

**“ZRT 80”
CRT TERMINAL BOARD**

**DIGITAL RESEARCH COMPUTERS
P.O. BOX 461565
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Theory of Operation

PROCESSOR CLOCK GENERATOR:

The processor clock is generated by the INS8250. The oscillator runs at 2.4576 MHz and is buffered by Z28 to drive the processor and CRT Controller. The duty cycle is controlled by R12 and R13. The INS8250 uses this clock to generate baud rates by dividing the clock by a divisor programmed into the INS8250.

CENTRAL PROCESSOR UNIT:

The CPU is a Z-80 and is used to control the operation of the video terminal. The CPU programs the video circuitry and the serial I/O (Input/Output) for proper operation then receives characters and places them on the screen. The RESET is generated at power up by C3, and may be activated at any time by closing the external reset switch. This signal is squared up and buffered by Z4 to drive the processor and peripherals.

SELECT LOGIC:

All I/O ports are enabled by Z11, a 74LS138 decoder. The outputs are enabled during an I/O cycle that is not an interrupt response. The memory is enabled by Z37, a 74LS139 decoder. Each bank of memory is enabled during a memory cycle.

CPU MEMORY:

The memory for the CPU consists of up to 8K ROM containing the program, and 1K of scratchpad RAM. The board normally requires only one 2732 EPROM for firmware, however another 2732 may be installed to expand the program. Z25 is the first EPROM and is addressed from 0000H to 0FFFH. Z24 is the second EPROM and is addressed from 1000H to 1FFFH. The first EPROM is enabled when A12 is low, the second is enabled when A12 is high. The RAM is provided by two 2114's addressed from 4000H to 43FFH.

KEYBOARD INPUT:

A parallel ASCII keyboard is connected to an input port at J3. The strobe from the keyboard is inverted if necessary by Z17, and used to generate a Non-Maskable Interrupt (NMI) for the CPU. The interrupt service routine reads the data from the port (Z7) when a key is pressed. Switch 1, position 7 should be closed for a negative keyboard strobe, and open for a positive keyboard strobe.

CONFIGURATION SWITCHES:

Two 8-position dip switches are provided to select the configuration of the terminal after reset. The switch outputs go to two input ports (Z6,Z9). The switches are read by the program to control the operating parameters.

SERIAL I/O:

All serial I/O functions are provided by an INS8250 Asynchronous Communications Element (ACE). It provides a Universal Asynchronous Receiver/Transmitter (UART), a baud rate generator, and parallel I/O in a single package. All operating parameters of this device are programmed by the CPU. The serial output from the ACE is buffered by an MC1488 to drive the RS-232 lines. Each RS-232 serial input is received by an MC1489 and sent to the ACE. The transmit and receive functions are enabled by the Clear To Send (CTS) and Data Terminal Ready (DTR) RS-232 inputs. Each must be high during normal operation. If the handshaking lines (DSR,CTS,DCD) are not used, they may be left floating and the terminal will still operate. This allows the terminal to be connected to a computer with only three wires (TxD,RxD,GND).

BEEPER OUTPUT:

The beeper is controlled by a 74LS123 dual one shot (Z10). There are two different tone durations, the longer is for the bell character (^G) and the other is for the end of line beep. The duration of the tones is controlled by the RC time constants set by C7 R8, and C8 R7. The outputs are gated together with Z16 to drive the beeper. A switch is included for peace and quiet.

DOT CLOCK:

A second crystal oscillator provides a clock signal to drive the video circuit. The oscillator normally runs at 20.000 MHz but may be run at other rates to accomodate various screen formats. An N-channel JFET forms a Pierce oscillator with crystal Y1. A resonant tank is formed by L1 and C23 to force oscillations at the correct frequency. C23 is adjusted to provide maximum amplitude at the correct frequency. The oscillator will work with either a fundamental or third overtone series resonant crystal. The oscillator output is buffered by an inverter (Z28) to drive the video circuitry. The clock is then divided by 10 to get the character rate, nominally 2.000 MHz.

CRT CONTROLLER:

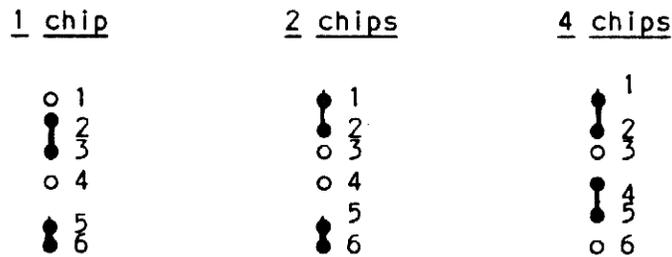
The CRT Controller (Z19) is used to provide the timing signals necessary to generate video. The CRTC provides horizontal and vertical sync, blanking, cursor, and address signals. The operating parameters of the CRTC are programmed by the CPU. The address outputs of the CRTC address the characters on the screen, and select which row of the character to generate.

SCREEN MEMORY:

Every character on the screen must be stored in RAM so that it can be refreshed on the CRT screen. This refresh memory consists of Z32, Z33, Z34, Z35. Only enough memory needs to be installed for the screen format being used; each RAM chip provides 2048 characters of storage. Jumpers labelled 1-6 tell the select logic (Z37) whether 1, 2, or 4 chips have been installed. If an 80 x 25 display is desired (2000 characters), then only 1 RAM needs to be installed at Z35. If two RAMs are selected, then they are installed at Z35, Z34. When the processor accesses the screen memory, the 74LS245 bus driver (Z36) becomes active and the CPU addresses are selected by the multiplexers (Z20-23). The memory write line is also selected by the multiplexers. Any time the CPU is not accessing the screen memory, the memory is connected to the CRTC to read out characters on the screen. Bits 0-6 represent the ASCII character, while bit 7 indicates inverse video (black on white).

JUMPER CONFIGURATION:

Jumpers are installed to select the number of screen RAM chips installed.



CHARACTER GENERATOR:

When a character is being displayed on the screen, its ASCII value appears at the output of the screen RAM. This character is then latched by Z31 and sent to the character generator EPROM (Z30). The output of the EPROM corresponds to the dot pattern that appears on the screen. This data is serialized by a shift register (Z29). The video is then put through an exclusive or gate (Z17) to get inverse video, and blanked by Z16.

The character generator is normally a 2716 EPROM. A 2732 may be used to get two fonts. The fonts are selected with an output bit on the 8250 under software control. A jumper is installed to select a 2716 or 2732.



VIDEO COMBINER AND OUTPUT:

The vertical and horizontal sync pulses from the CRTC are buffered by Z1 and connected to the video connector, J1. Composite sync is generated by ex-oring the two sync lines. The NTSC composite video output is generated by combining the video and composite sync signals with resistors R3 and R4, then buffering this with Q1. A 75 ohm resistor reduces the output level to 1 volt, and provides a 75 ohm source impedance to drive the video monitor.

SEPERATE VIDEO OUTPUTS:

Outputs are generated to drive monitors requiring seperate sync and video. Available are video, composite sync, horizontal sync, and vertical sync. Each output has a switch and an exclusive-or gate to change the polarity. The switch is closed to get positive sync or video. The pulse width of each sync output is controlled by the CRTC.

INTERRUPTS:

Both interrupt inputs are used on the Z-80 to service input devices. Pressing a key causes a non-maskable interrupt; the UART causes an interrupt when it has received a character. Each interrupt service routine reads the character and processes it.

POWER SUPPLIES:

The board requires three power supplies. The terminal will function on +5V only; however the RS-232 line drivers require +12V for operation. The ± 12V supplies are also supplied to the keyboard if it requires them.

CONNECTORS

J1: VIDEO CONNECTOR

| | | | | |
|----------|------|------|----|-----------------|
| Ground 1 | ---o | o--- | 2 | Seperate Video |
| Ground 3 | ---o | o--- | 4 | Horizontal Sync |
| Ground 5 | ---o | o--- | 6 | Vertical Sync |
| Ground 7 | ---o | o--- | 8 | Composite Sync |
| Ground 9 | ---o | o--- | 10 | Composite Video |

Sync lines should be connected with ribbon cable, twisted pairs, or coax lines. Video outputs should be connected with 75 ohm coax.

J2: POWER CONNECTOR:

| | | |
|------|---|--|
| o--- | 8 | Beeper output (connect negative terminal here, positive terminal to +5V) |
| o--- | 7 | L.E.D. output (Cathode goes here, anode goes through 220 ohm series resistor to +5V) |
| o--- | 6 | Reset input (connect normally open pushbutton switch to ground) |
| o--- | 5 | Ground for reset switch |
| o--- | 4 | +12V input, 80 mA + requirements of keyboard |
| o--- | 3 | +5V input, 900 mA + requirements of keyboard |
| o--- | 2 | Ground, for power supplies |
| o--- | 1 | -12V input, 80 mA + requirements of keyboard |

J3: KEYBOARD CONNECTOR

| | | | | |
|------------------|-------|------|----|-----------|
| Bit 0 | 1--- | o--- | 2 | Ground |
| Bit 1 | 3--- | o--- | 4 | Ground |
| Bit 2 | 5--- | o--- | 6 | Ground |
| Bit 3 | 7--- | o--- | 8 | Ground |
| Bit 4 | 9--- | o--- | 10 | Ground |
| Bit 5 | 11--- | o--- | 12 | Ground |
| Bit 6 | 13--- | o--- | 14 | Ground |
| Alternate Keypad | 15--- | o--- | 16 | Ground |
| Strobe | 17--- | o--- | 18 | Caps Lock |
| +12V | 19--- | o--- | 20 | +12V |
| Ground | 21--- | o--- | 22 | -12V |
| -12V | 23--- | o--- | 24 | +5V |
| +5V | 25--- | o--- | 26 | +5V |

The keyboard must provide 7 bits parallel ASCII with either positive or negative strobe. The strobe input is edge triggered. The Alternate Keypad, Reset, and Caps Lock inputs are switched to ground to perform the indicated function. All inputs are LS TTL compatible.

J4: SWITCH CONNECTOR

| | | | | | |
|-----------|-------|---|------|----|--------|
| Ground | 1--- | o | o--- | 2 | Ground |
| Caps Lock | 3--- | o | o--- | 4 | Reset |
| SW3-8 | 5--- | o | o--- | 6 | SW2-7 |
| SW3-7 | 7--- | o | o--- | 8 | SW2-8 |
| SW3-6 | 9--- | o | o--- | 10 | SW2-4 |
| SW3-5 | 11--- | o | o--- | 12 | SW2-3 |
| SW3-1 | 13--- | o | o--- | 14 | SW2-2 |
| SW3-2 | 15--- | o | o--- | 16 | SW2-1 |
| SW3-3 | 17--- | o | o--- | 18 | SW2-5 |
| SW3-4 | 19--- | o | o--- | 20 | SW2-6 |

Switch 2 and Switch 3 inputs are available at this connector so external switches may be attached. Each input is a contact closure to ground. Closing the switch turns on the indicated function. External switches may be attached for such functions as Line/Local, Local Copy, Caps Lock, etc.

J5: RS-232 CONNECTOR

| | | | | | | |
|---|-------------------|-------|---|------|----|-----------------------|
| | Protective Ground | 1--- | o | o--- | 14 | |
| 0 | Transmit Data | 2--- | o | o--- | 15 | |
| 1 | Receive Data | 3--- | o | o--- | 16 | |
| 0 | Request To Send | 4--- | o | o--- | 17 | |
| 1 | Clear To Send | 5--- | o | o--- | 18 | |
| 1 | Data Set Ready | 6--- | o | o--- | 19 | |
| | Signal Ground | 7--- | o | o--- | 20 | Data Terminal Ready 0 |
| 1 | Carrier Detect | 8--- | o | o--- | 21 | |
| | | 9--- | o | o--- | 22 | |
| | | 10--- | o | o--- | 23 | |
| | | 11--- | o | o--- | 24 | |
| | | 12--- | o | o--- | 25 | |
| | | 13--- | o | o--- | 26 | |

These pins may be connected directly to a DB-25 connector. If handshaking is not needed, then use only pins 2,3, and 7. Pin 1 is used as a chassis ground. 0's and 1's indicate inputs and outputs.

DIP SWITCH ASSIGNMENTS

0 indicates closed switch, 1 indicates open switch
Switches have effect at any time except as noted.

DIP Switch 1:

position

- 1 0 Positive Composite Sync
 1 Negative Composite Sync

- 2 0 Positive Vertical Sync
 1 Negative Vertical Sync

- 3 0 Positive Video
 1 Negative Video

- 4 0 Alternate Keypad (disregard "CAPS" on comp.legend)
 1 Numeric Keypad

- 5 0 Positive Horizontal Sync
 1 Negative Horizontal Sync

- 6 0 CPU reset
 1 CPU operating

- 7 0 Negative keyboard strobe
 1 Positive keyboard strobe

- 8 0 Beeper enable
 1 Beeper silent

DIP Switch 2:

- 1234 0000--50 baud (active only at power-up and reset)
 1000--75 baud
 0100--110 baud
 1100--134.5 baud
 0010--150 baud
 1010--300 baud
 0110--600 baud
 1110--1200 baud
 0001--1800 baud
 1001--2000 baud
 0101--2400 baud
 1101--3600 baud
 0011--4800 baud
 1011--7200 baud
 0111--9600 baud
 1111--19,200 baud

- 56 00--transmit odd parity
 10--transmit even parity
 01--transmit marking parity bit
 11--transmit spacing parity bit

- 7 0--use xon/xoff protocol
 1--use CTS line for handshaking

- 8 0--auto line feed on carriage return
 1--carriage return does not line feed
 (active at power-up only and reset)

DIP Switch 3:

- 123 000--96 chrs x 24 lines, 15750 hz horiz, 50 hz vert
 100--80 48 15750 50
 010--80 24 15750 50
 110--96 24 15750 60
 001--80 48 18700 60
 101--80 24 17540 60
 011--80 48 15750 60
 111--80 24 15750 60
 (active at power-up only and reset)

- 45 00--Emulate: Adds
 10--Emulate: Beehive
 01--Emulate: LSI ADM-3
 11--Emulate: Heath H-19

- 6 0--Local
 1--Line

- 7 0--Local Copy (half duplex)
 1--Full Duplex

- 8 0--Wraparound mode
 1--Wraparound mode disabled
 (active at power-up only)

SUMMARY OF TERMINAL COMMANDS

Cursor Functions

Carriage Return: Returns cursor to left margin (column 1). This may optionally generate line feed.

Line Feed: Moves cursor down one line. If cursor is at bottom of screen, the text is scrolled up one line and a blank line is entered at the bottom. This may optionally generate a carriage return.

Back Space: Moves the cursor one character position to the left. The cursor will stop at left margin.

Tab: Moves the cursor to tab stop. Tab stops are preset at columns 8,16,24,32,....

Home: Moves cursor to the first character position on the first line. (Upper lefthand corner of the screen.)

Up: Moves cursor up one line, stops at the top of the screen. (Will not scroll the display.)

Down: Moves cursor down one line, stops at the bottom of the screen. (Will not scroll the display.)

Right: Moves cursor one character position to the right. Cursor will stop at right margin.

Left: Moves cursor one character position to the left. Cursor will stop at left margin.

Reverse Line Feed: Moves cursor up one line; when cursor reaches the top of the screen the text will scroll down one line.

Direct Cursor Addressing: Allows direct positioning of the cursor. It requires line+31 (ASCII character) then column+31 (ASCII character) following escape sequence. EXAMPLE: If you wanted to position the cursor in the fifth column of the twentieth line you would send the ZRT-80 (H-19 Mode) Esc Y3\$. The ASCII °3° has the value 51 (decimal); 20+31=51. The °\$° has the value 36; 5+31=36. Any line specified greater than the length of the screen will access the status line. (Note that it must be turned on with ESC x 1.

Read Cursor Address: Reports the current cursor position in the form Esc Y line#+31 (ASCII Character) column#+31 (ASCII Character).

Save Cursor Position: The current cursor position is saved so that the cursor can later be returned to this position with a single command. This is useful for changing the status line.

Recall Cursor Position: The cursor is returned to the position previously saved with the **Save Cursor Position** command.

Editing and Erasing

Clear Display: Erases the screen and returns the cursor to the home position.

Erase to Top: Erases the screen from the start of the display to the cursor position, inclusive.

Erase to End: Erases the screen from the cursor position to the end of the display, inclusive.

Erase Line: Erases the entire line that the cursor is on.

Erase Left: Erases characters to the left of the cursor and under the cursor, on the same line.

Erase Right: Erases characters to the right of the cursor including the cursor position.

Delete Line: Deletes the entire line that the cursor is on; the cursor is moved to the beginning of the next line and the following display is moved up one line. A blank line is added at the bottom of the screen.

Insert Character: Move characters from cursor to right end of line one character position right, insert a blank under the cursor. The last character on the line is lost.

Insert Character Mode: Automatically moves characters to the right of cursor and places each character entered at the cursor.

Insert Character Mode Off: Exits from the **Insert Character Mode**.

Delete Character: Deletes the character under the cursor. Any characters to the right of the cursor, on the same line, are moved to the left one character position.

Mode Control

Disable Keyboard: In this mode the ZRT-80 will ignore any entry from the keyboard. (Keyboard Lockout)

Enable Keyboard: Re-establishes keyboard input.

Reverse Video: Screen will display dark characters on a light background. Can be used on a character by character basis. This mode stays in effect until the next Normal Video sequence.

Normal Video: Screen will display light characters on a dark background. (Default Setting)

Enter Graphics Mode: Allows special characters or graphic symbols located in the first 32 locations (0 - 31) of the character generator EPROM (Z30). Lower case characters are displayed as special symbols; other characters are treated normally.

Exit Graphics Mode: Returns to normal character mode.

Wrap Around On: Cursor automatically moves to next line when it reaches the end of line. (Default set by switch)

Wrap Around Off: Disables **Wrap Around** mode.

Alternate Character Set: This command enables the second character set if a 2732 type EPROM is used for the character generator. Option pin #8 must be jumpered to option pin #9 if a 2732 EPROM is used in place of a 2716.

Normal Character Set: As above, reselects the first character set in the character generator EPROM.

Cursor On/Off: Alternately enables and disables the cursor.

Next Character Graphic: The next character received will be interpreted as a graphic character (see Graphics Mode)

Set Mode Controls: This command allows various operating modes to be enabled via the keyboard or under software control. The format is ESC x 0 - 9 as follows: (Heath H-19 Emulation)

- 0 Blinking Cursor (Default Setting)
- 1 Status Line On (at bottom of screen)
- 2 End of Line Beep Off
- 4 Block Character Cursor (Default Setting)
- 5 No Cursor
- 8 Auto Line Feed: Line Feed automatically generated with each Carriage Return. (default set by switch)
- 9 Auto Carriage Return: Carriage Return automatically generated with each Line Feed

Reset Mode Controls: Disables the modes set by the **Set Mode Controls** command. Format is ESC y 0 - 9 as follows:

- 0 No Blinking Cursor
- 1 No Status Line (Default Setting)
- 2 End of Line Beep On (Default Setting)
- 4 Underscore Cursor
- 5 Enable Cursor (Default Setting)
- 8 Auto Line Feed Off (Default set by switch)
- 9 Auto Carriage Return Off (Default Setting)

Set Baud Rate: Allows the ZRT-80's serial baud rate to be changed via the escape command ESC r @ - 0 as follows:

- @ = 19200
- A = 9600
- B = 7200
- C = 4800
- D = 3600
- E = 2400
- F = 2000
- G = 1800
- H = 1200
- I = 600
- J = 300
- K = 150
- L = 134.5
- M = 110
- N = 75
- O = 50

Test Mode: Selects one of four test routines. These are useful for debugging the terminal and application software. Format is ESC t 1 - 4 (H-19 Mode)

- 1 Terminal prints every character received including all control and escape codes. The only way to exit this mode is to reset the terminal.
- 2 Fills the screen with a pattern of all the characters in the character generator EPROM in both normal and reverse video.
- 3 Fills entire screen with the same character.

- 4 Allows the CTRC registers to be changed.
See software listing for information.

Set CRTC Mode: This sets the screen format and scanning rates used by the video monitor. The next character defines the mode:

| <u>Chr</u> | <u>Cols</u> | <u>Lines</u> | <u>Horizontal</u> | <u>Vertical</u> |
|------------|-------------|--------------|-------------------|-----------------|
| @ = | 80 x | 24 | 15,750Hz | 60Hz |
| A = | 80 x | 48 | 15,750 | 60 |
| B = | 80 x | 24 | 17,540 | 60 |
| C = | 80 x | 48 | 18,700 | 60 |
| D = | 96 x | 24 | 15,750 | 60 |
| E = | 80 x | 24 | 15,750 | 50 |
| F = | 80 x | 48 | 15,750 | 50 |
| G = | 96 x | 24 | 15,750 | 50 |

Reset to Power-On State: Restores the ZRT-80 to the power-on configuration according to the setting of dipswitches S2 and S3, ignoring any previously entered Escape commands.

Miscellaneous

Escape: Starts an escape sequence. The following character will be interpreted as a command to perform some action or set a mode.

Bell: Sounds the bell.

BASIC OPERATION

The following conditions are necessary for the initial operation and checkout of the ZRT-80 in the local mode:

- 1) A parallel ASCII keyboard must be connected at J3.
- 2) A suitable power supply must be connected at J2.
- 3) A standard video monitor (60Hz vertical, 15750Hz horizontal sweep rates) must be connected at J1.
- 4) Nothing should be connected to J4 or J5.

(See Theory of Operation section for connector pinouts)

The ZRT-80 board should be configured as follows:

- 5) One 6116 type RAM should be installed at Z35. Jumper option pins 2-3 and 5-6 (See Memory section in Theory of Operation).
- 6) The 2716 type character generator EPROM supplied with the kit should be in location Z30. Jumper option pins 7-8.
- 7) Turn **OFF** all dipswitches except switch #6 on dipswitch S3 which should be on.
- 8) Apply power to the board. The red LED should light indicating the processor is operating properly.
- 9) Adjust the variable capacitor, C23, until a clear display appears. The control should be set to the middle of the range that provides a good display.

10) The monitor should now display a clear screen with a blinking block cursor in the upper left hand corner. The ZRT-80 is now functioning in the Heath H-19 emulation, local mode. In this condition the ZRT-80 will act as a "TV typewriter" displaying whatever characters are typed on the keyboard. Entering the escape sequence **ESC † 2** will display a test pattern showing the entire character set in both normal and reverse video. Provided the ZRT-80 is operating as indicated you should now reconfigure the system for your specific application as necessary.

TERMINAL INTERFACING

J5 is an RS-232 compatible port for connecting the ZRT-80 to external computer equipment via a modem or a direct hardwired connection. If handshaking is not required only lines 2,3 and 7

are necessary for operation, otherwise additional lines must be connected as required. J5 is configured as "data terminal equipment" (DTE); if ribbon cable and IDC type connectors are used the lines will match up properly in the RS-232/DB-25 pinout.

DISPLAY AND EMULATION MODES

Screen Formats

By virtue of the fact that the CRTIC (Z19) is register programmable the ZRT-80 can generate various display formats. Switches #1,2 and 3 on dipswitch S3 select one of eight firmware supported screen formats. For general operation the 80 column by 24 line, 60Hz vertical, 15750Hz horizontal format is used. The higher resolution formats with a large number of lines, i.e. 80 x 48, will use interlaced video. This will produce some flickering on short persistence phosphor monitors.

The terminal board can be used with a very wide variety of video monitors or screen formats with special programming. The source code is available so it can be modified. It is recommended that only experienced programmers modify the source code.

Terminal Emulation

Switches #4 and 5 on dipswitch S3 select which terminal type the ZRT-80 will emulate. This affords the ZRT-80 escape code and control code compatibility with the types of terminals most often specified for use with off the shelf software. It should be noted that the degree of emulation will not be absolute in all regards but should prove to be completely satisfactory in most applications; the Heath H-19 emulation offers the greatest versatility. A listing of the control codes and escape codes for each emulation is provided for easy comparison.

Parts List

CHIPS:

| NUMBER | DEVICE | COMMENTS |
|--------|-----------|---------------------------------------|
| Z1 | 74196 | dot clock divider (or Sig.8290A) |
| Z2 | 74LS86 | video output buffer |
| Z4 | 74LS14 | schmitt trigger |
| Z6 | 74LS244 | S2 input port |
| Z7 | 74LS244 | keyboard input port |
| Z9 | 74LS244 | S1 input port |
| Z10 | 74LS123 | beeper one shot |
| Z11 | 74LS138 | port selection |
| Z12 | Z-80 CPU | CPU |
| Z13 | INS8250-B | serial I/O |
| Z14 | MC1489 | RS-232 input (or 75189) |
| Z15 | MC1488 | RS-232 output (or 75188) |
| Z16 | 74LS08 | and gate |
| Z17 | 74LS86 | xor gate for video |
| Z18 | 74LS175 | latch for video |
| Z19 | HD46505S | CRT Controller (Hitachi 6845SP) |
| Z20 | 74LS157 | address MUX |
| Z21 | 74LS157 | address MUX |
| Z22 | 74LS157 | address MUX |
| Z23 | 74LS157 | address MUX |
| Z24 | 2732 | * additional firmware |
| Z25 | 2732 | standard firmware (ZRT ROM) |
| Z26 | 2114 | scratchpad RAM |
| Z27 | 2114 | scratchpad RAM |
| Z28 | 74LS04 | inverter |
| Z29 | 74166 | video shift register |
| Z30 | 2716 | character generator |
| Z31 | 74LS374 | character latch |
| Z32 | 6116 | * screen RAM 3 |
| Z33 | 6116 | * screen RAM 2 |
| Z34 | 6116 | * screen RAM 1 |
| Z35 | 6116 | screen RAM 0 (also 2016 or 8725 rams) |
| Z36 | 74LS245 | data bus buffer |
| Z37 | 74LS139 | memory decoder |

* Indicates optional part, not included in basic kit

RESISTORS

| NUMBER | PART |
|--------|---|
| Z3 | 4.7k resistor pack (10 pin SIP, pin 1 common) |
| Z5 | 4.7k resistor pack " " " " " |
| Z8 | 4.7k resistor pack " " " " " |
| R1 | 1 K |
| R2 | 330 |
| R3 | 1K |
| R4 | 680 |
| R5 | 75 |
| R6 | 150 |
| R7 | 220K |
| R8 | 220K |

R9 4.7K
 R10 4.7K
 R11 4.7K
 R12 2.2M
 R13 1.0M
 R14 10K
 R15 330
 R16 4.7K
 R17 100K

All resistors 1/4 watt

SOCKETS

8- 14 pin low profile sockets
 9- 16 pin "
 2- 18 pin "
 2- 20 pin "
 3- 24 pin "
 3- 40 pin "

CAPACITORS

| NUMBER | PART |
|--------|--------------------------------|
| C3 | 100 uf/10V alum. electrolytic |
| C4 | 22uF or greater / 10V tantalum |
| C7 | 1uF / 10V tant. |
| C8 | 4.7 uF / 10V tant. |
| C20 | 150 pF |
| C22 | 15 pF |
| C23 | 10-30 pF variable |
| C36 | 100 pF |

All other capacitors (28) are 0.01 uF to 0.1 uF bypass caps

OTHER

Y1 20.000 MHz crystal HC18
 Y2 2.4576 MHz crystal HC33

Q1 2N3904 or 2N2222
 Q2 2N5485 or equivalent

L1 10 uH RFC

D1 1N4148
 D2 LED

J1 10 pin header (video)
 J2 8 position terminal strip (power conn.)
 J3 26 pin header (keyboard)
 J4 20 pin header
 J5 26 pin header (RS232)

S1,S2,S3- 8 position DIP switches

3- Jumper Blocks

1- 3 pin jumper post

1- 6 pin jumper post

ESCAPE CODE AND CONTROL CODE TABLE

| Function | H-19 | | ADM-3A | | BEEHIVE | | ADDS 200 | |
|----------------------------|--------|---------|--------|---------|---------|---------|----------|---------|
| | Escape | Control | Escape | Control | Escape | Control | Escape | Control |
| <u>Cursor Function</u> | | | | | | | | |
| Carriage Return | | M | | M | | M | | M |
| Line Feed | | J | | J | | J | | J |
| Back Space | | H | | H | | H | | H |
| Tab | | I | | I | | I | | I |
| Home | H | | H | ^ | H | | | A |
| Up | A | | A | K | A | | | |
| Down | B | | B | | B | | | |
| Right | C | | C | L | C | | | F |
| Left | D | | D | | D | | | U |
| Reverse Line Feed | I | | I | | | | | |
| Direct Cursor Addressing | Y | | = | | F, Y | | Y | |
| Read Cursor Address | n | | n | | G, \ | | | |
| Save Cursor Position | j | | j | | | | | |
| Recall Cursor Position | k | | k | | | | | |
| <u>Editing and Erasing</u> | | | | | | | | |
| Clear Display | E | | E | Z | E | | | L |
| Erase to Top | b | | b | | | | | |
| Erase to End | J | | J | | J | | k | |
| Erase Line | l | | l | | | | | |
| Erase Left | o | | o | | | | | |
| Erase Right | K | | K | | K | | K | |
| Insert Line | L | | L | | L | | M | |
| Delete Line | M | | M | | M | | l | |
| Insert Character | | | | | | | F | |
| Insert Character Mode | @ | | @ | | Q | | F | |
| Insert Chr. Mode OFF | O | | O | | @ | | | |
| Delete Character | N | | N | | P | | E | |
| <u>Mode Control</u> | | | | | | | | |
| Disable Keyboard | } | | } | Q | c | | | Y |
| Enable Keyboard | { | | { | N | b | | | B |
| Reverse Video | p | | p | | l | | | |
| Normal Video | q | | q | | m | | | |
| Enter Graphics Mode | F | | F | | R | | | |
| Exit Graphics Mode | G | | G | | S | | | |
| Wrap Around On | v | | v | | | | | |
| Wrap Around Off | w | | w | | | | | |
| Alternate Character Set | f | | f | | | | | |
| Normal Character Set | g | | g | | | | | |
| Cursor On/Off | | | | | Z | | | |
| Next Character Graphic | | | | | | | Z | |
| Set Mode Controls | x | | x | | | | | |
| Reset Mode Controls | y | | y | | | | | |
| Set Baud Rate | r | | r | | 7 | | A | |
| Test Mode | t | | t | | | | | |
| Set CRTC mode | s | | s | | | | | |
| Reset to Power-On State | z | | z | | V | | s | |
| <u>Miscellaneous</u> | | | | | | | | |
| Escape | | [| | [| | [| | [|
| Bell | | G | | G | | G | | G |