

VT52 DECscope Maintenance Manual

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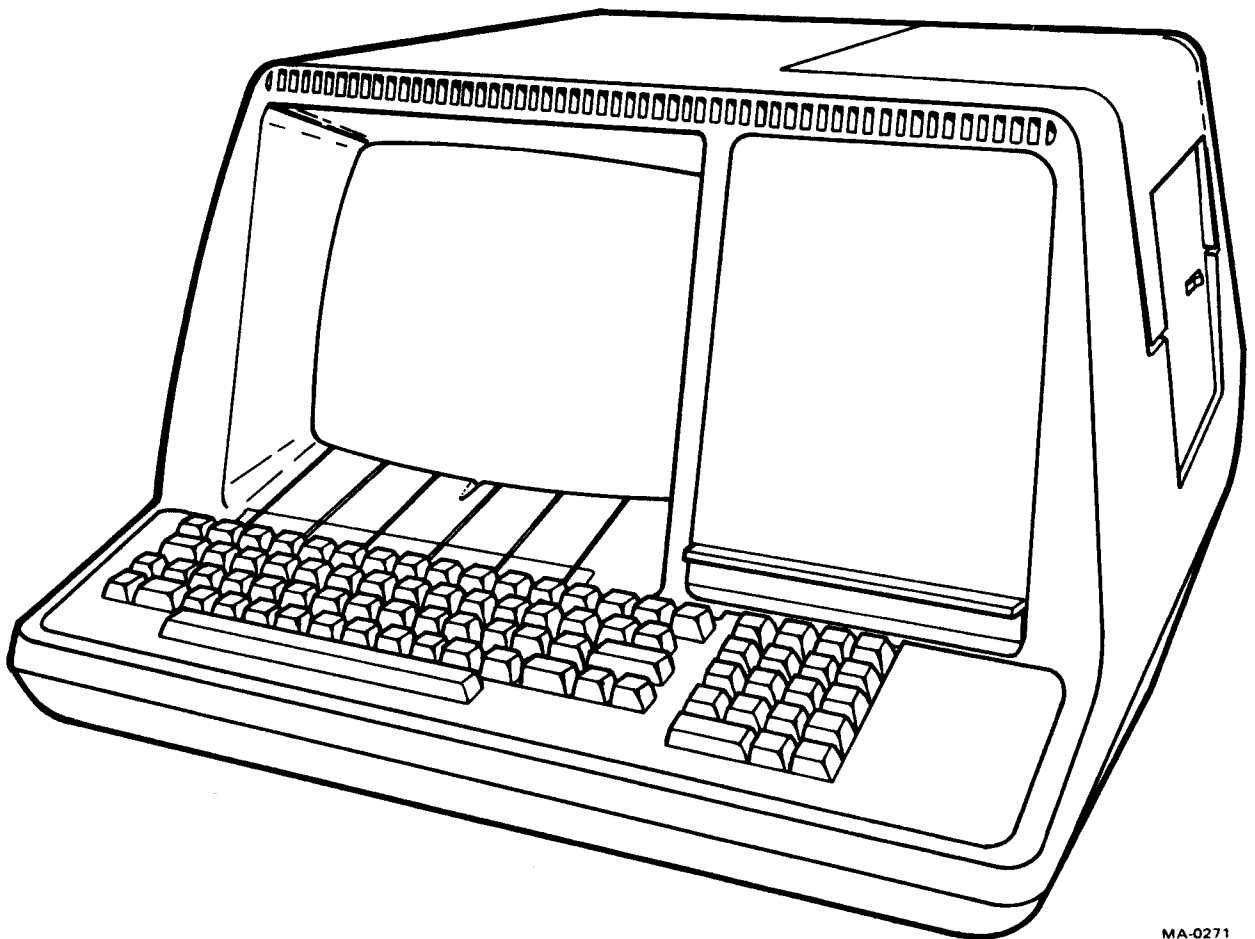
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CHAPTER 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The VT52 Video Display Terminal (Figure 1-1) is a 24-line, 80-character display terminal that serves as an input/output device to a host processor. It transmits and receives data at speeds up to 9600 baud. The main keyboard uses a standard typewriter layout that supplies upper- and lowercase alphabetic characters as well as numeric, symbol, and control characters to a host. A 7×7 dot matrix is used to form the displayable characters. All input, output, and display operations are controlled by a ROM resident microprogram.



MA-0271

Figure 1-1 VT52 Video Display Terminal

1.2 FEATURES

Design features of the VT52 include a 19-key auxiliary keyboard for applications requiring much numeric input, and a Hold-Screen mode for operator control of processor files. These and other features are described in the following paragraphs.

1.2.1 19-Key Auxiliary Keypad

This feature allows the operator to use the convenient 19-key numeric pad in applications requiring much numeric input. In one mode, numeric keys from the pad transmit the same code as numeric keys from the main keyboard. In the Alternate-Keypad mode, each key transmits a unique Escape Sequence that is used to invoke a user-defined function.

The three blank keys on the pad also transmit a unique Escape Sequence and can be defined by the customer for his own particular application.

Four cursor control keys transmit unique Escape Sequences that will move the cursor one position UP, DOWN, LEFT, or RIGHT, in the direction of the arrow, if the code produced by the key is echoed back to the terminal by the host.

1.2.2 Hold-Screen Mode

The Hold-Screen mode allows the operator to regulate the speed of the data received from the host and displayed on the screen. Normally, the host transmits data at a rate that is too fast for the operator to read; as the host adds new information to the bottom line, the information on the top line is scrolled off and lost forever to the operator. When in Hold-Screen mode, the terminal will not process information that would cause a line scroll until requested to do so by the operator. The operator can request a new line of characters by typing SCROLL or a new screenful of characters by typing SHIFT, SCROLL.

1.2.3 Direct Cursor Addressing

Direct cursor addressing allows the host to move the cursor to any position on the screen by transmitting an Escape Sequence to the terminal. Cursor positioning commands are defined in Chapter 3.

1.2.4 Identification Feature

This feature allows the host software to poll every terminal on the system, requesting each to identify itself. The VT52 will automatically respond with a 3-character Escape Sequence that identifies it as a VT52. This allows the VT52 to be mixed with other terminals in a system with the software responding correctly to each different type of terminal.

1.2.5 Terminal Interface

The VT52 is available with either the 20 mA current loop interface or, if ordered by the customer, a standard EIA interface.

1.2.6 Copier Option

An electrolytic copier is available to provide hard copy capability to the terminal. The copier can print a screenful of information or print the information one line at a time.

1.2.7 Printer Interface Option

The Printer Interface Option VTXK-KA is a field installable option available on all new VT52s and certain units already in the field. It provides a data path between the VT52 Video Terminal and a serial or parallel printer such as the LA36 or LA180.

1.3 VT52 SPECIFICATIONS

Dimensions	Height: 360 mm (14.1 in) Width: 530 mm (20.9 in) Depth: 690 mm (27.2 in) Minimum Table Depth: 450 mm (17.7 in)
Weight	20 kg (44 lbs)
Operating Environment	DEC STD 102 – Class B Environment 10° C to 40° C (50° F to 104° F)
Relative Humidity	10% to 90%
Maximum Wet Bulb	28° C (82° F)
Minimum Dew Point	2° C (36° F)
Line Voltage	U.S. model: 100–126 V (115 V nominal) European model: 191–238 V or 209–260 V (220/240 V nominal switch selectable)
Line Frequency	U.S. model: 60 ± 1 Hz European model: 60 ± 1 Hz or 50 ± 1 Hz
Power Consumption	110 Watts
Power Line Hash Filter	Low-leakage Balun type
Display	
Format	24 lines × 80 characters
Character	7 × 7 dot matrix
Character Size	2.4 mm × 3.4 mm (0.08 in × 0.16 in)
Active Display Size	218 mm × 114 mm (8.6 in × 4.5 in)
Character Set	96-character displayable ASCII subset (upper- and lowercase, numeric, and punctuation)
Keyboard	
Character Set	Complete 7-bit ASCII set (128 codes)
Key Layout	Typewriter – rather than keypunch – format; 63 keys
Auxiliary Keypad	19-keys: numerals, cursor-movement, three user-definable function keys
CAPS LOCK Key	Locks alphabetic keys to uppercase state, but does not affect non-alphabetic keys

Audible Signals	
Key-Click	Keyclick sound simulates typewriter
Bell	Sounds (1) upon receipt of control characters BEL; (2) when keyboard input approaches right margin (output from host approaching right margin does not cause bell to ring)
Page Overflow	LF causes upward scroll.
Parity	Even or mark (no parity) switch-selectable; odd or space possible with rewiring. (Note that received data is not checked for parity error)
Type	Blinking underline
Control	Up or down one line, right or left one character, home, tab (fixed tab stops every eight spaces), direct cursor addressing (allows cursor to be moved to any character position on the screen)
Functions	Erase display from cursor position to end of line; erase to end of screen; scroll up
Hold-Screen Mode	Allows operator to halt transmission from host, preserving data on display. Operator can request new data, line- or screenful-at-a-time; enabled/disabled by Escape Sequences sent by system software.
Terminal Self-Identification	Terminal transmits on command a sequence unique to its model; software can identify features available on any terminal it is in contact with.
Communications	20 mA current loop or EIA interface; specify at time of order.
Code	USASCII extended through Escape Sequences
Baud Rates	Switch-selectable
Transmission Rates	Full duplex (switch selectable) 75, 110, 150, 300, 600, 1200, 2400, 4800, and 9600 baud
	Switch-selectable local copy
Synchronization	Automatically transmits control codes to host, requesting suspension and resumption of transmission, when unable to process data
Operator Controls	Power On/Off, Intensity Control, Baud Rate Switch, Terminal Mode Switch, Even/No Parity
Overload Protection	Thermal cutout (circuit breaker)

Case Material

Injection-molded Noryl thermoplastic

Screen Phosphor

P4

1.4 DOCUMENTATION ORDERING INFORMATION

The following VT52 DECscope Video Terminal hardware manuals can be purchased from Digital's Accessory and Supplies Group:

Title	Document No.
FB-VT52	VT52 DECscope Maintenance Documentation Package
EK-VT5X-OP-001	DECscope Users' Manual

All purchase orders, invoicing inquiries and correspondence should be forwarded to:

Digital Equipment Corporation
Cotton Road
Nashua, New Hampshire 03060
Attention: Accessory and Supplies Group

CHAPTER 2 INSTALLATION

2.1 SITE PLANNING

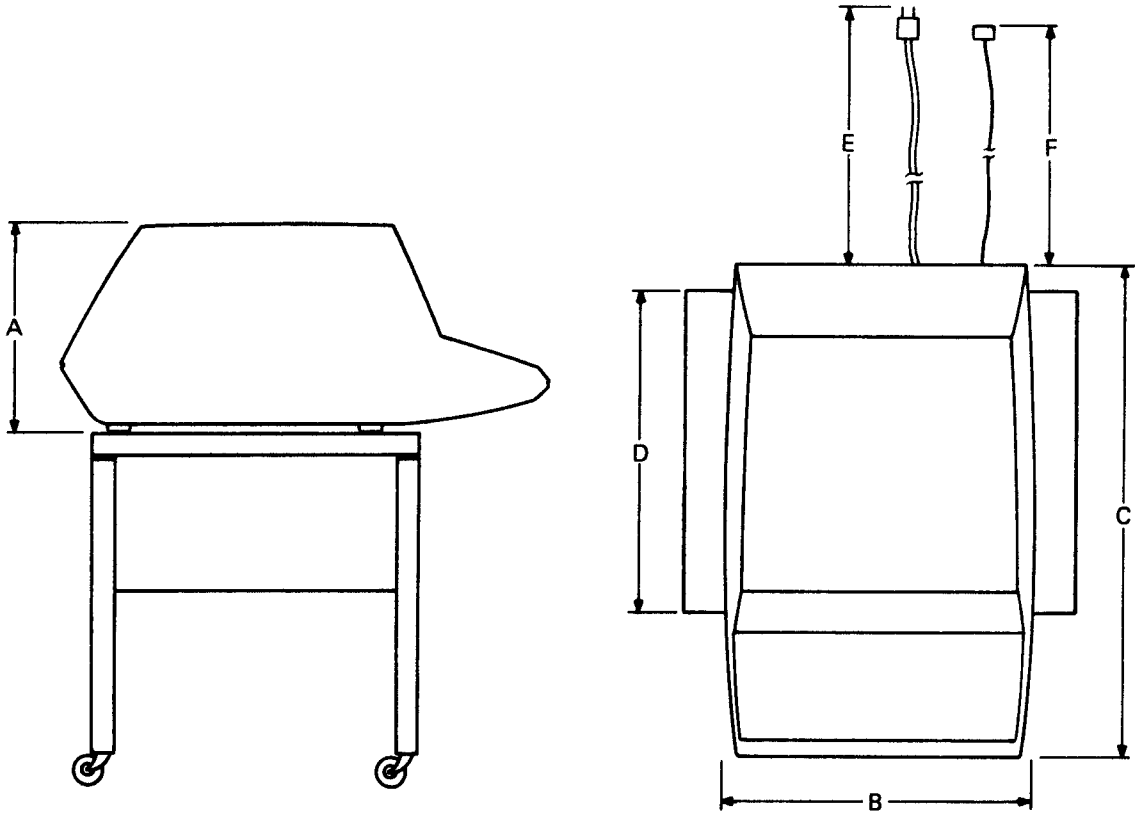
The design of the VT52 will normally pose few constraints on the selection of a place to install the terminal (Figure 2-1). Extremes of temperature and humidity should be avoided. A summary of the operating conditions of the VT52 is given in Chapter 1.

2.2 UNPACKING AND INSPECTION

1. Unpack the unit and place it on the desk or surface where it will be operated.
2. Inspect the unit for physical damage.
3. Tip the unit on its back and check the interface cable. It should be fastened to the base with a strain relief (Figure 2-2).
4. Check that site power meets the requirements of the terminal. The voltage and power requirements of the terminal are listed on the ON/OFF switch plate located on the right-hand side of the unit.

2.3 INSTALLATION AND SETUP

1. Make certain that the terminal line cord is not connected to an electrical outlet and that the power (ON/OFF) is in the OFF position.
2. After making certain that there is enough room on the platform on which the terminal is located, tip the unit back until it is stable. This must be done to gain access to the operator control switches (Figure 2-3).
3. Using a screwdriver or small coin, set the switches on the bottom of the terminal to the OFF LINE and 9600 baud positions (S1 to position 1 and S2 to position G). These switch positions are shown on the label mounted below the switches.
4. Return the VT52 to its normal operating position.
5. Figure 2-2 shows another cable coming from the unit. This cable will have a Mate-N-Lok connector or an EIA connector, depending on which option you have ordered. Plug this connector into the I/O part of the computer or modem with which you wish to communicate.
6. Plug the line cord into an electrical outlet that meets the requirements of the terminal.

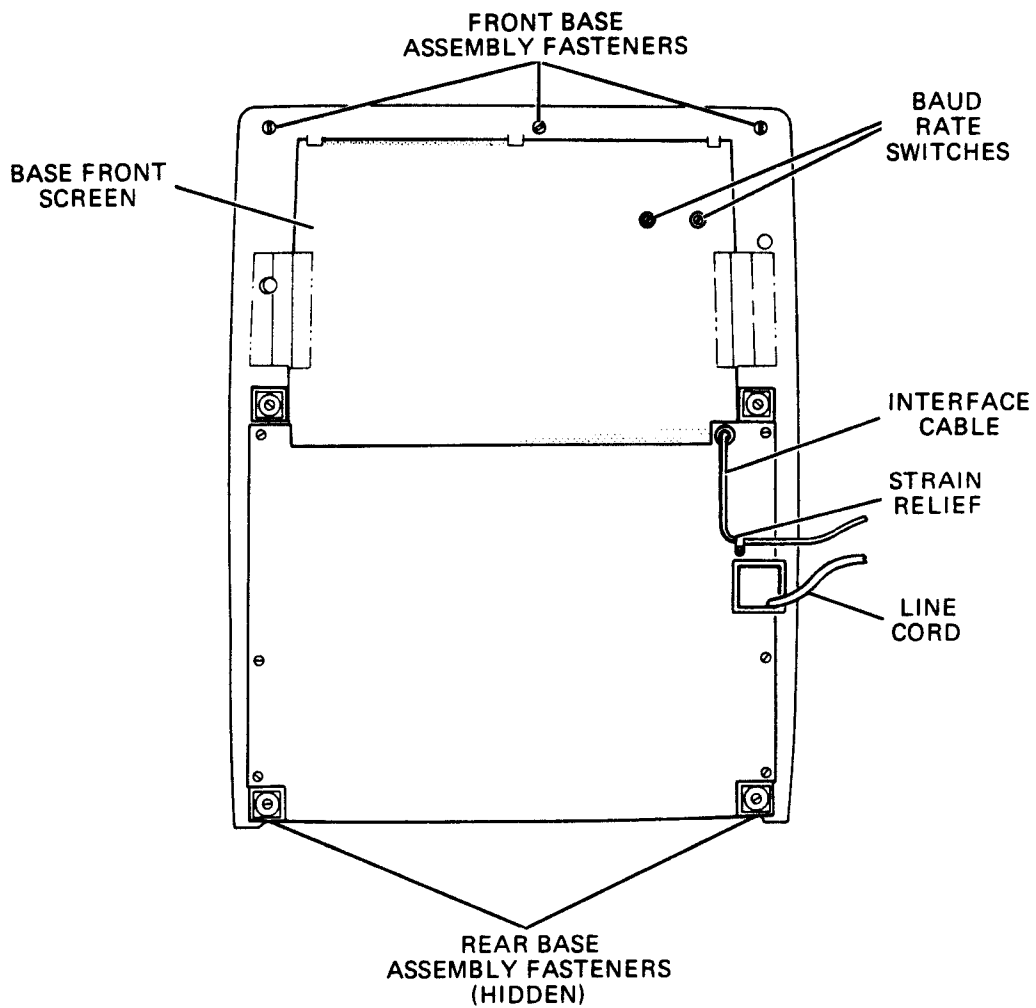


DIMENSIONS	MILLIMETERS	INCHES
A. HEIGHT	360	14.1
B. WIDTH	530	20.9
C. DEPTH	690	27.2
D. MINIMUM TABLE DEPTH	450	17.2
E. AC LINE CORD LENGTH	2438	96.0
F. INTERFACE CABLE	*	*

* TOTAL CABLE LENGTH (INCLUDING THE 7,620 METER (25 FOOT) CABLE SUPPLIED) MUST NOT EXCEED 304.8 METERS (1000 FEET).

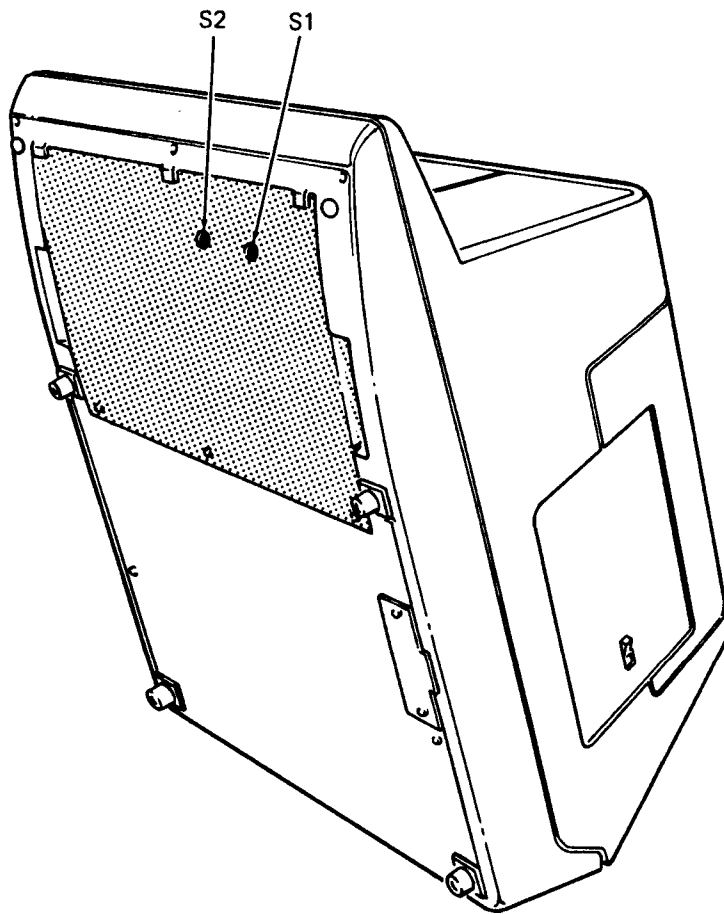
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Figure 2-1 Site Considerations



MA-0111

Figure 2-2 VT52, Bottom View



MA-2052

Figure 2-3 Operator Control Switch Access Position

2.3.1 Off-Line Tests

Perform the tests described in Paragraphs 2.4.1 through 2.4.6 of the acceptance test procedures.

2.3.2 On-Line Tests

Run the appropriate diagnostic listed in Paragraph 2.4.7 of the acceptance test procedures.

2.4 ACCEPTANCE TEST PROCEDURES

2.4.1 Flashing Cursor Check

Apply power to the unit by placing the power (ON/OFF) switch to the (ON) position. After a one-half minute warm-up period, a flashing cursor should appear in the upper left corner of the screen. If nothing is seen or the display is too bright, reach over and adjust the intensity control on the rear of the terminal at the top right-hand corner. Control moves to the right for increased brightness.

Check for the terminal to display characters as keys are pressed.

2.4.2 Escape and Control Command Check

Escape and control commands are invoked by:

1. Pressing the ESC key and then following with a certain character to identify which escape function is to be performed.
2. Holding down the CTRL key and simultaneously typing a character to identify which control function is to be performed.

Notice that the ESC key must only be typed once and then followed by the identifying character; while the CTRL key must be held down while the identifying character is being typed.

Note the key labeled CAPS LOCK. This key is similar to the SHIFT LOCK key on a typewriter except that CAPS LOCK will only give you capital letters and will not shift anything other than letters. Keys with numbers or symbols are not affected by CAPS LOCK. To get the uppercase of these keys, you must use the SHIFT key. The SHIFT key will also give you capital letters while CAPS LOCK is off.

1. Miscellaneous
 - a. Press "CTRL G"; check for bell to ring
2. Move Cursor Functions
 - a. Press "ESC C"; cursor should move to right; repeat until cursor is in the center of screen.
 - b. Press "CTRL J"; cursor should move down one line.
 - c. Press "ESC A"; cursor should move up one line.
 - d. Press "CTRL H"; cursor should move left one position.
 - e. Press "CTRL I"; cursor should move to the next TAB stop.
 - f. Press "ESC I"; cursor should move up one line; this performs a downward scroll if the cursor was on the top line.
 - g. Press "ESC B"; cursor should move down one line.
 - h. Press "ESC D"; cursor should move left one position.
3. Erase Functions:
 - a. Type some characters on all 24 lines.
 - b. With cursor on the bottom line, press "CTRL M"; check for cursor to move to the leftmost position on that line.
 - c. Press "ESC K"; check for all characters on the bottom line to be erased.
 - d. Press "ESC H"; check for cursor to go to the top left of screen.
 - e. Press "ESC J"; check for all characters on the screen to be erased.

2.4.3 Terminal Identification Check

Press "ESC Z"; check for the terminal to identify itself with a different character for each VT52 variation:

VT52	"K"
VT52 with Copier	"L"
VT52 with Printer Interface	"M"

2.4.4 Alternate Keypad Mode

Press "ESC =" and check for the terminal to enter ALTERNATE KEYPAD MODE. Numbers typed on the numeric pad should respond with the following characters:

Key	Character Displayed
.	n
0	p
1	q
2	r
3	s
4	t
5	u
6	v
7	w
8	x
9	y
enter	m

The terminal should exit the Alternate Keypad Mode when "ESC >" is typed. Numbers displayed should correspond to those numbers typed on numeric pad.

2.4.5 Hold Screen Mode

1. Place cursor on bottom line.
2. Press "ESC ["; enters Hold-Screen mode.
3. Press "LF."
4. Type "VT52"; characters should not appear on the screen.
5. Press "SCROLL"; the message "VT52" should now appear on the screen.
6. Press "ESC \"; exits Hold-Screen mode.
7. Press "LF"; check for message to scroll up.

2.4.6 Direct Cursor Addressing

1. Press "ESC H"; cursor should move to the first character position in the first line.
2. Press "ESC Y" "7" "o"; cursor should move to the last character position on the last line
3. Press "ESC Y" "7" "SPACE"; cursor should move to the first character position on the last line.
4. Press "ESC Y" "SPACE" "o"; cursor should move to the last character position on the first line.
5. Press "ESC Y" "SPACE" "SPACE"; cursor should move back to the first character position on the first line.

2.4.7 On-Line Acceptance Test

If the VT52 is connected to a DECsystem, run the appropriate VT52 in-house diagnostic for at least one pass.

PDP-8 Diagnostic - MAINDEC-08-DHVT-D
PDP-11 Diagnostic - MAINDEC-11-DZVT-C

CHAPTER 3 OPERATION

3.1 CONTROLS

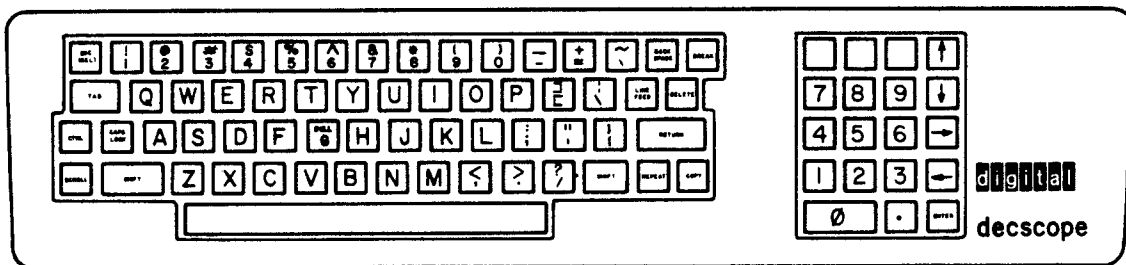
Two groups of controls are used in the VT52 Video Display Terminal, the operator controls and the keyboard. The operator controls set the operating parameters of the terminal such as parity, baud rate, etc. The keyboard keys select the codes to be transmitted to the host.

3.1.1 Operator Controls

The operator controls and their functions are listed in Table 3-1.

3.1.2 Keyboard

Input data to the host is entered by typing keys on the main keyboard or the auxiliary keypad (Figure 3-1). The keyboard transmits upper- and lowercase alphabetic code, numeric code, fixed control code, and user-defined control code.



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Figure 3-1 VT52 Keyboard

Table 3-1 Operator Controls

Control	Location	Function
ON/OFF	Right side	Applies power to the unit
Baud rate switches	Front, bottom	
S1-1		OFF-LINE*
S1-2		Full duplex with local copy*
S1-3		Full duplex*
S1-4		300 baud
S1-5		150 baud
S1-6		75 baud
S1-7		4800 baud
S2-A		Match (Bell 103) - Local Copy*
S2-B		110 baud
S2-C		Match (Bell 103)*
S2-D		600 baud
S2-E		1200 baud
S2-F		2400 baud
S2-G		9600 baud
S3†	Front, bottom	Selects NO (mark) parity or EVEN parity (SPACE or ODD with jumpers)
Brightness	Rear	Sets screen intensity level

* In positions indicated with an asterisk, receiving and transmitting speeds will be the same. In other positions, S1 selects the transmitting speed and S2 selects the receiving speed. S1 and S2 switch positions 1A, 1C, 2A, 2C, 3A, and 3C are illegal.

† Not user accessible, see the decal on the base for more information.

3.1.2.1 Alphabetic Keys – All alphabetic keys transmit in uppercase and lowercase code. Uppercase is transmitted when a key is typed while either or both SHIFT keys are down or while the CAPS LOCK key is down. (The CAPS LOCK key does not affect codes transmitted by keys other than the alphabetic keys.) Upper- and lowercase codes are listed in Table 3-2.

Table 3-2 Alphabetic Key Codes*

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

*All codes are expressed in octal.

3.1.2.2 Numeric/Symbol Keys – Numeric and symbol key codes are listed in Table 3-3.

3.1.2.3 Function Keys – Function keys transmit control codes to the host. They cause an action to occur in the terminal such as tab, line feed, etc., if the host echos these codes back to the terminal. Table 3-4 lists the function keys, the code they transmit to the host, and the terminal action taken if the code is echoed back to the terminal.

3.1.2.4 The CONTROL Key – The CONTROL key is used in conjunction with other keys on the keyboard to produce control codes in the range of 000–037. When held down, it alters the code normally produced by a typed key by forcing the two high-order bits of the code to zero. Table 3-5 lists the codes transmitted when the CONTROL key is held down. The original code is included for comparison.

3.1.2.5 The BREAK Key – Typing the BREAK key forces the serial data output line of the terminal to the zero state for as long as the key is held down. The BREAK function is provided for users with software written to operate in half-duplex mode.

Table 3-3 Numeric/Symbol Key Codes

Key	Neither SHIFT Key Down	Either or Both SHIFT Keys Down
1	061	041 (!)
2	062	100 (@)
3	063	043 (#)
4	064	044 (\$)
5	065	045 (%)
6	066	136 (^)
7	067	046 (&)
8	070	052 (*)
9	071	050 (()
0	060	051 ())
-	055	137 (_)
=	075	053 (+)
[133	135 (])
;	073	072 (:)
,	047	042 (")
.	054	074 (<)
/	056	076 (>)
\	057	077 (?)
`	134	174 (:)
'	140	176 (=)
{	173	175 (())

Table 3-4 Function Key Codes

Key	Code	Action Taken if Codes Are Echoed
RETURN	015	Carriage Return function
LINE FEED	012	Line Feed function
BACK SPACE	010	Backspace (Cursor Left) function
TAB	011	Tab function
Space Bar	040	Deposit a space on the screen, erasing what was there before
DELETE	177	Nothing
ESC (SEL)	033	Interpret the next character from the host as a command, rather than displaying it

Table 3-5 CONTROL Key Codes*

Name	Transmitted Code	Original Code
NUL	000	040 or 100 or 140
SOH	001	041 or 101 or 141
STX	002	042 or 102 or 142
ETX	003	043 or 103 or 143
EOT	004	044 or 104 or 144
ENQ	005	045 or 105 or 145
ACK	006	046 or 106 or 146
BELL	007	047 or 107 or 147
BS	010	050 or 110 or 150
HT	011	051 or 111 or 151
LF	012	052 or 112 or 152
VT	013	053 or 113 or 153
FF	014	054 or 114 or 154
CR	015	055 or 115 or 155
SO	016	056 or 116 or 156
SI	017	057 or 117 or 157
DLE	020	060 or 120 or 160
DC1 or XON	021	061 or 121 or 161
DC2	022	062 or 122 or 162
DC3 or XOFF	023	063 or 123 or 163
DC4	024	064 or 124 or 164
NAK	025	065 or 125 or 165
SYN	026	066 or 126 or 166
ETB	027	067 or 127 or 167
CAN	030	070 or 130 or 170
EM	031	071 or 131 or 171
SUB	032	072 or 132 or 172
ESC	033	073 or 133 or 173
FS	034	074 or 134 or 174
GS	035	075 or 135 or 175
RS	036	076 or 136 or 176
US	037	077 or 137 or 177

*The CONTROL key must be held down while typing the character key.

3.1.2.6 Auxiliary Keypad – The 19-key auxiliary keypad is provided for applications requiring heavy use of the numeric keys. In addition to the 10 numeric keys, the keypad has a decimal point key, 4 cursor move keys, 3 blank keys, and an ENTER key.

In normal mode the decimal point key and the numeric keys transmit the same code as the decimal point key and the numeric keys on the main keyboard; the host cannot distinguish between them. The ENTER key transmits the same code as the RETURN key.

When the ESC command = is typed on the keyboard, the terminal will enter the Alternate-Keypad mode and the ENTER, decimal point, and numeric keys will each transmit a unique Escape Sequence. This will allow the host to distinguish between main keyboard entries and auxiliary keypad entries. It also provides the host with 12 user-definable keys to use for his particular application. Table 3-6 lists the codes transmitted by these keys.

Table 3-6 Keypad Numeric Key Codes

Code(s) Transmitted To Host		
Key	VT52 not in Alternate-Keypad Mode	VT52 in Alternate-Keypad Mode
0	060	033 077 160 (ESC ? p)
1	061	033 077 161 (ESC ? q)
2	062	033 077 162 (ESC ? r)
3	063	033 077 163 (ESC ? s)
4	064	033 077 164 (ESC ? t)
5	065	033 077 165 (ESC ? u)
6	066	033 077 166 (ESC ? v)
7	067	033 077 167 (ESC ? w)
8	070	033 077 170 (ESC ? x)
9	071	033 077 171 (ESC ? y)
ENTER	056	033 077 156 (ESC ? n)
	015	033 077 115 (ESC ? M)

The seven remaining keys on the keypad are the four cursor move keys and three blank keys. The cursor move keys transmit an Escape Sequence to the host, and if the host echos these codes back to the terminal, the cursor will move one character position up, down, left, or right, depending upon the typed key. The three blank keys transmit user-defined Escape Sequences; the user can define the meaning of each key to fit his particular application. Table 3-7 lists the codes transmitted by these seven keys.

None of the keys on the auxiliary keypad are affected by pressing the SHIFT, CAPS LOCK, or CTRL keys.

Table 3-7 Keypad Control Key Codes

Keypad Key	Codes Transmitted to Host
Blank (left)	033 120 (ESC P)
Blank (center)	033 121 (ESC Q)
Blank (right)	033 121 (ESC R)
Up-arrow	033 101 (ESC A)
Down-arrow	033 102 (ESC B)
Right-arrow	033 103 (ESC C)
Left-arrow	033 104 (ESC D)

3.1.2.7 The REPEAT Key – The REPEAT key is used in conjunction with other keys; it does not transmit a code. Any key that transmits a code to the host will transmit that code repeatedly if pressed while the REPEAT key is down. Keys that transmit more than one code will transmit their sequence repeatedly if pressed while the REPEAT key is down.

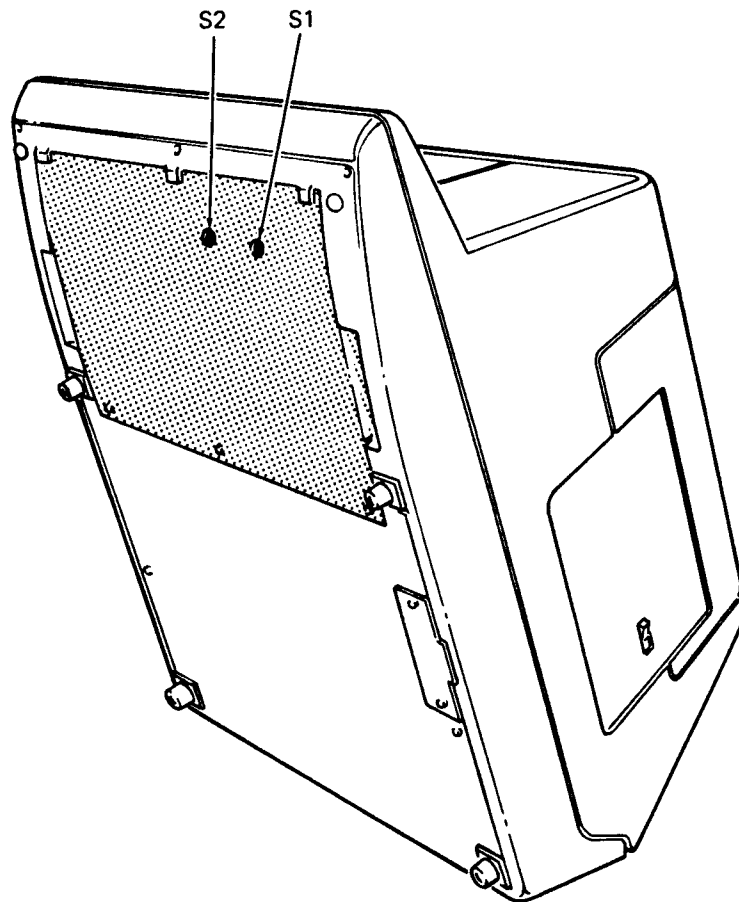
3.1.2.8 The SCROLL Key – The SCROLL key performs a local function; it does not transmit a code to the host. It is used to request more data from the host when the terminal is in Hold-Screen mode. Typing SCROLL will add one line of characters to the display screen; typing SHIFT SCROLL adds a screenful.

3.1.2.9 The COPY Key – The COPY key is also a local function key. When typed, the COPY key will produce a hard copy of the current screenful of characters, if the optional copier is installed.

3.2 OPERATING PROCEDURE

3.2.1 OFF-LINE

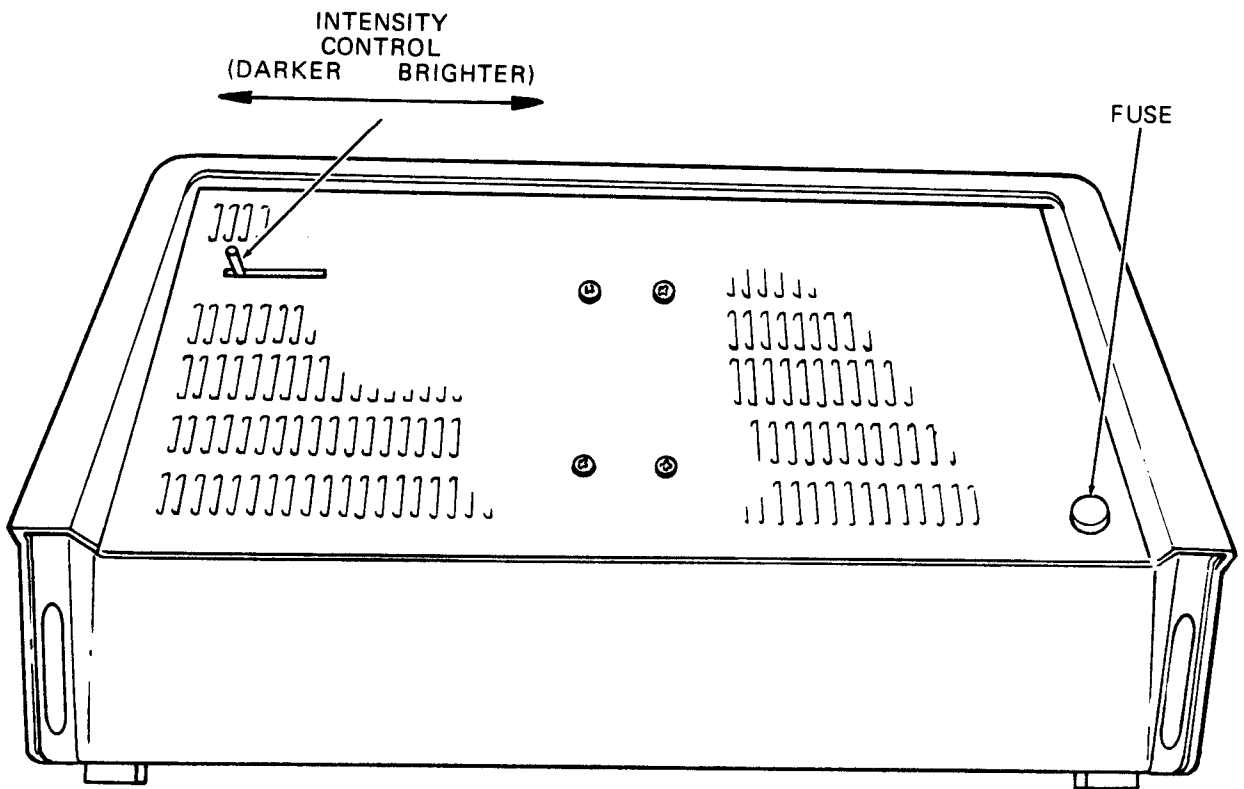
1. Make certain that the terminal line cord is not connected to an electrical outlet and that the power (ON/OFF) switch is in the (OFF) position.
2. Set the unit for OFF-LINE operation. To do this, set rotary switch S1 to position 1 and rotary switch S2 to position G. These switches are located at the front of the unit, under the keyboard. The unit will have to be tipped to the rear to gain access to the switches (Figure 3-2).



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Figure 3-2 Operator Control Switch Access Position

3. Return the VT52 to its normal operating position and plug the line cord of the unit into an electrical outlet that meets the requirements of the terminal.
4. Apply power to the terminal by setting the ON/OFF switch to ON. This switch is located on the right side of the terminal.
5. After warmup (about half a minute) the flashing cursor will appear at the top left of the screen. This is called the HOME position.
6. Using the brightness control located at the rear of the terminal (Figure 3-3), adjust the brightness of the cursor to the desired level. For the most comfortable viewing, set the brightness to the lowest possible level while still maintaining good character definition. High screen intensity causes characters to become fuzzy and prolonged viewing of the bright display is very tiresome.



MA-2055

Figure 3-3 VT52, Rear View

7. Type a character. The character will appear on the screen at the cursor location and the cursor will move one character location to the right.
8. With the REPEAT key held down, type another character. The character will appear in all the remaining locations of the top line and the cursor will be under column 79 (the last column).

9. Type a different character. It will replace the last character in the line because that is the cursor location. The cursor advances automatically as characters are typed, until it reaches the last character position in the line. RETURN and LINE FEED must be typed at the end of each line.
10. Type the RETURN key. The cursor will move to the left end of the line. Now type LINE FEED. The cursor will move down to the next line. Type a few characters to form the second line.
11. Try the rest of the cursor move keys. They will all move the cursor one character position. The BACK SPACE key will move the cursor to the left; the four cursor move keys on the auxiliary keypad will move the cursor one character position in the direction indicated by the arrow.
12. Move the cursor to the left-hand margin on a blank line. Alternately type a character and TAB. The typed characters will appear eight character locations apart. These are the TAB STOP locations. If the cursor is at the end of a line, TAB will not move the cursor.
13. Position the cursor under a displayed character and type SPACE BAR. The character will be replaced with a space and the cursor will be advanced one character position. The space bar may be used for erasing.
14. Type some characters with the SHIFT key and then the CAPS LOCK key held down. Alphabetic characters will appear in uppercase when typed with either SHIFT or CAPS LOCK pressed. Numeric keys are not affected when CAPS LOCK is held down. Symbols associated with the numeric keys are displayed only when the numeric keys are typed with the SHIFT key held down.
15. Move the cursor to the left-hand margin of the bottom line. With REPEAT held down, type a character key and fill the bottom line. Type RETURN and LINE FEED. The terminal will move all lines UP by one position erasing the bottom line for new entries. The top line is lost in this operation. This is called scrolling and will occur whenever a LINE FEED is typed while the cursor is on the bottom line unless the terminal is in Hold-Screen mode.

3.2.2 ON-LINE

1. Remove power from the terminal by switching the ON/OFF switch to OFF.
2. Tip the unit up and set the baud rate switches to the desired frequency. Transmission speed must be set to the same frequency as the host's receiving speed; receiving speed must be set to the same frequency as the host's transmission speed.
3. Return the VT52 to its normal operating position and set the ON/OFF switch to ON to restore power to the terminal. After warmup the terminal is ready for communication with the host.

3.3 USER MAINTENANCE

The keyboard and key-click mechanism are the only moving parts of the terminal and require no preventive maintenance by the owner. The DECscope may be cleaned with soap and water or any mild detergent. Although the terminal's shell provides superior resistance to damage from solvents, cleaners with solvents should not be used.

The DECscope packaging is not meant to be weatherproof; there are also several openings in the case through which liquids, coins, paper clips, and other objects can fall. Such objects will disturb the electronic operation of the terminal if they come in contact with the circuitry. For this reason, avoid putting drinks and metal objects on the top of the terminal, or using excessive water to clean the terminal. The keyboard area is an area where the electronics are particularly close to the exterior. Rubbing the keys with a dry or barely moist cloth should suffice to clean them. Do not remove the keycaps to clean them more thoroughly; damage may result to the switch contacts if they are replaced incorrectly.

CHAPTER 4

TECHNICAL DESCRIPTION

4.1 GENERAL

This chapter provides a description of the major functions performed by the VT52. It includes descriptions of the three circuit boards that make up the terminal control logic, the major logic assemblies located on each board, and a functional description of the terminal control features.

A functional block diagram of the VT52 terminal is shown in Figure 4-1 and should aid the reader in understanding the descriptions presented here.

4.2 FUNCTIONAL DESCRIPTION

Three major functions are performed by the VT52 keyboard display. It operates as an input terminal, an output terminal, and a video terminal. As an input terminal, it processes keyboard data and transmits this data to the host processor. As an output terminal, displayable characters received from the host processor are stored in memory and displayed on the screen. As a video terminal, the VT52 displays the contents of main memory on the CRT screen and refreshes this display at the line frequency rate. Main memory consists of 1920 RAM (random access memory) locations used to store the codes for the 1920 characters displayed on the screen (24 rows of 80 characters each). The remaining 128 RAM locations are used as a scratchpad by the microprogram.

In addition to displayable characters, control characters are received at the terminal and are interpreted as commands. Commands exist to position the cursor, erase part or all of the information on the screen, place the terminal in another mode, and force the terminal to identify itself to the host.

4.2.1 VT52 Video Terminal

The function of the video terminal logic is to fetch ASCII characters from the RAM, convert the ASCII code to one that will form characters in a 7×7 dot matrix, and then display these characters on the screen. In order to do this, the video circuits must provide a raster to the screen. That is, reflect the electron beam of the CRT such that, from top to bottom 240* lines are drawn across the face of the screen, 10 lines for each character row. This process is repeated continuously at the line frequency rate: 60 times each second on 60 Hz units; 50 times each second on 50 Hz units. Synchronization of this process is controlled by a crystal oscillator and associated timing circuits. A signal on the cathode of the CRT switches the beam on and off, providing either light (display) or dark (no display).

The signal on the cathode is the output of the Video Shift Register which was loaded from the Character Generator. The Character Generator converts the ASCII code received from memory into a code that will form a character on the screen by displaying selected dots of a 7×7 -dot matrix (Figure 4-2). Character Generator outputs shifted to the CRT cathode represent one line of a 7-line character. Therefore, it takes seven horizontal scans to form a complete character on the screen. In fact, these 7 scans will form 80 complete characters on the screen because during each scan, one line of every character in the row, is displayed.

*On 50 Hz units, the raster consists of 264 lines, 11 lines for each character row.

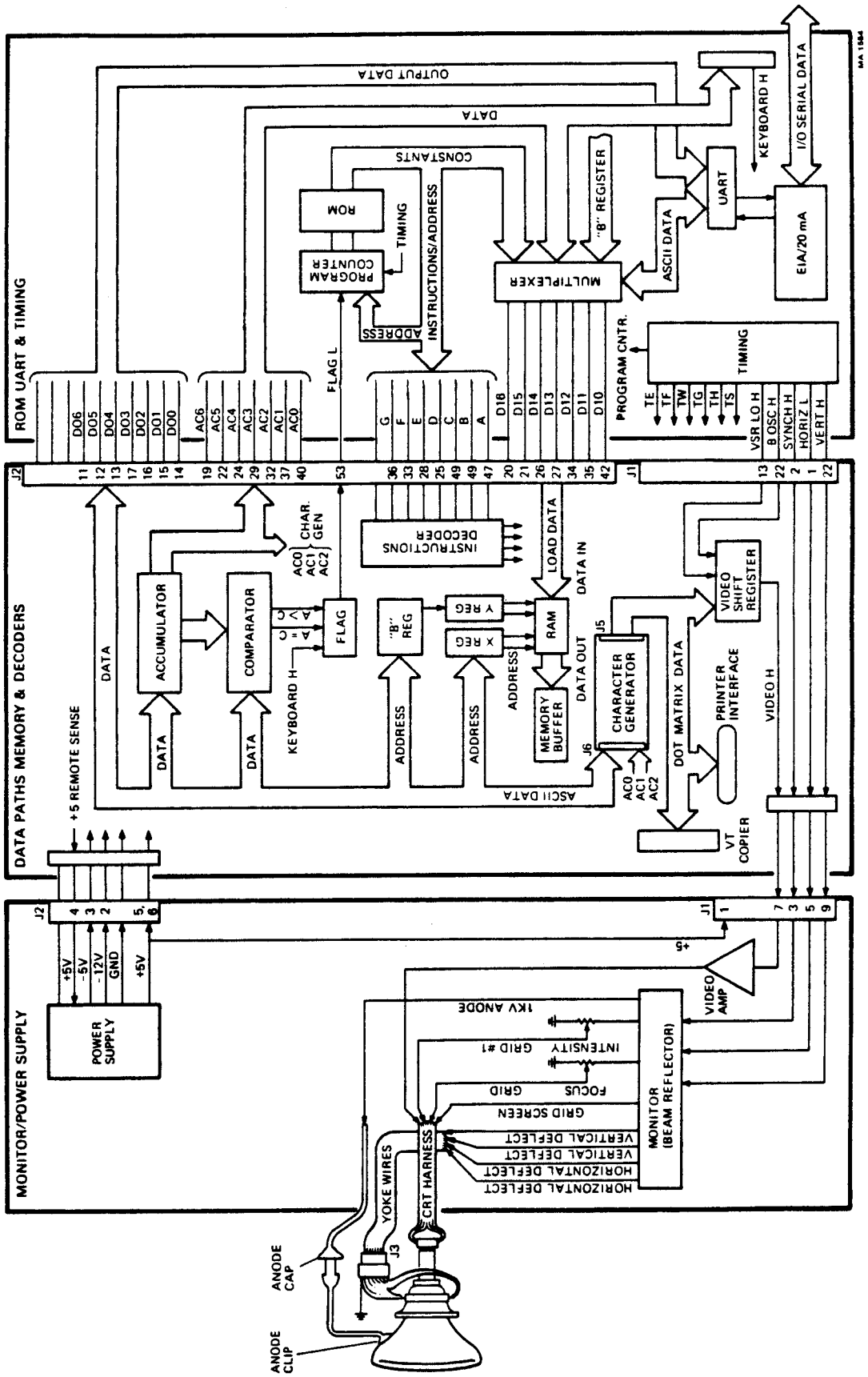
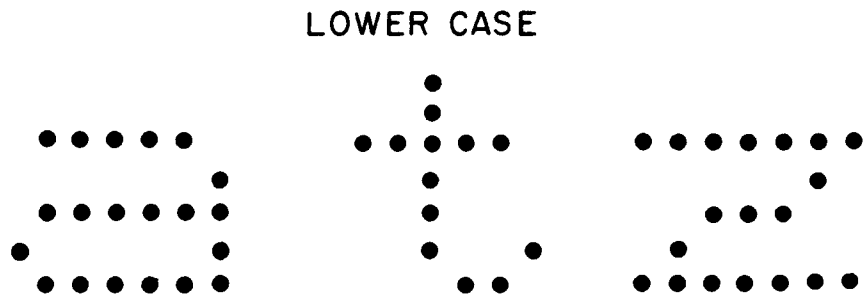
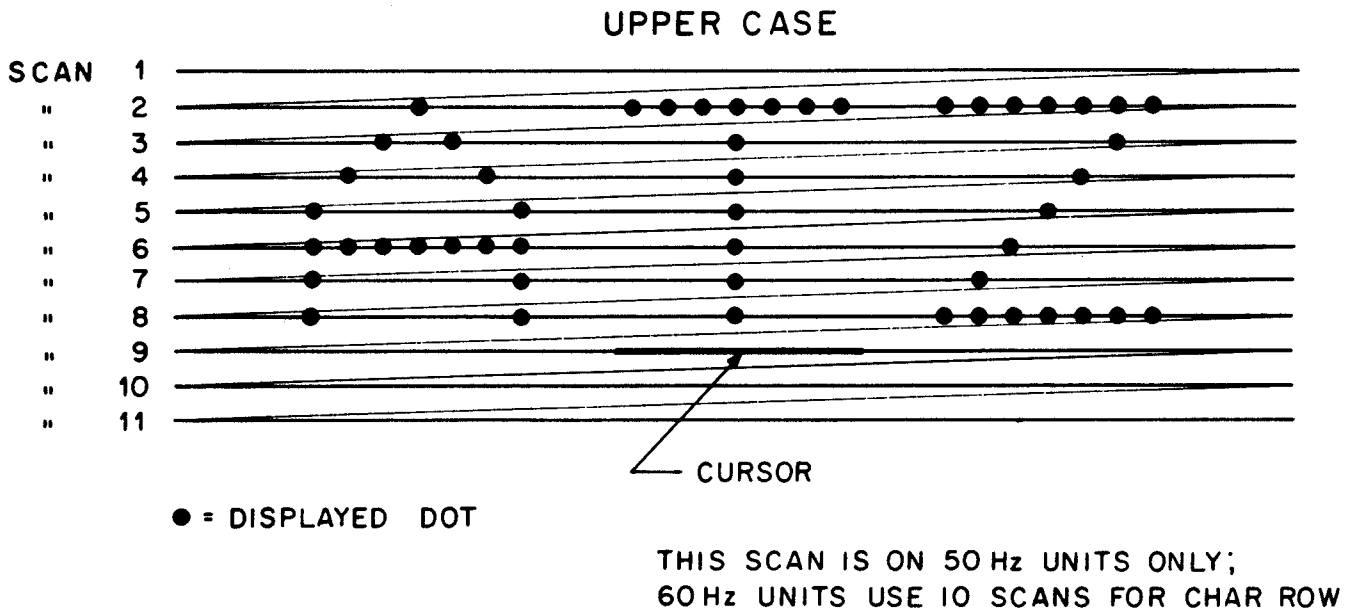


Figure 4-1 VT52 Block Diagram



CP-2291

Figure 4-2 7 x 7 Character Matrix

During each display cycle, 1920 characters stored in the RAM are displayed in the 1920 character positions of the CRT. Character locations in the RAM are identical to character positions on the screen. That is, the code for the character displayed in screen location 0,0 (top, left) will be found in RAM location 0,0 (Y register=0; X register=0). All other characters, 1 through 79, displayed on the top line of the screen will have the same Y address (Y=0) but will have an X address between 1 and 79, i.e., X=1 selects character position 1; X=2 selects character position 2, etc.

At the beginning of every display cycle, when the CRT beam is at the top of the screen, the Y register, X register, and the three least-significant bits of the AC register are cleared to zero. Y=0 and X=0 selects the RAM location containing the character that will be displayed in row 0, column 0 of the screen. AC0,1,2=0 selects the top line of that character. (If one or more scroll operations have been performed, the top character row (row 0) will not be selected when Y=0. This description assumes that no scroll operations have been performed. Scrolling is described in Paragraph 4.5.2.)

At T2 time of every timing cycle, the RAM location selected by the contents of the X and Y registers is loaded into the Memory Buffer. The Character Generator is wired to the Memory Buffer. ASCII characters applied to the input of the Character Generator appear at the output in a code that will cause one line of the character to be painted on the screen, when this code is applied to the cathode of the CRT.

The T2 pulse also loads the Character Generator output into the Video Shift Register and increments the X register. In this way, one complete row of characters is automatically fetched from the RAM and displayed during each scan of the video screen. Remember that only one line of each of the 80 characters is displayed during each scan. The displayed line is selected by the decoded output of the three least-significant bits of the AC register. At the beginning of each character row, AC0, 1, and 2 are cleared to zero. At the end of each scan, the AC register is incremented by 1, causing the next line of the same 80 characters to be displayed. After 7 scans, 7 lines of all 80 characters will have been displayed in the character row selected by the contents of the Y register.

There are 10 scans per character row in the 60 Hz terminals; 50 Hz terminals have 11 scans per character row. Seven scans are used to display the characters and the extra scans are used to display the cursor and to provide spacing between the character rows. The cursor is displayed on the scan directly below the last character scan of one of the 24 character rows. The cursor address is stored in scratchpad memory location CUR X and CUR Y. The character format is illustrated in Figure 4-2.

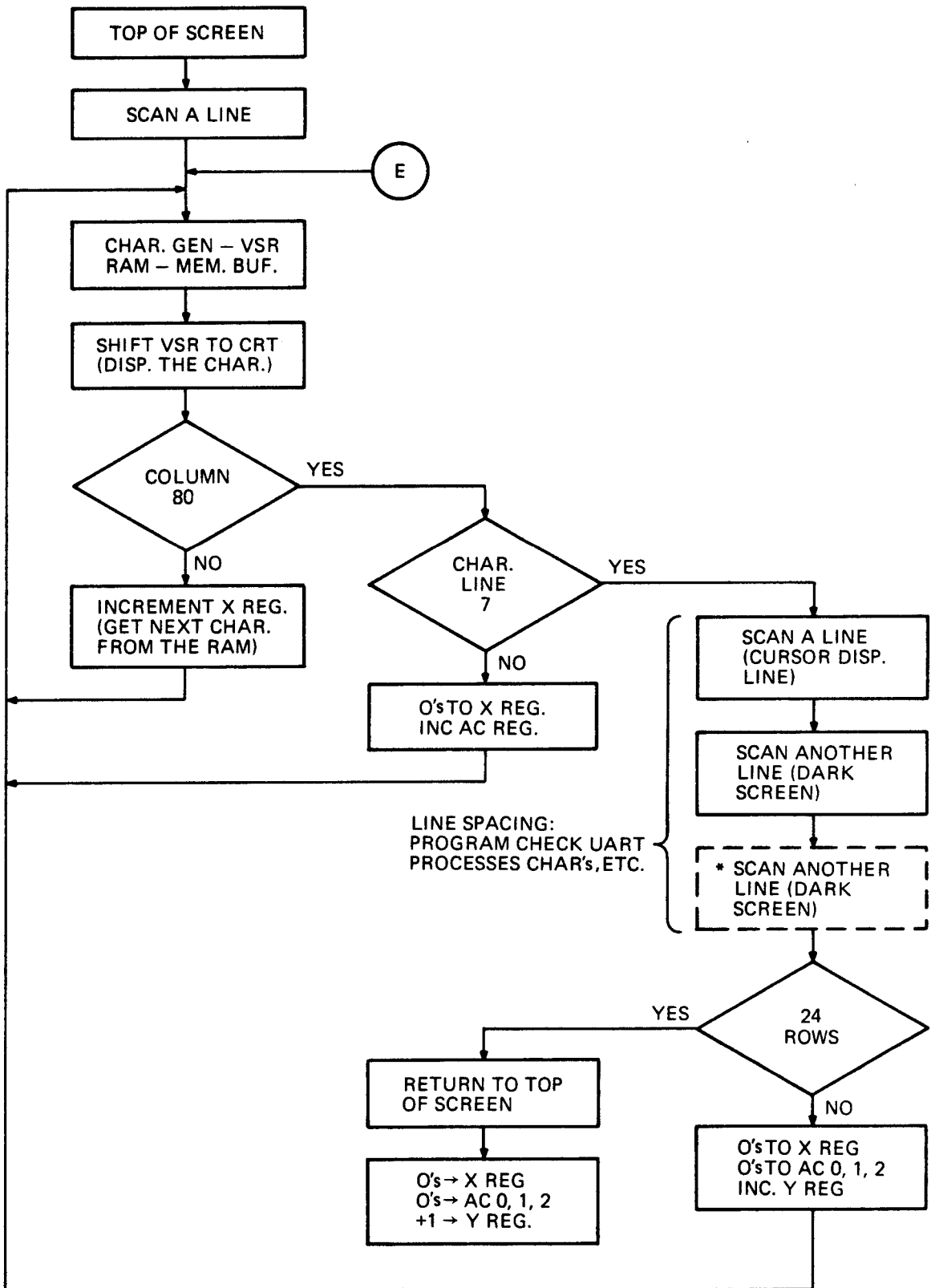
After the last scan, the Y register is incremented by 1 to select the RAM characters to be displayed in the next row, and AC0, 1, 2, and the X register are cleared to zero to select the top line of the character to be displayed in column 0 of the new row. This process continues until 80 characters have been displayed in all 24 rows and is repeated at the line frequency rate. Figure 4-3 is a flow diagram showing the display process.

4.2.2 VT52 Input Terminal

Figure 4-4 is a simplified flow diagram of a keyboard character transmission. Keyboard data entered by an operator is transferred to the host processor under control of the microprogram. Sixty times each second (50 times each second on 50 Hz units), during vertical retrace time, the microprogram checks the keyboard, searching for a typed key. To do this, the program tests the condition of every key in the keyboard. The AC register is set to equal the highest numbered key on the keyboard and then a KEYJ command tests the flag to see if the key is down. If the key is not down, the AC register is decremented and the flag is tested again. This loop is repeated until a typed key is found. When an active key is located, the program stores the identification number of the key in the scratchpad memory to prevent multiple transmission of the same character. The program then looks up the ASCII code for the typed key in a table in the ROM, loads the ASCII character into the UART, and transmits the character to the host.

At the beginning of every keyboard entry routine, the program checks the status of the UART (Universal Asynchronous Receiver/Transmitter). If the UART is still busy transmitting the previous entry, the program makes no further test of the keyboard. If the UART is not busy, the program then tests the keyboard to determine if the previously processed keys are still down. If they are, the program does not process them again. Instead, it exits the keyboard routine. When the previously processed keys have been released, the program resumes keyboard testing.

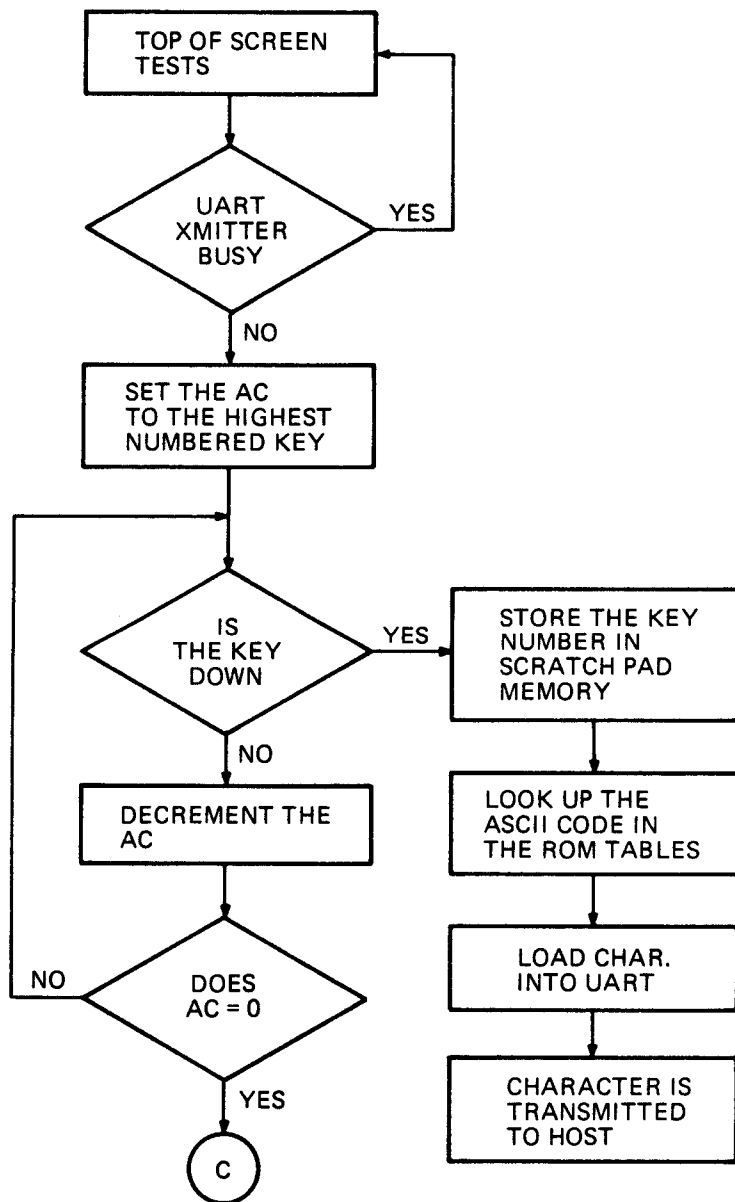
If none of the keys are down, the program will exit the routine when the AC register is equal to zero. A jumper in the keyboard is wired to act like a typed key whenever it is referenced. It is referenced when the AC = 0, meaning the keyboard was polled but no keys were down.



*THIS LINE PAINTED
ON 50 Hz UNITS ONLY.

CP-2306

Figure 4-3 Display Cycle Flow Diagram

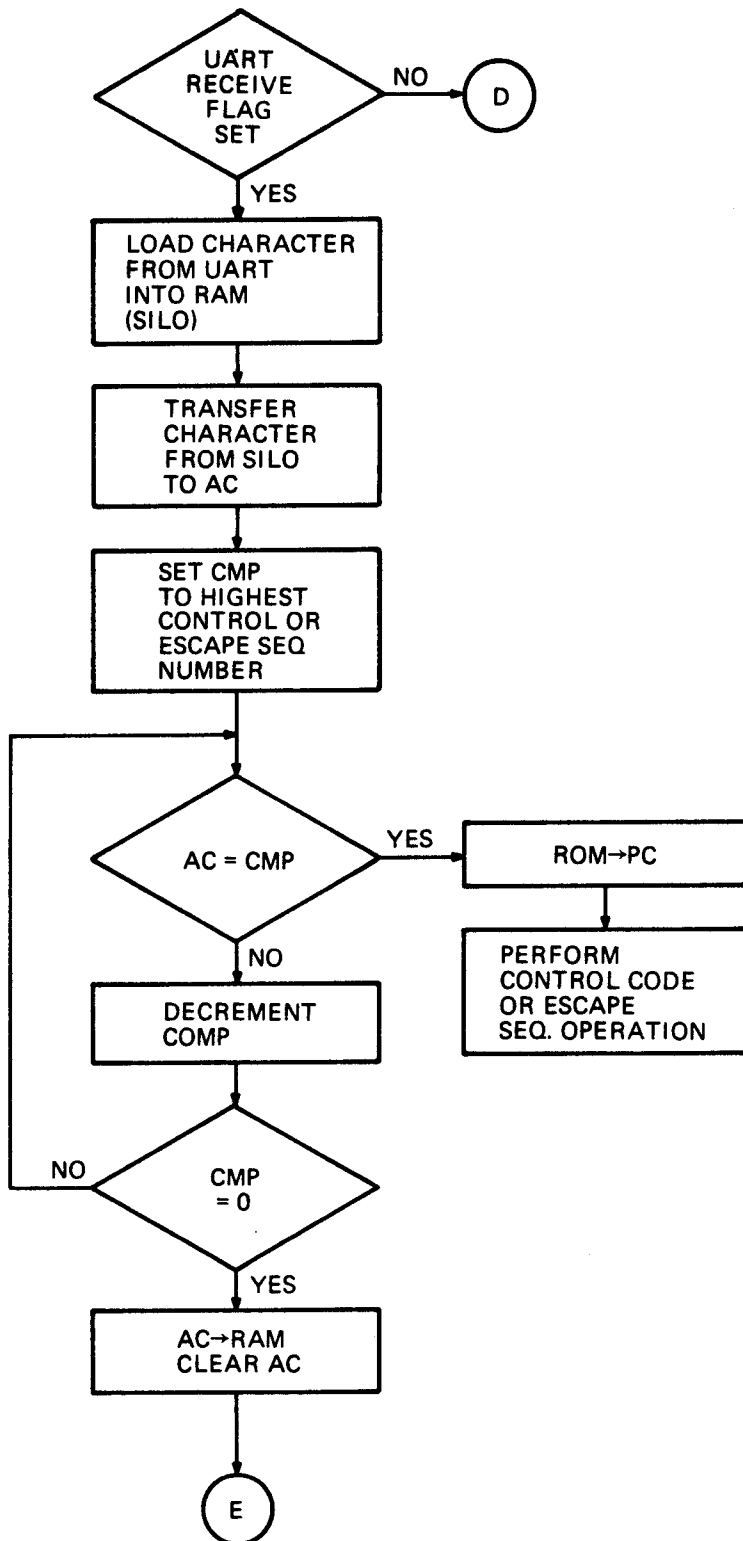


CP-2308

Figure 4-4 Keyboard Character Transmission Flow Diagram

4.2.3 VT52 Output Terminal

Figure 4-5 is a simplified flow diagram of a received character subroutine. When the UART receiver recognizes a start bit at the data input line, serial data from the host is shifted into the UART by the receive clock. When all bits of the character are in the input buffer, the UART control circuit will set the receive flag UR, TRUE, requesting service from the program. After displaying each character row (during the spacing scans), the program checks the condition of the receiver flag. If UR is TRUE, the program loads the UART character into the RAM location specified by the cursor address (CUR X and CUR Y locations in the scratchpad). The UR flag is then cleared and the cursor address is incremented in preparation for the next character that will be received from the host. Control codes received by the terminal will not be stored in memory or displayed on the screen. They will be interpreted by the terminal as commands and the action defined by that command will be performed, e.g., move the cursor.



MA-1553

Figure 4-5 Received Character Flow Diagram

4.3 MODULE DESCRIPTION

The complete logic package for the VT52 has been assembled on three modules: the Data Paths, Memory, and Decoders module (DP); the ROM, UART, and Timing module (RUT); and the Monitor/Power Supply module. The following paragraphs provide a detailed description of the major logic assemblies located on each module.

4.3.1 Data Paths, Memory, and Decoders Module (DP)

The RAM and Memory Buffer, the Character Generator, the Video Shift Register (VSR), the instruction decoders, and the Memory Select and Program Test Registers are located on the Data Paths, Memory, and Decoders module. Each of these logic groups will be discussed separately.

4.3.1.1 RAM and Memory Buffer – The RAM consists of fourteen 2102 chips arranged to provide two, 1024×7 -bit read/write memories (Figure 4-6). To the programmer, the memory appears as a 2048×7 -bit memory because the RAM addressing scheme assigns all even addresses to one 1024 memory (page 1) and all odd addresses to the other memory (page 2); 1920 locations are used to store a screenful of characters (24 lines \times 80 columns); the remaining 128 locations are used by the microprogram as a scratchpad memory, i.e., temporary storage of keyboard characters, cursor address, etc.

The Memory Buffer contains the contents of the RAM location selected by the current contents of the X and Y registers. Twice during each instruction time the selected RAM output is strobed into the Memory Buffer for transfer to the video circuits during display time, or to the UART for transmission to the host processor, or to the X, Y, AC, or B registers because of a command test condition. Data written into the RAM can be from the AC register, the B register, the ROM (Read Only Memory – contains the microprogram), or the UART. These inputs are multiplexed into the RAM by the signals MUX A and BUX B. The TRUE/FALSE condition of MUX A and MUX B is the result of decoded microprogram transfer commands.

RAM Addressing – As previously stated, the RAM consists of two 1024×7 -bit memories labeled page 1 and page 2. Page 1 contains all the even locations addressed by the X and Y registers; page 2 contains all the odd locations. Page selection is controlled by the least significant bit of the Y register (not Y0). The X register and Y3, Y2, Y1, and Y0 are decoded to select one of 1024 memory locations; the least significant bit of the 5-bit Y register selects the page. For this discussion then, we will only consider the selection of locations within one of the pages since memory selection in both pages is identical.

Since the RAM contains all the characters displayed on the screen, it is convenient to have the RAM locations reflect the character positions on the screen, i.e., consider the RAM configuration to be $12 \times 80^*$. The 1024-bit RAM cannot be directly addressed to provide this configuration. It requires 10 bits of address information to select one of 1024 locations in memory. If 7 bits are used for column selection, only 3 bits remain to select one of the 12 rows. If 4 bits are used for row selection, the remaining 6 bits are inadequate for selecting one of 80 columns. To solve the problem, address mapping is used (Figure 4-5). That is, by manipulating some of the address lines, the operator/programmer is allowed to think of the RAM as a 12×80 configuration.

Figure 4-7 illustrates how the address mapping is accomplished. The memory is arranged in a 16×64 configuration with Y3, Y2, Y1, and Y0 selecting one of 16 rows and X5, X4, X3, X2, X1, and X0 selecting one of 64 columns. Whenever the X register ≤ 64 , or the Y register ≤ 12 , the two most significant Y address lines are forced high and the two most significant X address lines are replaced by Y3 and Y2. This effectively divides the RAM into five sections: one 12×64 section and four 4×16 sections. Memory references for characters displayed in columns 0 through 63 will be made to the 12×64 section; memory references for characters displayed in columns 64 through 79 will be made to one of three 4×16 sections. The contents of the Y register will determine which one of the three 4×16 sections will be referenced.

*Although the VT52 displays 24 rows, Y register decoding selects only 12, page-selection provides the other 12.

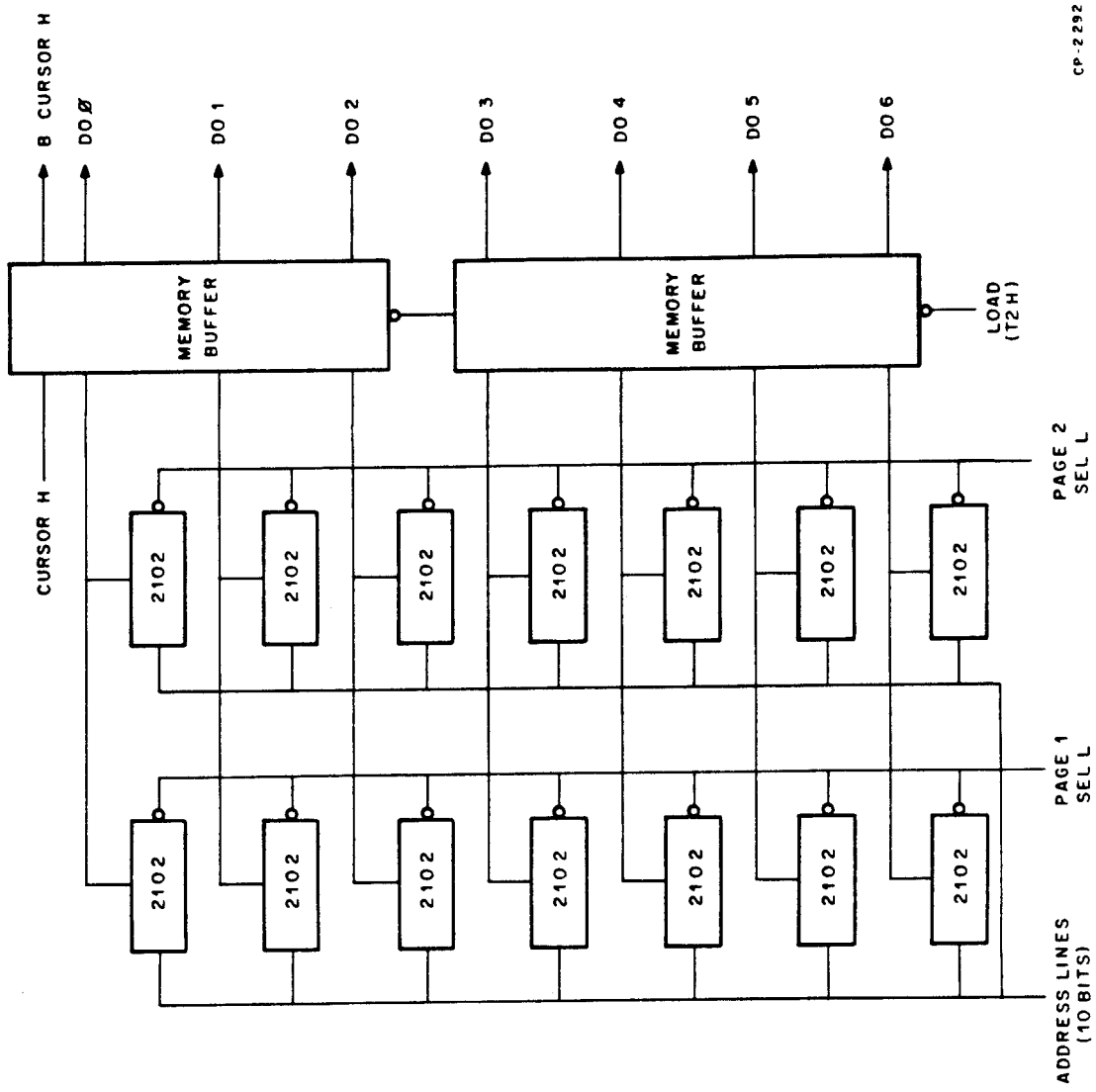
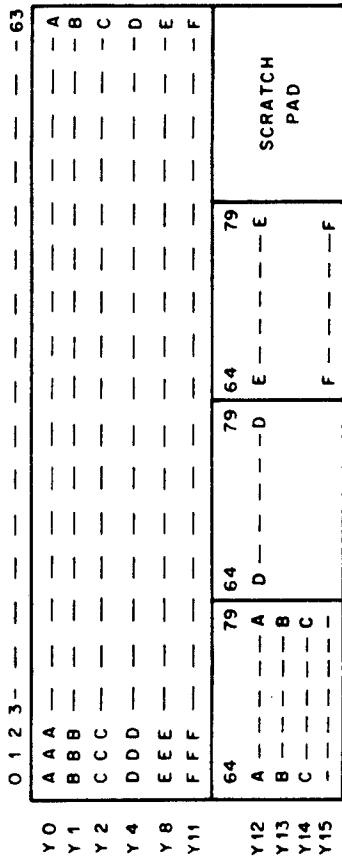
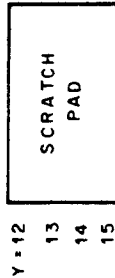
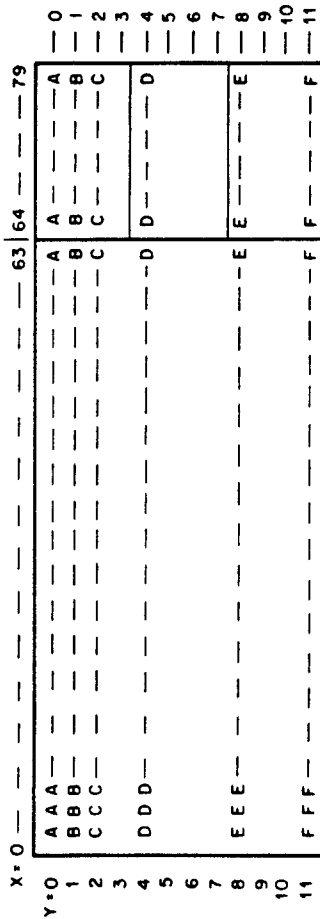


Figure 4-6 RAM and Memory Buffer

ACTUAL LAYOUT OF RAM CHIP



PROGRAMMER/OPERATOR VIEW OF RAM LAYOUT



X=0

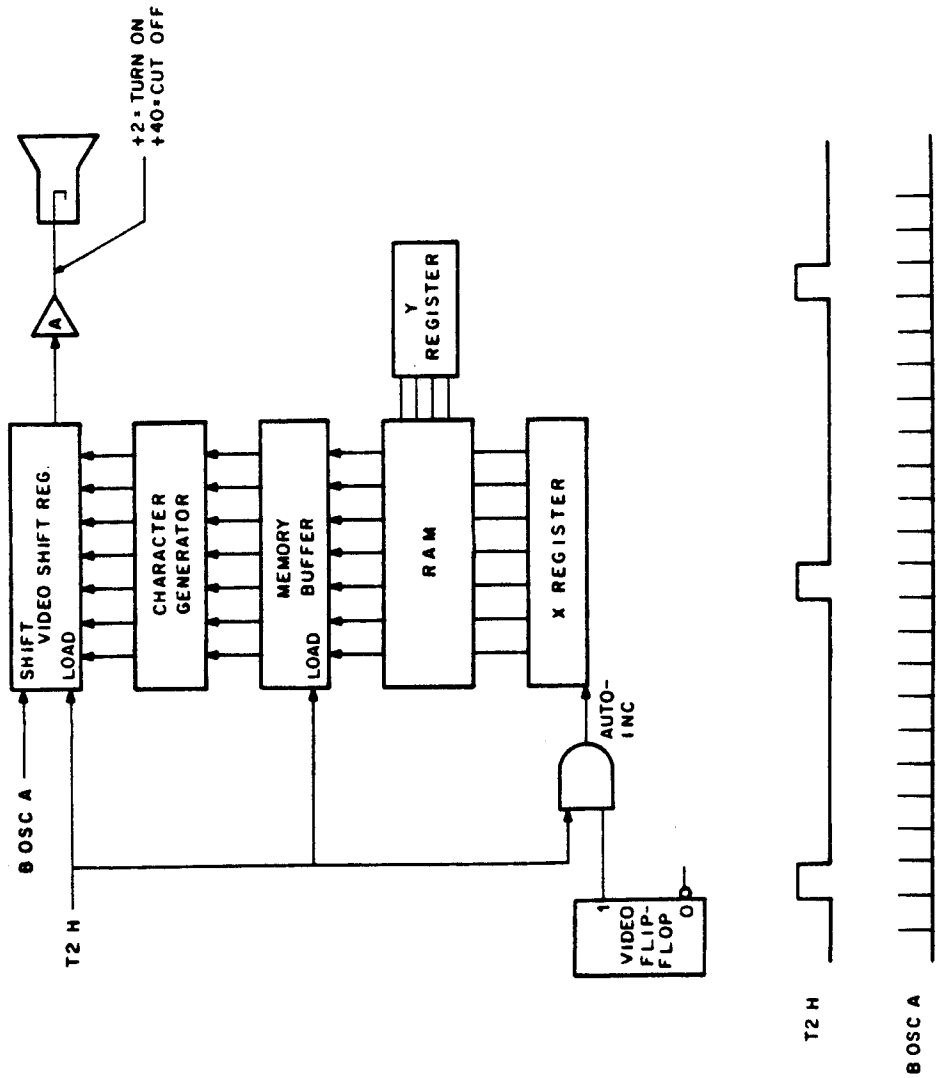
The remaining 4×16 section is used as a scratchpad memory by the microprogram. This section is addressed whenever the Y register contains a number greater than 11. The address mapping circuits replace the two most significant bits of the X register selection bits with Y3 and Y2. Since Y3 and Y2 will both contain 1s when a number greater than 11 is in the Y register, they will select the highest 4×16 memory section. X3, X2, X1, and X0 will select one of the 16 locations in this section. Uses of the scratchpad are described in the microprogram section.

4.3.1.2 Video Shift Register (VSR) – The VSR is a 7-bit shift register that holds one line of the 7-line character currently being displayed on the CRT screen. During each video scan, the VSR is loaded from the Character Generator 80 times, once for each character position. After loading, the contents of the VSR are shifted by B OSC A, the basic timing clock, through the video amplifier to the cathode of the CRT where they modulate the electron beam. Signal 0s shifted out of the VSR will cause a +2 V signal on the cathode, and light on the screen. Signal 1s will cause a +40 V signal on the cathode cutting off the CRT and producing a dark screen.

Figure 4-8 illustrates the data path of the character from the RAM to the CRT cathode. Display timing is also illustrated in the figure. T2H, a timing pulse that occurs once every timing cycle, simultaneously loads the VSR with one line of the character to be displayed and loads the Memory Buffer with the character that will be displayed in the following screen location. Assume the terminal is ready to display a line starting in column 0, and assume the display characters to be an A in column 0, a B in column 1, a C in column 2, etc. At T2H time, one line of the display code for A is loaded into the VSR and the ASCII code for B is loaded into the Memory Buffer. The X register is incremented, selecting the RAM location containing the ASCII code for C. While B OSC A shifts A to the CRT, the Character Generator is encoding the B into a display code, and the ASCII code for C is settling at the input to the Memory Buffer.

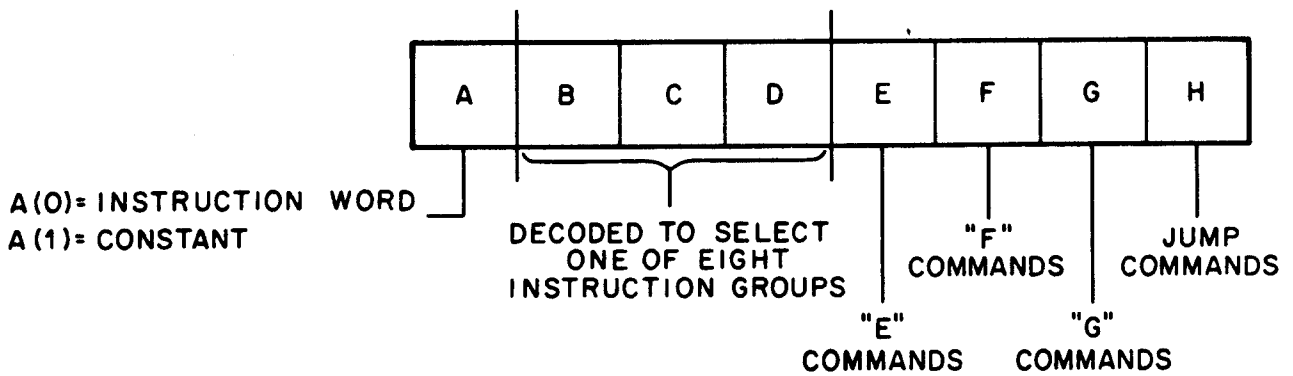
4.3.1.3 Decoders – Every operation performed by the VT52 is the result of an instruction stored in the 1024×8 -bit ROM. The 8-bit ROM word is decoded by the decoder logic to produce an instruction. This instruction will cause some action to take place in the terminal. The bits of the ROM word are labeled A, B, C, D, E, F, G, H.

As Figure 4-9 shows, the ROM word is divided into three groups: A, BCD, and EFGH. If bit A=0, bits B, C, and D are decoded into one of eight instruction groups. Bits E, F, G, and H are sampled to determine what action is to be taken. An action occurs if one or more of the bits are set to 1. For example, if bit E is a 1, a certain action will occur; if bits E and F are both set to 1, two actions will occur but not at the same time. If E, F, G, and H are all set to 0, a different action takes place depending on the state of B, C, and D. Table 4-1 is a list of VT52 commands that are available when ROM bit A is set to 0. If bit A of the ROM word is set to 1, a load RAM from ROM command will be decoded. When operating in mode 1, the command is unconditional. The seven least significant bits of the ROM word, BCDEFGH, are loaded into the RAM location specified by the contents of the X and Y registers. When operating in mode 0, the load command is conditional. In operation, the command increments the AC register and then compares the AC to the selected RAM location. If $AC < RAM$, the load command is not performed, i.e., the contents of the selected RAM location remain unchanged. If $AC > RAM$, BCDEFGH are loaded into the RAM and the DONE flip-flop is set. All instructions listed in Table 4-1 are decoded at specific times in the instruction cycle. Six time states are produced during each instruction cycle (Figure 4-10) TE, TF, TW, TG, TH, and TJ. These signals are gated with ROM bits EFGH to enable the desired action. Table 4-2 lists the timing states and the instructions performed at each state in the instruction cycle.



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Figure 4-8 Character Display Timing



CP-2295

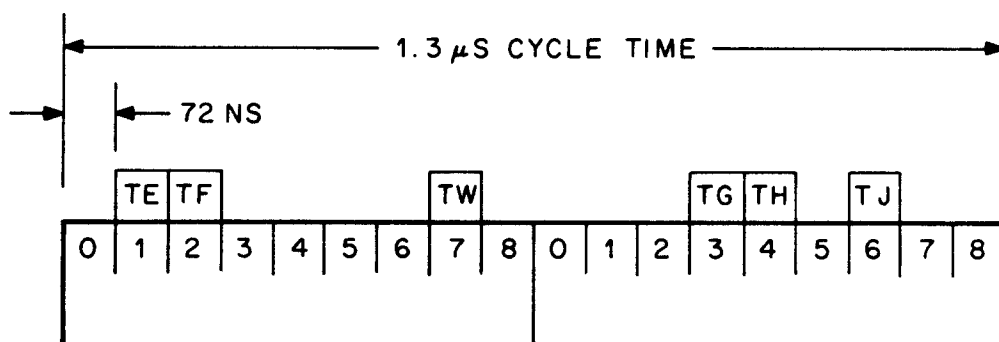
Figure 4-9 Division of ROM Word Bits

Table 4-1 VT52 Instruction Set

ABCD	E F G H	Instruction	Mnemonic
0000	0 0 0 0	Set Cursor flip-flop	(SCFF)
	1 X X X	Clear the X and Y registers	(ZXZY)
	X 1 X X	Decrement the X and Y registers	(DXDY)
	X X 1 X	Load AC from memory	(M2A)
	X X X 1	Mode 0: Printer scan flag set? Mode 1: Jump if UART has received a character	(PSCJ) (URJ)
0001	0 0 0 0	Set Video flip-flop	(SV1D)
	1 X X X	Complement bit X3 (8s-bit) of X register	(X8)
	X 1 X X	Increment AC register	(IA)
	X X 1 X	Load RAM from AC	(A2M)
	X X X 1	Mode 0: Jump if AC _{0, 1, 2} = 7 ₈ Mode 1: Jump if AC = RAM	(TABJ) (AEMJ)
0010	0 0 0 0	Load Y register from Y buffer	(B2Y)
	1 X X X	Increment X; decrement Y	(IXDY)
	X 1 X X	Increment AC register	(IA1)
	X X 1 X	Load UART from RAM	(M2U)
	X X X 1	Mode 0: Jump if key-click Mode 1: Jump if AC < RAM	(KCLJ) (ALMJ)
0011	0 0 0 0	Complement Bell flip-flop	(CBFF)
	1 X X X	Increment X register	(IX)
	X 1 X X	Increment Y register	(IY)
	X X 1 X	Load RAM from B register	(B2M)
	X X X 1	Mode 0: Jump if 60 Hz line frequency Mode 1: Jump if AC ≠ X register	(FRQJ) (ADXJ)

Table 4-1 VT52 Instruction Set (Cont)

ABCD	EFGH	Instruction	Mnemonic
0100	0 0 0 0 1 X X X X 1 X X X X 1 X X X X 1	Clear cursor and Video flip-flop Clear AC register Decrement Y register Load X register from RAM Mode 0: Printer request flag set? Mode 1: Jump if AC = RAM	(ZCAV) (ZA) (DY) (M2X) (PRQJ) (AEM2J)
0101	0 0 0 0 1 X X X X 1 X X X X 1 X X X X 1	Load Print Shift register Enter Mode 1 Increment ROM Bank Load RAM from UART Mode 0: Mode 1:	(LPB) (M1) (IROM) (U2M) (TRUJ)
0110	0 0 0 0 1 X X X X 1 X X X X 1 X X X X 1	Start printer Clear X register Decrement X register Load Y buffer from RAM Mode 0: Jump if UART is transmitting Mode 1: Jump if video scan flag	(EPR) (ZX) (DX) (M2B) (UTJ) (VSCJ)
0111	0 0 0 0 1 X X X X 1 X X X X 1 X X X X 1	Halt printer and clear Y register Enter Mode 0 Decrement AC register Spare Mode 0: Jump if not top of screen Mode 1: Jump if key not typed	(HPR!ZY) (M0) (DA) (TOSJ) (KEYJ)



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Figure 4-10 Instruction Cycle Timing Diagram

Table 4-2 Instruction Time States

Time State	Decoded Instruction	ROM Enabling Signals
TE	ZXZY, X8, IXDY, IX, ZA, M1 2Z, M0	A · E
TF	DXDY, IA, IA1, IY, DY, IROM, DX, DA	A · F
TW	SCFF, SVID, B2Y, CBFF, ZCAV, LPB, EPR, HPR ZY	A · E · F · G · H
TG	CLEAR the WRITE FLIP-FLOP	
TH	M2A, A2M, M2U, B2M, M2X, U2M, M2B	A · G
TJ	JUMP, NO-OP	A · H

4.3.1.4 Character Generator – The Character Generator consists of a 1024 × 8-bit ROM and associated address gating. The display code for all characters displayed on the screen is stored in the ROM.

During display scans, characters fetched from the RAM are loaded into the Memory Buffer in ASCII format. Because the address selection lines of the Character Generator are wired directly to the Memory Buffer, the Character Generator never needs to be “loaded”; it is always selecting the ROM location addressed by the ASCII code in the Memory Buffer. For example, if the Memory Buffer contains the ASCII code for A (101₈), the Character Generator address lines will select the ROM location containing the 7 × 7 display code for the letter A. However, since the character display method used by the VT52 requires that only one line of the 7 × 7 character be displayed during a single horizontal scan, three more address lines are provided to select one of the seven lines of the matrix; the three least-significant bits of the AC register. In operation, ASCII characters are loaded into the Memory Buffer; the Character Generator uses this code as an address to select the ROM location containing the display code for the desired character. AC bits 0, 1, and 2 are decoded to select one of the seven lines of the character matrix for output to the Video Shift Register.

Character Generator outputs CD0–6 are loaded into the Video Shift Register during T2 time of every clock cycle. CD6 will be the first bit shifted out of the VSR; CD0 will be the last.

4.3.2 ROM, UART, Timing Module (RUT)

The ROM with resident microprogram, the Program Counter (PC), the basic clock and timing chain, and the Universal Asynchronous Receiver Transmitter (UART) are located on the RUT module.

4.3.2.1 ROM and PC – The ROM is a 1024 × 8-bit read-only memory that stores the VT52 microprogram. It consists of eight 256 × 4-bit chips organized as illustrated in Figure 4-11 to provide four pages of 256 × 8-bit memory. The outputs ABCDEFGH reflect the contents of the location addressed by the Program Counter (PC). The eight least significant bits of the PC will address one 8-bit ROM word from page 1, 2, 3, or 4. Page selection is determined by the condition of PC bits 8 and 9. The PC is normally counted at TH time of every instruction cycle to fetch a new command or address from the next sequential ROM address.

Commands that affect the PC and the ROM are JUMP and IROM. A program jump is accomplished by loading a new address into the PC. The new address is always the contents of location JUMP + 1. At TH time of the JUMP command, the PC is counted and the ROM output word will contain the new address (JUMP + 1). If the jump conditions have been met, FLAG L will be TRUE and PC COUNT will load the new address into the PC. Program skips are the result of not meeting JUMP conditions; there is no skip command. If JUMP conditions are not met, FLAG L will be false and the PC will not receive the new address. Instead, PC COUNT will increment the PC a second time, fetching the next command from location JUMP + 2.

The JUMP command just described allows jumping within the selected page. To jump to a different page, the program must perform one or more IROM commands followed by a jump command. The IROM command increments the page counter (flip-flops A and B in Figure 4-9) and when a jump command is executed, the new page address is loaded into PC9 and PC8. At the same time, the contents of ROM location JUMP + 1 are loaded into PC7 through PC0 to select one of the 256 locations in the new page.

4.3.2.2 Timing – All operations in the VT52 are synchronized by the basic timing clock and timing chain (Figure 4-12). The clock is a crystal-controlled oscillator operating at 13.824 MHz. Clock output B OSC A provides the basic clock frequency for the timing shift register and frequency dividers. It is also used to perform shift operations in the Video Shift Register. The output of the crystal clock becomes the input clock of an 8-bit shift register. The outputs of the shift register are ANDed together to provide an input data signal to the register. When all bits in the register are set to 1, the input data signal will be a “0”; at all other times, the input data signal will be a “1.” The result is that the register acts like a 9-bit ring counter with a “0” being shifted through all of the bit positions.

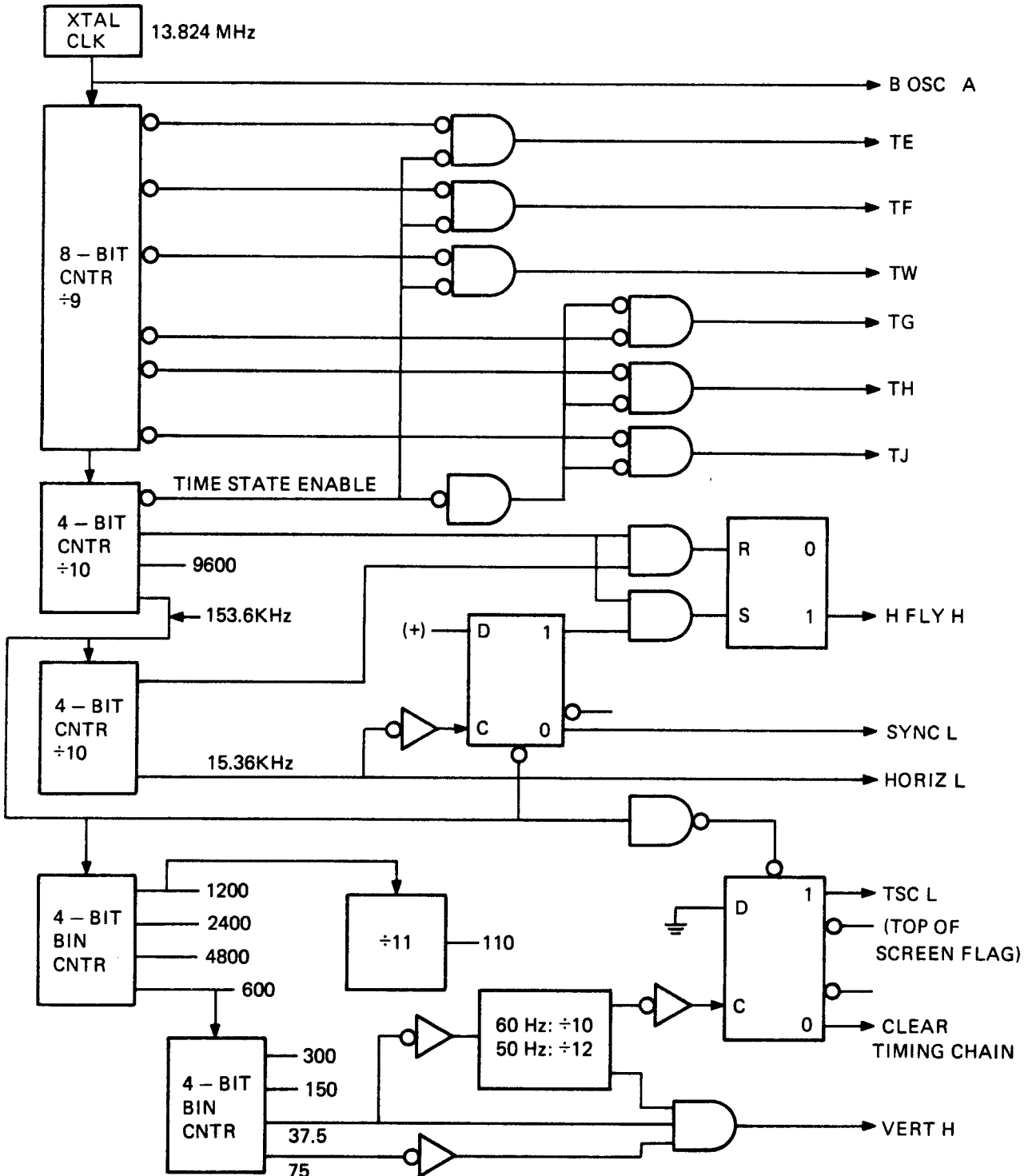
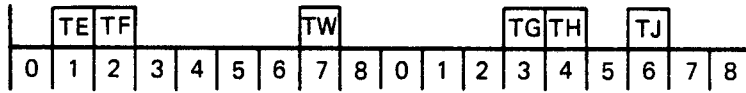
The output from this register when ANDed with the TIME STATE ENABLE signal produces the six time state signals required by the VT52 for instruction decoding. The TIME STATE ENABLE signal is the output of the first stage of a 4-bit divide-by-10 counter that follows the shift register in the timing chain. The input clock to this counter is wired to the last stage (bit 7) of the shift register. This means that the TIME STATE ENABLE flip-flop is toggled once for each complete cycle of the shift register. It also means that it takes two complete cycles of the shift register to produce the six time state signals.

The input clock frequency applied to the 4-bit decade counter is 1.536 MHz which is the crystal clock frequency divided by 9. Since this is a divide-by-10 counter, the frequency at the final stage will be one-tenth of the input frequency, or 153.6 kHz. The 9600-baud clock is taken from this counter (baud rate \times 16 = clock frequency).

The clock is again divided by 10 in a second decade counter producing an output frequency of 15.36 kHz which is the horizontal display frequency. The output of the final stage of this counter is signal HORIZ L which is at ground level during horizontal retrace time. The high-to-low transition of this signal clocks the SYNC flip-flop enabling SYNC L to the flag multiplexer. The SYNC transition clocks another flip-flop producing H FLY H which inhibits automatic incrementing of the X register and the loading of the VSR.

The clock is fed to three more counters to produce the clocks for the rest of the baud rates available in the VT52. The last counter in the timing chain is used to develop the vertical display synchronization signal, VERT H. This counter is jumper selected to divide by 10 or divide by 12 to produce a 60 Hz or 50 Hz VERT H signal.

4.3.2.3 Interface Module – The interface may be a 20 mA current loop interface or an EIA standard interface; customer specified. Each interface is mounted on a 2 \times 6 adapter card and connector J1 on the card connects directly to the ROM, UART, and Timing module connector, J4. Cables are supplied with both interfaces for connecting the terminal to a host processor or a modem. Table 4-3 lists the signals that connect the terminal to the interface.



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Figure 4-12 VT52 Basic Timing

Table 4-3 Terminal Interface Signals

Terminal Connection	Interface Connection	Signal
RUT/J4-1	J1-1	+5
RUT/J4-2	J1-2	-12
RUT/J4-3	J1-3	+15
RUT/J4-4	J1-4	Ground
RUT/J4-5	J1-5	Received Data
RUT/J4-7	J1-7	Transmitted Data

20 mA Adapter Card* - The 20 mA adapter card is supplied with a 4-meter, No. 22 AWG stranded 4-wire cable that terminates in an 8-pin Mate-N-Lok connector. Table 4-4 lists the cable signal names.

Table 4-4 20 mA Interface Signals

Mate-N-Lok Pin No.	Signal Name	Color
7	Transmitted Data (+)	Green
3	Transmitted Data (-)	Red
5	Received Data (+)	White
2	Received Data (-)	Black

EIA Adapter Card - The EIA adapter card is supplied with a 7620 mm cable terminating in a 25-pin, MALE CANNON DB 19604-432 or equivalent connector. Table 4-5 lists the cable signal names.

Table 4-5 EIA Interface Signals

Cannon Pin No.	Signal Name	Comments
1	Protective Ground	Logic 1 = OFF = -10 V
2	Transmitted Data	Logic 0 = ON = +10 V
3	Received Data	Logic 1 = OFF = -5 to -25 V Logic 0 = ON = +5 to +25 V
4	Request to Send	Wired TRUE (+10 V)
7	Signal Ground	
20	Data Terminal Ready	Wired TRUE (+10 V)
All others	No connection	

*Unless otherwise specified, the 20 mA current loop interface is shipped in VT52 terminals.

4.3.2.4 UART – The UART is a full-duplex receiver/transmitter that accepts asynchronous, serial binary characters from the host processor and converts them to parallel format for transfer to the RAM. It also accepts parallel binary characters from the RAM, converts them to serial data with added START and STOP bits and transmits this data to the host processor. The send/receive frequency of the UART (baud rate) is selected by setting switches S1 and S2 located at the front, bottom of the unit, under the keyboard.

The VT52 will transmit data with odd parity, even parity, or no parity. A parity switch (S3) and two jumper slots located under the keyboard are used for parity selection. Switch positions are NONE and EVEN. If the switch is set to NONE, the UART will transmit mark parity, i.e., the parity bit is always a “1” regardless of the number of 1 bits in the word. If a jumper is inserted in slot W5, a “0” will always be transmitted in the parity bit (space parity). Odd parity can be selected by setting switch S3 to EVEN and adding a jumper in slot W6. The terminal ignores parity on received data.

Transmitting – To transmit a character to the host, the microprogram checks UART status signal UT and if the UART is not busy, the program does a Memory-to-UART (M2U) transfer. This transfer loads the contents of the selected RAM location into the input data buffer of the UART. UART control then loads the character into the output shift register allowing the X CLK to transmit the character to the host. While shifting the data, parity is calculated and then appended to the data followed by the stop bit(s). The End-of-Character (EOC) flag is set and remains in this state until a new character is transferred from the input buffer to the output shift register. Status signal UT goes TRUE when a character is transferred from the input buffer to the shift register to alert the microprogram that it is ready for another character. Figure 4-13 shows the UART timing.

Receiving – Serial input data from the host processor is shifted into the receive shift register by the receive clock (R CLK) upon receipt of a START bit on the serial input pin. When the STOP bit is recognized, the character is transferred to the output data buffer and signal UR goes TRUE signaling the program that a character has been received. (The program checks UART status after displaying each character row.) A UART-to-Memory (U2M) command transfers the character to the RAM location specified by the cursor if the received code is a displayable character. At TF time of the transfer command, flip-flop RUF will set, producing RUF L which clears the UR signal flag. Refer to Figure 4-11 for UART timing.

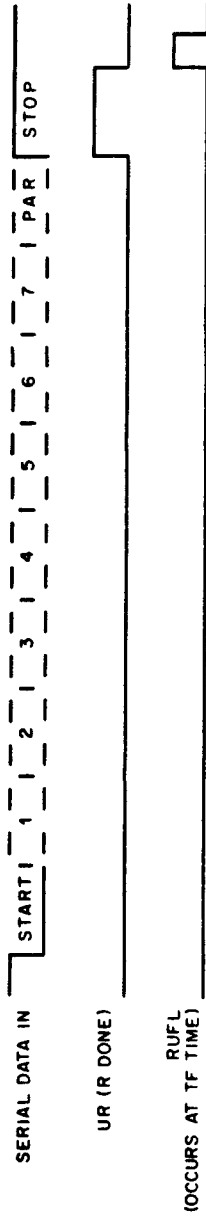
4.3.3 The Monitor and Power Supply Module

The monitor includes a cathode ray tube, horizontal and vertical deflection circuits to position the electron beam leaving the cathode, and a video amplifier to modulate that beam with the signal from the Video Shift Register.

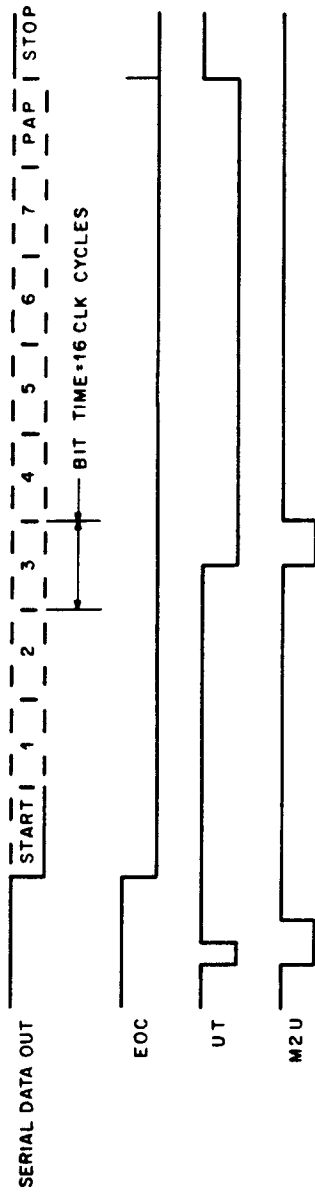
4.3.3.1 The CRT – Figure 4-14 is a diagram of the cathode ray tube used in the VT52. It consists of a heater, an electron-emitting cathode, a control grid for biasing, a focus grid for shaping the beam, a screen grid for accelerating the beam, and a high voltage anode for attracting the beam to the phosphor-coated face of the tube (screen). The beam strikes the screen at a high velocity causing the phosphor to give off light. Magnetic fields, produced by driving current through the horizontal and vertical deflection coils (yoke drivers), deflect the beam left and right, and up and down. The angle of deflection is proportional to the strength of the magnetic field, which is proportional to the current flowing through the coil.

4.3.3.2 Beam Deflection – As stated in Paragraph 4.6.1, field strength is proportional to current. Therefore, if the current through the coils is steadily increased, the magnetic field will also increase and the beam will deflect from left to right and from top to bottom, an amount proportional to the increase in current. If the currents are quickly returned to their original value, the beam will quickly return to its original position.

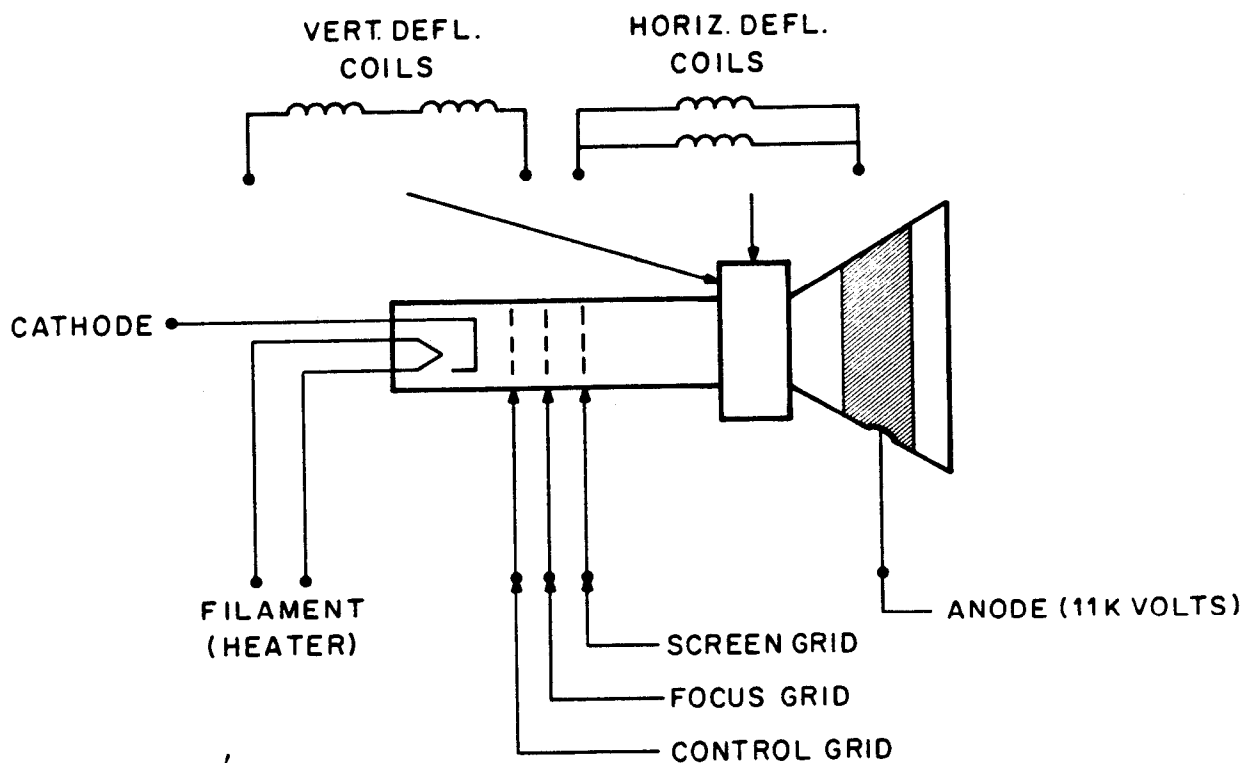
RECEIVER TIMING



TRANSMITTER TIMING



C P - 2299



CP-2300

Figure 4-14 Cathode Ray Tube

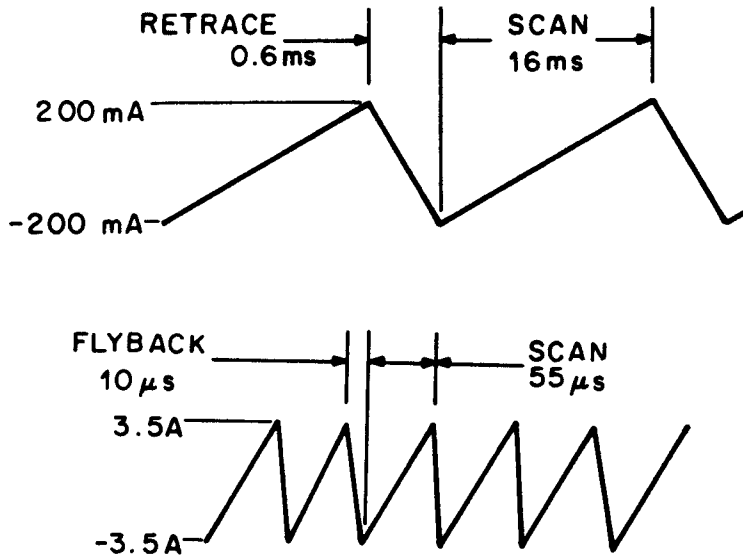
Figure 4-15 shows the horizontal and vertical sawtooth current waveforms through the deflection coils. Vertical deflection is very slow compared to horizontal deflection. This is because 240 horizontal scans occur for each vertical scan in 60 Hz units; 50 Hz units have 264 horizontal scans per frame. During vertical retrace time, the beam makes 16 additional horizontal scans.

Yoke Drivers (Refer to Monitor/PS Drawing D-CS-5410886-0-1, sheet 3) – Due to a large change in voltage per unit time and greater angle of deflection required, most of the voltage drop across the horizontal yoke is through inductance whereas, in the vertical yoke, resistance is more significant than inductance in causing the voltage differential. For this reason the two driver circuits are designed differently.

Vertical Yoke – At the center of the driving circuit for the vertical yoke is an operational amplifier (E5) in a current-sampling integrator configuration (with capacitor C42). The basic functional circuit is shown in Figure 4-16.

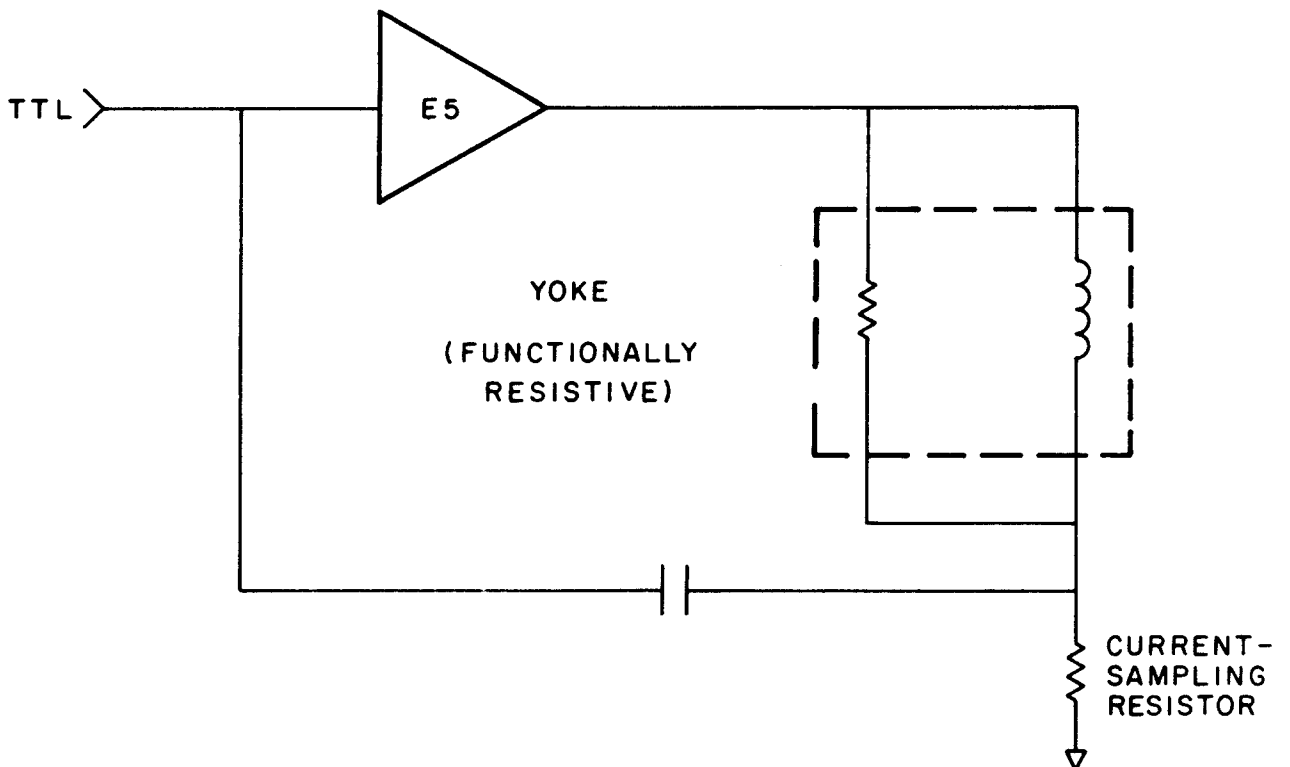
A power-driver stage is added by an emitter-follower (transistors Q16 and Q17). Transistor Q18 serves as a voltage-level converter. It is a common-emitter amplifier. To prevent dc leakage current from flowing through the vertical yoke, a capacitor is put in series with it. In addition, feedback is brought from the yoke back to the operational amplifier. E5's gain is 1 under dc conditions, when the resistance between the inverting input (pin 2) of E5 and ground is 100 k Ω ; under ac conditions, C40 lowers that resistance to 10 k Ω , giving E5 a gain of 10. This ensures saturation of the output of the operational amplifier, which makes the flyback cycle more effective.

Diode D23 charges capacitor C31 during vertical retrace. This reduces the current requirements of the vertical circuit during the downward scan, since it uses the energy stored in the capacitor.



CP-2301

Figure 4-15 Horizontal and Vertical Current Waveforms



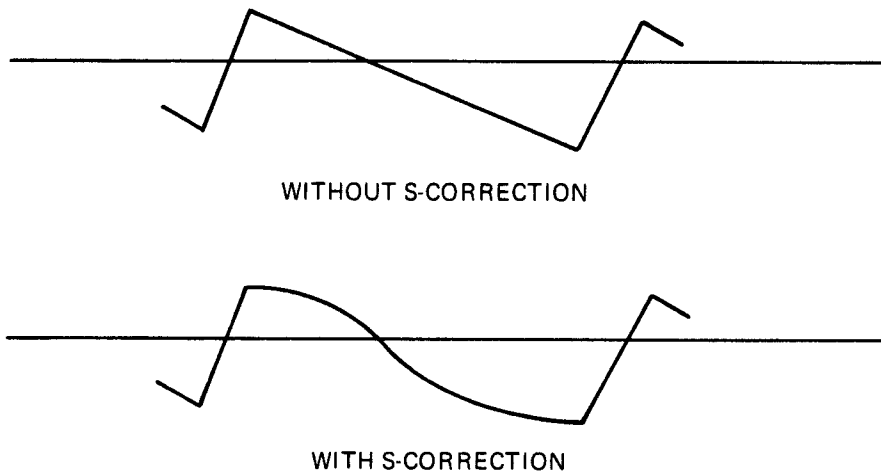
CP-2302

Figure 4-16 Vertical Deflection Circuit

Horizontal Yoke – The horizontal yoke is basically an inductor. By supplying a constant voltage, a constantly rising current will result which causes the horizontal scan. The momentum of this current across the coil is used to charge a capacitor which supplies the reverse voltage needed in flyback. This capacitor and the yoke form a resonant circuit. A diode is added to keep the capacitor from ringing after flyback has been achieved. As a result of flyback, the high current in the reverse direction is also sent to T1, the flyback transformer where it performs several functions:

1. It is stepped up to 11,000 V and rectified to provide the high dc voltage required by the anode of the cathode ray tube.
2. It provides a source of several high voltages.
3. It is used to generate the third harmonic of the waveform of the capacitor as it charges. This signal has about 15 percent of the amplitude of the original waveform, and is added on the secondary side of the transformer and subtracted on the primary side to produce a higher voltage with the same power consumption.

Again, there is a capacitor in series with the yoke. As well as eliminating dc across the yoke, it supplies the S-correction (Figure 4-17) to the yoke. It was mentioned before that the angle through which the yoke deflects the electron beam varies directly with the current through the yoke. But this does not result in a constant rate of speed of the beam's travel across the screen; since all the points on the screen are not an equal distance from the source of the electron beam, a deflection of 1 degree, when the beam is at the center, would produce less distance change than the same deflection when the beam is at an edge of the screen. The capacitor performs S-correction by slowing down the movement of the electron beam when it is near the edges.



CP - 02303

Figure 4-17 Horizontal Yoke Current

A variable inductor (T3) in series with the yoke is used to provide adjustment of the width of the scan.

The other coil in series with the yoke, T4, is the linearity coil. Its non-linear inductance corrects for some of the second-order effects; the resistance of the yoke and some of the voltage drops in the circuit.

The circuit at coordinates D3 uses the SYNC signal as the time base to integrate voltage sampled from pins 8 and 9 of the flyback transformer T1. A fast power transistor, which has started flyback too early with respect to the SYNC signal, will allow more current to be integrated. This circuit will compensate for the power transistor's fast storage by increasing its base current, which will slow it down. A power transistor which is too slow will likewise be compensated for by reducing its base current. Another benefit of this circuit is to guarantee that the power transistor will always be saturated when the horizontal scan begins, which will ensure its linearity.

Video Circuits – The screen grid provides +360 V in order to accelerate the electrons emitted from the cathode to the screen.

The focus circuit supplies a voltage from 0 V to 450 V to the focus grid. R71 is used to adjust this voltage to obtain the sharpest picture on the screen.

The intensity circuit supplies from 0 V to -80 V to the control grid. R93, which is the operator control at the rear of the unit, is used to fix this voltage, regulating the general intensity of the screen. A more negative voltage will suppress the flow of electrons to the screen, producing a dimmer image.

The two levels of intensity that are used to display characters on the screen are produced as Q21 switches on and off. This will take the cathode from +40 V (dark) to +2 V (light). D37 prevents Q21 from saturating, ensuring high speed of operation.

4.3.3.3 Power Supply – The power supply is located on the same module as the monitor electronics. It provides four voltages to the terminal electronics: (+)15 V, (-)12 V, (-)5 V, and (+)5 V. The voltage distribution is as shown in Table 4-6. Figure 4-18 is a block diagram of the power supply.

The linear transformer has a flux shield optimally positioned to prevent interaction between the flux generated by the transformer and the electron beam of the CRT, which should produce, if the line frequency varied from the nominal, a phenomenon known as "swimming." Current goes into a full-wave rectifier with center-tap. The positive and negative outputs of this rectifier are regulated to +15 V and -12 V respectively.

Table 4-6 VT52 Voltage Distribution

Voltage	Use
+15	Horizontal and Vertical Deflection Circuits and EIA Interface Option
-12	Vertical Deflection Circuit and EIA Interface Option UART Character Generator
-5	Character Generator Bias
+5	TTL Logic and RAM

Another winding of the transformer is passed through a full-wave center-tap rectifier and capacitor-input filter to be regulated to +5 V. The power supply of +15 V, -12 V, and +5 V uses only one voltage reference, utilizing a Zener diode. (The -5 V supply uses its own Zener diode.)

Each rectifier has current-limiting and foldback to protect against inadvertent short-circuits during maintenance or for any other reason.

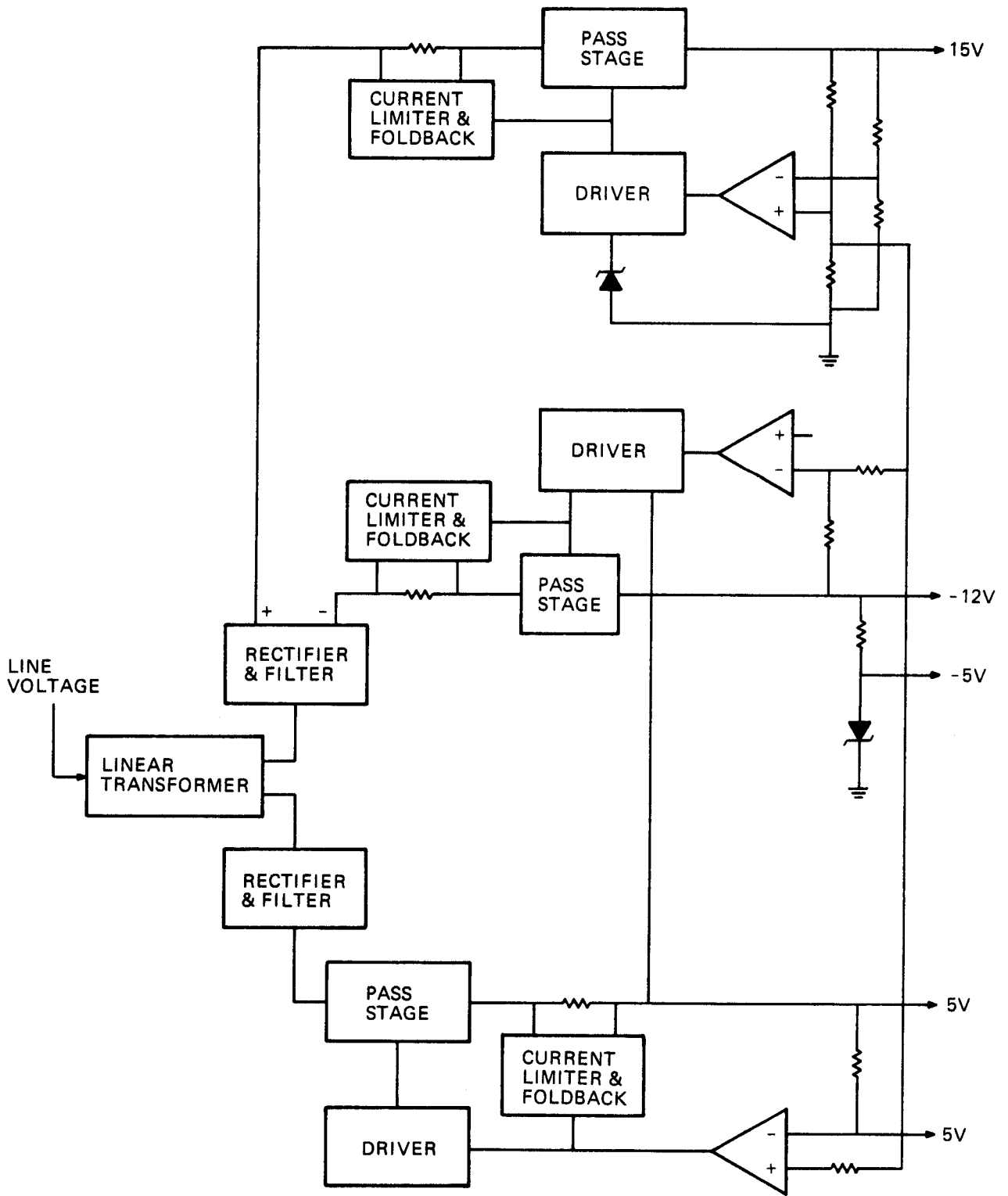


Figure 4-18 VT52 Power Supply

4.4 KEYBOARD

The keyboard is arranged so that the keys form an 8 × 10 matrix and every key except the BREAK key has been assigned a unique identifying number representing its position in the matrix. The AC register is used to detect keys that have been activated (typed). AC0, 1, and 2 are decoded to enable one of the eight lines of the matrix; AC3, 4, 5, and 6 are decoded to enable one of the 10 columns. Any key can be checked by placing its identifying number into the AC register. If the key is not down, FLAG L will be TRUE, causing a program JUMP when instruction KEY J is executed.

The program polls the keyboard during vertical retrace time by loading the AC register with the highest key number and entering a program loop that continually subtracts 1 from the AC register and tests the result until an active key is found or until the AC=0.

When a key is found “down,” the program leaves the test loop and stores the key number in location Keyboard A or Keyboard B of the scratchpad memory. On subsequent keyboard pollings, the program will fetch the numbers stored in Keyboard A and Keyboard B and check the keyboard to see if one or both of these keys are still “down.” If both keys are down, the program leaves the loop and no keyboard entries are made. When either of these keys are found to be “up,” scratchpad locations Keyboard A and/or Keyboard B are cleared and a new keyboard search is started. This test routine is always performed before every keyboard test to prevent multiple entries of the same character.

After storing the identification number of the active key, the program looks up the ASCII code for that key in a table in the ROM, then transfers the ASCII-coded character to the UART for transmission to the host.

The BREAK key cannot be tested by the program. The CONTROL key, if activated while a ROM word is being loaded into the RAM, will force the two most significant bits of the ROM word to zero. The ROM word is transferred to the RAM if AC > RAM during a conditional load RAM command. The BREAK key interrupts the UART serial data output line for as long as the key is held down and operates independently of the program.

4.5 MICROPROGRAM

The ROM resident microprogram controls all operations in the VT52 terminal. This includes the three major operations performed by the VT52 and described earlier in the chapter, i.e., display a screenful of characters and refresh the screen at line frequency rate, act as an input device by transmitting to the host processor key codes entered by an operator, and act as an output device by processing or displaying codes received from the host. In addition, the microprogram directs the advanced features of the VT52 such as controlling the data flow when operating in Hold-Screen mode, performing line relocation when SCROLL is typed, and identifying itself when requested to do so by the host. All VT52 operations are performed by executing one or more of the VT52 instructions listed in Table 4-7.

Table 4-7 VT52 Instruction Set Mnemonics

B	C D	EFGH=0	E=1	F=1	G=1	H=1 Mode 1	H=1 Mode 0
0	0 0	SCFF	ZXZY	DXDY	M2A	URJ	PSCJ
0	0 1	SVID	X8	IA	A2M	AEMJ	TABJ
0	1 0	B2Y	IADY	IA1	M2U	ALMJ	KCLJ
0	1 1	CBFF	IX	IY	B2M	ADXJ	FRQJ
1	0 0	ZCAV	ZA	DY	M2X	AEM2J	PRQJ
1	0 1	LPB	M1	IROM	U2M		TRUJ
1	1 0	EPR	ZX	DX	M2B	VSCJ	UTJ
1	1 1	HPR!ZY	M0	DA	SPARE	KEYJ	TOSJ

To perform all these tasks, the microprogram needs control registers and flip-flops, counters, temporary storage, etc. The scratchpad memory serves all these requirements. All VT52 status information is stored in the scratchpad. In addition, the scratchpad memory contains the silo used for storing incoming characters and provides temporary storage for keyboard characters. Figure 4-19 is a layout of the scratchpad memory.

Addressing the scratchpad memory is simple with the available microinstructions. Executing instruction ZXZY!DXDY will clear the X and Y registers and then decrement both registers, setting the Y register to 17₈, the X register to 177₈, and selecting scratchpad location SCAN COUNT/KB COUNT.

Another instruction (X8) complements X register bit X3. This is the most significant X selection bit when addressing the scratchpad. Complementing this bit is like jumping eight X locations. Other instructions that increment or decrement the X and Y registers can be used to move around within the scratchpad.

Figure 4-20 is a flow diagram of the VT52 microprogram operations. Top-of-screen tests are performed at line frequency rates, i.e., 60 times each second in 60 Hz units; 50 times each second in 50 Hz units. The UART flag is checked after horizontal scans.

4.5.1 Servicing the Keyboard

The keyboard is checked between displayed frames, i.e., during vertical retrace time. If one or more keys are pressed, the terminal transmits to the host the code representing the pressed key.

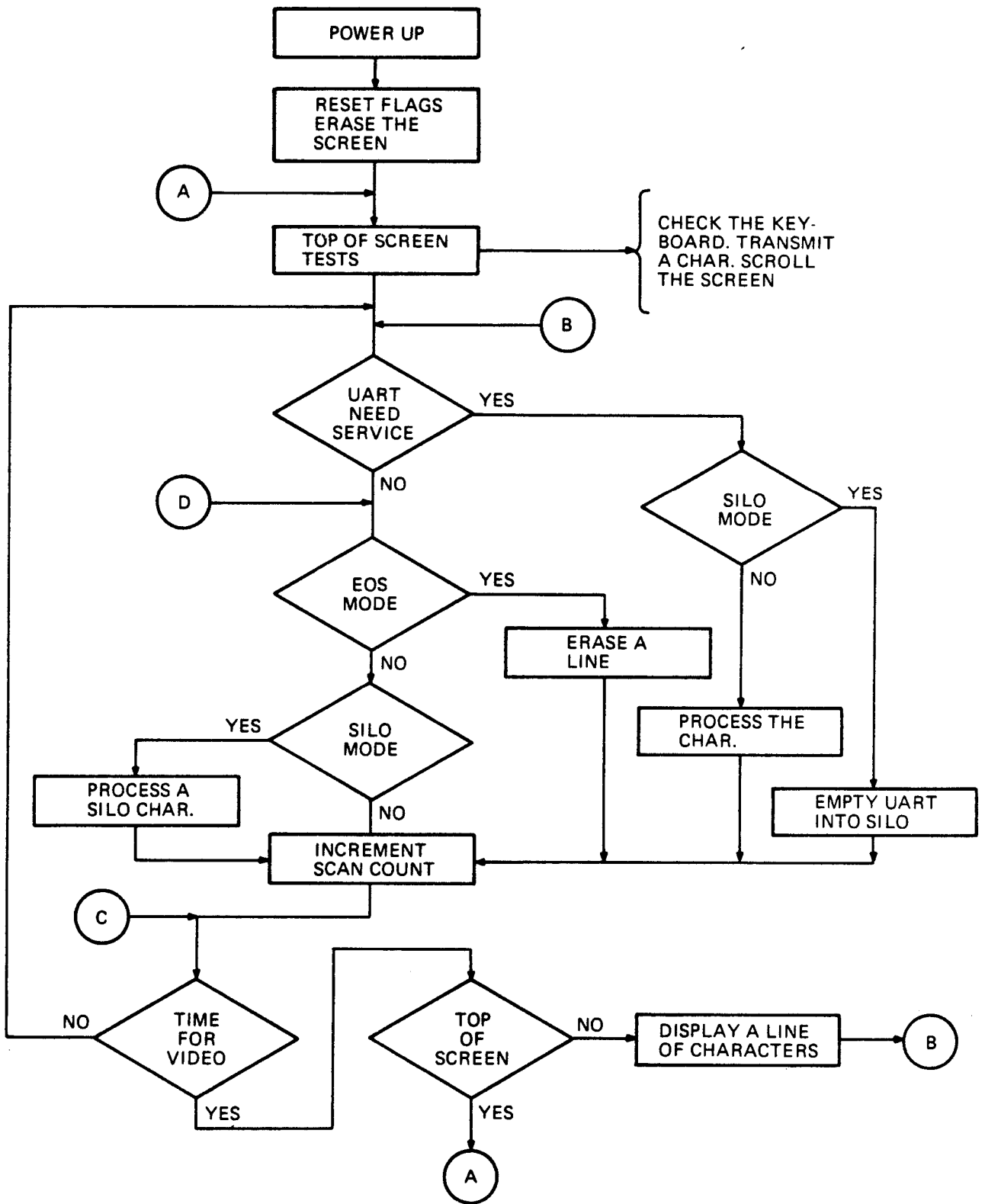
Figure 4-21 is a simplified flow diagram of the keyboard entry subroutine. The AC register is set to equal the highest numbered key on the keyboard and then a KEYJ command tests the flag to see if the key is down. If the key is not down, the AC register is decremented and the flag is tested again. This loop is repeated until a typed key is found. When an active key is located, the program stores the identification number of the key in the scratchpad memory. The program then looks up the ASCII code for the typed key in a table in the ROM, loads the ASCII character into the UART and transmits the character to the host.

If none of the keys are down, the program will exit the routine when the AC register is equal to zero. A jumper in the keyboard is wired to act like a typed key whenever it is referenced. It is referenced when the AC=0, meaning the keyboard was polled but no keys were down.

The identification number of the key is written into the scratchpad to prevent multiple transmission of the same character. Since the keyboard is polled 60 times a second, it is just about impossible not to detect a typed key more than once. As a first step then, the program reads the identification numbers stored in Keyboard A and Keyboard B of the scratchpad and checks the keyboard to see if these keys are still down. If they are, no transmission takes place during this scan. If one or both of the keys are up, the program clears the scratchpad location associated with the key and polls the keyboard.

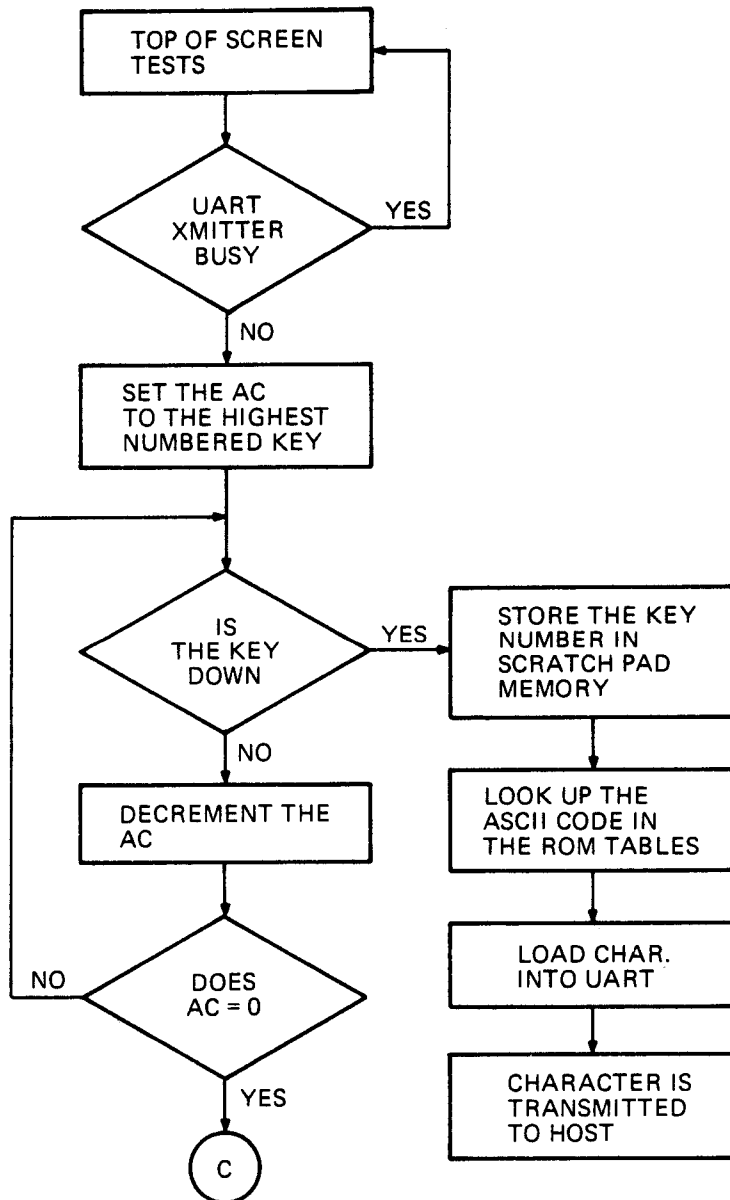
4.5.2 Scrolling

A Line Feed (LF) command received from the host when the cursor is on the bottom line will cause the terminal to scroll. That is, every line on the screen will move up one position, leaving the bottom line blank, ready to receive more characters. Information displayed on the top line is lost and will be replaced by information previously displayed on the second line (line 1). To erase every RAM line and rewrite these lines with the contents of the following RAM line would take too much time and be an unreasonable way to accomplish scrolling. Instead, any RAM line can be displayed as the top line on the screen. This means that after one scroll the top line would be RAM line 1 and the bottom line would be RAM line 0. Successive scrolls would cause RAM lines 2, 3, 4, etc. to be displayed as the top line and RAM lines 1, 2, 3, etc. to be displayed as the bottom line.



CP-2307

Figure 4-20 Microprogram Flow Diagram



CP-2308

Figure 4-21 KYBD Entry Flow Diagram

A scratchpad location is used to remember which RAM line is displayed on the top screen line. This location, TOP LINE, contains a line number between 0 and 23 and is cleared to 0 at power-up time. Memory location CUR Y contains the RAM line address of the cursor: location SCREEN LINE contains the screen line address of the cursor.

As an example, if the cursor is on line 5 and the top line is line 3, CUR Y will contain a 5 and SCREEN LINE will contain a 3; the cursor will be displayed on line 3 of the screen.

4.5.3 Hold-Screen Mode

Hold-Screen mode allows the operator to control the rate at which data from the host enters and leaves the screen. If left unchecked, high-speed data from the host would be displayed for a very short time and then scrolled up and off the screen; the operator would not have enough time to read the data. In Hold-Screen mode, the terminal will avoid scrolling the display until commanded to do so by the operator.

When the cursor is on the bottom line of the screen and an LF command is received from the host, the program stores the Line Feed command in the LINE FEED BUFFER of the scratchpad and transmits the code for signal X OFF to the host. X OFF is used to request the host to stop transmitting data to the terminal. A few characters will be sent by the host before it receives and acts on the request. The program stores these characters in the silo portion of the RAM.

To request more data, the operator types SCROLL. The program responds by scrolling the screen and then processing the characters previously stored in the silo until the silo is empty. The program then sends X ON to the host and data transmission is resumed until another LF is received.

The silo portion of the RAM is addressed whenever the Y register contains 14₈. The X address of the silo is determined by two other locations in the scratchpad: SILO OUTPUT and SILO INPUT. SILO OUTPUT contains the X address of the next character to be processed by the terminal. SILO INPUT contains the X address of the first free silo location (the location where the next character will be stored). SILO OUTPUT = SILO INPUT when the silo is empty. When writing into the silo, SILO INPUT is incremented after each character is stored. When processing the silo characters, SILO OUTPUT is incremented every time a character is removed. SILO COUNTER, another scratchpad location, counts the number of characters stored in the silo; it contains the difference between SILO INPUT and SILO OUTPUT. As an example, assume the cursor is on the bottom line of the screen and an LF command is received from the host. SILO INPUT = SILO OUTPUT and we will assign address 2 to both of these registers. The LF command is stored in LINE FEED BUFFER and X OFF is sent to the host. If three characters are received before the data transmission stops, they will be stored in silo locations X2, X3, and X4. SILO OUTPUT will still contain 2 but SILO INPUT = 5 and SILO COUNTER = 3. When the characters are processed as a result of typing SCROLL, SILO COUNTER will contain a zero, SILO OUTPUT = SILO INPUT = 5 and the LINE FEED BUFFER will be cleared. If one of the characters in the example was an LF, it would not have been processed. Instead, it would have been stored in LINE FEED BUFFER and X OFF again sent to the host.

4.5.4 Terminal Identification

When the terminal receives the code for ESC Z from the host, it interprets this code as a request for the terminal to identify itself. The basic VT52 terminal does this by transmitting ESC/K to the host. A VT52 with copier option will transmit ESC/L; a VT52 with printer option will transmit ESC/M. The code for these three characters cannot be sent as one sequence; therefore, one character is sent after each frame displayed on the screen. The terminal must remember what portion of the sequence has been sent. Location ID of the scratchpad is used to store the status of the identification process. Five values are assigned to ID to indicate the different stages of the identification process. They are:

- 0 An ESC Z command is not pending.
- 135 An ESC Z has been received.
- 033 Code for ESC has been sent to the host.
- 057 Code for slash (/) has been sent to the host.
- 101 Code for K (or L or M) has been sent to the host.

During the identification process, the keyboard is not polled. This is to prevent keyboard characters from being mixed with the 3-character Escape Sequence.

When the last character in the sequence has been sent, location ID is cleared to 0 and keyboard polling resumes.

4.5.5 Flashing the Cursor

The cursor appears as a flashing underscore on the screen on the ninth scan of one of the 10 scan character rows. Although the screen is refreshed 60 times a second, the cursor display is refreshed only 4 times a second in order to produce a blinking cursor. To achieve this low frequency refresh rate, scratchpad location FRAME COUNT is preset to 160 and is incremented every time the Y line containing the cursor is to be painted on the screen. When FRAME COUNT overflows (every 15 frames), the CRT beam is turned on displaying the cursor, and FRAME COUNT is again preset to 160.

CHAPTER 5 SERVICING

5.1 SERVICE PHILOSOPHY

After the VT52 has been installed and checked out at the customer's site, it can be expected to operate error free for long periods of time. As with all electronic devices, however, the VT52 will occasionally require some corrective maintenance due to a failing or marginal component. When the terminal requires service, it is recommended that service be performed at the subassembly level; the fault should be isolated to a module or other major component and the faulty part replaced with a completely tested spare. If the failing part is a module, it should be returned to an authorized DIGITAL repair depot where facilities are available for efficiently locating the faulty component. After repair and complete testing, the module can be returned to Field Service stock.

With the exception of the Monitor/Power Supply module, all data and control circuitry in the VT52 depends upon the microprocessor for timing and/or data information. Without specially designed test equipment, field testing this circuitry to the component level is difficult and time consuming and is not recommended.

NOTE

The spares kit consists of a complete set of modules for the VT52.

5.2 SUBASSEMBLY LEVEL TROUBLESHOOTING

To find and repair the cause of a failing terminal, the serviceman must first identify the faulty subassembly and then replace it with a good spare part. Replacement procedures for all major subassemblies are described in Paragraph 5.3. To identify the faulty subassembly, the serviceman must analyze the symptoms and make a judgment as to which module or major component is at fault. Replacing the suspect subassembly will fix the problem or at least eliminate that subassembly as a possible cause of the problem.

5.2.1 Identifying the Faulty Subassembly

Identifying the faulty subassembly will be fairly easy in some cases and quite difficult in others. Failures to the Monitor/Power Supply module will usually result in an obvious display malfunction, i.e., loss of horizontal or vertical deflection, no display, etc.

In some cases, the serviceman will be able to decide which subassembly is failing by analyzing the symptoms displayed on the screen. In other cases he will have to make additional keyboard tests and/or voltage and waveform checks to determine the failing subassembly. To assist you in making this decision, timing waveforms and other test data are included in this chapter.

The PMK04 Off-Line Terminal Tester can be used to exercise serial terminals and assist the serviceman in isolating faults within the terminal or communication interface. (Refer to PMK04 manual).

5.2.2 Analyzing the Symptoms

To start with there are some basic checks the serviceman should make before disassembling the unit.

1. Is the unit turned on?
2. Is the unit plugged into the outlet?
3. Is the intensity level set too low?
4. Are the baud rate switches set to legal positions?
5. Are the send/receive baud rates of the terminal set to the receive/send baud rates of the host?

After determining that the terminal is properly set up for operation and still does not work, the unit should be placed off-line and some keyboard tests made to develop a list of symptoms and possible causes. The more symptoms the serviceman has to work with, the better the judgment that can be made as to which part is failing.

NOTE

The possible equipment malfunctions listed in Tables 5-1 and 5-2 are categorized by abnormal symptoms. Corresponding causes are listed in order of probability. Corrective actions are for the most part limited to the adjustment and/or substitution of major replaceable subassemblies.

1. After warm-up, is the cursor at HOME position and blinking?

If not, go to step 2.

If the cursor is at HOME position, the serviceman can assume that the CRT and its associated components and the Monitor/Power Supply module are all functioning normally. Further testing is required (Table 5-2).

2. Is there a raster on the screen when the intensity level is set for maximum brightness?*

If there is no raster, see Table 5-1.

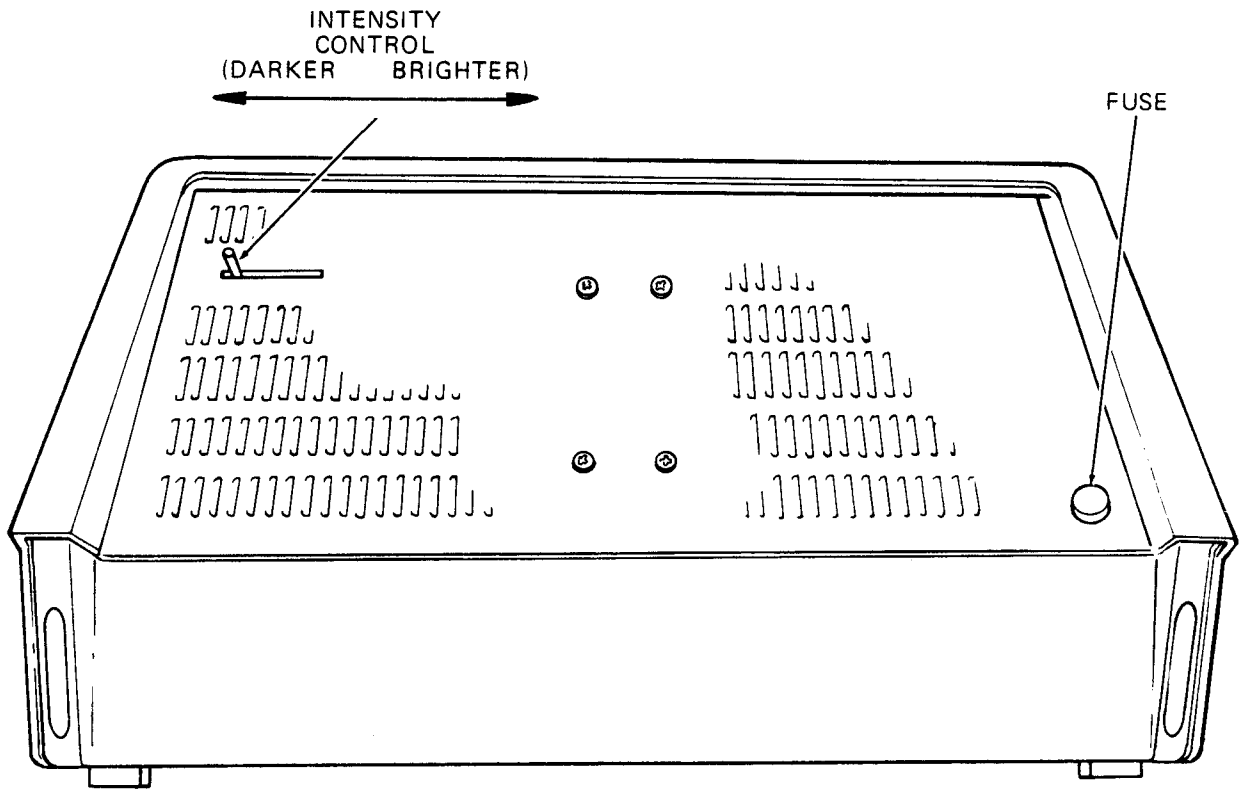
If there is a raster, the serviceman can assume that the MONITOR/PS module and the CRT and its associated components are alright. A possible exception is the video amplifier circuitry on the Monitor/PS module.

If further testing is required to locate the problem, the unit must be tipped back and the base removed. The base removal procedures are described in Paragraph 5.3.

*On some units the raster is not visible even with the intensity control set for maximum brightness.

Table 5-1 Power On Troubleshooting Procedure

Symptom	Possible Cause	Corrective Action
No cursor	Intensity control turned down	Adjust intensity control (Figure 5-1)
No cursor, raster missing	Blown fuse	Replace fuse (Figure 5-1)



MA-2055

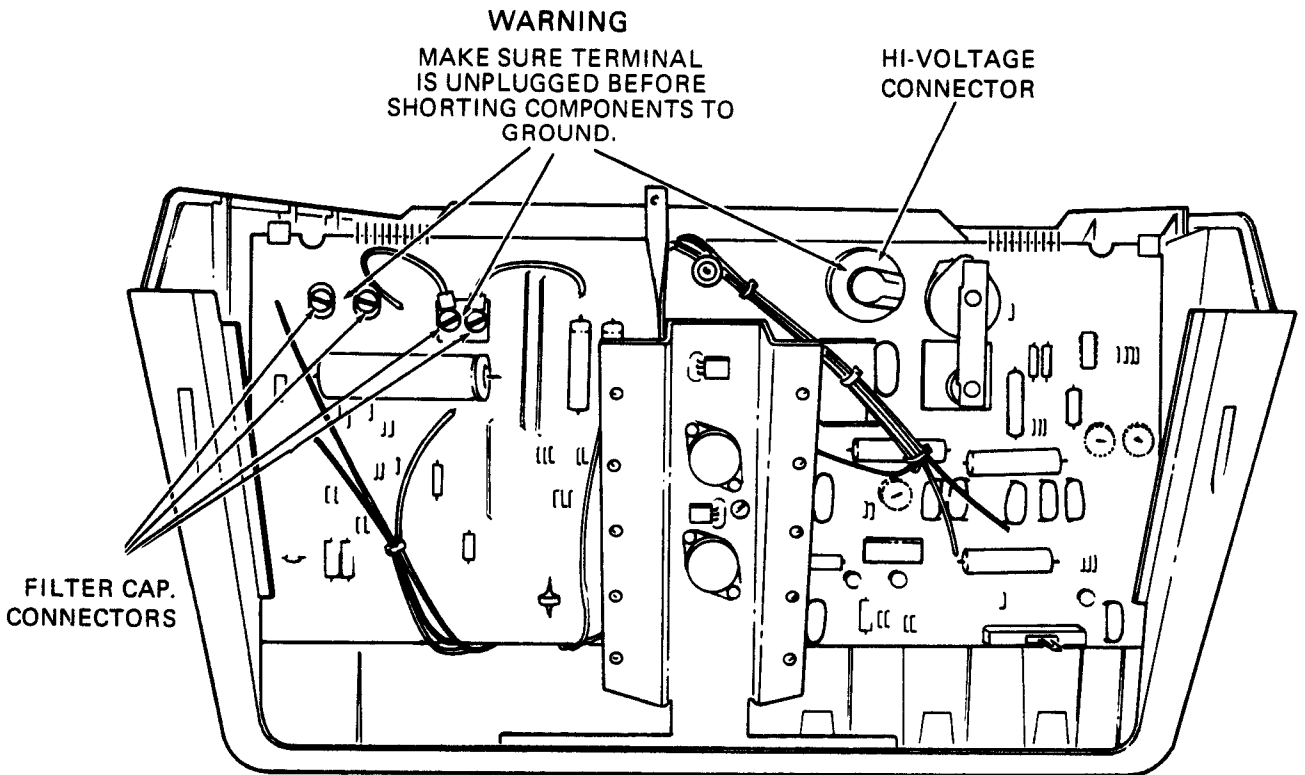
Figure 5-1 Intensity Control and Fuse Locations

Table 5-1 Power On Troubleshooting Procedure (Cont)

Symptom	Possible Cause	Corrective Action
No cursor, raster missing	No prime power	Restore source of prime power

WARNING

There are high voltages present in the power supply and CRT. Make sure the terminal power line is unplugged and the CRT and capacitors are discharged as shown in Figure 5-2 before handling the power supply or CRT components. Make sure ground connection is made before discharging these points.

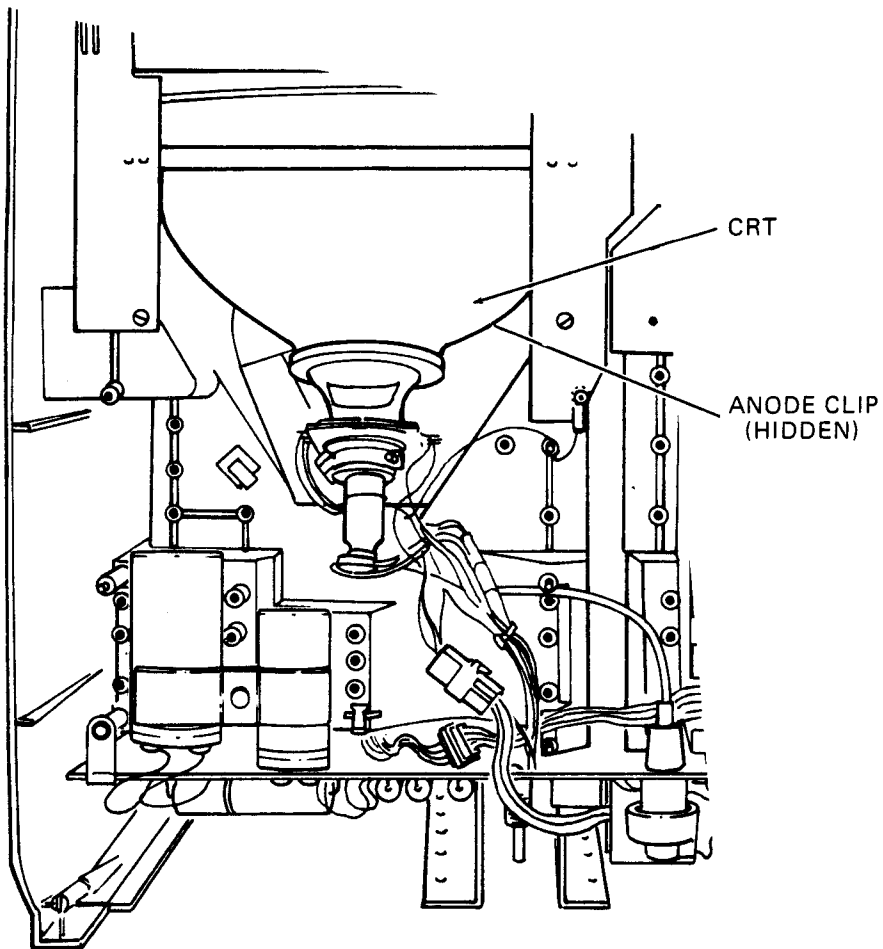


MA-2058

Figure 5-2 High Voltage Discharge Locations

Table 5-1 Power On Troubleshooting Procedure (Cont)

Symptom	Possible Cause	Corrective Action
No cursor, raster missing (Cont)	Anode cap disconnected	Connect anode cap at power supply (Paragraph 5.3.3)
	Anode clip disconnected	Connect anode clip at CRT bell (Paragraph 5.3.3 and Figure 5-3)

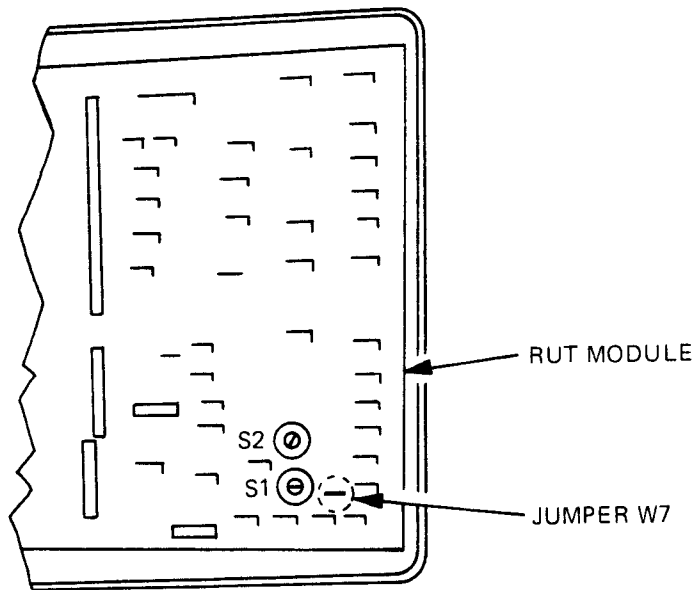


MA-2053

Figure 5-3 Anode Clip Locations

Table 5-1 Power On Troubleshooting Procedure (Cont)

Symptom	Possible Cause	Corrective Action
No cursor, raster missing (Cont)	Defective monitor/power supply assembly	Replace monitor/power supply assembly
<p>WARNING Use caution when handling the CRT to avoid shattering the tube. The CRT is an evacuated device which can implode when broken.</p>		
	Defective CRT	Replace CRT (Paragraph 5.3.5)
	Defective RUT module	Replace RUT module (Paragraph 5.3.2)
	Defective DP module	Replace DP module (Paragraph 5.3.2)
	Defective character generator module	Replace character generator module (Paragraph 5.3.2)
<p>WARNING There are high voltages present in the power supply and CRT. Make sure the terminal power line is unplugged and the CRT and capacitors are discharged as shown in Figure 5-2 before handling the power supply or CRT components.</p>		
No cursor, raster present, arcing heard	Defective monitor/power supply assembly	Replace monitor/power supply assembly (Paragraph 5.3.3)
	Anode cap loose	Tighten cap (Figure 5-2)
	Anode clip loose	Tighten clip (Figure 5-3)
Cursor present, but display flickers	W7 jumper on RUT	Remove W7 jumper (60 Hz units) or insert jumper W7 (50 Hz units) (Figure 5-4)

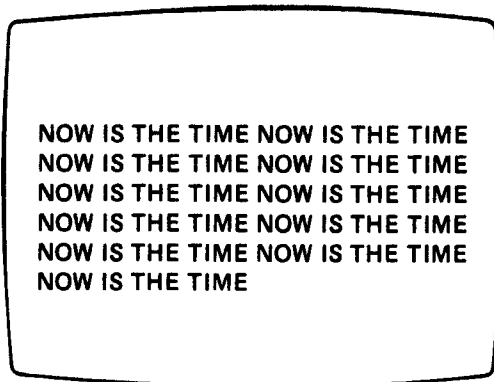


MA 0260

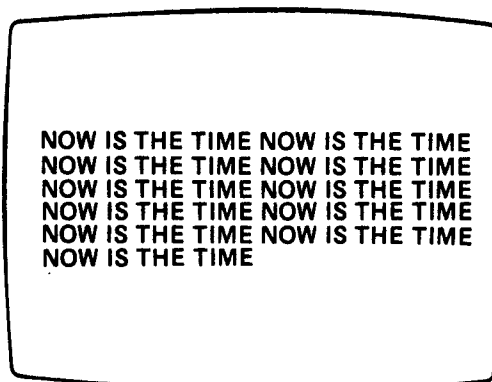
Figure 5-4 Jumper W7 Location

Table 5-2 Operational Troubleshooting Procedures

Symptom	Possible Cause	Corrective Action
Unable to adjust focus; display remains fuzzy	Defective monitor/power supply board	Replace monitor/power supply board (Paragraph 5.3.3)
Entire raster too short (Figure 5-5)	Vertical size/linearity out of adjustment	Adjust vertical size/linearity control (Paragraph 5.4.1 or 5.4.3)
Unable to adjust raster or character width	Defective monitor/power supply board	Replace monitor/power supply (Paragraph 5.3.3)
Entire raster too narrow (Figure 5-6)	Horizontal size out of adjustment	Adjust horizontal size control (Paragraph 5.4.2)
Unable to adjust intensity/brightness	Defective monitor/power supply board	Replace monitor/power supply board (Paragraph 5.3.3)
	Defective CRT	Replace CRT (Paragraph 5.3.5)



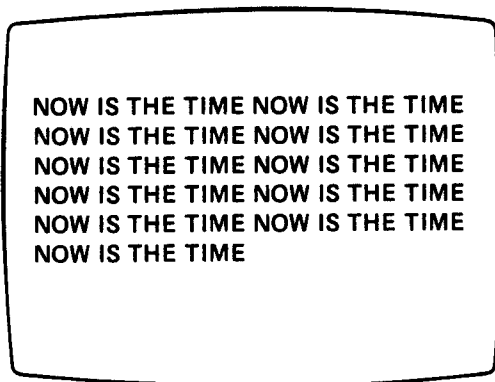
(NORMAL DISPLAY)



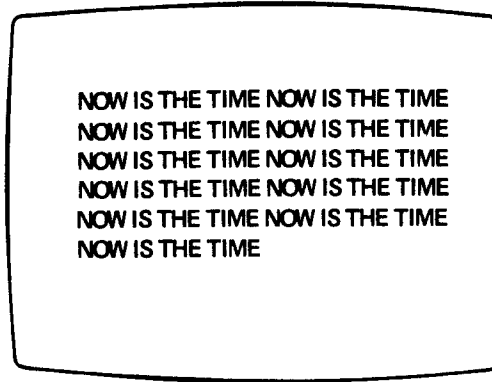
(SHORT RASTER)

MA-0254

Figure 5-5 Short Raster Indication



(NORMAL DISPLAY)



(NARROW RASTER)

MA-0247

Figure 5-6 Narrow Raster Indication

Table 5-2 Operational Troubleshooting Procedures (Cont)

Symptom	Possible Cause	Corrective Action
Characters too short (Figure 5-7)	Vertical size out of adjustment	Adjust vertical size control (Paragraph 5.4.1)
	Vertical linearity out of adjustment	Adjust vertical linearity control (Paragraph 5.4.3)
Illegal characters generated (Figure 5-8)	Defective monitor/power supply board	Replace monitor/power supply board (Paragraph 5.3.3)
	Defective character generator board	Replace character generator board (Paragraph 5.3.2)
	Defective RUT module	Replace RUT module (Paragraph 5.3.2)

NOW IS THE TIME

(NORMAL SIZE)

NOW IS THE TIME

(SHORT CHARACTERS)

MA-0248

Figure 5-7 Short Character Indication

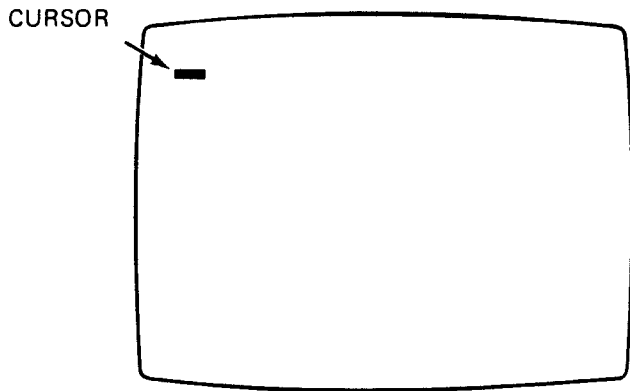
N O W I S T H E T I M E

MA-0250

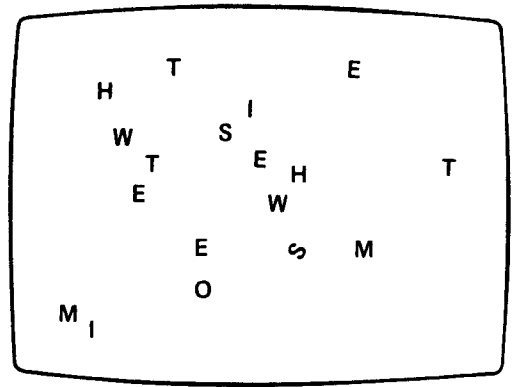
Figure 5-8 Illegal Characters Indication

Table 5-2 Operational Troubleshooting Procedures (Cont)

Symptom	Possible Cause	Corrective Action
Random characters generated or screen fills with random characters when first turned on (Figure 5-9)	RUT/Character ROM/PROM chips are incorrect	Check that ROM/PROM chips are correct (Figure 5-10 and Appendix A)
	Defective character generator module	Replace character generator module (Paragraph 5.3.2)
	Defective DP module	Replace DP module (Paragraph 5.3.2)
Wrong character displayed when typed	Defective RUT module	Replace RUT module (Paragraph 5.3.2)
	Defective keyboard	Replace keyboard (Paragraph 5.3.4)
	Defective keyboard character generator	Replace character generator (Paragraph 5.3.2)
No key-clicks; cursor present	Defective RUT module	Replace defective module (Paragraph 5.3.2)
No key-click or cursor, raster present	Defective DP module	Replace defective module (Paragraph 5.3.2)
	Defective keyboard	Replace keyboard (Paragraph 5.3.4)
No key-clicks; characters displayed	Defective DP module	Replace defective module (Paragraph 5.3.2)
	Defective RUT module	Replace defective module (Paragraph 5.3.2)
No key-clicks; characters generated wrong but legal	Defective DP module	Replace DP module (Paragraph 5.3.2)
	Defective RUT module	Replace defective module (Paragraph 5.3.2)
	Defective keyboard	Replace keyboard (Paragraph 5.3.4)
	Defective keyboard character generator	Replace character generator (Paragraph 5.3.2)
Entire raster tilted (Figure 5-11)	Incorrect yoke position	Adjust yoke tilted on the neck of the CRT (Paragraph 5.4.1)
Raster too large; all characters enlarged and fuzzy (Figure 5-12)	Incorrect yoke position	Push yoke forward to the CRT bell as far as it will go. Tighten hold down screw.



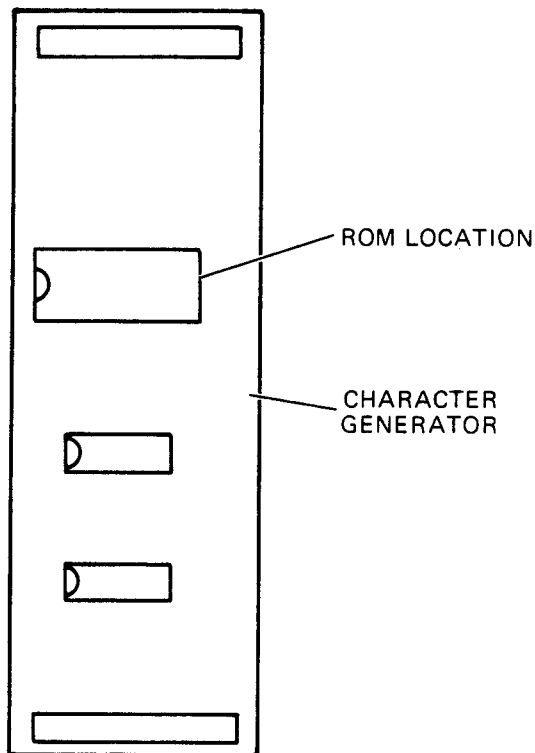
(NORMAL DISPLAY WHEN FIRST TURNED ON)



(RANDOM CHARACTERS)

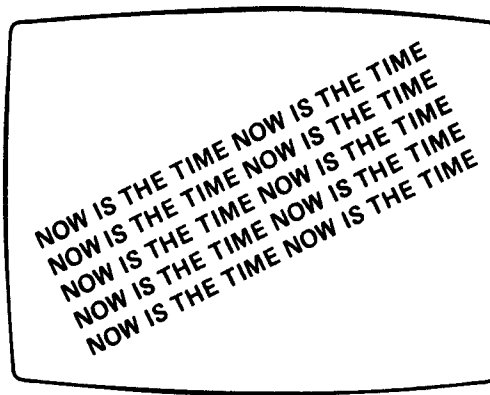
MA-0246

Figure 5-9 Random Character Indication



MA-0270

Figure 5-10 ROM Chip Location



MA-0256

Figure 5-11 Tilted Raster Indication

NOW IS THE TIME

(NORMAL DISPLAY)

NOW IS THE TIME

(ENLARGED AND FUZZY CHARACTERS)

MA-0249

Figure 5-12 Enlarged and Fuzzy Characters Indication

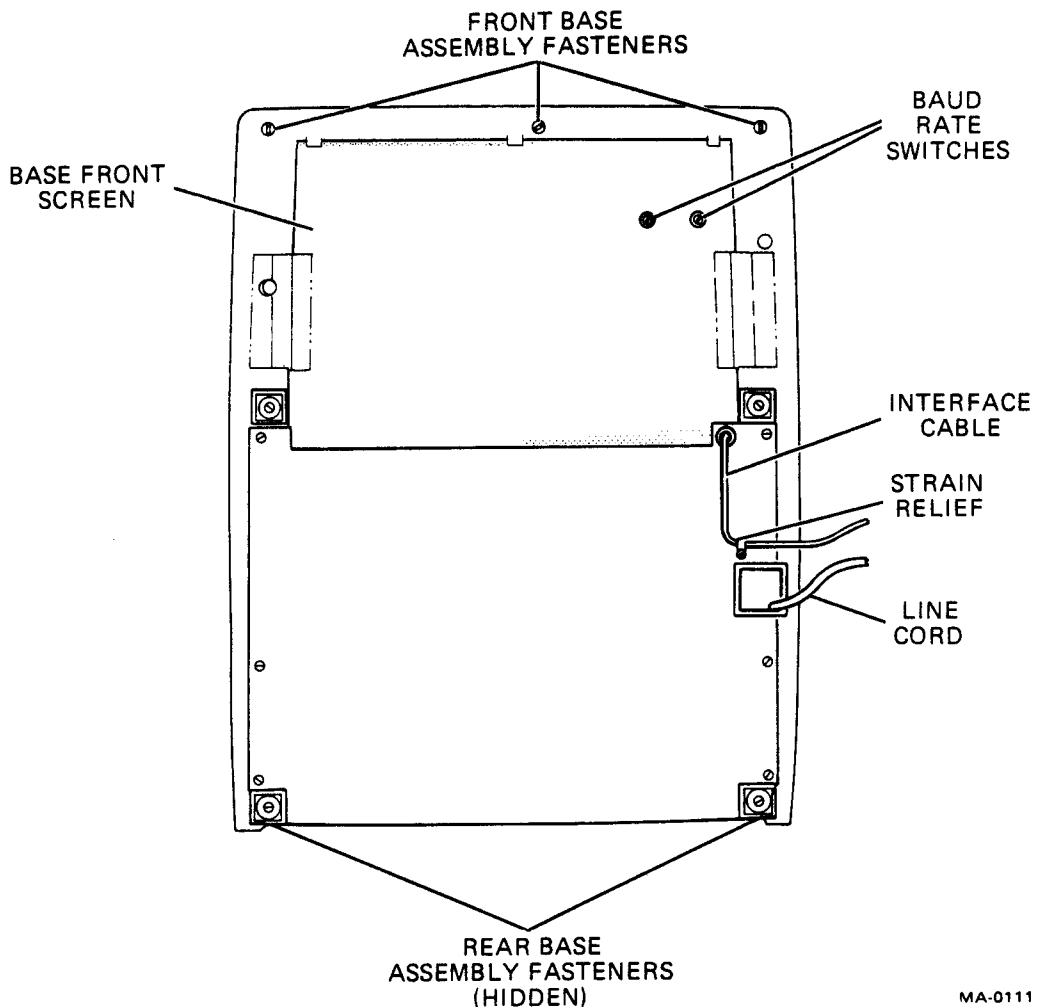
5.3 SUBASSEMBLY REPLACEMENT

The following paragraphs provide step-by-step procedures for swapping modules and major components in the VT52 terminal.

5.3.1 Removing the Base Assembly

To remove the base assembly refer to Figure 5-13 and perform the following steps.

1. Make certain the unit is not plugged into an electrical outlet and the power (ON/OFF) switch is OFF.
2. Place the unit upside down on a bench or table.
3. Unscrew the sliding cover (two screws) covering the line cord opening.
4. Remove the base front screen (three screws).
5. Remove the screws (as many as ten) holding the rear louver plate on (Figure 5-20).
6. Remove ground leads.
7. Slide the interface cable and its rubber grommet from the slot in the rear screen.
8. Unfasten the ground connection from the rear of the base screen (one screw).



MA-0111

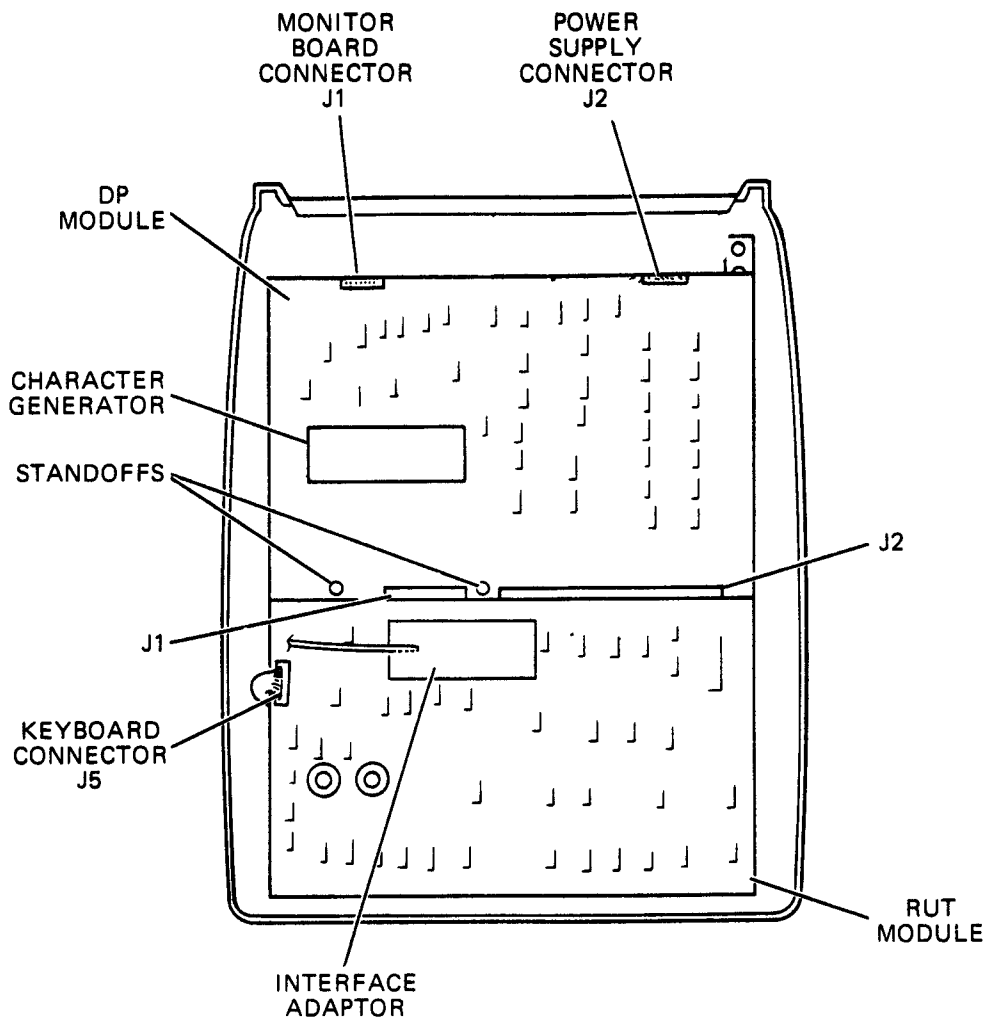
Figure 5-13 Base Assembly Removal and Replacement

9. Remove the base assembly from the shell by first turning the five, 1/4 turn fasteners 90° counterclockwise. Notice that the five 1/4 turn fasteners are *not* removed but merely turned, using a 1/4 inch nut driver, 90° counterclockwise to loosen, and 90° clockwise to tighten.
10. Reverse steps 1 through 9 to reassemble.

To remove the base assembly from older units,* do steps 1, 2, 3, and 4. Then remove the base-securing screws with a 1/4 inch nut driver and lift the base from the unit.

Figure 5-14 is a bottom view of the terminal with the base cover removed. J1 and J2 on the ROM, UART, and Timing (RUT) module connect directly to J1 and J2 on the Data Path, Memory, and Decoder (DP) module. The keyboard is cable connected to RUT connector J5. The Monitor signals are cable connected to DP-J8; the Power Supply is cable connected to DP-J9.

*Up to and including the following serial numbers: Westfield serial number 3657, Phoenix serial number 5400.



MA-2061

Figure 5-14 RUT and DP Module Removal and Replacement

5.3.2 Replacing the ROM, UART and Timing (RUT) or Data Path, Memory and Decoder (DP) Module

The RUT module and the DP module must be removed and replaced as a unit; they should not be separated until they have been removed from the terminal. To replace the RUT/DP modules, refer to Figure 5-14 and do the following:

1. Remove the base assembly from the shell (Paragraph 5.3.1).
2. Unplug the EIA or 20 mA adapter card, the keyboard connector, and the two connectors to the power supply board.
3. Unscrew nine small plastic wing nuts.
4. Remove two 8-32 × 1/4 inch aluminum standoffs.

5. Pick up the assembled board set from the unit and set aside. Separate the RUT module from the DP module being careful to save the small plastic clip holding the corners of the two boards.
6. A board set *must* be reassembled (including the small plastic clip) outside the shell and installed as a set. It is installed by sliding the front board slots under the three front 1/4 turn fasteners and over the 8-32 studs.
7. The plastic wing nuts can be screwed on or pushed on with a smaller nut driver.
8. If the character generator is to be removed from the DP module, unplug the assembly. (The character generator is secured to the DP module by its connectors.)

To replace the RUT and DP modules reverse steps 1-8.

The following steps outline the procedure to be followed when removing the RUT or DP module from earlier terminals (Westfield serial number 3657 and lower; Phoenix serial number 5400 and lower).

CAUTION

When replacing the RUT and DP modules, make sure that connectors are aligned properly before applying pressure. Observe that color-coded wires on both sides of the connectors match and, where indicated, pin 1 is located at the extreme left of the connector as shown in Figure 5-14. If the character generator has been removed, make sure the arrow on the assembly points to the rear of the unit.

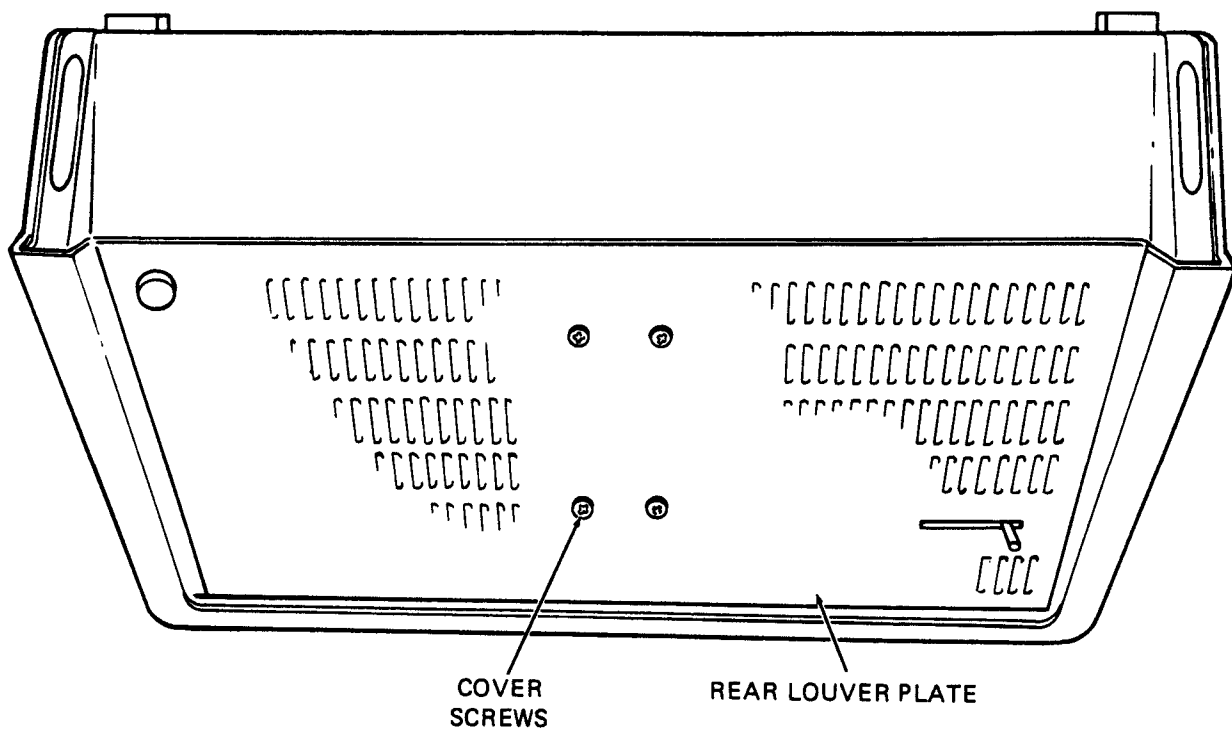
5.3.3 Replacing the Monitor/Power Supply Module

WARNING

There are high voltages present in the power supply. Make sure that the terminal line cord is not plugged into a source of power when servicing, removing, or replacing power supply assemblies or components. Using a screwdriver or clip lead, discharge the filter capacitors by shorting the capacitors to the assembly chassis or any suitable ground. Make sure ground connection is made before discharging the capacitors.

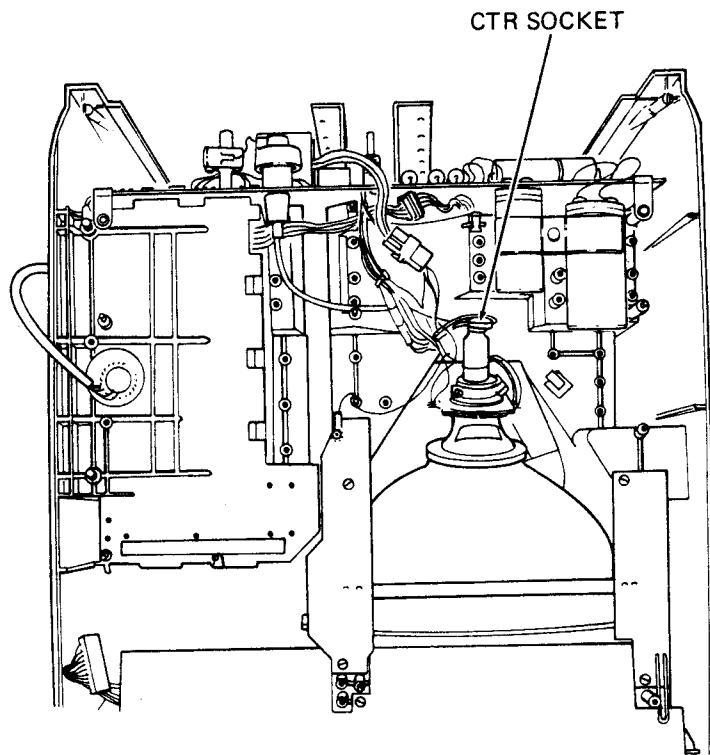
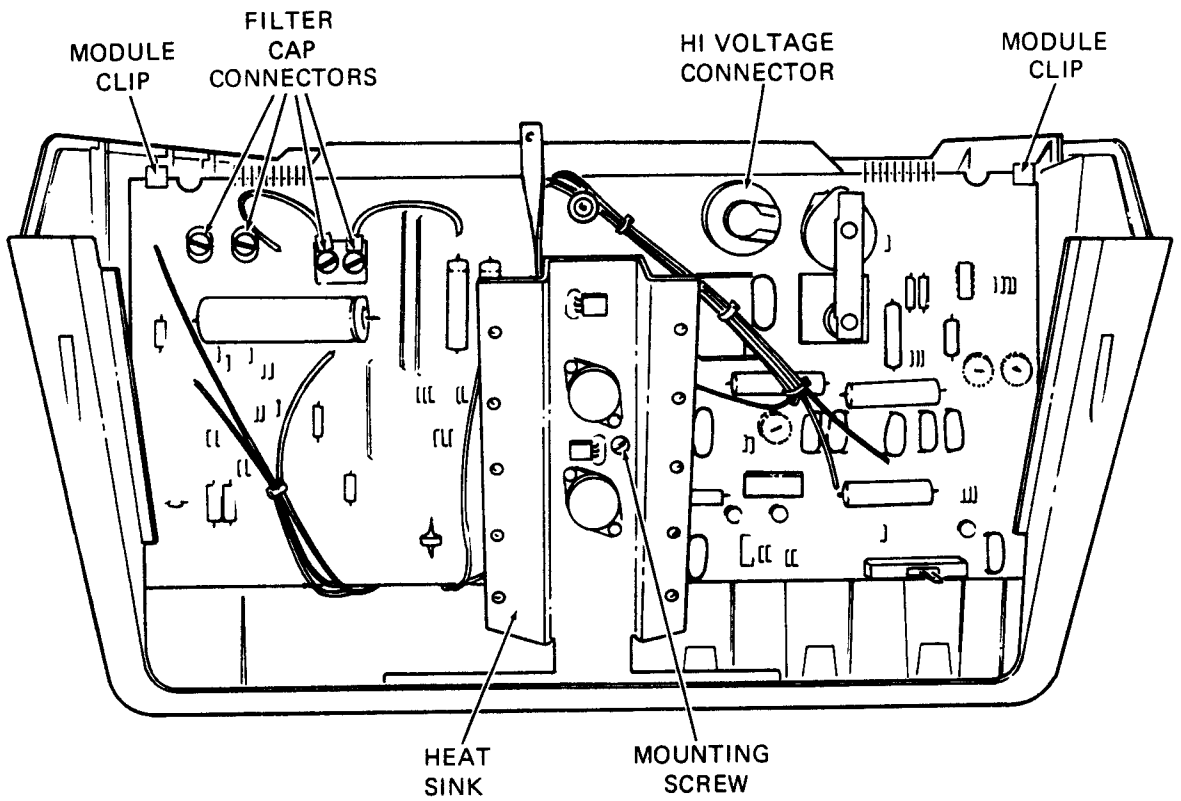
Refer to Figures 5-15 and 5-16 and do the following:

1. Remove the base (Paragraph 5.3.1).
2. Remove the RUT and DP module set (Paragraph 5.3.2).
3. Remove screws (as many as ten) holding the heat sink (louver plate) plate on. Set heat sink aside.
4. Remove ground leads.
5. Disconnect 9-pin Mate-N-Lok connector.



MA-2054

Figure 5-15 Rear Louver Plate Removal and Replacement



MA-2057

Figure 5-16 Monitor/Power Supply Board Removal and Replacement

6. Disconnect the socket from the neck of the CRT and the Faston connector on the black ground wire from the braided strap.
7. Disconnect the 6-pin Mate-N-Lok that connects the yoke to the Monitor/Power Supply board.
8. Disconnect the four wires from the two large capacitors. Note that the red wires go to the positive terminal.
9. Remove the two small plastic clips holding the left and right corners of the power supply board.
10. Remove one screw from the middle of the heat spreader. Note that there is a small plastic spacer between the power supply board and the shell. The spacer must be saved and reinstalled with the new board.
11. Remove the power supply assembly.
12. Install a new power supply assembly being careful that the two lower corners fit into the molded-in slots and that the plastic spacer is used between the power supply board and the shell.
13. The small plastic clips that hold the top corners are installed using the outer slot of the clip on the left corner and the inner slot on the right corner (right and left are defined when facing the rear of the upside down unit).

The following steps outline the procedure to be followed when removing the Monitor/Power Supply module from earlier VT52 terminals (Westfield serial number WFO 3657 and lower; Phoenix serial number PNO 5400 and lower).

1. Remove the Data Paths, Memory, and Decoders module (Paragraph 5.3.2).
2. Remove the 10 screws holding the heat spreader to the large heat sink.
3. Disconnect the yoke connector.
4. Disconnect the CRT socket connector.
5. Disconnect the anode connector from the CRT high voltage socket and then squeeze the side tabs on the plastic socket to remove it from the module.
6. Disconnect the power supply filter capacitors by unscrewing the four connectors.
7. Remove the module securing screw from the center of the heat sink.
8. Squeeze the tabs on the four plastic locking posts while exerting slight pressure on the etch side of the module.
9. Lift the module.

5.3.4 Replacing the Keyboard

Refer to Figure 5-17 and do the following:

1. Place the terminal upside down on a bench or table and remove the base assembly (Paragraph 5.3.1).
2. Remove the RUT and DP modules (Paragraph 5.3.2).
3. Remove the six hold-down screws from the keyboard module (Figure 5-17).
4. Lift the keyboard from the terminal.

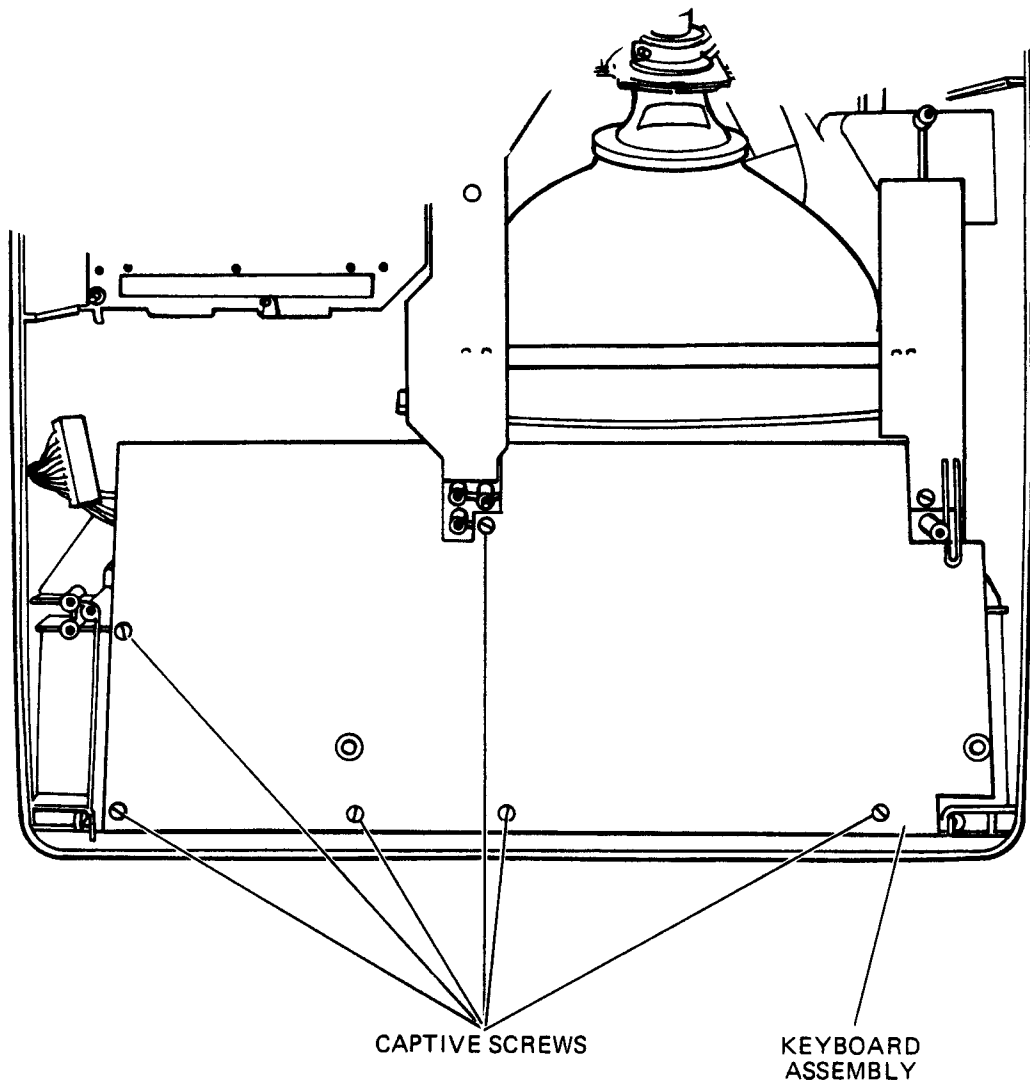
5.3.5 Replacing the CRT Assembly

WARNING

There are high voltages present in the power supply and near the CRT. Make sure the terminal power line is unplugged and the CRT and capacitors shown in Figure 5-18 are discharged before handling the high voltage anode clip and the CRT. Use care when handling the CRT. The CRT is an evacuated device and could shatter if broken.

Refer to Figure 5-18 and do the following:

1. Remove the base (Paragraph 5.3.1).
2. Remove the RUT and DP board set (Paragraph 5.3.2).
3. Remove the keyboard assembly (Paragraph 5.3.4).
4. Unclip the connectors from the yoke assembly.
5. Remove one ground screw if it has the old arcing ECO or unclip one wire if it has the new ECO.
6. Remove the screws (as many as ten) holding the new CRT wire form.
7. Remove two plastic spacers before removing CRT assembly. Be sure to replace the spacers when CRT is reinstalled.
8. Lift the CRT assembly out.
9. Slide a new one in and reassemble the unit.



MA-2062

Figure 5-17 Keyboard Assembly Removal and Replacement

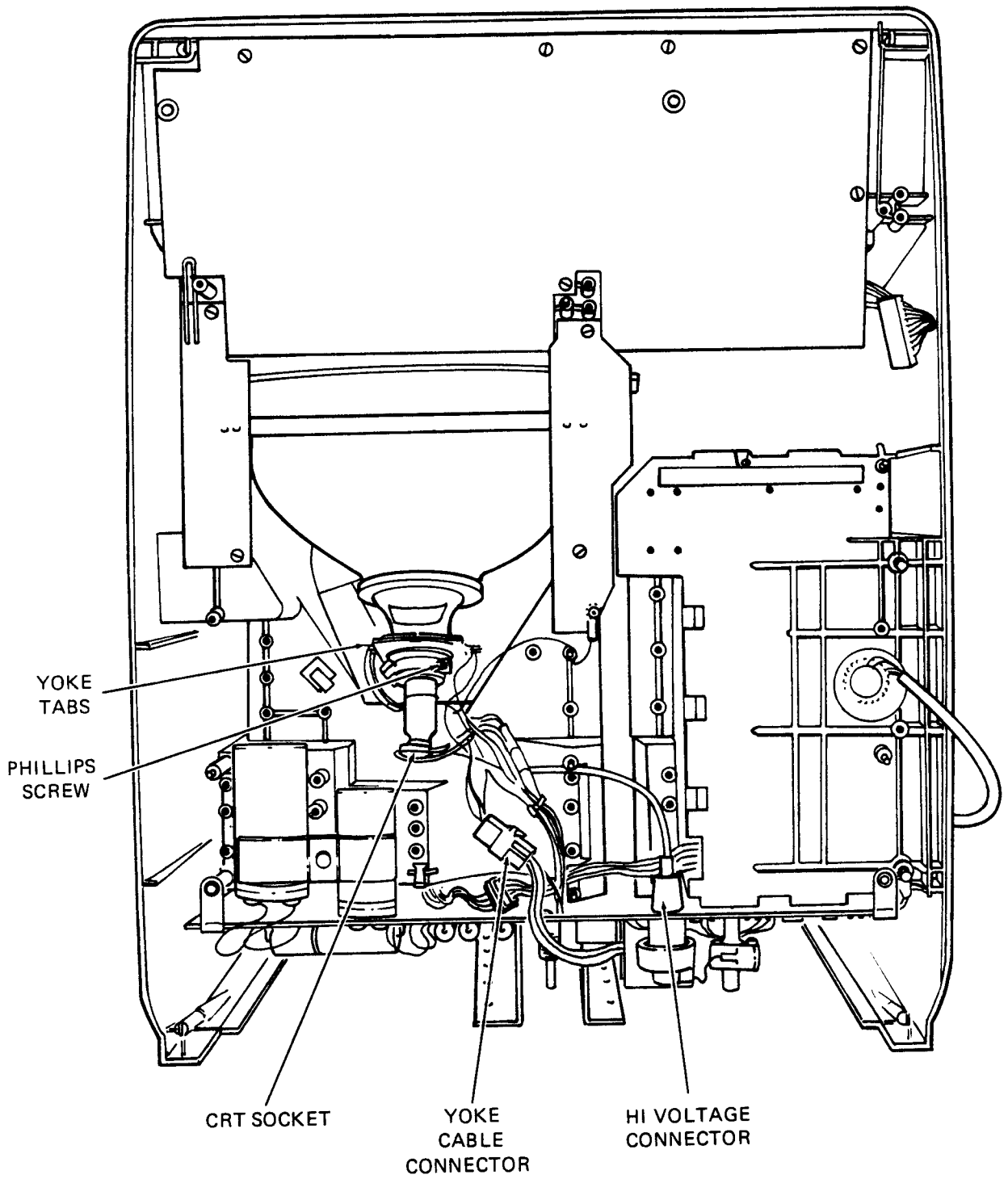


Figure 5-18 CRT Assembly Removal and Replacement

MA-2056

5.3.6 Replacing the Transformer Assembly

1. With the unit right-side up, remove the fixed copier cover by first removing the louvered heat sink plate (four screws) and then pushing the small plastic tab of the cover at the upper left-hand corner of the shell while lifting on the cover. Notice that the "snap-in" tabs are molded on and care should be taken when reinstalling the cover that they are securely fastened. The cover is securely on if, after installing it, you can lift the side of the unit off the table with your fingers under the serrated edge.
2. After removing the fixed copier cover, turn the unit on its back and remove the base (Paragraph 5.3.2) and the RUT and the DP modules.
3. Disconnect the cables leading to the power supply board.
4. Remove two 8-32 kep-nuts.
5. Slide out the old transformer assembly and replace it.
6. Reassemble the unit.

5.4 DISPLAY ALIGNMENTS AND ADJUSTMENTS

Normally, except for the intensity level, no adjustments are required to the terminal after the initial manufacturing checkout and alignment of the unit. However, after replacing a CRT or deflection yoke, the display must be realigned and adjusted.

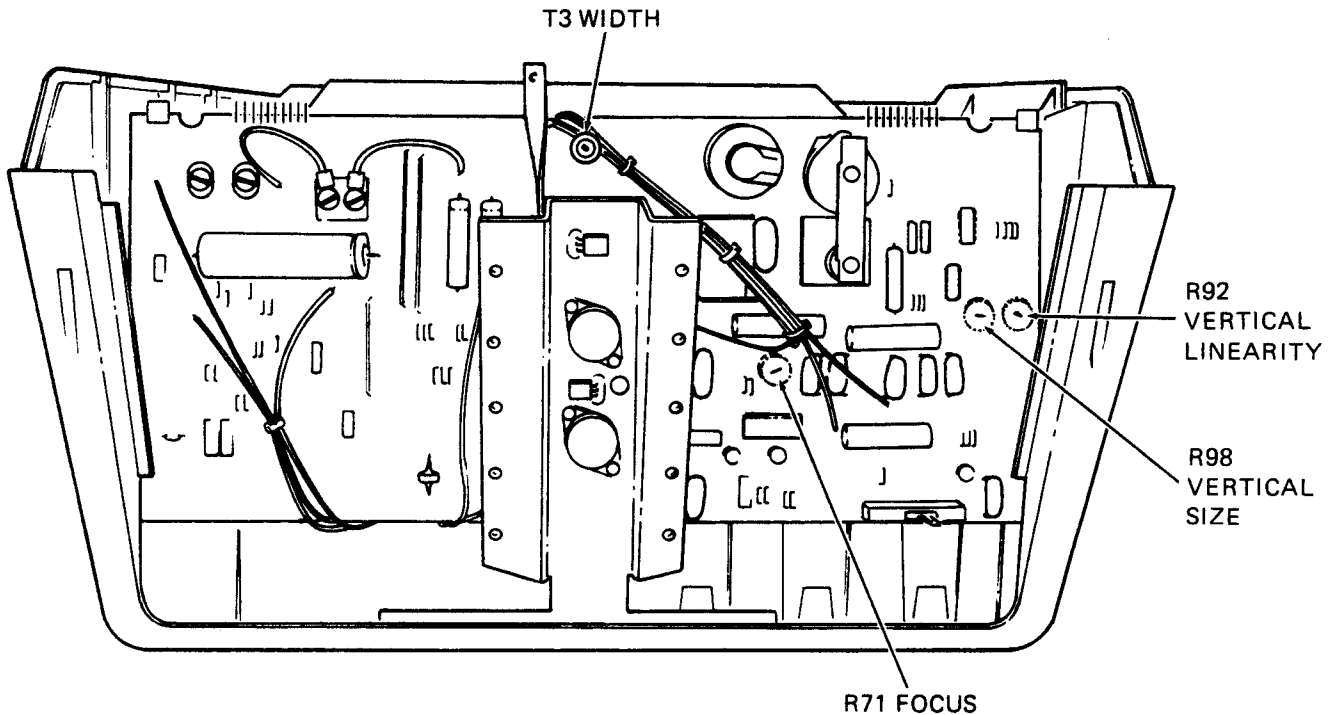
5.4.1 CRT Yoke Alignment

To align the CRT yoke, perform the following:

1. Remove both covers on the top of the terminal.
2. Loosen the Phillips head screw securing the yoke to the neck of the CRT (Figure 5-18). If the screw is inserted so that the head is not accessible (upside down), remove the RUT and DP modules as directed in Paragraph 5.3.2. Remove the Phillips head screw and insert it in the opposite direction so that the screw head will be accessible when the terminal is assembled. Reassemble the terminal but leave the top covers off.
3. Set up the terminal for local operation as described in Chapter 3 and type a screen full of characters.
4. Rotate the yoke until the display is straight. Do not center the display at this time.
5. Tighten the Phillips head screw until the yoke is snug.
6. Adjust the yoke tabs as necessary to center the display (Figure 5-18).
7. Replace the top covers.

5.4.2 Display Adjustments

All adjustments are located on the monitor/power supply board. Remove the rear louver plate assembly as described in Paragraph 5.3.3. Set the unit to the off-line mode of operation as described in Chapter 3 and fill the screen with characters before making any adjustments. Refer to Figure 5-19 for locations of the adjusting coil and potentiometers.



MA-2059

Figure 5-19 Alignment Control Adjustment Locations

5.4.2.1 Height

Adjust the vertical-size potentiometer (R98) until the height of the display is 114 mm or 4.5 inches. This measurement is from the upper edge of the top character line to the lower edge of the bottom character line.

5.4.2.2 Width

Using a non-conductive hexagonal-tipped alignment tool, adjust the iron slug in coil T3 until the width of the display measures 218 mm or 8.6 inches.

5.4.2.3 Vertical Linearity

Adjust the vertical linearity potentiometer (R92) until the characters displayed on the top line are the same size as the characters displayed on the bottom line.

5.4.2.4 Focus

Adjust the focus potentiometer (R71) until characters in all sections of the screen are sharp and clear.

5.5 VOLTAGE CHECKS

If further testing is required to locate the problem, the unit must be tipped back and the base removed. To scope the monitor waveforms, the unit must be placed upside down with the heat spreader removed. The base removal procedures are described in Paragraph 5.3. With the unit tipped back and the base removed, the Monitor/Power Supply connectors J1 and J2 are accessible for measuring the voltages listed in Table 5-3.

CAUTION

Use extreme care when measuring voltages on J2 of the Monitor/Power Supply module. The CRT anode connector carrying 11,000 V is mounted close to this connector.

If any voltages are incorrect, remove the heat spreader and proceed to Paragraphs 5.5.1, 5.5.2, 5.5.3, or 5.5.4. If the voltages are correct, check the voltages after distribution to other modules.

Table 5-3 Monitor/Power Supply Voltages

Connector/Pin	Voltage
J1-1	+5
J1-2, 4, 6	GND
J1-10	+15
J2-2	-12
J2-3	-5
J2-4	+5 Sense
J2-5	+5
J2-6	+5
J2-7	GND Remote Sense
J2-8, 9, 10	GND

5.5.1 Testing the NO VOLTAGE Condition

ACTION:

Ground the collector of transistor Q2 and measure the +15 V supply.

If the voltage measures LOW or 0:

Check for open R1, Q11 or R6; check for shorted Q1; check for short from collector of Q11 to ground.

If the voltage measures +15 or HIGH:

Check for open Q2, D6, D5 or R27; also check R10, R28.

5.5.2 Testing the +15 V Supply

CONDITION:

+15 measures LOW.

ACTION:

Ground the collector of transistor Q2.

If the voltage measures LOW or 0:

Check for faulty C35, R5, R6, or R1; check for short between Q2 and Q1.

If the voltage measures +15 or HIGH:

Check for faulty D8, D7, R12, R29, R1, R13, or R27; Check E1.

Table 5-4 Distributed Voltages

Connector/Pin	Voltage
RUT/DP J1-16	GND
RUT/DP J1-17	+15
RUT/DP J1-18	-12
RUT/DP J1-19	+5
RUT/DP J2-1	+5
RUT/DP J1-8	+5
RUT/DP J1-9, 10	GND
RUT/DP J1-45	GND
RUT/DP J1-46	+5
RUT J4-1	+5
RUT J4-2	-12
RUT J4-3	+15
RUT J4-4	GND
RUT/DP J5-9	GND
RUT/DP J11	+5
DP J3-6	GND
DP J3-7	+5
DP J5-8	+15
DP J5-9	-5
DP J5-10	-12
DP J5-11	GND
DP J6-11	+5

CONDITION:

+15 measures HIGH.

ACTION:

Check the -12 V supply. If it measures LOW or 0, fix the -12 V condition before proceeding. Short the base of transistor Q2 to ground.

If the voltage measures LOW or 0:

Measure pin 6 of E1. If $E1-6 < 2\text{ V}$, replace E1. If $E1-6 > 2\text{ V}$, check R9, R12, and R13.

If the voltage measures +15 or HIGH:

Check for shorted Q2 or Q11.

5.5.3 Testing the +5 V Supply

CONDITION:

+5 measures 0 V

ACTION:

Connect the base of transistor Q9 to the collector of transistor Q6.

If the voltage measures LOW or 0:

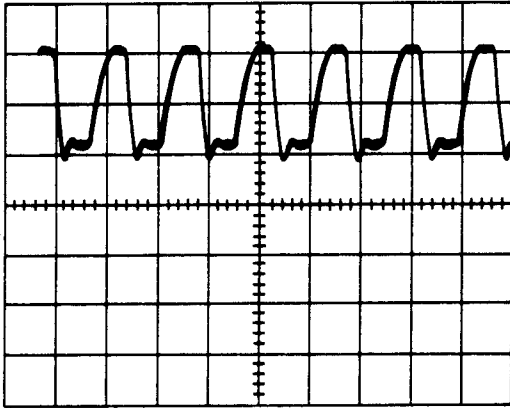
Check for open Q8, Q9, or R35; check for a short to ground at the collector of Q8.

If the voltage measures +5 or HIGH:	Check for open Q6, R42, R41; Check for shorted Q5 or faulty E3.
CONDITION:	+5 measures HIGH.
ACTION:	Short the base to the emitter of Q9.
If the voltage measures LOW or 0:	Measure pin 6 of E3. If pin 6 = 0, Q6 is shorted. If pin 6 = 8 V, check for open R33 or R36; also check R40 and E3.
If the voltage measures +5 or HIGH:	Check for shorted Q8 or Q9.
CONDITION:	+5 measures LOW.
ACTION:	Short the collector to the emitter of Q6.
If the voltage measures LOW or 0:	Check for open Q8, Q9; check R34.
If the voltage measures +5 or HIGH:	Check for open Q6, R40; check for faulty E3, Q5, R35, D12, R37, R38, R41.
5.5.4 Testing the -12 V Supply	
CONDITION:	-12 measures 0V.
ACTION:	Short the collector of transistor Q4 to ground.
If the voltage measures LOW or 0:	Check for shorted Q3; check for open R52, Q12, R19, R20; check for short between ground and the collector of Q12.
If the voltage measures -12 or HIGH:	Check for open Q4, D20; check for shorted D10.
CONDITION:	-12 measures HIGH.
ACTION:	Short the base to the emitter of Q4.
If the voltage measures 0:	Check for faulty E2, R15, R17, R14.
If the voltage measures HIGH:	Check for shorted Q4, Q12.
CONDITION:	-12 measures LOW
ACTION:	Short the collector of transistor Q4 to ground and measure the voltage.
If the voltage measures low:	Check R19, R21, D20, R25, R52, R22, Q3.

5.6 TIMING WAVEFORMS

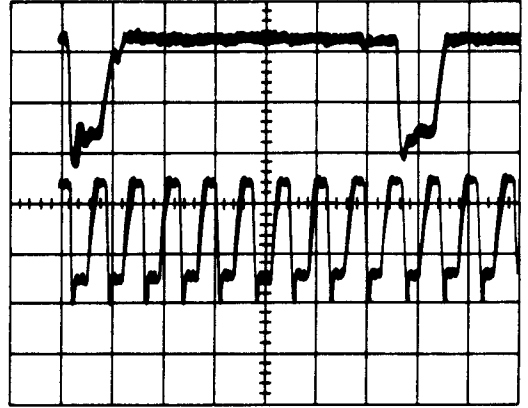
Figures 5-20 through 5-28 are waveforms of the VT52 timing signals. Included in each figure are the signal location and the oscilloscope setting for observing the waveform. The serviceman should not assume that because a signal is present at the indicated pin location it is not suspect. It may be missing at some other point in the logic due to a broken etch or connection.

For instance, B OSC A, the basic timing clock, may be observed at J1-22 as indicated in the figure but may be missing at the input to the VSR.



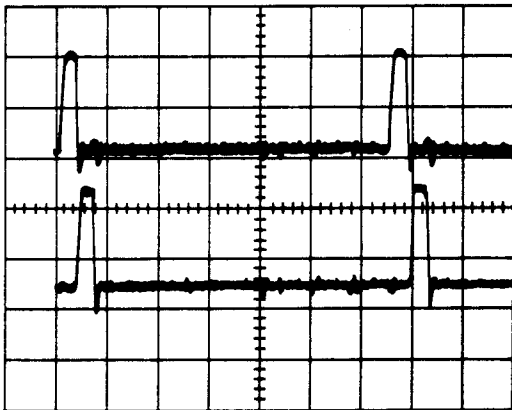
MA-1623

Figure 5-20 B OSC A



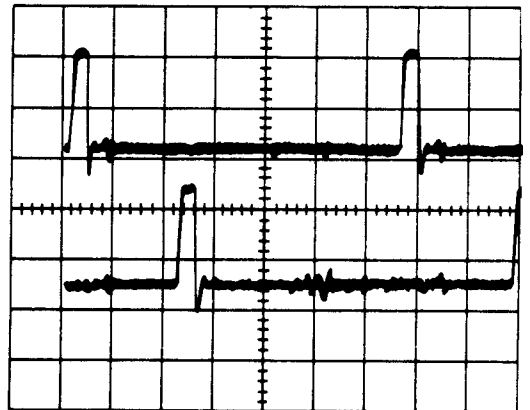
MA-1624

Figure 5-21 B OSC A and Shift Register Output



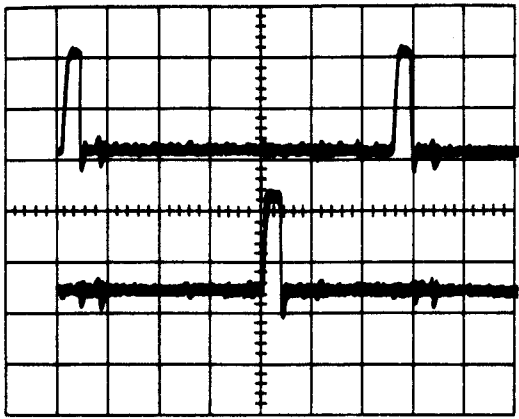
MA-1625

Figure 5-22 Time States TE and TF



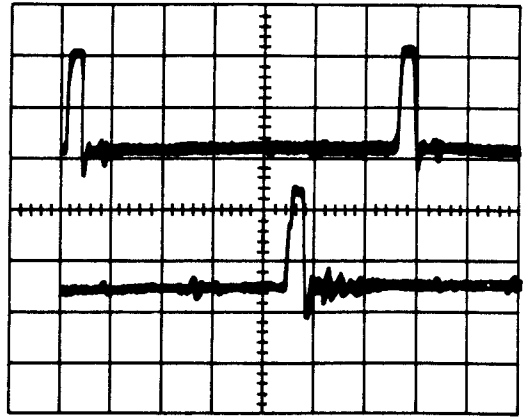
MA-1626

Figure 5-23 Time States TE and TW



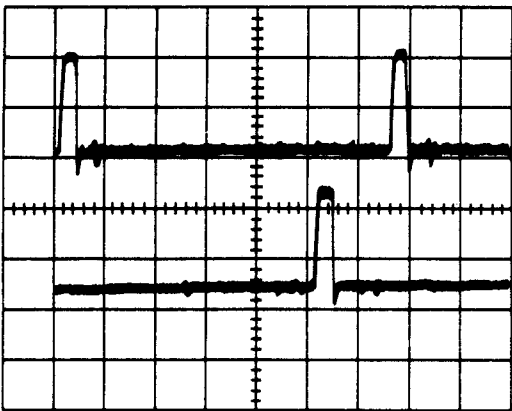
MA-1627

Figure 5-24 Time States TE and TG



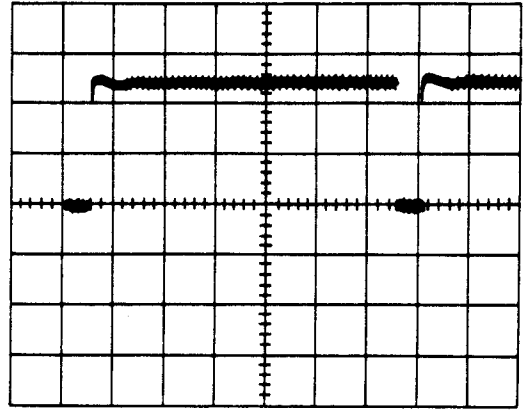
MA-1628

Figure 5-25 Time States TE and TH



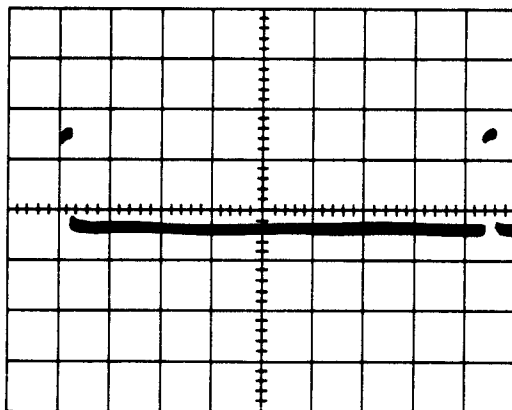
MA-1629

Figure 5-26 Time States TE and TJ



MA-1630

Figure 5-27 Sync L



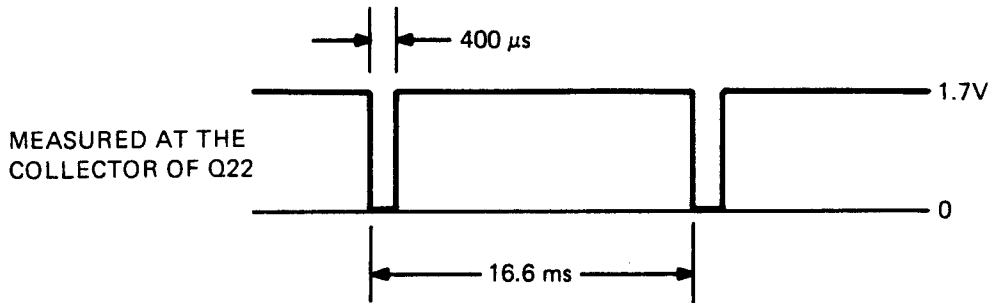
MA-1631

Figure 5-28 Vert H

5.7 MONITOR WAVEFORMS

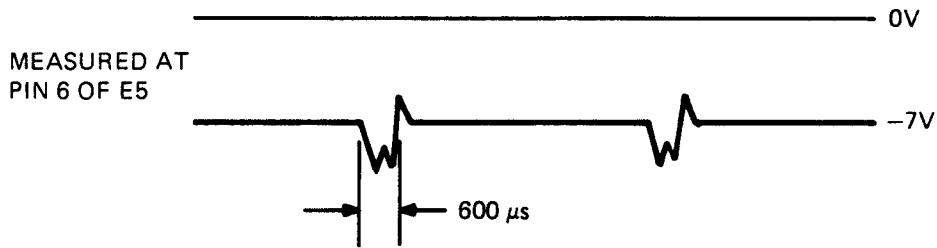
The signals illustrated in Figures 5-29 through 5-39 show the normal Monitor waveforms; the waveforms one would observe in a working VT52 terminal. If the serviceman suspects that the Monitor/Power Supply module is the cause of some failing condition, he can confirm or reject his suspicions by comparing the waveforms on the failing unit with the waveforms illustrated in the figures.

Although component level troubleshooting is not recommended when servicing most of the circuitry in the VT52, the Monitor/Power Supply module can in many cases be serviced to this level because it is not completely dependent on the microprocessor.



CP-2309

Figure 5-29 Test Point 1

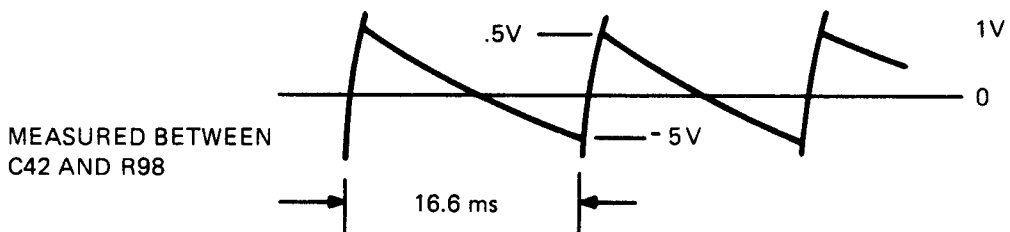


NOTE:

THE SAME PATTERN APPEARS AT BASE OF Q18
- VOLTAGE IS APPROX. -10V

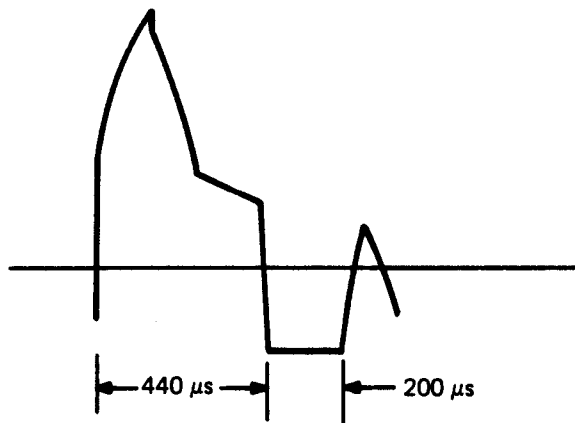
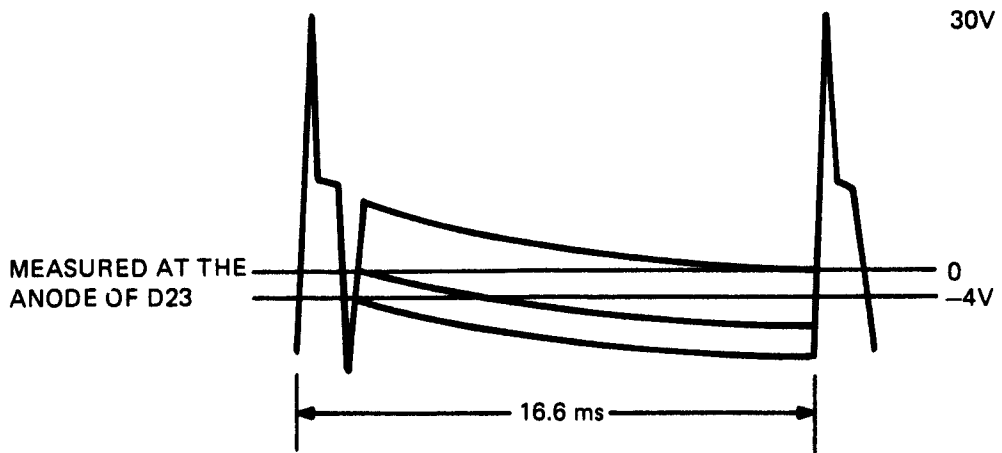
CP-2310

Figure 5-30 Test Point 2



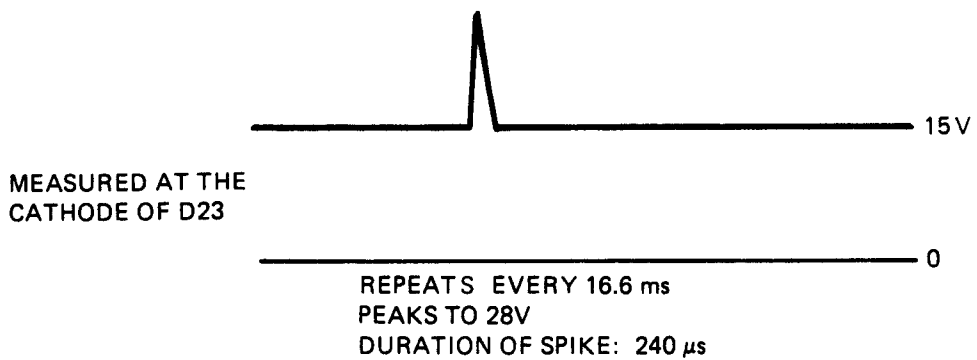
CP-2311

Figure 5-31 Test Point 3



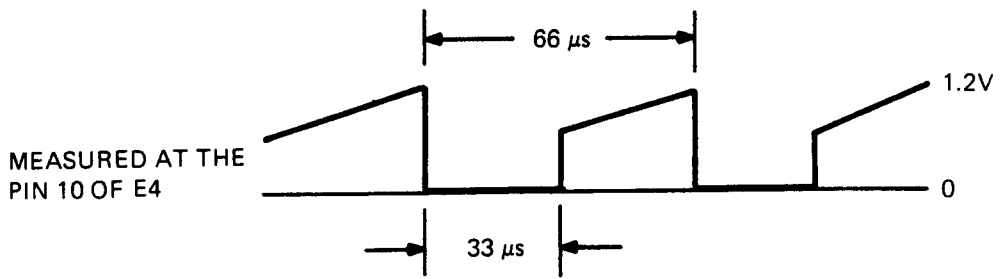
CP-2312

Figure 5-32 Test Point 4



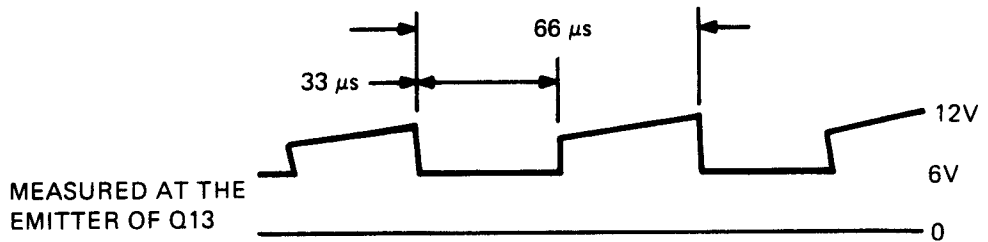
CP-2313

Figure 5-33 Test Point 5



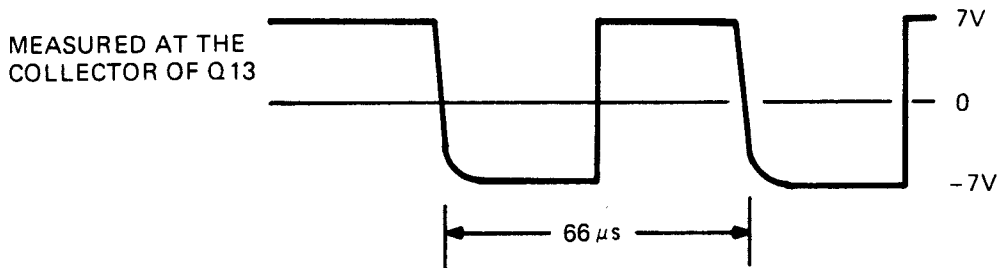
CP-2314

Figure 5-34 Test Point 6



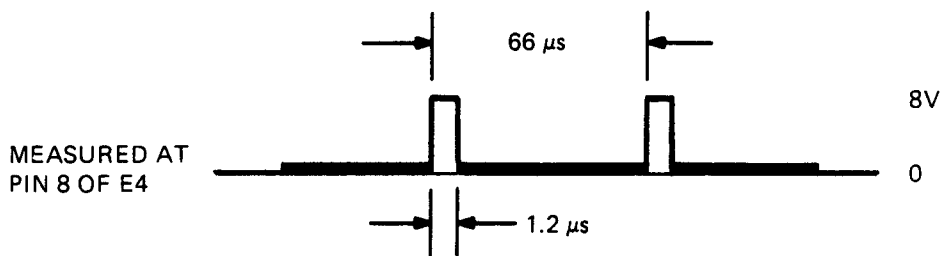
CP-2315

Figure 5-35 Test Point 7



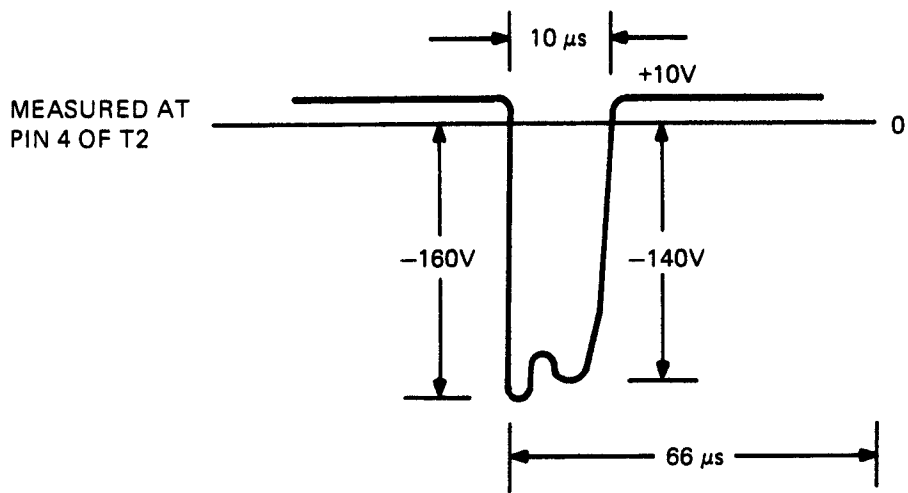
CP-2316

Figure 5-36 Test Point 8



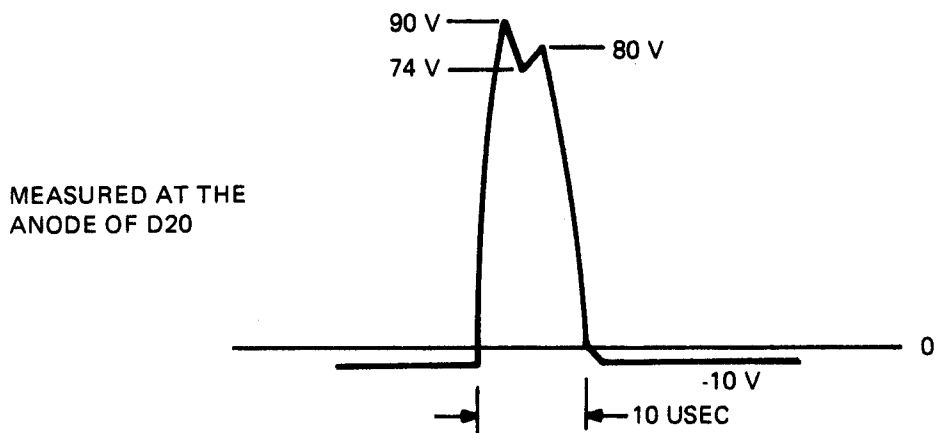
CP-2317

Figure 5-37 Test Point 9



CP-2318

Figure 5-38 Test Point 10



TEST POINT 11 MEASURED AT THE COLLECTOR
OF Q19 SHOULD BE A 9 VOLT DC LEVEL.

CP-2319

Figure 5-39 Test Point 12

CHAPTER 6 VT50-SERIES COPIER OPTION

6.1 VT50-SERIES COPIER INTRODUCTION

The electrolytic copier provides the video terminal with hard copy capability. The copier can print a screenfull of information or can print the information line-by-line.

6.2 COPIER BLOCK DIAGRAM

Figure 6-1 shows the basic block diagram for the copier and related circuits. When the keyboard COPY key is pressed, the microprogram issues the COPY ENABLE L (CEN L) command to the copier logic via the connector board. If the anode cover switch is closed, relay K1 picks up, and AC power is applied through the triac to the helix and paper feed motors.

As the helix rotates, the microprogram of the VT52 waits for the COPY SCAN FLAG (CFS L), which indicates the helix is at left margin. The first COPY LOAD L (CLD L) signal from the VT52 resets the scan flag.

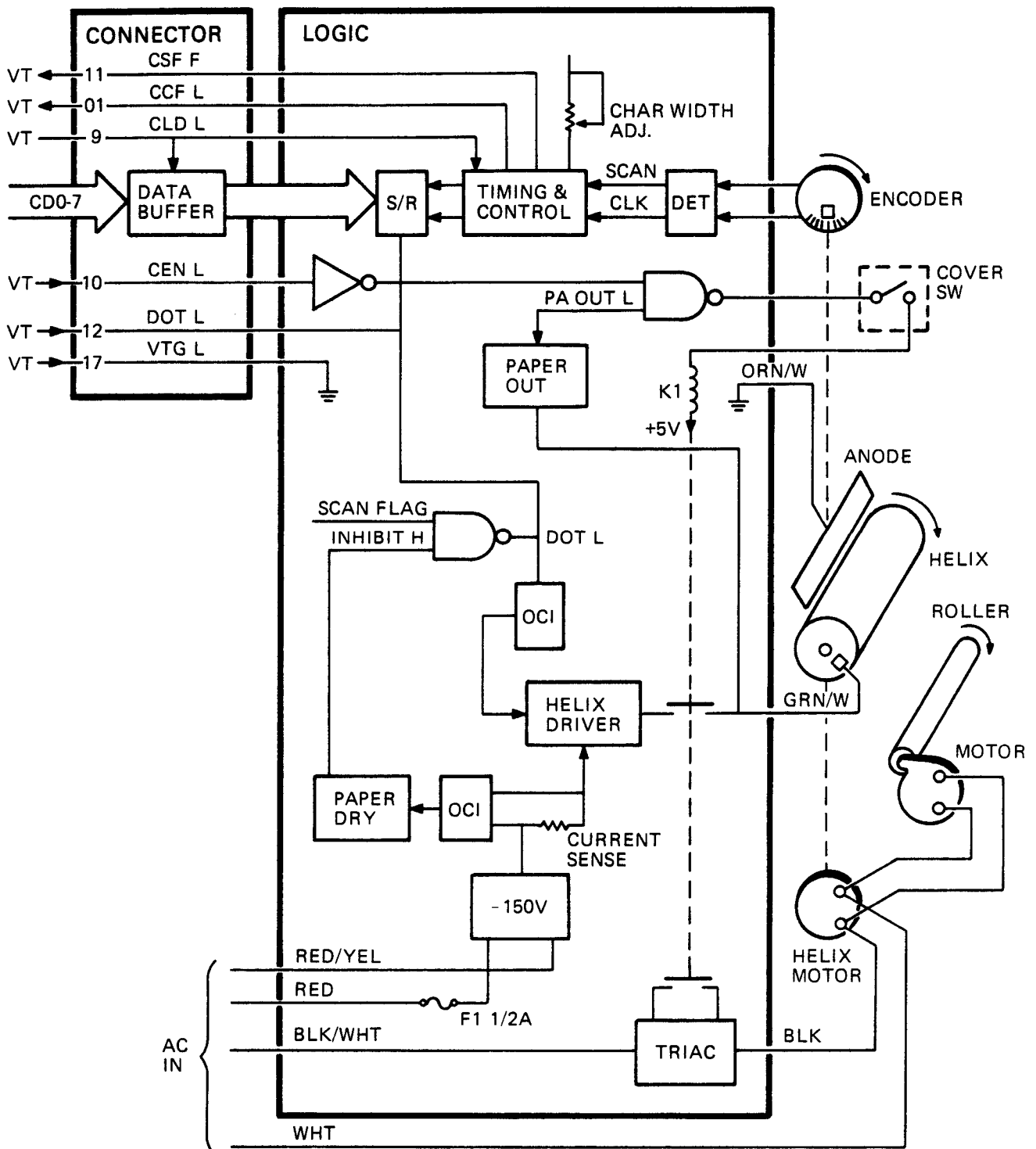
As the helix completes one rotation, 80 COPY CHARACTER FLAGS (CCF L) are generated by the logic. On each flag the VT52 responds by sending the data output from its character generator (CD0-CD7) along with a COPY LOAD L pulse. CLD L clocks the data into the data buffer on the connector card and resets the copy character flag.

The timing and control section of the logic transfers the contents of the data buffer to the S/R and then shifts the data out, serially, to the helix driver circuitry.

An OCI optically couples the data into the first stage of the helix driver. The -150 Vdc regulator provides a current source to the helix. The driver provides a 90 V pulse to the helix each time a metallic dot (DOT L) is to be provided to the paper.

Should a paper out condition occur, the anode would short directly to the helix, providing a ground to the paper out sensor. The paper out sensor de-energizes relay K1 which disconnects the helix from its source and turns off the triac. The motors stop.

A current sense resistor in the helix driver emitter circuit is used to detect a dry paper condition. As the paper dries, its conductivity decreases as does the anode-helix current each time a dot is generated. The OCI detects this condition and activates signal INHIBIT. INHIBIT prevents the generation of the CHARACTER FLAG to the VT52. At the same time, it is ANDed with the SCAN FLAG to produce a dot once each helix rotation. The result is a vertical line down the margin of the paper.



MA-1557

Figure 6-1 Copier Block Diagram

6.3 COPIER TIMING

Figure 6-2 shows the copier timing sequence.

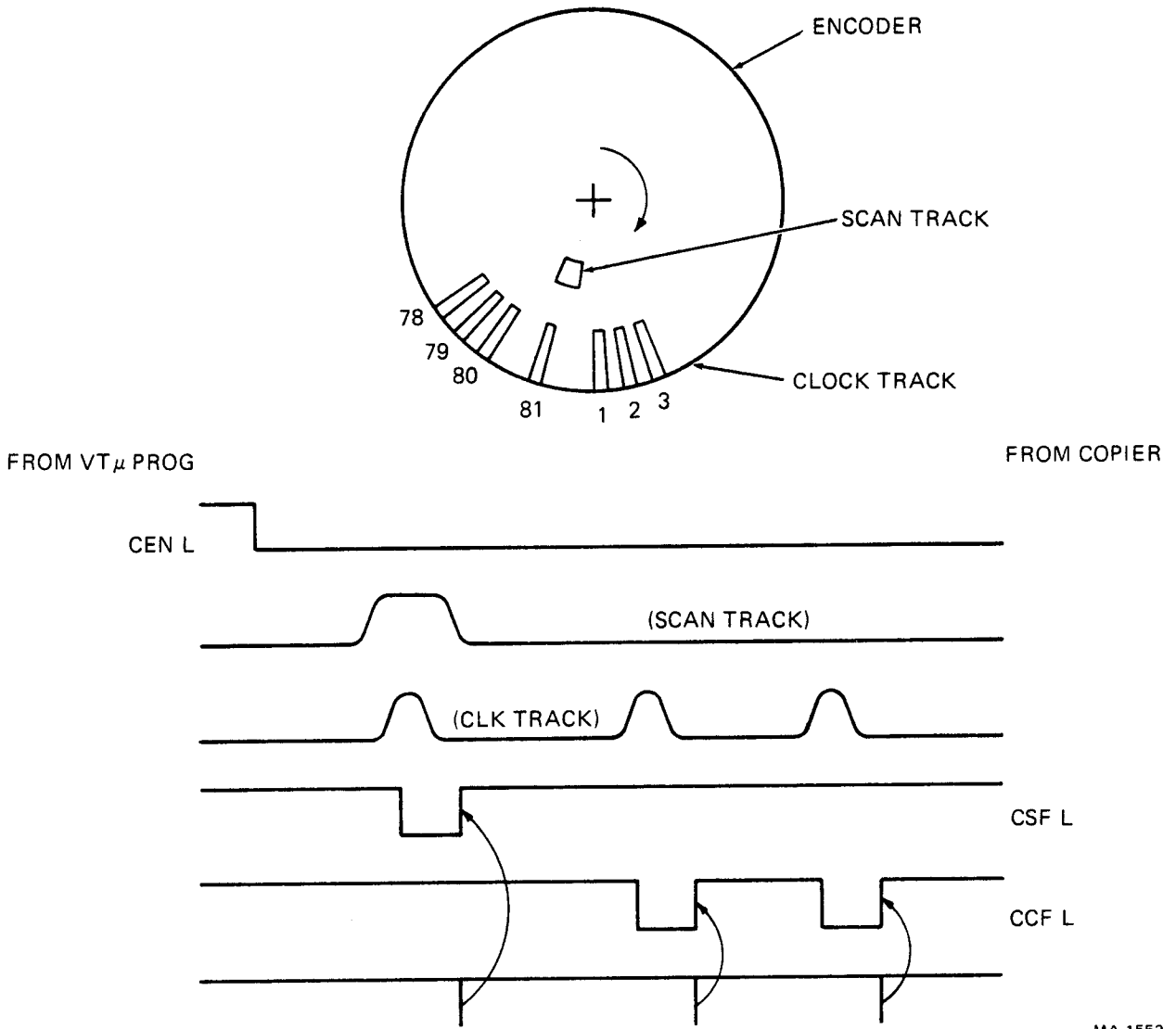


Figure 6-2 VT Copier Timing

Character print timing within the VT52 hardcopy unit is generated from an optoelectronic encoder disk mounted on the helix motor shaft. One complete revolution of the disk corresponds to one line scan on the paper. The encoder has two tracks – an inner scan track consisting of a single aperture and an outer clock track with 81 suits.

When the VT52 is ready to transfer print data to the copier, it sets the COPY ENABLE signal (CEN L) low. The helix motor turns on and the encoder begins to turn. The VT52 waits for the COPY SCAN FLAG (CSF L) to go low. It responds with the first of 81 COPY LOAD (CLD L) pulses. This pulse resets the scan flag and enables the copier logic to develop COPY CHARACTER FLAGS from the clock track. As each character flag goes low the VT52 transfers a 7-bit dot pattern output from its character generator to the copier logic. The CLD L signal clocks the data in and resets the character flag.

NOTE

A quick check to determine if the VT52 and copier are communicating is to check the character flag signal. If the signal remains low, and helix is rotating, problem is in VT52. If signal remains high, check scan flag. If scan flag remains high, the problem is in the copier.

6.4 OPERATING THE COPIER

When the COPY key is pressed, all the information currently being displayed on the screen is copied.

In addition to this screen-by-screen method of copying, a continuous-copying mode exists. Auto-Copy mode, like Hold-Screen mode, requires one command to enter it and another to exit it.

In Auto-Copy mode, downward movement of the cursor causes copying to occur. When a Line Feed or Cursor Down command is performed, the line the cursor was on is copied. If a Direct Cursor Addressing command moves the cursor from line 4 to 9, then lines 4 through 8 are copied. (It is more accurate to say that such lines are not copied but "marked for copying," since the cursor can be moved down again, marking another line for copying, while previous lines are still being copied.) The copier is activated whenever one or more lines have been marked for copying. If Auto-Copy mode is exited before all the marked lines have been copied, they will still be copied. To enter Auto-Copy mode, the operator holds the SHIFT key down and presses the COPY key. Doing so again will cause the terminal to exit Auto-Copy mode. Entering and exiting Auto-Copy mode does not mark any lines for copying.

To remove output from the copier, lift the metallic lever on the side of the unit where the paper appears – the detent lever – and pull on the paper until all the information is visible. Lower the detent lever, and pull the paper up sharply so that it tears on the serrated cutting edge built into the shell of the terminal. If the copier has been idle for several minutes, lift the detent lever and pull the paper out until the wet portion is reached before trying to copy anything. When the copier will not be used for an extended period of time, lift the detent lever to disengage the rubber rollers which feed the paper through the copier.

6.5 PROGRAMMING THE COPIER

The COPY key performs three functions: when unshifted, it causes the screen to be copied; when shifted, it tells the terminal to enter or exit Auto-Copy mode. Software can perform these functions also, by transmitting Escape Sequences to the terminal. A separate Escape Sequence exists for each of the three functions.

Copier Commands	Octal Codes
ESC]	Copy Screen (033 135)
ESC ^	Enter Auto Copy Mode (033 136)
ESC —	Exit Auto Copy Mode (033 137)

Here are two examples of software use of Auto-Copy mode:

1. To output a file to the copier, software sends the following:
 - a. CR and LF, if necessary, to ensure that the file begins on a new line.
 - b. ESC J, if necessary, to erase extraneous data from the portion of the screen below the cursor.
 - c. ESC ^ to enter Auto-Copy mode.
 - d. The body of the file.
 - e. An LF must be supplied if it is not the last character in the file, in order to mark the last line in the file for copying.
 - f. ESC — to exit Auto-Copy mode.

The file, and only the file, will be copied.

2. To make a copy of the cursor line, the host sends the following commands: Enter Auto-Copy mode, Line Feed, Exit Auto-Copy mode, Cursor Up (seven characters). The cursor will be returned to its former location in the data, but if it was on the bottom line to begin with, this procedure will cause a scroll.

Although the action of the copier is not instantaneous and may lag behind data transmission, provisions exist to ensure that requested output is copied as it appears on the screen at the time of the copying request. In three situations where requested information to be copied might be destroyed or altered before it can be copied, the terminal will cease processing incoming characters:

1. In Auto-Copy mode, when the cursor is moved up to a line that was marked for copying, but has not yet been copied, the terminal will cease processing incoming characters until the cursor line is copied.
2. In Auto-Copy mode, if the top line was supposed to be copied but has not yet been copied, and if the cursor is on the bottom line and LF is received – so that a scroll would be performed and the top line would leave the screen – the terminal will not process the LF and subsequent characters until the top line has been copied. (This is the only situation in Auto-Copy mode in which scrolls are prohibited. In general, the terminal does not require that data being copied be on the same line on the screen that it was when the request was made to copy it.)
3. The terminal will not process incoming characters after a Copy Screen command, until the entire screen has been copied.

In these situations, the terminal begins putting incoming characters in its silo buffer, and transmits XOFF to the host. When the necessary copying has been finished, the terminal will begin to process the characters in the silo. When it has processed all the characters in the silo, the terminal will send XON to the host to indicate that it is ready for more characters.

Note that the host cannot determine if the terminal operator has pressed the COPY key. If there is any possibility that one of the above situations may occur, host software *must* support synchronization with XOFF/XON or the silo may overflow, interfering with the accuracy of the output.

In the three situations described above, characters typed by the operator are still transmitted to the host. If the terminal is switched for either off-line or local-copy operation, these characters will also go into the silo. Therefore, the operator of such a terminal should refrain from typing when the copier is running, since he could cause the silo to overflow.

6.6 COPIER REMOVAL AND REPLACEMENT PROCEDURE

1. Remove ac power cord. The copier unit is installed in an area where dangerous voltages are present when the power cord is installed.
2. Remove the copier cover.
3. Remove the five screws that hold the copier to the shell. Gently lay the copier on a table or shell to facilitate detaching connecting cables.
4. Detach the Mate-N-Lok connector that connects the copier to the ac line voltage and transformer secondary. It has four wires – red, red/yellow, black, and white.
5. Gently remove copier signal connector J1. A slight rocking motion may be used to accomplish this. Avoid breaking or bending the connector pins. Holding the data path module from the bottom will keep the mating socket ready while J1 is being retracted.
6. Remove the green copier ground wire from the ground lug on the inside of the transformer mounting plate assembly. A nutdriver should be utilized or remove the fastening nut.
7. Install the new copier by reversing the above steps.

6.7 COPIER MAINTENANCE

There are four maintenance functions the copier user must perform: changing the paper, replacing the anode (the printing blade), moistening the wick, and cleaning the helix wires. Doing all these things at the same time saves time and maintains the highest quality of copier output.

When the blue line appears on the side of the paper, there are only 2 to 3 meters left in the roll. Since the last meter of paper will be too tightly wrinkled to copy well, remove the paper and perform the maintenance at this time.

Access to the copier compartment is gained by lifting off the cover, taking hold at the serrated edge. Lift the print head assembly up by the three thumbscrews and swing it out toward you.

The anode is a long metal strip bent lengthwise. It is held in place by the thumbscrews. Turn the thumbscrews counterclockwise as far as they will go to release the anode. The anode can then be slid to the right and removed. Do not use your fingers to remove the anode! A worn anode often has a sharp edge where it has been rubbing against the paper. Instead, use a pencil to slide the anode out, by inserting it through one of the anode's windows.

Remove the paper cover, take out the remaining paper and the pastic hubs. Removing the paper will reveal a large cylinder with spiraled (helical) wires on its surface. This cylinder rotates when the copier is running. Salt deposits on the helix wires from the special copy paper used can cause streaks on the paper where characters are faint or do not appear at all. The helix wires can be cleaned with a damp cloth. Rotate the cylinder by hand in order to clean the entire surface. Do not try to remove the cylinder.

The wick pad and its plastic housing are in the paper chamber. Take hold of the housing by the round finger-hole and pull it out. Hold it under a faucet and run warm water over the felt, so that the wick is moistened. This helps to keep the copier paper moist throughout the life of the roll. By removing the housing to moisten the wick, the possibility of water leaking into the interior of the terminal is avoided. When the wick is moist, shake off the excess water and put the housing back in the paper chamber. Three tabs in the frame at the rear of the paper chamber will hold down the back of the wick housing. By applying pressure to the center of the housing, three tabs in the front of the paper chamber will come through rectangular holes in the wick housing, snapping the housing into place.

To install a new roll of paper, remove it from its plastic bag and unravel about 1/2 meter of paper. With one hand, lift the drag bar which is inside the paper chamber. With the other hand, place the roll in the chamber so that the paper issues from the underside of the roll. Thread the paper through the rollers, and out the side of the terminal, and replace the paper cover.

A new anode can now be slid in from the right. A new anode will not be dangerously sharp. Push it to the left as far as it will go and retighten all three thumbscrews when it is in place.

To summarize the six steps in this maintenance routine:

1. Remove the anode.
2. Remove the old roll of paper.
3. Clean the helix wires.
4. Moisten the wick.
5. Install a new roll of paper.
6. Install a new anode.

If the paper is allowed to dry, it will not work in the copier. Do not leave a roll of paper in the copier for more than a month, or in its plastic bag for more than six months. To avoid unnecessary wear to the helix wires, never operate the copier without paper.

The Character-Width lever is the only operator control found in the copier compartment. It is a lever located to the left of the paper chamber. This lever can be adjusted to produce characters of the desired width. Characters in the copier output which run together, or whose rightmost portions appear to be cut off, are indications that the character-width lever is set too wide.

6.8 COPIER TROUBLESHOOTING

The troubleshooting chart in Table 6-1 lists the common trouble symptoms that could be observed during initial checkout or normal operation.

Table 6-1 Copier Troubleshooting Procedures

Symptom	Probable Cause	Solution
Copier fails to start when COPY key is pressed	Paper empty	Install paper.
	Copier not receiving CEN L signal from VT	Check for signal at J1, pin 10 (copier connector). Signal should go low when COPY is pressed. If not, VT is defective.

Table 6-1 Copier Troubleshooting Procedures (Cont)

Symptom	Probable Cause	Solution
Copier starts up, but does not print	<p>Defective relay K1 or defective triac</p> <p>Defective cover switch</p> <p>Dry paper</p> <p>Fuse F1 blown</p> <p>Copier not receiving CLD L signal from VT</p>	<p>Replace copier.</p> <p>Replace copier.</p> <p>Check paper moisture content. Replace paper and dampen wick if necessary.</p> <p>Replace fuse on copier logic board (1/2 A).</p> <p>Check CLD L signal at J1, pin 9. If signal is not present when copier motor is running, check CSF L at J1, pin 1. If signal remains low problem is in VT.</p>
Copier prints a vertical line down margin	<p>Dry paper</p>	<p>Dampen felt wick. Clean helix wire.</p>
Copier image differs from screen image	<p>Copier defective</p>	<p>Replace copier.</p>
Paper Feed	<p>Paper improperly threaded</p> <p>Bad anode. Anode dragging on paper</p> <p>Roller alignment</p> <p>Humidor cover improperly seated</p> <p>Felt insert improperly seated</p> <p>Drag roller jammed</p> <p>Dirty drive and/or pinch roll</p> <p>Wrong paper</p> <p>Bad Anode</p>	<p>Rethread paper.</p> <p>Anode dimension should not exceed 14.00 mm along the entire length.</p> <p>Check drive and pinch roller for parallelism in vertical plane.</p> <p>Reseat cover so that mylar seal is not causing drag.</p> <p>Snap felt insert into place.</p> <p>Unjam roller.</p> <p>Clean rollers of all oil or deposits.</p> <p>Check that paper has the letter "K" prefixed to the lot number printed on the side.</p> <p>Check Anode dimension.</p>
Print character height variation	<p>Bad Anode</p>	<p>Check Anode dimension.</p>

6.9 COPIER SPECIFICATIONS

General

Device Type Electrolytic copier
Principle Facsimile technology

Print Characteristics

Character Set Same characters as are displayable on video screen
Character Format Same dot matrix as video screen
Columns 80
Lines Variable number (continuous form)
Page Size There is no fixed page size, since the paper is unperforated and copying can take place on a line-at-a-time basis. Pages with the same number of lines as the video screen can be copied by a single command.

Operation

Copy Speed 30 lines per minute

Modes of Operation

1. *Page-by-Page Output* – The contents of the screen are copied on command.
2. *Auto-Copy Mode* – In Auto-Copy mode, each time an LF (Line Feed) is received, the line the cursor was on is copied.

Control

1. *Operator Control* – The three copier commands – Copy Screen, Enter Auto-Copy Mode, and Exit Auto-Copy Mode, can be issued from the terminal by use of the COPY key.
2. *Software Control* – The same commands can be issued from the host computer, in the form of Escape Sequences.

Synchronization

The terminal transmits XOFF (or DC3; 023₈) and XON (or DC1; 021₈) to the host to regulate the flow of data from the host to the terminal during a copying operation. The terminal will accept and display data from the host during a copying operation unless a line that has yet to be copied would be modified. The terminal features a finite buffering capacity to prevent loss of data after XOFF is sent.

CHAPTER 7

VT52 PRINTER INTERFACE OPTION

7.1 VTXX-KA INTRODUCTION

The VT52 Printer Interface Module, VTXX-KA, is a field-installable option available on all new VT52s, and certain units already in the field. It provides a data path between the VT52 video terminal and a parallel printer such as the LA180 or a serial printer such as the LA36 or the LA180 with a serial interface.

7.2 PRINTER INTERFACE BLOCK DIAGRAM

Figure 7-1 shows the basic block diagram for the printer interface module and related circuits.

7.2.1 Parallel Operation

The VTXX-KA transfers ASCII data from the VT52 RAM via the data bus D00-D06 to the parallel interface port J5. Drivers E1-E4 are impedance matched to the LA180 input data lines and can drive the data up to 100 feet.

The demand line from the LA180 is raised when the LA180 is ready to accept a new character. This signal sets the flip-flop E10, which asserts the character flag signal (CCFL) to the VT52. On the next cycle of the VT52 microprogram the Enable Cycle signal (EN CYCLE L) is asserted and the VT52 places an ASCII character on the data bus. A Parallel Strobe signal (P STROBE L) is generated to clock the ASCII character to the LA180. At the same time the strobe resets flip-flop E10, thereby deasserting the character flag signal (CCFL) to the VT52. This completes a character transfer cycle. The cycle repeats itself each time the LA180 raises the Demand flag.

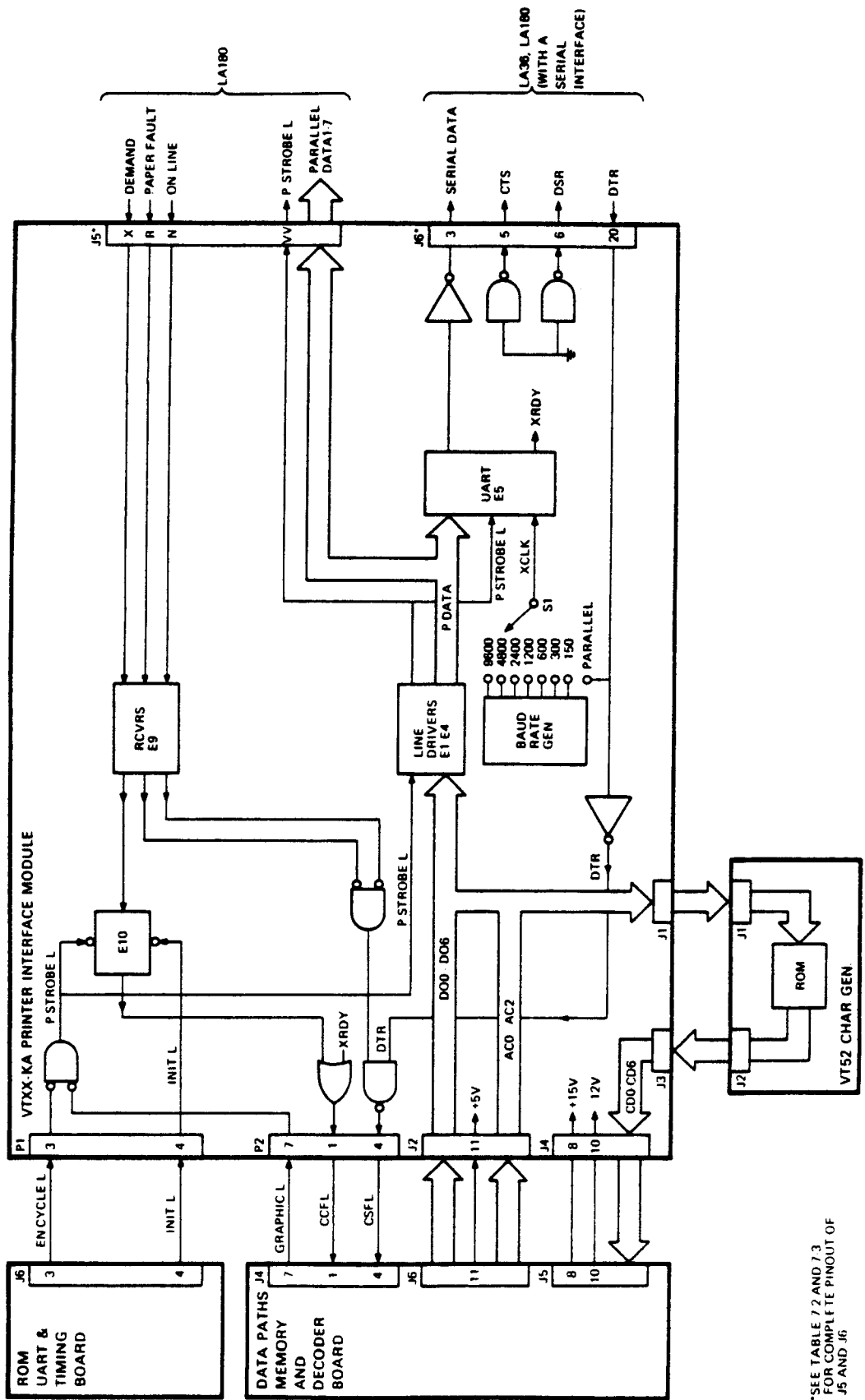
During this process the Paper Fault and ON LINE signals from the LA180 enable the character scan flag (CSFL) signal to the VT52. The process is interrupted by paper out, local mode or the cover interlock switch at the LA180. Additionally, the selector switch S1 (Paragraph 7.1) on the VTXX-KA module must be in position 1 or the character scan flag (CSFL) signal will be disabled and no data transfer will occur.

7.2.2 Serial Operation

During the serial operation, the serial hardcopy device requests data by asserting DATA TERMINAL READY (DTR) through the serial interface. As long as this signal is asserted the VTXX-KA enables the Character Scan Flag (CSFL) signal to the VT52. The signal Transmitter Ready (XRDY) asserts the Character Flag (CCFL) signal to the VT52. On the next cycle of the VT52 microprogram, the Enable Cycle (EN CYCLE L) is used to generate a Parallel Strobe (P STROBE L) which clocks the ASCII data into the UART. The UART (E5) is used to convert parallel ASCII data from the VT52 to serial formatted data. As the data is clocked in, the UART deasserts Transmitter Ready (XRDY). The Transmitter Ready (XRDY) signal is reasserted after the UART has completed the serial character transmission.

NOTE

Jumpers (not labelled in the schematic) on the NB1, NP, EP and XD7 input to the UART, allow character parity selection, odd or even.



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*SEE TABLE 7.2 AND 7.3 FOR COMPLETE PINOUT OF J5 AND J6

Figure 7.1 VTXX-KA Block Diagram

Serial data from the UART is placed on pin 3 of the serial EIA interface connector J6 after conversion from TTL to EIA by the EIA driver E12.

EIA outputs Clear to Send and Data Set Ready are held at 12 V whenever the VT52 is powered on. (The VTXX-KA draws its power [+5 V, -12 V, +15 V] from the VT52 power supply via the Data Paths, Memory and Decoders board).

Serial data transfer is enabled whenever Data Terminal Ready (DTR) is asserted. The functionality of DTR depends upon the printer and EIA device selected as follows:

LA35 or LA36 with the LAXX-KG (EIA data only) interface option:

DTR is asserted whenever printer power is ON. There is no prevention of data loss when the printer is disabled by a paper out, local mode or cover interlock switch.

LA35 or LA36 with the LAXX-LG (EIA with modem control) option:

DTR drops on local mode, paper out, cover interlock, or power down. The VT52 reverts to normal operation.

LA180 with the EIA Serial Interface LAXX-NW option:

XON/XOFF protocol selected on the LAXX-NW cannot be used to control data flow to the FIFO buffer since there is no transmit data line into the VTXX-KA.

DTR may be controlled by paper out or the contents of the FIFO buffer. The latter will have to be selected if the data throughput of the VT52/printer exceeds the print speed of the LA180.

7.3 VTXX-KA INSTALLATION

Figure 7-2 shows the interrelationship of the RUT module, the DP module, the VTXX-KA module, and the character generator module as well as the various communication interface connectors.

The installation of the VTXX-KA printer interface module consists of removing the base assembly and character generator module which is located on the RAM and Data Path module. The VTXX-KA module plugs into the DP module and is held in place by two screws which secure it to two threaded hex head stand-offs which are factory installed. The character generator module is then reinstalled on the VTXX-KA module and the interface cables connected to the VT52. All parts necessary to perform the VTXX-KA module installation are supplied with the module and are listed in Table 7-1.

Table 7-1 VTXX-KA Parts List

Part No.	Description	Quantity
54-12046 (MS40595)	VT52 Printer Interface Module	1
90-06036-01	#8-32 × 5/16 inch Screw	2
90-06040-1	#8-32 × 5/8 inch Screw	1
90-08072	#8 Lockwasher	2
90-07081	1/4 inch Cable Clamp	1
90-07084	7/16 inch Cable Clamp	1
90-07016	Grommet	1

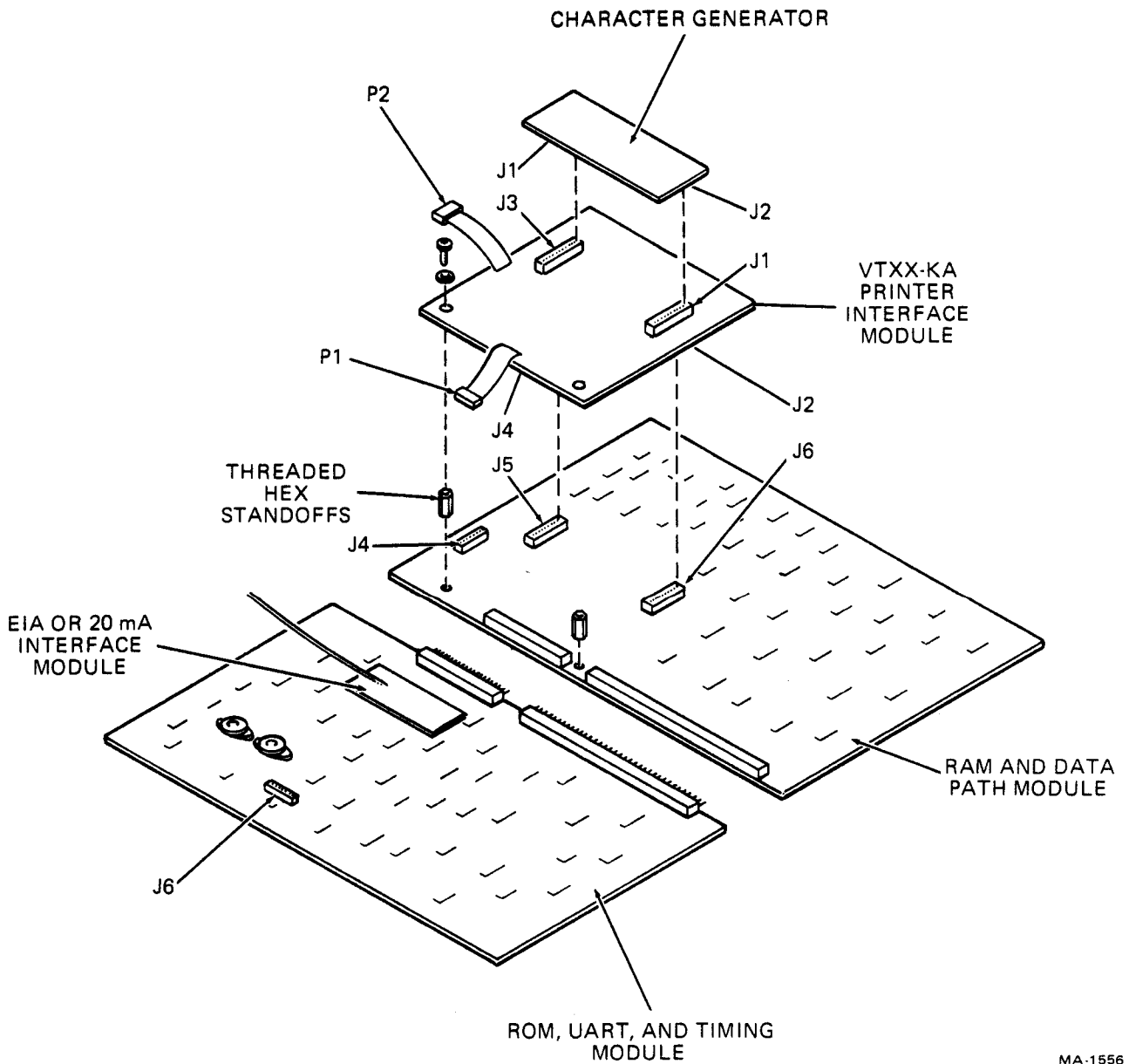
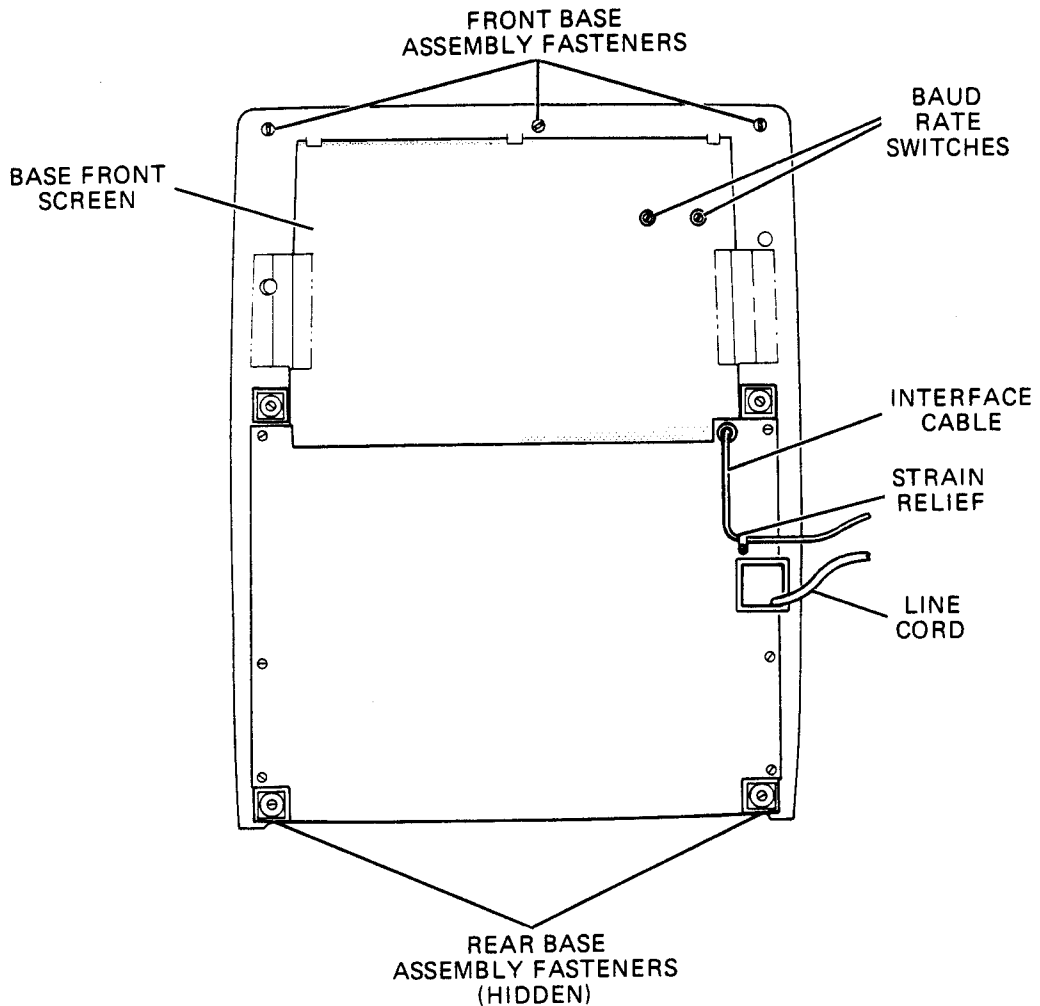


Figure 7-2 Module Interface Relationship

7.3.1 Installation of the VTXX-KA Module

Perform the following steps to install the VTXX-KA printed interface module.

1. Make certain that the terminal line cord is not plugged into an electrical outlet and that the power (ON/OFF) switch is in the (OFF) position.
2. Disconnect the VT52 interface cable from the host computer.
3. Place the unit upside down on a bench or table with the CRT facing you (Figure 7-3).



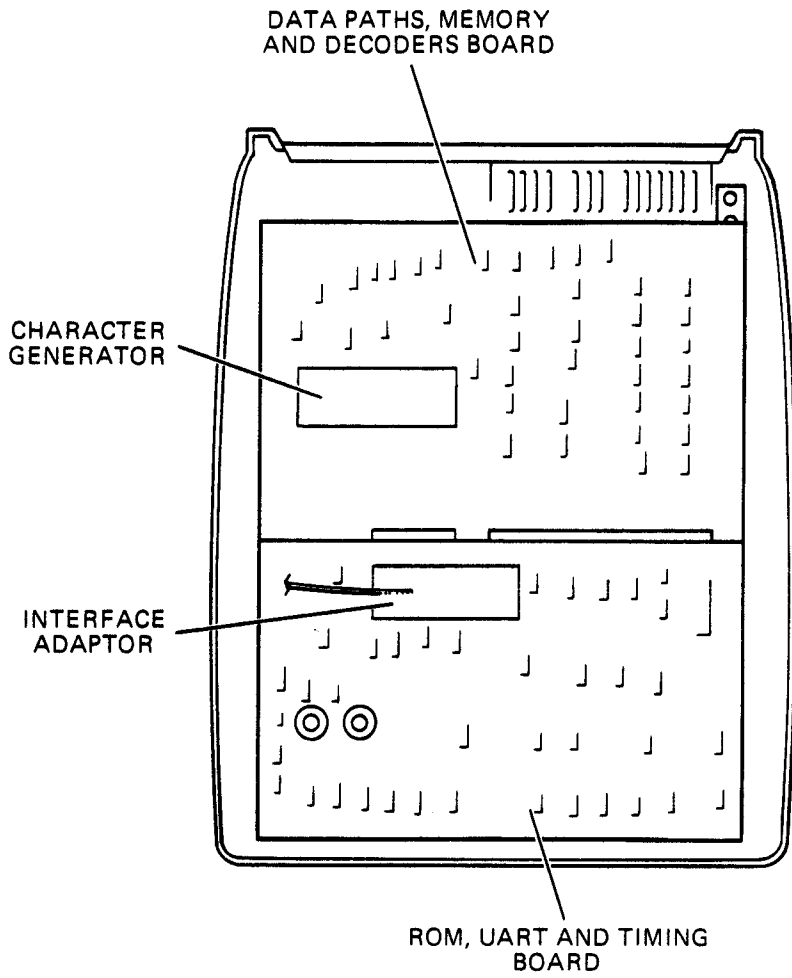
MA-0111

Figure 7-3 VT52 Servicing Position

4. Remove the base (Paragraph 5.3).
5. Remove the character generator from the RAM and Data Path module by alternately lifting the left and right edges of the character generator module until both 11-pin module connectors are free. Do not bend the pins or place excess stress on the module (Figure 7-4).
6. The VTXX-KA module plugs into J5 and J6 on the DP module (Figure 7-2). To install the VTXX-KA module align the two 11-pin male connectors (J2 and J4) with the two 11-pin female connectors (J5 and J6) on the DP module and alternately apply pressure to the left and right VTXX-KA connectors until they properly seat (Figure 7-5).

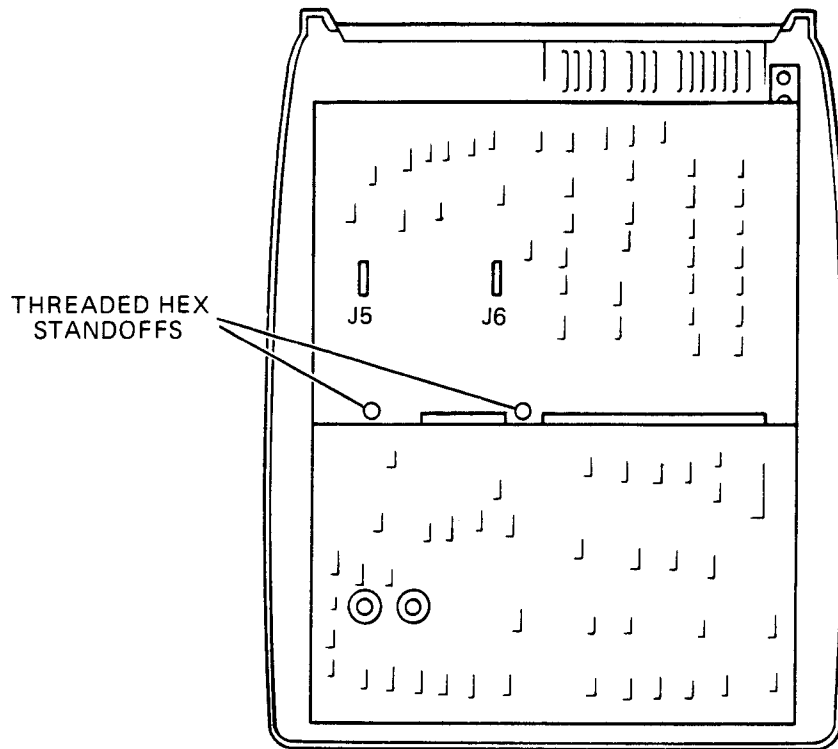
NOTE

Be sure not to bend the pins and check to see that the VTXX-KA connector pins are entering the proper holes on the DP module connectors. The cable connectors on the VTXX-KA module must face the front of the VT52.



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Figure 7-4 Character Generator Removal



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Figure 7-5 VTXX-KA Installation Site

7. Secure the VTXX-KA module to the two threaded hex standoffs on the DP module using the two 8-32 \times 5/16 screws and #8 lockwashers (Figure 7-5).

NOTE

The VTXX-KA module may have to be moved slightly to align the mounting holes with the threaded hex stand-offs on the DP module. Do not overtighten the two mounting screws.

8. Install the character generator by aligning the two 11-pin male connectors (J1 and J2) on the character generator with the two 11-pin female connectors (J1 and J3) on the VTXX-KA module. Alternately apply pressure on the left and right edges of the character generator until properly seated (Figure 7-2).

NOTE

The arrow and the word "REAR" on the etch side of the character generator must be positioned on the left side of the VTXX-KA module. The arrow points to the rear of the VT52 when the character generator is properly installed (Figure 7-6).

9. Connect P2 from the VTXX-KA module to J4 on the DP module.

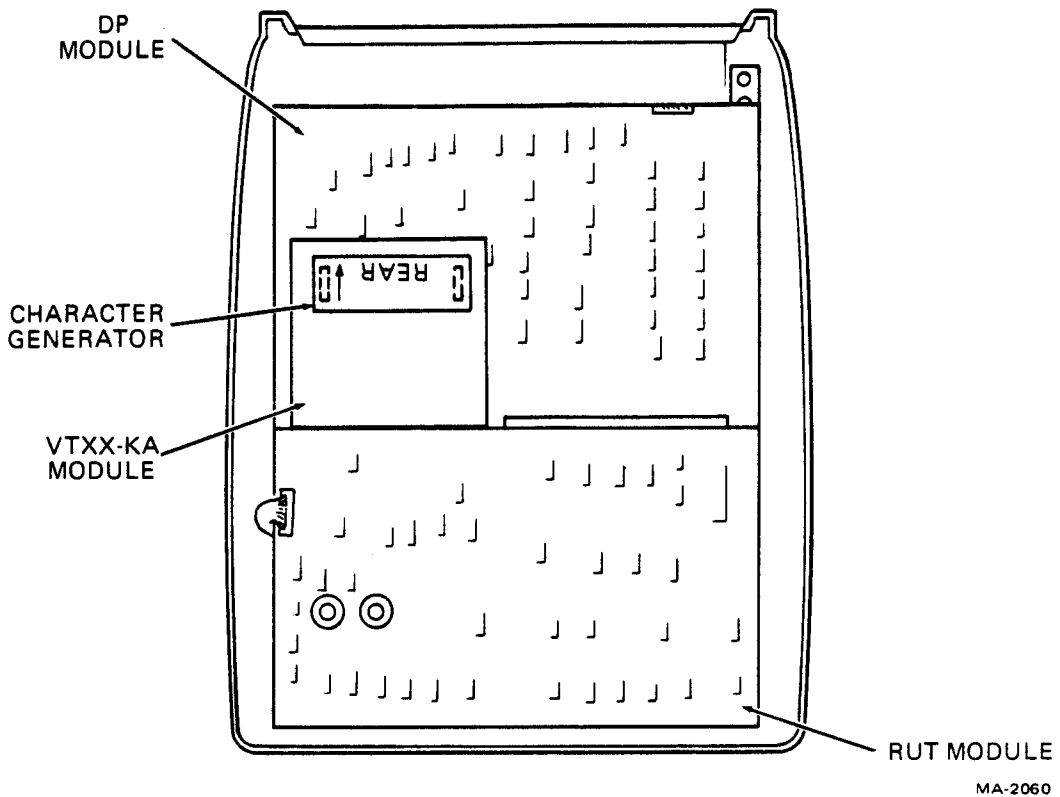
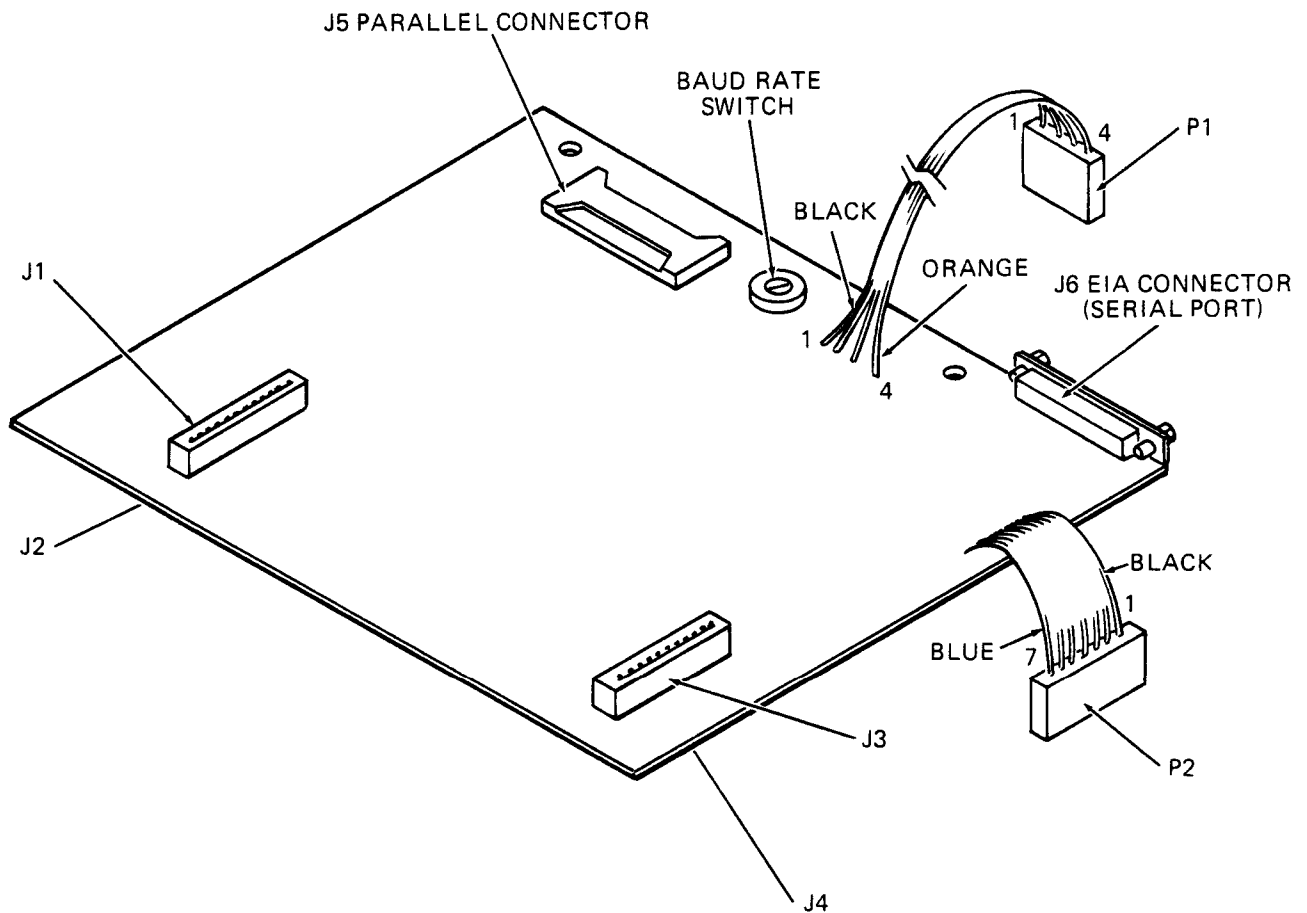


Figure 7-6 Character Generator Installation

10. Connect P1 from the VTXX-KA module to J6 on the RUT module. When properly installed the black cable wire from P1 will be towards the right of the VT52 (Figures 7-2 and 7-7).
11. Select the desired interface mode (serial or parallel) and the desired baud rate by turning the VTXX-KA baud rate switch (Figure 7-7) to the appropriate position. Paragraph 7.5 describes the various switch selections.
12. Perform the appropriate cable installation procedure described in Paragraph 7.3.2.

7.3.2 VTXX-KA Cable Installation

In addition to the interface cable from the VT52 to the host computer there is an interface cable required between the VTXX-KA module and the user's printer. This cable may be an EIA type cable for a serial interface or may be a parallel interface cable for a parallel interface. Paragraph 7.3.2.1 describes the installation procedure for a serial interface cable while Paragraph 7.3.2.2 defines the procedure for installing a parallel interface cable.



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Figure 7-7 VTXX-KA Printer Interface Module

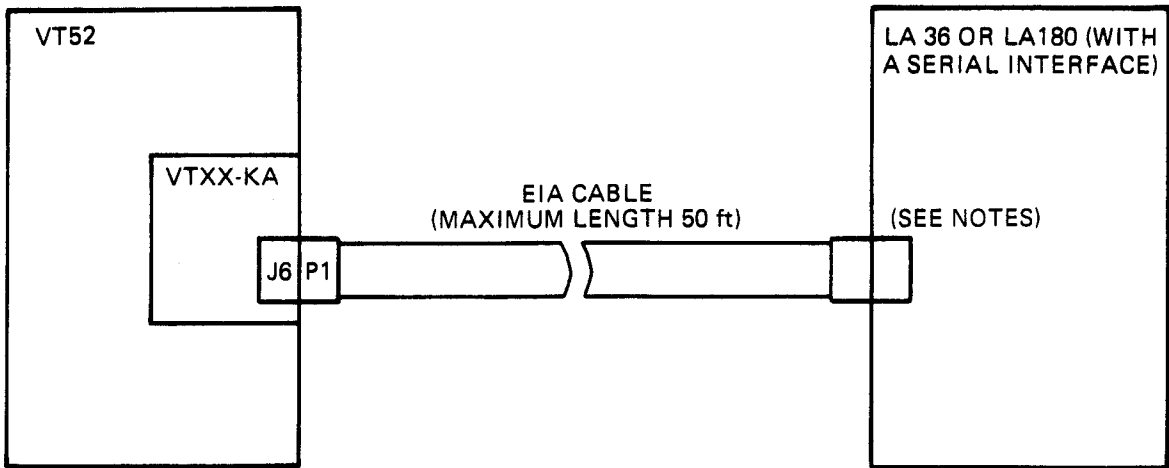
7.3.2.1 Serial EIA Printer Interface Cable Installation – Figure 7-8 shows a typical EIA installation and Table 7-2 shows J6 EIA signal locations.

1. Remove the grommet from the host computer interface cable.
2. Mate the male connector from the serial interface cable to the female serial port J6 on the VTXX-KA module (Figure 7-7).

NOTE

The two hold-down screws on the printer interface connector (some connectors do not have these screws) cannot be secured to the VTXX-KA module.

3. Pass the host computer and printer interface cables, as well as the AC power cord, through the VT52 base (Figure 7-9).
4. Position the base on the VT52 main assembly and tilt the base towards the rear of the unit.
5. Using a 1/4 inch nut driver, secure the ground strap from the main assembly to the base.

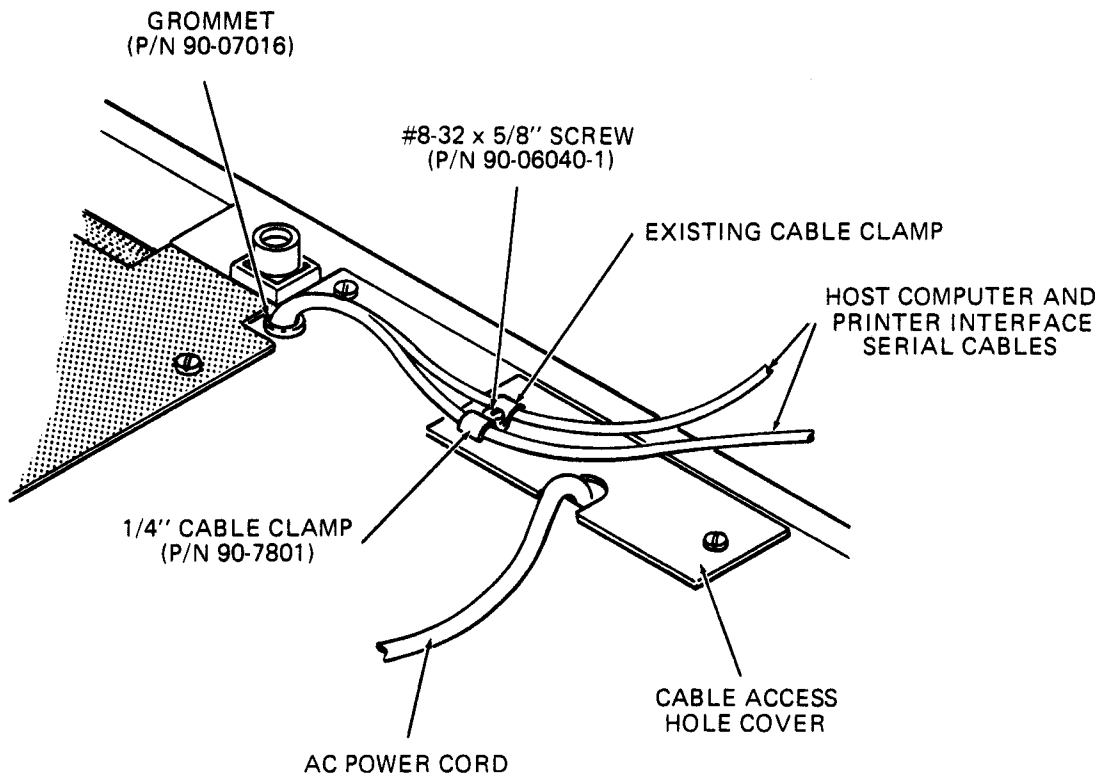


NOTES

1. LA36: EIA CABLE IS AN INTEGRAL PART OF EIA OPTION LAXX-LG OR KG.
2. LA180S: EIA CABLE BC05C-09 CONNECTS FROM J2 ON THE LA180S LAXX NW, NX BUFFERED SERIAL INTERFACE

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Figure 7-8 Serial EIA Printer Cable Installation



NOTE:

REINSTALL THE CABLE ACCESS HOLE COVER, SECURING IT WITH ONE SCREW TOWARDS THE REAR OF THE UNIT

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Figure 7-9 Serial Interface Cable Installation

6. Lower the base onto the VT52 main assembly and turn the five base fasteners 1/4 turn clockwise with a 1/4 inch nut driver.
7. Place the grommet from the VTXX-KA kit around the host computer and printer interface cables. Insert the grommet into the VT52 base plate (Figure 7-9).
8. Replace the AC power cord access cover securing it in position with one screw towards the rear of the terminal.
9. Place the 1/4 inch cable clamp from the VTXX-KA kit around the serial interface cable. Secure both the host computer and printer interface cables to the VT52 base with the 8-32 x 5/8 screw supplied with the VTXX-KA kit (Figure 7-9).
10. Replace the base front screen on the VT52 base securing the three screws with a 1/4 inch nut driver.
11. Return the VT52 to its normal operating position.
12. Connect the serial printer interface cable to the printer.
13. Connect the host computer interface cable to the computer or modem with which you wish to communicate.
14. Connect the AC power cord to an electrical outlet that meets the requirements of the terminal.
15. The installation of the VTXX-KA is now complete. Perform the initial checkout procedure given in Paragraph 7.5.

NOTE

The 7/16 inch cable clamp (Pin 90-7084) from the VTXX-KA kit is not used with the serial interface cable.

Table 7-2 J6 EIA Signal Locations

VTXX-KA Pin Number	EIA Circuit Designation	Description
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	Data Set Ready
7	AB	Signal Ground
20	CD	Data Terminal Ready

*All pins not listed above are not used

7.3.2.2 Parallel Printer Interface Cable Installation – Figure 7-10 shows a typical parallel installation. Table 7-3 gives the VTXX-KA parallel port (J5) signal locations.

1. Remove the communication interface adapter located on the RUT module (Figure 7-4).
2. Pass the parallel interface cable through the AC power cord access hole in the VT52 base. This is accomplished by folding the connector up against the cable to pass through the access hole. Unfold the cable after passing it through the access hole.
3. Connect the 40-pin female connector from the parallel interface cable to the 40-pin male connector J5 on the VTXX-KA module (Figures 7-2 and 7-7).
4. Pass the ac power cord through the ac power cord access hole in the VT52 base.
5. Position the base on the VT52 and tilt it towards the rear of the unit.
6. Secure the ground strap from the VT52 main assembly to the base using a 1/4 inch nut driver.
7. Lower the base onto the VT52 main assembly and then turn the five base fasteners 1/4 turn clockwise with a 1/4 inch nut driver.
8. Place the 7/16 inch cable clamp from the VTXX-KA kit around the parallel printer interface cable. Secure the cable clamp to base using the screw hole to the rear of the ac power cord access hole and the 8-32 × 5/8 inch screw from the VTXX-KA kit (Figure 7-11).

NOTE

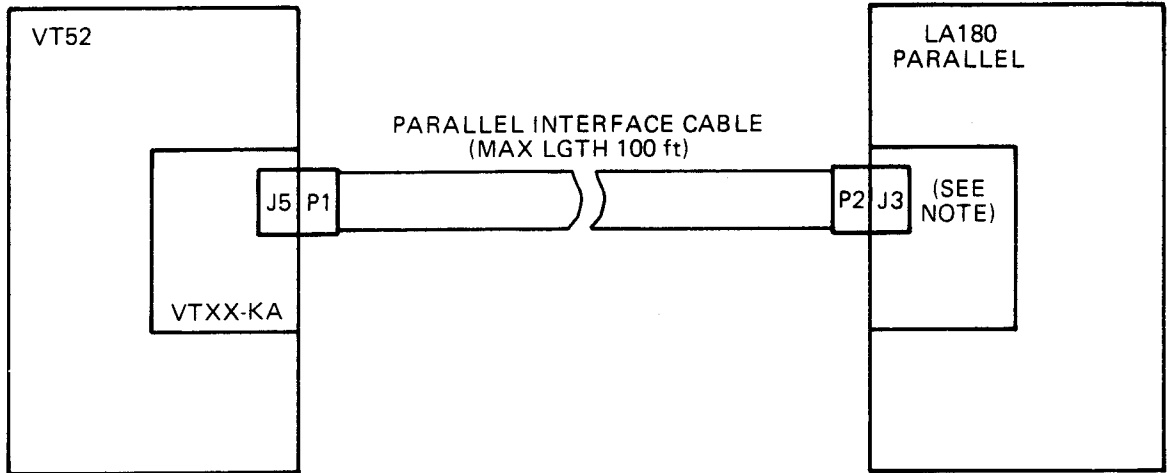
The cable access hole cover which was removed during disassembly is not reinstalled when the round parallel interface cable is used.

9. Reinstall the communication interface adapter onto the RUT module with the host computer interface cable towards the left of the VT52 (Figure 7-4).
10. Adjust the slack in the parallel interface cable so that the cable does not rest on top of the communication interface adapter.
11. Insert the host computer interface cable (along with the grommet) into the slot in the VT52 base plate (Figure 7-11).
12. Secure the host computer interface cable strain relief to the VT52 base plate.
13. Replace the base front screen securing the three screws with a 1/4 inch nut driver.
14. Return the VT52 to its normal operating position.
15. Connect the parallel printer interface cable to the printer.
16. Connect the host computer interface cable to the computer or modem with which you wish to communicate.
17. Plug the ac power cord into an electrical receptacle that meets the power requirements of the terminal.

18. The installation of VTXX-KA printer interface module is complete. Perform the initial checkout procedure given in Paragraph 7.5.

NOTE

The grommet (pin 90-07016) and the 1/4 inch cable clamp (pin 90-07081) from the VTXX-KA kit are not used when the parallel interface cable is installed.



NOTE

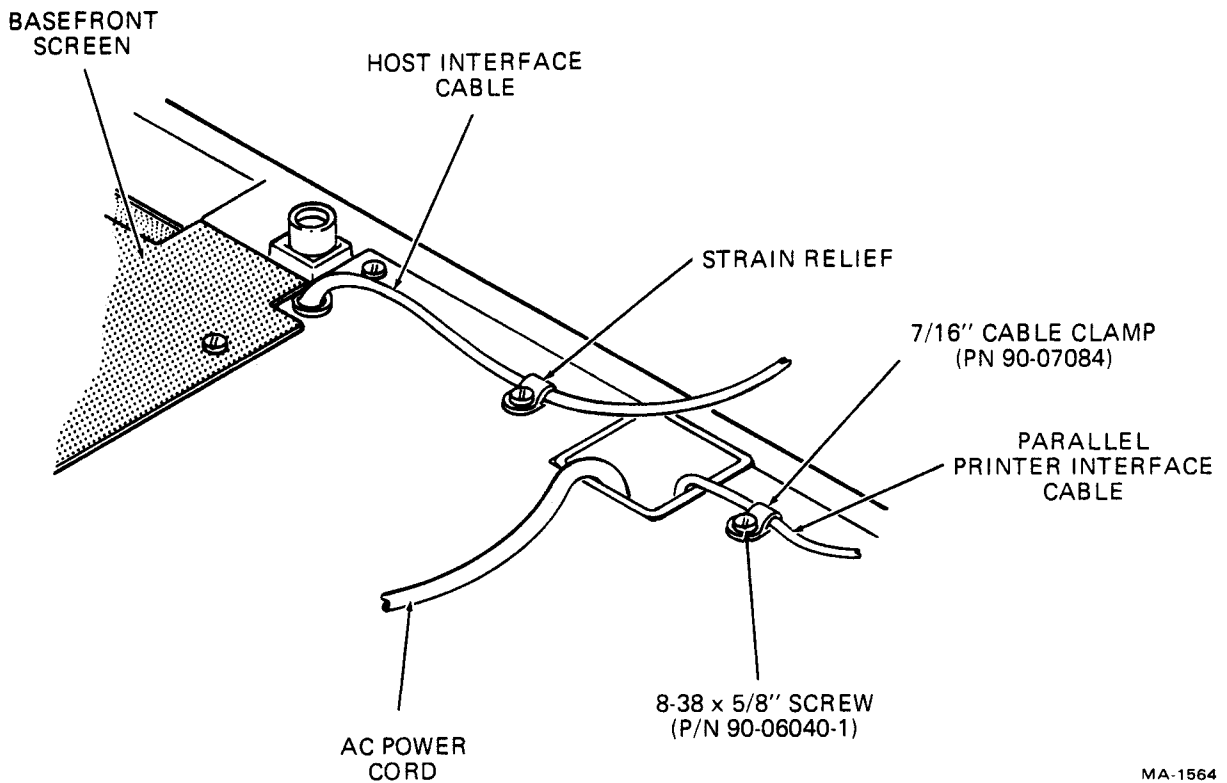
1. THE PARALLEL CABLE (P/NBCIIS) IS CONNECTED BETWEEN J3 ON THE LA180 LOGIC BOARD AND J5 ON THE VT52 VTXX-KA OPTION.

MA-1550

Figure 7-10 Parallel Printer Cable Installation

Table 7-3 J5 Parallel Port Signal Locations

Pin Number	Signal	Corresponding Pin on LA180 Printer
VV	Data Strobe	A
TT	Data 5	C
RR	Data 6	E
LL	Data 2	K
JJ	Data 1	M
FF	Data 4	P
DD	Data 7	S
BB	Data 3	U
D	Data 8 (parity)	SS
X	Demand	Y
R	Paper Fault	EE
N	On Line	HH
UU, SS, PP, MM, KK, HH, EE, CC, AA, Y, W, U, S, P, M, H, E, C, A	Ground	B, D, F, J, N, R, T, V, X, Z, BB, DD, FF, JJ, NN, RR, TT, VV
NN, Z, V, T, L, K, J, F, B	Open	H, W, AA, CC, KK, LL, MM, PP, UU



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Figure 7-11 Parallel Interface Cable Installation

7.4 INITIAL SET UP

On the VTXX-KA interface module there is a small 8-position rotary switch (Figure 7-7). This switch selects which interface (parallel or serial) will be used and, if the serial interface is selected which baud rate will be used.

NOTE

The VTXX-KA baud rate is independent of the VT52 on-line baud rate but must match the baud rate of the printer.

The switch has the following positions:

- | | | | |
|---|----------|------|------|
| 1 | parallel | | |
| 2 | serial | 150 | Baud |
| 3 | serial | 300 | Baud |
| 4 | serial | 600 | Baud |
| 5 | serial | 1200 | Baud |
| 6 | serial | 2400 | Baud |
| 7 | serial | 4800 | Baud |
| 8 | serial | 9600 | Baud |

Position 1 is the most counterclockwise position. To select a certain position, turn the switch fully counterclockwise, then count to the desired setting. If there is no printer attached to the VT52, the selector switch should be set to one of the serial positions to ensure that the terminal does not receive erroneous signals from the VTXX-KA parallel circuitry.

7.5 INITIAL TEST PROCEDURE

The initial test procedure verifies proper operation of the VT52 after installing the VTXX-KA printer interface.

Perform the following steps:

1. Plug the line cord of the VT52 into an electrical outlet that meets the requirements of the terminal.
2. Apply power to the unit by setting the power (ON/OFF) switch to ON. This switch is located on the right side of the terminal.
3. Place the printer on-line and be sure it has a supply of paper.
4. On the VT52, press the copy key. The key should click when pressed, and the printer paper should advance 24 lines.
5. Place the VT52 in the local mode.
6. Type your name for several lines on the VT52 screen. Press the VT52 copy key. Several lines of print with your name should be printed as they appear on the screen.

If after performing the initial checkout procedure the printer does not output the proper results, refer to Paragraph 7.8 for troubleshooting information.

7.6 VTXX-KA OPERATION INSTRUCTIONS

When the VTXX-KA module is installed, the operator can make the VT52 output data to the printer by using the copy key on the VT52 main keyboard. There are two variations of the output to the printer depending on whether the operator holds the shift key down when the copy key is typed.

If the copy key is typed without the shift key down, then the terminal will output the entire contents of the screen to the printer.

If the copy key is typed while the shift key is held down, then the terminal enters Auto Print mode. While in the Auto Print mode the terminal can output a variable number of lines of text to the printer. Whenever the terminal gets a line feed command to move the cursor down one line, the line that the cursor was on at the time will be output to the printer. This will be true as long as the terminal is in the Auto Print mode. To take the terminal out of Auto Print mode, the operator types the copy key again while holding down the shift key. None of these three uses of the copy key cause any codes to be sent to the host.

7.7 VTXX-KA PROGRAMMING INFORMATION

7.7.1 Host Computer Commands

The three commands which the operator can issue by using the copy key can also be issued from the host computer. To command the terminal to send text to the printer, the host sends the VT52 two character commands called Escape Sequences. A separate Escape Sequence exists for each of the three functions:

	Commands	Octal Codes
ESC]	Print the Screen	(033 135)
ESC ^	Enter Auto Print Mode	(033 136)
ESC —	Exit Auto Print Mode	(033 137)

There are two additional ways in which the host computer can command the terminal to send text to the printer: by specifying individual lines to be printed; or by placing the terminal in a mode in which it sends the received characters to the printer instead of to the screen (Printer-Controller Mode). The Escape Sequences for the two additional print modes are:

ESC V	Print Cursor Line	(033 126)
ESC W	Enter Printer-Controller Mode	(033 127)
ESC X	Exit Printer-Controller Mode	(033 130)

When the terminal receives ESC V from the host, it will output the entire contents of the line which the cursor is on to the printer. An ESC W sent from the host to the terminal causes the VT52 to enter Printer-Controller Mode. During the Printer-Controller Mode, every character the VT52 receives will be passed directly to the printer without being acted upon by the VT52. The VT52 becomes essentially a remote printer controller. ESC X will cause the terminal to exit Printer-Controller Mode.

NOTE

The characters ESC W cause the VT52 to enter the Printer-Controller Mode and are not sent to the printer. When the VT52 receives ESC X, which causes it to exit Printer-Controller Mode, the ESC will have already been sent to the printer. Instead of sending the X to the printer, the VT52 sends the character CAN (whose code is 030), which cancels the effect of the ESC.

7.7.2 Data Format

In the previous paragraph, four print commands have been described. Each of these commands cause a certain number of lines to be printed. The print line command causes one line to be sent to the printer and the print screen command causes 24 lines to be printed. Although entering or exiting Auto Print Mode does not cause anything to be printed, 1 line is sent to the printer each time a LF is received when the terminal is in Auto Print Mode. Each of these lines must first appear on the video display of the VT52.

A line on the VT52's display consists of 80 character positions. In each character position there may be a space or a displayable character. The text which appears on a given line may not use all 80 character positions. In this case, the spaces will remain in the character positions to the right of the text.

When the VT52 sends a line to the printer, it first sends the ASCII code for the character in the leftmost column (column 1) to the printer interface. Then it sends the ASCII code for the character in column 2, and so on. After it has sent the code for the character in column 80, the VT52 sends the code CR (015), and then LF (012) to the printer. These last two codes cause the printer to return to column 1 of the next line on the paper.

The terminal will ensure that the text on the line is not changed between the time the print command is issued and the time the characters are physically sent to the printer by using the XON and XOFF signals to the host.

If there are spaces in a line of text, the VT52 sends the code for Space (040), to the printer to mark the position where the spaces occurred in the screen. This causes the printer to advance the printhead so that a space is actually seen at the correct position. However, if spaces occur past the end of the text, there is no point in sending those spaces to the printer. Therefore, to save time, if 16 or more spaces occur to the right of the text on a line to be printed, the VT52 will trim all spaces occurring after the last printable character by sending a CR and an LF to the printer.

NOTE

If the printer has more than 80 columns, the columns to the right of the 80th column will never be used by the single line print commands since the VT52 has only 80 columns. However, many programs will want to control the printer in more detail (print in 132 columns, overprint lines, send control codes to the printer etc.), without the interpretive action of the VT52 (trimming blanks and inserting line delimiters). This is accomplished by placing the terminal in the Printer-Controller mode. The VT52 then passes every character it receives directly to the printer without converting or otherwise acting on the characters. The VT52 becomes essentially a remote printer controller.

7.7.3 Synchronization

Although the action of the printer is not instantaneous and may lag behind data transmission from the host to the terminal, provisions exist to ensure that all requested output goes through to the printer. In three situations where requested information to be printed might be destroyed or altered before it can be printed, the terminal will cease processing incoming characters:

1. In Auto Print Mode, when the cursor is moved up to a line that was marked for printing but has not yet been printed, the terminal will cease processing incoming characters until the cursor line is printed.
2. In Auto Print Mode, if the top line was supposed to be printed but has not yet been printed, and if the cursor is on the bottom line and LF is received – so that a scroll would be performed and the top line would leave the screen – the terminal will not process the LF and subsequent characters until the top line has been printed. (This is the only situation in Auto Print Mode in which scrolls are prohibited. In general, the terminal does not require that data being printed be on the same line on the screen that it was when the request was made to print it.)
3. The terminal will not process incoming characters after a Print Screen or Print Line command, until the specified data has been printed.

In these situations, the terminal begins putting incoming characters in its silo buffer, and transmits XOFF to the host. When the necessary printing has been finished, the terminal will begin to process the characters in the silo. When it has processed all the characters in the silo, the terminal will send XON to the host to indicate that it is ready for more characters.

When the terminal is in Printer Controller Mode, so that data flows through the terminal and out to the printer as it is received from the host, the terminal will use the silo, and XOFF and XON signals, to limit the data rate on the transmission line to a rate the printer can keep up with. Therefore, the maximum data rate for output to the printer via Printer Controller Mode is the minimum of the baud rate between the terminal and the printer, and the baud rate between the terminal and host. For example, if the terminal were set to communicate with the host at 9600 baud, and to communicate with the printer at 1200 baud, then the terminal would use the XOFF and XON signals to limit the net data flow to 1200 baud. If the terminal were set to communicate to the host at 300 baud and with the printer at 1200 baud, the host would never receive an XOFF from Printer Controller Mode. The transmission would be limited to 300 baud by the line between terminal and host.

Note that the host cannot determine if the terminal operator has pressed the copy key. If there is any possibility that one of the above situations may occur, host software **MUST** support synchronization with XOFF/XON (must suspend its transmission promptly upon receiving XOFF, and resume upon receiving XON), or else the silo may overflow, interfering with the accuracy of the output.

Specifications for exactly how promptly the host must respond to XOFF by ceasing output are found in the DECscope User's Manual.

NOTE

In the situations listed above where the terminal refuses to process characters from the host, the terminal will still allow the operator to use the keyboard to transmit characters to the host. If the terminal is switched for either Off-Line or Local Copy operation, these characters will also go into the silo. Therefore, the operator of such a terminal should refrain from typing when the printer is running, since he could cause the silo to overflow by his typing.

7.7.4 Status Reporting

Whenever any VT50-series terminal receives the Escape Sequence ESC Z, it transmits a three-character identification sequence to the computer which uniquely specifies its model number and capabilities, so that software can determine what features are available in that terminal. This identification sequence will allow the computer to determine whether a printer is available on the terminal.

ESC / K VT52 without printer

ESC / M VT52 with printer

The terminal will transmit the second Escape Sequence only if it determines that the printer is capable of printing.

If the Selector is set to one of the serial positions, then the VT52 will respond to the computer with ESC / K (no printer) if the signal DTR (Data Terminal Ready) is deasserted (Paragraph 7.2.2).

If the Selector is set for parallel transmission, then the VT52 will transmit the "no printer" Escape Sequence if either the ON-LINE signal is deasserted, or the PAPER FAULT signal is asserted (Paragraph 7.2.1).

When no printer is plugged into either the serial or the parallel slot, the Selector should be set to one of the serial positions. Doing this will ensure that the terminal will always report to the computer that a printer is not present.

7.8 VTXX-KA TROUBLESHOOTING

If after performing the initial checkout procedure the printer does not print the correct results, do the following:

1. Make sure the printer power is on, the printer is on-line and that the printer has a supply of paper.
2. Check the printer interface connections at the printer and the VT52.
3. If the printer is a parallel printer, check the baud rate switch on the VTXX-KA module. It should be set to position 1 for parallel operation.
4. If the printer is a serial printer and the message is unintelligible, check the baud rate switch on the VTXX-KA module. It should match the baud rate of the printer.
5. Type ESC Z on the VT52. The character M should be displayed on the screen. If the character K is displayed recheck the printer for an adequate paper supply and on-line operation. If the character M is displayed but the printer will not print any data from the VT52 further testing is required.

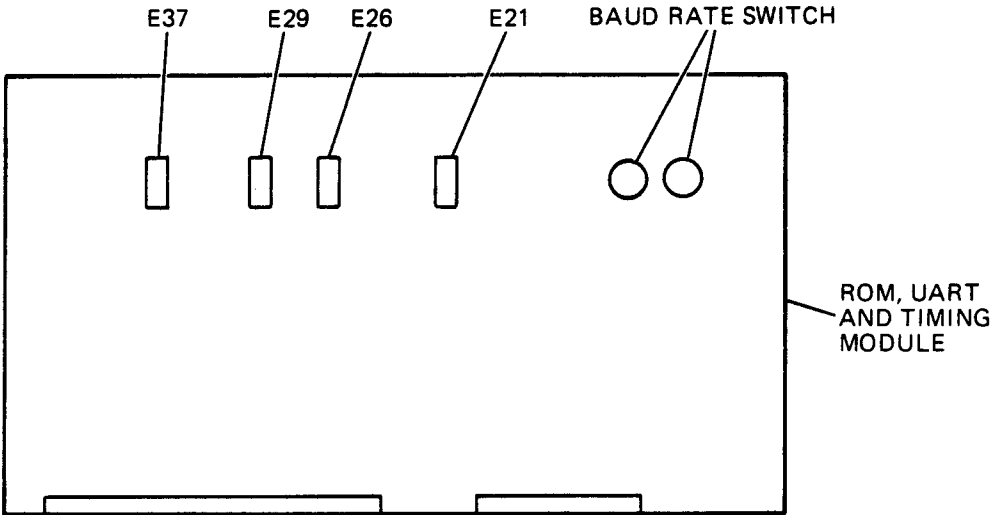
NOTE

If the VTXX-KA fails to operate, ensure the RUT module contains the proper PROM/ROM variation (Appendix A).

APPENDIX A REFERENCE DATA

A.1 PROM, ROM CROSS REFERENCE CHART

Not all Character Generator chips will work properly with all PROM/ROM sets. Table A-1 lists the PROM/ROM variations and their compatible Character Generator chips. Figure A-1 shows the PROM set layout.



MA-1560

Figure A-1 PROM Set Layout

Table A-1 Compatible Character Generator Chips for PROM/ROM Variations

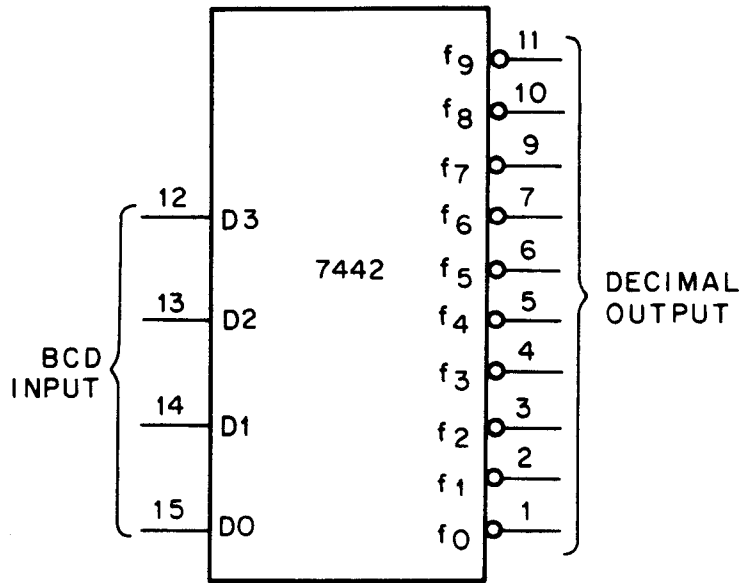
Variations	PROM Set Label	ROM Set Part No.	Character Revision	Generator Chip Part No.
VT52 with serial numbers up to WF 03660, and part no. 04600, and VT52 with copiers use the 54-11743 (no variation) ROM/UART board.	K1 or L1-3 K1 or L1-2 K1 or L1-4 K1 or L1-1	23-119A9 23-120A9 23-121A9 23-122A9	* or A	23-001B4 ⁰⁰ or 23-002B4 ⁰⁰
Basic VT52, supporting the Printer Interface Module (PIM), uses the 54-11743-04 ROM boards.	M4-3 M3-2 M4-4 M4-1	23-124A9 23-125A9 23-126A9 23-127A9	A	23-002B4 ⁰⁰
VT55, with/without copier use the 54-11743-02 ROM boards.	128 129 130 131	23-128A9 23-129A9 23-130A9 23-131A9	A	23-002B4 ⁰⁰

Note that the revision * Character Generator boards will not work properly with M4 PROMs.

⁴⁰⁰ denotes that on the Character Generator chip the part number may end in 400 or 4.

A.2 IC PIN LOCATION DRAWINGS

7442 BCD TO DECIMAL DECODER



V_{CC} = PIN 16
 GND = PIN 08

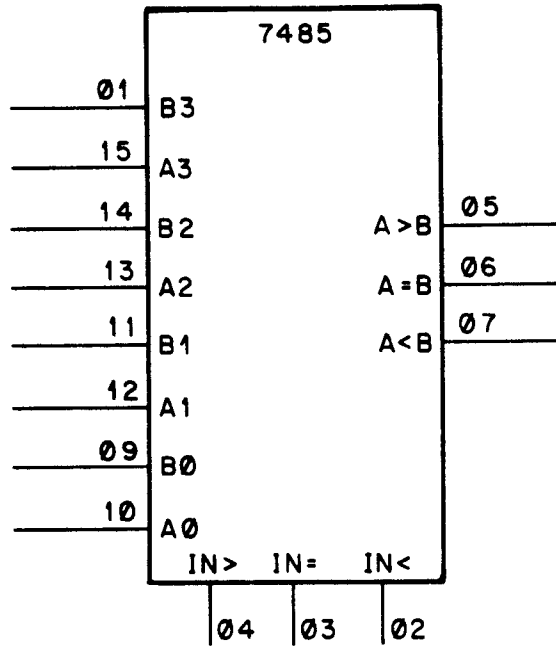
7442
 TRUTH TABLE

BCD INPUT				DECIMAL OUTPUT									
D3	D2	D1	D0	f0	f1	f2	f3	f4	f5	f6	f7	f8	f9
0	0	0	0	0	1	1	1	1	1	1	1	1	1
0	0	0	1	1	0	1	1	1	1	1	1	1	1
0	0	1	0	1	1	0	1	1	1	1	1	1	1
0	0	1	1	1	1	1	0	1	1	1	1	1	1
0	1	0	0	1	1	1	1	0	1	1	1	1	1
0	1	0	1	1	1	1	1	1	0	1	1	1	1
0	1	1	0	1	1	1	1	1	1	0	1	1	1
0	1	1	1	1	1	1	1	1	1	1	0	1	1
1	0	0	0	1	1	1	1	1	1	1	1	0	1
1	0	0	1	1	1	1	1	1	1	1	1	1	0
1	0	1	0	1	1	1	1	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1	1	1	1	1	1
1	1	0	0	1	1	1	1	1	1	1	1	1	1
1	1	0	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1

IC-7442

7485 4-BIT COMPARATOR

The 7485 performs magnitude comparison of straight binary or straight BCD codes. Three fully decoded decisions ($A > B$, $A < B$, $A = B$) about two 4-bit words (A,B) are made and externally available at three outputs.



VCC = PIN 16
GND = PIN 08

TRUTH TABLE

COMPARING INPUTS				CASCADING INPUTS			OUTPUTS		
A3, B3	A2, B2	A1, B1	A0, B0	IN >	IN <	IN =	A > B	A < B	A = B
A3 > B3	X	X	X	X	X	X	H	L	L
A3 < B3	X	X	X	X	X	X	L	H	L
A3 = B3	A2 > B2	X	X	X	X	X	H	L	L
A3 = B3	A2 < B2	X	X	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 > B1	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 < B1	X	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 > B0	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 < B0	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	L	L	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	H	L	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	H	L	L	H

NOTE: H = high level, L = low level, X = irrelevant

IC-7485

7490 4-BIT DECADE COUNTER

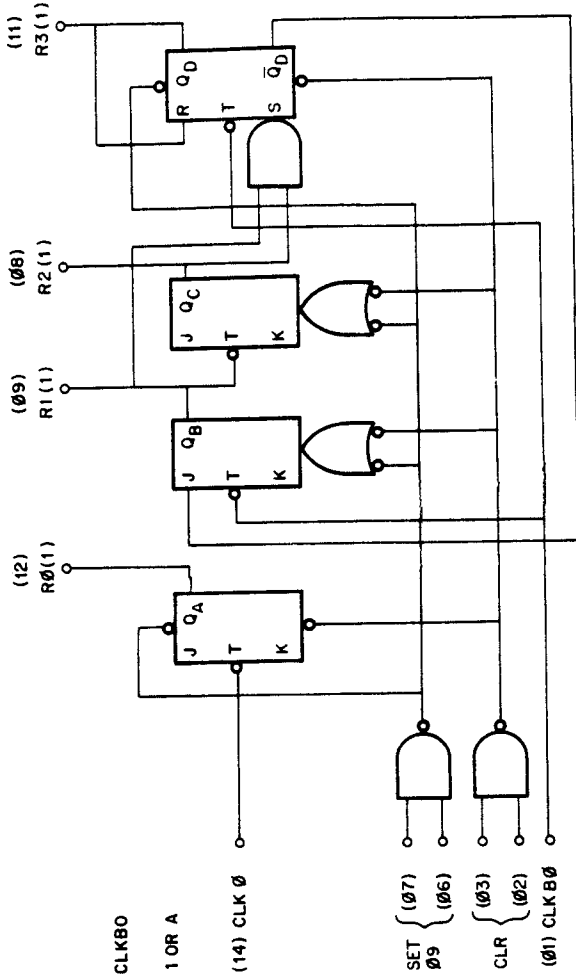
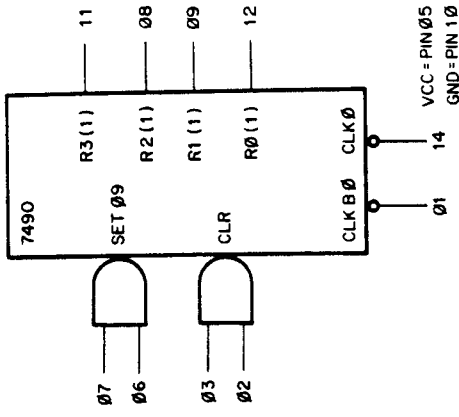
BCD COUNT SEQUENCE
(See Note 1)

COUNT	RESET INPUTS			OUTPUT			
	R3(1)	R2(1)	R1(1)	R3(1)	R2(1)	R1(1)	R0(1)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1
2	0	0	0	1	0	0	0
3	0	0	0	1	1	0	0
4	0	1	0	0	0	0	0
5	0	1	0	1	0	0	1
6	0	1	1	0	0	0	0
7	0	1	1	1	0	0	1
8	1	0	0	0	0	0	0
9	1	0	0	0	0	1	0

TRUTH TABLES

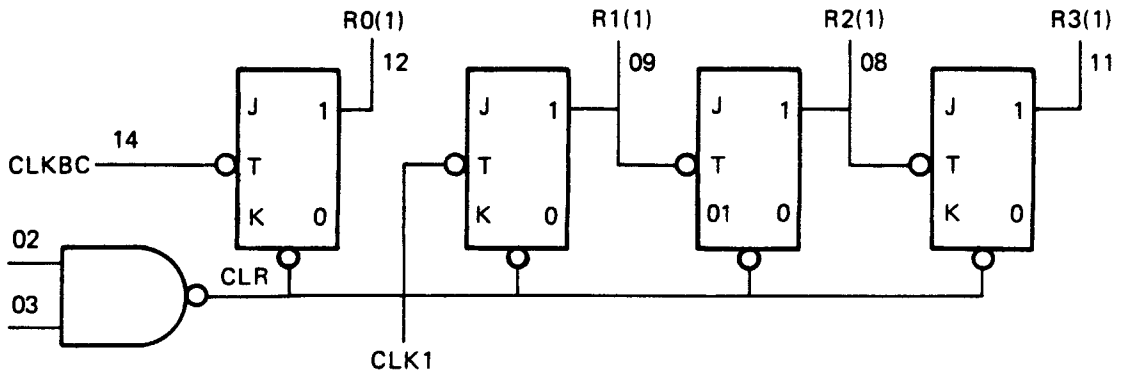
RESET/COUNT (See Note 2)

Q2	RESET INPUTS			OUTPUT			
	Q3	Q6	Q7	R3(1)	R2(1)	R1(1)	R0(1)
1	1	0	X	0	0	0	0
1	1	1	X	0	0	0	0
X	X	1	1	1	0	0	1
X	0	X	0	COUNT			
0	X	0	X	COUNT			
0	X	X	0	COUNT			
X	0	0	X	COUNT			

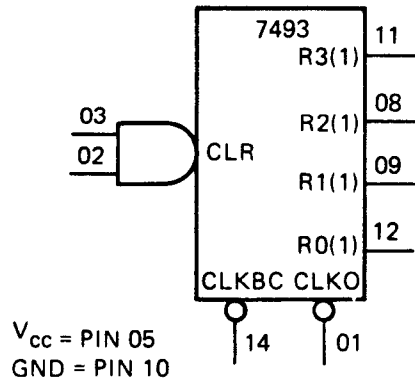


- NOTES:
1. OUTPUT R0(1) CONNECTED TO INPUT CLKB0 FOR BCD COUNT.
 2. X INDICATES THAT EITHER A LOGICAL 1 OR A LOGICAL 0 MAY BE PRESENT.

7493 BINARY COUNTER



LOGIC DIAGRAM



7493 TRUTH TABLE
(SEE NOTES)

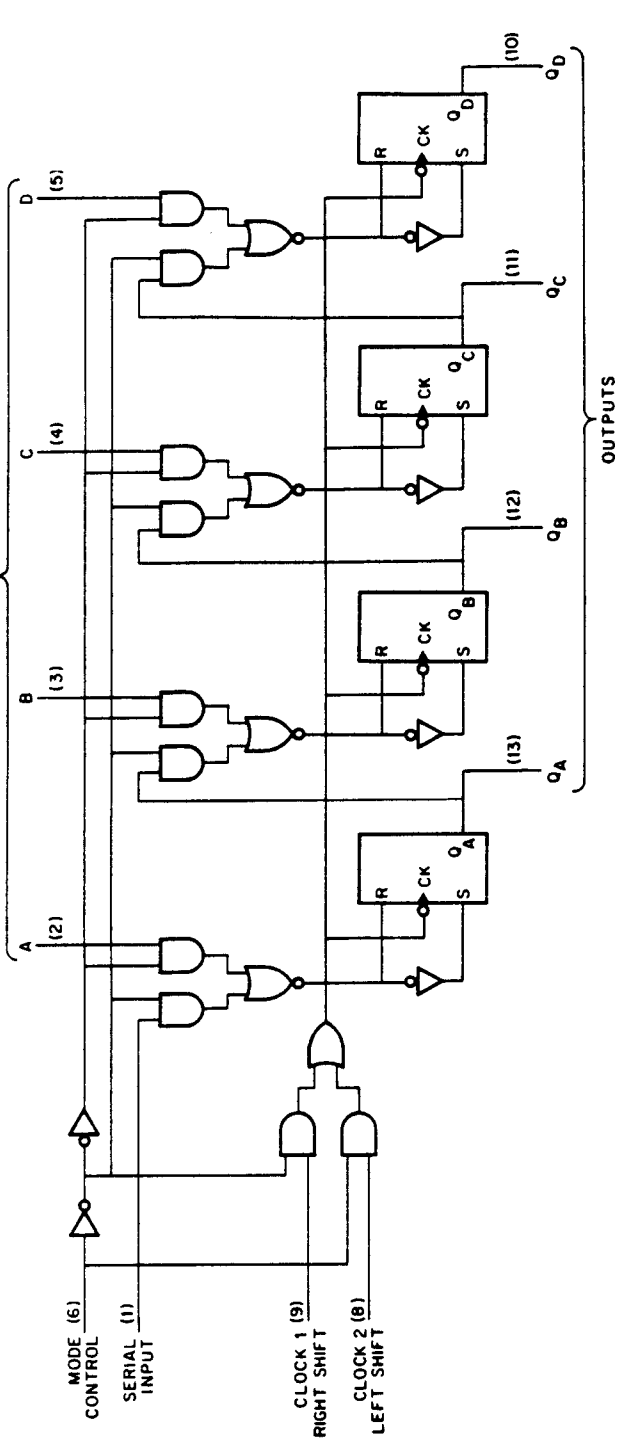
CLKBC INPUT PULSE	OUTPUT			
	R0 (1)	R1 (1)	R2 (1)	R3 (1)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1
11	1	1	0	1
12	0	0	1	1
13	1	0	1	1
14	0	1	1	1
15	1	1	1	1

0 = LOW 1 = HIGH

NOTE:

1. TRUTH TABLE APPLIES WHEN 7493 IS USED AS A 4-BIT RIPPLE – THROUGH COUNTER.
2. OUTPUT R0(1) CONNECTED TO INPUT CLKO
3. TO RESET ALL OUTPUTS TO LOGICAL 0 BOTH PINS 02 AND 03 INPUTS MUST BE HIGH.
4. EITHER (OR BOTH) RESET INPUTS R0(1) (PINS 02 AND 03) MUST BE LOW TO COUNT.

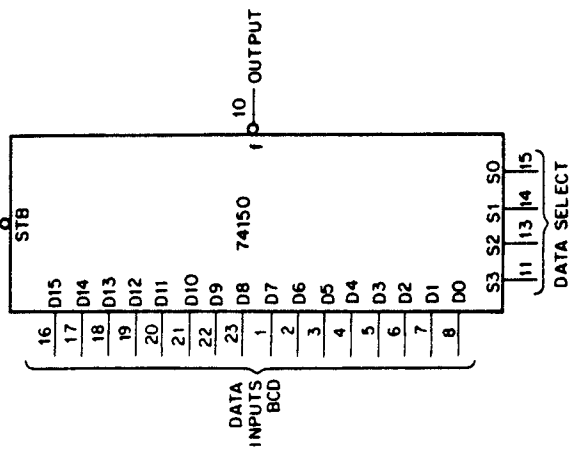
7495 4-BIT SHIFT REGISTER



IC-7495

74150 16 TO 1 MULTIPLEXER

- LOW TO ENABLE
- OUTPUT IS HIGH IF STROBE IS HIGH



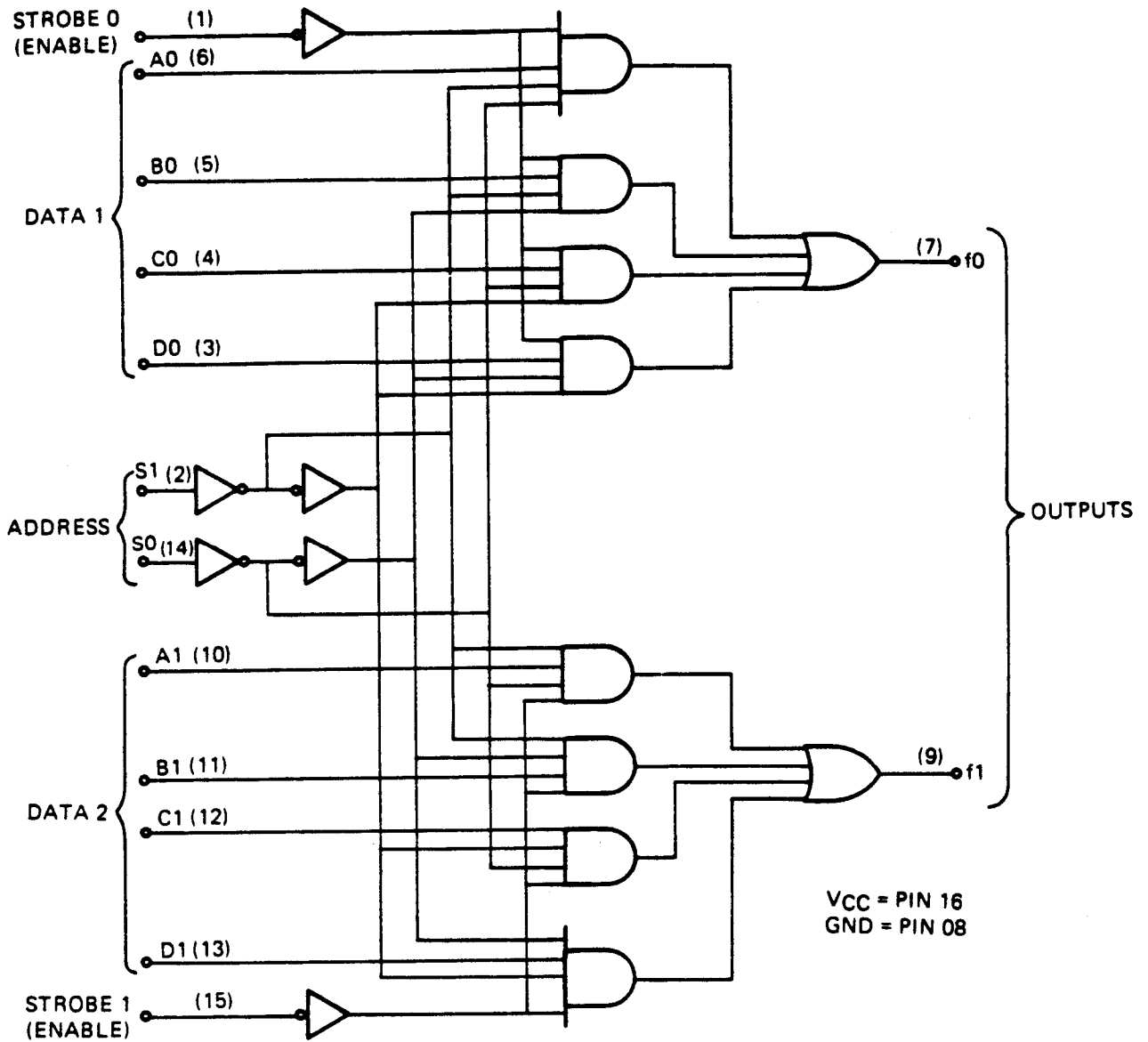
+5V = PIN 14
GND = PIN 7

74150 TRUTH TABLE

INPUTS																OUTPUT					
S3	S2	S1	S0	STROBE	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	f
0	0	0	0	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
0	0	0	1	0	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
0	0	1	0	0	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	0
0	0	1	1	0	X	X	1	X	X	X	X	X	X	X	X	X	X	X	X	X	0
0	0	1	1	0	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	1
0	1	0	0	0	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	0
0	1	0	0	0	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X	X	0
0	1	0	1	0	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	1
0	1	0	1	0	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X	0
0	1	1	0	0	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X	1
0	1	1	0	0	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	0
0	1	1	1	0	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	1
0	1	1	1	0	X	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	0
1	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	0	0	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	0	0	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	0	1	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	0	1	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	0	1	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	0	1	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	1	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	1	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	1	0	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	1	0	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	1	1	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	1	1	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	1	1	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	1	1	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
1	1	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1	1	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1

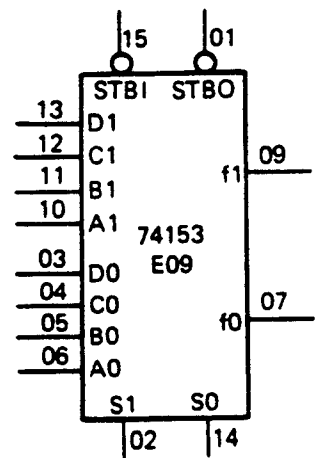
WHEN USED TO INDICATE AN INPUT CONDITION, X = LOGICAL 1 OR LOGICAL 0

74153 DUAL 4 TO 1 MULTIPLEXER

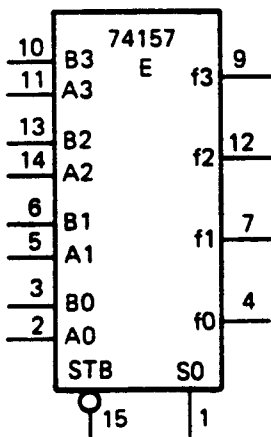
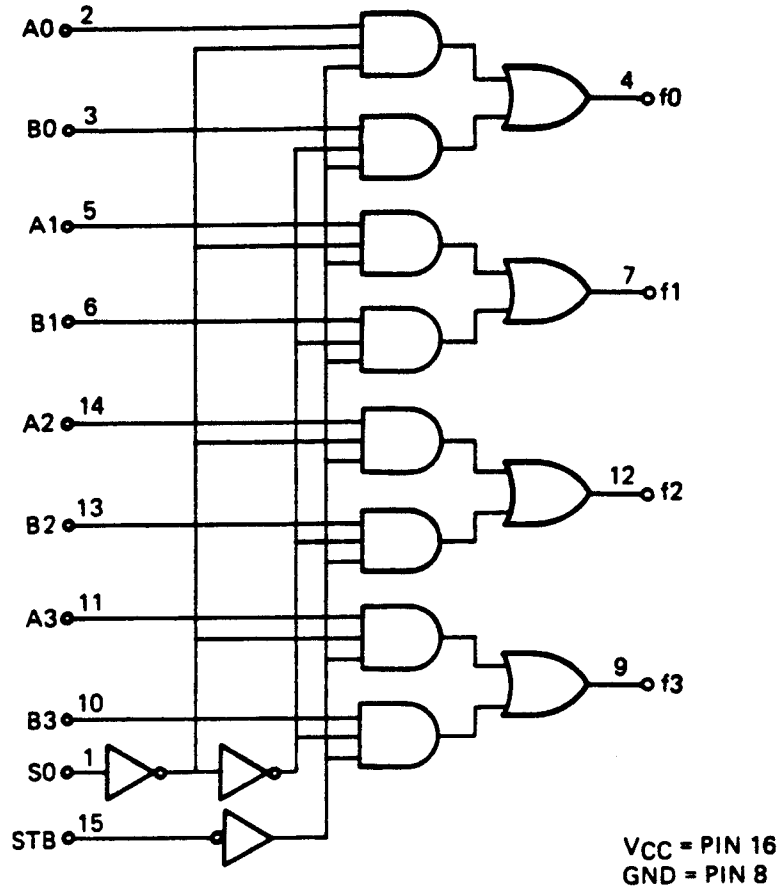


ADDRESS INPUTS		DATA INPUTS				STROBE OUTPUT	
S1	S0	A	B	C	D	STB	f
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

ADDRESS INPUTS S0 AND S1 ARE COMMON TO BOTH SECTIONS: H=HIGH LEVEL, L=LOW LEVEL, X=IRRELEVANT



74157 QUAD 2-TO-1 MULTIPLEXER

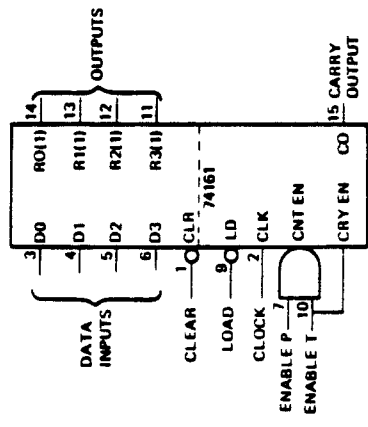


INPUTS			OUTPUT
STROBE	SELECT	A B	
H	X	XX	L
L	L	LX	L
L	L	HX	H
L	H	XL	L
L	H	XH	H

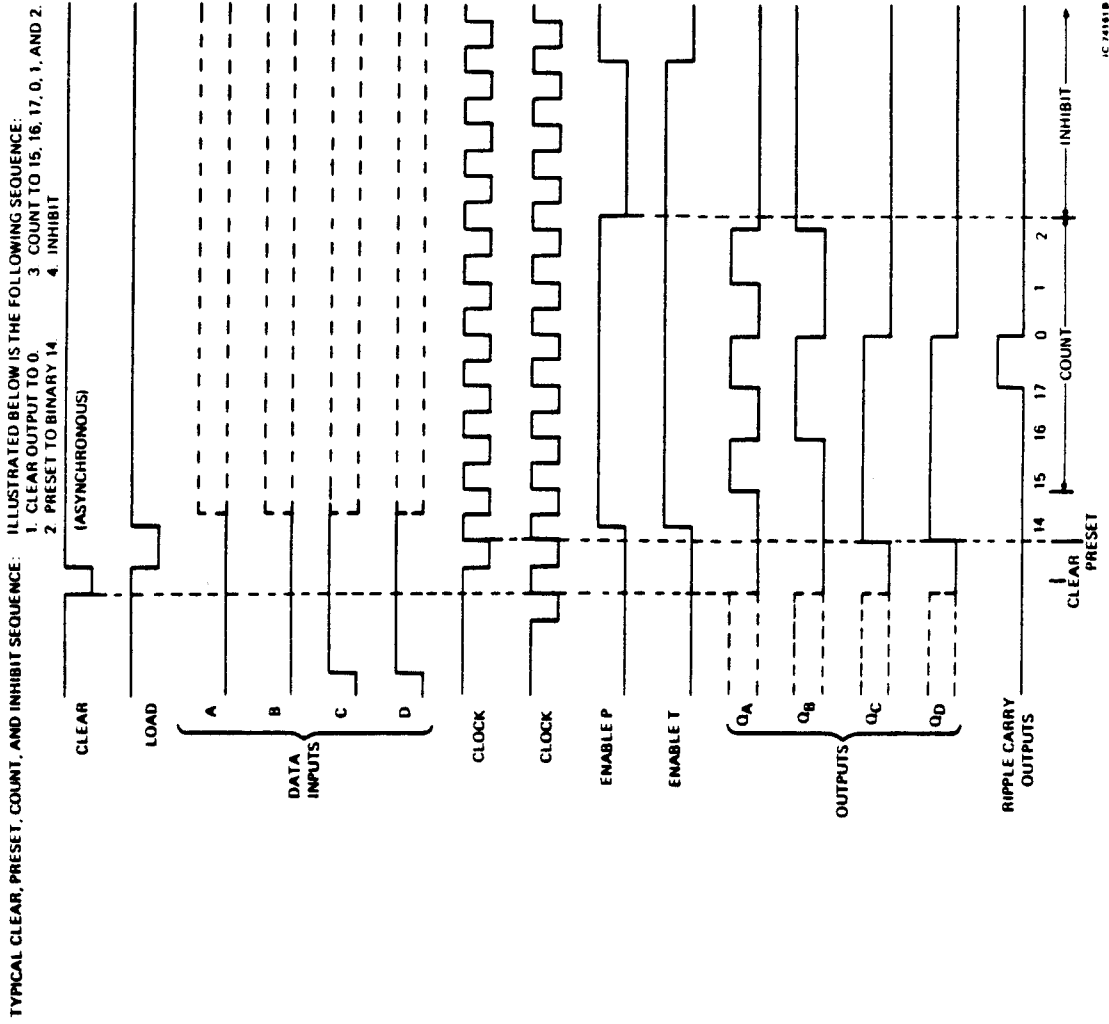
H = HIGH LEVEL, L = LOW LEVEL
X = IRRELEVANT

IC-74157

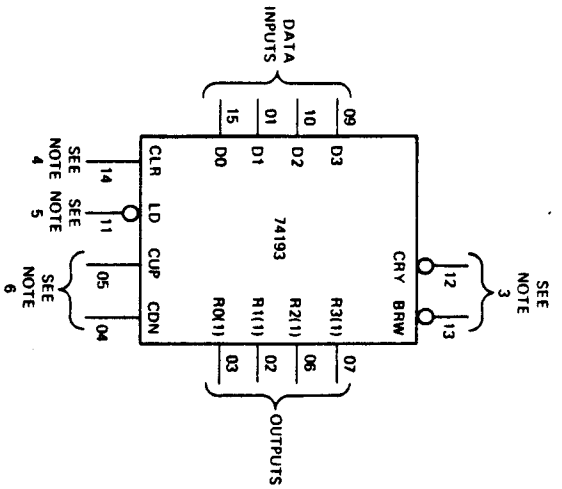
74161 SYNCHRONOUS 4-BIT COUNTER



GND = PIN 8
+5V = PIN 16



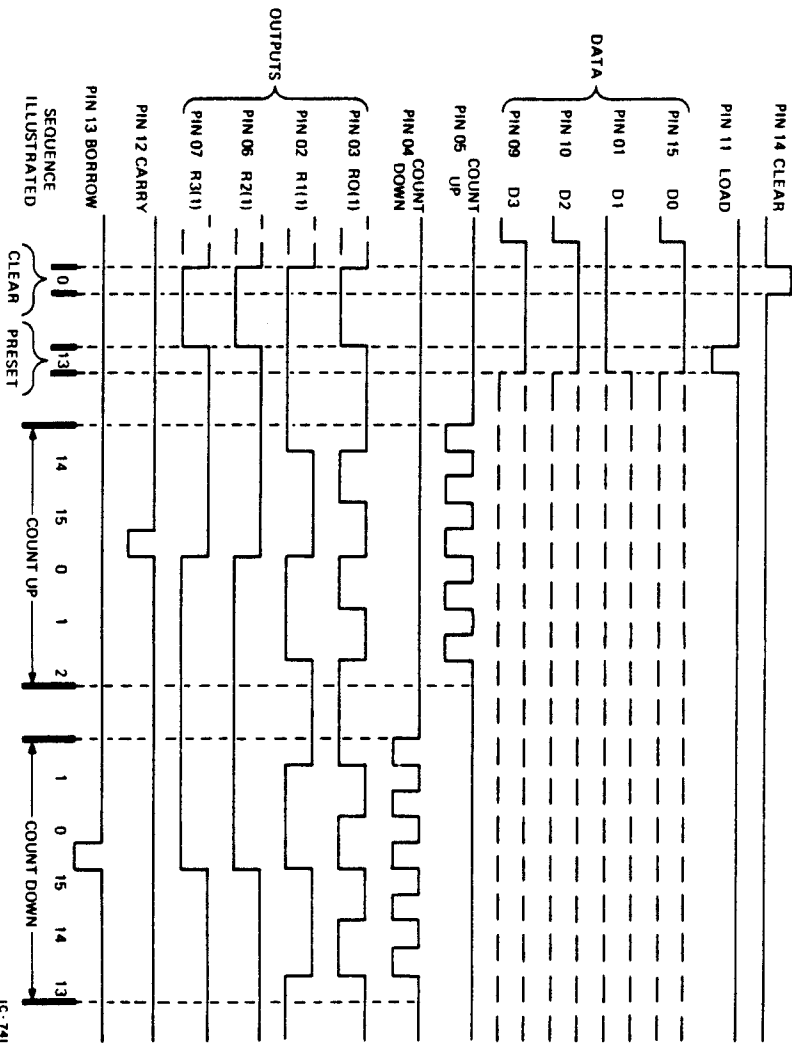
74193 4-BIT UP/DOWN COUNTER



- NOTES:
1. CLEAR OVERRIDES LOAD, DATA, AND COUNT INPUTS.
 2. WHEN COUNTING UP, COUNT DOWN INPUT MUST BE HIGH; WHEN COUNTING DOWN, COUNT UP INPUT MUST BE HIGH.
 3. PRODUCE PULSES EQUAL TO WIDTH OF COUNT PULSES DURING UNDERFLOW (BORROW) OVERFLOW (CARRY)
 4. CLR INPUT HIGH FORCES ALL OUTPUTS LOW. CLR OVERRIDES LOAD, DATA AND DN/UP INPUTS
 5. PRESET TO ANY STATE BY APPLYING INPUT DATA WITH LOAD INPUT LOW. OUTPUT CHANGES TO AGREE WITH INPUTS INDEPENDENT OF COUNT PULSES.
 6. SELECT DN OR UP CLOCK WHILE OTHER IS HELD HIGH.

TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES FOR 74193
ILLUSTRATED BELOW IS THE FOLLOWING SEQUENCE:

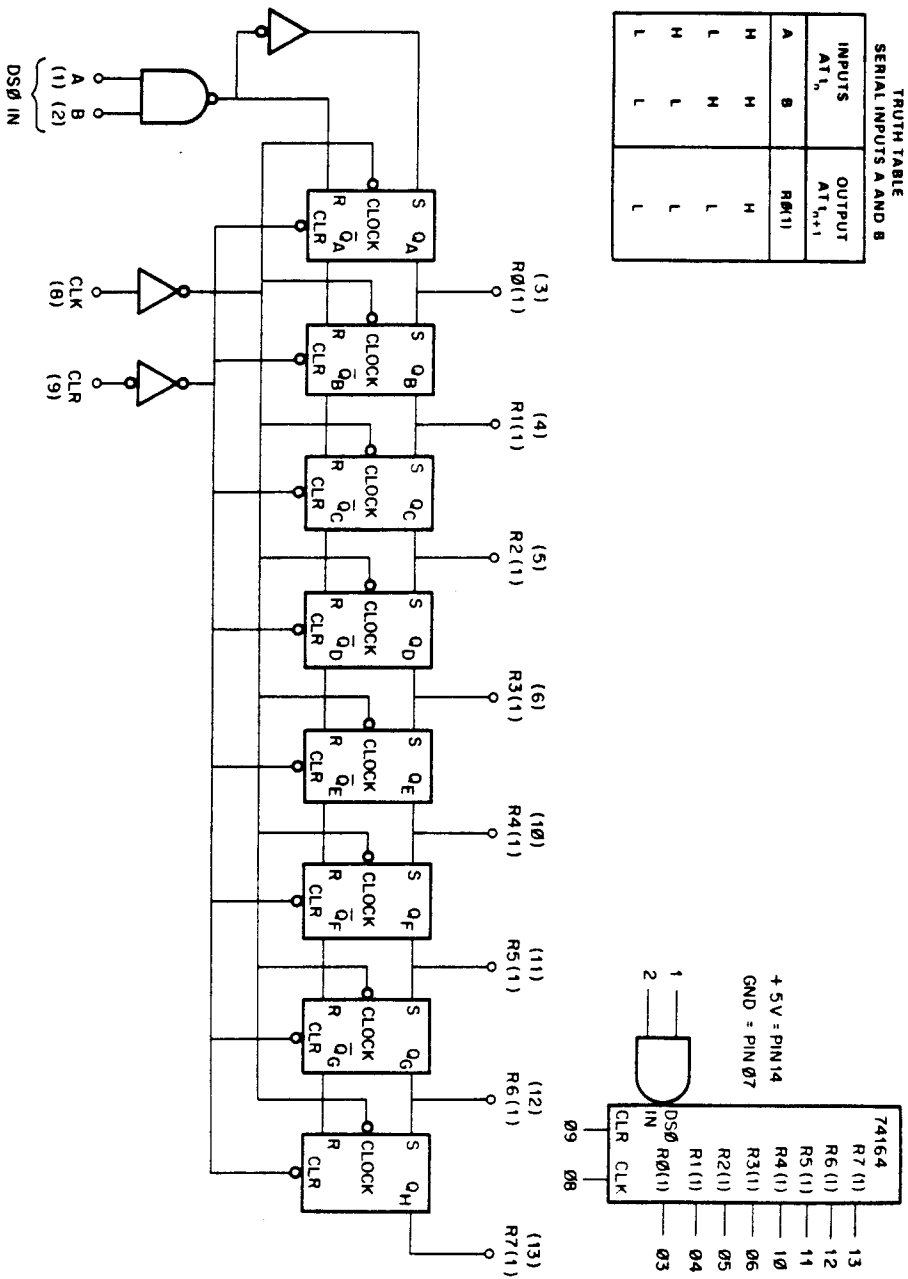
1. CLEAR OUTPUTS TO ZERO.
2. LOAD (PRESET) TO BCD THIRTEEN.
3. COUNT UP TO FOURTEEN FIFTEEN, CARRY, ZERO, ONE, AND TWO.
4. COUNT DOWN TO ONE, ZERO, BORROW, FIFTEEN, FOURTEEN, AND THIRTEEN.



74164 8-BIT SHIFT REGISTER

TRUTH TABLE
SERIAL INPUTS A AND B

INPUTS $A T_n$		OUTPUT $A T_{n+1}$	
A	B	R _n (1)	R _{n+1}
H	H	H	H
L	H	L	L
H	L	L	L
L	L	L	L



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