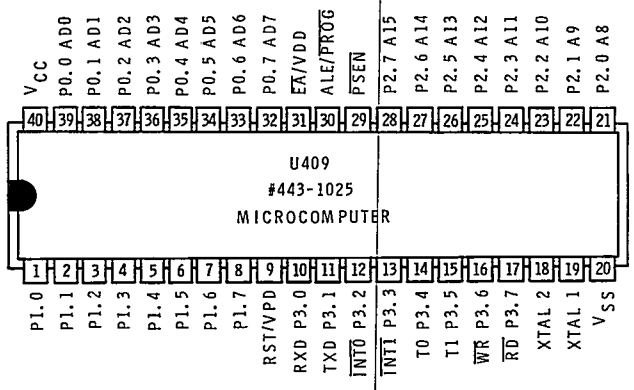
The hardware required to complete the serial link is made up by the microcomputer (U409), a 2-line to 1-line output multiplexer (U404), a quadruple line driver (U401), and a quadruple line receiver (U403).

Both of the serial ports meet the EIA standards for RS-232C. Since the serial port on the microcomputer has only one receive and one transmit data line, the two user-available ports cannot be used simultaneously. U404 multiplexes the request to send (RTS) signal and the received serial data (RCV) between the auxiliary port and the computer port. The port select bit (PRT CTRL) on pin 1 of multiplexer U404 is connected to a latched I/O (pin 7 of U416). When this line is a logic 1, the microcomputer is set up to receive data from the auxiliary port. When this line is a logic Ø, it is set up to receive data from the computer port.

The transmit line drivers are tied directly to the transmit pin (11) of the microcomputer (U409) through OR gate (U402C or U402D). The second inputs to these OR gates are tied to the port select bit (U416, pin 7). When the port select bit is high, the output of OR gate U402 is high regardless of the logic level of the data to be transmitted. Therefore, when the port select bit is logic 1, the auxiliary port (DCE) transmits. When the port select bit is low, the output of OR gate U402D is high regardless of the logic level of the data to be transmitted because of inverter U410C. Thus, when the port select bit is low (logic Ø), the computer port (DTE) transmits.

The clear to send (CTS) and data terminal ready (DTR) control signals (handshaking) on the computer port (DTE) are taken directly from the microcomputer and passed to the line drivers. On the auxiliary port the clear to send (CTS), data terminal ready (DTR), data set ready (DSR), and the received line signal detect (RLSD) signals are all tied together.

CPU and CONTROL CIRCUITRY



The heart of this Terminal is the microcomputer integrated circuit (U409) and its associated circuitry (ROM, RAM, and control logic). Microcomputer U409 contains a non-volatile 4K × 8 read-only-memory (ROM), a volatile 128 × 8 random-access-memory (RAM), 32 I/O lines, two 16-bit timer/counters, a five-source two-priority level nested interrupt structure, an on-chip oscillator/clock circuit, and a high performance full-duplex serial channel which was previously discussed. The internal ROM holds approximately one-half of the total monitor firmware. An expansion socket is included on the terminal logic circuit board for installation of an additional 4K × 8 of ROM or other options. More information about the expansion socket is included later in this Circuit Description.

The 32 I/O lines are divided into four 8-bit ports. Port 0 is an open-drain bi-directional I/O port, while ports 1, 2, and 3 are quasi-bidirectional I/O ports. Each of the ports will be described separately.

Port 0

Port 0 functions as the multiplexed data bus and low order address line. Since the memory and peripheral devices in this Terminal do not have on-chip address latching, the microcomputer circuitry must demultiplex the address and data lines into their respective buses. The address exits at port 0 and, approximately 100 nanoseconds later, the address latch enable (U409 pin 30) goes low. The low at this pin is inverted by U410B before it is applied to address latch U411, where the address is latched at the rising edge of the signal (ALE).

Port 1

Port 1 is a general purpose I/O port. Bit 0 (P1.0, U409 pin 1) is used as the handshake line between the terminal and the keyboard. Bit 1 (P1.1, U409 pin 2) is used as the input communication line from the keyboard to the terminal logic board. Both of these lines are properly buffered by U412B and U412F respectively, and filtered for RFI suppression.

Bit 2 (P1.2, U409 pin 3) is used as the video enable bit. When logic low, this bit, inverted by U412D, is connected to U432 pin 13 and allows the video to be displayed. When toggled to logic high by microcomputer U409, this bit causes the video information to be inhibited. This feature is particularly useful in blanking the extra unused logical rows of video in 50 Hz operation. It is also used during the screen saver option, where the screen is turned off after 15 minutes of inactivity if this feature is enabled in setup. This bit blanks the screen during a manual reset, while all RAM including video RAM is being initialized.

Bit 3 (P1.3, U409 pin 4) is used as an output. When jumpered to +5 volts, this bit inhibits the Setup mode key via firmware. When the bit is pulled up by firmware and recognized as being at a logic high, information from the keyboard that the Setup key has been pressed is ignored.

Bit 4 (P1.4, U409 pin 5) acts as the data terminal ready ($\overline{\text{DTR}}$) signal for proper handshaking at the computer DTE port and is applied to port connector P402 through line driver U401B.

Bit 5 (P1.5, U409 pin 6) acts as the clear to send ($\overline{\text{CTS}}$) signal for proper handshaking at the computer DTE port and is applied to port connector P402 through line driver U401A.

Bit 6 (P1.6, U409 pin 7) is routed to expansion socket U440 pin 37 and is an unused I/O bit in the present configuration. It may be used in future expansions or in user-designed options.

Bit 7 (P1.7, U409 pin 8) is used as an initialization synchronization signal to the video circuit (U428 pin 1). This signal is also routed to expansion socket U440 pin 38 in case it is needed in expansion circuits. The bit is firmware controlled to stop the video circuit clock and start it at a specified time after the two CRTC controllers have been properly initialized.

NOTES:

1. Further information about the keyboard communication bits is provided in the "Keyboard" section.

2. Further information about the video enable bit is provided in the "Character Generation" section.

3. Further information about the RS-232 handshaking bits is provided in the "Serial Ports" section.

Port 2

Port 2 (P2.0 – P2.7, U409 pins 21 - 28) is used only for the higher order address byte when the microcomputer accesses external memory. The combination of ports 0 and 2 form the total 16-bit address bus and the primary address bus.

Port 3

Port 3 is used as a general purpose I/O port. Bits 0 and 1 (P3.0 and P3.1, U409 pins 10 and 11 respectively) are used in the serial port. Bit 0 acts as the serial port asynchronous receive data input, while bit 1 acts as the asynchronous transmit data output. For further information see "Serial Ports" on Page 30.

Bit 2 (P3.2, U409 pin 12) is used as the interrupt Ø input from the character CRT controller (U422). A logic low level at this port bit indicates that a row buffer is ready for the loading of character data. The logic high level buffer ready signal (BRDY) (U422 pin 5) is inverted at gate U401F. This interrupt initiates a DMA transfer at the two CRTCs. For further information see "DMA From Video RAM to CRTC" on Page 35.

Bit 3 (P3.3, U409 pin 13) is used as the interrupt 1 input from the character CRT controller (U422). A logic low level at this bit indicates the last display row and last retrace character has been handled. For the domestic version this indicates the 25th display line and is used as a reference for both 50 Hz and 60 Hz models.

Bit 4 (P3.4, U409 pin 14) is also connected to the video circuitry. Used as an output, the bit causes the jammed DMA instruction to become 20 hex. This is used to clear a row of video memory quickly via DMA. For further clarification, see the "Clear Line DMA" on Page 35.

Bit 5 (P3.5, U409 pin 15) is used as an input to the serial port as the request to send ($\overline{RTS}$) signal from the selected port, depending on the PRT CTRL signal. For further information see "Serial Port" on Page 30.

Bit 6 and 7 (P3.6 and P3.7, U409 pins 16 and 17) are the $\overline{WR}$ and $\overline{RD}$ signals for latching data bytes from port 0 to the data bus or vise versa, respectively.

$\overline{PSEN}$ stands for program store enable output and is a control signal from the microcomputer (U409 pin 29). It enables the external program memory to the bus during normal fetch operations versus using the microcomputer's internal program memory.

The microcomputer (U409) receives character data and attribute information from either the keyboard interface or the host. When a key is pressed on the keyboard, the microcomputer at the keyboard (Z1) converts it to character data to send to the Terminal. The attribute information is provided to the microcomputer in the form of ESCape commands which cause the firmware to provide attribute data associated with the character data already provided. The microcomputer then sends the attribute data to the attribute display memories (U444 and U445) by enabling bus buffer U405 with the $\overline{16K}$ address signal and the write signal ($\overline{WR}$), and directly connecting the attribute data bus to the primary data bus. The attribute data is a four-bit-wide nibble (D0 - D3) appropriate to the four possible attributes.

After placing the attribute data in the display memory, the microcomputer now writes the character data out to the character display memory (U417). The $\overline{20K}$ address signal and the write signal from the microcomputer enables the memory chip select and the bi-directional bus driver (U442) so that the secondary data bus and the primary data bus are connected. The microcomputer places the character and associated attribute data in display memory chips in an address location equivalent to a video screen position.

After the microcomputer has placed the display data in the appropriate display memory, this data must be transferred from the character display memory and the attribute display memory to their corresponding CRT controller (U422 and U446 respectively). This operation occurs by way of direct memory access (DMA), which is described in the "Video Display" section.

MEMORY MAP (see Table 3)

Address lines A15 through A12 are connected to the memory select circuit (U439) as well as other circuits. U439 is a 3-input to 8-output data selector/demultiplexer and selects 4K increments of the memory map. The $\overline{ØK}$ signal is provided to the expansion socket (U440 pin 26) for use by earlier models. Later units have that portion of memory "on chip" on the microcomputer (U409). The $\overline{4K}$ signal is routed to J405 and J402 for proper connection to external program memory ROM U407.

Octal bus transceiver U442 separates the primary data bus from the secondary data bus. The secondary data bus services the character CRTC (U422) and the character memory (U417). This buffer is accessed at the 8K boundary for access to the character CRTC (U422) registers. It is also accessed at the $\overline{20K}$ boundary for access to the character display memory (U417). The direction of data flow through this buffer is controlled by the buffered read signal from microcomputer U409.

Buffers U405 and U423 form eight single-direction bus drivers: four in the direction for a CPU read from attribute display memory U444 and U445, and four in the direction for a CPU write to attribute display memory. The two quad-controlled portions of hex bus drivers used in this circuit (U405 and U423) are accessed at $\overline{8K}$ and $\overline{16K}$. The $\overline{8K}$ access is for the attribute CRTC (U446) control registers, and the $\overline{16K}$ access is for the attribute display memory (U444 and U445).

Control functions from microcomputer U409 are transferred via the primary data bus to a hex D flip-flop (U416). This control function latch is positioned in the memory map at the $\overline{12K}$ boundary. Data is transferred from the CPU to the latch when the memory select IC (U439) has the $\overline{12K}$ signal selected and, at the same time, the write signal from the microcomputer is active. The signals held by the latch are as follows.

$\overline{EAROMSTORE}$: When this bit is set, the current setup information is stored in the ROM portion of the NVRAM. Therefore, if the Terminal is powered down, the setup information remains.

$\overline{BI}$: When this bit is set, the blink attribute is activated.

PRT CNTL : This bit controls the selection between the auxiliary and computer ports.

$\overline{\text{EAROMRECALL}}$: When this bit is set, the information stored in the ROM portion of the NVRAM is brought into the RAM portion and is ready to use.

I/O 1 : This is an I/O bit that is used for future options. It is brought out through the expansion socket (U440 pin 4).

I/O 2 : This is an I/O bit that is used for control lines in future options. It is brought out through the expansion socket (U440 pin 5).

Both of the previously discussed circuits, the character display memory and the attribute display memory, are further accessed at $\overline{24K}$ as DMA memory. See further discussion under the "DMA" section.

The $\overline{28K}$ signal is ORed at U419D with the $\overline{WR}$ or $\overline{RD}$ (U402A or U408A) to produce the low level chip select signal required to access the NVRAM (U413).

Table 3
MEMORY MAP

ADDRESS LOCATION	USED FOR
0K–4K	Physically located in the expansion socket EPROM. It is internal to the microprocessor in later models.
4K–8K	External program firmware.
8K–12K	CRT controller registers.
12K–16K	Control signal latch.
16K–20K	Attribute display memory.
20K–24K	Character display memory.
24K–28K	DMA memory.
28K–32K	NVRAM memory.
32K–64K	The upper half of the memory map is completely open. All devices in the lower 32K of memory are disabled by an address above 32K. This opens the expansion socket for an infinite number of user-implementable options, or for future design options. All 16 address lines are available to the user to do the proper decoding, and insures the correct operation of all Terminal functions. The 0K decoding signal on pin 26 of this socket must not be used. This decoding is only used in earlier models, where the 0K–4K boundary is filled by external program memory.

DMA FROM VIDEO RAM TO CRTC

The DMA begins when the CRT controller (U422) interrupts (INTØ) the microcomputer (U409) because it needs data. Signalling this interrupt with BRDY at U422 pin 5 (a high on this output indicates that the CRT controllers are ready to receive display data), the CRTC uses the $\overline{BS}$ signal to fill one buffer with a row of video data into both CRT controllers. $\overline{BS}$, when low, enables the write function for video data into the row buffers.

Before DMA begins, the registers in microcomputer U409 are saved and all interrupts are disabled except the internal timer Ø interrupt. The attribute and characer display data is then loaded simultaneously into CRT controllers U422 and U446 from their respective memory chips. The firmware calculates and sets timer Ø (in the microcomputer) to count down at the approximate moment that the DMA should cease. When timer Ø is done, it causes an internal interrupt in the microcomputer to signal the microcomputer to resume normal activities. The microcomputer interrupts are then enabled and the firmware calculates the next line to be DMA'd and saves the value in system RAM (in the microcomputer).

The CRT controller has double buffering so that when the character display codes for the current display row are outputted from the row buffer just filled, the other row buffer is simultaneously being filled. After all lines are scanned, the buffers are swapped and the same procedure is followed for the next row. This process continues until all of the character rows are displayed.

Since the CRT controllers have double buffers and can have 80 characters DMA'd at a time into their row buffers, the microcomputer has increased access to the display memory. The double buffering allows the microcomputer an approximate 75% access time to the display memories versus the approximate 20% access time if the microcomputer access time were to be limited to the retrace portion of the video timing as in older terminals. The desired result of the DMA technique is reduced data bus contention at the display memories.

A major contribution to the speed in which the DMA is performed is due to the instruction 24 hex being forced onto the data bus when the address for DMA is decoded. The decoding of the DMA occurs in the 24K to 28K boundary of the memory map. Once the memory select decoder (U439) enables that portion of the memory map, the buffers (U405 and U406) that are hard-wired for the 24 hex instruction force that data onto the bus so that it is available to the microcomputer.

Instruction 24 hex translates to an "add immediately 24 hex to accumulator A". This instruction is used because it is non-destructive and causes it two fetches per cycle. Read signals are, therefore, continuously emitted and the program counter is continually bumped. The microcomputer is running on the primary data bus, but the actual DMA transfer is taking place on the secondary data bus and the alternate data bus. Data transfer is independent of microcomputer U409, but the timing of the transfer originates from the microcomputer.

CLEAR LINE DMA

A line is cleared through DMA in much the same way that character DMA is accomplished. The only difference in the instruction on the bus is that data bit 2 (bit 2) on U406 pin 10 changes from a 1 to a Ø under microcomputer control. This change causes the instruction to change from 24 hex to 20 hex, which is the instruction for "space". During clear line DMA, therefore, spaces (20H) are shifted into the character CRT controller (U422) row buffers and into the corresponding display memory positions.

Another feature about the instruction 20 hex is that the lowest four bits of data are zero. Since the attribute data bus only contains the lowest four data bits, the attributes that coincide with the spaces being shifted in are also cleared, and facilitate a line clear of characters and attributes.

NVRAM

The memory device (U413) used in the CPU circuit is called an NVRAM (Nonvolatable Random Access

Memory). This memory contains 512 bits of memory and is organized as a conventional 256-bit static RAM that is overlaid bit-for-bit with a non-volatile 256-bit electrically erasable PROM (programmable read only memory). This memory IC is capable of reads and writes when it is selected. The 3-state output buffer provides direct TTL compatibility. The $\overline{\text{STORE}}$ pin controls the modification of data in the NVRAM. A low applied to this pin initiates an internal automatic store operation. While this pin is held low, write enable and array recall are inhibited and the data pins are held in a high impedance state. These pins will not come out of this high impedance state until the store operation is complete, or until the store pin receives a logic high, whichever takes longer.

The circuit is designed to prevent unintentional initiation of a store cycle during power-up and power-down. During power-up or power-down, a pull-up resistor on the store line insures that the line follows the build-up of the power supply voltage. The non-volatile data that is stored in the NVRAM can be copied back into the RAM with the $\overline{\text{ARRAY RECALL}}$ pin. A logic low on this pin starts the recall cycle which, in a single operation, transfers the entire 256-bit NVRAM data bit-for-bit into the RAM portion of the memory. Any data existing in the RAM before the recall is lost, but the data in the NVRAM remains unaltered. A recall cycle can be initiated when the chip select line is high or low. When a recall is in operation, the activation of the $\overline{\text{STORE}}$ pin is inhibited. Once the data from the NVRAM is back in the RAM section of the IC, it can be accessed by normal read and write cycles. Data in the NVRAM portion of the memory remains valid even when the power supply is removed (Terminal turned off).

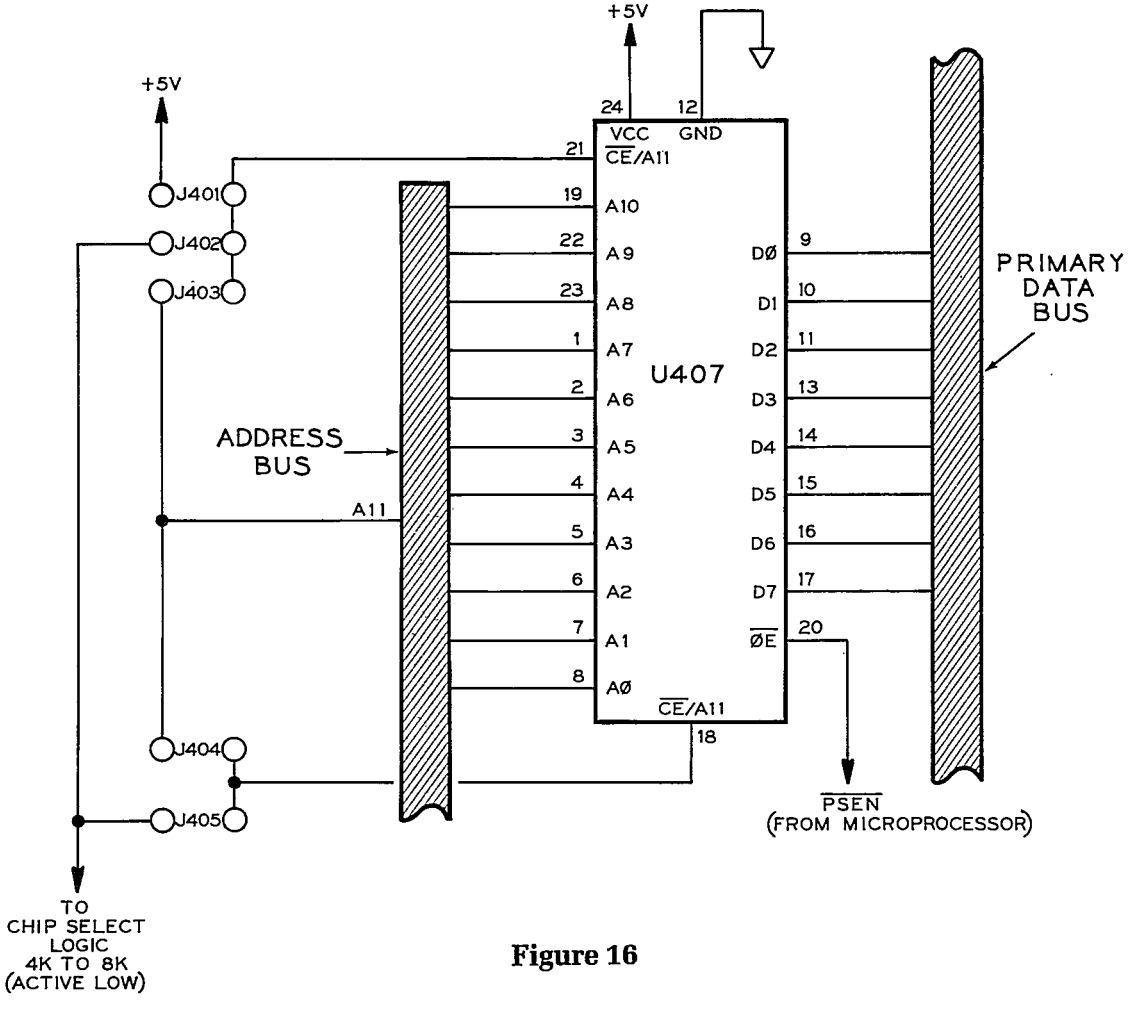


Figure 16

PROGRAM ROM

A 24-pin program ROM socket (see Figure 16) is available on the terminal logic circuit board at U407. Jumpers are provided so the socket can accept either a 2K or a 4K ROM or EPROM. The following chart shows the various jumper pinouts that are possible:

JUMPER INSTALLED	PIN USE
J401	Pin 21 is high.
J402	Pin 21 is the chip select.
J403	Pin 21 is address line A11.
J404	Pin 18 is address line A11.
J405	Pin 18 is the chip select.

For the circuit to operate properly, a jumper must be installed at either J401, J402, or J403, and at either J404 or J405. In addition, the access time for this chip should be a maximum of 350 nanoseconds to insure that, in the worst case, there are no timing errors.

EXPANSION SOCKET

A 40-pin expansion socket (see Figure 17) is available on the terminal logic circuit board (at U440). This socket may be used for future design options, or as the connection point for user-expandable options (in early models, pins 9 through 32 of this socket directly handles a 4K × 8 EPROM). The additional memory IC should be installed so that pin 1 of the IC is in socket pin 9 etc. Pins 1 through 8 and pins 33 through 40 are not used. In later models, this 4K of firmware is internal to the microcomputer and allows the entire socket to be used for other optional functions.

Unregulated +9.6 volts DC as well as +5, +12, and –12 volts DC is available at this socket. In addition, the socket has three I/O bits available, the full 8-bit data bus, the full 16-bit address bus, buffered read and write lines from the microcomputer, the reset line, the INIT SYNC signal, the $\overline{OE}$, and one memory map decoding signal available ($\overline{ØK}$).

Pin 26 of this socket decodes the ØK–4K boundary and is only used in early models to decode the 4K firmware EPROM. This pin must not be used for any other function. As noted earlier, the memory map of this Terminal is completely filled from ØK up to 32K. This leaves the entire second half of the memory map for user options. Address line A15 is available at pin 40 of this socket for decoding. When line A15 is a logic 1, the expansion socket may be used for options. When this line is a logic Ø, the basic Terminal is addressed. Any additional buffering of signals that are not used in Heath Company options are the responsibility of the user.

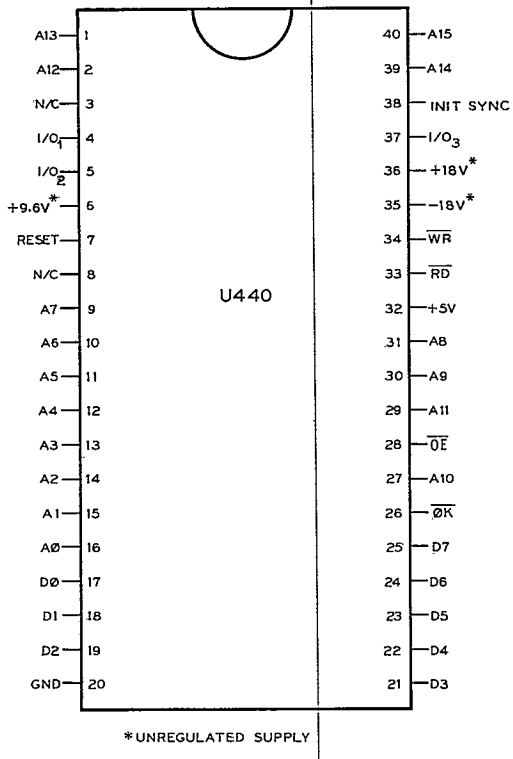


Figure 17

CLOCK CIRCUIT

The main oscillator clock circuit (see Figure 18, Illustration Booklet, Page 6) controls all of the time operations of the Terminal. It consists of an inverter (U427A) that is biased by resistors R408 and R409 to operate linearly. Crystal Y401 provides positive feedback to the inverter to generate a 14.784 MHz clock signal. Decoupling capacitor C411 prevents unwanted negative feedback from output to input, which would alter the oscillator frequency, and capacitors C410 and C412 provide impedance matching for the crystal. Inverter U427D buffers the high-frequency clock signal and provides the necessary current drive for the remainder of the clock circuitry. The remaining buffers inside U427 are not used, which prevents the high-frequency signal from being coupled into other circuits and reduces the radio frequency interference (RFI) levels of the Terminal.

The buffered 14.784 MHz clock signal is coupled to the dot clock circuit, the main processor clock, and the video timing and synchronization circuits. In the dot clock circuit, the signal is fed directly to the clock input of the shift register (U431) and the video latch (U433). This allows the video dots to be shifted out and latched at the 14.784 MHz rate. In the main CPU clock circuit, a D-type flip-flop (U420A) divides the high-frequency clock signal by two to produce a 7.392 MHz CPU clock signal. The remaining signal path is to the counter (U428), which divides the high-frequency signal by two, four, and eight for use in the video timing and synchronization circuits. The divide-by-eight signal is fed directly to the two CRT controllers (U422 and U446) and is used as the character clock. This signal is used because it matches the eight horizontal video dots per character cell.

Integrated circuit U419A NANDs the three signals from U428 and produces a signal that is used to clock U447 and signal the shift register (U431) to accept the parallel load of character data from character ROM U429. U447 is a high-speed Schottky integrated circuit that features synchronous edge-triggered flip-flops, along with an internal look-ahead carry. The high speed and synchronous triggering of these flip-flops is necessary for the precise video timing to function properly.

The 14.784 MHz clock is used so that the screen refresh could be programmed for exactly 50 or 60 Hz. Also, the 7.392 MHz clock rate for the CPU (14.784 ÷ 2) is ideal for the CPU's serial port baud rate generation, which is a divisor on the CPU clock. Refer to the "Serial Port" section for more information on serial port baud rate generation, and to "Character Generation" for further information about the screen refresh.

CHARACTER GENERATION

From CRTC to Screen Display

The heart of the character generator and display circuits is formed by CRT controllers U422 and U446. One of these controllers (U422) is initialized by the firmware to generate the raster timing. It produces the horizontal sync pulse (HRTC) and the vertical sync pulse (VRTC), sometimes referred to as Horizontal ReTraCe or Vertical ReTraCe pulses.

U422 also generates all the CRTC (cathode ray tube controller) to microcomputer signals such as BRDY and $\overline{BS}$, whose functions are explained below. The same CRTC (U422) operates on the character data while the other (U446) operates on the attribute data. Although this type of CRTC usually handles attributes on a field defined format (see Table 4), the use of the second CRTC (U446) allows the Terminal to use the attribute data on a per-character format. Both controllers are connected to the same clock circuit which provides the necessary synchronization.

Initialization of the CRT controllers must be complete before they can function properly. The information that is necessary for the controllers to display correctly is: type of cursor (underline, blinking underline, block, and blinking block), cursor home position, all video control information, and synchronization timing. This information is located in the initialization firmware or provided in the Setup memory. The CRTC clocks are stopped (U409 pin 8) until the initialization is complete.

The CRT controller is used to determine when data should be transferred from the display RAM to the character generating circuitry. The five control lines that are used for the transfer of data on the data bus, both to and from one of the internal registers are:

BRDY — Buffer ready. This output signal indicates that a row buffer is ready for the loading of character data. This output is inverted and sent to pin 12 (P3.2) of microcomputer U409, where it is used to initiate DMA.

$\overline{BS}$ — Buffer select. Input signal enabling the write signal for character data into the row buffers.

$\overline{RD}$ — Read input. A control signal used to read the registers.

$\overline{WR}$ — Write input. A control signal used to write commands to the control registers or to write data into the row buffers.

$\overline{CS}$ — Enables the read of the status registers or the write of command, paramters, or data.

Table 4
FIELD ATTRIBUTES

VSP — Video suppression on output (for blink).

HGLT — Highlight output.

RVV — Reverse video output.

LTEN — Light enable output (for underline).

GPØ, GP1 — General purpose outputs.

For further information on the DMA transfer of data to the CRT controller, see the "DMA" section on Page 35.

ATTRIBUTES

All character data, attributes, and synchronization pulses are supplied from the two CRT controllers directly to the video logic. The underline attribute, if set (active high), allows the tenth scan line in that particular character cell to be decoded through the line count (LC) outputs of the controller. The LC3, LCØ, and underline bits are fed to 3-input NAND gate U419C as a high that forces the output low. This output is inverted by U424D and then OR'ed with the blink attribute in U430B. If the blink attribute is not set, or if it is in an off blink position, the underline information passes through. If the blink attribute is set, it turns off the underline and creates the blink effect until the blink line returns to the low state, allowing the video information to pass through. The blink line continues to toggle in this fashion as long as the blink attribute is set. The blink rate is controlled by the microcomputer via BL signal (U416 pin 5) and can be varied.

The underline is then exclusive OR'ed with the cursor information (in U43ØC) coming from the LTEN and RVV pins of the CRT controller for the underline and block cursor. Exclusive OR'ing the underline and cursor signal enables the normal video cursor to be visible through the underline by blinking it for that interval. Next the information is exclusive OR'ed (by U430D) with the reverse video attribute. This disables the underline information, so it is visible as a blank line through the reverse video information in that character cell. The video information is now logically AND'ed (by U421D) with the inverted HRTC and VRTC control lines from the controller. This causes all video to be suppressed during horizontal and vertical retraces. The VSP output of the controller (which is normally used for retrace suppression) is not used here, since it would also blink the first and last scan lines of each row. This would not work well with graphic characters that must connect from one row to the next.

SYNCRHONIZATION

The next step is to latch the video information so that the reverse video information from U421D, the half-intensity attribute (fed directly from the second CRT controller to the latch), and the horizontal and vertical retrace control signals can be synchronized exactly. The reverse video output of the latch is exclusive OR'ed (by U430A) to create the reverse video of the characters. This information is again latched with the half-intensity attribute and the horizontal and vertical retrace control signals. All of the video information is now present at the open collector AND gates (U434A, B, C, and D) at exactly the same time. This exact timing allows the circuit to directly drive the video circuit board.

Since there is no delay from the end of a line of characters to the horizontal retrace pulse going active, no delay can occur for the vertical pulses with respect to the end of the screen. The open-collector gates increase the drive capability, increase the noise immunity, and increase the rise and fall times of the video dots. This creates crisper dots and improves the overall video picture. The open-collector gates also enable the half-intensity attributes to be obtained by a resistor divider network using only the pull-up resistors.

FROM CHARACTER ROM TO SCREEN

The CCØ through CC6 outputs of the controller contain the character code information coming from the row buffers. These outputs, along with the line count outputs, form the 10 address lines for the character generator ROM (U429). Address line A11 selects from the upper or lower 2K of the character ROM (selects between a standard and an alternate character set). Once the ROM presents the valid data on its bus, the eight bits of information are latched into the shift register (U431) on the low pulse (U431 pin 7) that is derived from the dot clock (U427D). The video characters are suppressed by the blink attribute or the retrace control signals (U430A). Then these three signals are logically OR'ed together (U426 B and C) and then logically OR'ed (U426D) with the clock signal that creates the load action of the shift register. If any of the control signals (the blink attribute or vertical or horizontal retrace) are active through the chain of OR gates, the load bit (U431 pin 15) of the shift register is held high and disables the load function of the shift register. This shifts out zeros that translate into video blanks.

Dots are shifted at the main clock frequency of 14.784 MHz. This clock rate, along with the timing controls from the controller, enables the screen to be refreshed at exactly 60 Hz intervals and ensures that the screen displays a steady frame without beating with the line frequency. Both domestic and foreign models are capable of 60 Hz refresh. 50 Hz refresh, however, requires the addition of an addressable latch. Four lines of unused video must be added and blanked (lines 26, 27, 28, and 29). The controller only has the ability to control the vertical retrace times at an accuracy of 1, 2, 3, or 4 row times. In order to change the screen refresh rate without drastically altering the horizontal scan frequency or changing the dot clock circuitry, extra rows are added. These extra rows effect the video exactly as added vertical retrace lines would.

The addressable latch (U432) blanks the video at the proper time by decoding the line count for the first scan line. If there is a disable video command (U412D) coming from microcomputer U409 pin 3 at the same time, it is gated with the video before it is displayed (U434A) and causes the video to be blank. This occurs because the line count changes during horizontal retrace and so line zero can be decoded before the line begins. If the video command is present at the beginning of the row, the entire row is blanked even if the disable video command goes inactive before the line count changes to zero again.

U423 is specifically used to blank rows 26, 27, 28, and 29 on the screen (these are the rows that are added to achieve 50 Hz refresh). In addition to blanking the extra rows, this circuit accomplishes the screen-saver function, which is selected in Setup. This function disables the video after 15 minutes of inactivity to save screen phosphor. The screen reappears as soon as any key on the keyboard is pressed. The shift key is suggested, as it does not affect the screen as would a character or cursor function.

VIDEO CIRCUIT BOARD

Refer to the Video Circuit Board Schematic as you read the following paragraphs.

Contained on the video circuit board are the horizontal and vertical sync circuits, the high voltage circuit, and the video driver circuit. Each of these circuits will be described separately.

HORIZONTAL SYNC CIRCUIT

The horizontal sync signal from the terminal logic circuit board enters the video circuit board through pin 6 of plug P101. It is coupled through capacitor C101 and resistor R101 to the base of transistor Q104. This transistor inverts the positive HRTC pulse to provide the negative trigger pulse to integrated circuit IC101.

IC101 is a type 555 timer which, with its associated circuitry, form an astable free-running oscillator. When power is first applied, capacitor C107 has no charge, so the trigger and threshhold inputs of the timer are low. This triggers the timer and establishes a charge/discharge path through resistors R109 and R113. Diode CR102 provides a duty cycle of less than 50%, so the charge-path for C107 is through R109 and the diode, while discharge occurs through R112. With the comparator trip points occurring at nominal levels of +8 volts for the threshhold input and +4 volts for the trigger input, the oscillator provides a stable horizontal sync signal. Capacitor C106, connected from the control voltage input to ground, provides further immunity to noise that could cause timing errors.

Horizontal driver transistor Q102, coupled through transformer TX101, provides the drive for horizontal output transistor Q103. Being direct-drive, there is zero-delay with respect to the end of a video line, providing good synchronization without the need for a phase control.

A shunt-series width coil presents a constant total inductance to the circuit, even for different widths. This is because the inductance of the shunt portion varies inversely with the series portion. Since the total inductance remains constant, the high voltage also remains constant and results in a more predictable raster size.

Horizontal output transformer TX102 steps up the sync driver signal to provide second anode and bias voltage for the CRT, as well as focus and blanking voltages. A diode inside the transformer rectifies the high voltage before it is applied to the second anode.

Two voltage sources are generated in the horizontal sweep circuit. One is the +40 volts from CR111, C122, and R132, through CR401 to the video output circuit. The other is +500 volts from CR106, R108, and Focus control R148 to supply focus and G2 voltage to the CRT.

VERTICAL SYNC CIRCUIT

The vertical sync signal from the terminal logic circuit board enters the video circuit board through pin 9 of plug P101 and is coupled through resistor R301 and capacitor C301 to the juncture of R302 and R303. Resistor R302 and diode CR301 provides bias and assures that only the negative edge of the sync pulse is applied to the vertical oscillator.

Transistors Q301 and Q302 simulate the action of a silicon-controlled rectifier (SCR), as just a small change in collector voltage at Q302 will cause both Q301 and Q302 to saturate. Once saturated, they charge capacitor C303 to the voltage on C304. Being a relaxation oscillator with the voltage on C303 being bled off by various resistors in the circuit, oscillation begins when this voltage drops to a predetermined point. As the sync signal is injected before this point, a sawtooth waveform is created on capacitor C303.

Transistors Q303 and Q304 serve as a voltage amplifier for the synchronized vertical signal, while transistors Q306 and Q307 provide current gain with their emitters connected to the vertical deflection yoke. Current developed in the vertical yoke is sensed by resistor R331 and fed back via C307 to the emitter of Q303, making its emitter and base essentially equal except for the 0.7 volt junction drop.

Vertical linearity is maintained by a feedback circuit for "S" correction between the yoke and the emitter of transistor Q303. This circuit integrates the parabolic waveform that appears on capacitor C316, creating a small sine wave which is also fed to the emitter of Q303, resulting in the correct "S" shaping waveform on resistor R331 and good linearity. Transistor Q308 provides vertical interval retrace.

VIDEO DRIVER

The video input signal from the terminal logic circuit board enter the video circuit board at pin 8 of plug P101 and is coupled through resistor R409 to the base of transistor Q402. Since Q402 is in the emitter circuit of Q401, a large voltage swing is developed across Q401 and Q402 to drive the cathode of the cathode ray tube (CRT) with the video signal.

KEYBOARD ASSEMBLY

Refer to the Keyboard Schematic as you read the following paragraphs.

NOTE: Circuit component designations used in the keyboard assembly may differ from Heath standards because the circuit board was purchased preassembled.

The keyboard assembly is connected to the monitor portion of the Terminal through a 6-conductor coiled cable. Pin 1 of the connector supplies +9.6 volts DC from the power supply circuit board (via the terminal logic board) to the keyboard assembly, where integrated circuit Z6 regulates this at +5 volts for use by the keyboard circuits. Pin 6 provides the return ground connection for the voltage supply.

Integrated circuit Z1 is a totally self-sufficient 8-bit parallel microcomputer. This IC features a 1K × 8 program memory ROM, a 64 × 8 data memory RAM, an 8-bit timer event counter, an internal oscillator and clock circuit, and twenty one I/O lines. These I/O lines are quasi-bidirectional interfaces, which allow buffered outputs and inputs. A logic low written to these ports causes a pull-down device to sink an external TTL load. A logic high creates a current through the pull-up device to allow fast data transfer. After less than one instruction cycle, the initial device is turned off and a small pull-up device maintains the high level indefinitely. Any data written can also be read, in that by writing a high to any pin, that pin can serve either as a true high level latched output pin or as a pull-up resistor on an input.

The microcomputer (Z1) acts as a keyboard encoder and port. It determines which key was pressed, according to the logic levels on ports A, B, and C. Port C is used as an output port to select a keyboard line to be pulled low. This is accomplished via the 4-line to 16-line demultiplexer chip (Z2). If a key matrixed on this line is pressed, a low logic level will appear at the corresponding port A bit. The microcomputer ROM program will then activate the output port to the terminal logic board to send the appropriate ASCII value. The appropriate ASCII value will also depend on the status of the bits at port B (pins 18 - 20) BØ - B2, since these bits may indicate a control type of key is also pressed.

The microcomputer also processes the information it receives to send a logic low to the appropriate port bit (B4 - B7) to either cause an LED (L2 - L4) to be lit or the timer to be initialized to cause transducer T1 to be sounded at the appropriate intervals (click vs. beep). The integrated circuit that operates the transducer directly does not have a component designation on the printed circuit board, but can be identified by its 8-pin package size.

At microcomputer port B, bit B3 (pin 21) and the timer bit (pin 13) pass back and forth between the terminal logic board in the monitor and the keyboard microcomputer (Z1). The terminal logic board supplies data flow control information to the timer bit (Z1 pin 13). This is the important handshaking signal that synchronizes data between the CPU on the terminal logic circuit board and the microcomputer in the keyboard assembly. ASCII data from port B bit B3 (Z1 pin 21) is inverted by Z4 and buffered by Z5 before it is sent over the coiled cable.

Keyboard reset information is sent over pin 2 of the connector. This reset is activated when the Shift and Reset keys are pressed simultaneously. The outputs of these two keys are logically NOR'ed, which presents a high when both are depressed. When a key is released, the circuit opens and the outputs are pulled high by pull-up resistors. Whenever one of these keys is depressed, it closes the circuit and ties the output to ground. The reset signal is inverted (by Z4) and buffered (by Z3) before it is sent over the cable to the terminal logic circuit board. The inverting is done to produce an active low, which ensures that the Terminal cannot be reset if the keyboard cable is unplugged. A pull-up resistor on the terminal logic circuit board pulls the unconnected reset line up to +5 volts.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part titled "General Troubleshooting Information," only pertains to your Terminal if you built it from a kit. It describes what to do about difficulties that may occur during or right after you assemble the Terminal.

The second part, titled "Troubleshooting Chart," lists problems or conditions that might occur. The "Possible Cause" column lists the components associated with the problem. This will help you relate a problem to the Schematic and Circuit Description.

Refer to the "Circuit Board X-Ray Views" (Illustration Booklet, Pages 7 and 8) for the physical location of parts on the circuit boards.

GENERAL TROUBLESHOOTING INFORMATION

NOTE: The following checks will be most effective if you apply them to one part of the kit at a time.

1. Refer to your Assembly Manual and recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by carefully inspecting the connections to make sure they are soldered as described in the "Soldering" information at the beginning of the Assembly Manual. Reheat any doubtful connections. Be sure all wires are soldered at places where several wires are connected.

3. Check each circuit board foil to be sure there are no solder bridges between adjacent connections. Remove any solder bridges by holding a clean soldering iron tip between the two points that are bridged until the excess solder flows **down** onto the tip of the soldering iron.

4. Check each resistor value carefully. A resistor that is discolored, or cracked, or shows any sign of bulging would indicate that it is faulty and should be replaced.

5. Be sure each diode is carefully installed with the banded end positioned correctly.

6. Check all component leads connected to the circuit boards. Make sure the leads do not extend through the circuit board and come in contact with other connections or parts.

7. The components listed in the "Possible Cause" column of the "Troubleshooting Chart" are the most likely causes (but not necessarily the only cause) of a problem. When you check these components, look first for the following items:

   — Parts installed incorrectly or backwards. This pertains especially to diodes, electrolytic and tantalum capacitors, and integrated circuits.

   — Unsoldered or inadequately soldered parts. Reheat the connections in the area of a problem.

   — Incorrect or interchanged parts. Check the part numbers on the diodes and integrated circuits.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your "Warranty" is located inside the front cover.

TROUBLESHOOTING CHART

The following chart lists conditions and possible causes of several specific malfunctions. If a particular part is mentioned (Q213 for example) as a possible cause, check that part and other components connected to that part to see that they are installed and/or wired correctly. Also check for solder bridges and poor connections in the surrounding area. It is also possible, on rare occasions, for a part to be faulty and require replacement.

The chart is divided into two sections. First is "Terminal Problems" which could result from improper assembly, wiring, or adjustment, or from a faulty component. The second is "Operating Problems" that might result from improper setup of parameters.

TERMINAL PROBLEMS

CONDITION	POSSIBLE CAUSE
Nothing happens at turn-on (Power-On LED not lit).	1. Line cord not plugged in. 2. Power switch not turned on. 3. Fuse missing or blown. 4. Poor connection on RF Trap circuit board. 5. Power transformer and its connections. 6. Coiled cable not connected to keyboard or monitor. 7. Keyboard not connected to terminal.
Blank sceen, (LED lit).	1. Brightness control. 2. Screen Saver option enabled. 3. Power supply. 4. Terminal logic board. 5. Video board. 6. Cathode ray tube.
Bright screen.	1. Brightness control. 2. Video board or brightness control. 3. CR107. 4. Q401, Q402 and associated circuits.
Poor focus.	1. Adjust Focus control R148. 2. Insufficient high voltage. 3. CR106, CR107.
Insufficient width.	Adjust Width coil L101.
No vertical deflection (horizontal line only).	Q304, Q305, Q306 or associated circuits.
Vertical unstable.	Q301, Q302 or circuits.
Fuse blows.	1. Power supply diodes D101 – D112. 2. Wiring of power supply plugs. 3. U101 shorted. 4. Capacitors C101, C102, C104. 5. Cable S102 to S405 miswired.
CRT filament not lit.	1. +12-volt supply. 2. Wiring of brown or black CRT wires. 3. Filament open. 4. CRT socket incorrectly installed (rotated).
No CRT anode voltage. CAUTION: Use a high voltage probe to measure CRT anode voltage.	1. +12-volt supply or its connection to deflection board. 2. Q103. 3. Horizontal output transformer or circuits.

OPERATING PROBLEMS

The following problems could result from an operating error such as improper programming, wrong "Setup" of parameters, etc. Refer to the "Operation" section of this Manual and check the "Setup" menus to see if baud rate, parity, duplex, line frequency, and other parameters are properly set.

PROBLEM	POSSIBLE CAUSE
Strange or wrong characters appear on screen.	1. Wrong Terminal mode. 2. Wrong communications mode (baud, parity, duplex, etc.).
Lines on screen appear wavy.	Wrong line frequency selected during Setup.
Monitor does not respond to the keyboard.	1. On-Line (under host control and full duplex). 2. Keyboard locked—reset. 3. Coiled cord disconnected.
Unable to alter Setup modes.	Optional "hardware" setup feature installed. See Page 23 and reconnect J406 (remove J407).

SHIPPING INFORMATION

In an extreme case where you are unable to resolve a difficulty, you may want to take your Video Terminal to your local Heathkit Service Center or ship it to the Heath Company.

If you can isolate the problem to a particular circuit board, take (or send) only that circuit board for repair. This will save shipping cost and service expense.

Whenever possible, take your Video Terminal (or circuit board) to your local Heathkit Electronic Center for service. Consult your Heathkit Catalog for the locations of the Electronic Centers.

However, if it becomes necessary to ship the complete unit to the Heath Company, refer to the "Customer Service" information inside the rear cover of the Manual and securely pack the Video Terminal. Be sure to close the top and latch it in place.

IMPORTANT: Include the following information with your Terminal. It will be helpful in diagnosing and repairing your unit.

A. The problem you are having.

B. Name and model of your computer system.

C. Baud rate.

D. System configuration.

E. Any additional information that will help describe your system.

VIDEO ADJUSTMENTS

If, after a period of time, your monitor should require adjustment, use the following procedure.

Refer to Figure 19 for the locations of the controls and adjustments on the video circuit board and the neck of the CRT.

1. Connect the keyboard to the monitor.
2. Preset the BRIGHTNESS control on the rear panel to the center of its rotation.

WARNING: When the Terminal is plugged in and turned on, high voltage is present on the back of the CRT and on the video circuit board.

3. Plug the line cord into the proper AC outlet.

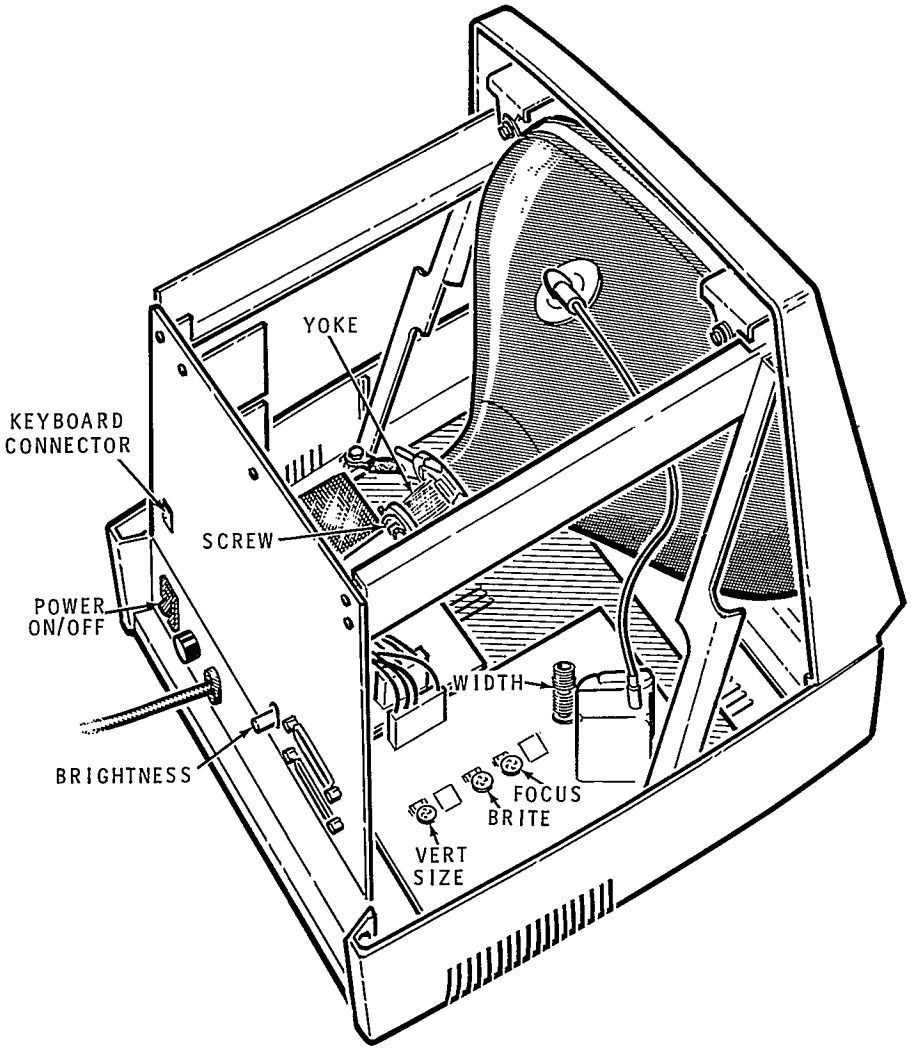


Figure 19

4. Push the POWER switch on the rear panel to ON. The Power On indicator on the keyboard should light and you should hear a short "beep." After a few seconds, the cursor will appear near the upper left corner of the screen. A display may also appear near the bottom of the screen. If it does, it will display the time (beginning at 0:00:00) and one or more other messages, such as CAPS LOCK, OFF LINE, or INSERT MODE.

NOTE: For the best results, perform the following adjustments in a dimly lit room.

5. Turn the BRITE control, on the video circuit board, until a large portion of the screen becomes bright. Then turn the control counterclockwise until this bright area just completely disappears.

6. Press the SET UP key on the keyboard. The bottom line of the screen will display:

```
**SETUP MENU A**  (VER 1.XX)  1. on line
MENUS -A- to -G- or -T- for TABS
(XX × latest version)
```

7. Press the G key on the keyboard. The bottom line of the screen will display:

```
*MENU G*  1. CHAR SET normal  2. FILL SCREEN
3. ATTRIBUTES  4. TEST
```

8. Press the 2 key on the keyboard. The screen will fill with E's.

9. Adjust the BRIGHTNESS control on the rear panel until the display is at a comfortable brightness level. Do not make the display too bright, as the screen phosphors may be damaged by too much brightness and "burn" the screen.

10. Remove any foam magnets that may be present on the yoke posts.

11. If necessary, loosen the indicated screw and rotate the deflection yoke until the edges of the display are vertical and horizontal. Then retighten the screw. Do not be concerned if the display is not centered on the screen at this time.

12. Adjust the FOCUS control, on the video circuit board, until the display characters are as sharp as possible in an area half way between the center and either side of the screw.

13. Adjust the centering rings on the deflection yoke to the position that best centers the display on the screen.

14. Adjust the WIDTH COIL, on the video circuit board, until the display nearly fills the width of the screen. Allow approximately three-fourths of an inch of screen outside the edges of the display.

15. Adjust the VERTICAL SIZE control, on the video circuit board, for a one-half inch border at the top and bottom of the screen.

16. Readjust the centering rings, if necesary, to center the display on the screen.

17. Locate the one area of the four edges of the display that is the least straight. Install a foam magnet on the yoke post that is nearest to the greatest bow in the display. Rotate the magnet slowly until the display is as straight as possible, with square corners.

18. Repeat this procedure as necessary all around the yoke at any of the eight locations which require straightening. The closer the magnets are to the CRT, the greater the effect they will have. Install only those magnets that will adequately correct the bowing and display a uniform rectangular-shaped display. NOTE: If you only want a little effect, you can reduce the magnets in size by cutting them with a pair of diagonal cutters, or moving them furhter out on the posts.

19. Simultaneously press the SHIFT and RESET keys on the keyboard to clear the screen.

20. Push the POWER switch on the rear panel to OFF. Then unplug the line cord.

21. Reinstall the cabinet top on the monitor.

This completes the "Video Adjustments."

USER MAINTENANCE

Your H-29 Terminal was designed to be as maintenance-free as possible. To clean the cabinet, use a damp lint-free cloth. WARNING: Do not use a liquid or spray solution on your Terminal. High Voltage is present inside the cabinet and you may create a serious shock hazard.

Do not block the ventilation slots by placing papers, folders or other objects on top of or under the Terminal.

Make sure paper clips or other small objects do not fall into the ventilation slots in the cabinet or the openings around the keys. This can cause a serious malfunction and/or damage to your Terminal. Do not attempt to plug **either** end of the keyboard cable into a conventional telephone company modular outlet! It can damage telephone company equipment. Also, voltages present at the telephone company's outlet will seriously damage the Terminal or the keyboard and will void your warranty.

SEMICONDUCTOR IDENTIFICATION

This section is divided into two parts; "Component Number Index" and "Part Number Index." The first section provides a cross-reference between semiconductor component numbers and their respective Part Numbers. The component numbers are listed In numerical order. The second section provides a lead configuration detail (basing diagram) for each semiconductor Part Number. The Part Numbers in the second section are also listed in numerical order.

COMPONENT NUMBER INDEX

This index shows the Part Number of each semiconductor in the Computer.

POWER SUPPLY CIRCUIT BOARD

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER
D101–D108	57-65
D109–D112	57-42
U101	442-739

VIDEO DRIVER CIRCUIT BOARD

Diodes

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER
CR102	234-299
CR104	234-264
CR106	234-263
CR107	57-27
CR109	234-265
CR111	234-263
CR112	234-267
CR301	234-266
CR302	234-299
CR303	234-299
CR304	234-267
CR401	234-267

Transistors — IC

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER
Q102	234-270
Q103	234-276
Q104	234-275
Q301	234-275
Q302	234-274
Q303	234-274
Q304	234-270
Q306	234-272
Q307	234-271
Q308	234-270
Q401	234-273
Q402	234-290
IC101	442-153

TERMINAL LOGIC CIRCUIT BOARD

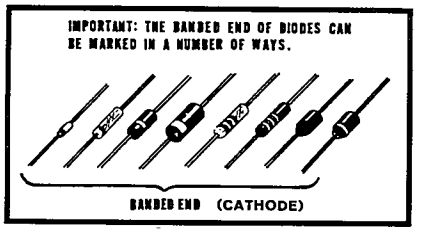
Diode — Integrated Circuits

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER
D401	56-56
U401	443-794
U402	443-875
U403	443-795
U404	443-799
U405	443-857
U406	443-857
U407	444-135
U408	443-780
U409	443-1025
U410	443-755
U411	443-805
U412	443-755
U413	443-1041
U414	443-728
U415	443-780
U416	443-879
U417	443-1027
U418	443-875
U419	443-797
U420	443-730
U421	443-780
U422	443-1068
U423	443-857
U424	443-755
U425	443-780
U426	443-875
U427	443-755
U428	443-924
U429	444-136
U430	443-915
U431	443-892
U432	443-804
U433	443-983
U434	443-89
U435	442-644
U436	442-646
U437	442-54
U438	442-54
U439	443-877
U440	444-134
U441	443-780
U442	443-885
U443	443-875
U444	443-764
U445	443-764
U446	443-1068
U447	443-983

PART NUMBER INDEX

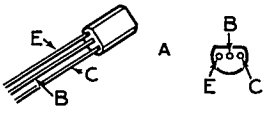
This index shows a lead configuration detail (basing diagram) of each semiconductor part number.

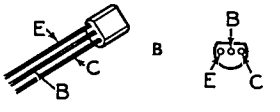
DIODES

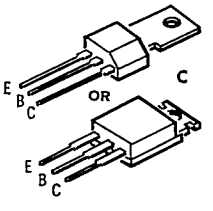
HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
56-56	1N4149	10 mA, 75 V	
57-27	1N2071	SI rectifier 1 A, 600 V	
57-42	3A1	SI rectifier 3A, 100 V	
57-65	1N4002	SI rectifier 1A, 100 V	
234-263	103 00323 04A	Diode 750 mA, 1.1 V	
234-264	103 00298 03A	Diode 1.5A, 1.2 V	
234-265	103 00339 02A	Diode 3A, 1.6 V	
234-266	103 00279 23A	Diode	
234-267	103 00254 01	Diode	
234-299	103 00142 01	Diode	

TRANSISTORS

HEATH PART NUMBER	MAY BE REPLACED WITH	BASING DIAGRAM	LEAD CONFIGURATION (TOP VIEW)
234-270	121 00819	B	
234-271	121 01035	A	
234-272	121 01036	A	
234-273	121 01058	C	
234-274	121 00699	B	
234-275	121 00975	B	
234-276	121 01070	D	
234-290	121 00895 SPS907	B	







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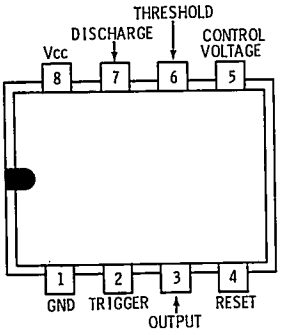
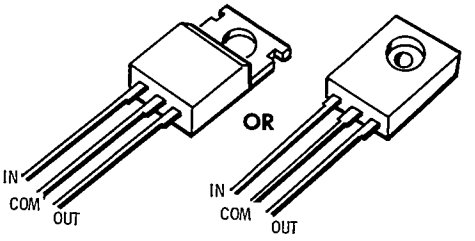
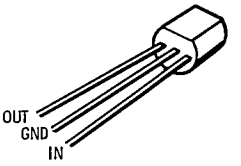
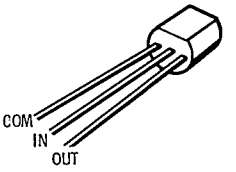
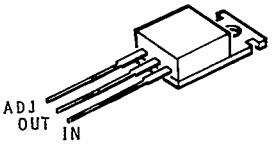
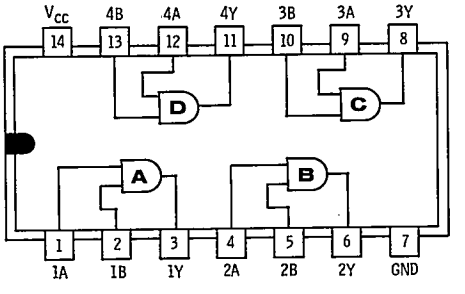
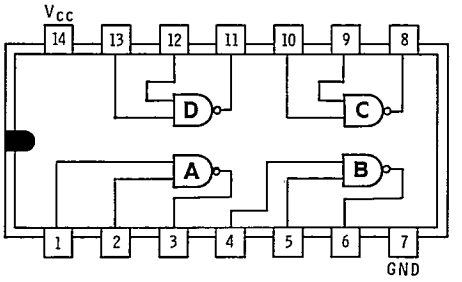
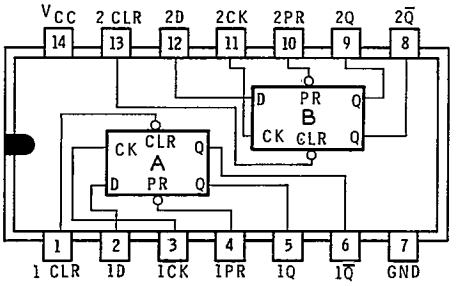
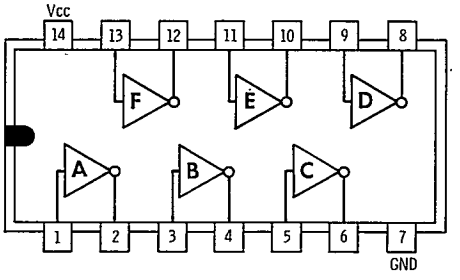
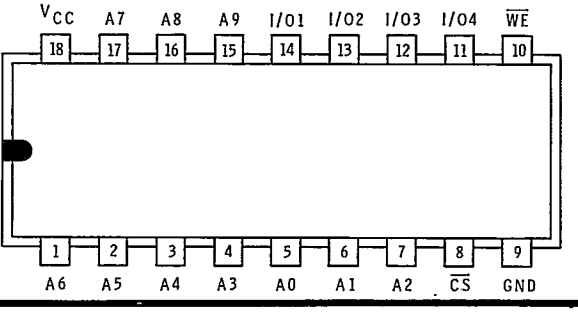
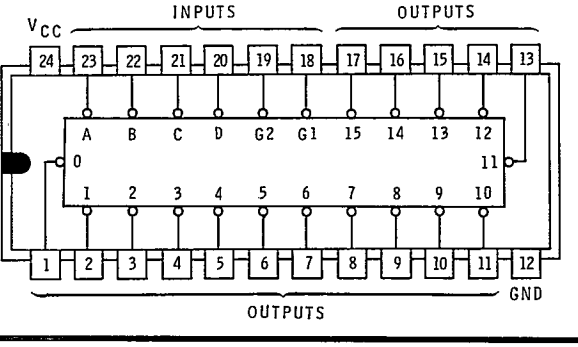
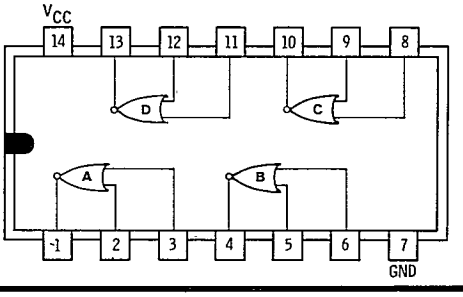
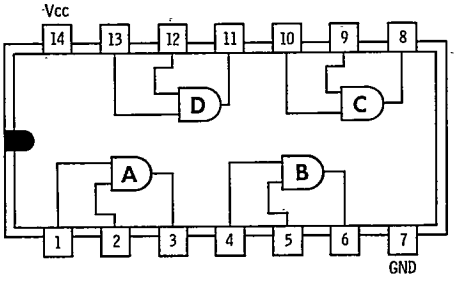
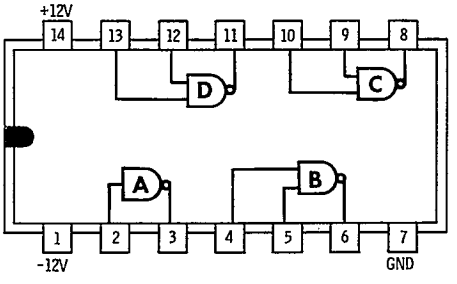
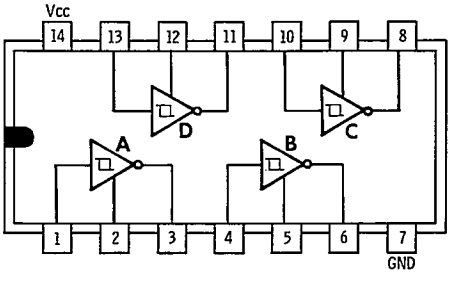
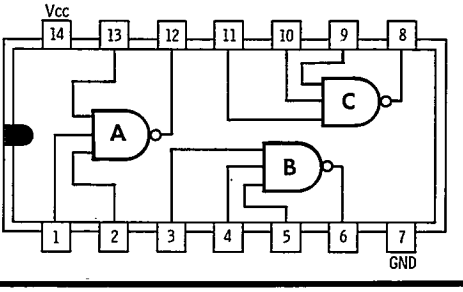
INTEGRATED CIRCUITS

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
234-269	442-53	555 Timer	
442-54	7805	+5V Regulator	
442-644	78L12	+12V Regulator	
442-646	79L12	–12V Regulator	
442-739	LM3501	Regulator	
443-89	SN7409	Quad 2-input AND gate	

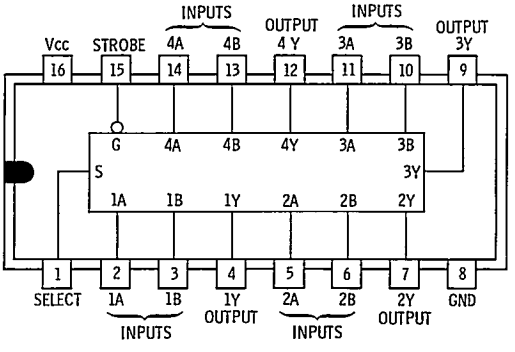
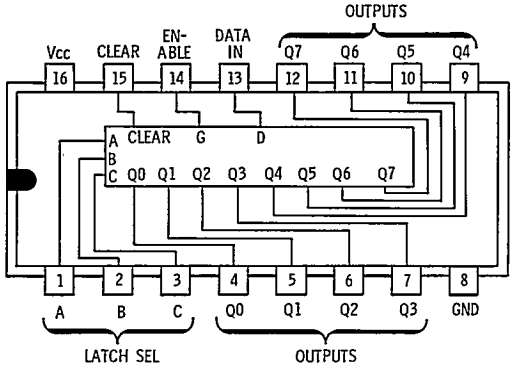
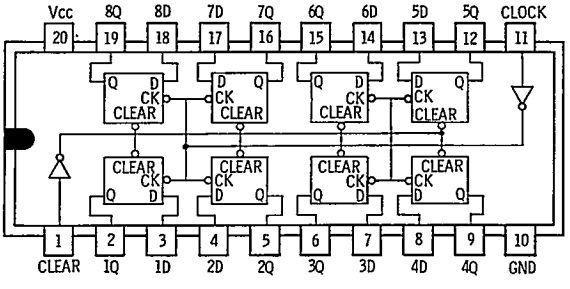
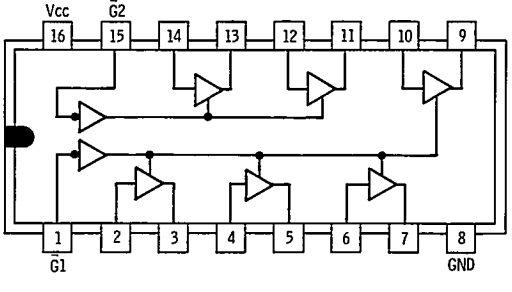
INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
443-728	74LS00	Quad 2-input NAND	
443-730	74LS74	Dual D flip-flop	
443-755	74LS04	Inverting Hex buffer	
443-764	2114	1k × 4 RAM	
443-768	74159	4-line to 16-line Decoder/ Demultiplexer	

INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
443-779	74LS02	Quad 2-input NOR	
443-780	74LS08	Quad 2-input AND	
443-794	75188 04 1488	EAI driver	
443-795	75189 04 1489	EIA receiver	
443-797	74LS10	Triple 3-input NAND	

INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
443-799	74LS157	Quad 2-line-to-1-line multipliers	
443-804	74LS259	8-bit latch	
443-805	74LS273	Octal D flip-flop with clear	
443-857	74LS367	Hex bus drivers	

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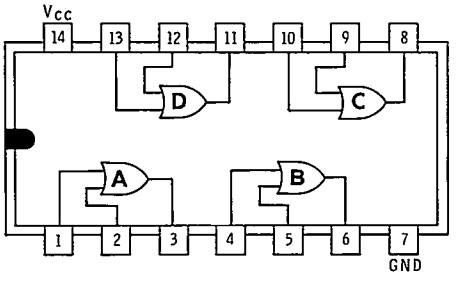
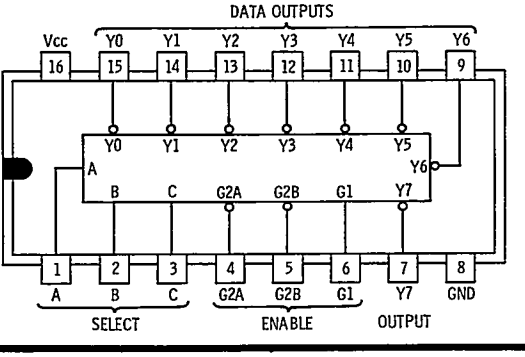
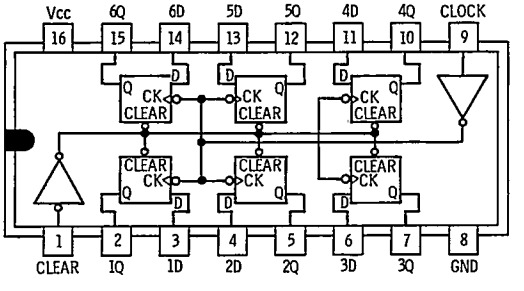
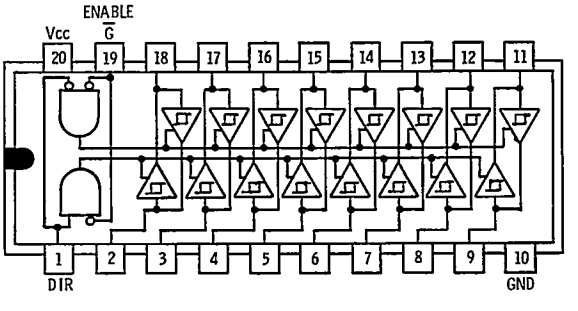
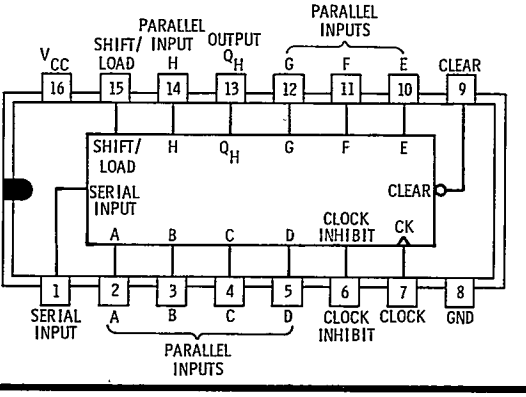
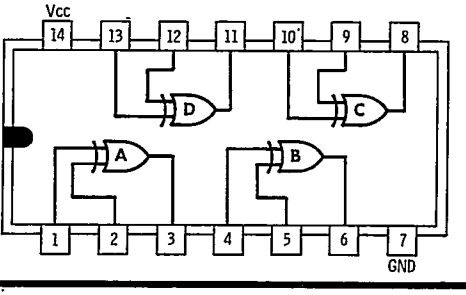
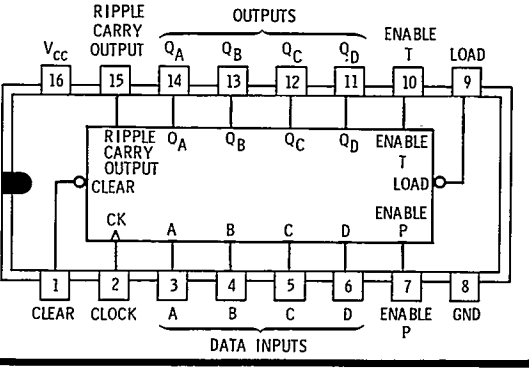
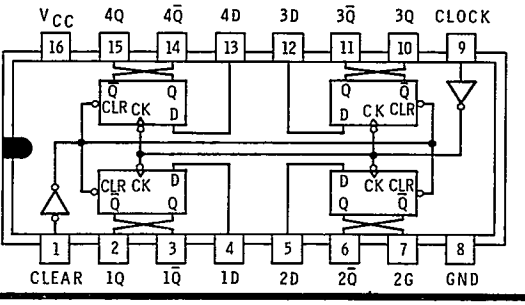
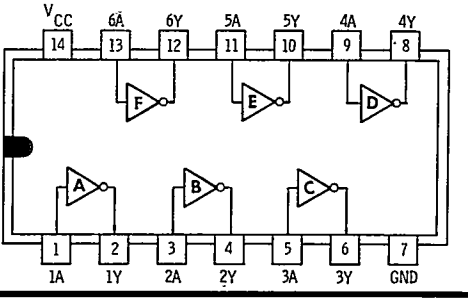
INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
443-875	74LS32	Quad 2-input OR	
443-877	74LS138	3-to-8-line decoder	
443-879	74LS174	HEX D FF decoder w/clear	
443-885	74LS245	Octal bus tranceiver	

INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
443-892	74LS166	8-bit shift register	
443-915	74S86	Quad 2-input Exclusive—OR	
443-934	74S163	Binary counter	
443-983	74S175	Quad D FF w/clear	
443-1020	7407	Hex Buffer w/open collector outputs	

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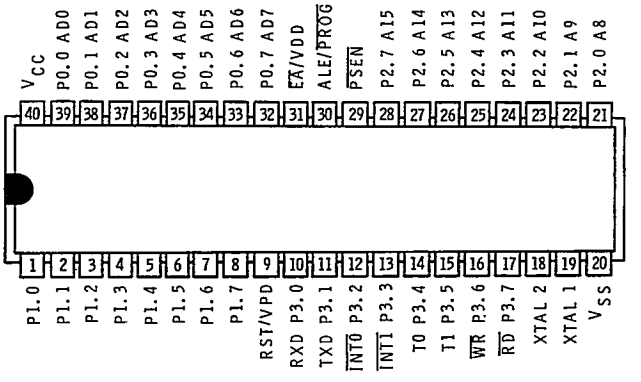
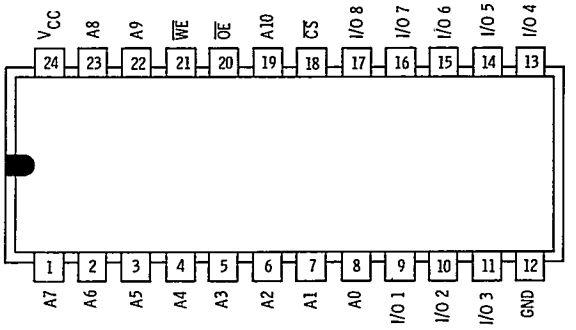
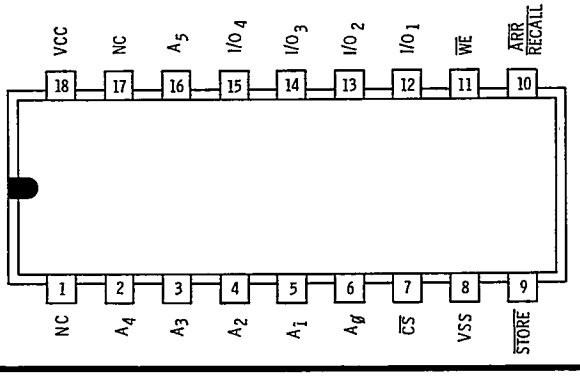
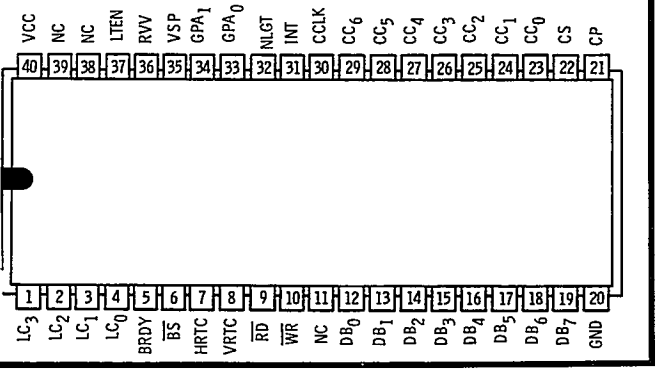
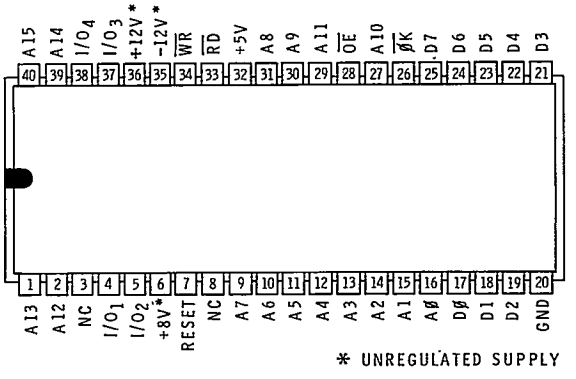
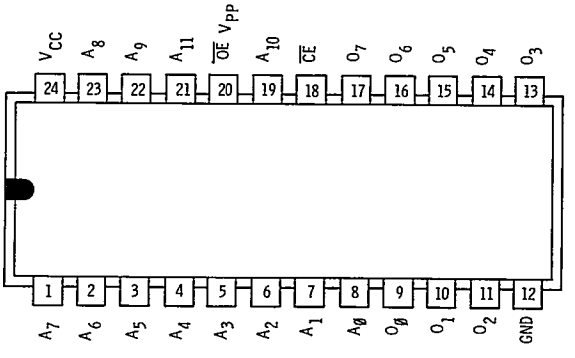
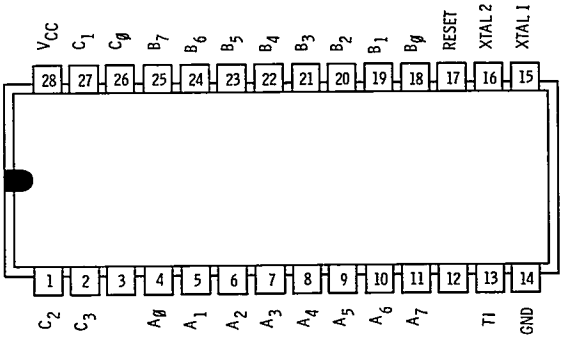
INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
443-1025	8031	Microcomputer	
443-1027	6116-P4	2k × 8 200 NS RAM	
443-1041	2210-30	NMOS NVRAM	
443-1068	8276	NMOS CR7 Controller	

INTEGRATED CIRCUITS (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	LEAD CONFIGURATION (TOP VIEW)
444-134	444-134	4k × 8 Programmable ROM (2732A-2)	
444-135	444-135	4k × 8 Programmable ROM (2732A-2)	
444-136	444-136	4k × 8 Programmable ROM (2732A-3)	
444-100	444-100	Keyboard Encoder (8021)	

Appendix A

ASCII CODE INFORMATION

ASCII CONVERSION CHART

OCT	DEC	HEX	ASCII	KEYS	DESCRIPTION
000	0	0	NUL	CTRL-@	Null, tape feed.
001	1	1	SOH	CTRL-A	Start of heading.
002	2	2	STX	CTRL-B	Start of text.
003	3	3	ETX	CTRL-C	End of text.
004	4	4	EOT	CTRL-D	End of transmission.
005	5	5	ENQ	CTRL-E	Enquiry, also WRU.
006	6	6	ACK	CTRL-F	Acknowledge, also RU.
007	7	7	BEL	CTRL-G	Rings the bell.
010	8	8	BS	CTRL-H	Backspace; also format effector backspace (FEB).
011	9	9	HT	CTRL-I	Horizontal Tab.
012	10	A	LF	CTRL-J	Line feed: advances cursor to next line.
013	11	B	VT	CTRL-K	Vertical Tab (VTAB).
014	12	C	FF	CTRL-L	Form feed to top of next page.
015	13	D	CR	CTRL-M	Carriage return to beginning of line.
016	14	E	SO	CTRL-N	Shift-out.
017	15	F	SI	CTRL-O	Shift-in.
020	16	10	DLE	CTRL-P	Data line escape.
021	17	11	DC1	CTRL-Q	Device control 1: turns transmitter on (XON).
022	18	12	DC2	CTRL-R	Device control 2.
023	19	13	DC3	CTRL-S	Device control 3: transmitter off (XOFF).

OCT	DEC	HEX	ASCII	KEYS	DESCRIPTION
024	20	14	DC4	CTRL-T	Device control 4.
025	21	15	NAK	CTRL-U	Negative acknowledge; also ERR (error).
026	22	16	SYN	CTRL-V	Synchronous idle (SYNC).
027	23	17	ETB	CTRL-W	End of transmission block.
030	24	18	CAN	CTRL-X	Cancel (CANCL). Cancels current escape sequence.
031	25	19	EM	CTRL-Y	End of medium.
032	26	1A	SUB	CTRL-Z	Substitute.
033	27	1B	ESC	CTRL-[	Escape.
034	28	1C	FS	CTRL-\	File separator.
035	29	1D	GS	CTRL-]	Group separator.
036	30	1E	RS	CTRL- ^	Record separator.
037	31	1F	US	CTRL- –	Unit separator.
040	32	20	SP	SPACE BAR	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	0	Number 0.
061	49	31	1	1	Number 1.
062	50	32	2	2	Number 2.
063	51	33	3	3	Number 3.
064	52	34	4	4	Number 4.
065	53	35	5	5	Number 5.
066	54	36	6	6	Number 6.

OCT	DEC	HEX	ASCII	KEYS	DESCRIPTION
067	55	37	7	7	Number 7.
070	56	38	8	8	Number 8.
071	57	39	9	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.
100	64	40	@	@	At sign.
101	65	41	A	A	Letter A.
102	66	42	B	B	Letter B.
103	67	43	C	C	Letter C.
104	68	44	D	D	Letter D.
105	69	45	E	E	Letter E.
106	70	46	F	F	Letter F.
107	71	47	G	G	Letter G.
110	72	48	H	H	Letter H.
111	73	49	I	I	Letter I.
112	74	4A	J	J	Letter J.
113	75	4B	K	K	Letter K.
114	76	4C	L	L	Letter L.
115	77	4D	M	M	Letter M.
116	78	4E	N	N	Letter N.
117	79	4F	O	O	Letter O.
120	80	50	P	P	Letter P.
121	81	51	Q	Q	Letter Q.
122	82	52	R	R	Letter R.
123	83	53	S	S	Letter S.
124	84	54	T	T	Letter T.
125	85	55	U	U	Letter U.
126	86	56	V	V	Letter V.
127	87	57	W	W	Letter W.
130	88	58	X	X	Letter X.
131	89	59	Y	Y	Letter Y.
132	90	5A	Z	Z	Letter Z.
133	91	5B	[	[	Open brackets.

OCT	DEC	HEX	ASCII	KEYS	DESCRIPTION
134	92	5C	\	\	Reverse slash.
135	93	5D	]	]	Close brackets.
136	94	5E	^	^	Up arrow/caret.
137	95	5F	_	_	Underscore.
140	96	60	`	`	Grave accent.
141	97	61	a	a	Letter a.
142	98	62	b	b	Letter b.
143	99	63	c	c	Letter c.
144	100	64	d	d	Letter d.
145	101	65	e	e	Letter e.
146	102	66	f	f	Letter f.
147	103	67	g	g	Letter g.
150	104	68	h	h	Letter h.
151	105	69	i	i	Letter i.
152	106	6A	j	j	Letter j.
153	107	6B	k	k	Letter k.
154	108	6C	l	l	Letter l.
155	109	6D	m	m	Letter m.
156	110	6E	n	n	Letter n.
157	111	6F	o	o	Letter o.
160	112	70	p	p	Letter p.
161	113	71	q	q	Letter q.
162	114	72	r	r	Letter r.
163	115	73	s	s	Letter s.
164	116	74	t	t	Letter t.
165	117	75	u	u	Letter u.
166	118	76	v	v	Letter v.
167	119	77	w	w	Letter w.
170	120	78	x	x	Letter x.
171	121	79	y	y	Letter y.
172	122	7A	z	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	DEL	Delete (rubout).

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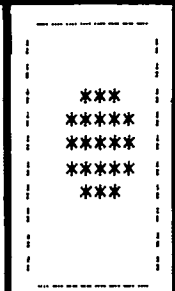
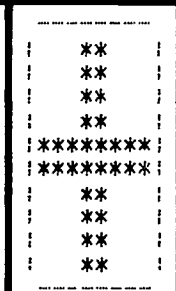
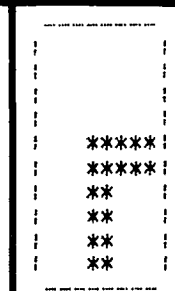
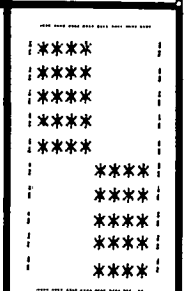
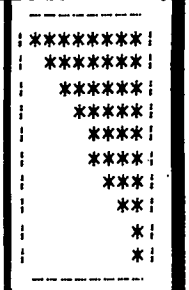
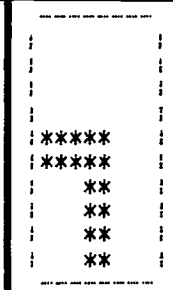
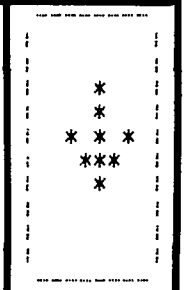
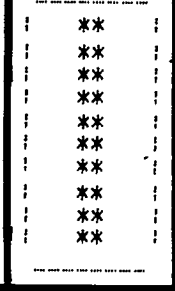
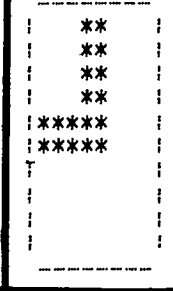
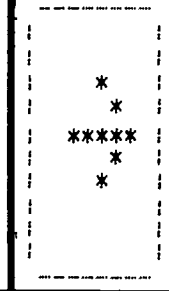
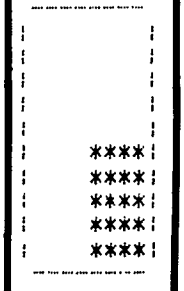
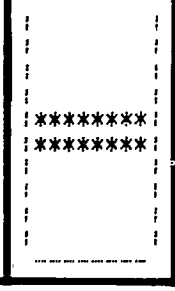
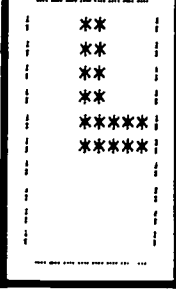
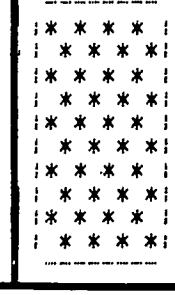
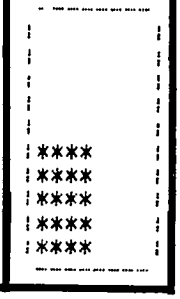
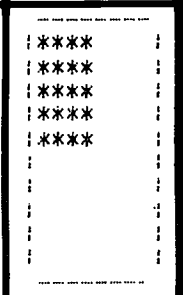
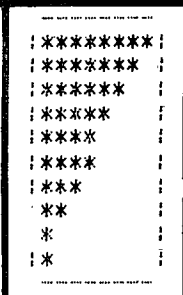
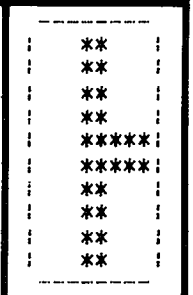
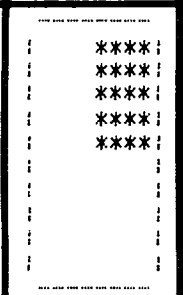
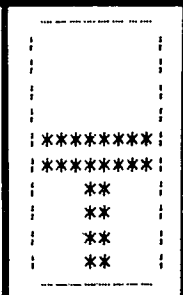
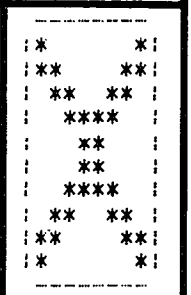
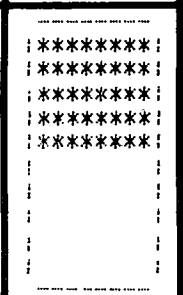
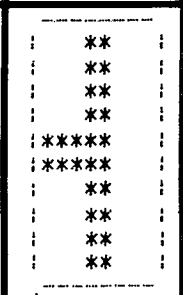
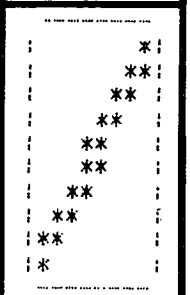
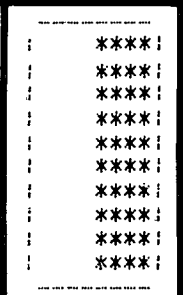
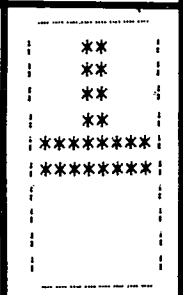
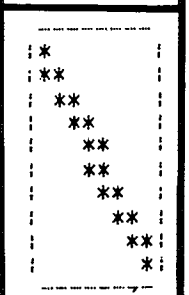
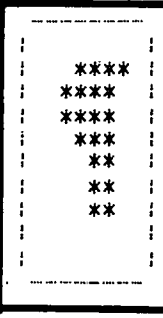
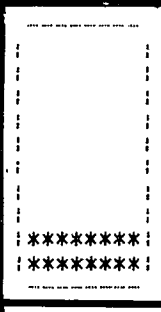
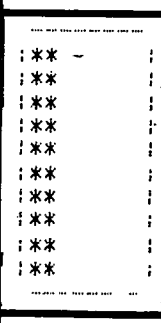
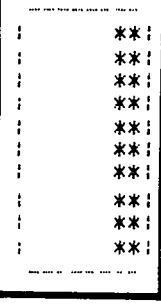
GRAPHIC SYMBOLS

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
^ (136) [94] {5E}		b (142) [98] {62}		f (146) [102] {66}		j (152) [106] {6A}	
_ (137) [95] {5F}		c (143) [99] {63}		g (147) [103] {67}		k (153) [107] {6B}	
` (140) [96] {60}		d (144) [100] {64}		h (150) [104] {68}		l (154) [108] {6C}	
a (141) [97] {61}		e (145) [101] {65}		i (151) [105] {69}		m (155) [109] {6D}	

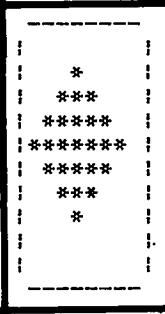
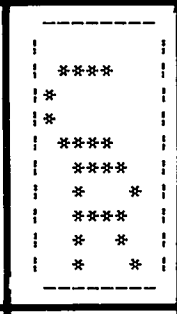
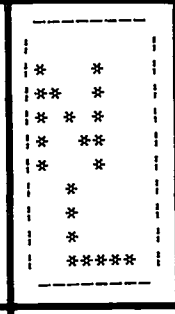
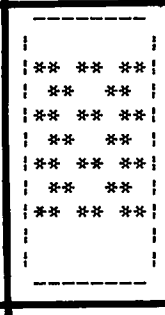
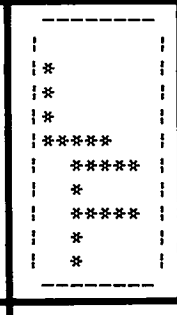
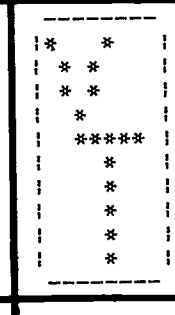
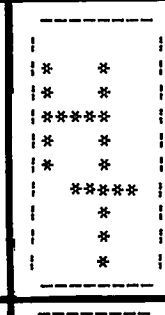
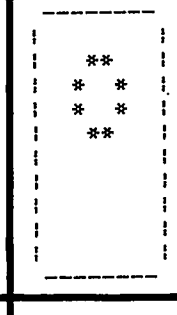
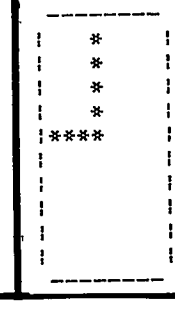
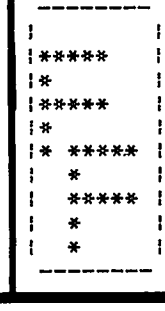
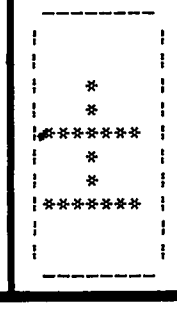
Graphic Symbols (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
n (156) [110] {6E}		r (162) [114] {72}		v (166) [118] {76}	
o (157) [111] {6F}		s (163) [115] {73}		w (167) [119] {77}	
p (160) [112] {70}		t (164) [116] {74}		x (170) [120] {78}	
q (161) [113] {71}		u (165) [117] {75}		y (171) [121] {79}	

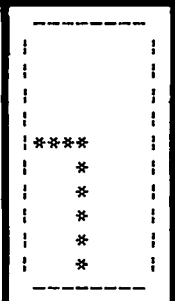
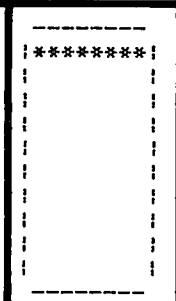
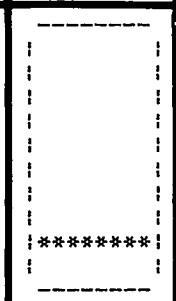
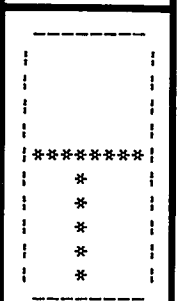
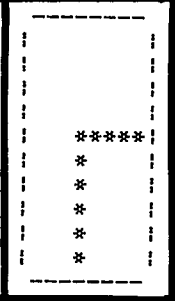
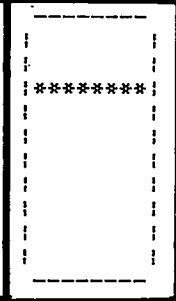
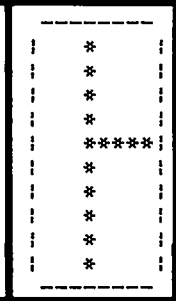
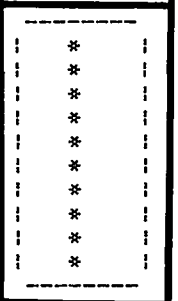
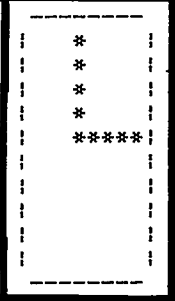
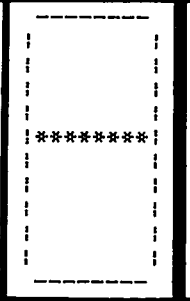
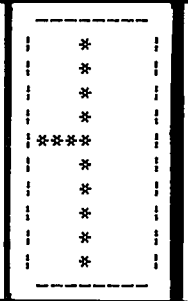
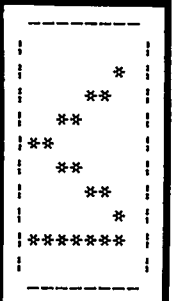
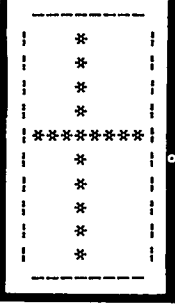
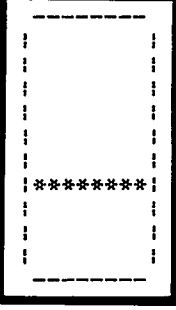
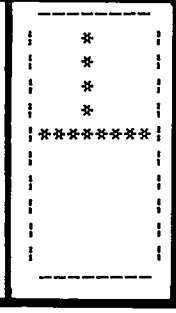
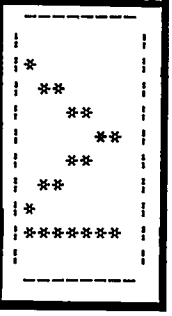
Graphic Symbols (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
Z (172) [122] {7A}		~ (176) [126] {7E}	
{ (173) [123] {7B}			
| (174) [124] {7C}			
} (175) [125] {7D}			

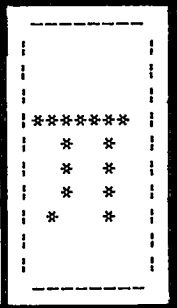
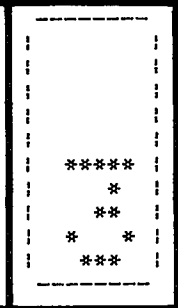
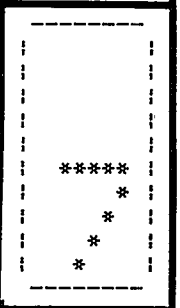
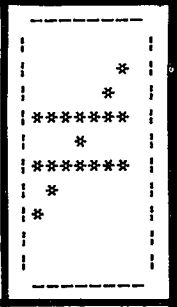
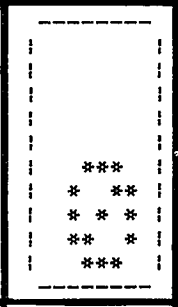
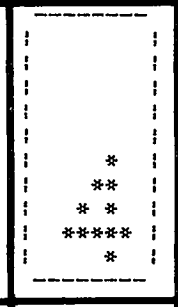
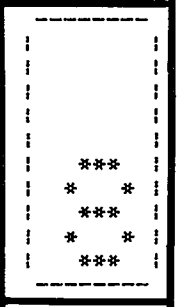
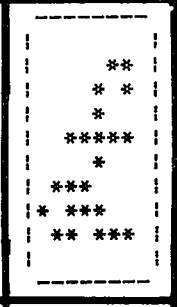
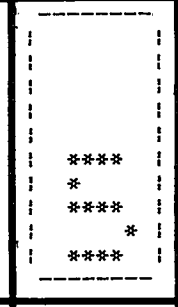
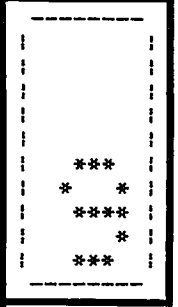
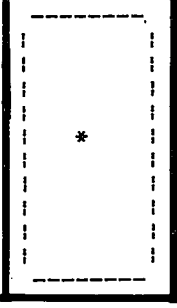
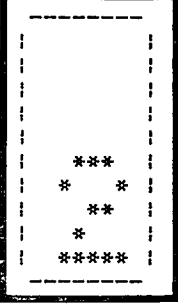
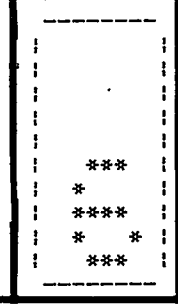
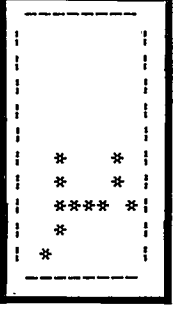
ALTERNATE CHARACTER SET AND GRAPHICS

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
^ @ (200) [128] {80}		^ D (204) [132] {84}		^ H (210) [136] {88}	
^ A (201) [129] {81}		^ E (205) [133] {85}		^ I (211) [137] {89}	
^ B (202) [130] {82}		^ F (206) [134] {86}		^ J (212) [138] {8A}	
^ C (203) [131] {83}		^ G (207) [135] {87}			

Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
^K (213) [139] {8B}		^O (217) [143] {8F}		^S (223) [147] {93}		^W (227) [151] {97}	
^L (214) [140] {8C}		^P (220) [144] {90}		^T (224) [148] {94}		^X (230) [152] {98}	
^M (215) [141] {8D}		^Q (221) [145] {91}		^U (225) [149] {95}		^Y (231) [153] {99}	
^N (216) [142] {8E}		^R (222) [146] {92}		^V (226) [150] {96}		^Z (232) [154] {9A}	

Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
^ [(233) [155] {9B}		^ _ (237) [159] {9F}		ASCII '#' (243) [163] {A3}		ASCII ''' (247) [167] {A7}	
^ \ (234) [156] {9C}		ASCII ' ' (240) [160] {A0}		ASCII '$' (244) [164] {A4}		ASCII '(' (250) [168] {A8}	
^] (235) [157] {9D}		ASCII '!' (241) [161] {A1}		ASCII '%' (245) [165] {A5}		ASCII ')' (251) [169] {A9}	
^ ^ (236) [158] {9E}		ASCII '"' (242) [162] {A2}		ASCII '&' (246) [166] {A6}		ASCII '*' (252) [170] {AA}	

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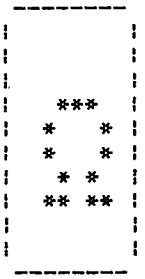
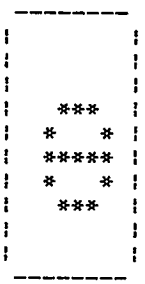
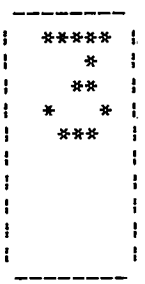
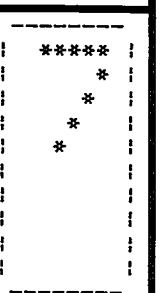
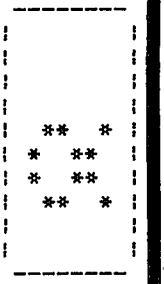
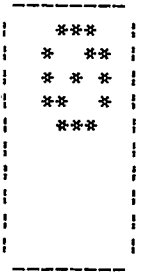
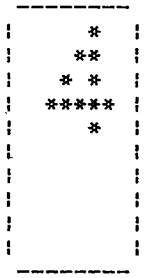
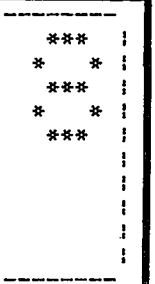
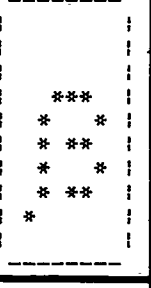
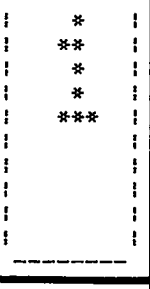
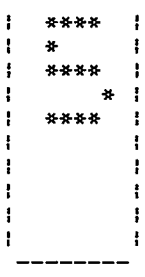
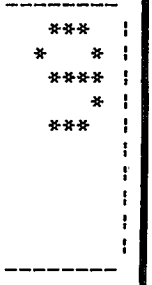
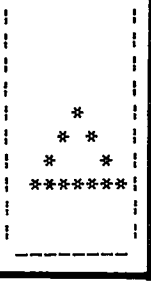
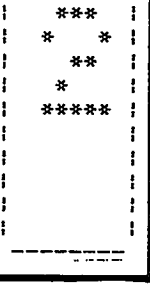
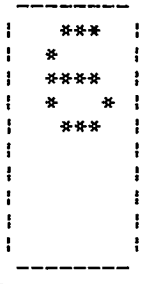
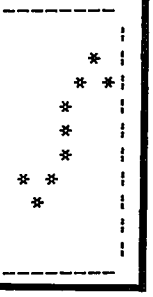
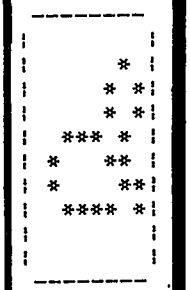
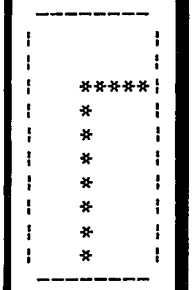
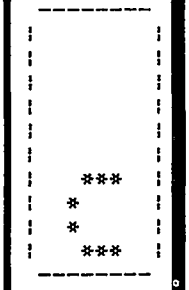
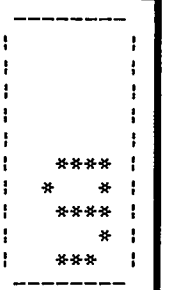
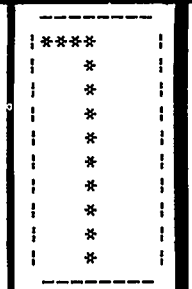
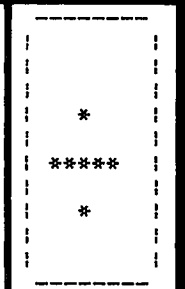
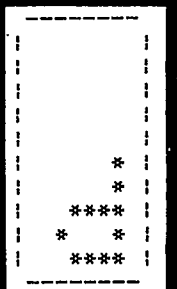
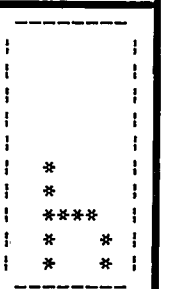
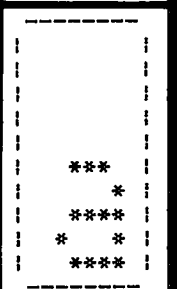
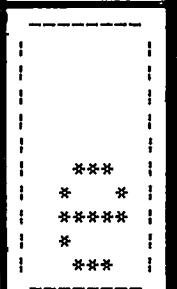
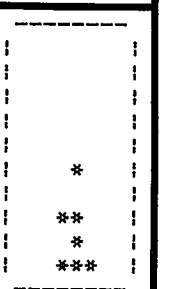
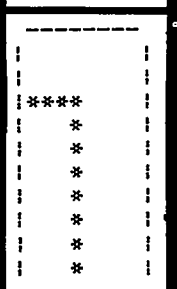
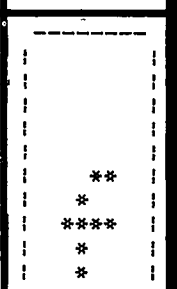
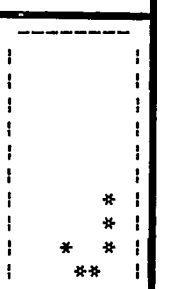
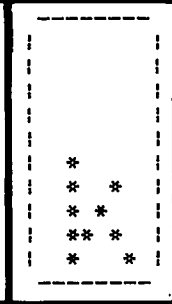
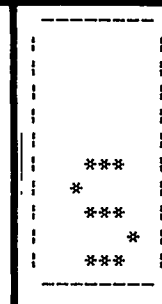
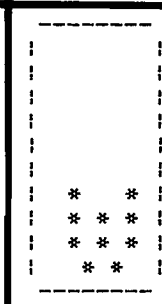
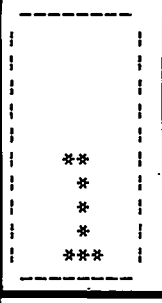
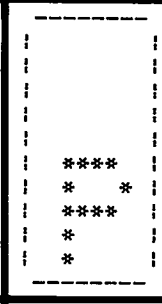
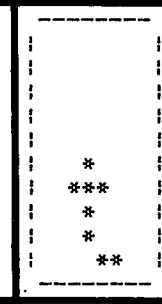
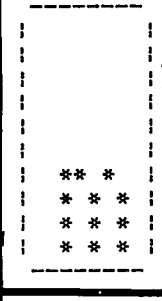
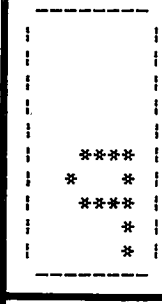
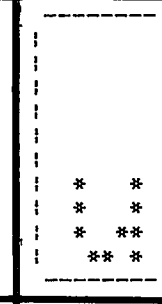
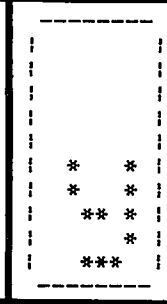
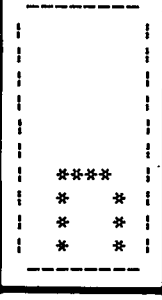
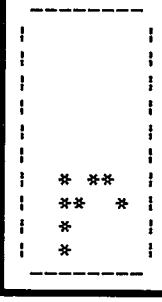
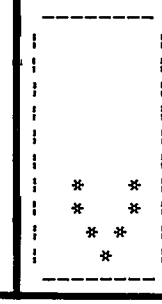
Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
ASCII '+' (253) [171] {AB}		ASCII '/' (257) [175] {AF}		ASCII '3' (263) [179] {B3}		ASCII '7' (267) [183] {B7}	
ASCII ',' (254) [172] {AC}		ASCII '0' (260) [176] {B0}		ASCII '4' (264) [180] {B4}		ASCII '8' (270) [184] {B8}	
ASCII '-' (255) [173] {AD}		ASCII '1' (261) [177] {B1}		ASCII '5' (265) [181] {B5}		ASCII '9' (271) [185] {B9}	
ASCII '.' (256) [174] {AE}		ASCII '2' (262) [178] {B2}		ASCII '6' (266) [182] {B6}		ASCII ':' (272) [186] {BA}	

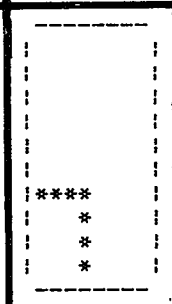
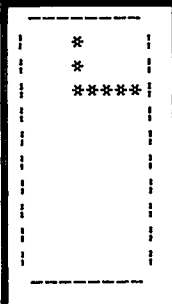
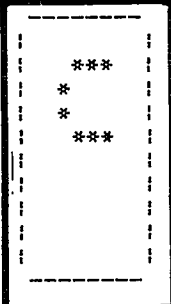
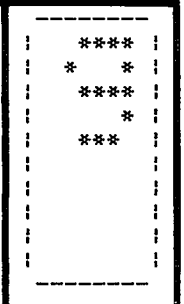
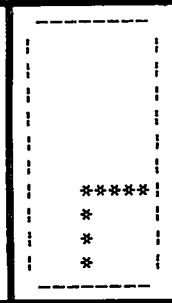
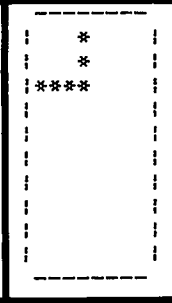
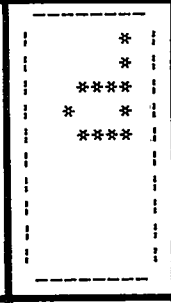
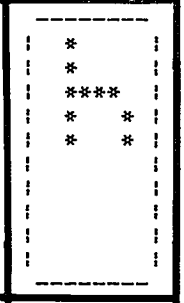
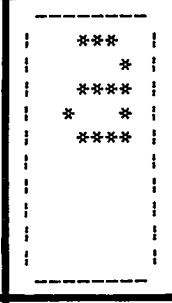
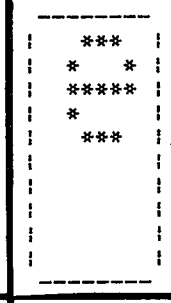
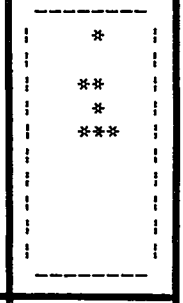
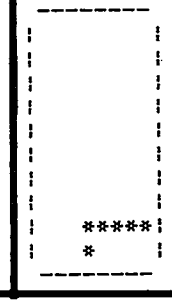
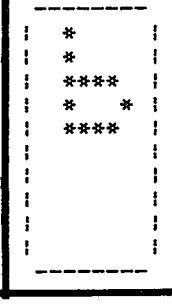
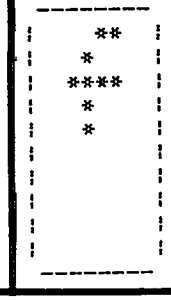
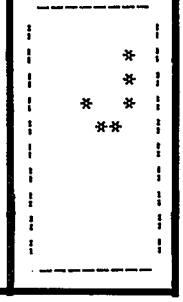
Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
ASCII ';' (273) [187] {BB}		ASCII '?' (277) [191] {BF}		ASCII 'C' (303) [195] {C3}		ASCII 'G' (307) [199] {C7}	
ASCII '<' (274) [188] {BC}		ASCII '@' (300) [192] {C0}		ASCII 'D' (304) [196] {C4}		ASCII 'H' (310) [200] {C8}	
ASCII '=' (275) [189] {BD}		ASCII 'A' (301) [193] {C1}		ASCII 'E' (305) [197] {C5}		ASCII 'I' (311) [201] {C9}	
ASCII '>' (276) [190] {BE}		ASCII 'B' (302) [194] {C2}		ASCII 'F' (306) [198] {C6}		ASCII 'J' (312) [202] {CA}	

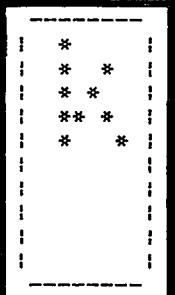
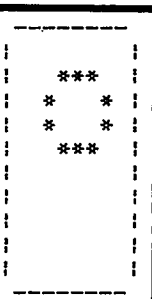
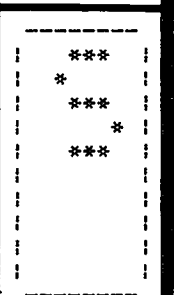
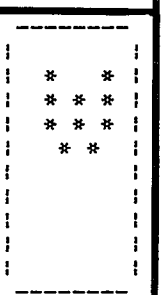
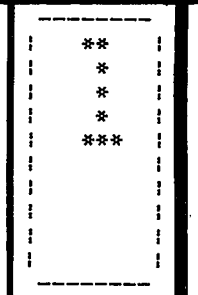
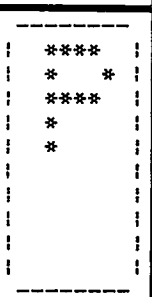
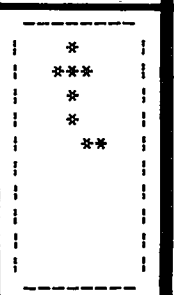
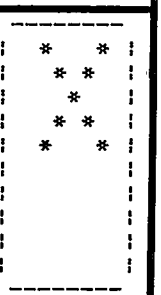
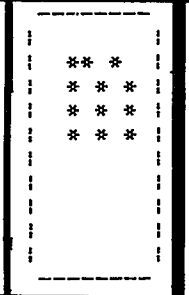
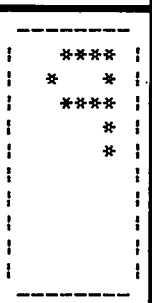
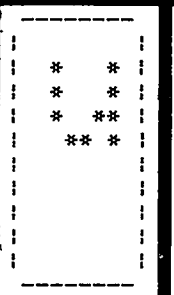
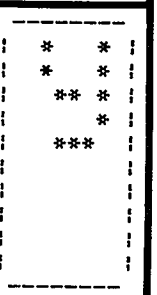
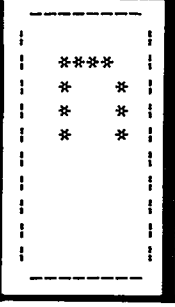
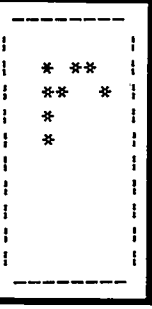
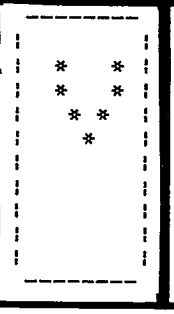
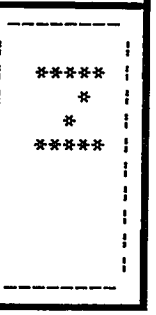
Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
ASCII 'K' (313) [203] {CB}		ASCII 'O' (317) [207] {CF}		ASCII 'S' (323) [211] {D3}		ASCII 'W' (327) [215] {D7}	
ASCII 'L' (314) [204] {CC}		ASCII 'P' (320) [208] {D0}		ASCII 'T' (324) [212] {D4}		ASCII 'X' (330) [216] {D8}	
ASCII 'M' (315) [205] {CD}		ASCII 'Q' (321) [209] {D1}		ASCII 'U' (325) [213] {D5}		ASCII 'Y' (331) [217] {D9}	
ASCII 'N' (316) [206] {CE}		ASCII 'R' (322) [210] {D2}		ASCII 'V' (326) [214] {D6}		ASCII 'Z' (332) [218] {DA}	

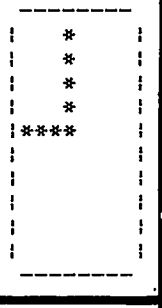
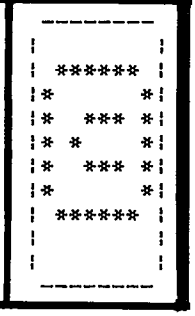
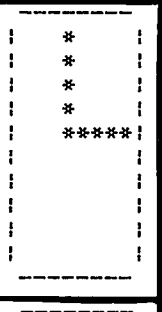
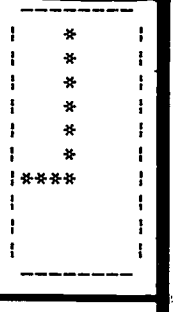
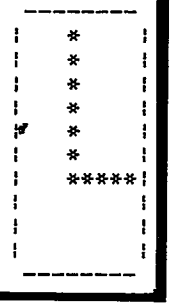
Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
ASCII '[' (333) [219] {DB}		ASCII '_' (337) [223] {DF}		ASCII 'c' (343) [227] {E3}		ASCII 'g' (347) [231] {E7}	
ASCII '\' (334) [220] {DC}		ASCII '`' (340) [224] {E0}		ASCII 'd' (344) [228] {E4}		ASCII 'h' (350) [232] {E8}	
ASCII ']' (335) [221] {DD}		ASCII 'a' (341) [225] {E1}		ASCII 'e' (345) [229] {E5}		ASCII 'i' (351) [233] {E9}	
ASCII '^' (336) [222] {DE}		ASCII 'b' (342) [226] {E2}		ASCII 'f' (346) [230] {E6}		ASCII 'j' (352) [234] {EA}	

Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
ASCII 'k' (353) [235] {EB}		ASCII 'o' (357) [239] {EF}		ASCII 's' (363) [243] {F3}		ASCII 'w' (367) [247] {F7}	
ASCII 'l' (354) [236] {EC}		ASCII 'p' (360) [240] {F0}		ASCII 't' (364) [244] {F4}		ASCII 'x' (370) [248] {F8}	
ASCII 'm' (355) [237] {ED}		ASCII 'q' (361) [241] {F1}		ASCII 'u' (365) [245] {F5}		ASCII 'y' (371) [249] {F9}	
ASCII 'n' (356) [238] {EE}		ASCII 'r' (362) [242] {F2}		ASCII 'v' (366) [246] {F6}		ASCII 'z' (372) [250] {FA}	

Alternate Character Set and Graphics (cont'd.)

KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL	KEY (OCTAL) [DECIMAL] {HEX}	SYMBOL
ASCII '{' (373) [251] {FB}		ASCII ' ' (377) [255] {FF}	
ASCII '|' (374) [252] {FC}			
ASCII '}' (375) [253] {FD}			
ASCII '≈' (376) [254] {FE}			

KEYPAD KEYS	UNSHIFTED	ZENITH UNSHIFTED ALTERNATE	ANSI UNSHIFTED ALTERNATE	SHIFTED
0	0	ESC ? p	ESC O p	0
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 ? l	ESC O l	, (Comma)
-	-	ESC ? m	ESC O m	- (Dash)
.	.	ESC ? n	ESC O n	. (Period)
ENTER	ENTER	ESC ? M	ESC O M	RETURN

SPECIAL FUNCTION KEYS

KEY	ZENITH 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
F6(BLUE)	ESC P	ESC O P
F7(RED)	ESC Q	ESC O Q
F8(GREY)	ESC R	ESC O R
F9	ESC 0I	ESC O X

Appendix B

ZENITH MODE CODE INFORMATION

The Z-29 Terminal recognizes the following ASCII characters while it is operating in the Zenith mode.

OCT	DEC	HEX	Chr	FUNCTIONAL DESCRIPTION OR CHARACTER
007	7	7	BEL	Sounds a tone.
010	8	8	BS	Backspace. Moves the cursor one position to the left. If it is at the left end of the screen, nothing happens.
011	9	9	HT	Tab. Moves the cursor to the next tab stop.
012	10	A	LF	Line Feed. Advances the cursor to the next line. At the bottom of the screen, it scrolls text up one line.
015	13	D	CR	Carriage Return. Moves the cursor to the first character position in the current line. Nothing happens if the cursor is already at the first character position.
016	14	E	50	Shift out. Selects the G1 character set as designated by the SCS control sequence.
017	15	F	51	Shift in. Selects the G0 character set as designated by the SCS control sequence.
030	24	18	CAN	Cancel. Cancels the current escape sequence.
033	27	1B	ESC	Escape.

SUMMARY OF ZENITH ESCAPE SEQUENCES

In the following listings of escape sequences, we have elected for the purpose of clarity to include a space between the escape key (ESC) and the actual code. Under no circumstances **should you include** this space. The term "defined scrolling region" appears several times in these listings and means lines 1-24 of the screen unless you have specifically altered this region through the use of escape sequences and codes.

CURSOR FUNCTIONS

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
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 Postion
ESC k	ZRCP	Set Cursor to Previously Saved Position
ESC Y	ZDCA	Direct Cursor Addressing
ESC -	ZCBT	Cursor Backward Tabulation
ESC .0	ZCTCP	Clear Tab at Cursor Position
ESC .3	ZCAT	Clear All Tab Positions
ESC .8	ZSTCP	Set Tabs at Current Cursor Postion

EDITING AND ERASING

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC E	ZCD	Clear Display (Shift Erase)
ESC b	ZBD	Erase Beginning of Display
ESC J	ZEOP	Erase to End of Display
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 Character Insert Mode
ESC O	ZERM	Exit Insert Character Mode

CONFIGURATION

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC z	ZRAM	Reset to Power Up Configuration
ESC r B_n	ZMBR	Modify Baud Rate:[B_n = @ = 75,A = 110, B = 150,C = 300,D = 600,E = 1200, F = 1800,G = ignored,H = 2400, I = ignored,J = 4800,K = ignored, L = 9600, and M = 19200
ESC x P_n	ZSM	Sets these modes where P_n equals: 1 = Enable "25th Line" 2 = Disable Key Click 3 = Enter Hold Screen Mode 4 = Block Cursor 5 = Cursor Off 6 = Keypad Shifted 7 = Enter Alternate Keypad Mode 8 = Auto LF on CR 9 = Auto CR on LF
ESC y P_n	ZRM	Resets these modes where P_n 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 LF on CR 9 = No Auto CR on LF
ESC<	ZEAM	Enter ANSI Mode
ESC [c		Identify as VT100 (ESC[?1;2c)

MODES OF OPERATION

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
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 s	ZSA	Set Attribute
ESC ~	ZHLP	HELP Key
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

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
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 i 0	ZRTT	Request Terminal Type [ESC i B 0]
ESC ^	ZXCL	Transmit Current Line
ESC _	ZXCC	Transmit Character at Cursor
ESC]	ZX25	Transmit 25th Line
ESC #	ZXMP	Transmit Page
ESC '	ZXPP	Transmit Page to Printer

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	ZF6	Function Key 6 (F6) Blue
ESC Q	ZF7	Function Key 7 (F7) Red
ESC R	ZF8	Function Key 8 (F8) Grey
ESC 0 I	ZF9	Function Key 9 (F9)

ZENITH ESCAPE SEQUENCES DEFINED

Cursor Functions

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

Code: ESC H
Mnemonic: ZCUH

Cursor Forward — Moves the cursor one character position to the right. If the cursor is at the right end of the line, it remains there.

Code: ESC C
Mnemonic: ZCUF

Cursor Backward — Moves the cursor one character position to the left (backspaces). If the cursor is at the start (left end) of a line, it remains there.

Code: ESC D
Mnemonic: ZCUB

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

Code: ESC B
Mnemonic: ZCUD

Cursor Up — Moves the cursor up one line. If the cursor reaches the top line of the defined scrolling region, it remains there. No scrolling takes place.

Code: ESC A
Mnemonic: ZCUU

Reverse Index — Moves the cursor to the same horizontal position on the preceding line. If the cursor is on the top line of the defined scrolling region, a scroll down is performed.

Code: ESC I
Mnemonic: ZRI

Cursor Position Report — The Terminal indicates the cursor position in the form of ESC Y line# column#.

Code: ESC n
Mnemonic: ZCPR

Save Cursor Position — The present cursor position is saved so that the cursor can be returned there later when given the ZRCP (Set Cursor to Previously Saved Position) command.

Code: ESC j
Mnemonic: ZSCP

Set Cursor to Previously Saved Position — Returns the cursor to the position where it was when the ZSCP (Save Cursor Position) command was received. If the saved position was the "25th Line" and the "25th Line" is no longer enabled, the cursor will not change lines, but, does change columns.

Code: ESC k
Menmonic: ZRCP

Direct Cursor Addressing — 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_{10} to 25_{10} (from top to bottom) and the columns from 1_{10} to 80_{10} (from left to right), you must add the proper line and column numbers to 31_{10}. 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". The "25th Line" must first be enabled.

Code: ESC Y line #(ASCII character) column # (ASCII character)
Mnemonic: ZDCA

Cursor Backward Tabulation — Moves the cursor backwards to the last tab set.

Code: ESC -
Mnemonic: ZCBT

Clear Tab at Cursor Position — Clears the TAB set at the current cursor position.

Code: ESC .0
Mnemonic: ZCTCP

Clear All Tab Positions — Clears all TABs previously set.

Code: ESC .3
Mnemonic: ZCAT

Set Tabs at Current Cursor Position — Sets a TAB at the current cursor postion.

Code: ESC .8
Mnemonic: ZSTCP

Erasing and Editing

Clear Display (Shift Erase) — Erases the entire screen, fills the screen with spaces, and then places the cursor in the home position.

Code: ESC E
Mnemonic: ZCD

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

Code: ESC b
Mnemonic: ZBD

Erase to End of Display (Erase Key) — Erases all the information from the cursor (including the cursor position) to the end of the display.

Code: ESC J
Mnemonic: ZEOP

ERASE Entire Line — Erases all of the line, including the cursor position.

Code: ESC l
Mnemonic: ZEL

Erase Beginning of Line — Erases from the beginning of the line to the cursor, including the cursor position.

Code: ESC o
Mnemonic: ZEBL

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

Code: ESC K
Mnemonic: ZEOL

Insert Line — Inserts a new blank line by moving the line that the cursor is on, and all following lines, down one line. The cursor is moved to the beginning of the new blank line. No area outside of the scrolling region will be affected.

Code: ESC L
Mnemonic: ZIL

Delete Line — 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, adding a blank line at the bottom of the defined scrolling region.

Code: ESC M
Mnemonic. ZDL

Delete Character — Deletes the character at the cursor position and shifts any existing text (to the right of the cursor) one character position to the left.

Code: ESC N
Mnemonic: ZDCH

Enter Insert Character Mode — Lets you insert characters or words into text already displayed on the screen. As you type new characters, existing text at 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.

Code: ESC @
Mnemonic: ZEIM

Exit Insert Character Mode — Exits from the insert character mode.

Code: ESC O
Mnemonic: ZERM

Configuration

Reset to Power-up Configuration — Cancels all previously set escape modes and returns to the power-up configuration.

Code: ESC z
Mnemonic: ZRAM

Modify Baud Rate — Modifies the baud rate, where B_n equals:
@ = 75, A = 110, B = 150, C = 300, D = 600,
E = 1200, F = 1800, G = ignored, H = 2400,
I = ignored, J = 4800, K = ignored, L = 9600, M = 19200

Code: ESC r B_n
Mnemonic: ZMBR

Set Mode(s) — Sets the following modes, where P_n equals:

1 = Enable "25th Line".
2 = Disable key click.
3 = Enter hold screen mode.
4 = Block cursor.
5 = Cursor off.
6 = Keypad shifted.
7 = Enter alternate keypad mode.
8 = Auto line feed on receipt of CR.
9 = Auto CR on receipt of line feed.

Code: ESC x P_n
Mnemonic: ZSM

Reset Mode(s) — Resets special modes, where P_n equals:

1 = Disable "25th Line". If the cursor is on the 25th Line, it returns to home.
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 on CR.
9 = No auto CR on LF.

Code: ESC yP_n
Mnemonic: ZRM

Enter ANSI Mode — Enters the ANSI mode.

Code: ESC<
Mnemonic: ZEAM
Identify as VT100 - VT100 (ESC[?1;2c).

Modes of Operation

Enter Hold Screen Mode — Determines when new information is printed on the screen. — Type the NO SCROLL key and a new line of information will be printed on the bottom line. The top line will scroll off. — Type SHIFT NO 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.

Code: ESC [
Mnemonic: ZEHS

Exit Hold Screen Mode — Exits the hold screen mode.

Code: ESC \
Mnemonic: ZXHS

Enter Reverse Video Mode — Enters the reverse video mode so characters are displayed as black characters on a green background.

Code: ESC p
Mnemonic: ZERV

Exit Reverse Video Mode — Exits the reverse video mode.

Code: ESC q
Mnemonic: ZXRV

Set Attribute — Sets the video attribute in the following form:
ESC s <attribute>

Where <attribute> is the ASCII character formed when the ASCII value for '0' (30 hex, 48 decimal) is added to the binary value obtained from data where each bit position represents an attribute. Bit positions are in the following locations:
<alt> <undr> <half> <blink> <rev>

Code: ESC s <attribute>
Mnemonic: ZSA

HELP Key

Code: ESC ~
Mnemonic: ZHLP

Enter Graphics Mode — Enters the graphics mode to display any of the 33 special symbols accessed by 26 lower-case keys and seven other keys corresponding to the graphic symbols in the selected character set.

Code: ESC F
Mnemonic: ZEGM

Exit Graphics Mode — Exits the graphics mode and returns to the standard character display in the selected character set.

Code: ESC G
Mnemonic: ZXGM

Enter Keypad Shifted Mode — Inverts the normal and shifted functions of the keypad. If you hold either SHIFT key down, you will get a normal, unshifted character.

Code: ESC t
Mnemonic: ZEKS

Exit Keypad Shifted Mode — Exits the keypad shifted mode.

Code: ESC u
Mnemonic: ZXKS

Enter Alternate Keypad Mode — Enters the alternate keypad mode, which allows the keypad keys to transmit the following escape codes instead of the normal character codes:

KEY	ESCAPE CODE
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 ? m
.	ESC ? n
,	ESC ? l
ENTER	ESC ? M

These special escape codes can be used by your software.

Code: ESC =
Mnemonic: ZAKM

Exit Alternate Keypad Mode — Exits the alternate keypad mode and returns to transmission of normal character codes.

Code: ESC >
Mnemonic: ZXAM

Additional Functions

Keyboard Disabled — Disables the output of the keyboard.

Code: ESC }
Mnemonic: ZDK

Keyboard Enabled — Enables the keyboard after it was disabled by the ZDK (Keyboard Disabled) command.

Code: ESC {
Mnemonic: ZEK

Wrap Around at End of Line — After receiving the 80th character, the cursor is automatically moved to the first character position on the next line. The region scrolls up if necessary.

Code: ESC v
Mnemonic: ZEWA

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

Code: ESC w
Mnemonic: ZXWA

Identify as VT52 (ESC/K) — The Terminal replies to the interrogation with ESC/K indicating that it can perform as a DEC VT52.

Code: ESC Z
Mnemonic: ZID

Request Terminal Type (ESC i B 0) — Requests terminal type. Terminal responds with ESC i B 0.

Code: ESC i 0
Mnemonic: ZRTT

Transmit Current Line — Transmits the current line.

Code: ESC ^
Mnemonic: ZXCL

Transmit Character at Cursor — Transmits the character at the cursor position.

Code: ESC _
Mnemonic: ZXCC

Transmit 25th Line — Transmits the " 25th line". (The computer requires a special user routine to handle this feature.)

Code: ESC]
Mnemonic: ZX25

Transmit Page — Transmits lines 1 through 24. (The computer requires a special user routine to handle this feature.)

Code: ESC #
Mnemonic: ZXMP

Transmit Page to Printer — Transmits the page to printer through the port **not** selected during the setup configuration.

Code: ESC `
Mnemonic: ZXPP

Function Key #1 (F1) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC S
Mnemonic: ZF1

Function Key #2 (F2) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC T
Mnemonic: ZF2

Function Key #3 (F3) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC U
Mnemonic: ZF3

Function Key #4 (F4) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC V
Mnemonic: ZF4

Function Key #5 (F5) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC W
Mnemonic: ZF5

NOTE: Function Keys F6, F7, and F8 correspond to the Blue, Red and Grey Keys, respectively, as found on older Zenith Terminals.

Function Key #6 (F6) — Transmits an escape code to be used to perform a user-defined function. There is no response by the computer.

Code: ESC P
Mnemonic: ZF6

Function Key #7 (F7) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC Q
Mnemonic: ZF7

Function Key #8 (F8) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC R
Mnemonic: ZF8

Function Key #9 (F9) — Transmits an escape code to be used to perform a user-defined function. There is no response by the Terminal.

Code: ESC 0I
Mnemonic: ZF9

Appendix C

ANSI MODE CODE INFORMATION

The Z-29 Terminal recognizes the following ASCII characters while it is operating in the ANSI mode.

OCT	DEC	HEX	Chr	FUNCTIONAL DESCRIPTION OR CHARACTER
007	7	7	BEL	Sounds a tone.
010	8	8	BS	Backspace. Moves the cursor one position to the left. If it is at the left end of the screen, nothing happens.
011	9	9	HT	Tab. Moves the cursor to the next tab stop.
012	10	A	LF	Line Feed. Advances the cursor to the next line. At the bottom of the screen, it scrolls text up one line.
015	13	D	CR	Carriage Return. Moves the cursor to the first character position in the current line. Nothing happens if the cursor is already at the first character position.
016	14	E	50	Shift out. Selects the G1 character set as designated by the SCS control sequence.
017	15	F	51	Shift in. Selects the G0 character set as designated by the SCS control sequence.
030	24	18	CAN	Cancel. Cancels the current escape sequence.
033	27	1B	ESC	Escape.

SUMMARY OF ANSI ESCAPE SEQUENCES

NOTES:

1. In the ANSI mode, the Terminal only recognizes and responds to escape codes whose syntax and semantics are in accordance with ANSI specifications.
2. "Default" is the value 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 taken from a list and used to select a subfunction. You can select several subfunctions at once by putting one number after another, separating them with delimiters (semicolons), to a maximum of eight parameters.

CURSOR FUNCTIONS

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC[H or ESC[0;0H or ESC[1;1H or ESC[f or ESC[0;0f or ESC[1;1f	CUP or HUP	Cursor Home.
ESC[P_nC	CUF	Cursor forward.
ESC[P_nD	CUB	Cursor backward.
ESC[P_nB	CUD	Cursor down.
ESC[P_nA	CUU	Cursor up.
ESC M	RI	Reverse index.
ESC[6n	CPR	Cursor position report.
ESC[s	PSC	Save cursor postion.
ESC[u	CUP	Restore cursor position.
ESC[p_l;P_cH or ESC[P_l;P_cf	CUP CHT	Direct cursor addressing.
ESC H		Cursor horizontal tab set.
ESC[P_nZ	CBT	Cursor backward tabulation.
ESC[P_sg	CCT	Clear horizontal cursor tab stops, P_s.= 0 = Clear horizontal tab at cursor. 3 = Clear all horizontal tab stops.
ESC D	SI	Index

ERASING AND EDITING

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC[2J	ED	Clear display (shift erase).
ESC[1J	ED	Erase beginning of display.
ESC[J or ESC[0J	ED	Erase to end of page (erase key).
ESC[2K	EL	Erase entire line.
ESC[1K	EL	Erase beginning of line.
ESC[K or ESC[0K	EL	Erase to end of line.
ESC[P_nL	IL	Insert line.
ESC[P_nM	DL	Delete line.
ESC[P_n@	IC	Perform insert character.
ESC[P_nP	DCH	Delete character.
ESC[4h	IRM	Insert replacement (Insert-character) Mode On.
ESC[4l	IRM	Insert/Replacement (Insert-character) Mode Off.
ESC[6h	SM	Set Erasure Mode.
ESC[6l	RM	Reset Erasure Mode.

CONFIGURATION

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESCc	RIS	Reset to power-up configuration.
ESC[z or	PRAM	
ESC[P_nW	PMBR	Modify baud rate(P_n = ; 0 = 75, 1 = 110,2 = 150,3 = 300,4 = 600, 5 = 1200,6 = 1800,7 = ignored, 8 = 2400,9 = ignored,10 = 4800, 11 = ignored,12 = 9600,13 = 19200

ESC[>P_nh	SM	Set Mode(s): P_n = 1 = Enable 25th line. 2 = Disable key click. 3 = Enter Hold Screen Mode. 4 = Block cursor. 5 = Cursor off. 6 = Keypad shifted. 7 = Enter Alternate Keypad Mode. 8 = Auto LF on CR. 9 = Auto CR on LF.
ESC[>P_nl	RM	Reset Mode(s): P_n = 1 = Disable 25th line. 2 = Enable key click. 3 = Exit Hold Screen Mode. 4 = Underscore cursor. 5 = Cursor off. 6 = Keypad unshifted. 7 = Exit Alternate Keypad Mode. 8 = No auto LF on CR. 9 = No auto CR on LF.
ESC[?2h	PEZM	Enter Zenith Mode.
ESC[20h	SMC	Enter auto CR on LF.
ESC[20l	SMC	Exit auto CR on LF.
ESC[P_t;P_br	SR	Define scrolling region.
ESC[P_n	SCS	G0 designator. Select character set where Pn = B = United States (USASCII). 0 = Special characters and line drawing set(VT100). 1 = Alternate character ROM, 2 = Alternate character ROM, special graphics characters.
ESC[Pn	SCS	G1 designator. Select character set where Pn = B = United States (USASCII). 0 = Special character and line drawing set(VT100). 1 = Alternate character ROM, 2 = Alternate character ROM, special graphics characters.
ESC[?21		Enter VT52 mode

MODES OF OPERATION

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC[>3h	SM	Enter Hold Screen Mode.
ESC[>3l	RM	Exit Hold Screen Mode.
ESC[7m	SGR	Enter Reverse Video Mode.
ESC[m	SGR	Exit Reverse Video Mode.
ESC[P_nv	SAR	Set blinking attribute.
ESC[P_h;P_m;P_s	SC	Set Clock (h:m:s).
ESC[10m	SGR	Enter Graphics Mode.
ESC[11m	SGR	Exit Graphics Mode. Set Mode.
ESC[11m	SGR	Exit Alternate Character Set Mode.
ESC[P_sm	SGR	Enter/exit Select Graphic Rendition Mode, where P_s= 0= Exit all attributes. 2= Enter 1/2 intensity. 4= Enter underline. 5= Enter blinking. 7= Enter reverse video.
ESC= or ESC[>7h	SM	Enter Alternate Keypad Mode.
ESC> or ESC[>7l	RM	Exit Alternate Keypad Mode.
ESC[>6h	SM	Enter Keypad Shift Mode.
ESC[>6l	SM	Exit Keypad Shift Mode.
ESC[P_n}	SPF	Select protective field, where P_n = 0= no fields protected. 2= 1/2 intensity protected. 4= underline protected. 5= blinking protected. 7= rev. video protected. 254= all attributes off-protected.

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC[1h	GATM	Set Guarded Area Transfer Mode.
ESC[1l	GATM	Reset Guarded Area Transfer Mode.
ESC[~	SS3	HELP key.

ADDITIONAL FUNCTIONS

ESCAPE SEQUENCE	MNEMONIC	DEFINITION
ESC[2h	SM	Keyboard disabled.
ESC[2l	RM	Keyboard enabled.
ESC[?7h	SM	Wraparound at EOL
ESC[?7l	RM	Discard at EOL.
ESC[p_nP	PXMT	Transmit Mode, where P_n= 0= transmit page. 1= transmit current line. 2=transmit character at-cursor. 3= transmit "25th Line".
ESC[<pn>v	SM	Set blinking rate in 1/30sec.
ESCOS	SS3	Function key 1 (F1).
ESCOT	SS3	Function key 2 (F2).
ESCOU	SS3	Function key 3 (F3).
ESCOV	SS3	Function key 4 (F4).
ESCOW	SS3	Function key 5 (F5).
ESCOP	SS3	Function key 6 (F6)Blue.
ESCOQ	SS3	Function key 7 (F7)Red.
ESCOR	SS3	Function key 8 (F8)Gray.
ESCOX	SS3	Function key 9 (F9).

NOTE: Function key F1 corresponds to DEC™ key F4.
Function key F6 corresponds to DEC key F1.
Function key F7 corresponds to DEC key F2.
Function key F8 corresponds to DEC key F3.

ANSI ESCAPE SEQUENCES DEFINED

NOTES:

1. In the ANSI mode, the Terminal only recognizes and responds to escape sequences whose syntax and semantics are in accordance with ANSI specifications.

2. "Default" is the value 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 taken from a list and used to select a subfunction. You can select several subfunctions at once by putting one number after another, separating them with delimiters (semicolons), to a maximum of eight parameters.

Cursor Functions

Cursor Position and **Horizontal/Vertical Position** — Moves the cursor to a position specified by the parameters. The first parameter specifies the line number. The second parameter specifies the column number. When the value zero is used, it is considered to be the value one. If no parameter is given, the cursor is placed in the home position.

CUP Cursor Position	ESC [H or ESC [0;0H or
OR	ESC [1;1 H
HVP Horizontal & Vertical Position	ESC [f or ESC [0;0f (or) ESC [1;1 f

Default Value:1

Cursor Forward — Moves the cursor 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-most character position.

Code: ESC [P_n C
Mnemonic: CUF
Default Value: 1

Cursor Backward — Moves the cursor 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-most character position.

Code: ESC [P_n D
Mnemonic: CUB
Default Value: 1

Cursor Down — Moves the cursor down 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 the bottom most line of the defined scrolling region. Direct Cursor Addressing must be used to move to the "25th Line".

Code: ESC [P_n B
Mnemonic: CUD
Default Value: 1

Cursor UP — Moves the cursor up 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.

Code: ESC [P_n A
Mnemonic: CUU
Default Value: 1

Index — Moves the cursor down, functions in the same manner as line feed.

Code: ESC D
Mnemonic: IND

Reverse Index — Moves the cursor to the same position on the preceding line. If the cursor is on the top line of the defined scrolling region, it will not move.

Code: ESC M
Mnemonic: RI

Cursor Position Report — The Terminal reports the cursor position as: ESC [P_l ;P_c R, where $_l$ = line and $_c$ = column expressed as decimals.

Code: ESC [6 n
Mnemonic: CPR

Save Cursor Position — The present cursor position is saved so that the cursor can be returned here later when the PRCP (Move To Previously Saved Position) command is given.

Code: ESC [s
Mnemonic: PSCP

Move To Previously Saved Position — Returns the cursor to the position where it was when it received the PSCP (Save Cusor Position) command.

Code: ESC [u
Mnemonic: PRCP

Direct Cursor Addressing — Same as CUP and HVP above. If the line number (P_l) 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.

With the "25th Line" enabled, this is the only way to move the cursor to the "25th Line". To move the cursor home, enter 0 ; 0 or 1 ; 1 or do not enter any values.

Code: ESC [P_l ; P_c H ESC [P_l ; P_c f
Mnemonic: CUP
Default Value: 1

Cursor Horizontal Tab Set — Sets the horizontal tabs at the cursor position.

Code: ESC H
Mnemonic: CHT

Cursor Backward Tabulation — Moves the cursor backwards to the previous tab set, where P_n indicates the number of tabs back from the cursor position.

Code: ESC [P_n Z
Mnemonic: CBT
Default Value: 0

Clear Horizontal Cursor Tab Stops — Clears the horizontal tab stops, where P_s determines where the horizontal tabs will be cleared.

0 = Clear horizontal tabs at cursor
3 = Clear all horizontal tabs stops

Code: ESC [p_s g
Mnemonic: CCT
Default Value: 0

Erasing and Editing

Erase in Display — Erases some or all of the characters in the display according to the value of P_n.

P_n	MEANS
0	Erases from the cursor to the end of the screen, including the cursor position.
1	Erases from the start of the screen to the cursor, including the cursor position.
2	Erases all of the screen. The cursor goes to the home position.

Code: ESC [P_n, J
Mnemonic: ED
Default Value: 0

Erase In Line — Erases some or all of the characters in the cursor line according to the value of P_n.

P_n	MEANS
0	Erases from the cursor to the end of the line including the cursor position.
1	Erases from the start of the line to the cursor including the cursor position.
2	Erases all of the line including the cursor position.

Code: ESC [P_n, K
Mnemonic: EL
Default Value: 0

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

Code: ESC [P_n L
Mnemonic: IL
Default Value: 1

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

Code: ESC [P_n M
Mnemonic: DL
Default Value: 1

Delete Character — Deletes 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 move left the number of characters that were deleted.

Code: ESC [P_n P
Mnemonic: DCH
Default Value: 1

Perform Insert Character — Inserts the number of characters as indicated by P_n if P_n is greater than one. Existing characters to the right of the inserted character(s) move right the number of characters that were inserted.

Code: ESC [P_n @
Mnemonic: IC
Default Value: 1

Insert/Replacement Mode On — Allows characters or words to be inserted 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 new character is inserted, the character at the end of the line is lost.

Code: ESC [4 h
Mnemonic: IRM

Insert/Replacement Mode OFF — Exits from the I/R mode.

Code: ESC [4 l
Mnemonic: IRM

Set Erasure Mode — Enables the erasure mode.

Code: ESC [6 h
Mnemonic: ERM

Reset Erasure Mode — Disables the erasure mode.

Code: ESC [6 l
Mnemonic: ERM

Configuration

Reset to Power-Up — Cancels all previously set escape modes and returns to the power-up configuration.

Code: ESC c or ESC [z
Mnemonic: PRAM

Modify Baud Rate — Modifies the baud rate, where P_n equals:0=75, 1=110, 2=150, 3=300, 4=600, 5=1200, 6=1800, 7=ignored, 8=2400, 9=ignored, 10=4800, 11=ignored, 12=9600, 13=19200

Code: ESC [P_n w
Mnemonic: PMBR

Set Mode(s) — Sets the following modes, where P_n equals:

1 = Enable 25th line.
2 = Disable key click.
3 = Enter hold screen mode.
4 = Block cursor.
5 = Cursor off.
6 = Keypad shifted.
7 = Alternate keypad mode.
8 = Auto LF on CR.
9 = Auto CR on LF.

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

Select Character Set — The appropriate G0 and G1 character sets are designated from one of the possible character sets. The G0 and G1 sets are invoked by the codes SI and SO (shift in and shift out) respectively. Pn = B = United States (USASCII), 0 = special character and line drawing set (VT100), 1 = alternate character ROM, and 2 = alternate character ROM, special characters, and line drawing sets.

For G0:

Code: ESC (P_n

For G1:

Code: ESC)P_n
Mnemonic(both): SCS

Code: ESC [>P_s h
Mnemonic: SM
Default Value: None

Reset Mode(s) — Resets the following 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 LF on CR.
9 = No auto CR on LF.

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

Code: ESC [> P_s l
Mnemonic: RM
Default Value: None

Enter ZDS Mode — Enters the ZDS Mode.

Code: ESC [? 2 h
Mnemonic: PEZM

Enter auto CR on LF Mode — Enables the auto carriage return on Line Feed Mode.

Code: ESC [20 h
Mnemonic: LNM

Exit auto CR on LF Mode — Disables the auto carriage return on Line Feed Mode.

Code: ESC [20 l
Mnemonic: LNM

Enter VT52 Mode — Enters VT52 Mode
Code: ESC[?21

Define Scrolling Region — Permits the user to define the region where scrolling may occur. The scrolling region is equal to the values of P_t and P_b, where $_t$ = the top of the scrolling region and $_b$ = the bottom of the scrolling region. The numbers indicating the line positions are expressed as decimals. Default is the entire screen. The minimum size of the scrolling region allowed is 2 lines (top must be less than bottom). The cursor is placed in the HOME position.

Code: ESC [P_t; P_b r
Mnemonic: SR

Modes of Operation

Enter Hold Screen Mode — Determines when new information is printed onto the screen. Type the NO SCROLL key and a new line of information will be printed on the bottom line. The top line will scroll off. - Type SHIFT NO 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.

Code: ESC [> 3 h
Mnemonic: SM

Exit Hold Screen Mode — Exits the hold screen mode.

Code: ESC [> 3 l
Mnemonic: RM

Enter Reverse Video Mode — Enters the reverse video mode so characters are displayed as black characters on a green background.

Code: ESC [7 m
Mnemonic: SGR

Exit Reverse Video Mode — Exits the reverse video mode.

Code: ESC [m
Mnemonic: SGR

Set Blinking Attributes — Sets the blinking attributes where
P_n = rate in $P_n/30^{th}$ second at 60 Hz.
0 = no blinking always "on."
255 = no blinking, always "off."

Code: ESC [P_n v
Mnemonic: SAR
Default Value: 32 (32/30th sec)

Set Clock — Sets the clock in the form P_h ; P_m; P_s, where $_h$ = hours (0-23), $_m$ = minutes (0-59), and $_s$ = seconds (0-59).

Code: ESC [P_h; P_m; P_s{
Mnemonic: SC

Enter Graphics Mode — Enters the graphics mode to display any of the 33 special symbols accessed by 26 lower-case keys and seven other keys corresponding to the graphics symbols of the selected character set.

Code: ESC [10 m
Mnemonic: SGR

Exit Graphics Mode — Exits the graphics mode and returns to displaying standard, normal characters from the selected character set.

Code: ESC [11 m
Mnemonic: SGR

Enter/Exit Select Graphic Rendition Mode — Enters or exits the select graphic rendition mode where P_s =

0 = Exit all attributes.
2 = Enter 1/2 intensity attribute.
4 = Enter underline attribute.
5 = Enter blinking attribute.
7 = Enter reverse video attribute.

Code: ESC [P_s m
Mnemonic: SGR

Enter Keypad Shifted Mode — Inverts the normal and shifted functions of the keypad. If you hold down either SHIFT key, you get a normally unshifted character.

Code: ESC [> 6 h
Mnemonic: SM

Exit Keypad Shifted Mode — Exits the keypad shifted mode.

Code: ESC [> 6l
Mnemonic: RM

Enter Alternate Keypad Mode — Allows you to enter the alternate keypad mode, which transmits the following escape codes instead of the normal codes:

KEY	ESCAPE CODE
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
,	ESC O l
-	ESC O m
ENTER	ESC O M

These special escape codes are available for use by your software.

Code: ESC = or ESC [> 7 h
Mnemonic: SM

Exit Alternate Keypad Mode — Exits the alternate mode and returns to transmit normal character codes.

Code: ESC > or ESC [> 7 l
Mnemonic: RM

Select Protective Field — Selects the protective field, where p_n =

0 = No fields protected.
2 = 1/2 intensity protected.
4 = Underline protected.
5 = Blinking protected.
7 = Reverse video protected.
254 = All attributes OFF-protected.

Code: ESC [p_n}
Mnemonic: SPF

Set Guarded Area Transfer Mode — Enables guarded area transfer mode (transmits all data).

Code: ESC [1 h
Mnemonic: SPF

Reset Guarded Area Transfer Mode — Disables guarded area transfer mode (transmits only unprotected data).

Code: ESC [1l
Mnemonic: SPF

HELP KEY — HELP Key.

Code: ESC [~
Mnemonic: SS3

Additional Functions

Keyboard Disabled — Disables the output of the keyboard. To activate the keyboard, send the "enable keyboard" escape sequence from the computer or reset the Terminal.

Code: ESC [2 h
Mnemonic: SM

Keyboard Enabled — Enables the keyboard after it was inhibited by an SM (keyboard disabled) command.

Code: ESC [2 l
Mnemonic: RM

Wraparound At End of Line — 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 (no hold screen mode enabled).

Code: ESC [? 7 h
Mnemonic: SM

Discard At End Of Line — After the 80th character in a line, the next characters received overprint. Only the last character received will be displayed in position 80.

Code: ESC [? 7 l
Mnemonic: RM

Transmit Mode — Allows the transmission of data where P_n =
0 = Transmit page
1 = Transmit current line
2 = Transmit character at cursor
3 = Transmit "25th Line"

Code: ESC [p_n P
Mnemonic: PXMT

Function Key #1 (F1) — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code. This key corresponds to the DEC™ key F4.

Code: ESC O S
Mnemonic: SS3

Function Key #2 (F2) — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code.

Code: ESC O T
Mnemonic: SS3

Function Key #3 (F3) — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code.

Code: ESC O U
Mnemonic: SS3

Function Key #4 (F4) — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code.

Code: ESC O V
Mnemonic: SS3

Function Key #5 (F5) — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code.

Code: ESC O W
Mnemonic: SS3

Function Key #6 (F6) Blue — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code. This key corresponds to the DEC key F1.

Code: ESC O P
Mnemonic: SS3

Function Key #7 (F7) Red — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code. This key corresponds to the DEC key F2.

Code: ESC O Q
Mnemonic: SS3

Function Key #8 (F8) Gray — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code. This key corresponds to the DEC key F3.

Code: ESC O R
Mnemonic: SS3

Function Key #9 (F9) — Transmits a unique escape code to perform a user-defined function. The Terminal will not respond to this code.

Code: ESC O X
Mnemonic: SS3

Appendix D

LEAR SIEGLER ADM3A MODE CODE INFORMATION

The Z-29 Terminal recognizes the following ASCII Characters while it is operating in the ADM3A mode.

OCT	DEC	HEX	Chr	FUNCTIONAL DESCRIPTION OR CHARACTER
007	7	7	BEL	Sounds a tone.
010	8	8	BS	Backspace. Moves the cursor one position to the left. If it is at the left end of the screen, nothing happens.
011	9	9	HT	Tab. Moves the cursor to the next tab stop.
012	10	A	LF	Line Feed. Advances the cursor to the next line. At the bottom of the screen, it scrolls text up one line.
013	11	B	VT	Moves the cursor up one position. If the cursor is already at the top of the screen, nothing else will happen.
014	12	C	FF	Moves the cursor one position to the right. If the cursor is already at the right side of the screen, nothing else will happen.
015	13	D	CR	Carriage Return. Moves the cursor to the first character position in the current line. Nothing happens if the cursor is already at the first character position.
016	14	E	SO	Enables keyboard entry after it has been disabled by code 0FH.
017	15	F	SI	Disables the keyboard entry. Use code 0EH to enable.
032	26	1A	SUB	Clears the screen and moves the cursor to the home position (first position on the top line).
036	30	1E	RS	Moves the cursor to the home position.

DIRECT CURSOR ADDRESSING

This command allows you to position the cursor to any line and column on the screen. Legal line numbers are 1 to 24 and column (print position) numbers are 1 to 80. Both are offset by 1FH(31 decimal). For instance, if you want to position the cursor to the third line, the tenth column, the code would be:

$$ESC = 34_{10}41_{10}$$

Where the desired line ($3_{10}+31_{10}$) is 34_{10} and the desired column ($10_{10}+31_{10}$) is 41_{10}

Code: ESC = line column

Appendix E

HAZELTINE 1500 MODE CODE INFORMATION

The Z-29 Terminal recognizes the following ASCII Characters while it is operating in the Hazeltine 1500 mode. Note that this Terminal can set up regions which act line independent screens under certain conditions. Also, instead of escape sequences (ESC), the 1500 Mode makes use of tilde (~) sequences.

OCT	DEC	HEX	Chr	FUNCTIONAL DESCRIPTION OR CHARACTER
007	7	7	BEL	Sounds a tone.
010	8	8	BS	Backspace. Moves the cursor one position to the left. If it is at the left end of the screen, nothing happens. If the line is not at the top of a scrolling region, the cursor will move up one line and be positioned to the right end of that new line.
011	9	9	HT	Tab. Moves the cursor to the beginning of the next field (foreground region — normal intensity). If there are no more fields, the cursor will not move.
012	10	A	LF	Line Feed. Moves the cursor down one line. If the cursor is on the last line of a scrolling region, the cursor will remain there and all data within the scrolling region will move up one line. Data on the top line of the scrolling region will be lost as it is scrolled out of the region. If the cursor is at the bottom of a fixed region, no action will take place.
015	13	D	CR	Carriage Return. Moves the cursor to the first character position in the current line. Nothing happens if the cursor is already at the first character position.

020	16	10	DLE	Moves the character one position to the right. If the cursor is at the right end of the line and the line is not the last line of a region, the cursor will move down one line and be placed at the first character position of the new line. If the cursor is already on the last line of the region, nothing else will happen if it is at the right end of the line.
033	27	1B	ESC	Escape.

In the following descriptions of special tilde control code sequences, the code is expressed in ASCII format. For instance, ENQ is equal to 5(decimal,hexadecimal, or octal) and DC3 is equal to 19(decimal),13(hexadecimal), or 23 (octal).

READ CURSOR ADDRESS

The current position of the cursor is reported in the form: column, line. Column positions 0_{10} to 31_{10} have 96_{10} added to them. Column positions 32_{10} to 79_{10} have 0_{10} added to them. The line numbers (0_{10} to 23_{10}) also have 96_{10} added to
them. If the cursor is currently on the third line in the tenth column, sending ~ ENQ will cause the Terminal to reply $106_{10}99_{10}(10_{10}+96_{10},3_{10}+96_{10})$.

If the cursor was at the 35th column of the same row, the Terminal would reply, $35_{10}\,99_{10}\,(35_{10}+0_{10},\,3_{10}+96_{10})$.

Code: ~ ENQ

Enable Keyboard — The keyboard is enabled after entry has been inhibited by a disable keyboard command.

Code: ~ ACK

Down Cursor — Moves the cursor down one line. If the cursor is already on the bottom line, nothing will happen.

Code: ~ VT

Up Cursor — Moves the cursor up one line. If the cursor is already on the top line, nothing will happen.

Code: ~ FF

Erase to end of line — Clears the remainder of the current line, including the cursor position. The cursor remains at the same position.

Code: ~ SI

Direct Cursor Addressing — Moves the cursor to the column and line indicated. Column positions may be represented by the decimal numbers 0_{10} to 79_{10}, although columns 0_{10} to 30_{10} may also be represented by 96_{10} to 126_{10}. Line numbers may be represented by the decimal numbers 0_{10} to 23_{10} or 96_{10} to 119_{10}. The higher ranges correspond to the cursor position report; this is the preferred method of cursor addressing for the Hazeltine 1500.

Code: ~ DC1 P_{column} P_{line}

Home Cursor — Moves the cursor to the first position of the first line.

Code: ~ DC2

Delete Line — Deletes the current line. The current line is defined as the line which the cursor is located on. The cursor does not move.

Code: ~ DC3

Disable Keyboard — Inhibits entry from the keyboard. ~ACK will cancel this command.

Code: ~ NAK

Clear and set to background to end of screen — Clears all text from the (and including the) cursor position to the end of the screen. In addition, this command will set the entire area to background spaces and leave the cursor at its current position If you want to clear the entire screen in this manner, move the cursor to the home position first. See "Home Cursor."

Code: ~ ETB

Clear and set to foreground to end of screen — Clears all text from (and including) the cursor position to the end of the screen. In addition, this command will set the entire area to foreground spaces and leave the cursor at its current position. If you want to clear the entire screen in this manner, use the "Clear Screen" command. See "Clear Screen."

Code: ~ CAN

Background Follows — All following data will be displayed as background data at half intensity. This condition will remain enabled until a "Foreground Follows" command is received. See "Foreground Follows."

Code: ~ EM

Insert Line — All text on the current line (and following) is moved down one line to allow the insertion of a new line of data. If text existed on the 24th line, or the bottom line of the defined scrolling region, it will be lost.

Code: ~ SUB

Clear Screen — The entire screen will be cleared and set to foreground spaces. The cursor will be moved to the home position (first position on the top line).

Code: ~ FS

Clear Foreground — Clears all foreground areas and moves the cursor to the home position (first position on the first line).

Code: ~ GS

Foreground Follows — All following data will be displayed as foreground data at normal intensity. This condition will remain enabled until a "Background Follows" command is received. See "Background Follows."

Code: ~ US

Appendix F

PROGRAMMER'S DATA INFORMATION

Decimal to Octal to Hex to ASCII Conversion

	ANSI MODE	HEATH/ZENITH MODE
TO ENTER GRAPHICS MODE	ESC [10 m	ESC F
TO EXIT GRAPHICS MODE	ESC [11 m	ESC G

Dec	Oct	Hex	ASCII	Alter Char	Dec	Oct	Hex	ASCII	Graphic Sym	Alter Char	Alter Graphic Sym	Dec	Oct	Hex	ASCII	Graphic Sym	Alter Char	Alter Graphic Sym
0	000	00	NUL		32	040	20	SP				64	100	40	@				96	140	60	`			
1	001	01	SOH		33	041	21	!				65	101	41	A				97	141	61	a			
2	002	02	STX		34	042	22	"				66	102	42	B				98	142	62	b			
3	003	03	ETX		35	043	23	#				67	103	43	C				99	143	63	c			
4	004	04	EOT		36	044	24	$				68	104	44	D				100	144	64	d			
5	005	05	ENQ		37	045	25	%				69	105	45	E				101	145	65	e			
6	006	06	ACK		38	046	26	&				70	106	46	F				102	146	66	f			
7	007	07	BEL		39	047	27	'				71	107	47	G				103	147	67	g			
8	010	08	BS		40	050	28	(				72	110	48	H				104	150	68	h			
9	011	09	HT		41	051	29	)				73	111	49	I				105	151	69	i			
10	012	0A	LF		42	052	2A	*				74	112	4A	J				106	152	6A	j			
11	013	0B	VT		43	053	2B	+				75	113	4B	K				107	153	6B	k			
12	014	0C	FF		44	054	2C	,				76	114	4C	L				108	154	6C	l			
13	015	0D	CR		45	055	2D	-				77	115	4D	M				109	155	6D	m			
14	016	0E	SO		46	056	2E	.				78	116	4E	N				110	156	6E	n			
15	017	0F	SI		47	057	2F	/				79	117	4F	O				111	157	6F	o			
16	020	10	DLE		48	060	30	0				80	120	50	P				112	160	70	p			
17	021	11	DC1		49	061	31	1				81	121	51	Q				113	161	71	q			
18	022	12	DC2		50	062	32	2				82	122	52	R				114	162	72	r			
19	023	13	DC3		51	063	33	3				83	123	53	S				115	163	73	s			
20	024	14	DC4		52	064	34	4				84	124	54	T				116	164	74	t			
21	025	15	NAK		53	065	35	5				85	125	55	U				117	165	75	u			
22	026	16	SYN		54	066	36	6				86	126	56	V				118	166	76	v			
23	027	17	ETB		55	067	37	7				87	127	57	W				119	167	77	w			
24	030	18	CAN		56	070	38	8				88	130	58	X				120	170	78	x			
25	031	19	EM		57	071	39	9				89	131	59	Y				121	171	79	y			
26	032	1A	SUB		58	072	3A	:				90	132	5A	Z				122	172	7A	z			
27	033	1B	ESC		59	073	3B	;				91	133	5B	[				123	173	7B	{			
28	034	1C	FS		60	074	3C	<				92	134	5C	\				124	174	7C	|			
29	035	1D	GS		61	075	3D	=				93	135	5D	]				125	175	7D	}			
30	036	1E	RS		62	076	3E	>				94	136	5E	^				126	176	7E	~			
31	037	1F	US		63	077	3F	?				95	137	5F	_				127	177	7F	DEL			

Zenith/Heath Mode	Ansi Mode	Description
Control Characters		
0 Decimal	00 Hex	NUL – Null
7 Decimal	07 Hex	BEL – Bell
8 Decimal	08 Hex	BS – Backspace
9 Decimal	09 Hex	HT – Horizontal tab (same as VT52)
10 Decimal	0A Hex	LF – Line feed
13 Decimal	0D Hex	CR – Carriage return
14 Decimal	0E Hex	SO – Shift out
15 Decimal	0F Hex	SI – Shift in
17 Decimal	11 Hex	DC1 – XON
19 Decimal	13 Hex	DC3 – XOFF
24 Decimal	18 Hex	CAN – Cancel current control sequence
27 Decimal	1B Hex	ESC – Escape
Cursor Functions		
ESC A	ESC [Pn A	Cursor up
ESC B	ESC [Pn B	Cursor down
ESC C	ESC [Pn C	Cursor forward
ESC D	ESC [Pn D	Cursor backward
ESC H	ESC [H	Cursor home
	ESC D	Index
ESC I	ESC M	Reverse index
ESC Y	ESC [Pl;Pc H	Direct cursor addressing
	or ESC [Pl;Pc f	(same as VT52)
ESC j	ESC [s	Save cursor position
ESC k	ESC [u	Set cursor to previously saved position
ESC n	ESC [6 n	Cursor position report
ESC -	ESC [Pn Z	Cursor backward tabulation
Erasing and Editing		
ESC E	ESC [2 J	Clear display (SHIFT ERASE)
ESC b	ESC [1 J	Erase beginning of display
ESC J	ESC [J	Erase to end of display (ERASE key)
ESC 1	ESC [2 K	Erase entire line
ESC o	ESC [1 K	Erase beginning of line
ESC K	ESC [K	Erase to end of line
ESC L	ESC [Pn L	Insert line
ESC M	ESC [Pn M	Delete line
	ESC [Pn @	Insert character
ESC N	ESC [Pn P	Delete character
ESC @	ESC [4 h	Enter insert character mode
ESC O	ESC [4 l	Exit insert character mode
ESC .0	ESC [0 g	Clear tab stop at cursor position
ESC .3	ESC [3 g	Clear tab stop positions
ESC .8	ESC H	Set tab stop at cursor position
Modes of Operation		
ESC <		Enter ANSI mode of operation
	ESC [? 2 h	Enter ZDS mode of operation
ESC F	ESC [10 m	Enter graphics mode
ESC G	ESC [11 m	Exit graphics mode
ESC =	ESC =	Enter alternate keypad mode
ESC >	ESC >	Exit alternate keypad mode
ESC [	ESC [> 3 h	Enter hold screen mode
ESC \	ESC [> 3 l	Exit hold screen mode
ESC s		Set attribute
	ESC [2 m	Enter half intensity mode
	ESC [4 m	Enter underline mode
	ESC [5 m	Enter blinking mode
ESC p	ESC [7 m	Enter reverse video mode
	ESC [m	Exit all attribute modes
ESC q		Exit reverse video mode
	ESC [0]	No fields are protected
	ESC [2]	Half intensity implies protection
	ESC [4]	Underline implies protection
	ESC [5]	Blinking implies protection
	ESC [7]	Reverse video implies protection
	ESC [254]	No attribute implies protection
ESC t	ESC [> 6 h	Enter keypad shifted mode
ESC u	ESC [> 6 l	Exit keypad shifted mode
	ESC (B	G0 designated as United States set
	ESC (0	G0 designated as graphic set
	ESC (1	G0 designated as alternate char set
	ESC (2	G0 designated as alt char graphic set
	ESC) B	G1 designated as United States set
	ESC) 0	G1 designated as graphic set
	ESC) 1	G1 designated as alternate char set
	ESC) 2	G1 designated as alt char graphic set
	ESC [1 h	Set GATM (transmit all data)
	ESC [1 l	Reset GATM (transmit only unprotected data)
ESC [	ESC [2 h	Disable keyboard input
ESC \	ESC [2 l	Enable keyboard input
	ESC [6 h	Set ERM (erase all data)
	ESC [6 l	Reset ERM (erase only unprotected data)
	ESC [20 h	Set LNM (auto CR on receipt of LF)
	ESC [20 l	Reset LNM (no auto CR on receipt of LF)
ESC v	ESC [? 7 h	Wrap-around at end of line
ESC w	ESC [? 7 l	Discard at end of line
Additional Functions		
ESC #	ESC [p	Transmit page
ESC '	ESC [1 p	Transmit current line
ESC _	ESC [2 p	Transmit character at cursor
ESC]	ESC [3 p	Transmit 25th line
ESC `	ESC #7	Transmit page to printer
	ESC [Pt;Pb r	Define scrolling region (top;bottom)
	ESC [Ph v	Set blinking rate (in 1/30 of second)
	ESC [Ph;Pm;Ps]	Program clock (hours;minutes;seconds)
ESC z	ESC c	Reset to power-up configuration
	ESC [z	
ESC i 0		Request terminal type (ESC i B 0)
ESC Z		Identify as VT52 (ESC / K)
	ESC [c	Identify as VT100 (ESC [? 1 ; 2 c)
	or ESC Z	

Zenith/Heath Mode	Ansi Mode	Description
Configuration		
ESC r Bn	ESC [Pn w	Modify baud rate
Bn = @	Pn = 0	75 baud
A	1	110 baud
B	2	150 baud
C	3	300 baud
D	4	600 baud
E	5	1200 baud
F	6	1800 baud
H	8	2400 baud
J	10	4800 baud
L	12	9600 baud
M	13	19200 baud
ESC x Ps	ESC [> Ps h	Set modes
	Ps = 1	Enable 25th line
	2	No key click
	3	Enter hold screen mode
	4	Block cursor
	5	Cursor off
	6	Keypad shifted
	7	Enter alternate keypad mode
	8	Auto line feed on receipt of CR
	9	Auto carriage return on receipt of LF
ESC y Ps	ESC [> Ps l	Reset Modes
	Ps = 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 carriage return
Function Keys Sequence		
ESC S	ESC O S	F1 function key
ESC T	ESC O T	F2 function key
ESC U	ESC O U	F3 function key
ESC V	ESC O V	F4 function key
ESC W	ESC O W	F5 function key
ESC P	ESC O P	F6 function key (Z-19 BLUE key)
ESC Q	ESC O Q	F7 function key (Z-19 RED key)
ESC R	ESC O R	F8 function key (Z-19 GRAY key)
ESC 0 !	ESC O X	F9 function key
ESC "	ESC ["	HELP function key
Alternate Keypad Sequence		
ESC ? M	ESC O M	"Enter" key
ESC ? l	ESC O l	"," (comma) key
ESC ? m	ESC O m	"-" (minus) key
ESC ? n	ESC O n	"." (period) key
ESC ? p	ESC O p	"0" key
ESC ? q	ESC O q	"1" key
ESC ? r	ESC O r	"2" key
ESC ? s	ESC O s	"3" key
ESC ? t	ESC O t	"4" key
ESC ? u	ESC O u	"5" key
ESC ? v	ESC O v	"6" key
ESC ? w	ESC O w	"7" key
ESC ? x	ESC O x	"8" key
ESC ? y	ESC O y	"9" key

ANSI modes which are always considered to be in SET or RESET states, and those which do not apply to this product, are:

CRM	Control Representation Mode	RESET
EBM	Editing Boundary Mode	RESET
FEAM	Format Effector Action Mode	RESET
FETM	Format Effector Transfer Mode	RESET
HEM	Horizontal Editing Mode	RESET
MATM	Multiple Area Transfer Mode	N/A
PUM	Positioning Area Transfer Mode	RESET
SATM	Selected Area Transfer Mode	SET
SEM	Select Editing Extent Mode	Edit In Line
SRM	Send – Receive Mode	SET
SRTM	Status Report Transfer Mode	N/A
TSM	Tabulation Stop Mode	RESET
TTM	Transfer Termination Mode	SET
VEM	Vertical Editing Mode	RESET

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH COMPANY • BENTON HARBOR, MICHIGAN

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