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TEKTRONIX®

RE4012

RUGGEDIZED

COMPUTER DISPLAY TERMINAL

INSTRUCTION MANUAL

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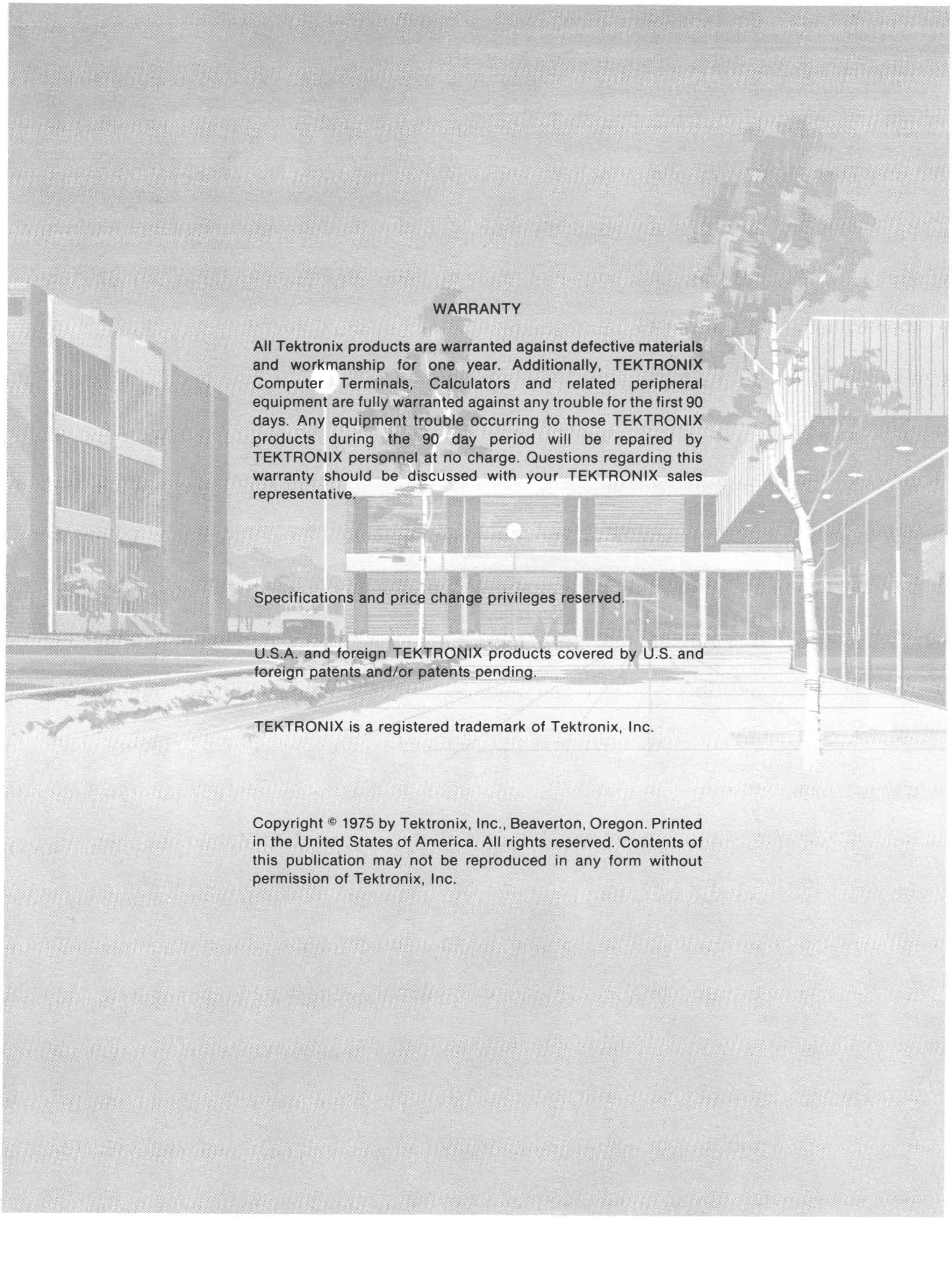

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Section 1

INSTALLATION AND OPERATION

DOCUMENTATION NOTE

This manual provides all operating and servicing information for the basic RE4012 Terminal. It does not include information about communication or peripheral interfaces, each of which are documented separately.

INTRODUCTION

The RE4012 is a ruggedized, rack-mountable Computer Display Terminal. Data from it can be input to a computer, either directly or through a modulator/demodulator (modem). Data from a computer can be displayed or otherwise executed by the Terminal, and can be relayed from the Terminal to other devices. The display's storage capability causes written data to remain on the screen until erased by a remote or keyboard command, permitting complex alphanumeric and graphic displays to be presented. Hard copies can be made of displays if the terminal is connected to a Hard Copy Unit.

OPERATING POWER

The terminal is intended to be operated from a single-phase power source which has one of its current-carrying conductors (the neutral conductor) at ground (earth) potential. Operation from other power sources where both current-carrying conductors are live with respect to ground (such as phase-to-phase on a multi-phase system, or across the legs of a 117-234 V single-phase three-wire system) is not recommended, as only the line conductor has over-current (fuse) protection within the instrument.

The Terminal is provided with a three-wire power cord with a three-terminal polarized plug for connection to the power source. The grounding terminal of the plug is directly connected to the instrument frame as recommended by national and international safety codes. Color coding of cord conductors follows the National Electrical Code (ANSI C1-1968) which specifies Line as Black, Neutral as White, Safety Earth or Ground as Green with a yellow stripe (or solid green).

The Terminal can be operated from either 110 or 220-volt nominal line voltage source. A front-panel fuse holder and a jumper arrangement on the transformer permit the Terminal to be modified to suit the supply. Fuse size is 3.2 amp slo-blo for 110 volt operation and 1.6 amp slo-blo for 220 volt operation. Line frequency may be between 48 and 64 Hz for a standard Terminal, and between 360 and 440 Hz for a Terminal equipped with a 440 Hz fan option.

INSTALLATION

Installation of the Terminal consists of the following steps:

1. Determine the compatibility of the Terminal to the available power. (The Terminal's status can be determined from the tag attached to its line cord.) If the two differ, rewire the Terminal's transformer in accordance with instructions in the Servicing section.

2. If not already done, install the Terminal in a rack in accordance with instructions given in the Servicing section. (The Terminal will work without being rack-mounted, permitting it to be checked out at any location.)

3. Perform the First-Time Operation as a check-out procedure. It is recommended that the Indicators, Controls and Adjustments and the Operating Modes topics be read before doing the actual operation.

4. Set circuit card strap options to their desired positions. Instructions are contained in the Servicing section.

5. Connect the Terminal directly or through a modem to a computer. The connector is located on the rear panel. Refer to the appropriate interface documentation for details.

6. Check the Terminal's operation with the computer.

7. Sequentially connect the Terminal to peripheral devices, if they are part of the installation. Check operation as each is installed. Instructions concerning each of them should be provided with the peripheral devices.

INDICATORS, CONTROLS, AND ADJUSTMENTS

All operator controls, indicators and adjustments are located on the front panel or keyboard. Adjustments contained within the instrument should be made only by qualified technicians.

Front Panel (Fig. 1-2)

POWER Switch	Controls line voltage to the Terminal.
Power Lamp	Illuminated by the +5 volt supply when the POWER switch is turned on.

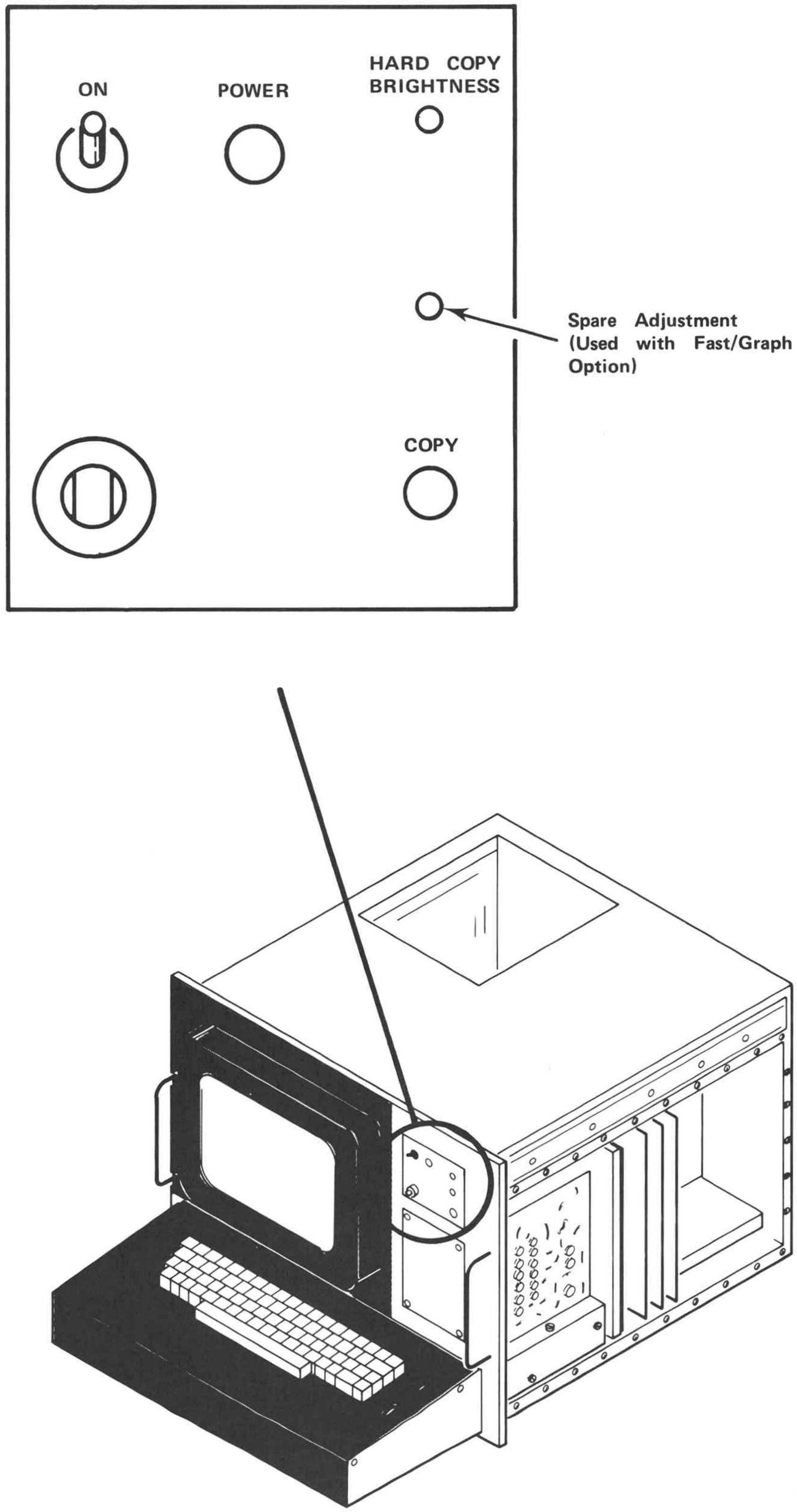

Fig. 1-2. Front Panel Controls.

Fuse Lamp	Built into line fuse holder. Lights when line fuse blows.
COPY	Hard Copy command button. Performs no function unless a Hard Copy Unit is attached.
HARD COPY BRIGHTNESS	Operator's screwdriver adjustment which controls the intensity of the display scanning bar during copying, thereby affecting hard copies.
Intensity (lower)	Operator's screwdriver adjustment which is used with optional accessories. When used with the Fast Graph option, it controls the intensity of write-through information.

Keyboard (Fig. 1-2)

LOCAL LINE	A two-position switch. LOCAL position isolates the Terminal from the computer and permits keyboard inputs to be displayed or otherwise executed by the Terminal. LINE position permits communication with the computer, and keyboard inputs are not displayed or otherwise executed by the Terminal unless echoing is being done by the Interface Unit, modem, or computer.
Indicator 1 Indicator 2	Multiple use lamps whose functions are determined by the accessories and optional equipment used with the Terminal. Connections to the lamp are made via the minibus. Low signals are required to light the lamps.
Switch 1 Switch 2 Switch 3	Two-position switches whose functions are determined by the accessories and optional equipment used with the Terminal. Switch 1 and Switch 2 make connection via the minibus. Switch 3 makes connection through a wire and pin connector which is fastened beneath a cable clamp on the right side within the cabinet.

Thumbwheels. These are located on the right side of the keyboard section. They position the crosshair cursor that is displayed in GIN (Graphic Input) Mode.

Character Keys. The keyboard shown in Fig. 1-3 is equipped to perform as an input for ASCII or TTY codes. Lower case letters, grave accent (`), opening brace ({), broken vertical line (¦), and tilde (~) cannot be transmitted when the TTY LOCK key is depressed, regardless of the position of the shift key.

Character transmission occurs when a key is pressed. If the key is held down, a one-half second (approximate) delay occurs, after which the character is repeatedly entered at a 10 Hz rate. If CTRL or SHIFT is used with a character key, the originally selected code continues to be transmitted as long as the character key is held down, even if CTRL or SHIFT is subsequently released.

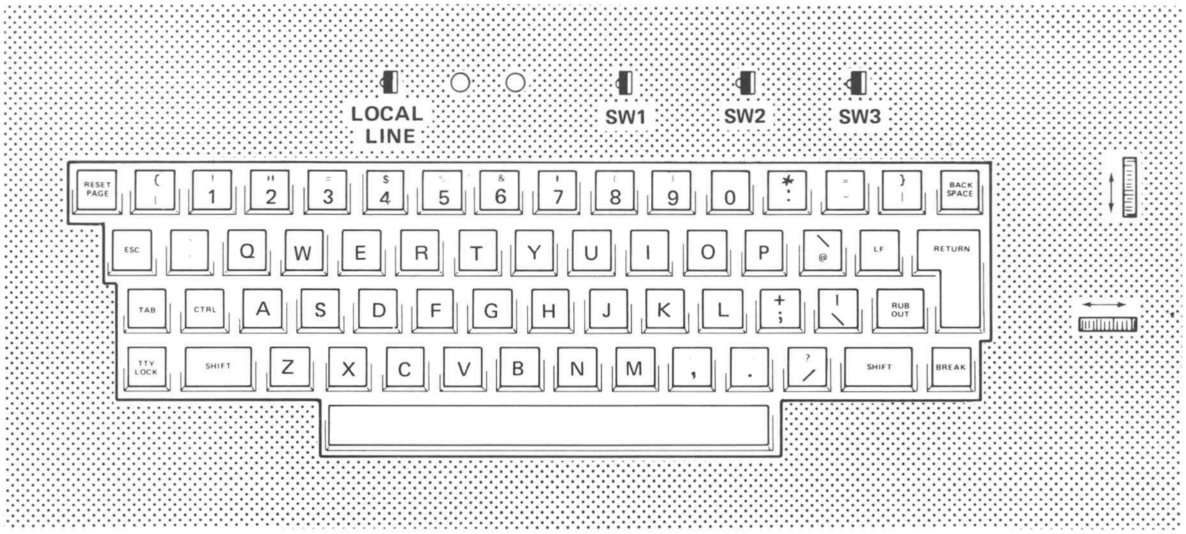

Fig. 1-3. Keyboard.

Control Keys. The following keys do not directly enter characters for transmission, but control operation of the keyboard or Terminal. Some of them are used independently, while others are used in combination with other control keys or character keys.

RESET/PAGE — Pressed alone, it performs a PAGE function. It erases the CRT, resets to Alpha Mode and Home position, shifts the display origin, resets to Margin Ø and cancels Echoplex Suppression. Pressed while SHIFT is held down, it creates a HOME function, resetting the Terminal to initial status; no erase occurs.

CTRL — Causes letter keys to transmit control characters if CTRL is held down before the letter key is pressed. It may be used in conjunction with SHIFT and a character key.

SHIFT — Used alone, it resets the Terminal from Hold to View status. It causes some keys to enter a shifted character if held down while the character key is pressed. It is also used in combination with CTRL and some letter keys for entering control characters.

TTY LOCK — Causes letter keys to transmit upper case letters, regardless of position of SHIFT key. TTY LOCK also inhibits transmission of the following:

` { ¦ ~

BREAK — Generates a BREAK signal, which is sent to the interface unit. Any resulting interrupt signal is interface dependent.

Control Character Inputs. Control characters are input at the keyboard as listed in Table 1-1, regardless of TTY selection. The CTRL key or CTRL and SHIFT keys must be held down while the letter key is being entered, as indicated in the listing.

OPERATING MODES

General

Normal operation of the Terminal is achieved with the keyboard LOCAL/LINE switch at LINE position. The following operations are then possible:

Transmitting—Coded data is transmitted to the computer as entered at the keyboard.

Receiving—Alpha Mode causes Alphanumeric characters to be written as received; control characters are executed as received; Terminal goes into a reduced intensity status (Hold) after approximately 90 seconds of inactivity; Terminal returns to View status upon keyboard entry or upon receipt of data from the computer. Graph Mode causes recieved data to be interpreted as specific addresses for the X and Y registers within the Terminal, resulting in moving the display unit beam to specific positions; the basic address positions are shown in Fig. 1-4. Control characters are executed as received.

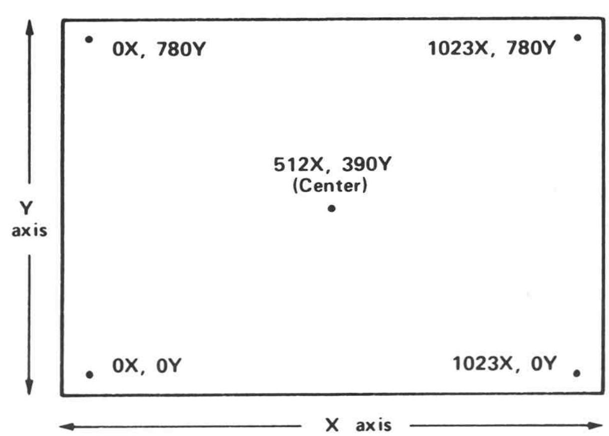

Fig. 1-4. Basic address positions on the display screen.

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TABLE 1-1

Control Characters versus Keyboard Equivalents

Control Character	Keyboard Entry	Control Character	Keyboard Entry
ACK	CTRL F	FS	CTRL SHIFT L
BEL	CTRL G	GS	CTRL SHIFT M
BS	BACKSPACE or CTRL H	HT	TAB or CTRL I
CAN	CTRL X	LF	LF or CTRL J
CR	RETURN or CTRL M	NAK	CTRL U
DC1	CTRL Q	NUL	CTRL SHIFT P
DC2	CTRL R	RS	CTRL SHIFT N
DC3	CTRL S	SI	CTRL O
DC4	CTRL T	SO	CTRL N
DLE	CTRL P	SOH	CTRL A
EM	CTRL Y	STX	CTRL B
ENQ	CTRL E	SUB	CTRL Z
EOT	CTRL E	SYN	CTRL V
ESC	ESC or ETRL SHIFT K	US	CTRL SHIFT o
ETB	CTRL W	VT	CTRL K
ETX	CTRL C		
FF	CTRL L		

Interactive—Graphic Input (GIN) Mode causes the Terminal to automatically send its status or the address of the display beam to the computer in response to commands from the computer. A crosshair cursor may be displayed in GIN Mode as a preparatory status.

Local operation occurs when the keyboard LOCAL/LINE switch is placed in the LOCAL position. The Terminal is then isolated from the computer, and keyboard entries are displayed or otherwise executed by the Terminal.

The Terminal has a Hard Copy Mode that permits a hard copy reproduction of the display to be made if a Hard Copy Unit is connected to the Terminal. The mode can be initiated by computer command, by a COPY button on the Terminal front panel, or by a switch on the Hard Copy Unit. Hard Copy intensity is adjustable at the Terminal front panel.

Transmitting

If the keyboard switch is at LINE position, data entered at the keyboard is transmitted in ASCII code form to the computer. The ASCII character set and its accompanying code is shown in Fig. 1-5.

The TTY LOCK key locks out ` { ¦ ~ and lower case letters. The TTY LOCK key affects the keyboard transmission circuits, not the receiving circuits.

The keyboard generates an eighth bit which is always either high or low, depending upon a strap option in the keyboard. This may be sent as set at the keyboard, or may be determined by the interface unit.

Receiving

General. The Terminal receiving circuits are essentially isolated from the keyboard and transmitting circuits while the keyboard switch is at LINE Position. Data is then received as a result of transmission from the computer, including data being echoed by the computer or modem. However, data entered at the keyboard is applied to the receiving circuits if an ECHO signal is being asserted by the interface unit. ECHO is controlled by a switch or a strap option, depending upon the type of interface. The ECHO signal creates a situation referred to as echoplexing.

The Terminal response to signals thus received is essentially the same in either case, and depends upon the operating mode.

Alpha Mode. The Alpha Mode is the initial condition of the receiving circuits. In addition, it occurs in response to receiving a US, CR, or ESC FF. It is also initiated by entering PAGE or SHIFT RESET at the keyboard. A pulsating cursor indicates the writing position of the next character. Alphanumeric

BITS			B7 / B6 / B5	Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		HIGH X & Y GRAPHIC INPUT		LOW X		LOW Y	
Ø	Ø	Ø	Ø	NUL Ø	DLE 16	SP 32	Ø 48	@ 64	P 8Ø	` 96	p 112
Ø	Ø	Ø	1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114
Ø	Ø	1	1	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	EOT 4	DC4 2Ø	$ 36	4 52	D 68	T 84	d 1ØØ	t 116
Ø	1	Ø	1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 1Ø1	u 117
Ø	1	1	Ø	ACK 6	SYN 22	& 38	6 54	F 7Ø	V 86	f 1Ø2	v 118
Ø	1	1	1	BEL 7 BELL	ETB 23	' 39	7 55	G 71	W 87	g 1Ø3	w 119
1	Ø	Ø	Ø	BS 8 BACK SPACE	CAN 24	(40	8 56	H 72	X 88	h 1Ø4	x 12Ø
1	Ø	Ø	1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 1Ø5	y 121
1	Ø	1	Ø	LF 1Ø	SUB 26	* 42	: 58	J 74	Z 9Ø	j 1Ø6	z 122
1	Ø	1	1	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 1Ø7	{ 123
1	1	Ø	Ø	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 1Ø8	¦ 124
1	1	Ø	1	CR 13 RETURN	GS 29	– 45	= 61	M 77	] 93	m 1Ø9	} 125
1	1	1	Ø	SO 14	RS 3Ø	. 46	> 62	N 78	Λ 94	n 11Ø	~ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	RUBOUT (DEL) 127

Fig. 1-5. ASCII/TTY Code Chart. Shaded areas are not included in the TTY Code.

characters are written on the display screen, essentially as shown in Fig. 1-6. Note that the TTY LOCK key has no control over incoming data, and any character can be written in response to appropriate code and character set selection. Space causes spacing only. DEL causes neither spacing nor writing. Control characters and control character sequences cause effects as listed in Table 2-1. Optional accessories may respond to other commands or sequences as determined by the optional accessory. Refer to Table 2-2 for a listing of Alpha Mode specifications.

Graph Mode. Control character GS puts the Terminal in Graph Mode. Then the Terminal draws vectors (either written or unwritten) in response to graphic address inputs as explained in Tables 2-4 and 2-5. The Terminal can still respond to control characters and control character sequences as explained in Table 2-1. Graph Mode ends and Alpha Mode occurs upon receipt of control characters US, CR, or control character sequence ESC FF. Graph Mode also ends upon receipt of ESC SUB, which sets GIN Mode and displays the crosshair cursor. Graph Mode can also be ended by pressing PAGE or SHIFT RESET at the keyboard. Refer to Table 2-3 for Graph Mode specifications.

Interactive

GIN Mode. GIN Mode occurs in response to receipt of ESC ENQ at any time the Terminal is "on line". It also occurs in response to an ESC SUB, which turns on the crosshair cursor. ESC SUB should not be entered at the keyboard while "on line", because immediate and erroneous transmission may occur. Receipt of ESC ENQ while in Alpha Mode results in immediate transmission of the Terminal status and the address of the point at the lower left corner of the Alpha cursor. CR or CR and EOT will automatically be transmitted immediately after the address, if selected by a strap option on TC-2. (EOT cannot be sent without CR.) Echoplexing is suppressed during GIN Mode. GIN Mode ends upon completion of transmission. If CR is transmitted during GIN Mode and is echoed by the computer, the Terminal will return to full Alpha Mode upon completion of the transmission. If CR is not echoed, the Terminal must be reset by one of the following before character writing can occur: BEL, BS, CR, ESC ETB, ESC FF, HT, LF, US, or VT. Note that if CR is echoed, or if any command affecting the display position is sent to the Terminal, it will cause the cursor to move away from the position that was referenced in GIN Mode; use BEL or US if the display position is to be left undisturbed.

Receipt of ESC ENQ while in Graph Mode also causes GIN Mode, sending the Terminal status and address of the Graph Mode beam position to the computer. The computer or modem may not echo GIN Mode data back to the Terminal if Graph Mode and beam position are to be retained after an ESC ENQ. (CR echoed will reset the Terminal to Alpha Mode, and will move the cursor to the left margin; echoing the status and address bytes will change the beam address to a point different from that sent to the computer.) GIN Mode ends automatically upon completion of transmission, and the Terminal returns to full Graph Mode if CR is not echoed.

Receipt of ESC SUB sets GIN Mode and turns on the crosshair cursor as a preparatory step in transmitting an address to the computer. The thumbwheels (located on the keyboard) can be used to position the crosshair cursor anywhere in the display area. The address at the crosshair intersection is sent to the computer in response to an ESC ENQ from the computer, or in response to entry of any keyboard character. The Terminal returns to full Alpha Mode upon completion of transmission if CR is sent and echoed. If CR is not echoed, one of the following must be sent before the Terminal can again write: BEL, BS, CR, ESC ETB, ESC FF, HT, LF, US, or VT. Refer to Table 2-6 for GIN Mode specifications.

Local

Operation with the LOCAL/LINE switch at LOCAL is much the same as just described for LINE operation. However, the following exceptions exist: (1) The Terminal is isolated from the computer; (2) data entered at the keyboard while in Alpha Mode results in writing or executing data at the Terminal; (3) data entered at the keyboard while in Graph Mode results in drawing vectors or executing control characters at the Terminal; (4) the crosshair cursor appears in response to CTRL SHIFT K and CTRL Z, and can be positioned by the thumbwheels—but it can only be removed by entering SHIFT RESET or PAGE.

Optional Operating Mode

Various other operating modes or features may be available if optional accessories are installed. The user should refer to the instruction manual for the specific installed option for details.

FIRST-TIME OPERATION

This operation procedure is intended to acquaint a user with the operating features of the Terminal. It can also be used as a Terminal check-out procedure. Although the Terminal is not connected to a modem or computer, all modes are exercised. Computer echoing is simulated by a local echo feature. Responses are explained for all options.

Preliminary

The Terminal should not be connected to a power source, modem, computer or peripheral devices at this time.

WARNING

Dangerous voltage exists beneath covers in the cabinet. Servicing should be done by a qualified technician.

Line Voltage. If the Terminal is being initially installed, check that the line voltage agrees with the data written on the tag which is attached to the Terminal. If it does not, change the transformer wiring and fuse size as described in the Servicing section.

Power. Plug the power cord into the power source and turn the Terminal POWER switch ON.

POWER Lamp. Check that the POWER lamp on the front panel illuminates, and the display screen becomes bright.

Data Transmission. With the keyboard switch at LINE, keyboard data is sent to the computer. It goes to the Terminal receiving circuits only if it is presented to them by one of the following methods: (1) Echoed by the computer or modem; (2) Echoed by the Terminal's interface unit.

With the keyboard switch at LOCAL, the Terminal is isolated from the computer; data entered at the keyboard is applied to the Terminal receiving circuits in a manner similar to that which occurs when the keyboard switch is at LINE and the interface unit is echoing data. LOCAL provides a dual advantage. It permits an evaluation of the data being transmitted by the keyboard, and at the same time tests the Terminal receiving circuits. For these reasons, LOCAL Operation is used for most of this procedure. Differences between LOCAL and LINE Operation are mentioned whenever they occur. *IT SHOULD BE KEPT IN MIND THAT THE KEYBOARD'S PRIMARY FUNCTION IS TO ACT AS A SOURCE FOR THE COMPUTER; THE RECEIVING CIRCUIT'S PRIMARY FUNCTION IS TO RESPOND TO DATA FROM THE COMPUTER: THE KKEYBOARD IS SIMPLY BEING USED AS A SOURCE OF DATA FOR THE RECEIVING CIRCUITS WHILE IN LOCAL OPERATION.*

Initialization

Press the PAGE key to erase the display screen. The screen must be erased each time the Terminal is turned on. PAGE also selects Alpha Mode and places the beam at the upper-left corner of the display (Alpha Mode "home" position). Each time the Terminal is erased, a new home position is selected to lengthen the usable life of the display screen.

Alpha Mode

ASCII Character Transmission and Character Effect. Check that the TTY LOCK key is not actuated. If it is, press the key once to release the lock. Press each key in the keyboard cluster and note the effect. Most of them will cause unshifted character writing, permitting a check of the code being transmitted by the keyboard and a check of the dot pattern being presented by the character generator in the receiving circuits. Keys that are an exception to this are aas follows:

PAGE/RESET—Causes no transmission. When pressed alone, it causes Alpha Mode to be selected, causes erasing and places the Alpha cursor to the top-left corner of the display (Alpha Mode "home" position). When pressed while the SHIFT key is held down, it initializes the Terminal without erasing it, selecting Alpha Mode "home" position, and resetting programmable circuits.

ESC—Transmits the control character ESC, which arms the Terminal circuits in anticipation of receiving one of certain subsequent characters. As an example, enter ESC and CTRL L, causing the control character FF to be transmitted. When FF is accepted by the receiving circuits after they have been armed by ESC, it causes the display to erase and the Alpha cursor to go home. FF alone cannot do it. (A complete listing of control character effects appears in Table 2-1.)

TAB—Transmits control character HT, which causes the cursor to move right one space.

CTRL—Has no effect as a single key entry. It causes the keyboard to transmit control characters when used with other keyboard keys. As an example, enter a G while the CTRL key is held down; it transmits the control character BEL, which causes the receiving circuits to ring the bell. As a second example, hold down CTRL and SHIFT and press M to transmit the control character GS. This switches the Terminal to Graph Mode, as evidenced by the absence of the Alpha cursor. Enter CTRL SHIFT O to transmit a US, which switches the Terminal back to Alpha Mode; the Alpha cursor will reappear.

SHIFT—Its only effect as a single key entry is to restore View condition, without otherwise affecting transmission or the receiving circuits. Wait until Hold status occurs. Then press SHIFT and note the effect. When SHIFT is used with the other keys, it causes the shifted character to be transmitted as indicated on each key. When used with CTRL and certain other character keys, it causes transmission of control characters as listed in Table 1-1, and defined in the CTRL key explanation.

BACK SPACE—Transmits control character BS, causing the cursor to move back one space. Enter a space command and then press BACK SPACE and note the effect.

LF—Transmits the control character LF. At the receiving circuits, LF causes the Alpha cursor to move down to the next line. The cursor may also move to the left margin if the "LF EFFECT" strap option on TC-1 is at LF → CR position. Enter an LF and observe the results.

RETURN—Transmits the control character CR. At the receiving circuits, it causes the Alpha Cursor to move to the left margin. There are two "left" margin positions. One is vertically aligned with the "home" position and is referred to as "Margin Ø". The second is near the horizontal center of the screen, and is referred to as "Margin 1". Margin 1 is automatically selected each time the Terminal line-feeds past the 35th (last) line while Margin Ø exists. Margin Ø is selected when the Terminal line-feeds past the 35th line while Margin 1 exists, and is also selected when ESC FF is received or when PAGE or SHIFT RESET is entered at the keyboard. CR also causes a line feed to occur if the CR EFFECT strap on TC-1 is in the CR → LF position.

RUBOUT—This key sends the ASCII code for DEL. The receiving circuits accept it, but it causes no spacing, writing, or other obvious effect.

BREAK—Sends a break signal to the interface unit, which may then transmit a break signal to the computer. Has no effect upon the receiving circuits.

Automatic Line Feed and Carriage Return. By now, it probably has been noticed that the Terminal receiving circuits automatically perform a carriage return and line feed each time the last (74th) character in a line is written. If it hasn't been noticed, hold down a writing character key until a full line of characters is written, and observe the effect. Note that the Alpha Cursor returns to the effective margin position—Margin Ø or Margin 1.

Margins. Enter a PAGE command and note the cursor position at the left edge (Margin Ø) of the display. Hold the LF key down until the cursor disappears past the bottom of the display screen, and note that it re-appears at the top-center of the display, in Margin 1 position. Hold the LF key down until the cursor moves past the bottom of the display; it will re-appear at the top in Margin Ø position. *THE EFFECTIVE MARGIN CONDITION CHANGES EACH TIME THE DISPLAY LINE-FEEDS PAST THE LAST (35th) LINE.*

Again arrive at the Margin 1 position and enter several SP characters at the Space bar. Then press the RETURN key to send a CR to the receiving circuits. Note that the cursor returns to the effective margin position, in this case Margin 1. Now enter enough characters to space past the end of the line. Note that the cursor returns to Margin 1. CR, RETURN, OR AUTOMATIC CARRIAGE RETURN SETS THE CURSOR BACK TO THE EFFECTIVE MARGIN POSITION.

Press the SHIFT RESET to set Margin Ø. Now enter characters until a line is fully written and an automatic line feed-carriage return occurs. Note that characterwriting ignores Margin 1 position or Margin 1 information while Margin Ø exists. *IF TWO-COLUMN FORMATTING IS TO OCCUR, MARGIN Ø INFORMATION MUST BE KEPT TO 36 CHARACTERS OR LESS.*

View/Hold. Wait about 90 seconds and note that the Terminal automatically enters a reduced intensity condition referred to as Hold. This condition prolongs tube life, and occurs in Alpha Mode only. *THEREFORE, THE TERMINAL SHOULD ALWAYS BE PLACED IN ALPHA MODE WHEN ENERGIZED, BUT NOT IN USE.* Additionally, stored displays should not be retained in Hold Mode for more than one hour; longer storage may damage the display screen.

TTY Character Transmission and Character Effects. The Terminal operation with TTY LOCK activated is essentially the same as for ASCII. The difference is that a truncated character set is available for transmission as illustrated in Fig. 1-5.

Place the TTY LOCK key in its active position. Now enter various letters and note that they write as upper case, regardless of the position of the SHIFT key.

Graph Mode

Press the SHIFT KEY and note the position of the Alpha Cursor. Then send GS (CTRL SHIFT M) to the receiving circuits and note that the Alpha cursor disappears. Send the address 383Y, 512X to place the beam near the center of the screen. The required bytes can be determined from Fig. 1-6 through 1-9. They equate to + DEL Ø @ in ASCII code. Enter + RUBOUT Ø @ at the keyboard. (RUBOUT transmits DEL.)

Unwritten Vector. No obvious results occur in response to the just entered characters, because they make up the first address to be received after a GS, and the beam is blanked while the movement occurs.

Written Vector. Enter @ again. It will execute a second vector, which will be written. This vector appears as a dot near the center of the screen, since no change in position was commanded. (The @ contains the code for a Low X byte, which causes vector execution.) Now send the address for 32Y, 32X. This equates to SP DEL SP _ and is entered at the keyboard as Space RUBOUT Space _ to draw the vector. Note that nothing happens until the Low X (last) command is entered, but then a vector is drawn from the center to the lower left corner.

Resetting With US. Now go back to Alpha Mode without otherwise disturbing the receiving circuits, by sending a US to the Terminal. Do it by entering a CTRL SHIFT O at the keyboard. Note that the Alpha cursor appears with its lower left corner at the end of the vector, since US causes no change in the Terminal position-register contents.

Graph Memory. Send ten SP commands to the Terminal by pressing the keyboard Space bar. Note that the cursor moves away from the end of the vector. Put the Terminal back in Graph Mode by sending it a GS (CTRL SHIFT M). Then send the same Low X command as was last used, by again entering _ at the keyboard. The beam will move unseen back to the end of the vector because of the Graph Mode memory circuits. This can be confirmed by entering a second _ at the keyboard, to again send the Low X command to the receiving circuits. Note that the same Low X command as contained in the last address must be used, or the beam position will differ by the amount of difference between the two Low X bytes.

Resetting With CR. Now switch from Graph Mode to Alpha Mode by sending a CR to the receiving circuits. This can be done by pressing the RETURN key or entering a CTRL M at the keyboard. This places the Alpha cursor at the left margin. If the CR EFFECT strap on TC-1 is at CR, the cursor is placed in line with the last graphic position of the beam; if the strap is at CR → LF, the cursor is placed one line below the last graphic position.

Resetting With ESC FF. Send a GS to the receiving circuits by entering a CTRL SHIFT M at the keyboard. Enter two _ commands to confirm that the Terminal is back in Graph Mode, and is at the end of the drawn vector. Then send an ESC FF sequence to the receiving circuits. Do this by entering ESC and then CTRL L. Note that this erases the display, selects Alpha Mode, and homes the Alpha cursor. This can also be done locally by pressing the PAGE key, regardless of the position of the LOCAL/LINE switch.

Resetting With RESET. Send another GS (CTRL SHIFT M) to the receiving circuits, enter _ to return to the last graphic address, and then draw a vector to 32Y, 1023X. This translates to SP DEL ? _ which can be sent by entering Space RUBOUT ? _ at the keyboard. Now press the SHIFT and RESET keys at the keyboard. Note that the Alpha Mode is restored, and the Alpha cursor appears at the top left corner of the screen. No erasing occurs. This particular operation can only be accomplished from the keyboard. No program command equivalent to SHIFT RESET can be sent.

Shortened Addresses. The sequence in Table 1-2 illustrates the ability of the receiving circuits to respond to various graphic commands of less than four bytes. The missing bytes remain sent in the last address which contained them. Table 2-5 specifies the minimum bytes that can be sent in any one situation.

View/Hold. The Hold feature is over-ridden while the Terminal is in Graphic Mode. *THE TERMINAL SHOULD ALWAYS BE RETURNED TO ALPHA MODE WHEN ENERGIZED, BUT NOT IN USE.* Stored displays should not be retained in view for more than 15 minutes; stored displays should not be retained in Hold Mode for more than one hour.

TABLE 1-2

Shortened Address Illustration

Address & Command	Send	
	ASCII	Keyboard
543Y, 543X. (Initial adress; send 4 bytes.)	Ø DEL Ø _	Ø RUBOUT
543Y, 512X. (Lo X changes; send only Lo X.)	@	@
541Y, 512X. (Lo Y changes; send Lo Y, Lo X.)	}@	}@
29Y, 512X. (Hi Y changes; send Hi Y, Lo X.)	SP @	Space @
29Y, 0X. (Hi X changes; send Lo Y, Hi X, Lo X.)	}SP @	}Space @
543Y, 0X. (Hi Y and Lo Y change; send Hi Y, Lo Y, Lo X.)	Ø DEL @	Ø RUBOUT @
31Y 543X. (Hi Y, Hi X, and Lo X change; send four bytes.)	SP DEL Ø _	Space RUBOUT Ø _

GIN Mode

Crosshair Cursor. Enter ESC and CTRL Z and note that a crosshair cursor appears. (If the horizontal thumbwheel is in either limit, the vertical line may be the only line to appear; with the vertical thumbwheel at the lower limit, the horizontal line may be the only line to appear. Move both thumbwheels out of their limits to present both lines.) Check that the cursor can be moved via the thumbwheels. Press any key except PAGE or SHIFT RESET and note that they have no effect. Press PAGE or SHIFT RESET and note that the crosshair cursor disappears and the Alpha cursor returns. *THE RECEIVING CIRCUITS*

ARE INSENSITIVE TO SIGNALS FROM THE KEYBOARD WHILE IN LOCAL WITH THE CROSSHAIR CURSOR DISPLAYED. IT SHOULD ALSO BE NOTED THAT THE CROSSHAIR CURSOR CANNOT BE CALLED INTO VIEW BY THE KEYBOARD WHILE ON LINE; IN NORMAL OPERATION, AN ESC SUB FROM THE COMPUTER COMMANDS IT TO APPEAR.

GIN Mode Transmissions. These cannot be demonstarted with the keyboard switch at LOCAL position. Refer to the Operating Modes information at the beginning of this section, or refer to Table 2-6 for details concerning "on-line" GIN Mode operation.

View/Hold. The Hold feature is disabled while the crosshair cursor is displayed. *THEREFORE, THE TERMINAL SHOULD ALWAYS BE RESET TO ALPHA MODE WHEN ENERGIZED, BUT NOT IN USE, TO PROLONG TUBE LIFE.*

Hard Copy Mode

Connect a Hard Copy Unit to the Terminal and energize it. Switch the Terminal's LOCAL/LINE control to LOCAL. Enter a number of alphanumeric characters at the keyboard to create a display.

Transmit an ESC ETB signal to the receiving circuits by entering ESC and CTRL W at the keyboard. (Pressing the Copy button on the keyboard, or pressing the Copy button on the Hard Copy Unit will achieve the same effects.) A scanning bar should appear and scan the display. A few seconds after scanning is completed, the Hard Copy Unit should eject a hard copy of the display. If the paper is blank, or if information dropout occurs, the HARD COPY BRIGHTNESS control on the front of the Terminal may be set too low. On the other hand, if the scanning bar causes storing on the display, the Hard Copy Intensity control may be set too high. Readjust the control while copy making is occurring, selecting a point just below that where the scanning bar stores. Then press PAGE, enter more characters on the display, and make another copy. If the adjustment is made properly, a clear copy of the display should result.

COORDINATE CONVERSION CHART

Low Order X		X or Y Coordinate								Low Order Y	
ASCII	DEC.									DEC.	ASCII
@	64	0	32	64	96	128	160	192	224	96	`
A	65	1	33	65	97	129	161	193	225	97	a
B	66	2	34	66	98	130	162	194	226	98	b
C	67	3	35	67	99	131	163	195	227	99	c
D	68	4	36	68	100	132	164	196	228	100	d
E	69	5	37	69	101	133	165	197	229	101	e
F	70	6	38	70	102	134	166	198	230	102	f
G	71	7	39	71	103	135	167	199	231	103	g
H	72	8	40	72	104	136	168	200	232	104	h
I	73	9	41	73	105	137	169	201	233	105	i
J	74	10	42	74	106	138	170	202	234	106	j
K	75	11	43	75	107	139	171	203	235	107	k
L	76	12	44	76	108	140	172	204	236	108	l
M	77	13	45	77	109	141	173	205	237	109	m
N	78	14	46	78	110	142	174	206	238	110	n
O	79	15	47	79	111	143	175	207	239	111	o
P	80	16	48	80	112	144	176	208	240	112	p
Q	81	17	49	81	113	145	177	209	241	113	q
R	82	18	50	82	114	146	178	210	242	114	r
S	83	19	51	83	115	147	179	211	243	115	s
T	84	20	52	84	116	148	180	212	244	116	t
U	85	21	53	85	117	149	181	213	245	117	u
V	86	22	54	86	118	150	182	214	246	118	v
W	87	23	55	87	119	151	183	215	247	119	w
X	88	24	56	88	120	152	184	216	248	120	x
Y	89	25	57	89	121	153	185	217	249	121	y
Z	90	26	58	90	122	154	186	218	250	122	z
[	91	27	59	91	123	155	187	219	251	123	{
\	92	28	60	92	124	156	188	220	252	124	|
]	93	29	61	93	125	157	189	221	253	125	}
^	94	30	62	94	126	158	190	220	254	126	~
_	95	31	63	95	127	159	191	223	255	127	RUBOUT (DEL)
DEC. →		32	33	34	35	36	37	38	39		
ASCII →		SP	!	"	#	$	%	&	'		
		High Order X & Y									

Fig. 1-6. Coordinate conversion chart, part 1 of 4. INSTRUCTIONS: Find coordinate value in body of chart; follow that column to bottom of chart to find decimal value of ASCII character which represents the High Y or High X byte, go to the right in the row containing the coordinate value to find the Low Y byte, or go to the left to find the Low X byte. EXAMPLE: 200Y, 48X equals 38 104 33 80 in decimal code and equals & h ! P in ASCII code.

COORDINATE CONVERSION CHART

(cont)

Low Order X		X or Y Coordinate								Low Order Y	
ASCII	DEC.									DEC.	ASCII
@	64	256	288	320	352	384	416	448	480	96	`
A	65	257	289	321	353	385	417	449	481	97	a
B	66	258	290	322	354	386	418	450	482	98	b
C	67	259	291	323	355	387	419	451	483	99	c
D	68	260	292	324	356	388	420	452	484	100	d
E	69	261	293	325	357	389	421	453	485	101	e
F	70	262	294	326	358	390	422	454	486	102	f
G	71	263	295	327	359	391	423	455	487	103	g
H	72	264	296	328	360	392	424	456	488	104	h
I	73	265	297	329	361	393	425	457	489	105	i
J	74	266	298	330	362	394	426	458	490	106	j
K	75	267	299	331	363	395	427	459	491	107	k
L	76	268	300	332	364	396	428	460	492	108	l
M	77	269	301	333	365	397	429	461	493	109	m
N	78	270	302	334	366	398	430	462	494	110	n
O	79	271	303	335	367	399	431	463	495	111	o
P	80	272	304	336	368	400	432	464	496	112	p
Q	81	273	305	337	369	401	433	465	497	113	q
R	82	274	306	338	370	402	434	466	498	114	r
S	83	275	307	339	371	403	435	467	499	115	s
T	84	276	308	340	372	404	436	468	500	116	t
U	85	277	309	341	373	405	437	469	501	117	u
V	86	278	310	342	374	406	438	470	502	118	v
W	87	279	311	343	375	407	439	471	503	119	w
X	88	280	312	344	376	408	440	472	504	120	x
Y	89	281	313	345	377	409	441	473	505	121	y
Z	90	282	314	346	378	410	442	474	506	122	z
[	91	283	315	347	379	411	443	475	507	123	{
\	92	284	316	348	380	412	444	476	508	124	|
]	93	285	317	349	381	413	445	477	509	125	}
^	94	286	318	350	382	414	446	478	510	126	~
_	95	287	319	351	383	415	447	479	511	127	RUBOUT (DEL)
DEC. →		40	41	42	43	44	45	46	47		
ASCII →		(	)	*	+	,	—	.	/		
		High Order X & Y									

Fig. 1-7. Coordinate conversion chart, part 2 of 4. (Refer to part 1 for interpretation instructions.)

COORDINATE CONVERSION CHART
(cont)

Low Order X		X or Y Coordinate								Low Order Y	
ASCII	DEC.									ASCII	DEC.
@	64	512	544	576	608	640	672	704	736	`	96
A	65	513	545	577	609	641	673	705	737	a	97
B	66	514	546	578	610	642	674	706	738	b	98
C	67	515	547	579	611	643	675	707	739	c	99
D	68	516	548	580	612	644	676	708	740	d	100
E	69	517	549	581	613	645	677	709	741	e	101
F	70	518	550	582	614	646	678	710	742	f	102
G	71	519	551	583	615	647	679	711	743	g	103
H	72	520	552	584	616	648	680	712	744	h	104
I	73	521	553	585	617	649	681	713	745	i	105
J	74	522	554	586	618	650	682	714	746	j	106
K	75	523	555	587	619	651	683	715	747	k	107
L	76	524	556	588	620	652	684	716	748	l	108
M	77	525	557	589	621	653	685	717	749	m	109
N	78	526	558	590	622	654	686	718	750	n	110
O	79	527	559	591	623	655	687	719	751	o	111
P	80	528	560	592	624	656	688	720	752	p	112
Q	81	529	561	593	625	657	689	721	753	q	113
R	82	530	562	594	626	658	690	722	754	r	114
S	83	531	563	595	627	659	691	723	755	s	115
T	84	532	564	596	628	660	692	724	756	t	116
U	85	533	565	597	629	661	693	725	757	u	117
V	86	534	566	598	630	662	694	726	758	v	118
W	87	535	567	599	631	663	695	727	759	w	119
X	88	536	568	600	632	664	696	728	760	x	120
Y	89	537	569	601	633	665	697	729	761	y	121
Z	90	538	570	602	634	666	698	730	762	z	122
[	91	539	571	603	635	667	699	731	763	{	123
\	92	540	572	604	636	668	700	732	764	|	124
]	93	541	573	605	637	669	701	733	765	}	125
^	94	542	574	606	638	670	702	734	766	~	126
_	95	543	755	607	639	671	703	735	767	RUBOUT (DEL)	127
DEC →		48	49	50	51	52	53	54	55		
ASCII →		0	1	2	3	4	5	6	7		
		High Order X & Y									

Fig. 1-8. Coordinate conversion chart, part 3 of 4. (Refer to part 1 for interpretation instructions.)

@

COORDINATE CONVERSION CHART
(cont)

Low Order X		X or Y Coordinate								Low Order Y	
ASCII	DEC.									DEC.	ASCII
@	64	768	800	832	864	896	928	960	992	96	`
A	65	769	801	833	865	897	929	961	993	97	a
B	66	770	802	834	866	898	930	962	994	98	b
C	67	771	803	835	867	899	931	963	995	99	c
D	68	772	804	836	868	900	932	964	996	100	d
E	69	773	805	837	869	901	933	965	997	101	e
F	70	774	806	838	870	902	934	966	998	102	f
G	71	775	807	839	871	903	935	967	999	103	g
H	72	776	808	840	872	904	936	968	1000	104	h
I	73	777	809	841	873	905	937	969	1001	105	i
J	74	778	810	842	874	906	938	970	1002	106	j
K	75	779	811	843	875	907	939	971	1003	107	k
L	76	780	812	844	876	908	940	972	1004	108	l
M	77	781	813	845	877	909	941	973	1005	109	m
N	78	782	814	846	878	910	942	974	1006	110	n
O	79	783	815	847	879	911	943	975	1007	111	o
P	80	784	816	848	880	912	944	976	1008	112	p
Q	81	785	817	849	881	913	945	977	1009	113	q
R	82	786	818	850	882	914	946	978	1010	114	r
S	83	787	819	851	883	915	947	979	1011	115	s
T	84	788	820	852	884	916	948	980	1012	116	t
U	85	789	821	853	885	917	949	981	1013	117	u
V	86	790	822	854	886	918	950	982	1014	118	v
W	87	791	823	855	887	919	951	983	1015	119	w
X	88	792	824	856	888	920	952	984	1016	120	x
Y	89	793	825	857	889	921	953	985	1017	121	y
Z	90	794	826	858	890	922	954	986	1018	122	z
[	91	795	827	859	891	923	955	987	1019	123	{
\	92	796	828	860	892	924	956	988	1020	124	|
]	93	797	829	861	893	825	957	989	1021	125	}
^	94	798	830	862	894	926	958	990	1022	126	~
_	95	799	831	863	895	927	959	991	1023	127	RUBOUT (DEL)
DEC →		56	57	58	59	60	61	62	63		
ASCII →		8	9	:	;	<	=	>	?		
		High Order X & Y									

Fig. 1-9. Coordinate conversion chart, part 4 of 4. (Refer to part 1 for interpretation instructions.)

Section 2

CHARACTERISTICS

Introduction

The charactertics are in two parts. The first part consists of an alphabetic listing. The alphabetic listing makes reference to the second part, which contains tabulated information.

The following conditions must be met before all characteristics can be considered valid:

The Terminal must have been adjusted at an ambient temperature between +20° C and +30° C. An exception to this exists when a Terminal is always operated at an extreme temperature within its −15 to +55° C range; the Terminal should then be adjusted at that temperature; it cannot then be expected to meet specifications at temperatures greatly different from that at which it was adjusted, even if they are within the specified −15 to +55° C range.

It must be operating in an environment as specified under Environmental Specification.

Operation must be preceded by a warmup period of at least 20 minutes.

Specified power requirements must be met.

The specifications pertain principally to On Line operation as selected at the keyboard rocker switch, and should not be presumed applicable to Local operation. Refer to the Local Operation specification for qualifying information.

The characteristics included in the alphabetic listing are as follows:

The following tables are included immediately after the alphabetic listing of characteristics:

Alphabetic Listing

Accessories. See Table 2-14.

Address. A display position with reference to a grid of 1024 x 1024 points with 0, 0 being at the bottom left. Point density is about 130 points per inch horizontal or vertical with Terminal adjusted as outlined in the adjustment procedure.

Alpha Mode. A Terminal writing mode in which characters are written on the display screen. See Character Effect on Terminal and Table 2-2 for details.

Arming. Certain functions at the Terminal require a control sequence whose first character "arms" the Terminal, permitting the next character to perform a function other than what it would do if the Terminal were not armed. ESC is normally used as the arming command. The execution commands are listed under "Character Effect on Terminal". In addition, accessory devices may use other execution commands as explained in the accessory device instruction manual. ESC does not cause the Terminal to go busy.

Carriage Return. Return of writing beam to the left or center margin (depending on effective margin position). Occurs on receipt of CR or ESC FF. Also occurs on receipt of LF if strapped on TC-1. Occurs automatically when beam spaces past 1023 address in Alpha Mode. Also caused by initializing or pressing PAGE key or SHIFT RESET keys. The CR character also causes a line feed to occur if the CR EFFECT option on TC-1 is in the CR → LF position.

Character Effect On Terminal. The Terminal recognizes all characters contained in the ASCII code. During Alpha Mode, all alphanumeric and graphic characters except space and delete result in character writing and subsequent spacing. Space does not write but causes spacing; delete causes neither writing nor spacing. Control characters and control character sequences are decoded and perform specific functions as shown in Table 2-1. Additional use of control characters or control character sequences may be made by accessory devices connected through circuit cards to the Terminal minibus. Control characters or control character sequences are recognized during Graph or GIN Mode; all other data received in Graph Mode is accepted as a vector address as explained in Graph Mode.

Character Matrix. A seven-by-nine dot pattern which creates characters by writing specific combinations of the dots. Dot position is determined by modifying the X or Y position of the deflection beam. The matrix stops long enough in each position to turn the beam on to store a dot during character writing, or to display a non-storing dot during Alpha Mode cursor writing. The bottom-left dot in the matrix is determined by the X and Y register contents (address). However, the X and Y deviation from this point is independent of the register address. The matrix is shifted down to write g, j, p, q, and y.

Character Size. Limits determined by character matrix, which is approximately .087 inch wide by 0.106 inch high.

Character Transmission in Alpha Mode. Depending upon the operation selected, the code for ASCII or TTY characters can be transmitted from the keyboard in response to a key, in response to a SHIFT and key combination, or in response to a CTRL SHIFT and key combination. RUBOUT sends the code for DEL. Bit 8 is sent as strapped at the keyboard (normally high), or as determined by the data communication interface in use. The minibus can accept any eight-bit combination from accessory units and transmit them to the computer.

Character Transmission in GIN Mode. A sequence of characters is transmitted to the computer in response to a control character sequence from the computer. See GIN Mode for details.

Character Writing. The Terminal has writing capability for all ASCII written characters. Since TTY is a subset of ASCII, TTY writing capability is included. Character writing time is approximately 1.0 ms.

Character Writing Suppression. The character generator is suppressed in GIN and Graph modes. The Alpha cursor, as well as alphanumeric characters, are prevented from being written. The character generator becomes fully enabled when the Terminal is switched from Graph to Alpha Mode. It also becomes fully enabled when GIN Mode is ended by an ESC FF or CR command from the computer, or by a PAGE or SHIFT RESET command from the keyboard. However, when GIN Mode is ended by transmitting the address of the Alpha cursor or the crosshair intersect address, the character generator will not become fully enabled unless the CR is sent as a part of the address transmission. *AND IS ECHOED BACK* by the computer. If CR is not echoed back, the Terminal will be unable to write in Alpha Mode (even though the Alpha cursor appears) until one of the following is received by the Terminal: BEL, BS, CR, ESC ETB, ESC FF, HT, LF, US, VT from the computer, or PAGE, SHIFT RESET or LOCAL from the keyboard, or until a hard copy is made.

Characters, Lower Case. Lower case characters are accepted and written during Alpha Mode. Lower case letters cannot be transmitted from the keyboard while the TTY LOCK key is depressed.

Clock. The Terminal operates on an internal 4.9 MHz clock. This and a 614 kHz derivation are available on the minibus.

Control Character. See Character Effect on Terminal.

Control Character Sequence. See Character Effect on Terminal.

Cursor, Alpha. Flickering, non-storing seven-by-nine dot matrix which indicates position of writing beam. Occurs in Alpha Mode, during View condition. Position of lower-left corner of matrix is sent to computer in response to receipt of an ESC ENQ command sequence.

Cursor, Crosshair. GIN Mode non-storing cursor occurring in response to an ESC SUB command sequence. Cursor is caused by cycling of the X and Y registers through each point, pausing at each point long enough to write the point with an intensity insufficient for storing it. The intersect point can be moved to any point within 4-1023 X and 0-779 Y by using the keyboard X and Y thumbwheels. The address of the intersect point is sent to the computer in response to an ESC ENQ from the computer or in response to entering a keyboard character. See GIN Mode for explanation of transmission.

Data Transfer Rate. Interface dependent; limited to approximately 10,000 words per minute (average of six characters per word).

Display Measurement Unit. Point. Equivalent to one increment of X or Y position register. Approximately 130 points per inch and .0076 inch between centers of horizontally or vertically adjacent points. 1024 X points addressable and viewable; 1024 Y points addressable, 780 Y points viewable. (Terminal adjusted as outlined in adjustment procedure.)

Display Size. Approximately 7.9 inches horizontal by 6 inches vertical with its center within 0.25 inch of CRT faceplate center.

Display Unit Specifications. Refer to Table 2-9.

Echoplex. Consists of executing data at the Terminal as the data is being sent to the computer. Can be caused by placing an $\overline{\text{ECHO}}$ command on the minibus, usually from the interface unit.

Echoplex Suppression. Over-rides the $\overline{\text{ECHO}}$ signal from the interface unit, inhibiting echoplex operation. Occurs automatically when the Terminal is in GIN Mode, permitting the coded position data to be sent to the computer without being written by the Terminal, despite condition of the $\overline{\text{ECHO}}$ signal. See Table 2-6 for additional details.

Environmental Specifications. See Table 2-12.

Fast Graph. An optional feature which provides faster vector writing, write through and non-store. Refer to Fast Graph documentation for details.

GIN Mode. An interactive graphic mode which permits the Terminal to send one of the following to the computer: Terminal status and the position of the bottom-left corner of the Alpha cursor; or the Terminal status and the Graph Mode beam position; or the position of the GIN Mode crosshair intersect point. The crosshair intersect point is controlled by the thumbwheels at the right on the keyboard. Note that moving the horizontal thumbwheel to either limit may remove the vertical line from the display and disable the vertical thumbwheel. Similarly, moving the vertical thumbwheel to the lower limit may remove the horizontal line from the display and disable the horizontal thumbwheel. The Terminal status and Alpha cursor position is sent if ESC ENQ is received while the Alpha cursor is being displayed. Terminal status and Graph Mode beam position are sent if ESC ENQ is received while in Graph Mode. Receipt of ESC SUB causes the crosshair cursor to be displayed. Its intersect point is then sent in response to ESC ENQ from the computer, or in response to the operator entering a keyboard character.

A delay of at least 20 ms must occur between ESC SUB and ESC ENQ. The 20 ms delay can be ignored under several circumstances, as follows: (1) Whenever the Inquire option on TC-1 is set at DELAY. (2) Whenever operating slower than 1000 baud; (3) Whenever only the Y address is required (X will always be sent, but may not be valid if the 20 ms delay is not used); (4) If the Terminal is addressed to 0Y before sending the Terminal an ESC SUB. Addressing can be done by sending GS 40_8 140_8 and any Low X byte. (Actually, any Y value less than the crosshair intersect point can be used. Therefore, low Y byte 140_8 can be omitted unless the crosshair intersect point is located lower than the 16Y coordinate.) It should be noted that if the third option is used, the Terminal graphic memory circuit is loaded with the address. This can be used to advantage in repetitive requests for the crosshair position; once loaded with a 0Y address, the Terminal need only be given a GS and a Low X byte to move the beam to 0Y. See Table 2-6 for GIN Mode details.

Graph Mode. A graphic display mode which occurs upon receipt of GS. It permits the Terminal to accept data as addresses. Movement to the address can either be dark or can result in drawing a vector. See Tables 2-3, 2-4, and 2-5.

Graphic Address. A combination of X and Y register values which indicates a position on the display (X 0-1023, Y 0-779) or off the display (Y 780-1023). Address of bottom-left corner of display is 0X, 0Y; address of top-right corner of display is 1023X, 779Y. See Tables 2-4 and 2-5 for information about sending an address to the Terminal.

Graph Mode Memory. The ability of the Terminal to remember the first three bytes of the last graphic address when switched out of Graph Mode. The Terminal requires receipt of only the low X byte to return to its last Graph Mode address when switched back to Graph Mode.

Graph Mode Vector Drawing. See Table 2-4.

Hard Copy Mode. Permits copying of the Terminal Display by a Hard Copy Unit. Mode is caused by READ from a Hard Copy Unit. $\overline{\text{TBUSY}}$ holds the Terminal busy during Hard Copy Mode. See Table 2-8. If ESC ENQ is received during copying, the Terminal will send its status to the computer immediately after copying ends.

Hold Status. A reduced intensity condition for the display unit. It occurs if the Terminal is inactive for approximately 90 seconds. The Terminal returns to View status as soon as data is received or a keyboard character is entered. Stored data may be retained in Hold status for up to one hour without damage to the screen.

Home Position. Top left corner of display unit in Alpha Mode, commanded by 0X, 767Y. Beam moves to that position upon initialization, and upon receiving ESC FF. It is also arrived at by entering PAGE or SHIFT RESET at the keyboard. The home position changes slightly each time the display is erased. This is caused by an origin shifter circuit within the Terminal, and it lengthens the usable life of the display screen.

Interface Specification. See documentation pertaining to specific interface unit.

Line, Alpha Mode. Consists of 74 character spaces; lines are 22 points apart (approximately 0.17 inch) between identical reference points. 35 lines comprise the total display.

Line Feed. Moves writing beam down 22 points. This equals one line in Alpha Mode. Occurs upon receipt of LF. Occurs automatically when spacing past the end of a line. May also occur upon receipt of CR if the CR EFFECT option is at CR → LF.

Line Length, Graphic. Maximum line lengths within the quality display area are approximately 7.8 inches horizontal, 5.9 inches vertical, 9.8 inches diagonal. (Values given are within the display quality area with the Terminal adjusted as outlined in the adjustment procedure.)

Local Operation. Off-line operation used principally for operator training, formatting of data, and equipment maintenance. It is selected by the LOCAL/LINE switch at the keyboard, and isolates the Terminal from the computer. See Table 2-7 for details.

Margin, Horizontal. Margin Ø is located at ØX; Margin 1 is located at 512X. Margins alternate automatically when line-feeding past the 35th line. Carriage return resets the beam to selected margin. ESC FF resets the Terminal to Margin Ø. Terminal also resets to Margin Ø in response to PAGE key or SHIFT RESET key combination.

Minibus. Signals available at each of the board-edge connectors on the motherboard. See Dictionary of Line Titles in the Circuits section for details.

Modes. Alpha (Alphanumeric), Graph (Graphic Display), GIN (Graphic Input), Hard Copy. See Specific mode descriptions for details.

Options, Strappable. See Table 2-13 for strappable options for the basic Terminal; see interface unit documentation for strap option information pertaining to interface units.

Origin Shifting. Slight repositioning of the display writing area, occurring each time the display is erased; extends the life of the display screen.

Pagefull. A condition occurring in Alpha Mode when line-feeding past the 35th line. It causes Margin 1 to occur (center of screen) if Margin Ø has been set, and vice-versa. Margin 1 can cause a Terminal busy signal, if selected by option on TC-2.

Physical Characteristics. See Table 2-11.

Point (Tekpoint). The basic unit of measurements for Graph and GIN Modes. 1024X (0-1023) and 1024Y (0-1023) points addressable; 1024X and 780Y (0-779) viewable. Point spacing is approximately .0076 inch. (Approximately 130 points per inch.) (Terminal adjusted as outlined in the adjustment procedure.)

Power Supply Specifications. See Table 2-10.

Receive Rate. Capable of ⩾10,000 words per minute (average of six characters per word). Interface dependent.

Remote Displays. A multiplexer option permits control of remote displays via the Terminal. Separate documentation is provided with the option and should be referred to for details.

Resetting GIN to Alpha Mode. GIN Mode is cancelled and Alpha Mode reset upon receipt of CR or ESC FF from the computer. Resetting with CR may leave the Terminal in Margin 1 status. It would be better to permit transmission of address and ignore it at the computer to ensure that the Terminal returns to Margin Ø status. Resets to Alpha (without transmitting to computer) in response to entering PAGE or SHIFT RESET at the keyboard. Terminal also resets to Alpha Mode after completing GIN transmitting function. Refer to Table 2-6 for details.

Resetting Graph to Alpha Mode. Graph Mode is cancelled and Alpha Mode set in response to US, CR, or ESC FF from the computer. It can also be reset by entering PAGE or SHIFT RESET at the keyboard.

Resetting Home Position. The Terminal display resets to home position (top-left of display) in response to ESC FF from the computer. It also resets to home position in response to line-feeding past line 35 if Margin 1 exists and TC-1 option is set so that line feed causes carriage return. Home position also occurs when PAGE or SHIFT RESET is entered at the keyboard.

Resetting Margin 1 to Margin Ø. Margin 1 (horizontal center of display) resets to Margin Ø (left edge of display) in response to ESC FF from the computer, or in response to an LF (line feed) past the 35th line. Margin Ø also occurs in response to PAGE or SHIFT RESET entered at the keyboard.

Space. An Alpha Mode measurement made from a reference point in a character to the same reference point in a horizontally adjacent character. A space is equal to 14 Tekpoints, which equates to approximately 0.11 inch. There are 74 spaces per line.

Status Bits. Bits transmitted in GIN Mode to denote the status of the Terminal. They are transmitted as part of a response to an ESC ENQ received while in Alpha or Graph Mode, and consist of the following:

Bit 8 = 1, Bit 7 = Ø, Bit 6 = 1.

Bit 5 = Hard Copy Unit status; Ø is intended to mean that the Hard Copy Unit is in working order, ready to accept a hard copy request.

Bit 4 = Vector status indicator. A 1 indicates that the Terminal is set up to draw vectors.

Bit 3 = Graphic Mode indicator. A Ø indicates that a graphic mode exists. 1 indicates Alpha Mode.

Bit 2 = Margin indicator. 1 indicates that Margin 1 exists. Ø indicates Margin Ø. If the Margin bit is 1 (true), it indicates that the Alpha cursor is on the right half of the screen. In the latter case, if the transmitted X address is less than 512, it must be increased by 512 to indicate its position with respect to the left edge of the screen. Effectively, if the Margin bit is 1 (true), the most significant X bit (512 bit) must be considered to be true regardless of what value was transmitted by the Terminal.

Bit 1 = Auxiliary device indicator. Ø indicates that some optional auxiliary unit is activated.

Strappable options. Optional operating features which can be selected by connectors within the Terminal. See Table 2-13.

Tekpoint. A unit of measurement associated with Tektronix Terminals. It consists of the distance between two adjacent points in the 1024 x 1024 grid provided by the X and Y registers. See Point. One Tekpoint equals approximately .0076 inch on the display.

Thumbwheels. Potentiometers located on the keyboard; used to position the crosshair cursor.

Time, Character Writing. Approximately 1.0 ms.

Time, Vector Drawing. Time required to draw a completer vector in a standard Terminal is approximately 2.6 ms. If the Fast Graph option is installed, drawing time is about 2 ms maximum, and decreases with vector length. Refer to Fast Graph Instruction manual for details. The Terminal is held busy during drawing time, only.

Transmission, Alpha Mode. Data is transmitted as entered at the keyboard, or as placed on the minibus by other devices.

Transmission, GIN Mode. Data is transmitted as a series of bytes in response to an EXC ENQ from the computer, or in response to a keyboard character entered while the crosshair cursor is displayed. Refer to Table 2-6 for details.

Transmission Rate. Interface dependent. See documentation pertaining to the specific interface unit. Also see Data Transfer Rate.

Vector Drawing Time. See Time, Vector Drawing.

Vector Dynamic Geometry Error. Deviation (due to vector generator circuitry) from mean straight line does not exceed 1.5% of line length in worst case (45° line).

Vector Length Error. Does not exceed 1% of actual vector length.

View Status. Normal intensity display. Occurs at all times except during copy making (Hard Copy Mode) and Hold status. Alpha Mode View status occurs upon keyboard entry or upon receipt of data, and remains for 60 to 120 seconds. It can be regained without affecting the display or causing transmission by pressing the SHIFT key. The Terminal remains in View status whenever in Graph or GIN Modes. The Terminal can remain in View status with a stored display for 15 minutes without permanent damage to the display screen.

TABLE 2-1

Control Character Effect on Terminal

Control Character	Keyboard Command	Effects
BEL	CONTROL G	A burst of 1200 hertz tone on the speaker. Makes Terminal go busy for approximately 50 ms.
BS	BACKSPACE or CTRL H	Backspace one space. Backspacing to the left of the margin will cause wraparound.

TABLE 2-1 (cont)

Control Character	Keyboard Command	Effects
CR	RETURN or CTRL M	Causes carriage return by clearing X register. Also causes line feed if the CR EFFECT option on TC-1 is at CR → LF. Clears GIN and Graph. (If the crosshair is cleared with CR, the resulting status of Y and Margin perform the Page Full function. With interfaces directly connected to the CPU, it is better to clear the cursor by sending ESC ENQ or ESC FF.)
ESC	ESC or CTRL SHIFT K	First character of a special multiple-character sequence. ESC activates LCE ($\overline{\text{B}}$ on the Minibus) which remains high until after the trailing edge of the next byte or activation of $\overline{\text{HOME}}$. Does not cause a response on $\overline{\text{TBUSY}}$.
ESC ENQ	ESC CTRL E	Causes Terminal status and/or Alpha cursor or Graph beam or crosshair cursor position to be sent to CPU. Useful for remote diagnostics, in addition to graphic uses. Local copy is not generated. See explanation under GIN Mode. Activates echoplex suppression. If the $\overline{\text{CSTROBE}}$(s) generated does not cause a $\overline{\text{CBUSY}}$ response, the Terminal will remain in GIN Mode. This occurs if ESC ENQ is entered while in LOCAL; can be cleared by PAGE or SHIFT RESET entry. Does not cause a response on $\overline{\text{TBUSY}}$.
ESC ETB	ESC CTRL W	$\overline{\text{MAKE COPY}}$ is asserted.
ESC FF	ESC CTRL L	Same as PAGE signal from keyboard. Erases screen. Resets X to 0. Resets Y to 767. Resets GIN, Echoplex Suppression, Margin, and Graph.
ESC SUB	ESC CTRL Z	Clears Graph. Starts crosshair cursor (which sets GIN). Activates Echoplex Suppression. (See explanation under ESC ENQ.) Does not cause a response on $\overline{\text{TBUSY}}$.
GS	CTRL SHIFT M	Sets Terminal to Graph Mode; sets for dark vector. Does not cause a response on $\overline{\text{TBUSY}}$.
HT	TAB or CTRL I	Spaces one space to right.

TABLE 2-1 (cont)

Control Character	Keyboard Command	Effects
LF	LF or CTRL J	Y moves down one line (counts down by 22). If Y counts through 0, margin switches between 0 and 1, and Y counts down to 767. Strap on TC-1 can be set so that LF also causes carriage return.
US	CTRL SHIFT O	Clears Terminal from Graphic Display Mode.
VT	CTRL K	Inverse line feed. Y counts up by 22. If Y exceeds 767 in Alpha Mode, Y will count back down to 767.

TABLE 2-2

Alpha Mode Specification

Writing Area	Approximately 7.9 horizontal by 6 inches vertical.
Character Writing Position	Indicated by pulsating cursor (7 x 9 dot matrix), approximately .087 inch wide by 0.106 inch high (11 x 14 points).
Character Recognition	Complete ASCII code is recognized.
Character Writing	All ASCII writing characters are written upon receipt.
Character Size	Size of largest character is approximately .087 x 0.106 inch (11 x 14 points) written within limits of 7 x 9 dot matrix.
Character Writing Time	Approximately 1.0 ms, providing at least 1000 characters per second.
Characters Per Line	74
Space	14 Tekpoints (equal to approximately 0.11 inch) between corresponding points in adjacent characters.
Number of Lines	35 lines.
Line Feed Spacing	22 Tekpoints (approximately 0.17 inch) between corresponding points on adjacent lines.

TABLE 2-2 (cont)

Carriage Return/Line Feed	Automatically occurs after character is written at end of line (74th character). Strap option can be set to cause carriage return to occur in response to programmed line feed.
Margin	Margin Ø (left edge) and Margin 1 (horizontal center) alternately occur when line-feeding past the bottom (35th) line.
Rubout	Does not print or space.
Home	Top-left corner of display (0X, 767Y). Position shifts slightly after each erasure.
Pagefull	Occurs when line-feeding past 35th line with Margin Ø set.
Alpha Mode set by	Initialization; PAGE or SHIFT RESET at keyboard; receipt of ESC FF or CR.
Writing Rate	⩾10,000 words per minute (average of 6 characters per word).
Cursor	Non-storing, pulsating 7 x 9 dot matrix.
Hold	Reduced intensity status which occurs in Alpha Mode only; occurs after approximately 90 seconds of inactivity. Stored display can be retained for up to one hour in Hold status without damage to the display screen.
View	Normal viewing status. Stored data can be displayed in View status for up to 15 minutes without damage to display screen.
Character Type	
Transmitting	Full ASCII code can be transmitted. TTY LOCK limits transmission to TTY code.
Receiving	Full ASCII code can be written, regardless of position of TTY LOCK key.
Origin Shifter	Relocates origin and display area each time the display is erased. Relocation cycles through a diagonal path which is approximately 0.128 inch in the X axis and .0921 inch in the Y axis.

TABLE 2-3

Graph Mode Specification

Mode Function	Display graphic information.
Mode Commanded By	GS.
Mode Ended By	US, CR, ESC FF, ESC SUB, or keyboard entry of PAGE or SHIFT RESET.
Basic Unit of Measurement	Point (Tekpoint).
Address Capability	1024X by 1024Y points.
Display Capability	1024X by 780Y points.
Display Address Orientation	0, 0 at bottom-left of display; 1023X, 779Y at top-right.
Display Area	Approximately 7.8 inches horizontal by 5.9 inches vertical.
Vector Length Error	Does not exceed 1% of actual vector length.
Vector Writing Time	2.6 ms in standard Terminal. Fast Graph Option provides shorter time for vector drawing, proportional to vector length.
Vector Dynamic Geometry Error	Deviation from prescribed path does not exceed 1.5% of total line length. This is exclusive of the 0.5% Line Straightness specification of the display circuits.
Display Scale Factor	Approximately .0076 inch, point center to point center (approximately 130 points per inch).
Dark Vectors	First vector to follow GS is unwritten. GS can be repeated at any time. Second vector following GS, and all subsequent vectors, are written.
Viewing Time	Indefinite; Hold status is inhibited. (Terminal should be returned to Alpha Mode when not in use. Stored display can be displayed in View status for up to 15 minutes without damage to the display screen.)
Vector Drawing Commands	See Tables 2-4 and 2-5.
Margin	Margin 1 is disabled.
Graph Mode Memory	First three bytes of last Graph Mode address are remembered when the Terminal is switched out of Graph Mode. Terminal requires only the Low X byte to return to its last graphic address when switched back to Graph Mode.

TABLE 2-4

Graph Mode Vector Drawing

(1)	GS Places the Terminal in Graph (Vector) Mode.
(2)	The Terminal can be addressed to any position within 0-1023X and 0-1023Y as follows:
	(A) Convert Y coordinate to ten binary digits; convert X coordinate to ten binary digits.
	(B) Form a Hi Y byte by affixing 01 (as bits 7 and 6) to the 5 MSB of the ten digits of the Y coordinate.
	(C) Form a Lo Y byte by affixing 11 (as bits 7 and 6) to the 5 LSB of the ten digits of the Y coordinate.
	(D) Form a Hi X byte by affixing 01 (as bits 7 and 6) to the 5 MSB of the ten digits of the X coordinate.
	(E) Form a Lo X byte by affixing 10 (as bits 7 and 6) to the 5 LSB of the ten digits of the X coordinate.
	(F) Send the four bytes as formed in (B) through (E).
(3)	The Lo X byte causes the beam to move to the new position. The first movement after a GS is unwritten (dark vector). Subsequent movement in response to a Lo X byte is written to form a vector. GS can be sent at any time to cause the next vector to be dark. (780Y-1023Y is outside the viewing area of the horizontally oriented display.)
(4)	Address transmission can consist of all four bytes or can be shortened to 3, 2, or 1 byte(s). Omitted bytes are assumed to be correct as held in the Terminal. Table 2-5 specifies the minimum byte transmission that is required under all addressing situations.
(5)	Hi Y, Lo Y, and Hi X bytes of the last address received are "remembered" by the Terminal if switched to Alpha or GIN Mode. The Terminal requires receipt of only the Low X command to return to its last address after being switched back to Graph Mode.
(6)	Hold status is inhibited during Graph Mode. A stored display should not be retained in Graph Mode for more than 15 minutes.
(7)	Graph Mode is ended by US, CR or ESC FF, which reset the Terminal to Alpha Mode. Graph Mode can also be ended by ESC SUB, which switches the Terminal to GIN Mode. PAGE and SHIFT RESET from the keyboard also end Graph Mode, resetting Alpha Mode.
(8)	$\overline{\text{TBUSY}}$ does not occur in response to Hi Y, Lo Y, Hi X.

TABLE 2-5

Bytes Required for Graphic Addressing

Bytes Which Change				Byte Transmission Required			
Hi Y	**Lo Y**	**Hi X**	**Lo X**	**Hi Y**	**Lo Y**	**Hi X**	**Lo X**
			#				#
		#			#	#	#
	#				#		#
#				#			#
		#	#		#	#	#
	#		#		#		#
#			#	#			#
	#	#			#	#	#
#		#		#	#	#	#
#	#			#	#		#
	#	#	#		#	#	#
#		#	#	#	#	#	#
#	#		#	#	#		#
#	#	#		#	#	#	#
#	#	#	#	#	#	#	#
Sending initial address				#	#	#	#
Returning to remembered address							#

TABLE 2-6

GIN Mode Specification

Functions	
Transmit Terminal Status and Alpha Cursor Position	With Alpha cursor displayed, the Terminal status, address of bottom-left corner of Alpha cursor, CR[1] and EOT[1] are transmitted to the computer in response to ESC ENQ from the computer. The Terminal automatically resets to full Alpha Mode upon completion of sending the following bytes if CR is echoed by the computer. Otherwise, the Terminal must be reset as explained under Echoplex Suppression. Note that if CR is echoed, it resets the cursor to the effective margin position.

Byte	Item	Bit 7	Bit 6	Bits 5—1
1	Terminal Status	0	1	Status Bits
2[2]	High bits of X address	0	1	5 MSB X
3	Low bits of X address	0	1	5 LSB X
4	High bits of Y address	0	1	5 MSB Y
5	Low bits of Y address	0	1	5 LSB Y
6	CR[1]	0	0	01101
7	EOT[1]	0	0	00100

[1]CR and EOT are optional, being dependent on straps on TC-2; EOT, or CR and EOT may be omitted. EOT cannot be sent withour sending CR.
[2]If the Margin bit of the Terminal Status Byte is 1 (true), the most significant X bit (512 bit) must be considered to be true, regardless of the value transmitted to the computer.

TABLE 2-6 (cont)

Transmit Terminal Status and Graph Mode Beam Position	If ESC ENQ is received while in Graph Mode, bytes 1 through 7 will be sent as explained above. Echoing of the bytes by the computer is not recommended because echoing of bytes 1 through 5 will affect the content of the Y memory latch, and echoing of CR will reset the Terminal to Alpha Mode.
Display Crosshair Cursor	ESC SUB from the computer turns the crosshair cursor on. (ESC SUB should not be entered at the keyboard.) This is a preparatory state for transmitting the address of the crosshair intersect point. The Terminal can be reset to Alpha Mode by ESC FF without causing it to transmit the crosshair intersect address. The Terminal can also be reset to Alpha Mode by a PAGE or SHIFT RESET command entered at the keyboard, without transmitting the crosshair intersect address.
Transmit Crosshair Intersect Address	
In Response to ESC ENQ	With crosshair cursor displayed, ESC ENQ from the computer causes transmission of bytes 2 through 7 as previously listed. The Terminal automatically returns to full Alpha Mode upon completion of transmission if CR is echoed by the computer. Otherwise, the Terminal must be reset as explained under Echoplex Suppression. A 20 ms delay must exist between ESC SUB and ESC ENQ. The 20 ms delay can be ignored under several circumstances, as follows: (1) Whenever the Inquire option on TC-1 is set at DELAY. (2) Whenever operating slower than 100 baud; (3) Whenever only the Y address is required. (X will always be sent, but may not be valid if the 20 ms delay is not used); and (4) If the Terminal is addressed to 0Y before sending the Terminal an ESC SUB.
In Response to Keyboard Character Entry	With crosshair cursor displayed, a keyboard character entry causes the Terminal to transmit the keyboard character, and then to tranmsit bytes 2 through 7 as previously listed. The Terminal automatically returns to full Alpha Mode upon completion of transmission if CR is echoed by the computer. Otherwise, the Terminal must be reset as explained under Echoplex Suppression.
Address	
Basic Unit of Measurement	Point (Tekpoint).

TABLE 2-6 (cont)

Address (cont)	
Alpha Cursor	
Limits	0 to 1023X, 0 to 767Y, inclusive.
Transmission Accuracy	Actual address of lower left corner is transmitted. However, if Margin 1 exists (as indicated by bit 2 of the status byte being true) the most significant X bit (512X) must be considered to be true, regardless of how it was transmitted by the Terminal.
Crosshair Cursor	
Limits	4 to 1023X, 0 to 779Y, inclusive.
Controlled By	Horizontal and vertical thumbwheels at right on keyboard panel.
Transmission Accuracy	Within ±1 point of actual position of crosshair cursor intersect point.
Status Bits	Bit 8 = 1, Bit 7 = Ø, Bit 6 = 1.
	Bit 5 = Hard Copy Unit status; Ø is intended to mean that it is in working order, ready to accept a hard copy request.
	Bit 4 = Vector status indicator; 1 indicates that the Terminal is set to draw vectors.
	Bit 3 = Graph Mode indicator; Ø indicates that a graphic mode exists; 1 indicates Alpha Mode.
	Bit 2 = Margin indicator; 1 indicates that Margin 1 exists; Ø indicates Margin Ø. See note 2.
	Bit 1 = Auxiliary device indicator; Ø indicates that some optional auxiliary device is activated.
Echoplex Suppression	Over-rides local echoing and disables character generator during GIN Mode. The receiving circuits automatically become enabled upon completion of transmission if CR is echoed by the computer. If CR is not echoed, the Terminal must be reset by BEL, BS, CR, ESC ETB, ESC FF, HT, LF, US, or VT from the computer, or by entering PAGE, RESET, LOCAL, or COPY at the keyboard. Resetting is not required in Graph Mode.

[2]If the Margin bit of the Terminal Status Byte is 1 (true), the most significant X bit (512 bit) must be considered to be true, regardless of the value transmitted to the computer.

TABLE 2-6 (cont)

Byte Format	8 bits. Within the keyboard, bit 8 is determined by a strap which is factory-wired to 1, but may be changed to zero. However, the transmitted bit 8 is communication interface dependent, and may be as determined by the keyboard, may indicate even or odd parity, or may be arbitrarily high or low. Refer to documentation on the applicable interface for further details.

TABLE 2-7

Local Operation Specification

General	The Terminal is isolated from the computer.
Alpha Mode	Terminal accepts keyboard data as though it were coming from a computer, writing alphanumeric characters and executing control characters.
GIN Mode	Crosshair cursor can be obtained by entering a sequence consisting of ESC and CTRL Z. The cursor is under full control of the thumbwheels. The keyboard is locked out; the cursor will not disappear in response to striking a keyboard key as it does when on-line. The Terminal can be reset to Alpha Mode by entering PAGE or SHIFT RESET at the keyboard.
Graph Mode	Can be obtained by entering CTRL SHIFT M at the keyboard. Terminal will then write vectors in response to keyboard entries of graphic addresses as explained in Tables 2-3, 2-4, and 2-5. Obviously, the addresses must be converted to alphanumerics before knowing which keys send which address bytes. Dark vectors will follow any CTRL SHIFT M entries. The Terminal retains the ability to execute control characters.

TABLE 2-8

Hard Copy Mode Specification

Function	Display is scanned by signals from the Hard Copy Unit, providing readout information to the Hard Copy Unit.
Initiated By	$\overline{\text{READ}}$ signal from Hard Copy Unit. ($\overline{\text{READ}}$ occurs in response to a COPY command from the Terminal front panel, a copy command from the Hard Copy Unit, or an ESC ETB sequence from the computer.)

TABLE 2-8 (cont)

GIN Cursor	Inhibited.
Alpha Cursor	Inhibited.
Hold Mode	Inhibited.
Display Unit	Under control of Hard Copy Unit.
Terminal Busy	Asserted.
GIN MODE	If commanded during Hard Copy Mode, the GIN transmission is delayed until copying is completed.
Copying Time	Hard Copy Unit dependent.

TABLE 2-9

Display Specification

Characteristics	Performance Requirements	Supplemental Information
Display Quality Area	8 inches horizontal by 6 inches vertical, whose center is within 0.25 inch of the CRT faceplate center.	
Deflection Factors		
Center of Screen		Zero volts.
Edge of Screen		+5.0 volts left or down, −5.0 volts right or up.
Usable Storage Time		Up to 15 minutes in View status or up to one hour in Hold status without permanent damage to the storage screen. If a residual image is retained after a long viewing period, the screen may sometimes be returned to normal condition by repeated erasures.
Line Straightness	Deviation from mean straight line (inside the specified display area) is within 0.5% of line length.	This is a function of the display circuitry and does not include the 1.5% dynamic geometry specification of the vector generator circuitry.

TABLE 2-9 (cont)

Geometry		
Orthogonality		⩽1°.
Parallelism	Within ±2%.	Condition for Test: Draw a rectangle on edge of specified area. Difference between lengths of vertical lines should be within 2% of length of horizontal line. Difference between lengths of horizontal lines should be within 2% of length of a vertical line.

TABLE 2-10

Power Supply Specification

Characteristics	Performance Requirements		Supplemental Information
Line Voltage Ranges	110 V AC	220 V AC	
Low	110 V ±10%	200 V ±10%	
Medium	115 V ±10%	220 V ±10% 230 V ±10%	
High	120 V ±10%	240 V ±10%	
Power Consumption			Approximately 135 watts at 115 V, 60 Hz, with standard Terminal configuration.
Line Frequency Range	48 to 66 Hz.		Fan option changes frequency range to 360-440 Hz.
Line Fuse	3.2 A slo-blo for 110 V operation. 1.6 A slo-blo for 220 V operation.		Located in front panel fuse holder.
+20 V DC	2 A fast-blo		Located near front, inside right side cover.
−20 V DC	2 A fast-blo		
+5 V DC	8 A fast-blo		

TABLE 2-11

Physical Characteristics

Finish	Painted metal cabinet.
Weight	Approximately 80 lbs. Shipping weight approximately 120 lbs.
Dimensions, Overall	See Fig. 2-1.
Height	Approximately 15-3/4 inches.
Width	Approximately 19 inches.
Depth	Approximately 30-1/2 inches.

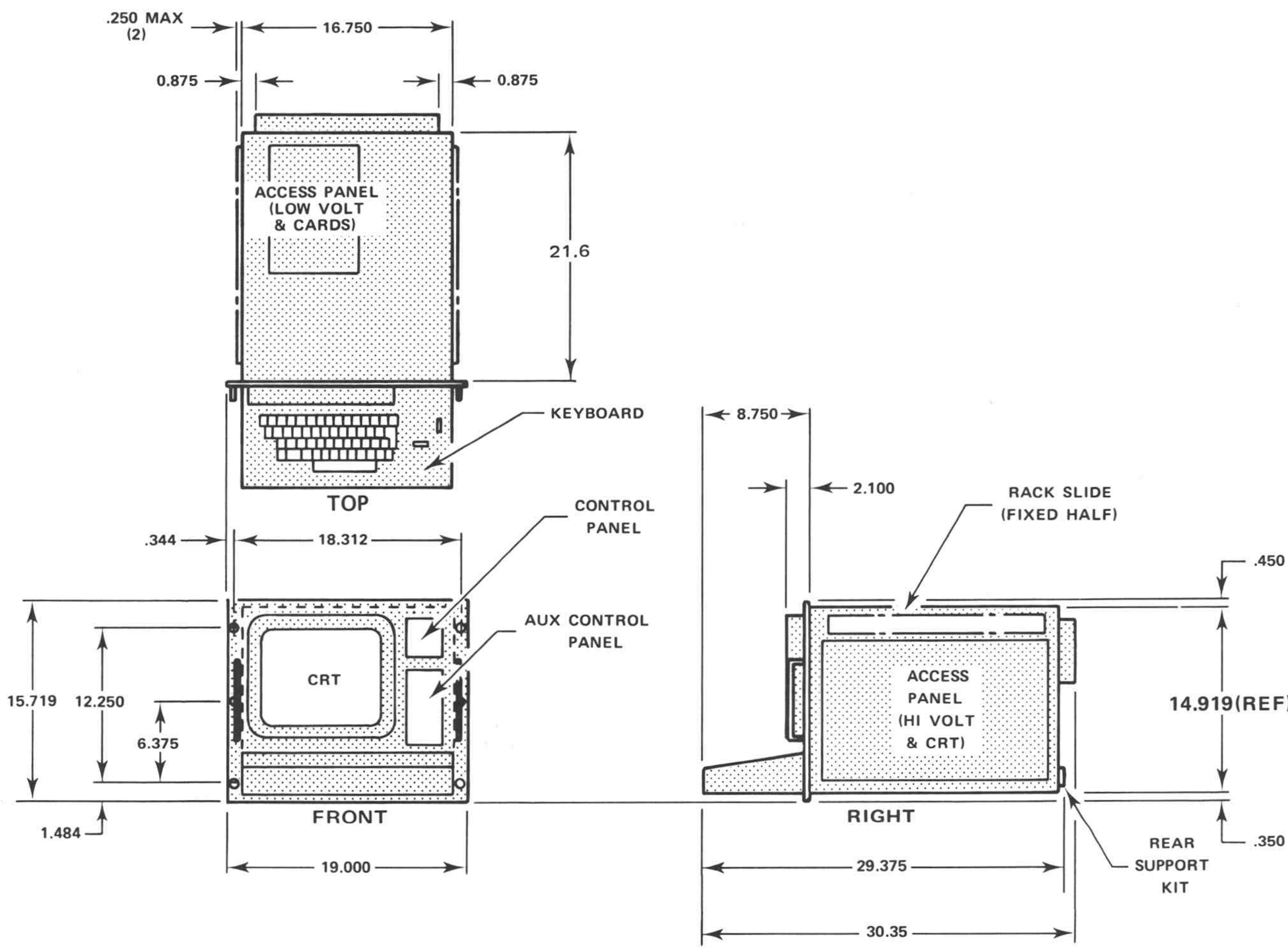


Fig. 2-1. Dimensions. All values are in inches.

TABLE 2-12

Environmental Specification

Meets MIL-T-28800A Class 3 Style D except where noted otherwise.

Temperature		
Nonoperating	−55°C to +75°C	
Operating		
Less Hard Copy	−15°C to +55°C	
With Hard Copy	0°C to +35°C	
Humidity, Operating	to 95%, relative, non-condensing (28800A states 100%)	Independent, non-concurrent
Altitude		
Nonoperating	to 50,000 feet	
Operating	to 15,000 feet (28800A states 10,000)	
Vibration	5 to 25 Hz: .025 inch 25 to 55 Hz: .020 inch	
Shock	to 30 g, 1/2 sine, 11 ms duration, 6 axis, 18 shocks minimum	
Transportation	Meets National Safe Transit Committee type of test when packaged as shipped by factory	This is in addition to 28800A
Bench Handling	4 inch drop (corner)	
Personnel Hazard	MIL STD 901C, Grade B (400 lb hammer shock test)	This is in addition to 28800A
Fungus	Certified non-nutrient materials; ref 28800A para 4.5.6.1	
Salt Atmosphere	Structural parts, per 28800A para 4.5.6.2.1	

TABLE 2-12 (cont)

Drip Proof	Full cone spray; ref 28800A para 4.5.5.5.3; front panel exposure only	This is in addition to 28800A
Electromagnetic Compatiability (EMC)	Meets MIL STD 462 CE-01, CE-03, CS-01, CS-02, CS-06, RE-02 (limited to 1 GHz), (T) RE-04, RS-01, and RS-03 (limited to 1 GHz); per 28800A para 4.5.6.6.1	Refer to EMC requirements of MIL STD 461A when tested with these test methods of MIL STD 642. RS-01 and RS-03 are not applicable during hard copying
Reliability	Level B, MIL STD 781, Test plan II, ref 28800A para 4.5.7	

TABLE 2-13

Strappable Options of Basic Terminal (See Fig. 2-2)

Feature	Location	Choice	Effect
LF Effect	TC-1, outer edge	LF LF → CR	LF causes Line Feed only; LF → CR causes Line Feed and Carriage Return
CR Effect	TC-1, outer edge	CR CR → LF	CR causes Carriage Return only; CR → LF causes Carriage Return and Line Feed
Inquire	TC-1 outer edge	NORM DELAY	NORM provides 1.6 μs delay after receipt of ESC ENQ sequence; DELAY provides 330 ms delay after receipt of ESC ENQ sequence
ROM Select	TC-1, outer edge	AB AB + BC	AB always selected; AB + BC not used in this Terminal.
Graphic Input Terminators	TC-2, outer edge, lower corner	CR & EOT CR NONE	CR & EOT transmits CR & EOT in GIN Mode; CR transmits CR in GIN Mode; NONE transmits neither CR nor EOT in GIN Mode

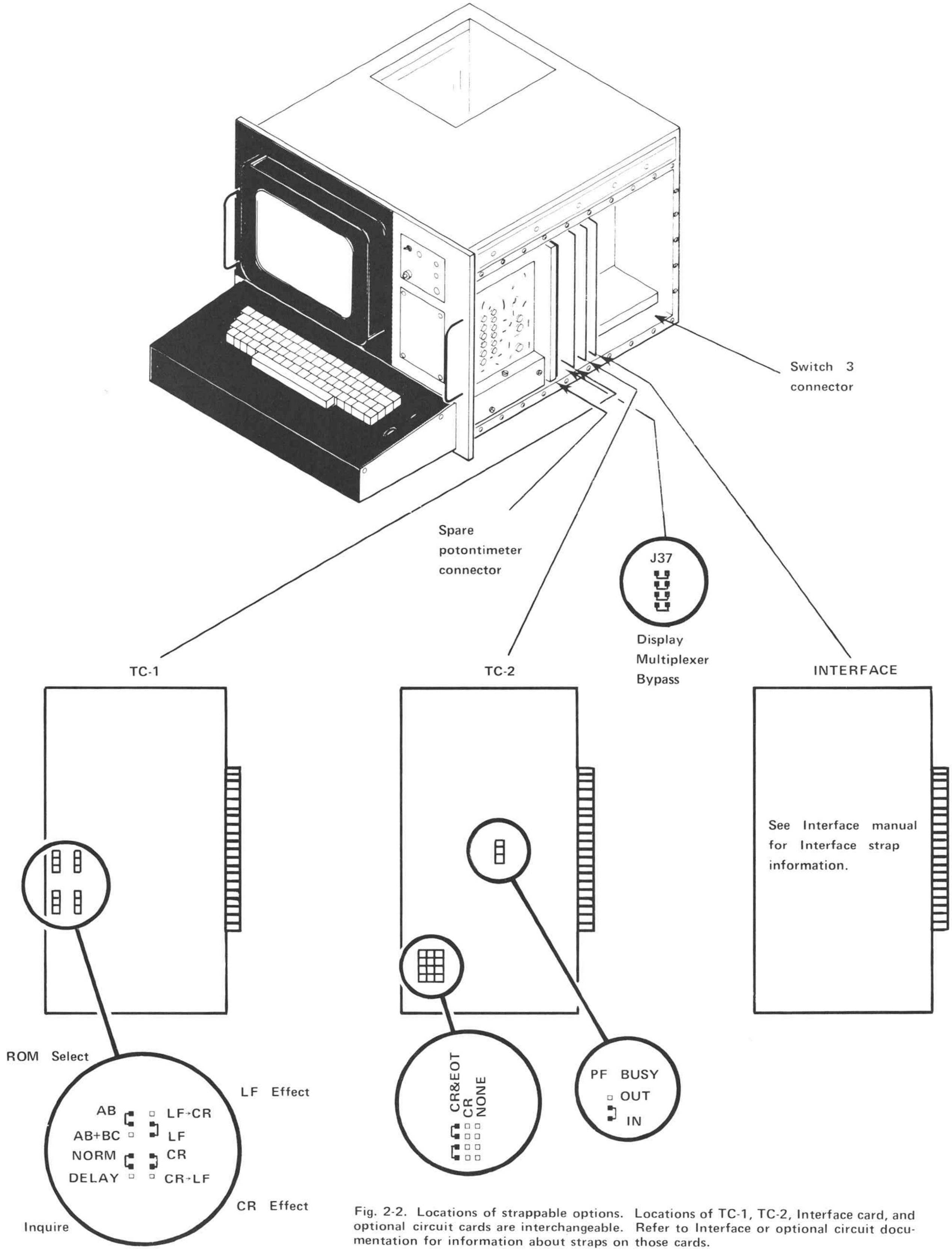


Fig. 2-2. Locations of strappable options. Locations of TC-1, TC-2, Interface card, and optional circuit cards are interchangeable. Refer to Interface or optional circuit documentation for information about straps on those cards.

TABLE 2-13 (cont)

Feature	Location	Choice	Effect
PF Busy	TC-2, board center		OUT prevents a page full from causing a busy signal; IN permits a page full to generate a Terminal busy signal ($\overline{\text{TBUSY}}$)
Display Multiplexer Bypass	Bottom-left on motherboard	(1) Corresponding pins from left and right column connected together. (2) With optional Display Multiplexer installed, connect Display Multiplexer cable to left column, matching reference indicators	(1) Terminal Control circuits directly control the display (2) Terminal Control circuits control the display at the discretion of an optional Display Multiplexer card
Spare Potentiometer Connection (Used with optional circuits, such as Fast Graph)	Under right side cover, bottom, middle, fastened in wire harness	(1) Unconnected (2) Connect to optional circuitry	(1) Dead-ended (2) Provides connection to wiper of spare 50 kΩ potentiometer (on front panel) which is connected between +5 V and +15 V
Switch 3 Connection	Under right side cover, bottom-back, fastened in wire harness	(1) Disconnected; (2) Connected to optional circuitry	(1) No effect (2) Provides ground connections via Switch 3 on keyboard

TABLE 2-14

Accessories for the Terminal

Item	Part No.
STANDARD ACCESSORIES	
General Purpose Asynchronous Serial Interface	021-0160-00
OPTIONAL ACCESSORIES	
RE4012 Computer Display Terminal Instruction Manual	070-1893-00
021-0160-00 Interface Instruction Manual	070-1911-00
General Purpose Parallel Interface	021-0159-01
021-0159-01 Interface Instruction Manual	070-1910-00
Motherboard Extender	018-0099-00
Display Multiplexer	018-0104-00
Display Multiplexer Instruction Manual	070-1759-00
Fast Graph	018-0100-00
Fast Graph Instruction Manual	070-1931-00
Feet	020-0149-00
SERVICING ACCESSORIES	
72 Pin Extender Card	670-3987-00
Test Graticule	067-0771-00
Wrench, 11/32 inch, Long Handled	003-0771-00

Section 3

SERVICING

INTRODUCTION

Beyond the need for occasional replacement of air filters and cleaning of the face of the display and outer surfaces of the Terminal, there is virtually no need for routine servicing of the Terminal. It has no lubrication points, and (with the exception of the crt) no vacuum tubes. The solid-state components provide stable operation, with little need for routine adjustment.

However, if a routine schedule and procedure is desired, a one-year interval and the following sequence is recommended. Naturally, if it is operated in a dusty environment, more frequent cleaning of the filter will be required. The disassembly and assembly instructions contained in this section should be referred to as necessary.

Servicing Procedure

1. Disconnect the line cord from the power source.

2. Remove the air filter shroud and remove the filters. Replace the filters with new filters. The part numbers are listed in the Mechanical Parts section. Then put the air filter shroud back in place.

3. Remove the right, top, and back covers from the unit.

4. Using a vacuum cleaner, remove dust accumulation from within the unit. Use a soft-bristled brush to loosen dust which won't otherwise vacuum out. A soft cloth and a mild soap and water solution can be used to remove any really stubborn dirt.

5. Inspect the interior for broken leads, loose connections, heat damaged components, etc. Correct as necessary. Investigate the cause of any heat-damaged components.

6. Wash the face of the display, using a soft cloth and a mild soap and water solution.

7. Perform the check-out procedure found in this manual. Perform the adjustment procedure if the check-out procedure indicates that it is necessary.

8. Put the covers back on the unit.

9. Clean the outside of the unit, using a soft cloth and a mild soap and water solution. Use particular care in cleaning the external surface of the display.

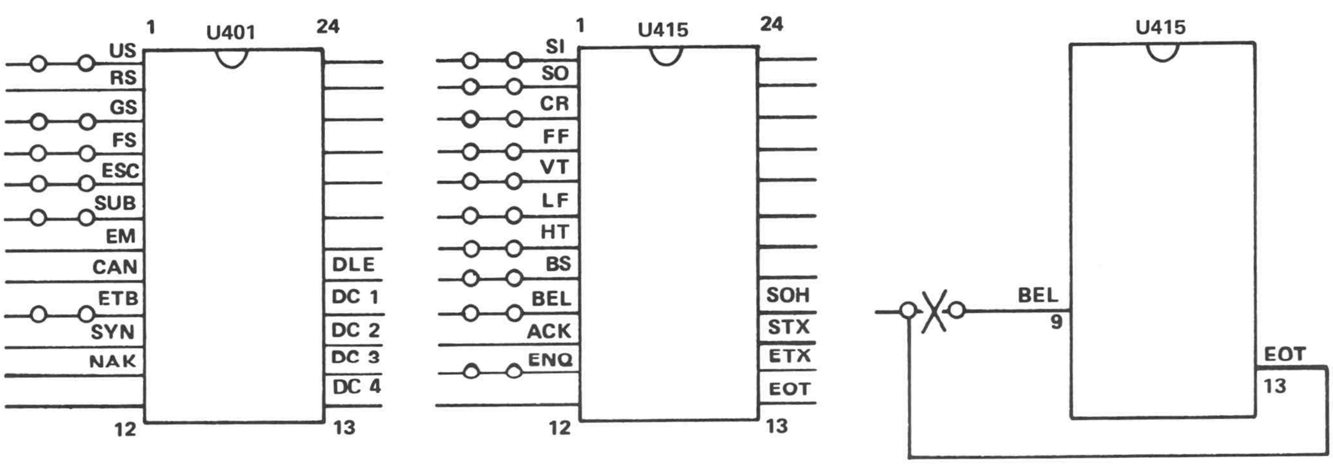
Soldered Options

In addition to strappable options, there are some options that can be selected by changing soldered wires. These changes should only be made by qualified technicians, to minimize the possibility of damage to the equipment.

Keyboard Bit 8. In standard factory-wired Terminals, the keyboard is wired so that a true bit 8 will accompany all characters that are entered at the keyboard. (The final determination of what is sent is made by the interface.) If a false bit 8 transmission is desired instead, the white-brown-blue wire on Pin 5 of the keyboard connector can be unsoldered and moved to pin 8. (Keyboard removal instructions are given in the Disassembly and Assembly instructions.

Control Characters. In standard factory-wired Terminals, control characters cause effects as listed in the Controls section of this manual. A network on the TC-1 circuit card permits changes to be made so that any one of the listed results can be obtained in response to any one of the listed control characters. The networks are shown in Fig. 3-1.

It is not recommended to have one control character control more than one output line; nor is it recommended to have more than one control character control the same output line. Each of these last two conditions requires special design considerations.



(A.) Standard factory-wired configuration. Unlabeled lines are inputs, power or ground connections.

(B.) An example of rewiring, making EOT control the BEL line, rather than having BEL do it.

Fig. 3-1. TC-1 Control character network details.

CRT Rotation

Since most writing occurs near the top of the crt, that area may degrade faster than the rest of the display area. It may be desirable to rotate the crt assembly 180° to take advantage of the relatively unused area on the bottom. To do so, remove the assembly, rotate it 180°, and reinstall it, following the procedure given in the Disassembly and Assembly topic. Note that connector P35 must be rotated 180° if the crt is rotated; otherwise, writing will be upside-down and backward.

Power Transformer Information

The power transformer can be wired for use with 115 V or 230 V nominal line voltage, and can be set for any of several ranges within the nominal setting. Refer to Fig. 3-2 for details.

Fuses

The Terminal has four fuses installed in it. One is in the front-panel line fuse holder and the other three are on the Low Voltage Power Supply board, under the right side cover. Sizes are as follows:

Front Panel line fuse

115 V operation	3.2 A
220 V operation	1.6 A

Low Voltage Power Supply

+5 V dc	8 A
+20 V dc	2 A
−20 V dc	2 A

A fuse may open for any of numerous reasons, either transient or fixed. Repeated fuse failure should be investigated by a qualified technician.

Mother Board Extender

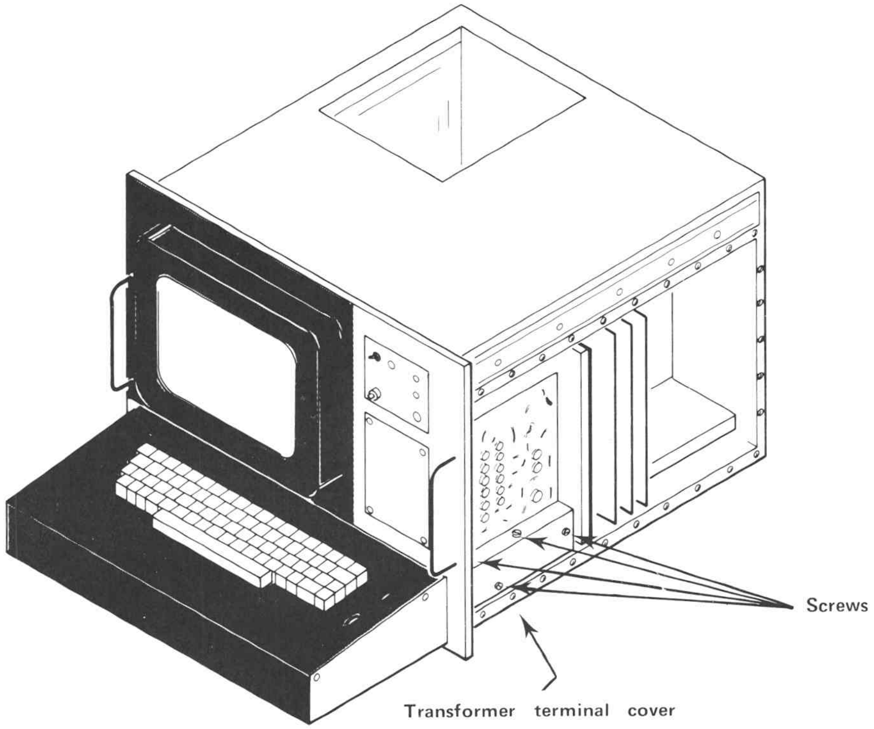
If a Mother Board Extender is installed in the Terminal, the +5 V power supply plug must be disconnected from J39 on the Mother Board and connected to J28 on the Mother Board Extender. See Fig. 3-3.

Silicone Grease

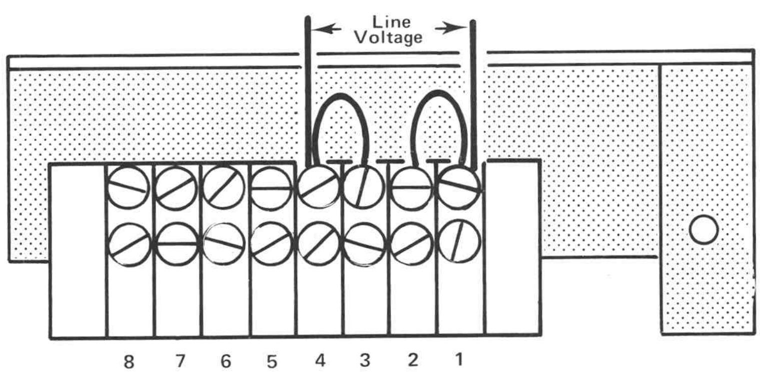
Many high-power components within the Terminal are mounted on mica wafers that are coated on both sides with silicone grease. A new application of grease should be used if any of these components are replaced.

Environmental Protection

Circuit cards and boards are coated with Humiseal 1B31. If the coating is penetrated or removed, or if new parts are added, affected areas should be re-coated with Humiseal 1B31 to restore specified environmental capability. (Humiseal 1B31 is a product of the Humiseal Division of Columbia Technical Corporation. 4 oz. containers of it are available from Tektronix, Inc. under Part No. 006-1744-00.



(A) Wiring terminal location



(B) Terminal layout, shown wired for 115V ± 10%.
Line voltage is always connected to 1 and 4.

Voltage (±10%)	100	115	120	200	220	230	240
Terminals jumpered together	1-8 4-5	1-2 3-4	1-7 4-6	5-8	5-7	2-3	6-7
	two jumpers required			one jumper required			
Line fuse	3.2A			1.6A			

(C) Connections and fuse sizes for various voltages.

Fig. 3-2. Transformer wiring information.

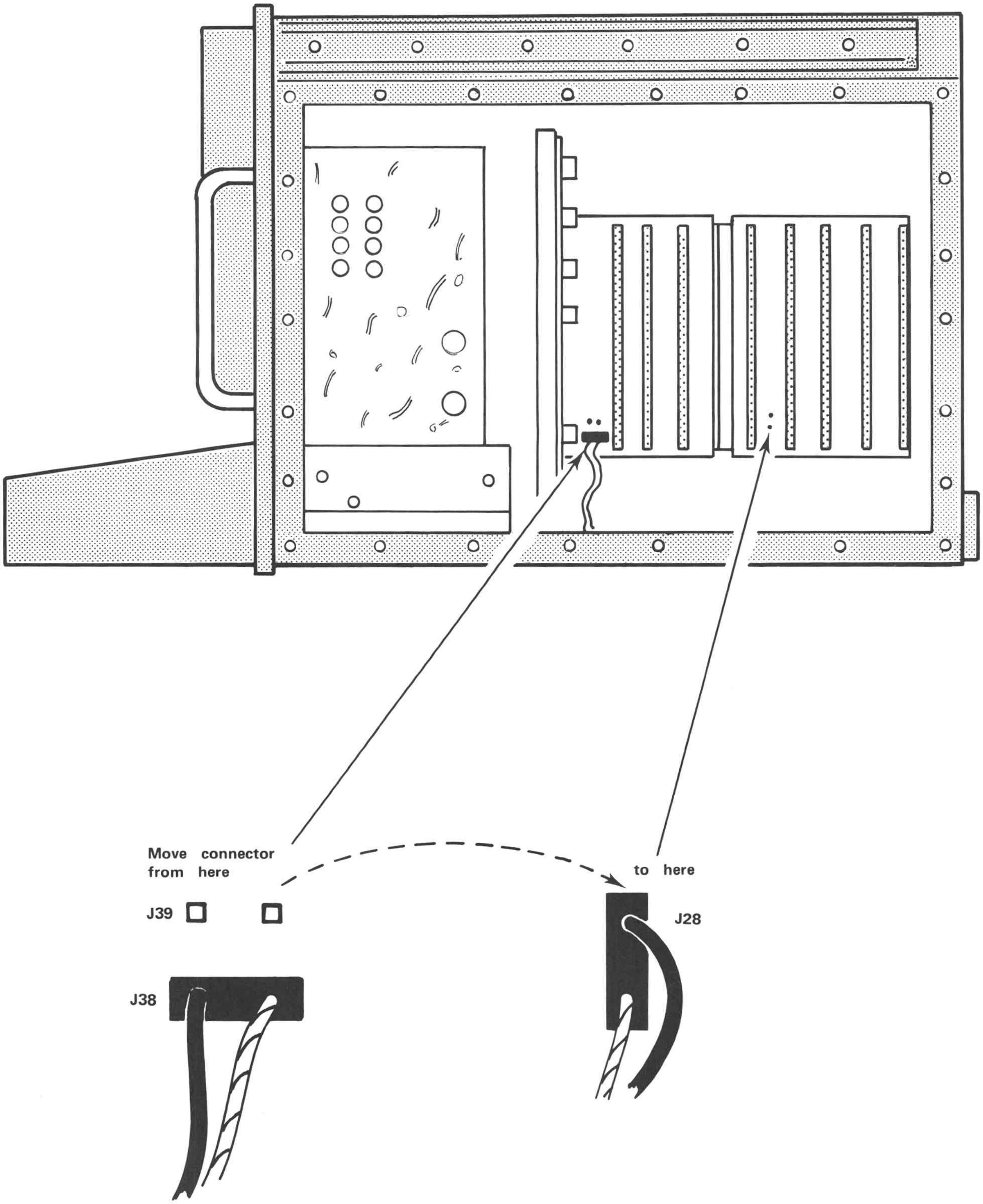


Fig. 3-3. Mother Board Extender +5V supply connector.

TROUBLESHOOTING INFORMATION

Troubleshooting of the Terminal can be done best if the various features of this manual are used to their fullest advantage. These features and recommended usage are listed here.

Controls and Operation. This information insures operator understanding of the Terminal features and operation.

Specification. A complete explanation of the Terminal capabilities is contained in the Specification, along with explanations of how to put the capabilities into use.

Performance Check. This provides a rapid means of checking for proper operation in a logical sequence under normal equipment configuration. It can also be used with the options and the interface unit removed, to indicate operating status of the basic Terminal.

Adjustment. The procedure follows a logical sequence of adjusting the basic Terminal (including verifying non-adjustable features).

Block Diagrams and Circuit Diagrams. These diagrams and their associated descriptions provide an understanding of Terminal operation on a circuit as well as component level. The information contained therein is essential to efficient location of trouble.

Component Layout Illustrations. These appear in the Diagrams section and can be used as aids for locating components.

Semiconductor Information. An illustration of semiconductors appears near the beginning of the Diagrams section, and can be used for pin identification. An integrated circuit test clip is recommended for use in troubleshooting the in-line integrated circuits, since it makes their leads easily accessible.

Troubleshooting Procedure

To troubleshoot the basic Terminal, remove alll accessory cards and the interface card. Then check operation by doing the Performance Check. Stop where the Terminal fails to respond properly, and troubleshoot the referenced area, using block diagrams, schematics, and associated descriptions. Replacement of suspected circuit cards is recommended as a fast means of confirming suspicions. If the Performance Check works satisfactorily in the basic Terminal, install option cards and the interface card one at a time and repeat the Performance Check until it fails. Then troubleshoot the last-inserted option card and the circuits with which it interacts.

Obviously, not all troubles can be high-lighted by the Performance Check or Adjustment Procedure. However, they should prove beneficial in most cases, and should go a long way in guiding a technician to the trouble area.

Recommended Troubleshooting Equipment

An extender card is available under Tektronix Part No. 670-3987-00. This card can be installed into the minibus to make bus lines available at test points, and can also be used as an extender for cards installed in the minibus.

A −25 V to +400 V dc voltmeter and a 10 MHz frequency response oscilloscope are recommended test equipment for troubleshooting low-voltage and logic circuits. A −6000 V dc meter is required for troubleshooting the high voltage circuits.

WARNING

Dangerous voltages exist within the unit. Normal electrical safety precautions should be observed at all times when working around exposed circuits.

When troubleshooting the power supply circuits, a resistive dummy-load should be connected in place of the Terminal circuits. This avoids accidental damage to other circuits in the Terminal. Recommended loads are listed in Table 3-1.

TABLE 3-1

Dummy Load Specifications

Power Supply	Connector	Load
+15 V	J77	30 Ω, 15 W
−15 V	J74	30 Ω, 15 W
+5 V	J76	0.83 Ω, 50 W

DISASSEMBLY AND ASSEMBLY

CRT and Deflection Yoke

The crt and deflection yoke are enclosed in an assembly that is replaced as a unit in event of crt or deflection yoke failure. To replace, follow this procedure.

1. Remove cover plate from top of Terminal.

2. Disconnect the plug from the back of the tube bell.

3. Disconnect the plug attached to the leads that come from the yoke, which is encased in the neck shield.

4. Pull the crt base plug off by pulling evenly on the wires that enter the back of the neck shield.

5. Remove the 2 screws from the top-outer lip of the crt bezel.

6. Remove the 2 screws from the bottom-outer lip of the crt bezel.

7. With a second person supporting the back of the assembly, remove 1 screw from each side of the bezel.

8. Carefully extract the assembly from the front of the unit and set it aside.

9. Replace by reversing the foregoing procedure.

Keyboard Information

Access. Perform the following for keyboard circuit access.

1. Remove 4 screws from the bottom of the unit, at the front of the keyboard housing.

2. Remove 2 screws from each side of the keyboard housing.

3. Slide the keyboard assembly front about 1 inch; then lift up and out.

Key Caps. These are removed by pulling straight up on the caps.

Key Housings. These are held in place by nuts, which are accessible on the under-side of the keyboard assembly. Reed switches can be withdrawn through the holes in the circuit board, after their leads are unsoldered from the board.

Bell Speaker. To remove, unsolder the speaker leads and unscrew the entire speaker, turning it counter-clockwise.

High Voltage & Z Axis Board and Shield

Access. Remove the top and lower back cover from the unit.

Shield Removal. Disconnect the base plug from the crt by pulling evenly on the wires, which enter the back of the neck shield. Then remove the 6 nuts from the shield mounting flanges. Manipulate the shield as necessary to withdraw it out the top of the unit. If the Focus Shaft interferes with removal, loosen its set screw and remove it.

Board Removal. Remove the shield. Disconnect the 6 plugs from the board, noting location and orientation. Remove the nuts and 1 nylon screw indicated in Fig. 3-4. Pull the board off of the studs. Be careful not to lose the board spacers from the mounting studs in the cabinet.

Board Replacement. Check that the mounting spacers are in place. Install the board, the nuts and the nylon screw. Do not tighten any of the fasteners until the board is properly seated on all studs. Return the plugs to their proper locations, matching the index markers on the board and plugs.

Hard Copy TARSIG Amplifier

This board is located under the Terminal's top cover plate. The board is held in place by 2 nuts and 2 mounting clips. To remove, unplug the 3 plugs, remove the 2 nuts, and pry it out of the mounting clips. Locations are shown in Fig. 3-5.

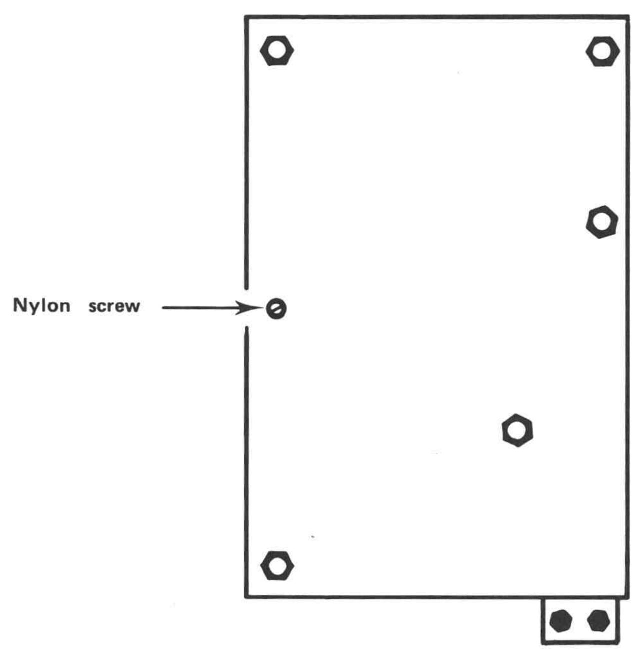


Fig. 3-4. High Voltage & Z Axis board fasteners.

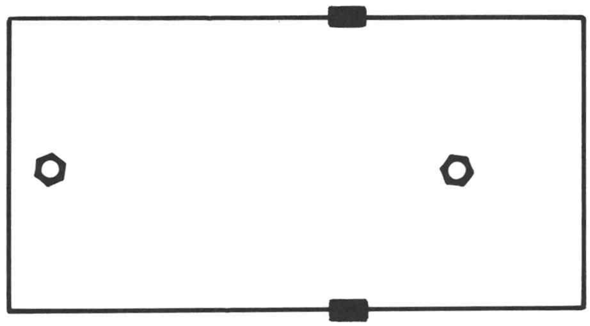


Fig. 3-5. Hard Copy TARSIG Amplifier board showing locations of nuts and mounting clips.

Low Voltage Power Supply

The Low Voltage Power Supply is removed from the Terminal as a single unit, consisting of the board, transformer, and heat sink. Remove as follows:

1. Lay the Terminal on its left side as shown in Fig. 3-6 and remove the 6 screws shown.

2. Lay the Terminal on its bottom and remove the right side cover, if not already off.

3. Remove all the plugs from the right side of the board, and one plug from the left-bottom of the board, to free the unit from other Terminal wiring.

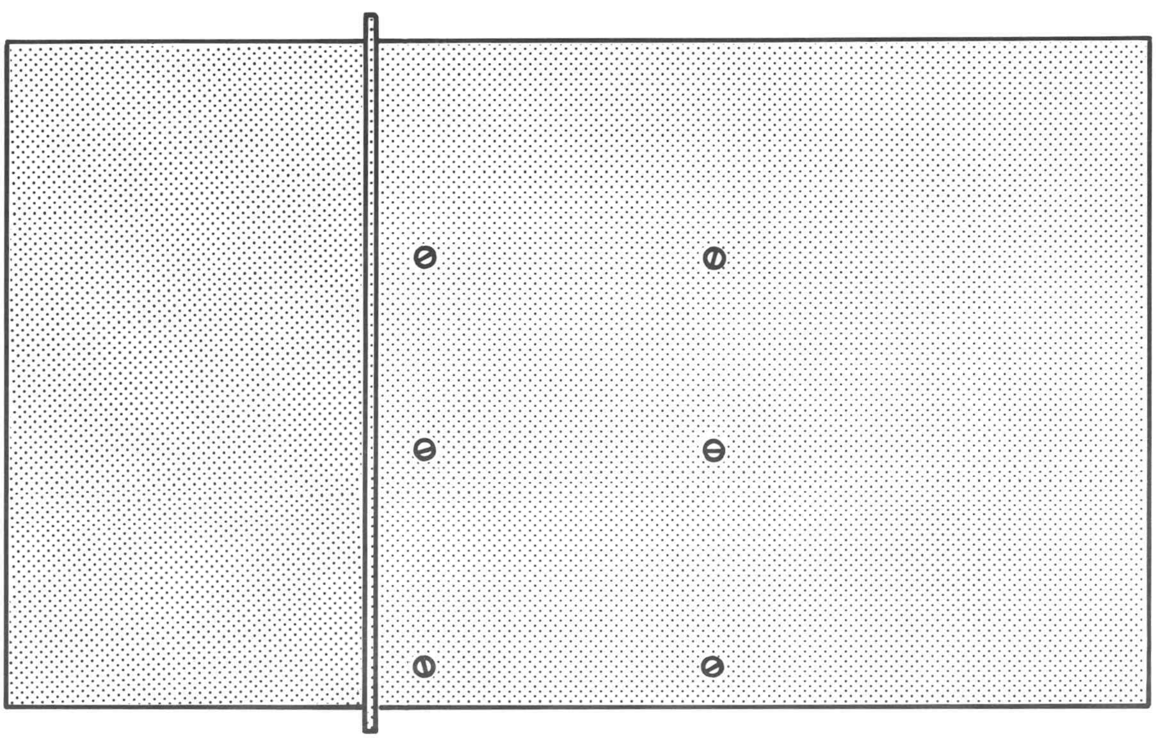


Fig. 3-6. Power Supply bottom-mounting screws. Unit should be on its left side (as shown) before removing the screws.

4. Disconnect the Power Supply plug from the connector to the left of the board, near the bottom.

5. Remove the 2 nuts from the Power Supply mounting flange at the bottom-outer edge of the Power Supply assembly. Lift the Power Supply assembly up and out.

6. When re-assembling, fasten the nuts in place first, then place the unit on its side as in Fig. 3-6 and install the 6 screws. Tighten all fasteners after all are in place.

7. Re-connect all plugs, being careful to align index markers on the board and plugs.

Deflection Amp & Storage Board

This board is fastened to its adjacent heat sink as well as being plugged into the Mother Board.

NOTE

Although this board is connected to the Motherboard, it cannot be plugged into any other connector on the Motherboard; nor can any other card be plugged into the Deflection Amp & Storage board connector on the Mother Board.

Do the following to remove the Deflection Amp & Storage board.

1. Remove the right side cover from the Terminal, if not already off.

2. Remove the 3 screws from the inner flange on the heat sink.

3. Remove the 1 screw from the heat-sink's bottom flange.

4. Remove the 1 screw from the top-outer edge of the heat sink.

5. Disconnect the wiring plugs from the bottom of the board and pull the board and heat sink out. (It may be desirable to pull the assembly out slightly before disconnecting the plugs.

6. Replace by reversing the sequence, aligning with the index markers on the board when replacing the plugs.

Mother Board

The Deflection Amp & Storage Board and all other circuit cards must be removed from the Mother Board before it can be taken out of the Terminal. If a Mother Board Extender is installed, it should be removed next, after removing its mounting screws and pulling it back off the Mother Board connector. Then remove the plugs from the Mother Board. Remove 4 screws from the top of the Mother Board and 4 from the bottom. The Mother Board can now be removed.

When replacing the Mother Board, be certain the plugs are aligned with the board's index markers before installing them.

Fan

The fan is mounted above the Mother Board & Card Holder Assembly, which must be removed before the fan can be removed. Proceed as follows:

1. Remove the right side cover.
2. Remove the top cover plate and disconnect the connectors from the back of the Mother Board.
3. Remove the Deflection Amp & Storage Board.
4. Remove the circuit cards from the Mother Board.
5. Disconnect the connectors from the Mother Board.
6. Remove 3 screws from the bottom of the assembly, on the inner vertical surface.
7. Remove 3 screws from the top, on the inner vertical surface.
8. Remove 3 screws from the outer edge of the lower flange.
9. Remove 1 screw from the rear flange.
10. Lift the Mother Board & Card Holder Assembly out.
11. Remove the 6 screws that hold the fan mounting plate in place, then remove the plate and fan.

12. Re-install in reverse order; replace the nylon cable guide bushings as the Mother Board & Card Holder Assembly is installed.

RACKMOUNTING

This instrument is designed for use in standard racks. Pertinent dimensions are given in Fig. 3-7.

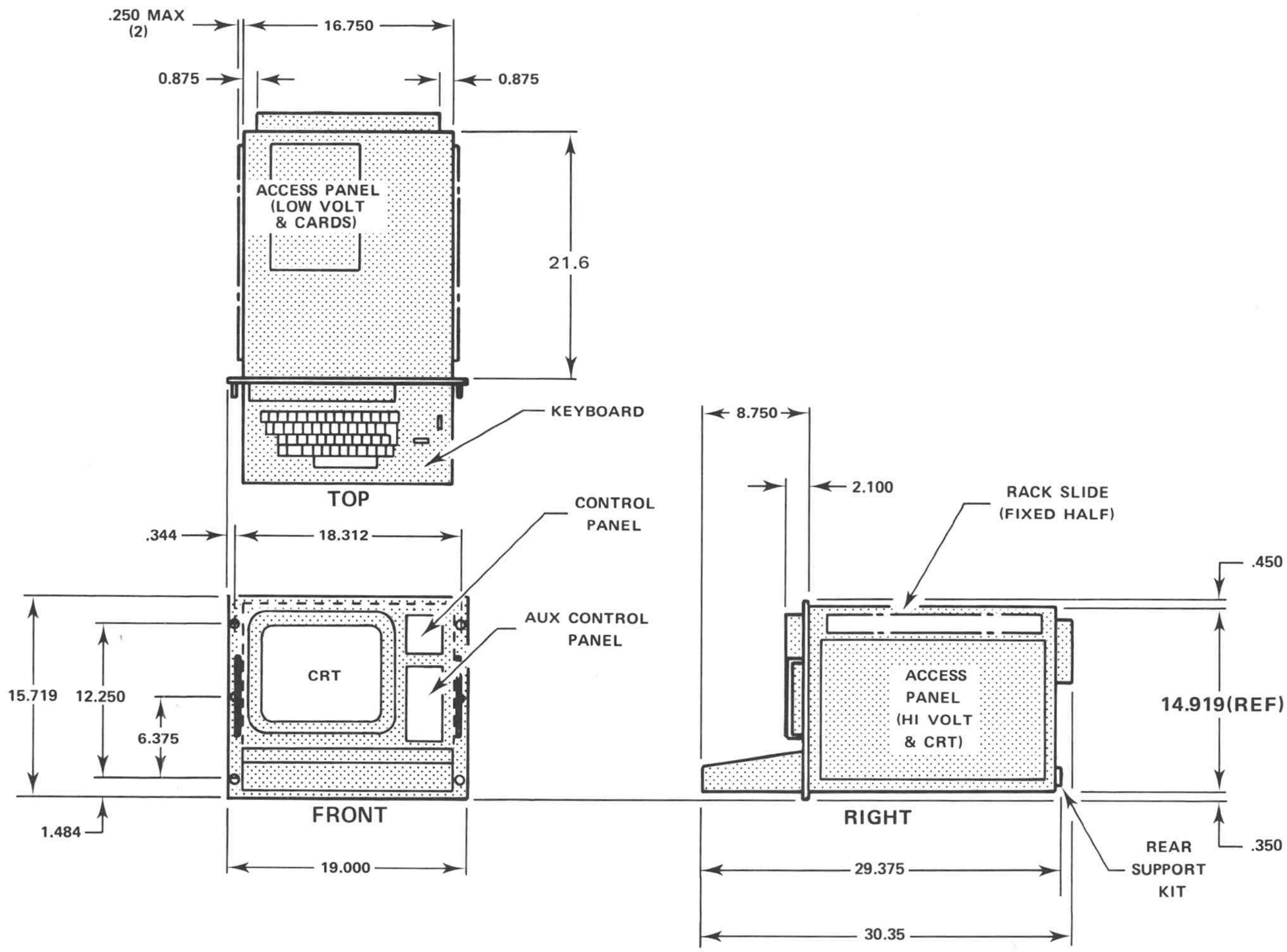


Fig. 3-7. Pertinent dimensions for rackmounting. All values are in inches.

Slide-out track assemblies are included with the instrument, as indicated in Fig. 3-8. Note that the chassis section of track is already installed on the instrument. Since the tracks are designed to fit a variety of racks, not all of the mounting hardware may be required in any one installation.

Install the tracks and instrument as follows. Some racks may require that new holes be drilled to accommodate the installation.

1. Put the stationary sections in place in the rack, and fasten the front of the track in place, similar to Fig. 3-9(A). Note that if the front rail has tapped holes, the bar nut will not be required, and the track's

slotted flange will be inserted between the screw heads and the rail, rather than as shown; in that case, washers should be used between the screw head and stationary section.

2. Put the rear support brackets in place as shown in Fig. 3-9(B) or (C), depending on rack depth.

3. Fasten the rear of the stationary sections to the rear support brackets, as in Fig. 3-9(B) or (C).

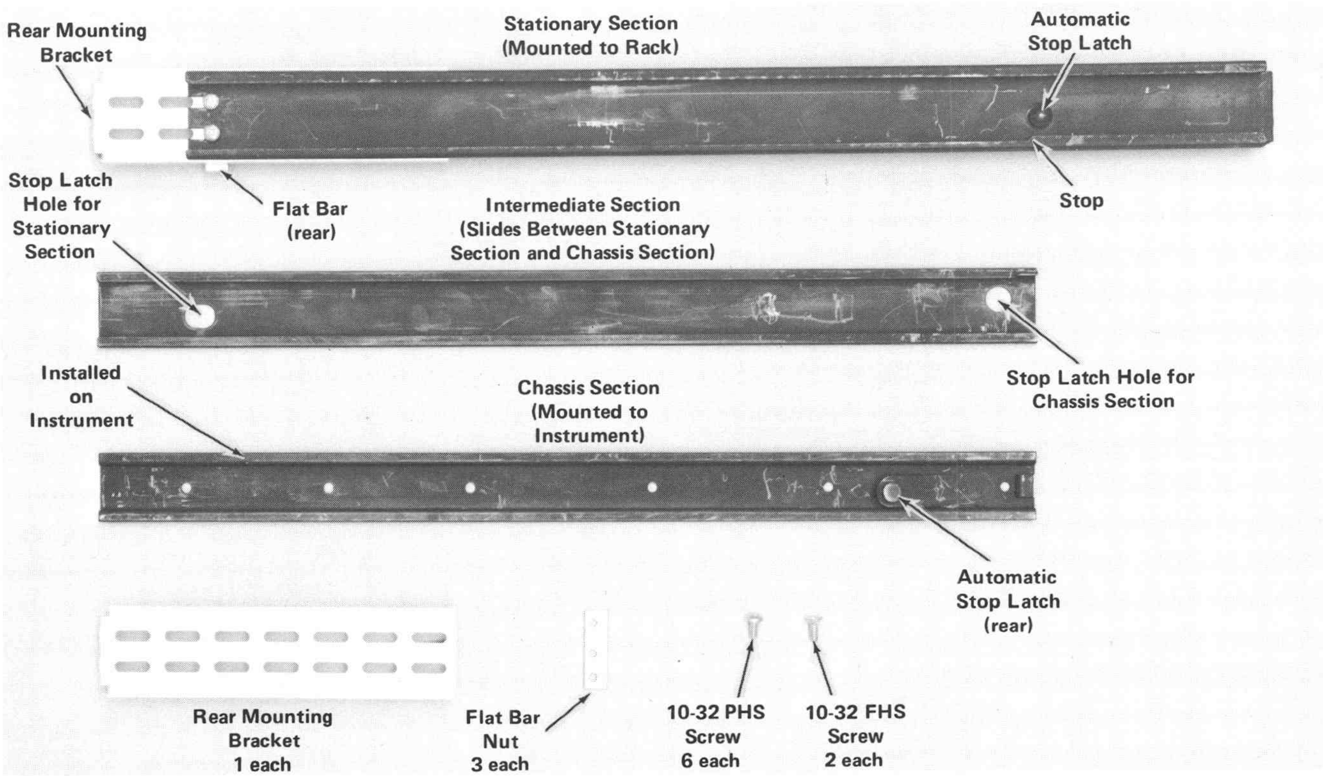


Fig. 3-8. Slide-out track assemblies and mounting hardware.

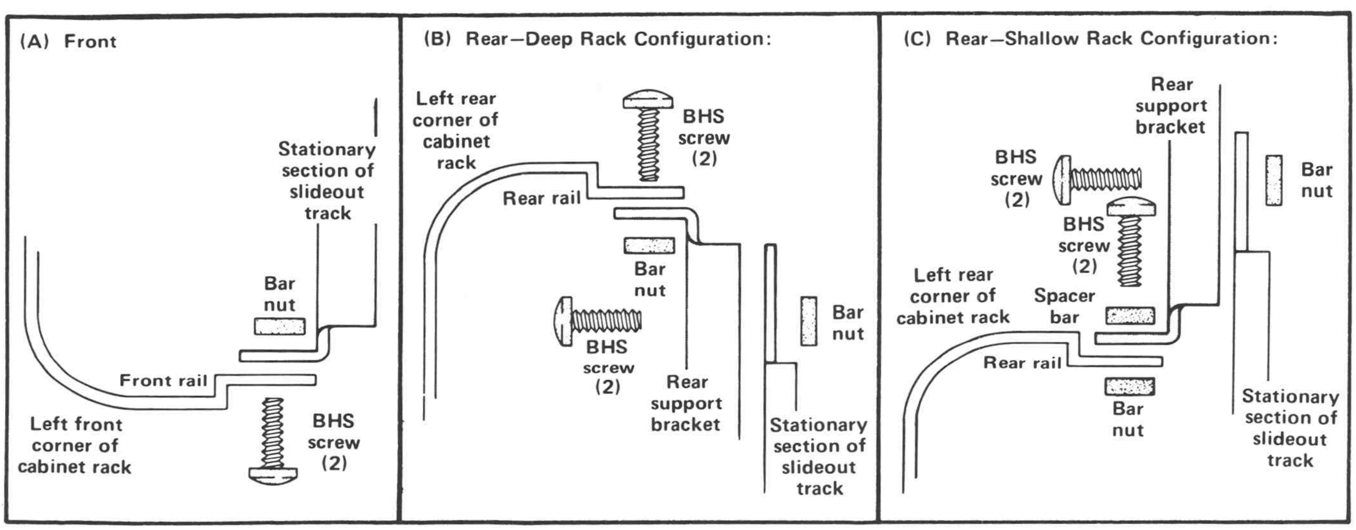


Fig. 3-9. Details for mounting stationary sections. Mounting configuration may vary, depending on type of rack.

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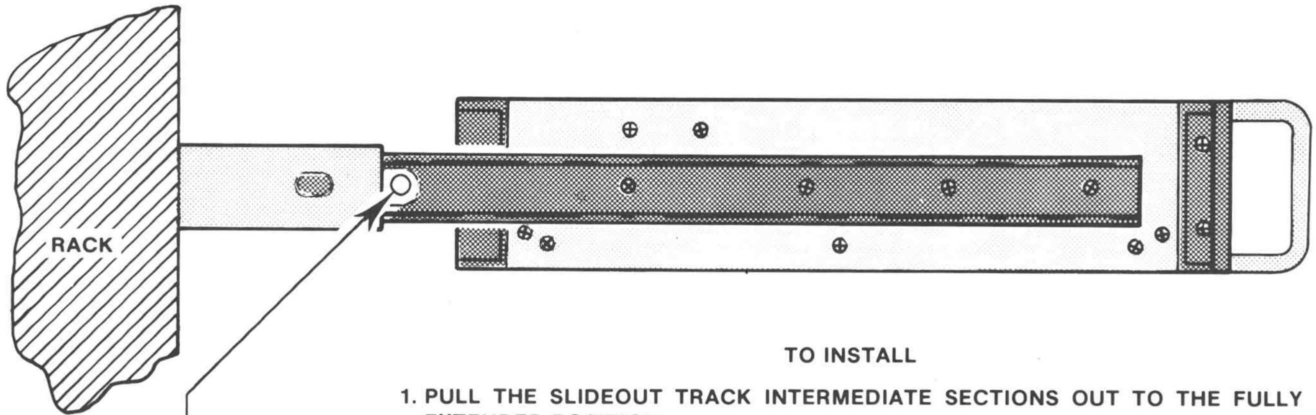
4. Slide the intermediate sections in place into the stationary sections. They are installed properly if they latch when pulled to the out position, but do not latch when pushed in.

5. With the intermediate sections latched in the out position, perform steps 1 through 4, as listed in Fig. 3-10.

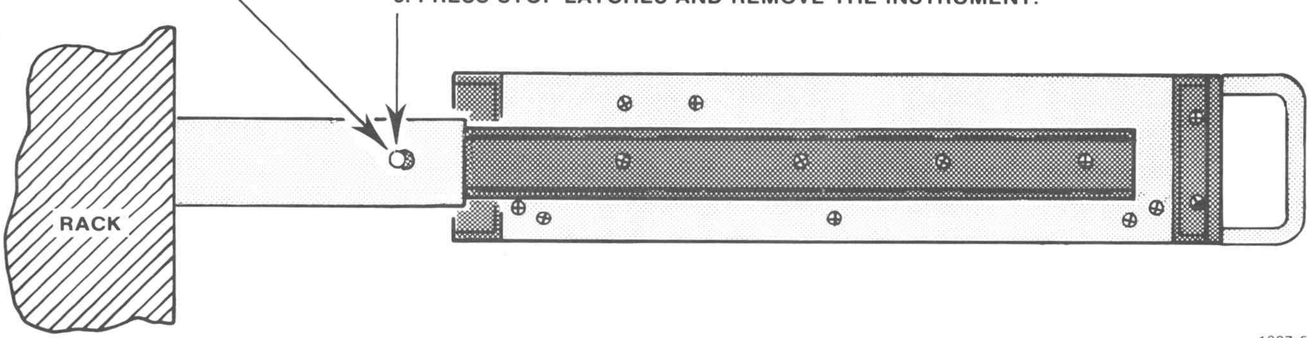


TO INSTALL

1. PULL THE SLIDEOUT TRACK INTERMEDIATE SECTIONS OUT TO THE FULLY EXTENDED POSITION.
2. INSERT THE INSTRUMENT CHASSIS SECTIONS INTO THE INTERMEDIATE SECTIONS.
3. PRESS STOP LATCHES AND PUSH INSTRUMENT TOWARD RACK UNTIL THE LATCHES SNAP INTO THEIR HOLES.
4. AGAIN PRESS STOP LATCHES AND PUSH INSTRUMENT INTO RACK.
5. SECURE THE INSTRUMENT IN PLACE WITH THE FRONT-PANEL SECURING SCREWS. DELETE THIS STEP FOR INITIAL INSTALLATION.

TO REMOVE

1. REMOVE THE FRONT-PANEL SECURING SCREWS.
2. PULL THE INSTRUMENT OUTWARD UNTIL THE STOP LATCHES SNAP INTO THE HOLES.
3. PRESS STOP LATCHES AND REMOVE THE INSTRUMENT.



1827-5

Fig. 3-10. Installing and removing a typical instrument.

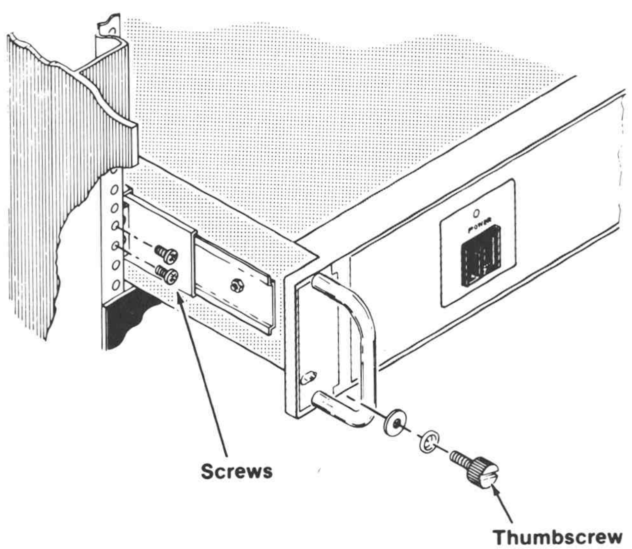
6. Adjust the slide out track positions as outlined in Fig. 3-11.

7. Push the instrument into the rack. Install and tighten the middle securing screw on each side of the front panel. Then unscrew them two turns each.

8. Install the support pin assemblies, as shown in Fig. 3-12. Push the assemblies forward against the instrument's rear support blocks while tightening them in place. This will insure a tight fit when the front panel screws are tightened.

9. Install the remaining front panel screws and tighten all front panel screws.

The tracks are permanently lubricated. However, if the instrument does not slide smoothly in the tracks after proper adjustment, a thin coat of paraffin can be rubbed onto the sliding surfaces.



1. LOOSEN SCREWS ON BOTH SIDES (LEFT SIDE SHOWN).
2. ALLOW SLIDES TO SEEK PROPER WIDTH.
3. CENTER INSTRUMENT.
4. RETIGHTEN SCREWS.
5. PUSH THE INSTRUMENT ALL THE WAY INTO THE RACK. IF TRACKS DO NOT SLIDE SMOOTHLY, CHECK FOR CORRECT SPACING BETWEEN THE REAR SUPPORTS.

1827-6

Fig. 3-11. Adjusting the slide-out tracks. (Typical instrument shown.)

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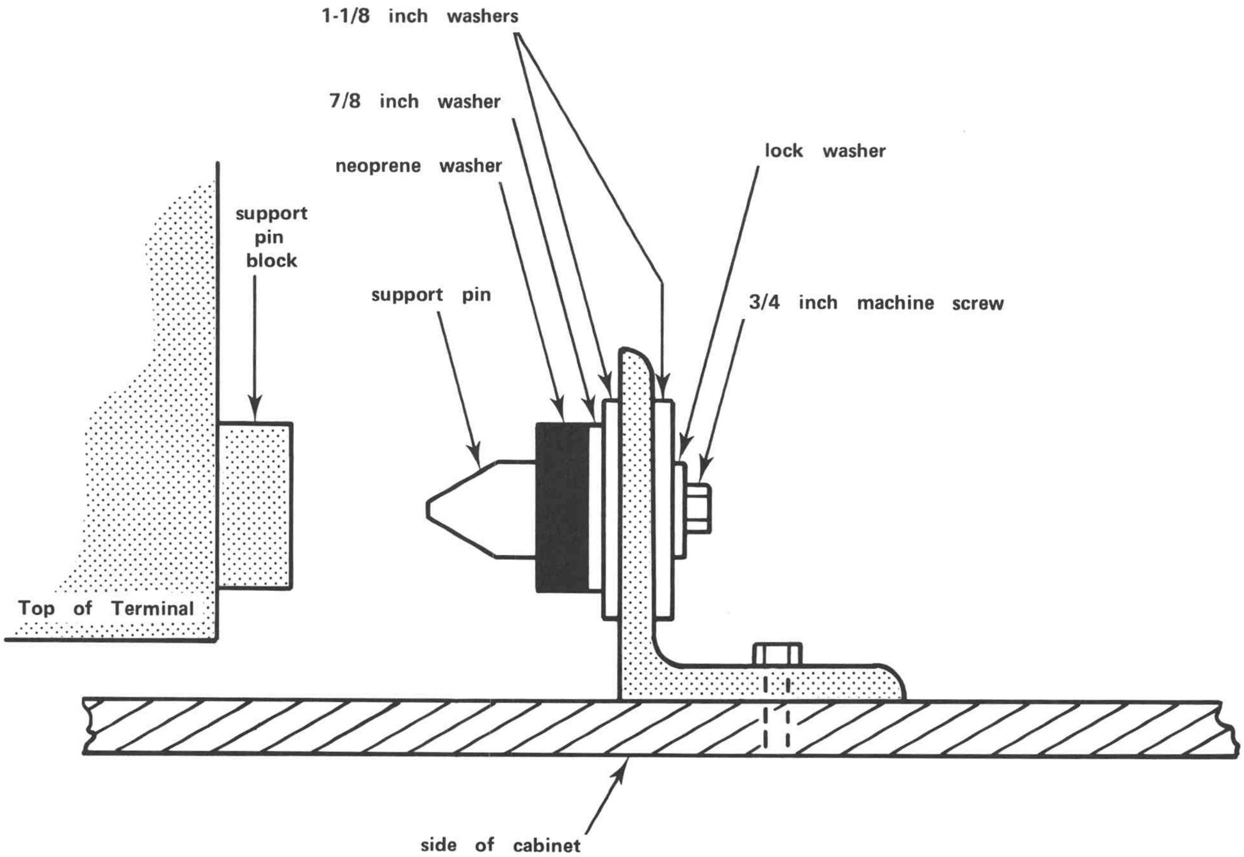


Fig. 3-12. Top view of right support pin assembly mounting. Mounting block does not have to be mounted to side of cabinet; any suitably placed horizontal or vertical surface may be used.

Section 4

PERFORMANCE CHECK/ADJUSTMENT

PERFORMANCE CHECK

General. This procedure can be used under normal operating conditions with all circuit cards installed. Since is uses LOCAL operation, no computer connection is required. Checks are referenced to a circuit and/or to a step in the Adjustment Procedure to permit rapid evaluation of incorrect results. In event of an improper response, recheck the step with all optional and interface cards removed from the Mother Board to determine if the Terminal itself is at fault. Steps requiring position measurement should be made without parallax. That is, the line of sight should be perpendicular to the viewing area; this can be achieved by closing one eye and checking that the reflection of the viewing eye is superimposed over the point being observed.

Activity	Results	Circuit/Adjustment
Connect the Terminal to appropriate line voltage and turn the Terminal on.	Green indicator glows: fuse indicator not lit	Power Supply (Steps 1 and 2)
Wait 30 seconds and then press PAGE	:rase cycle occurs.	Storage circuits (step 5)
Wait 3 minutes and again press PAGE	Alpha cursor appears in top-left of display, approximately 1/4 inch from left edge and from top edge of display area	High Voltage and Z Axis circuits; Deflection circuits (steps 3 and 4) Terminal Control (TC) circuits; Cursor brightness (steps 6 and 7)
Wait about 2 minutes	Cursor disappears	View/Hold circuits
Press SHIFT	Cursor re-appears	View/Hold circuits
Select LOCAL; Hold 8 key down and enter about ten 8s.	8s are written in line and remain stored on display	Keyboard; Deflection circuits; Character Generator; Storage circuits (step 5); Character brightness (steps 6 and 8)
Wait 5 minutes and press SHIFT	Check for fade-positive and drop-out effects. See Fig. 4-12.	Storage circuits (step 5)

Activity	Results	Circuit/Adjustment
Enter LF	With LF EFFECT option at LF, cursor moves vertically to next line; with LF EFFECT option at LF → CR, cursor moves to next line and to margin at left of display	TC
Enter 8s to complete a line (74 characters)	Cursor resets to next line and to margin at left of display	TC
Press PAGE	Erase cycle occurs; cursor goes home	TC
Enter 34 LFs	Cursor goes to bottom-left corner of display	
Enter 35th LINE FEED	Cursor moves to Margin 1 position at top-center of display	
Enter 37 8s	8s written and stored; cursor moves to next line and back to Margin 1	TC
Enter 5 Space commands	Cursor moves 5 spaces to right	TC
Enter RETURN	With CR EFFECT option at CR, cursor moves to margin at center of display; with CR EFFECT option at CR → LF, cursor moves to margin at center of display and also moves vertically to the next line	TC
Check that the TTY LOCK key is released.	Check for proper writing and focus of ASCII characters	Keyboard; TC; Focus (step 9)
Enter each written character indicated on the keyboard, including shifted characters.	Characters are written on display	Keyboard; TC
Enter PAGE	Display erases; cursor goes home	

Activity	Results	Circuit/Adjustment
Press the TTY LOCK key to place it in its locked position. Press each character key with the SHIFT key released	All letters should be written upper case	Keyboard
Enter ` { ¦ and ~	Note that they are inhibited. The code for the unshifted symbol is sent, regardless of the SHIFT key position	Keyboard
Press the TTY LOCK key	Lock releases	
Enter PAGE	Display erases; cursor goes home	
Enter ESC CTRL Z	Crosshair cursor appears but does not store. (Move thumbwheels to check for storage)	TC; Crosshair Cursor Intensity or Focus (steps 10 and 11)
Move vertical thumbwheel to upper limit	Horizontal line moves up near top of display; approximately 1/4 inch spacing exists between ends of line and edges of display area	TC; Deflection Amplifier (step 4)
Move horizontal thumbwheel to mid-position	Vertical line is positioned near center of display; bottom of line should be approximately 1/4 inch from bottom edge of display area; horizontal line should be approximately 1/4 inch from top edge of display area	TC; Deflection Amplifier (step 4)
Check horizontal line straightness	All points should be within 0.5%. Distance between any point on line and the mean path of the line should not exceed .04 inch	Deflection Amplifier (step 4)

Activity	Results	Circuit/Adjustment
Move vertical line to a position near the left edge of the display area (using the horizontal thumbwheel) and check vertical line straightness	All points should be within 0.5%. Distance between any point on the line and the mean path of the line should not exceed .03 inch.	Deflection Amplifier (step 4)
Enter PAGE	Crosshair disappears, Alpha cursor appears at top-left corner	TC
Enter ESC CTRL Z	Crosshair returns	
Enter any key except PAGE or SHIFT RESET	No effect	
Position the crosshair intersection to approximate mid-screen and enter SHIFT RESET	Crosshair disappears and Alpha appears at top-left corner	
Enter CTRL SHIFT M	Cursor disappears	TC
Enter Space Space @	Dark vector is executed; cannot be observed	TC
Enter @	Dot appears in lower-left corner	TC
Enter 8 k 8 K	45° diagonal line appears; starting from bottom-left corner	TC
Check line focus	Should be sharply focused	step 9
Check dynamic geometry	Distance between any point on the line and the mean path of the line should be within 2% (0.17 inch) of line length.	
Press PAGE	Alpha cursor appears at top-left	TC
Enter CTRL G (BEL)	Rings bell	TC
Enter TAB	Cursor moves one space to right	TC

Activity	Results	Circuit/Adjustment
Enter CTRL I (HT)	Cursor moves one space to right	TC
Enter BACKSPACE	Cursor moves one space to left	TC
Enter CTRL H (BS)	Cursor moves one space to left	TC
Enter LF	Cursor moves down one line; may also return to margin if the LF EFFECT option is at LF → CR	TC
Enter CTRL J (LF)	Cursor moves down one line	TC
Enter CTRL K (VT)	Cursor moves up one line	TC
Enter CTRL SHIFT M (GS)	Selects Graph Mode; cursor disappears	TC
Enter Space RUBOUT Space _ + RUBOUT Ø _	Vector is drawn from lower-left corner to center of screen	TC
Enter ESC CTRL W (ESC ETB)	Copy of display is made if Hard Copy Unit is attached and energized	TC; Hard Copy TARSIG Amp; Hard Copy Selector; High Voltage and Z Axis circuit; Storage circuit; steps 16 through 20
Enter ESC CTRL L (ESC FF)	Display erases; Alpha cursor homes	TC
Enter CTRL SHIFT M (GS)	Cursor disappears	TC
Enter @ @	Dot appears near display center	TC
Enter CTRL SHIFT O (US)	Alpha cursor appears with bottom-left corner at dot	TC
Enter CTRL SHIFT M (GS)	Cursor disappears	TC
Enter @ _	A horizontal line is written near display center	TC
Enter CTRL M (CR)	Alpha cursor appears at left margin opposite the line. If CR EFFECT strap is at CR → LF, the cursor will also move down one line	TC

Activity	Result	Circuit/Adjustment
Enter CTRL SHIFT M Space Space DD	A dot should appear at bottom-left corner	TC
Enter CTRL SHIFT M 8 k ? _ _	A dot should appear at upper-right corner	TC
Enter ESC CTRL Z (ESC SUB)	Crosshair cursor appears (should not be entered at keyboard with switch at LINE)	TC
Using thumbwheels, move intersect point to dot at bottom left of display	Intersect point is positioned to 4X, 0Y	TC
Move intersect point to dot at top right of display	Intersect point is positioned to 1023X, 779Y	TC
Press PAGE	Display erases; Alpha Mode is reset; Alpha cursor goes home. Performance check completed	

ADJUSTMENT

Introduction

Adjustment of the Terminal normally is required only when it ceases to properly perform its intended functions, or after circuit repairs have been made. However, if adjustment is to be performed on a routine schedule, an interval of one year between adjustments is recommended. Adjustment should be preceded by a thorough cleaning and inspection as outlined in the Servicing section. Adjustment should be performed in a +20° C to +30° C environment and should be preceded by a thirty minute warmup period. In the event the Terminal will be used in an environment whose temperature is always at an extreme, adjustment should be done at that temperature instead of at the previously stated +20° C to +30° C.

Equipment Required

The following equipment is required in this procedure:

Variable Voltage Source. Output capability of at least 2 A at 100, 110, or 120 V ac or at least 1.25 A at 200, 220, or 240 V ac. The instrument output should be variable to at least plus and minus 10% from the stated value.

Oscilloscope. Dual trace with vertical deflection factors of 5 mV, 0.5 V, and 2 V per division, and sweep rates of 0.1 μs, 10 μs and 10 ms per division; frequency response should include DC to at least 10 MHz.

Voltmeter. Range at least −25 V dc to +400 V dc; accuracy within at least .05% at +15 V, 0.1% at −15 V, 0.2% at +5 V, and at least 1% at all other voltages. High voltage range to −6000 V dc, accurate to within at least 0.5% at −5850 V dc.

Test Graticule. (optional) Tektronix Part No. 067-0771-00. Provides greater convenience and accuracy in adjusting display size and geometry.

Wrench. 11/32 inch, open end, minimum of 8 inches overall. Tektronix Part No. 003-0771-00.

Screwdriver. 1/8 inch tip; non-conductive, not more than six inches overall length.

Hard Copy Unit. Used for adjusting copy-making circuitry, which must be adjusted only if the Terminal will be used with a Hard Copy Unit.

Index of Adjustments

The following can serve as an index, or as an adjustment record. It can also be used as a short form adjustment procedure for technicians experienced in adjusting the Terminal. If used as a record of adjustment, copies should first be made to avoid writing on the copy in the manual.

Date adjusted:__________ By:______________________________

Preliminary Procedure. Set the equipment up for adjusting. Page 4-11

Detailed Procedure. Page 4-11

1. Low Voltage Power Supply Check/Adjustment (R57, Reg Voltage on Power Supply Board) Page 4-13

   See Tables 4-1 and 4-2 for details.

2. High Voltage Check/Adjustment (HV LEVEL on High Voltage & Z Axis Board) Page 4-18

   Adjust HV LEVEL for −5850 V at TP45.

3. Pre-adjust Writing Intensity, Focus, and Alpha Cursor Brightness (FOCUS ADJUST and WRITING INTENSITY on High Voltage & Z Axis Board; Alpha cursor Brightness on TC-1) Page 4-20

With Cursor Brightness on TC-1 fully CW, adjust WRITING INTENSITY until no dot appears after an erase cycle; adjust Cursor Brightness on TC-1 for minimum brightness consistent with good viewing; adjust FOCUS ADJUST for focused cursor.

4. Display Positioning Check/Adjustment (X GAIN, Y GAIN, X POS, Y POS, X GEOM, Y GEOM on Deflection Amp & Storage Board) Page 4-21

Adjust Crosshair Brightness, R29, on TC-2 for non-storing cursor; with Test Graticule installed, adjust X GAIN and X POS for proper position and length of crosshair cursor's horizontal line; adjust Y GAIN and Y POS for proper position of bottom of crosshair cursor's vertical line, and vertical position of Alpha cursor at "home" position; adjust X GEOM for straight vertical line; adjust Y GEOM for straight horizontal line.

4 (Alternate). Display Positioning Check/Adjustment (X GAIN, Y GAIN, X POS, Y POS, X GEOM, Y GEOM on Deflection Amp & Storage Board) Page 4-24

Adjust R29, Crosshair Brightness on TC-2 for non-storing cursor. Adjust X POS to center horizontal GIN line; with vertical thumbwheel at upper limit, adjust Y POS so horizontal line is the same distance from the top of the display area as the bottom of the vertical line is from the bottom of the display area; rotate yoke-mounting bracket for parallelism between horizontal line and top of display area; adjust X GEOM for straight vertical line; with horizontal line near top of display, adjust Y GEOM for straight horizontal line; adjust X GAIN for 7.8 inch horizontal line; adjust Y GAIN for 5.9 inches between bottom of vertical GIN line and top of top line of Alpha Mode characters.

5. Storage Check/Adjustment (NORM COLL, OP LEVEL in Deflection Amp & Storage Board in display unit) Page 4-29

Adjust NORM COLL for presence (at Hard Copy TARSIG Amplifier board TP127) of CE value written on shield; adjust OP LEVEL for presence (at Hard Copy TARSIG Amplifier board TP35) of STORAGE LEVEL value written on shield for same CRT, or to value midway between fade-positive and drop out for replacement CRT. Re-adjust OP LEVEL as necessary to avoid fade-positive after erase cycle, or drop out from fully written page. Re-adjust NORM COLL for optimum uniformity and brightness; NORM COLL should not be set to less than 90 V.

6. Writing Intensity Check/Adjustment (WRITING INTENSITY on High Voltage & Z Axis Board) Page 4-34

Adjust WRITING INTENSITY for complete vectors drawn by the following commands:

Space Space @ 8 k ? _ 8 k Space @ Space ` ? 8 k ? _

7. Alpha Cursor Brightness Check/Adjustment (R91, Alpha Cursor Brightness on TC-1) Page 4-36

Adjust R91 for desired non-storing Alpha cursor intensity.

8. Alpha Character Brightness Check/Adjustment (R95 Character Brightness on TC-1) Page 4-37

Adjust R95 for desired brightness of Alpha Mode characters.

9. Character and Vector Focus Check/Adjustment (FOCUS and CHARACTER/VECTOR FOCUS on High Voltage & Z Axis Board) Page 4-37

Adjust FOCUS for best focus of an e character in top-left corner of display. Compromise for sameness in four corners of display area. Adjust CHARACTER/VECTOR FOCUS for similar focus of e near center of display.

10. Crosshair Cursor Intensity Check/Adjustment (R29, Crosshair Cursor Brightness on TC-2) Page 4-39

Adjust R29 in GIN Mode so that the cursor is visible but does not store.

11. Cursor Focus Check/Adjustment (Cursor Focus on High Voltage & Z Axis Board) Page 4-39

With crosshair displayed, intersect near screen center, adjust cursor Focus for optimum overall focus.

12. Vector Dynamic Geometry error check Page 4-39

Check that separation between vectors does not exceed 1/4 inch after entering following commands in Graph Mode:

Space ` Space @ 8 k 8 K Space ` Space @

13. Vector Parallelism Check Page 4-40

Enter Space ` Space @ 8 k @ k ? _ Space ` _ ` Space @ and then check that the difference between lengths of the horizontal lines does not exceed 0.16 inch, and that the difference between lengths of the vertical lines does not exceed 0.12 inch. Or, using graticule, lengths should be within limits defined on graticule.

14. Character Transmission and Writing Check Page 4-41

Check writing of each ASCII character; check that TTY LOCK restricts transmission to TTY code.

15. Control Character Transmission and Response Check — Page 4-41

Check control character response as outlined in step 15 of the detailed procedure.

16. Hard Copy position and Amplitude Check/Adjustment (X HC AMP, Y HC AMP, X HC POS, Y HC POS on Deflection Amp & Storage Board) — Page 4-43

Adjust Y HC POS and Y HC AMP for scan 1/4 inch below and 1/8 inch above page full of written characters; adjust X HC POS and X HC AMP for scan 1/8 inch beyond left and right edges of page full of written characters.

17. Hard Copy Intensity Adjustment, HC INTENSITY, COARSE on the High Voltage & Z Axis Board, HARD COPY BRIGHTNESS on the front of the Terminal — Page 4-45

With the front-panel HARD COPY BRIGHTNESS at mid-range position, adjust the HC INTENSITY, COARSE just below the level at which the Hard Copy scan bar stores.

18. Hard Copy Threshold Check/Adjustment (R167, Hard Copy Threshold on Hard Copy Amplifier Board) — Page 4-45

Adjust R167 so that pulses observed at TP85 and TP195 are almost touching during Hard Copy scanning. Oscilloscope at 0.5 μs and 0.5 V per division.

19. Hard Copy Dynamic Threshold Adjustment (R265, Hard Copy Dynamic Threshold on Hard Copy Amplifier Board) — Page 4-48

Adjust R265 so separation between waveforms remains fairly constant during Hard Copy scanning. Oscilloscope at 10 μs and 0.5 V per division.

20. Hard Copy Writing Check — Page 4-49

Check for five sequential satisfactory copies of the same display. Re-adjust HARD COPY BRIGHTNESS if necessary.

21. Restoring Original Conditions — Page 4-50

Turn Terminal off; remove line plug; reset transformer wiring and fuse; reset option straps. Remove jumpers(s) if asynchronous interface is installed, and reconnect output cable. Replace covers.

Preliminary Procedure

Turn off the Terminal POWER switch and remove the line cord from the power source.

WARNING

Dangerous voltages exist within the Terminal. Normal electrical precautions should be observed whenever working within the unit while the covers are removed. Keep the line cord disconnected when working in the transformer area.

Remove the top, left side and back covers from the Terminal. Pull the interlock (under right cover, at bottom-front) to its out position.

This procedure does not include accessory cards which may be used with the Terminal (such as Display Multiplexer). Therefore, remove all cards other than TC-1, TC-2, the Communication Interface Card (i.e., General Purpose Asynchronous Serial Interface) and the Deflection Amp & Storage board from the Mother Board. See Fig. 4-1.

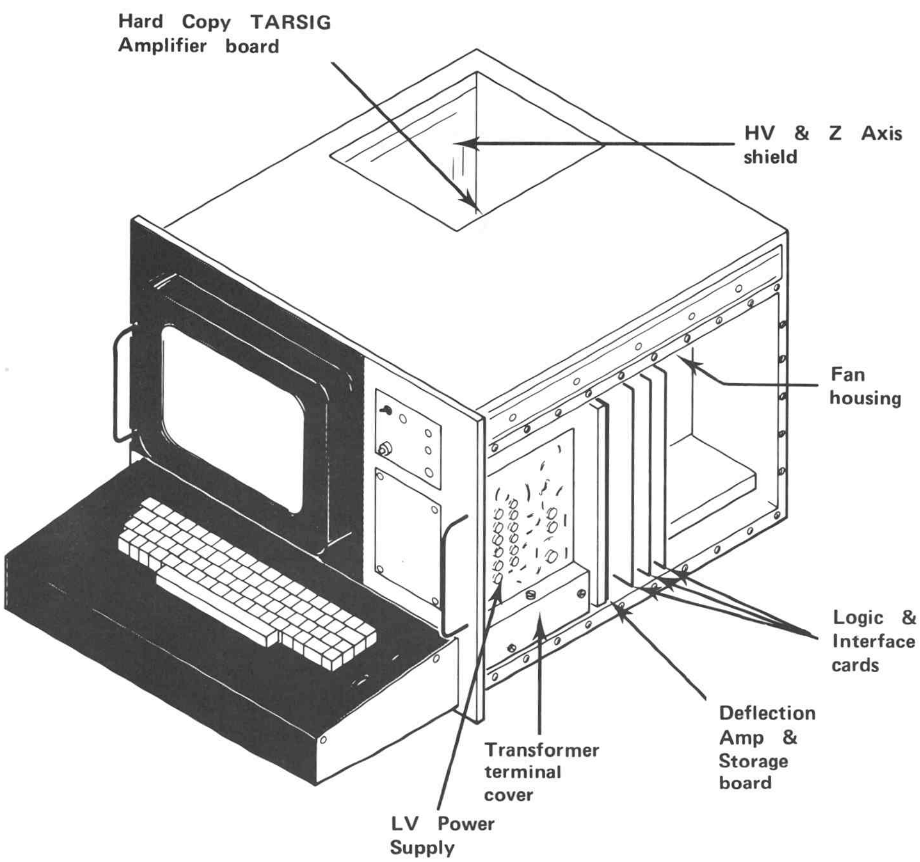


Fig. 4-1. Setup for adjusting.

Performance Check/Adjustment—RE4012

Pull TC-1 and TC-2 out and check the strap options shown in Fig. 4-2. TC-1 can be identified by the two adjustments on the front edge, near the top. TC-2 has an adjustment and cable connections near the bottom-outer corner. If the strap option positions must be changed, record their original positions and change them to agree with Fig. 4-2. Then install the cards in the minibus.

Change the Origin Shift strap on the Deflection Amp & Storage Board (Fig. 4-1 and 4-2) to CAL position.

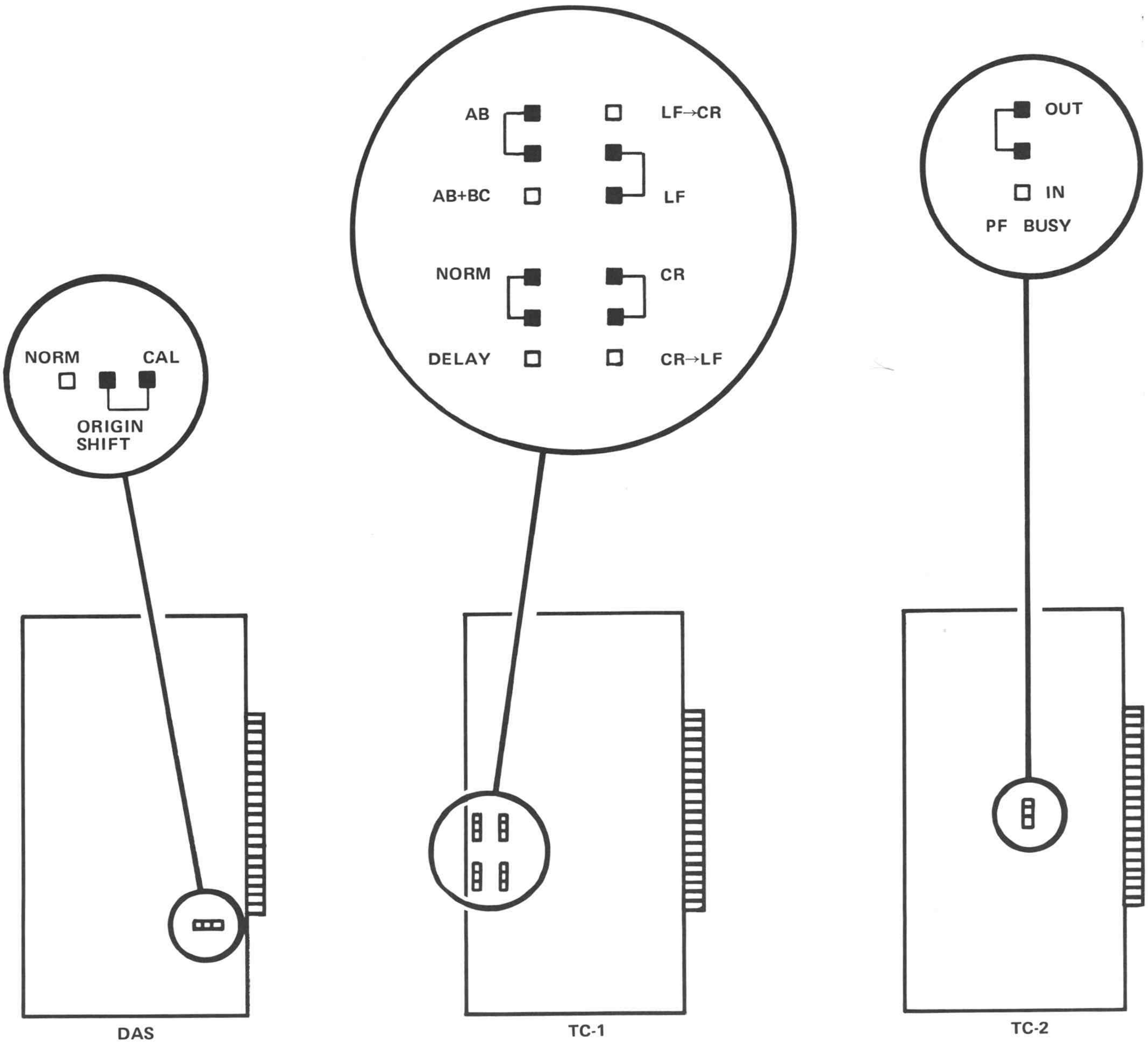


Fig. 4-2. TC-1, TC-2 and Deflection Amp and Storage strappable option selections for adjusting the Terminal.

Determine the type of Interface card installed. If it is a General Purpose Asynchronous Serial Interface 021-0160-00, check it against Fig. 4-3 and set the indicated straps to specified positions. Although positions of other straps are not pertinent, all straps should be in place in some valid position. Note that P110 is disconnected from J110, and J110 pins 2 and 6 are shorted together. Install the Interface card in the Mother Board.

If a General Purpose Parallel Interface 021-0159-01 is installed, all straps should be in a valid position, and it should be connected to a computer, if available.

At the lower left corner, within the right side of the cabinet, remove the shield which covers the transformer terminals (see Fig. 4-1). It is held in place by four screws. Determine what voltage the transformer is wired for, by comparing the connections against Fig. 4-4. If a variable AC power supply is available, it will be set to that value. If the indicated supply is not available, record the transformer wiring condition so that it can be restored upon completion of the adjustment procedure. Then rewire the transformer connections to agree with the available voltage supply, as indicated in Fig. 4-4. Replace the shield to minimize shock hazard.

Install an appropriate slow blow fuse (3.2 A for 115 V or 1.6 A for 230 V) in the front-panel fuse holder.

Check the remaining fast blow fuses for proper sizes. Their values should be F221-2A, F225-2A, F381-8A.

Detailed Procedure

1. Low Voltage Power Supply Check/Adjustment (R57, Reg Voltage on Power Supply Board)

a. After the preliminary procedure has been completed, connect the line cord to a variable power source (autotransformer) which is set to the voltage for which the transformer is wired. If no autotransformer is available, connect it to the available power source, after wiring the transformer circuit to be compatible, as explained in the preliminary procedure.

b. Turn the Terminal power switch ON and place the LOCAL/LINE switch at LOCAL.

c. Connect the voltmeter reference lead to ground at J71. See Fig. 4-5.

d. Using a voltmeter which has .05% or better accuracy at 15 V, adjust R57 to obtain +15.000 V at J77 pin 1. Adjustment and test point locations are shown in Fig. 4-5.

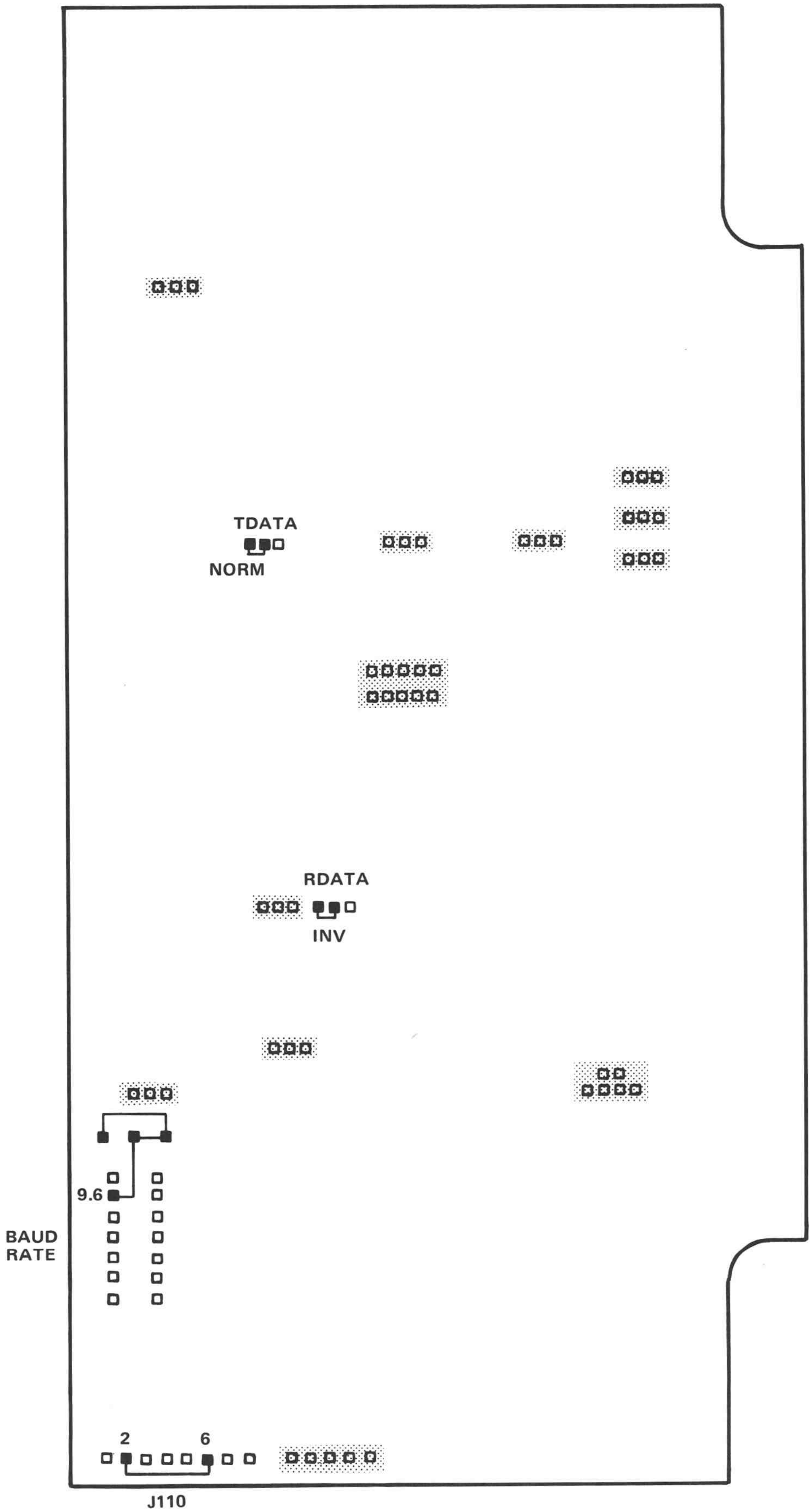
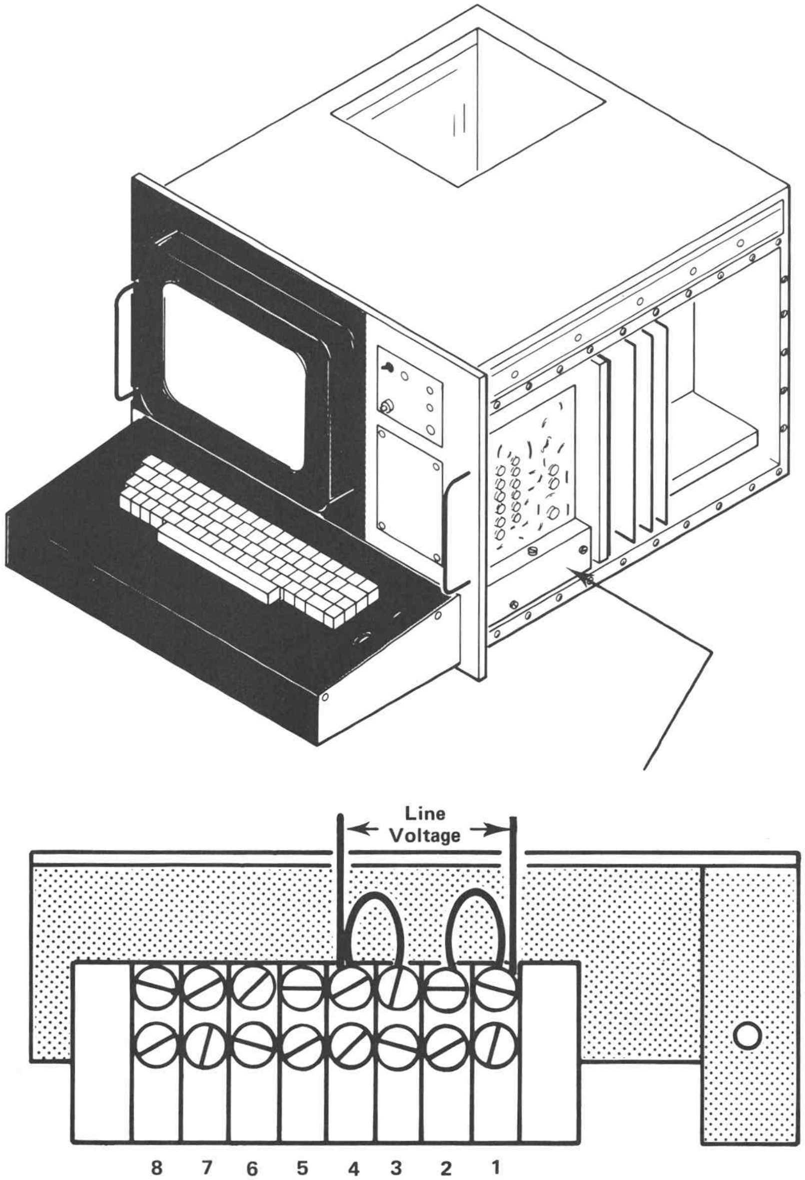


Fig. 4-3. General Purpose Asynchronous Serial Interface strap positions for adjusting the Terminal. Positions of pertinent straps are shown. Other straps are indicated by blocks and may be in any valid position.



(A) Terminal layout, shown wired for 115V ± 10%.
Line voltage is always connected to 1 and 4.

Voltage (±10%)	100	115	120	200	220	230	240
Terminals jumpered together	1-8 4-5	1-2 3-4	1-7 4-6	5-8	5-7	2-3	6-7
	two jumpers required			one jumper required			
Line fuse	3.2A			1.6A			

(B) Connections and fuse sizes for various voltages.

Fig. 4-4. Transformer connection information.

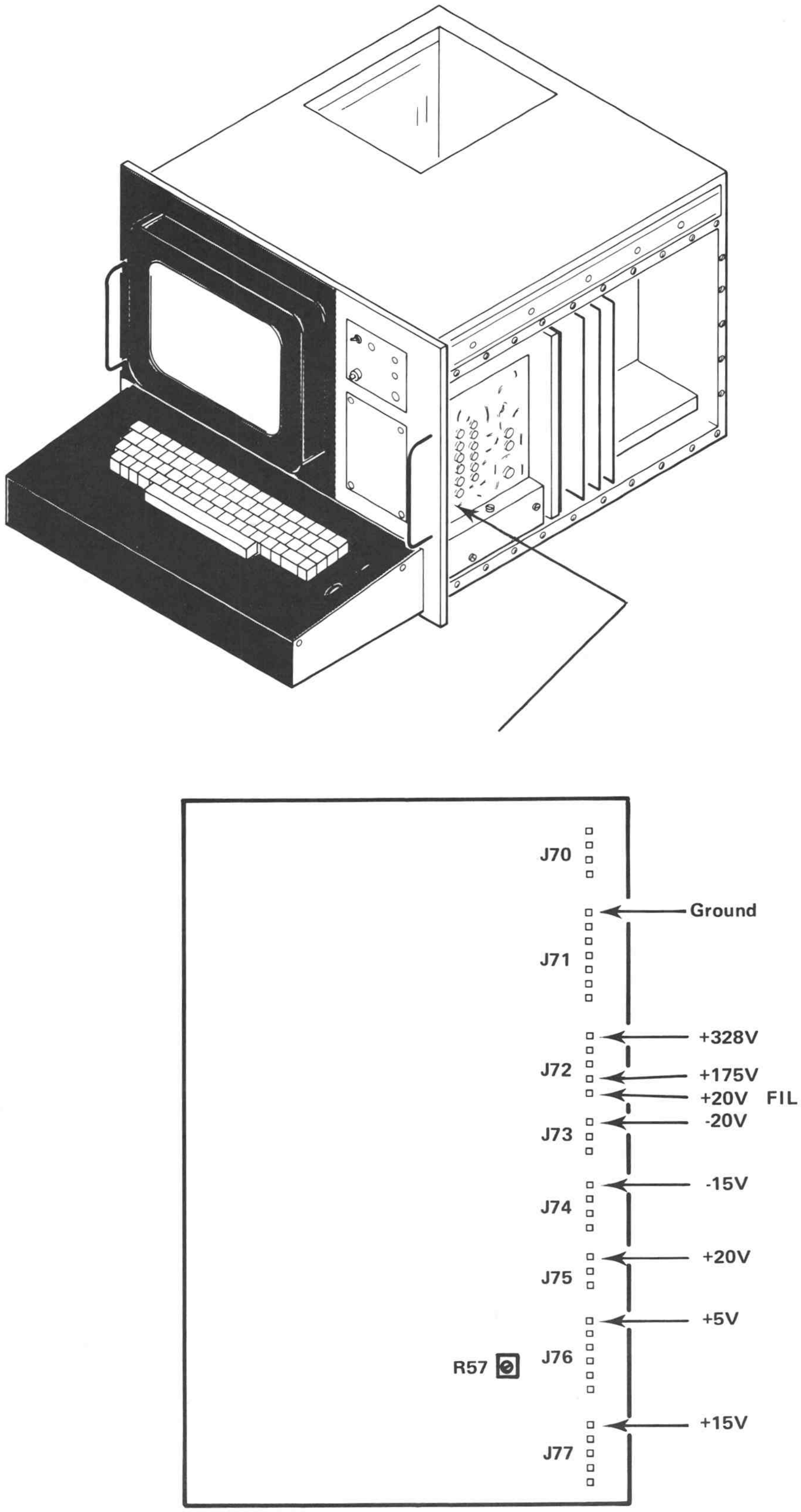


Fig. 4-5. Low Voltage Power Supply adjustment and test point locations.

e. Measure the various power supply voltages as listed in Table 4-1. Test points are shown in Fig. 4-5. Record all voltages in Table 4-2. (Make duplicate copies of Table 4-2 for future use.)

f. Using the test oscilloscope, check that ripple voltages do not exceed those values given in Table 4-1.

g. Change the variable power source to 10% below the center value for which the tranformer is wired.

h. Measure and record the supply voltages, again using Tables 4-1 and 4-2. Then check the ripple of each supply.

i. Change the variable power source to 10% above the center value for which the transfomer is wired.

j. Again measure and record the supply voltages and check ripple.

k. Analyze the results. All voltages should be within the specified values. The differences between voltages at center line and either high or low line should not show a regulation factor larger than that specified in Table 4-2.

l. Set the line voltage to the center voltage for which the tranformer is wired.

TABLE 4-1

Power Supply Voltage Limits

Supply	Jack	Voltage Limits	Ripple (P-P)	Comments
+15 V	J77	+14.025 to +15.075	10 mV	Adjust R57 for +15.000 V; readjust if necessary to compromise so that +15, +5, and −15 V supplies are all within limits with line voltage at mid-position as well as at high and low limit.
+5 V	J76	+4.9 to +5.1	10 mV	
−15 V	J74	−14.850 to −15.150	10 mV	
−20 V Unreg	J73	−21 to −27	2.8 V	Not adjustable
+20 V Unreg	J75	+21 to +27	2.8 V ±0.8 V H.V.	
+20 V Fil	J72-5	36 to 44 V more positive than −20 V Supply	2.8 V	
+175 V Unreg	J72-4	+163 to +176	6 V	
+328 V Unreg	J7103	+317 to +330	8 V	

TABLE 4-2

Observed Voltages

Supply	(A) Center Line Voltage	(B) Low Line Voltage	(C) High Line Voltage	(D) Greater Deviation From (A)	% Observed Regulation $\frac{(D)}{(A)}$ X100	Regulation Limit
+15 V						0.2%
+5 V						1.0%
−15 V						0.2%
−20 V Unreg				NOT APPLICABLE		
+20 V Unreg						
+20 V Fil						
+175 V Unreg						
+328 V Unreg						

2. High Voltage Check/Adjustment (HV LEVEL on High Voltage & Z Axis Board)

a. With the Terminal off, set the voltmeter to read −5850 Vdc and connect it to TP45 on the High Voltage & Z Axis board in the back of the unit. See Fig. 4-6. The TP45 eyelet can be seen by looking into the cutouts on the front edge of the shield.

b. Reconnect the line cord and turn the Terminal power switch ON.

c. After about one minute, press PAGE. Then check for −5850 V at TP45. Adjust HV LEVEL (Fig. 4-6) as necessary to obtain that value. Use a non-metallic screwdriver to minimize the possibility of causing a short circuit.

d. Set the variable power source first to 10% below the transformer center voltage and then to 10% above it and check that the high voltage remains between −5557 and −6143 volts at both positions.

e. Set the variable power source to the transformer center voltage.

f. Turn the terminal power switch OFF.

g. Disconnect the voltmeter from TP45.

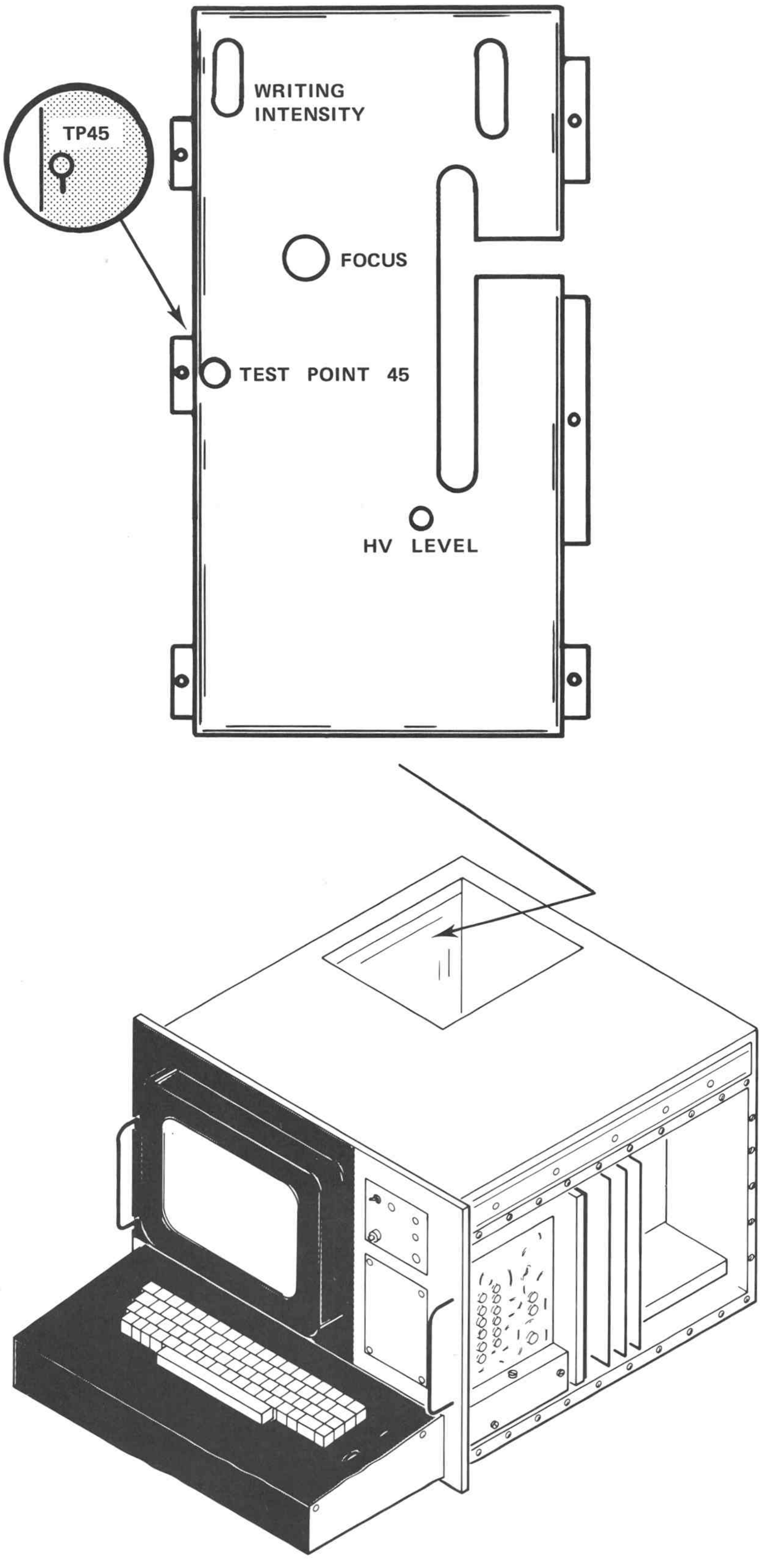


Fig. 4-6. High Voltage adjustments and test points.

3. Preadjust Writing Intensity, Focus, and Alpha Cursor Brightness (FOCUS ADJUST and WRITING INTENSITY on High Voltage & Z Axis Board; Alpha Cursor Brightness on TC-1)

a. In this and subsequent steps employing Alpha Mode, the Terminal may go into Hold status, diminishing display brightness. Entering any character will restore the View status; however, pressing the SHIFT key will restore View status without otherwise affecting the display.

b. Turn the Terminal ON and after approximately one minute, momentarily press the PAGE key to initiate an erase cycle.

c. Note the edges of the display area after the erase cycle has been completed. If the edges become obviously brighter than the rest of the display area (fade-positive, Fig. 4-12), turn the OP LEVEL (on Deflection Amp & Storage board, Fig. 4-7) fully counterclockwise. (OP LEVEL will be adjusted properly in a later step.)

d. At TC-1, turn R91, Alpha Cursor Brightness, fully clockwise. (See Fig. 4-7 for location.)

e. Enter 17 LF commands and 37 space commands.

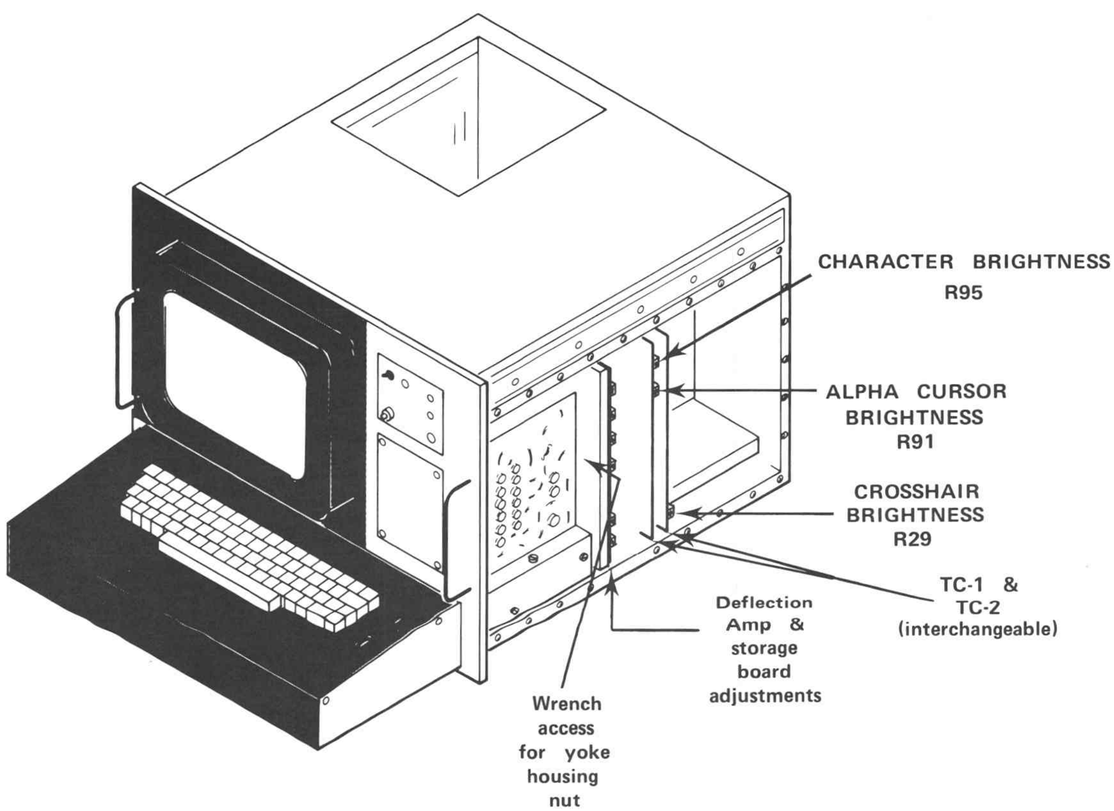


Fig. 4-7. Circuit card and adjustment information.

f. On the High Voltage & Z Axis board in the back of the unit, rotate WRITING INTENSITY (Fig. 4-6) to increase intensity until the Alpha cursor can be seen near the center of the display. Do not make the cursor any brighter than is necessary. If the Alpha cursor doesn't appear, R91 on TC-1 may be set to the wrong limit, or the Terminal may be in Hold status. (Press SHIFT to clear Hold status.)

g. Press PAGE. The cursor should move to the top-left corner of the display. If the cursor was viewable in step f, and now has moved entirely out of the viewing area turn X POS fully clockwise and Y POS fully counterclockwise to bring the cursor back into view. X POS and Y POS are located on the top of the Deflection Amp & Storage board, whose location is shown in Fig. 4-7.

h. Press PAGE and check for the momentary appearance of a dot at the bottom-left of the cusor position. The dot may appear just before the cursor comes back into view. Adjust WRITING INTENSITY (Fig. 4-6) until a dim dot momentarily appears at the bottom-left corner of the cursor position after the erase cycle, as just described. *CAUTION—Do not allow the dot to become too bright.* Then readjust WRITING INTENSITY just to the point where the dot no longer appears after an erase cycle. The cursor should still be visible.

i. At TC-1, adjust R91, Alpha Cursor Brightness (Fig. 4-7) until the cursor is at minimum brightness consistent with good viewing.

j. Adjust FOCUS ADJUST on the High Voltage & Z Axis board (Fig. 4-6) to obtain a reasonable focused cursor. (Final focusing will be done later in the procedure.)

4. Display Positioning Check/Adjustment (X GAIN, Y GAIN, X POS, Y POS, X GEOM, Y GEOM on Deflection Amp & Storage Board)

NOTE

Use this procedure if a Test Graticule, Tektronix Part No. 067-0771-00 is available. If a graticule is not available, use Step 4 (Alternate) which immediately follows step 4.

a. Situate the Terminal so that the display screen is facing approximately East or West to minimize effect of earth's magnetic field.

b. Install the test graticule over the display screen, within the bezel. Move the graticule so the outer lines on the top and right are superimposed over the top and right edges of the screen, where it meets the dark mask area. This will hereafter be referred to as reference position.

c. Enter ESC and CTRL Z and place the keyboard thumbwheels near midrange. A crosshair cursor should appear on the display. If it does not, or if it is excessively bright or dim, adjust R29, Crosshair Brightness (on TC-2, Fig. 4-7) as necessary to provide a display of minimum intensity, consistent with good viewing. The crosshair should not be so bright that it stores; move the thumbwheels to check for storing.

d. Enter PAGE and ESC and CTRL Z to erase the display and regain the crosshair cursor. Place the horizontal and vertical thumbwheels near mid-position; then perform a rough check of the display as follows. If the display appears approximately correct, continue with the procedure without adjusting anything at this point. If any parameters are grossly in error, perform a coarse adjustment of any or all of the listed adjustments to approximately obtain described results before proceding. Adjustments are located on the Deflection Amp & Storage Board, whose location is shown in Fig. 4-7.

Desired Results	Adjust
Cursor's horizontal line is approximately parallel with the graticule's center horizontal line.	Yoke Rotation (Follow procedure and precautions in Step 4e.)
Cursor's horizontal line extends from graticule's left vertical line to its 2nd from right vertical line.	X GAIN, X POS
Cursor's vertical line starts at graticule's bottom horizontal line.	Y GAIN, Y POS
With vertical thumbwheel at upper limit, cursor's horizontal line is *in the vicinity* of the two closely-spaced vertical lines at the top of the graticule.	Y GAIN, Y POS
Horizontal line is approximately straight.	Y GEOM
Using horizontal thumbwheel, move cursor's vertical line to the vicinity of the two closely-spaced vertical lines at the left on the graticule. Vertical line should be approximately straight.	X GEOM

e. Check/Adjust Yoke Rotation. Using the vertical thumbwheel, locate the cursor's horizontal line directly under the center horizontal line on the graticule. The two should be parallel. If not parallel, loosen the yoke housing nuts (Fig. 4-8) and adjust the yoke rotation lever to obtain parallelism.

CAUTION

Access for the special 11/32 inch open-end wrench is provided between the LV Power Supply board and the Deflection Amp & Storage board (Fig. 4-7). However because of the proximity of voltage-laden transistor cases, the Terminal should be shut off prior to loosening the Yoke Housing nuts.

After loosening, turn the Terminal on, press PAGE and enter ESC CTRL Z; move the Yoke Rotation Lever to obtain parallelism. Then turn the Terminal off and tighten the Yoke Housing nuts.

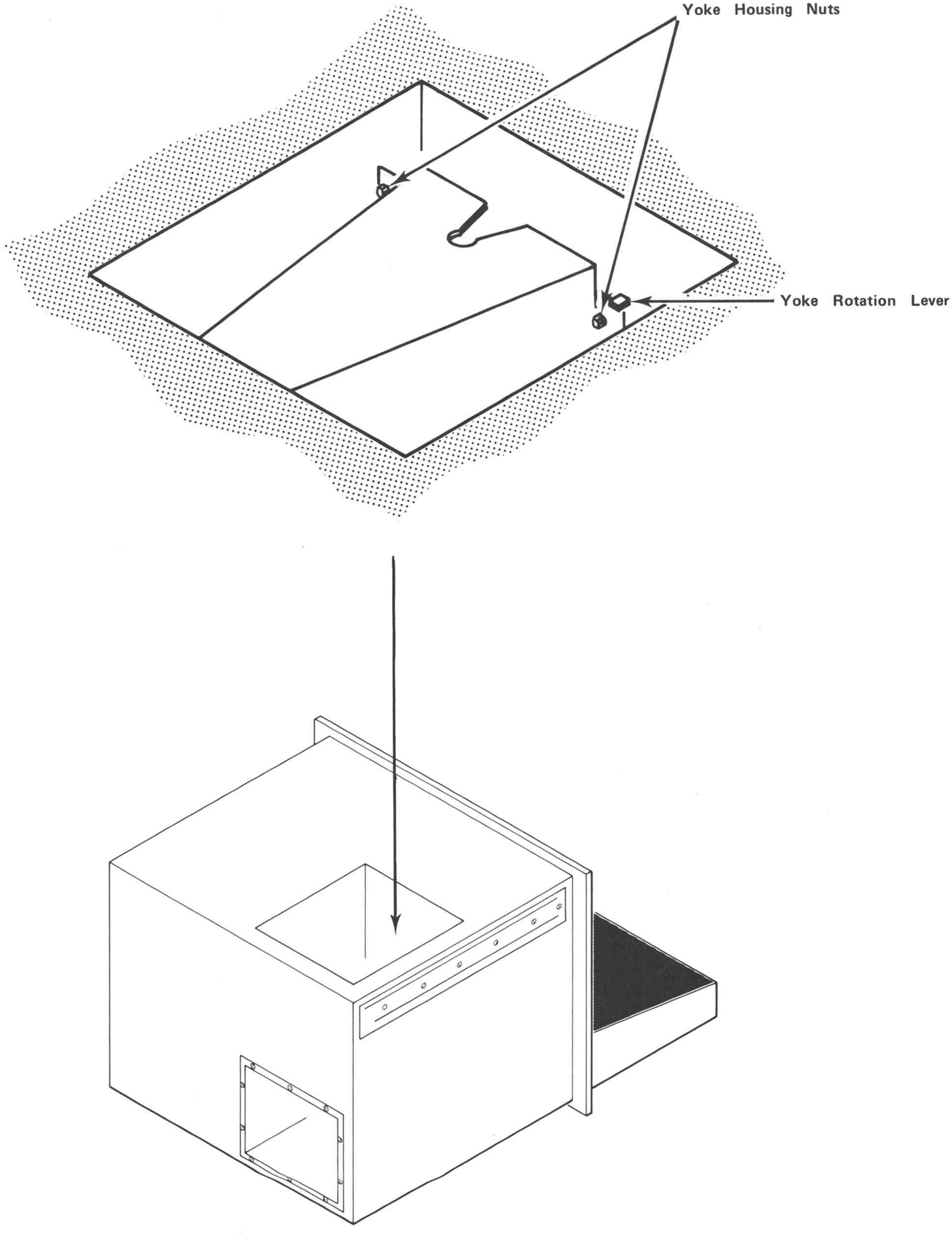


Fig. 4-8. Yoke Housing information.

f. Check/Adjust X GAIN and X POS. Turn the Terminal on and press PAGE and ESC CTRL Z. The crosshair cursor's vertical line should start at the bottom horizontal line and extend through the top edge of the display area. If it doesn't, adjust Y GAIN and/or Y POS on the Deflection Amp & Storage Board (Fig. 4-7) to achieve those results.

g. Press PAGE and check the top of the Alpha cursor. It should be aligned with the upper of the two closely-spaced graticule lines. If it isn't adjust Y GAIN and/or Y POS to achieve those results. Repeat steps f and g until both are acceptable.

h. Check Orthogonality. Enter ESC and CTRL Z and align the cursor's vertical line with the graticule center vertical line. Check that the top and bottom of the vertical line passes between the two short vertical lines which straddle the graticule's center vertical line at top and bottom. (Note that the cursor's horizontal line must be parallel to the graticule's horizontal line before this check can be reliably made. Orthogonality is not adjustable.)

i. Check/Adjust vertical line straightness. Move the horizontal thumbwheel to position the cursor's vertical line to fall within the left two vertical lines. Shift the graticule as necessary for optimum alignment. All points on the line should fall within the confines of the two lines (except that the line will extend up beyond the graticule markings). Adjust X GEOM (on Deflection Amp & Storage board, Fig. 4-7) as necessary to achieve the described results. Move the vertical line to the right side and repeat the check. It may again be necessary to move the graticule slightly. If necessary, compromise the adjustment to achieve specified results on both sides.

j. Check/Adjust horizontal line straightness. Relocate the graticule to its reference position. Move the horizontal line to fall between the two closely-spaced lines near the top of the graticule. Rotate the graticule slightly for optimum alignment if the line is tilted slightly. All points on the cursor's horizonal line should fall within the confines of the two lines. Adjust the Y GEOM (Deflection Amp & Storage board, Fig. 4-7) as necessary to achieve the described results. Then move the horizontal line to the bottom of the display and repeat the check, again moving the graticule as necessary. Compromise the Y GEOM adjustment to achieve the desired results at both top and bottom.

4 (Alternate). Display Positioning Check/Adjustment (X GAIN, Y GAIN, X POS, Y POS, X GEOM, Y GEOM on Deflection Amp & Storage Board)

NOTE

This procedure is to be used if no Test Graticule is available. It provides for an approximately centered display of specific size. Both positioning and size may be modified as desired by changing the adjustment parameters accordingly. All position and size measurements should be made with a minimum of parallax. This can be achieved by closing one eye and keeping the reflection of the viewing eye superimposed over the point being observed.

a. Situate the Terminal so the display screen is facing approximately East or West to minimize Earth's magnetic field effect.

b. Enter ESC and CTRL Z and place the keyboard thumbwheels near midrange. A crosshair cursor should appear on the display. If it does not, or if it is excessively bright, adjust R29, Crosshair Brightness, on TC-2 (Fig. 4-7) as necessary to provide a display of minimum intensity, consistent with good viewing. The crosshair should not be so bright that it stores; move the thumbwheels to check for storing.

c. Put the Vertical Thumbwheel to its upper limit, and the Horizontal thumbwheel to mid-position.

d. Enter PAGE and ESC and CTRL Z to erase the display and regain the crosshair. (ESC and CTRL Z must be entered to regain the crosshair cursor each time the display is erased, since PAGE also resets the Terminal to Alpha Mode.)

e. Check display positioning against the following requirements (see Fig. 4-9). Go to step f if any discrepancies are found.

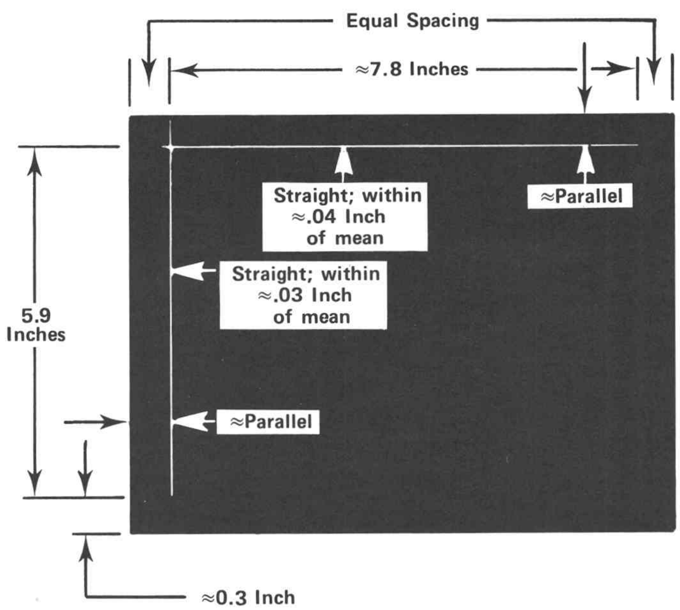


Fig. 4-9. Display positioning, using crosshair cursor.

Horizontal line	Should remain in view
	Both ends occur before reaching edges of display area
	Approximately centered horizontally in display area
	Approximately 7.8 inches long
	Parallel with top edge of display area
	Distance between any point on the line and the mean path of the line should not exceed .04 inch (0.5% of line length)
Vertical line	Bottom end occurs approximately 0.3 inch before reaching edge of display area
	Horizontal intercept is approximately 5.9 inches above bottom of vertical line
	Approximately parallel with left edge of display area
	When positioned near left edge of display area (by using horizontal thumbwheel), distance between any point on the line and the mean path of the line should not exceed .03 inch (0.5% of line length)

f. If lines are excessively long, set X GAIN and/or Y GAIN fully counterclockwise. (These, and other display adjustments are located on the top of the Deflection Amp & Storage board. See Fig. 4-7. Use Fig. 4-9 as a display reference.)

g. Adjust display positioning as follows:

(1) Adjust X POS for approximate left-right centering of horizontal line.

(2) Adjust Y POS to approximately center the vertical line segment described by its lower end and the point of intercept with the horizontal line (vertical thumbwheel at upper limit).

(3) If necessary, rotate the yoke-mounting bracket (Fig. 4-8) to obtain approximately equal spacing between the ends of the cursor's horizontal line and the top edge of the display area. Two nuts hold the yoke housing in place. Final adjustment and tightening of the yoke housing is done in a later step.

CAUTION

Access for the special 11/32 inch wrench is provided between the LV Power Supply board and the Deflection Amp and Storage board (Fig. 4-7). However, because of the proximity of voltage-laden transistor cases, the Terminal should be shut off prior to loosening or tightening the yoke housing nuts. Enter PAGE and ESC CTRL Z to regain the crosshair cursor.

(4) Adjust X GEOM for approximate straightness of the vertical line; vertical line to be positioned as close to the left edge of the display area as possible by using the horizontal thumbwheel.

(5) Adjust Y GEOM for approximate straightness of the horizontal line, with the vertical thumbwheel at its upper limit.

(6) Adjust X GAIN for a horizontal line length of approximately 7.8 inches.

(7) Readjust X POS for approximate centering of the horizontal line.

(8) Adjust Y GAIN for approximately 5.9 inches between the bottom of the vertical line and the horizontal line intercept point. (Vertical potentiometer at upper limit.)

(9) Readjust Y POS to approximately center the area described in (8).

(10) Adjust X GEOM for optimum straightness of the vertical line.

(11) Adjust Y GEOM for optimum straightness of the horizontal line.

(12) Press PAGE and then enter four Zs. Check that the Zs are clearly noticeable as writing occurs. The Zs might or might not store at this time, depending on the position of the OP LEVEL adjustment. If the Zs are not clearly noticeable during writing, adjust R95, Character Brightness, on TC-1 (Fig. 4-7) and repeat the check.

(13) If the Zs do not store, gradually increase the OP LEVEL setting (Top of Deflection Amp & Storage board, (Fig. 4-7) while entering Zs until they do store. Do not set OP LEVEL any higher than necessary.

(14) Press PAGE and again enter four Zs.

(15) Enter ESC and CTRL Z. The Zs should remain and the crosshair cursor should appear.

(16) Using the horizontal thumbwheel, place the vertical line so that is passes through a Z.

(17) Check vertical gain. The distance from the bottom of the vertical line to the top of a Z should be approximately 5.9 inches. If it is not, adjust Y GAIN to compensate for the error. (Adjust the bottom of the vertical line one-half of the desired total correction. An equal amount of correction will occur at the top of the line.) Then repeat steps (14), (15), and (17).

(18) Check Vertical Position. The bottom of the vertical line and the top of the Z should be equidistant from their respective horizontal edges of the display area. If not, adjust Y POS to center the display vertically. Observe the bottom of the vertical line during adjustment. Then repeat steps (14), (15), and (18).

(19) Recheck parallelism between the horizontal line and the top edge of the display area. Readjust the yoke rotation as necessary. The yoke housing is held in place by two nuts which must be loosened before the Yoke Rotation Lever can be moved. See Fig. 4-8. Access to one of the nuts is provided between the LV Power Supply board and the Deflection Amp and Storage board (Fig. 4-7); turn off the Terminal before loosening it or tightening it. A special, long-handled, 11/32 inch wrench is required. After loosening, turn the terminal on, press PAGE, enter ESC CTRL Z, check the parallelism, adjust the Yoke Rotation Lever as necessary, turn off the Terminal, and tighten the nuts. Then turn the terminal back on, press PAGE, enter ESC CTRL Z and recheck. Repeat as necessary.

(20) Recheck horizontal and vertical line straightness, with lines positioned near the top and left edges, respectively. Readjust X GEOM for vertical line, and Y GEOM for horizontal line straightness as necessary.

(21) Position the cursor lines to various places on the display area and check for line straightness. If necessary, readjust X GEOM and Y GEOM for best overall compromise.

h. Press PAGE to return to Alpha Mode.

5. Storage Check/Adjustment (NORM COLL, OP LEVEL on Deflection Amp & Storage Board)

a. If a General Purpose Asynchronous Interface is installed, connect $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ by connecting a piece of wire from pin 3 to pin 5 of the connection on the end of the Mother Board, or between pins 3 and 5 of an empty connector if a Mother Board Extender is installed. (See Fig. 4-10.) The pins are 3rd and 5th from the bottom on the inner-most column of pins on the connector on the end of the Mother Board; on a Mother Board Extender the pins are 3rd and 5th from the bottom in the left row.

CAUTION

Do not put the terminal in graph mode, while the $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ strap is installed.

b. Perform step 5b for adjusting a Terminal in which the CRT has not just been changed. If the CRT has just been changed, go to step c.

(1) Note the CE voltage value written on the tag attached to the top of the CRT shield in the unit. Check for that value at TP137 on the Hard Copy TARSIG Amplifier Board (Fig. 4-11), with the Terminal in View status. *CAUTION: Turn the Terminal off while connecting to TP137.* (Press SHIFT to regain View staus.)

(2) Adjust NORM COLL (top of Deflection Amp & Storage board Fig. 4-7) to obtain the specified value.

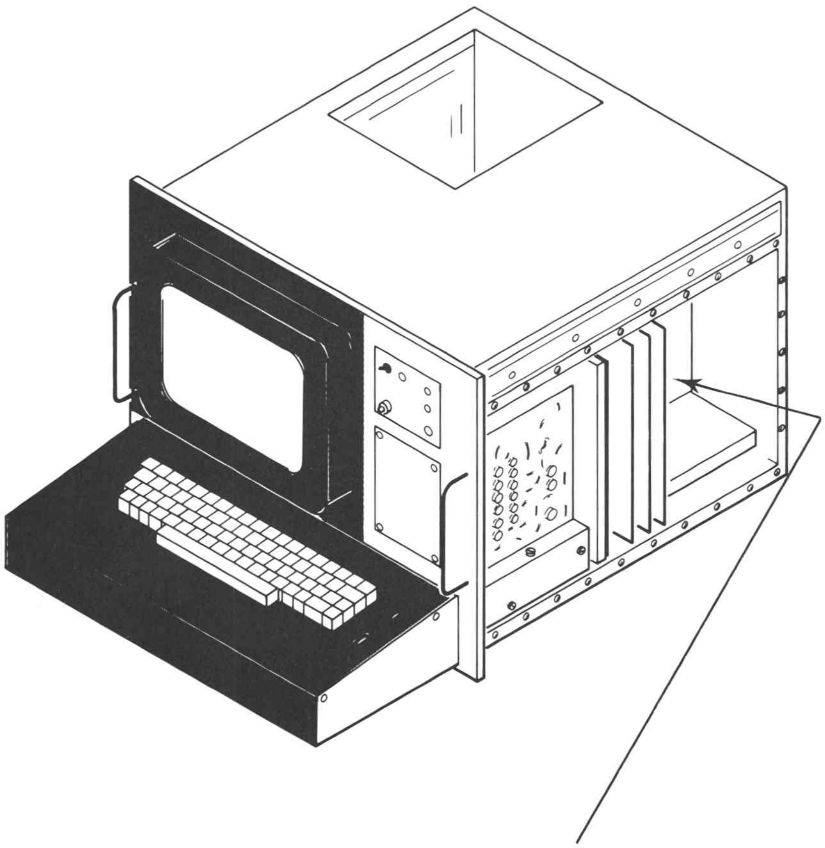
(3) Turn the Terminal off. Move the meter lead from TP137 to TP35 on the Hard Copy TARSIG Amp board. (Fig. 4-11.)

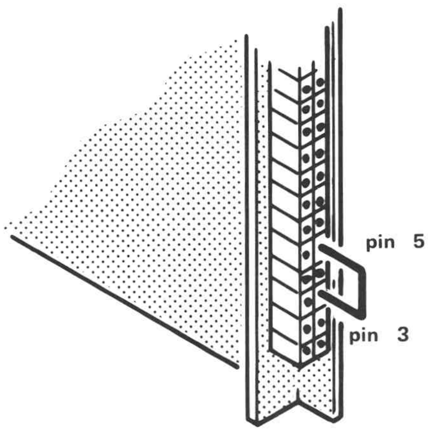
(4) Turn the Terminal on; then press PAGE.

(5) Note the STORAGE LEVEL value written on the tag attached to the top of the CRT shield. Check for that value at TP35.

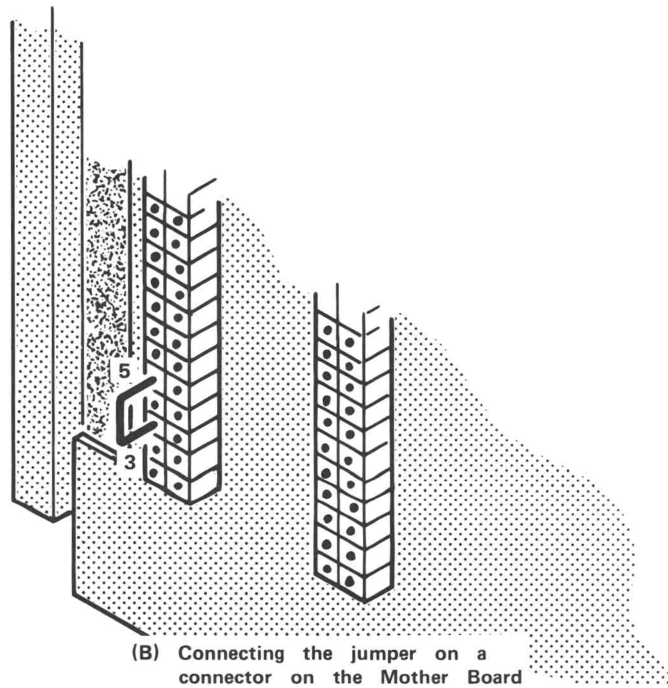
(6) Adjust OP LEVEL (top of Deflection Amp & Storage board, Fig. 4-7) to obtain the specified value.

(7) Put the LOCAL/LINE switch at LINE. Then go to step 5d.





(A) Connecting the jumper on the end of the Mother Board.



(B) Connecting the jumper on a connector on the Mother Board Extender.

Fig. 4-10. $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ jumper.

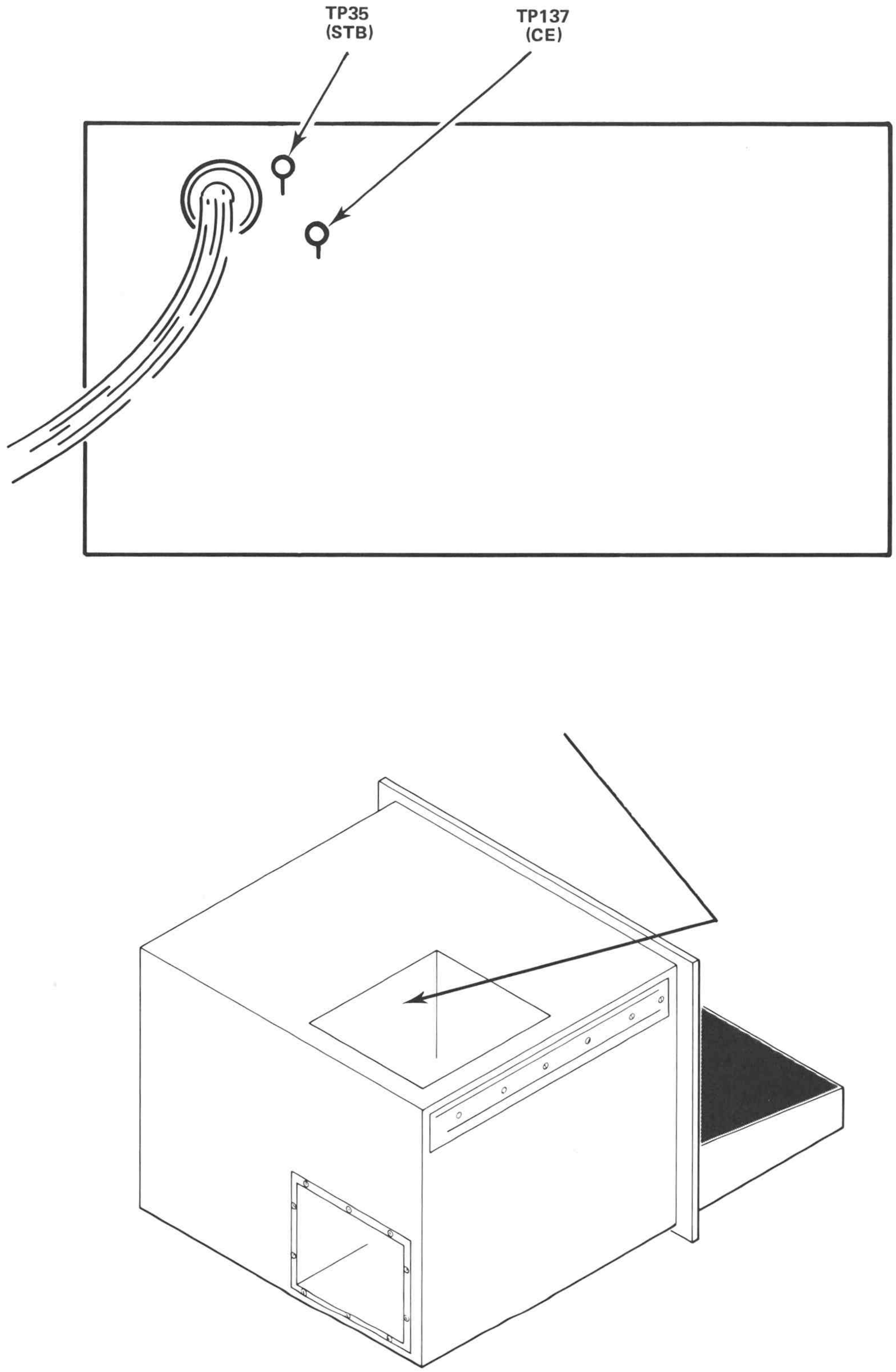


Fig 4-11. Hard Copy TARSIG amplifier board, indicating STB and CE test points.

c. Perform step 5c for adjusting a Terminal in which the CRT has just been changed.

(1) Turn the Terminal off and connect the meter lead to TP137 on the Hard Copy TARSIG Amplifier board. (Fig. 4-11.) Set the meter to accept about +100 V dc.

(2) Note the CE Voltage value written on the tag supplied with the replacement CRT. Turn the Terminal on and adjust NORM COLL (top of Deflection Amp & Storage board Fig. 4-7) to obtain that CE voltage.

(3) Turn the Terminal off and move the voltmeter lead to TP35 on the Hard Copy TARSIG Amplifier board (Fig. 4-11). Set the meter to accept approximately +200 V dc.

(4) Set OP LEVEL (top of Deflection Amp & Storage board) fully counterclockwise. Then turn the Terminal on and adjust OP LEVEL clockwise in moderate increments, pressing PAGE between increments, until a point is reached where the edges of the display area start to become obviously brighter, or "fade positive" right after an erase cycle. (See Fig. 4-12A). Record the voltage which exists at TP35.

(5) Reduce the OP LEVEL setting slightly, just to the point where fade positive no longer occurs after PAGE is pressed.

(6) If a General Purpose Asynchronous Serial Interface is installed, put the LOCAL/LINE switch at LINE and press the 8 key. The display should fill with 8s. If a General Purpose Parallel Interface is installed, use computer assist to rapidly fill the screen with characters. If a General Purpose Parallel Interface is installed and no computer is available, leave the LOCAL/LINE switch at LOCAL and use the keyboard to fill the display with characters.

(7) Turn the OP LEVEL counterclockwise until the displayed numbers appear to degrade due to dots disappearing (dropping out). (See Fig. 4-12B.) Record the TP35 voltage at which this occurs. (Press the SHIFT key as necessary to maintain View status.)

(8) Determine the mid-voltage between the two recorded voltages. Set the OP LEVEL to obtain this value.

d. Press PAGE and fill the page with 8s. Wait approximately five minutes and view the display, checking for drop-out or fade-positive conditions. If drop-out occurs, adjust the OP LEVEL in five-volt positive increments and repeat the check. If fade-positive occurs, adjust in five-volt negative increments and repeat the check. (If both conditions occur, the CRT is near the end of its useful life, and a slight fade-positive condition must be tolerated if drop-out is to be avoided.)

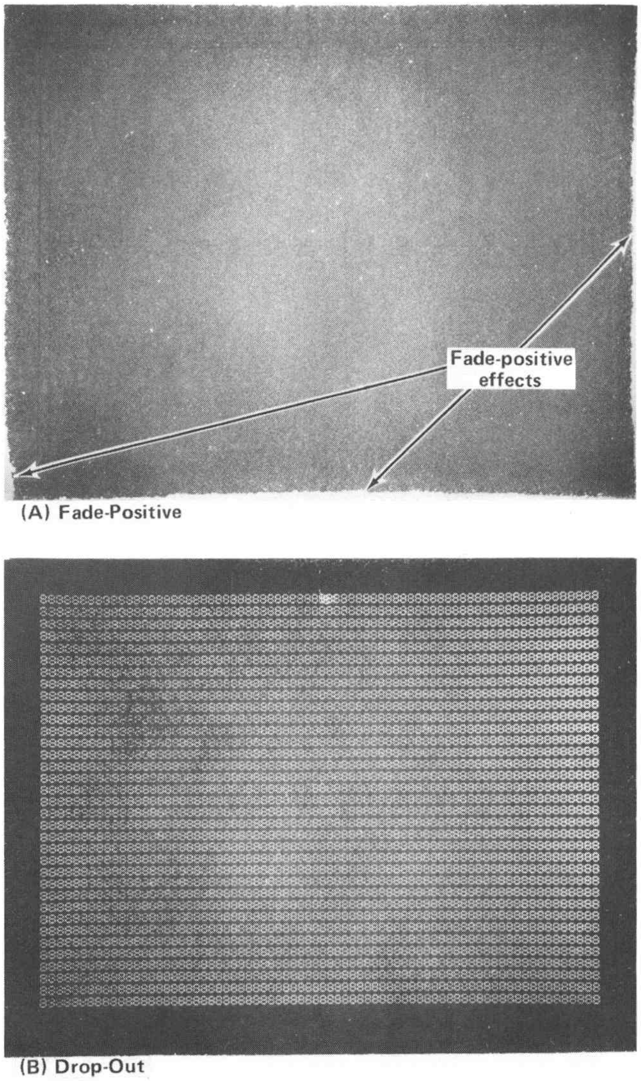


Fig. 4-12. Display Conditions.

e. Upon completion of step d, measure the voltage at TP35 and write the value opposite STORAGE LEVEL on the tag on the CRT shield.

f. Observe the overall brightness uniformity of the screen. This is controlled to a great extent by the CE voltage (NORM COLL adjustment), and affects uniformity of storing, drop-out, focus, and hard copy. If the overall screen brightness appears too uneven, NORM COLL can be experimented with to achieve better results. Perform the following:

(1) Turn the Terminal off and move the voltmeter lead to TP137 (Fig. 4-11) on the Hard Copy TARSIG Amplifier board, expecting about +100 V.

(2) Turn the Terminal on and press PAGE and fill the page with 8s.

(3) Adjust NORM COLL in small increments, pressing PAGE and filling the display with 8s after each adjustment. Note the voltage at TP137 and the effect on display uniformity.

(4) Select the position which provides the brightest display consistent with optimum uniformity and record the voltage. The best position usually occurs at a voltage slightly more positive than that which provides maximum display brightness. A too-positive voltage will often cause obvious streaking or shadows around some characters. A too-negative voltage may result in oscillation which causes the screen to appear to blink rapidly. A too-negative voltage may also give a mottled effect to some of the stored characters. Settings below 90 V may also provide degraded displays at low temperatures, and should be avoided.

(5) Record the selected NORM COLL voltage on the tag attached to the CRT shield. If the CRT has not been replaced, do not obliterate the old voltage value; simply draw a line through it and write the new value alongside. The new voltage normally will not differ greatly from the old one. In the case of a replacement CRT, obliterate the old value and write in the new one. The new voltage normally will not differ greatly from that supplied with the CRT.

g. If a General Purpose Asynchronous Serial Interface is installed, remove the $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ strap from the Mother Board connector.

6. Writing Intensity Check/Adjustment (WRITING INTENSITY on High Voltage & Z Axis Board)

a. Check the position of the FUZZ strap on the High Voltage & Z Axis board. The strap is visible through the CHARACTER/VECTOR FOCUS slot in the High Voltage & Z Axis shield. (Fig. 4-13.) The strap should always be in the position shown.

b. Put the LOCAL/LINE switch at LOCAL.

c. Press PAGE to erase the display.

d. While observing the Alpha cursor, adjusting WRITING INTENSITY (on the High Voltage & Z Axis board, Fig. 4-13) until the Alpha cursor intensity diminishes to where it can barely be seen.

e. Press PAGE to erase the display.

f. Check that the $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ strap has been removed (step 5f). Then enter CTRL SHIFT M at the keyboard to put the Terminal in Graph Mode.

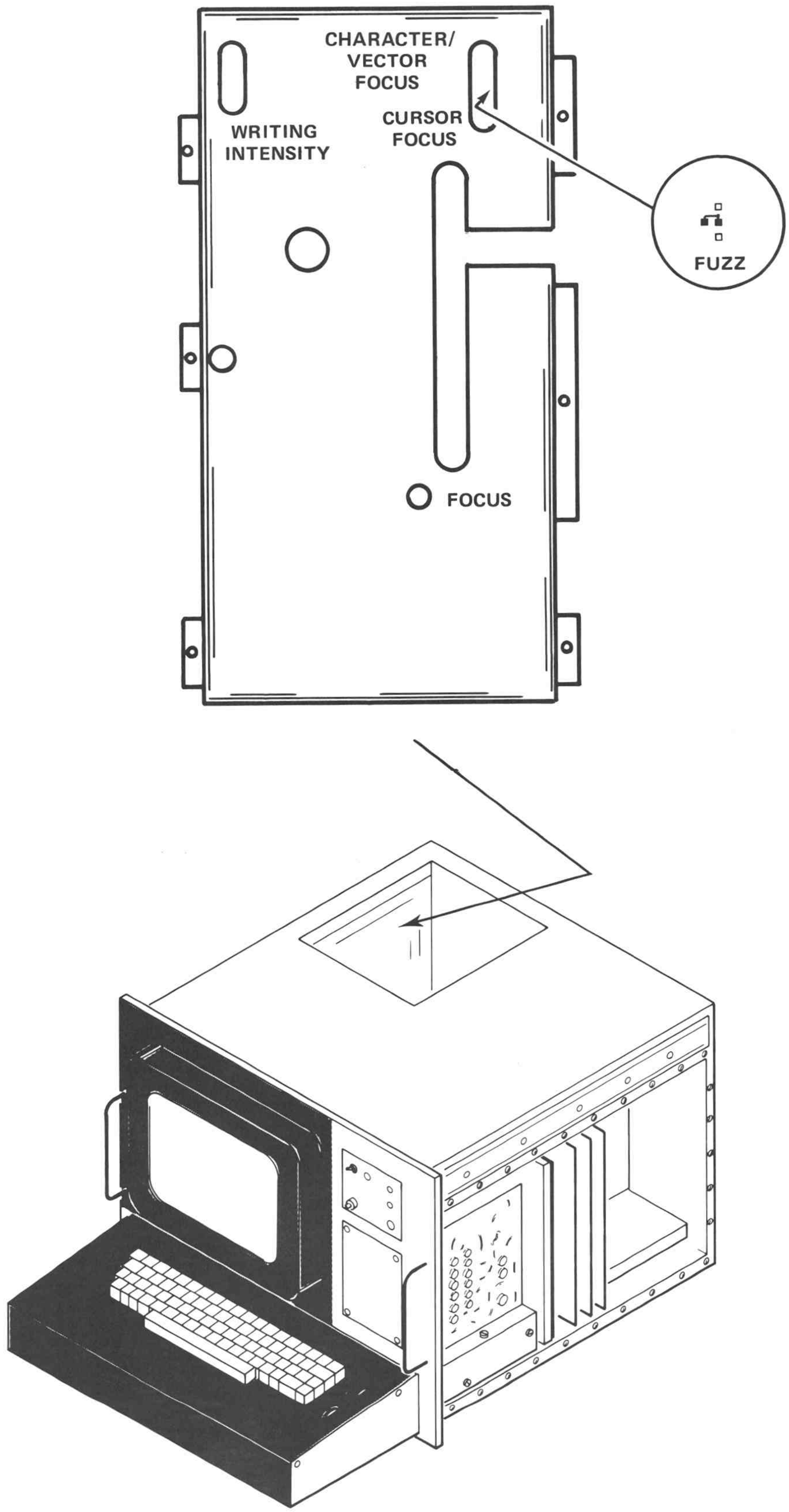


Fig. 4-13. Location of intensity and focus adjustments.

g. Enter the following characters to draw a vector from the bottom-left of the display to the top-right.

Space ` Space @ 8 k ? _

h. Check vector writing. A vector should have been drawn from the bottom-left corner to the top-right corner of the display. Some or all of it may be missing. If a complete vector is drawn from the bottom-left to the top-right corner, press PAGE and again adjust WRITING INTENSITY to diminish the intensity of the Alpha cursor. It may be necessary to increase the setting of R91, Alpha Cursor Brightness, the lower adjustment on TC-1 (Fig. 4-7), to keep a visible cursor so the effect of the WRITING INTENSITY adjustment can be observed.

i. Repeat steps e through h until a partial vector is obtained.

j. Press PAGE and then adjust WRITING INTENSITY about 10 degrees to increase the intensity of the Alpha cursor slightly.

k. Enter CTRL SHIFT M Space Space @ 8 k ? _ and check for a complete vector, drawn from the bottom-left to the top-right. If the vector remains broken, repeat steps j and k until it is satisfactory.

l. Enter PAGE and CTRL SHIFT M and Space ` Space @ 8 k ? _ 8 k Space @ Space ` ? _ 8 k ? _ and check for complete vectors. If incomplete or insufficiently bright, repeat steps j and l.

m. Enter PAGE and CTRL SHIFT M and 8 k Space @ Space ` Space @ Space ` ? _ 8 k Space @ 8 k ? _ and check for complete vectors. If incomplete or insufficiently bright, repeat steps j and m.

NOTE

Tube life varies inversely with intensity. Therefore, the intensity should always be adjusted for minimum brightness consistent with good viewing of complete vectors.

7. Alpha Cursor Brightness Check/Adjustment (R91, Alpha Cursor Brightness on TC-1)

a. Press PAGE to erase the display.

b. Note the intensity of the Alpha cursor. It should be bright enough for convient viewing, but not so bright that it stores.

c. Adjust Alpha Cursor Brightness (R91, the lower adjustment on TC-1) to obtain the desired intensity. If the cursor continues to store with R91 at minimum intensity, the WRITING INTENSITY adjustment may be set too high; step 6 should be re-checked.

8. Alpha Character Brightness Check/Adjustment (R95, Character Brightness on TC-1)

a. Enter several writing characters and note the writing brightness.

b. Adjust Character Brightness (R95, the upper adjustment on TC-1) for desired brightness, entering additional characters to check results. Adjustment will not affect previously-stored characters.

c. Enter PAGE and CTRL SHIFT M and then enter the following to draw a vector:

, f ' _ f 8 @

d. Enter RESET while holding down the SHIFT key, to enter Alpha Mode without erasing.

e. Using the LF and Space keys, place the cursor near the left end of the vector, either above or below it.

f. Enter writing characters and compare the character and vector brightness. If necessary, adjust the character brightness to provide characters whose intensity is comparable to the vector brightness.

g. Press PAGE to erase the display.

9. Character and Vector Focus Check/Adjustment (FOCUS and CHARACTER/VECTOR FOCUS on High Voltage & Z Axis Board)

a. Press PAGE.

b. Enter an e character and check its focus.

c. Adjust FOCUS (alongside yoke housing—Fig. 4-13) in small increments, entering e after each adjustment, until optimum appearance is achieved. Press PAGE as necessary to keep the writing in the corner of the display.

d. If a General Purpose Asynchronous Interface is installed connect the $\overline{\text{CSTROBE}}$ to $\overline{\text{TSTROBE}}$ strap between pins 3 and 5 on the Mother Board connector. See Fig. 4-10.

e. Switch the LOCAL/LINE switch to LINE. Fill the display with e characters. If a parallel interface is installed, use computer assist, or leave the LOCAL/LINE switch at LOCAL and fill the page from the keyboard. Compare the writing in the four corners. (Ignore other areas of the display.) It should appear similar. If noticeable difference exists, slightly adjust FOCUS ADJUST. Press PAGE and then recheck. Repeat until the best focus compromise is achieved for the four corners.

f. Note the focus of the characters near the center of the display. It is desirable that they be similar to the focus achieved in the corners. To adjust, proceed as follows:

(1) Place the LOCAL/LINE switch at LOCAL.

(2) Press PAGE.

(3) Using the Space Bar, LF, RETURN, and e keys, enter several e characters in each of the four corners. Then position the cursor to the center of the display area.

(4) Alternately enter the e character and adjust CHARACTER/VECTOR FOCUS (on High Voltage & Z Axis board in the display unit, Fig. 4-13) until center focus and corner focus are approximately the same.

g. Place the LOCAL/LINE switch at LINE. Then press PAGE.

h. If an asynchronous interface is installed, enter an 8 and the display should fill with 8s. If a parallel interface is installed, use computer assist to fill the display or leave the LOCAL/LINE switch at LOCAL and fill the display from the keyboard.

i. Check the display. The overall display should have approximately even focus. If unsatisfactory, repeat steps e through h one time to provide optimum overall focus. Note that Character Brightness (R95, upper adjustment on TC-1) affects the writing of characters, and may have to be increased or decreased to provide a good compromise between brightness and focus. As previously noted, the NORM COLL adjustment also affects focus. If all else fails, it can be experimented with. However, after readjusting it, this procedure must be resumed at step 6. Focus is highly dependent upon the WRITING INTENSITY adjustment (step 6), which is set for complete vector drawing. Its adjustment may be compromised for focus considerations, but steps 7, 8 and 9 must then be repeated.

j. If an asynchronous interface is installed, remove the CSTROBE to TSTROBE jumper from the Mother Board connector.

10. Crosshair Cursor Intensity Check/Adjustment (R29, Crosshair Cursor Brightness on TC-2)

a. Put the LOCAL/LINE switch at LOCAL.

b. Set the cursor thumbwheels near midrange.

c. Press PAGE. Then enter ESC and CTRL Z to obtain a crosshair cursor.

d. If necessary, adjust R29 Crosshair Intensity (on bottom of TC-2) so that the cursor can be seen.

e. Move the thumbwheels and check to see if the cursor stores. Readjust R29 as necessary to provide a clearly visible non-storing cursor.

11. Cursor Focus Check/Adjustment (CURSOR FOCUS on High Voltage & Z Axis Board)

a. Place the intersect point at mid-screen, using the thumbwheels.

b. Adjust CURSOR FOCUS (on the High Voltage & Z Axis board, Fig. 4-13) for uniform focus of the lines.

c. Move the cursor to various positions on the screen. If necessary, adjust CURSOR FOCUS (Fig. 4-13) to obtain the most uniform line focusing throughout the display.

d. Press PAGE to return to Alpha Mode.

12. Vector Dynamic Geometry Error Check

a. Check that the $\overline{\text{CSTROBE}}$ to $\overline{\text{TSTROBE}}$ jumper has been removed. Then press PAGE and enter CTRL SHIFT M.

b. Enter Space ` Space @ to set the beam to 0, 0.

c. Enter 8 k 8 K to draw a vector from 0, 0 to 779, 779.

d. Enter Space ` Space @ to draw a vector from 779, 779 to 0, 0.

e. Check that the separation between the two lines does not exceed 3% of line length (approximately 0.25 inch) at any point. See Fig. 4-14.

f. Press PAGE to erase the display.

13. Vector Parallelism Check

a. Enter PAGE and CTRL SHIFT M.

b. Enter the following sequence to draw a rectangle:

Space ` Space @ 8 k @ k ? _ Space ` _ ` Space @

c. If a test graticule is installed, continue with step c; otherwise, go do d.

(1) Check that the difference in horizontal line lengths does not exceed the distance of separation between the graticule's two vertical lines on the left plus the distance of separation between the graticule's two vertical lines on the right. This can be checked by moving the graticule slightly as necessary.

(2) Check that the difference in vertical line lengths does not exceed the distance of separation between the graticule's two vertical lines on the bottom plus the distance of separation between the graticule's two vertical lines on the top. Again, the graticule can be moved slightly to check.

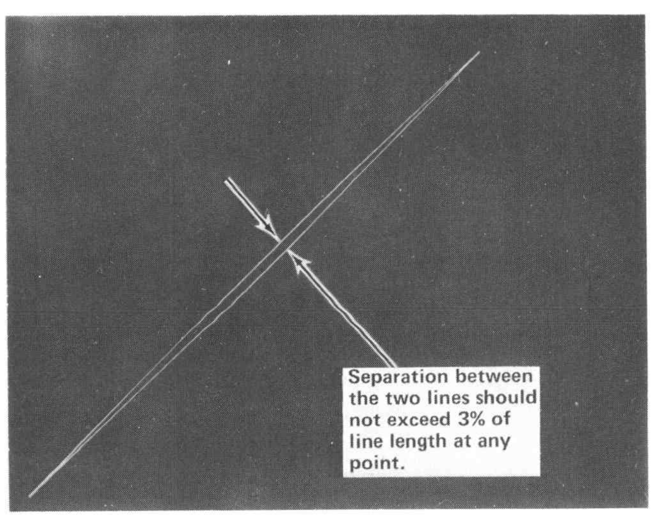


Fig. 4-14. Vector dynamic geometry illustration.

d. If no test graticule is available perform this step.

(1) Measure and record the length of all lines.

(2) Check parallelism. The difference in the length of the horizontal lines should not exceed 2% of the vertical line length. The difference in the length of the vertical lines should not exceed 2% of the horizontal line length. With the Terminal adjusted as outlined in this procedure, the line length is approximately 7.8 inches horizontal and 5.9 inches vertical. Line length difference should not exceed approximately 0.12 inch horizontal and approximately 0.16 inch vertical.

14. Character Transmission and Writing Check

a. Check that each ASCII writing character appears on the screen in response to key entry.

b. Activate the TTY LOCK by pressing the key. The key should remain down.

c. Press each writing character key and note character writing is limited to the TTY code. The TTY LOCK function key affects the code being transmitted.

d. Release the TTY LOCK key by pressing it once.

15. Control Character Transmission and Response Check

a. With the LOCAL/LINE switch at LOCAL, enter the following at the keyboard and check the response:

CONTROL CHARACTER RESPONSE CHECK

Command	Code Equivalent	Response
CTRL SHIFT K and CTRL L	ESC FF	Erases display, homes cursor
CTRL G	BEL	Rings Bell
CTRL I	HT	Moves cursor one space to right
CTRL H	BS	Moves cursor back one space
CTRL J	LF	Moves cursor down one line; if LF EFFECT strap is at LF → CR, the cursor will also move to the left margin.

CONTROL CHARACTER REPONSE CHECK (cont)

Command	Code Equivalent	Response
CTRL K	VT	Moves cursor up one line
CTRL SHIFT M	GS	Selects Graph Mode and dark vector
Space RUBOUT Space _	SP DEL SP _	Executes a dark vector and sets the Terminal for a bright vector
Ø @	Ø @	Draws a vector
CTRL SHIFT M	GS	Sets the Terminal for a dark vector
Λ	Λ	Executes a dark vector and sets the Terminal for a bright vector
Λ	Λ	Writes a point
CTRL SHIFT O	US	Switches back to Alpha without moving the writing beam
CTRL SHIFT M	GS	Selects Graph Mode
Λ	Λ	Executes a dark vector and resets for a bright vector
2 x & H	2 x & H	Draws a vector
CTRL M	CR	Switches to Alpha Mode and moves writing beam to margin Ø; if CR EFFECT option is at CR → LF, a line feed will also occur
CTRL SHIFT K and CTRL Z	ESC SUB	Selects GIN Mode and displays the crosshair cursor
Put LOCAL/LINE switch at LINE; then enter Space	SP	Crosshair cursor disappears if an Interface is installed. If no Interface is installed, the crosshair cursor will remain

b. Press PAGE and place the LOCAL/LINE switch at LOCAL.

16. Hard Copy Amplitude and Position Check/Adjustment (X HC AMP, Y HC AMP, X HC POS, Y HC POS on the Deflection Amp & Storage Board)

a. If an asynchronous interface is installed, replace the $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ strap between pins 3 and 5 on the Mother Board connector.

b. At the Hard Copy Unit, remove the copying paper (or disable the paper drive)) to avoid waste during this procedure. If necessary, refer to the Hard Copy Unit manual for instructions.

c. Connect the Hard Copy Unit to the Terminal, via the HARD COPY Unit connector on the back of the display unit.

d. Turn the Hard Copy Unit on.

e. Turn the HARD COPY BRIGHTNESS on the front of the Terminal fully clockwise.

f. Press the Terminal COPY button and note that a scan bar moves up or across the screen. (Direction will depend upon type of Hard Copy Unit and upon option selection within the Hard Copy Unit.) If the scan bar does not appear, adjust HC INTENSITY, COARSE (on the High Voltage and Z Axis board, Fig. 4-15) until the bar does appear. Alternately press PAGE and COPY, and adjust the HC INTENSITY, COARSE, until the display is just at the point where thecomplete scan bar stores.

g. Note the position of the stored scan bar with respect to the edges of the display area. If the bar scans beyond the limits of the display area in the vertical and/or horizontal direction, place the Y HC AMP and/or X HC AMP adjustments (bottom of Deflection Amp and Storage board) fully counterclockwise. Then press PAGE and COPY and again note the stored scan bar position with respect to the edges of the display area. (If the bar still overscans the display area, the Y HC AMP and/or X HC AMP adjustment(s) may be in the wrong limit.)

h. Adjust the X HC POS and the Y HC POS (bottom of Deflection Amp & Storage board) to approximately center the display. The axis along which the bar scans should be adjusted between scans, pressing PAGE and COPY after each adjustment. The other axis can be adjusted while the bar is scanning, since its effects can be seen immediately.

i. Adjust the X HC AMP and the Y HC AMP to place the ends of the scanning bar approximately 1/8 inch from the edges of the display area. Again, the direction in which the bar scans should be adjusted between scans, and the other direction during scans. Readjust X HC POS and Y HC POS (on Deflection Amp & Storage board) as necessary to bring both ends and top and bottom of the stored scan bar display to within approximately 1/8 inch of the edges of the display area.

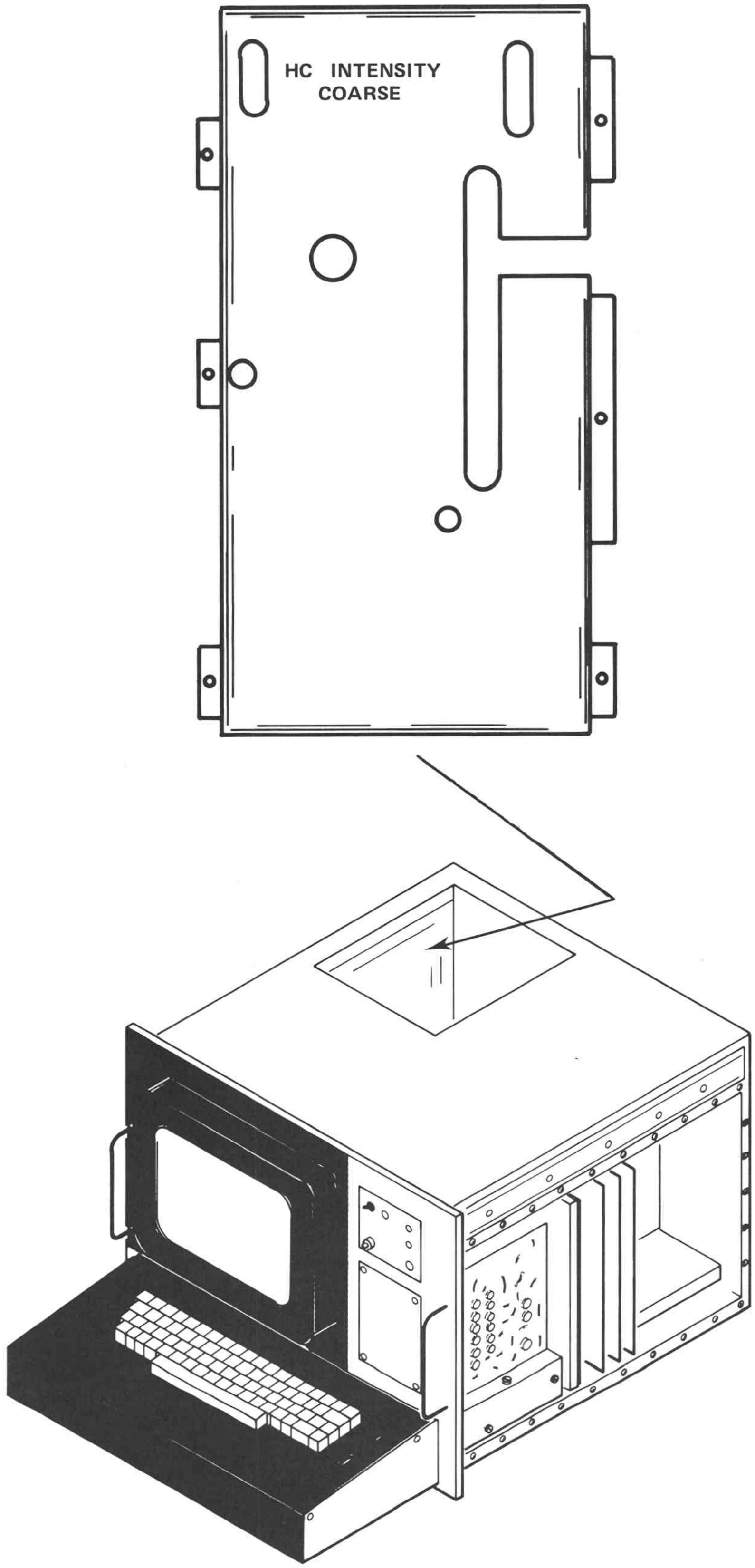


Fig. 4-15. Location of HC INTENSITY, COARSE.

@

j. Alternately press PAGE and COPY and adjust the front panel HARD COPY BRIGHTNESS control while the bar is scanning, until a point is reached just below that where the scanning bar does any storing. Readjust HC INTENSITY, COARSE, at the High Voltage and Storage board, if necessary to achieve this.

k. Check the adjustment as follows: if an asynchronous interface is installed, put the LOCAL/LINE switch to LINE, press PAGE and 8 and fill the display with 8s. If a parallel interface is installed, use computer assist or the keyboard to fill the display. Press COPY and observe that the bar extends approximately 1/8 inch to left, right and above the 8s, and approximately 1/4 inch below. The scan bar should not extend to the edge of the screen in any direction. Refine the X HC POS, Y HC POS, X HC AMP, Y HC AMP adjustments, if necessary.

17. Hard Copy Intensity Adjustment (HC INTENSITY, COARSE, on the High Voltage & Z Axis Board, HARD COPY BRIGHTNESS on the front of the Terminal)

a. Set HARD COPY BRIGHTNESS (front of Terminal) to mid-position.

b. Press PAGE and COPY and adjust HC INTENSITY, COARSE (on High Voltage & Z Axis board) to a point just below that at which the scan bar does any storing. Repeat as necessary to eliminate storing at all points on the display area.

18. Hard Copy Threshold Check/Adjustment (R167, Hard Copy Threshold on Hard Copy Amplifier Board)

a. Set the oscilloscope for alternate trace operation. Set each vertical channel for 0.5 V/division. Neither channel should be inverted. Set the sweep rate to 0.5 μs/division. Set both input switches to ground and set both traces to the second horizontal graticule line from the bottom. Then switch both input switches to dc.

b. Connect a probe from the oscillosocpe's external trigger jack to the X signal line at pin 4, either on the end of the Mother Board, or at pin 4 on a connector on the Mother Board Extender, if one is installed. (See Fig. 4-16.) Switch the oscilloscope to external triggering.

c. Connect a probe from channel 1 of the oscilloscope to TP85 on the Hard Copy Amplifier board (Fig. 4-17). Connect the probe ground lead to the ground test point on the board.

d. Connect a probe from channel 2 of the oscilloscope to TP195 on the Hard Copy Amplifier board (Fig. 4-17). Connect the probe ground lead to ground on the board.

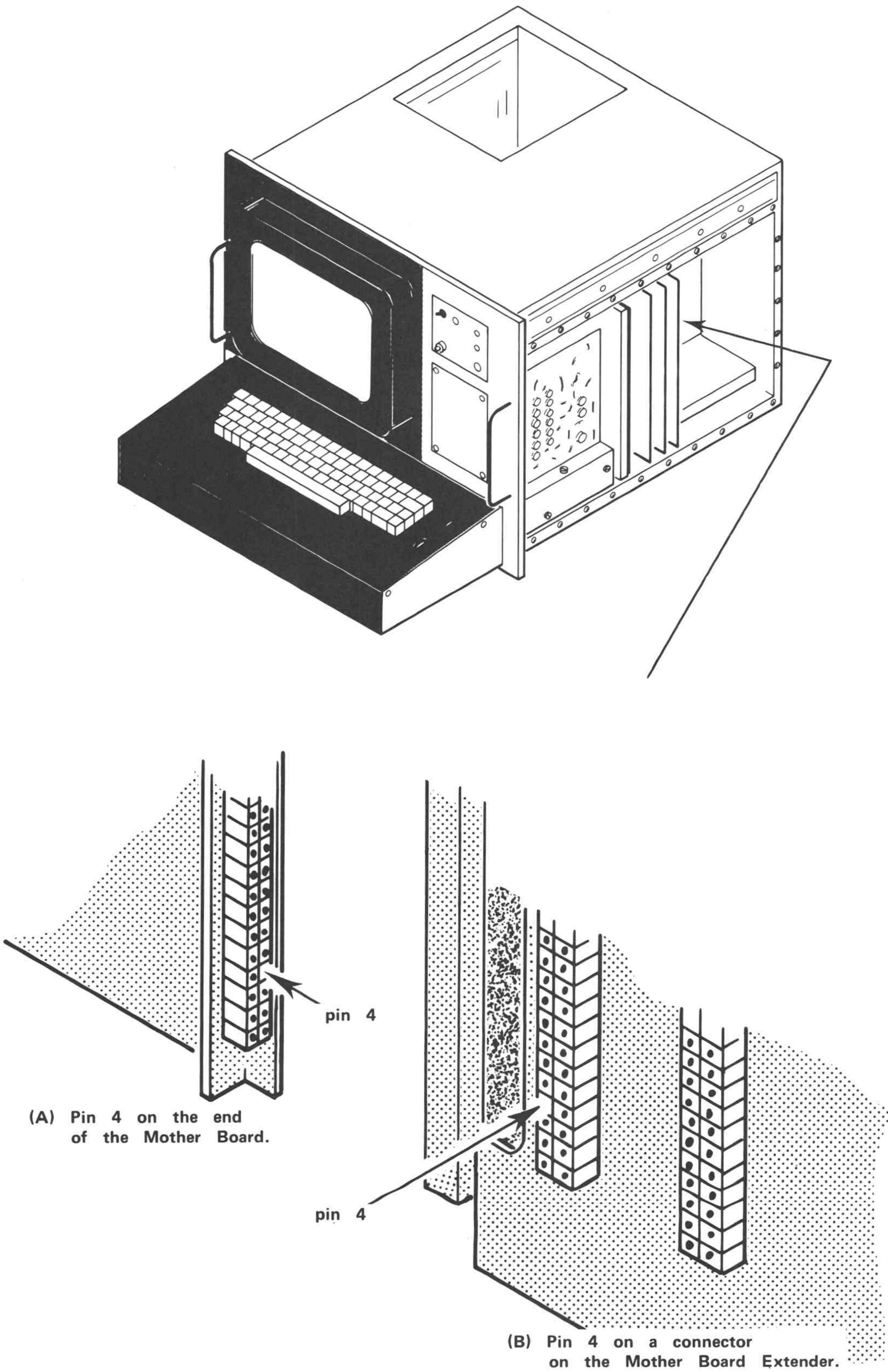


Fig. 4-16. Minibus pin 4 location on Mother Board.

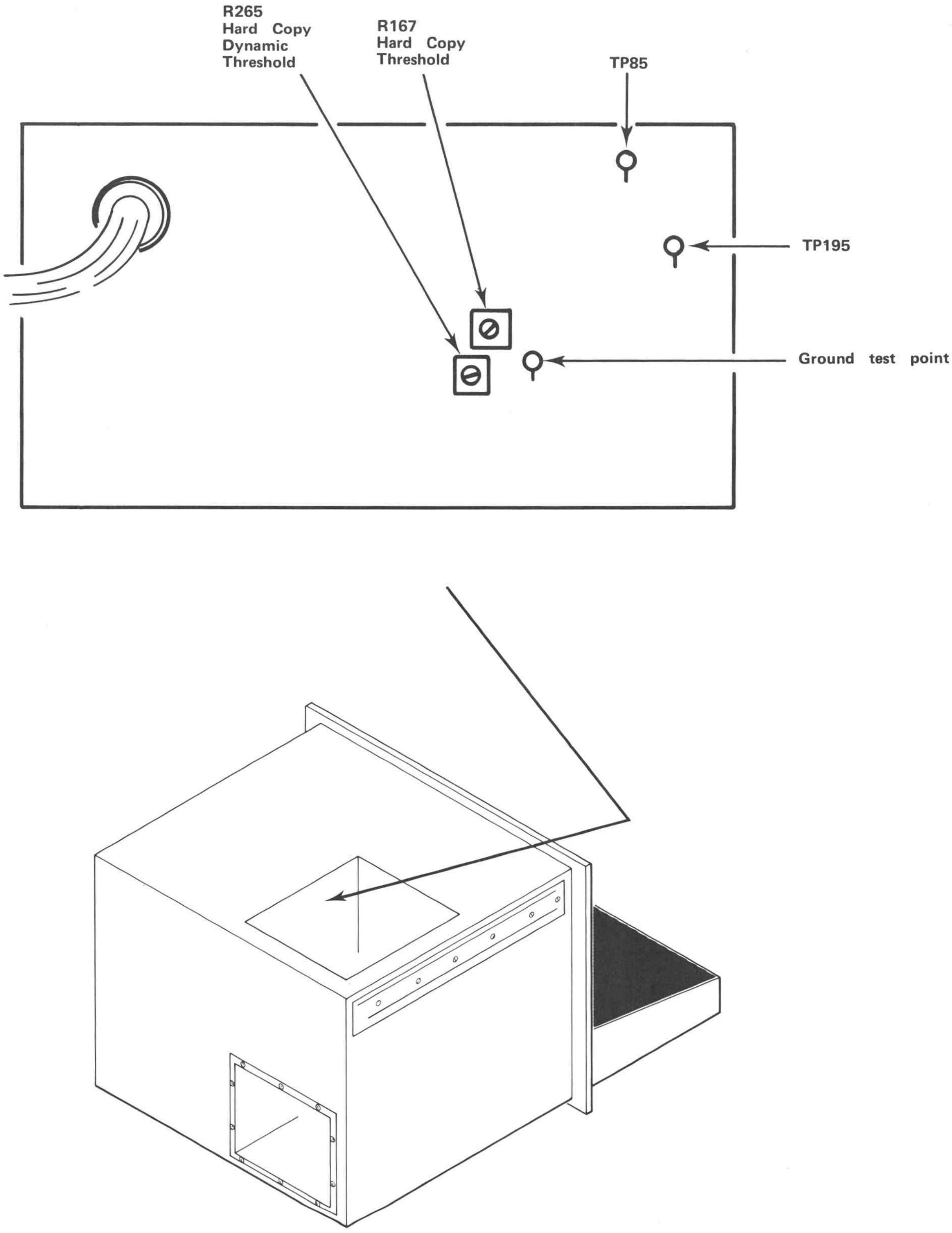


Fig. 4-17. Hard Copy TARSIG amplifier board; threshold test point and adjustment locations.

e. Switch the Terminal to LOCAL. Then press PAGE and COPY and check for an oscilloscope display as in Fig. 4-18. The peaks of the most prominent pulses should almost touch.

f. Adjust R167—Hard Copy Threshold (on the Hard Copy Amplifier board, Fig. 4-17) until the peaks almost touch as in Fig. 4-18. The separation may vary with the position of the scan bar on the screen. If so, adjust for minimum separation of the closest pulses. The waveform may vary slightly between specific units.

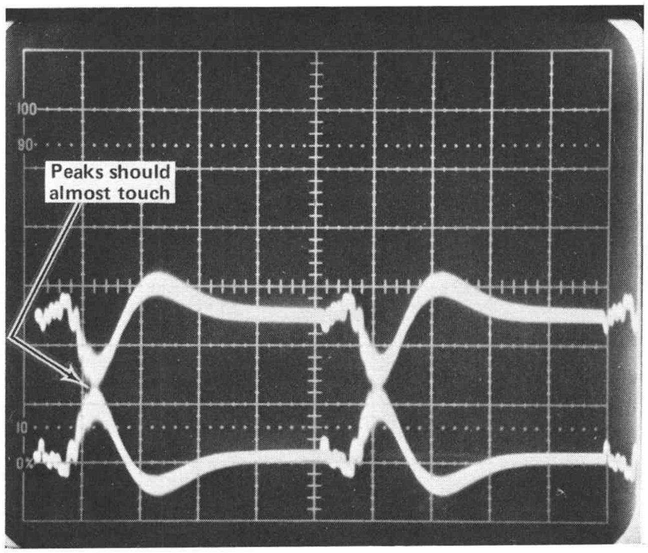


Fig. 4-18. Hard Copy Treshold adjustment waveform. 0.5V/division vertical; 0.5 μs/division horizontal.

19. Hard Copy Dynamic Threshold Check/Adjustment (R265, Dynamic Threshold Adjust on Hard Copy Amplifier Board)

a. Switch the oscilloscope sweep rate to 10 μs/division. The oscilloscope remains connected as in step 20.

b. Press COPY and check the display as the scanning bar moves across the screen. The vertical separation between the pulse peaks of the two traces should remain fairly constant as the hard copy bar scans.

c. Press COPY and adjust R265, Dynamic Threshold Adjust (Fig. 4-17) until the separation between the pulse peaks remains fairly constant as the Hard Copy bar scans. The appearance may change with the position of the scan bar; in that case, adjust for the best compromise.

d. If the Dynamic Threshold was grossly out of adjustment, steps 18 and 19 should be repeated.

e. Disconnect the probes from the Hard Copy TARSIG Amplifier board.

20. Hard Copy Writing Check

a. Re-install the paper in the Hard Copy Unit or engage the paper drive, as appropriate.

b. Press PAGE. If an asynchronous interface is installed, press the A key to write a full page. If a parallel interface is installed, use computer assist or the keyboard to fill the display.

c. Press COPY. The Hard Copy Unit should make a copy of the display.

d. Examine the copy for writing quality. Assuming that the Hard Copy Unit is properly adjusted, writing quality is controlled by the following adjustments in the Terminal:

Condition	Possible Causes
Information does not copy or information drop-out occurs	Mis-adjusted Hard Copy Intensity setting on Terminal (step 17); Scanning pulses too far apart (step 18); Pulse separation not constant (step 19).
Excessive background writing (noise)	Hard Copy Intensity setting on Terminal set too high (step 17; Insufficient separation between scanning pulses (step 18).
Information missing around perimeter	Underscan caused by X HC AMP and/or Y HC AMP being set too low (step 16).
Information missing from one edge	X HC POS or Y HC POS not properly set (step 16).
Copy too small; bars on edge or edges of paper	X HC AMP and/or Y HC AMP set too high (step 16). Y HC POS or X HC POS improperly set (step 16).

NOTE

If the copying uniformity in the various areas of the copy is unacceptable, and all else fails, the NORM COLL voltage may have to be adjusted to provide satisfactory results. However, because of low temperature considerations, NORM COLL should not be set below 90 V. The NORM COLL adjustment also affects uniformity of storing, drop-out, focus, and intensity. If readjusted, steps 6 through 11 and step 20 should be repeated.

e. If the copy appears satisfactory, make five copies of the same full page display. The fifth copy should remain satisfactory, with minimum degradation due to repetitive scanning of the display data. If the fifth copy is unacceptable, decrease HARD COPY BRIGHTNESS setting slightly and repeat step 3.

f. Disconnect the probes from the Terminal.

21. Restoring Original Conditions

a. Turn the Terminal OFF and disconnect the line plug from the power source.

b. If necessary, remove the transformer protection plate and rewire the Terminal transformer to its previous configuration. Then replace the transformer protection plate. Change the front-panel line fuse, if necessary, to agree with the voltage selection.

c. Reset the option straps on TC-1, TC-2 and the Interface Card to the condition recorded in the Preliminary Procedure.

d. If an asynchronous interface is installed, remove the jumper strap which was installed in the Preliminary Procedure. Reconnect the output cable to J110.

e. Remove the $\overline{\text{TSTROBE}}$ to $\overline{\text{CSTROBE}}$ strap from the Mother Board Connector.

f. Reinstall the ORIGIN SHIFT strap (Deflection Amp and Storage board) to NORM.

g. Reinstall any accessory cards which are to be used with the Terminal. If desired, check them out referring to their documentation.

h. Reinstall the side and back covers.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P. O. BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY CO.	1201 2ND ST. SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P. O. BOX 5012	DALLAS, TX 75222
01807	PETERSEN RADIO CO., INC.	2800 WEST BROADWAY	COUNCIL BlUFFS, IA 51501
01963	CHERRY ELECTRICAL PRODUCTS CORP.	3600 SUNSET AVE.	WAUKEGAN, IL 60085
02735	RCA CORP., SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03877	TRANSITRON ELECTRONIC CORP.	168 ALBION ST.	WAKEFIELD, MA 01880
04713	MOTOROLA, INC., SEMICONDUCTOR PRODUCTS DIV.	5005 E. MCDOWELL RD.	PHOENIX, AZ 85036
05347	ULTRONIX, INC.	461 N 22ND ST.	GRAND JUNCTION, CO 81501
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS ST.	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPT.	NELA PK.	CLEVELAND, OH 44112
11237	CTS KEENE, INC.		PASO ROBLES, CA 93446
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON ST.	DOVER, NH 03820
12954	DICKSON ELECTRONICS CORP.	8700 E. THOMAS RD.	SCOTTSDALE, AZ 85252
12969	UNITRODE CORP.	580 PLEASANT ST.	WATERTOWN, MA 02172
14099	SEMTECH CORP.	652 MITCHELL ROAD	NEWBURY PARK, CA 91320
14936	GENERAL INSTRUMENT CORP., SEMICONDUCTOR PRODUCTS GROUP	600 W. JOHN ST.	HICKSVILLE, NY 11802
15818	TELEDYNE SEMICONDUCTOR	1300 TERRA BELLA AVE.	MOUNTAIN VIEW, CA 94040
16758	DELCO ELECTRONICS, DIV. OF GENERAL MOTORS CORP.	700 E. FIRMIN ST.	KOKOMO, IN 46901
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
18657	TOKYO SHIBAURA ELECTRIC CO., LTD.		TOKYO, JAPAN
21845	SOLITRON DEVICES, INC., TRANSISTOR DIV.	1177 BlUE HERON BlVD.	RIVIERA BEACH, FL 33404
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SAN YSIDRO WAY	SANTA CLARA, CA 95051
27193	CUTLER-HAMMER, INC. SPECIALTY PRODUCTS DIVISION	4201 N. 27TH ST.	MILWAUKEE, WI 53216
28480	HEWLETT-PACKARD CO., CORPORATE HQ.	1501 PAGE MILL RD.	PALO ALTO, CA 94304
32159	WEST-CAP ARIZONA	2201 E. ELVIRA ROAD	TUCSON, AZ 85706
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
33297	ELECTRONIC ARRAYS, INC.	550 E. MIDDLEFIELD RD.	MOUNTAIN VIEW, CA 94043
50157	N. L. INDUSTRIES, INC., ELECTRONICS DEPT.	P. O. BOX 787	MUSKEGON, MI 49443
52833	KEYTRONICS CORP.	BLDG. 14 SPOKANE INDUSTRIAL PK	SPOKANE, WA 99216
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
63743	WARD LEONARD ELECTRIC CO., INC.	31 SOUTH ST.	MOUNT VERNON, NY 10550
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
74199	QUAM NICHOLS CO.	218 E. MARQUETTE RD.	CHICAGO, IL 60637
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BlVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE.	COMPTON, CA 90224
80009	TEKTRONIX, INC.	P. O. BOX 500	BEAVERTON, OR 97077
80294	BOURNS, INC., INSTRUMENT DIV.	6135 MAGNOLIA AVE.	RIVERSIDE, CA 92506
81073	GRAYHILL, INC.	561 HILLGROVE AVE.	LA GRANGE, IL 60525
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BlVD.	LOS ANGELES, CA 90069
82877	ROTRON, INC.	7-9 HASBROUCK LANE	WOODSTOCK, NY 12498
83003	VARO, INC.	800 W. GARLAND AVE.	GARLAND, TX 75040
86684	RCA CORP., ELECTRONIC COMPONENTS	415 S. 5TH ST.	HARRISON, NJ 07029
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY CO., INC.	3029 E. WASHINGTON ST.	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NB 68601

CIRCUIT BOARD ASSEMBLIES

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	----- -----			CHASSIS PARTS		
A2	119-0714-00			CKT BOARD ASSY:KEYBOARD	52833	65-1125-01
A2	119-0714-01			CKT BOARD ASSY:KEYBOARD	52833	65-1125-01
A3	670-3911-00			CKT BOARD ASSY:MOTHER	80009	670-3911-00
A4	670-3882-00			CKT BOARD ASSY:TC1	80009	670-3882-00
A5	670-3883-01			CKT BOARD ASSY:TC2	80009	670-3883-01
A6	670-3917-00			CKT BOARD ASSY:H.V. AND Z AXIS	80009	670-3917-00
A7	----- -----[1]			CKT BOARD ASSY:DEFLECTION AMP		
A8	670-3920-00			CKT BOARD ASSY:HARD COPY	80009	670-3920-00
A9	670-3852-00			CKT BOARD ASSY:POWER SUPPLY	80009	670-3852-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	----- -----			CHASSIS PARTS		
B1001	119-0147-00			FAN,TUBEAXIAL:115V,50-60HZ,14W	82877	MUZA1
C353	290-0697-00			CAP.,FXD,ELCTLT:86,000UF,+75-10%,15V	90201	CG5863M015X4C3PC
CR1004	152-0274-00			SEMICOND DVC,DI:SILICON,100V,10A	80009	152-0274-00
CR1005	152-0274-00			SEMICOND DVC,DI:SILICON,100V,10A	80009	152-0274-00
CR1090	150-1001-00			LAMP,LED:RED,2V,100MA,LED 2	28480	5082-4403
CR1092	150-1001-00			LAMP,LED:RED,2V,100MA,LED 1	28480	5082-4403
DS1004	150-0108-00			LAMP,CARTRIDGE:10V,0.04A	08806	367X
F1001	159-0026-00			FUSE,CARTRIDGE:3AG,3.2A,125V,SLOW-BLOW	71400	MDX3-2
FL1001	119-0376-01			FILTER,RAD INT:2 X 3A,250V,400 HZ	80009	119-0376-01
L1040	----- -----[2]			COIL,TUBE DEFL:		
Q1002	151-0337-00			TRANSISTOR:SILICON,NPN	21845	93SX287
Q1004	151-0148-00			TRANSISTOR:SILICON,NPN	02735	39539
Q1005	151-0275-00			TRANSISTOR:SILICON,NPN	02735	2N3771
Q1007	151-0337-00			TRANSISTOR:SILICON,NPN	21845	93SX287
Q1030	151-0286-00			TRANSISTOR:SILICON,NPN	18657	2SC515
Q1032	151-0241-00			TRANSISTOR:SILICON,NPN	02735	39625
Q1034	151-0241-00			TRANSISTOR:SILICON,NPN	02735	39625
Q1036	151-0210-00			TRANSISTOR:SILICON,NPN	02735	39626
Q1040	151-0433-00			TRANSISTOR:SILICON,NPN	80009	151-0433-00
Q1042	151-0258-00			TRANSISTOR:SILICON,PNP	04713	MJ2955
Q1044	151-0433-00			TRANSISTOR:SILICON,NPN	80009	151-0433-00
Q1046	151-0258-00			TRANSISTOR:SILICON,PNP	04713	MJ2955
R1050	311-0642-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	12697	382-CM39820
R1070	311-0546-00			RES.,VAR,NONWIR:10K OHM,20%,0.75W,Y POT	01121	W-8154
R1072	311-0546-00			RES.,VAR,NONWIR:10K OHM,20%,0.75W,X POT	01121	W-8154
R1076	311-0580-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	11237	41695
S1001	260-1060-01			SWITCH,LEVER:DPST,15A,125VAC	27193	8906K-1640
S1002	260-1497-00			SWITCH,PUSH-PUL:DPDT,10A,250VAC	01963	E79-30A

[1]Available under 672-0504-00 only.
[2]Available under 610-1034-00 only.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
S1080	260-1113-00			SWITCH,LEVER:DPST,6A,125VAC,SW 1	27193	870K-24H
S1081	260-1113-00			SWITCH,LEVER:DPST,6A,125VAC,SW 2	27193	870K-24H
S1082	260-1113-00			SWITCH,LEVER:DPST,6A,125VAC,SW 3	27193	870K-24H
S1085	260-1739-00			SWITCH,PUSH:SPST,MOM,1A,115VAC	81073	30-251B
S1087	260-1113-00			SWITCH,LEVER:DPST,6A,125VAC,LOCAL	27193	870K-24H
SP1000	119-0709-00			LOUDSPEAKER,PM:2.25",45 OHM	71499	22A05Z45K
T1001	120-0977-00			XFMR,PWR,SDN/SU:	80009	120-0977-00
V1	----- -----[1]			ELECTRON TUBE:		
A2	119-0714-00			CKT BOARD ASSY:KEYBOARD	52833	65-1125-01
A2	119-0714-01			CKT BOARD ASSY:KEYBOARD	52833	65-1125-01
C2	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131N075WR5223K
C3	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C4	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131N075WR5223K
C5	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025NLF
C6	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C7	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025NLF
C8-11	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
Q1	----- -----			TRANSISTOR:	52833	023-02907-002
Q2	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q3	----- -----			TRANSISTOR:	52833	023-02907-002
Q4	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q5	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
R1	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R2	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R4	315-0102-00[2]			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R5	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R6	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R7	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R8	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R9	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R10	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R11	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R12	----- -----			RES.,FXD,CMPSN:68K NOMINAL VALUE,SEL		
R13	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R14	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R15	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R16	----- -----			RES.,FXD,CMPSN:43K NOM VALUE,SEL		
R17	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R18	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R19	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R20	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R21	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R22	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R23	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R25	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R26	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
S1-60	260-1507-00			SWITCH,REED:	52833	60-0003-02

[1] Avaible under 610-1034-00 only.

[2] Used on 119-0714-01only.

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Z1	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z2	156-0075-00			MICROCIRCUIT,DI:SNGL 8-BIT DATA SEL MUX	80009	156-0075-00
Z3	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z4	156-0075-00			MICROCIRCUIT,DI:SNGL 8-BIT DATA SEL MUX	80009	156-0075-00
Z5	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	01295	SN7493AN
Z6	156-0111-00			MICROCIRCUIT,DI:BCD TO DEC DCDR/DRVR	01295	SN7414SN
Z7	156-0047-00			MICROCIRCUIT,DI:3-INPUT NAND GATE	01295	SN7410N
Z8	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
Z9	156-0058-00			MICROCIRCUIT,DI:HEX INVERTER	04713	MC7404P
Z10	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT ST	01295	SN7413N
Z11	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	01295	SN7430N
Z12	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
Z13	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	01295	SN7420N
Z14	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS EXCL GATE	04713	MC7486P
Z15	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	01295	SN7420N
Z16	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z17	156-0043-00			MICROCIRCUIT,DI:2-INPUT NOR GATE	01295	SN7402N
Z18	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z19	156-0043-00			MICROCIRCUIT,DI:2-INPUT NOR GATE	01295	SN7402N
Z20	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	01295	SN7438N
Z21	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT ST	01295	SN7413N
Z22	156-0092-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN7405N
A3	670-3911-00			CKT BOARD ASSY:MOTHER	80009	670-3911-00
C164	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
CR161	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR164	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
R11	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R12	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R85	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R87	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R115	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R119	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R131	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R135	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R147	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R149	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R151	315-0680-00			RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R155	315-0680-00			RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R159	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R164	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R184	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
U111	307-0455-00			RES.,FXD,FILM:1.8K OHM,2%,1.5W	91637	CDP14-182G-02
U145	307-0455-00			RES.,FXD,FILM:1.8K OHM,2%,1.5W	91637	CDP14-182G-02
U171	307-0455-00			RES.,FXD,FILM:1.8K OHM,2%,1.5W	91637	CDP14-182G-02

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A4	670-3882-00			CKT BOARD ASSY:TC1	80009	670-3382-00
C9	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C28	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C44	283-0647-00			CAP.,FXD,MICA D:70PF,1%,100V	00853	D151E700F0
C50	283-0647-00			CAP.,FXD,MICA D:70PF,1%,100V	00853	D151E700F0
C85	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C88	281-0551-00			CAP.,FXD,CER DI:390PF,10%,500V	72982	301-000X5P0391K
C101	290-0273-00			CAP.,FXD,ELCTLT:68UF,10%,60V	56289	109D686X9060T2
C113	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C147	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-505B102J
C153	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C166	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C172	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-505B102J
C222	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	72982	301-000X5U0471M
C241	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C259	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C301	290-0273-00			CAP.,FXD,ELCTLT:68UF,10%,60V	56289	109D686X9060T2
C310	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C325	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2
C341	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C353	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C361	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C383	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C386	290-0539-00			CAP.,FXD,ELCTLT:47UF,20%,20V	90201	THF476M020P1F
C447	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C455	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C501	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C521	290-0189-00			CAP.,FXD,ELCTLT:33UF,10%,35V	12954	D33D35K1
C580	290-0539-00			CAP.,FXD,ELCTLT:47UF,20%,20V	90201	THF476M020P1F
C590	290-0539-00			CAP.,FXD,ELCTLT:47UF,20%,20V	90201	THF476M020P1F
C591	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
CR66	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR324	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR325	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
L43	108-0317-00			COIL,RF:15UH	32159	71501M
L51	108-0317-00			COIL,RF:15UH	32159	71501M
Q1	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q280	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q283	151-0460-00			TRANSISTOR:SILICON,NPN	07263	2N3947
Q285	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q455	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q457	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
R2	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R3	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R49	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R59	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R72	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R78	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R86	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R87	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R91	311-1285-00			RES.,VAR,NONWIR:25K OHM,+/-10%,0.5W	73138	62PAS-331-0
R95	311-1285-00			RES.,VAR,NONWIR:25K OHM,+/-10%,0.5W	73138	62PAS-331-0

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R111	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R116	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R118	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R120	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R122	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R129	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R180	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R185	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R186	321-0313-00			RES.,FXD,FILM:17.8K OHM,1%,0.125W	75042	CEATO-1782F
R187	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R189	321-0355-00			RES.,FXD,FILM:48.7K OHM,1%,0.125W	75042	CEATO-4872F
R190	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	75042	CEATO-4121F
R191	321-0342-00			RES.,FXD,FILM:35.7K OHM,1%,0.125W	75042	CEATO-3572F
R192	321-0296-00			RES.,FXD,FILM:11.8K OHM,1%,0.125W	75042	CEATO-1182F
R194	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	75042	CEATO-3011F
R196	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	75042	CEATO-2151F
R216	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R253	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R266	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R280	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEATO-4021F
R281	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEATO-8061F
R282	321-0309-00			RES.,FXD,FILM:16.2K OHM,1%,0.125W	75042	CEATO-1622F
R283	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEATO-2001F
R286	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R287	321-0259-00			RES.,FXD,FILM:4.87K OHM,1%,0.125W	12697	MFF1816G48700F
R288	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	75042	CEATO-4321F
R289	321-0259-00			RES.,FXD,FILM:4.87K OHM,1%,0.125W	12697	MFF1816G48700F
R290	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R291	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R292	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R293	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	75042	CEATO-4022F
R295	321-0376-00			RES.,FXD,FILM:80.6K OHM,1%,0.125W	75042	CEATO-8062F
R296	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	75042	CEATO-4022F
R316	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R326	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R327	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R329	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R388	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	75042	CEATO-1072F
R401	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R422	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R429	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R455	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R457	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R522	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
U1	156-0594-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	01295	SN74122J
U11	156-0606-00			MICROCIRCUIT,DI:4-B D-TYPE RGTR,3 STATE OUT	01295	SN74177
U21	156-0606-00			MICROCIRCUIT,DI:4-B D-TYPE RGTR,3 STATE OUT	01295	SN74177
U31	156-0606-00			MICROCIRCUIT,DI:4-B D-TYPE RGTR,3 STATE OUT	01295	SN74177
U35	156-0606-00			MICROCIRCUIT,DI:4-B D-TYPE RGTR,3 STATE OUT	01295	SN74177
U61	156-0557-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7473J
U65	156-0560-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7476J
U71	156-0596-00			MICROCIRCUIT,DI:4-50MHX PRESETTABLE COUNTER	01295	SN74197
U75	156-0562-00			MICROCIRCUIT,DI:MONOSTABLE MULTIVIBRATOR	01295	SN74121J

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U81	156-0594-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	01295	SN74122J
U91	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U95	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U101	156-0593-00			MICROCIRCUIT,DI:DUAL J-K MA SLAVE FF	01295	SN74111J
U131	156-0587-00			MICROCIRCUIT,DI:TPL 3 INP,POST NAND GATE	01295	SN7412J
U135	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U141	156-0558-00			MICROCIRCUIT,DI:DUAL D-TYPE W/POS EDGE TRIG	01295	SN7474J
U145	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U151	156-0552-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN7404J
U161	156-0588-00			MICROCIRCUIT,DI:QUAD 1-INPUT POS NAND GATE	01295	SN7408J
U165	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U171	156-0551-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	01295	SN7402J
U175	156-0584-00			MICROCIRCUIT,DI:QUAD 2-INPUT HV INTFC	01295	SN7426J
U181	156-0590-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NOR GATE	01295	SN7425J
U201	156-0555-00			MICROCIRCUIT,DI:8-INPUT POS NAND GATE	01295	SN7430J
U211	156-0555-00			MICROCIRCUIT,DI:8-INPUT POS NAND GATE	01295	SN7430J
U221	156-0557-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7473J
U231	156-0591-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFRS	01295	SN7437J
U235	156-0554-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NAND GATE	01295	SN7420J
U241	156-0551-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	01295	SN7402J
U245	156-0553-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	01295	SN7410J
U251	156-0591-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFRS	01295	SN7437J
U261	156-0561-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	01295	SN7493J
U265	156-0596-00			MICROCIRCUIT,DI:4-50MHX PRESETTABLE COUNTER	01295	SN74197
U271	156-0585-00			MICROCIRCUIT,DI:HEX INVBFR/DRVR,W/OPEN	01295	SN7416J
U275	156-0556-00			MICROCIRCUIT,DI:BDC TO DECIMAL DECODER	01295	SN7442J
U301	156-0558-00			MICROCIRCUIT,DI:DUAL D-TYPE W/POS EDGE TRIG	01295	SN7474J
U311	156-0552-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN7404J
U321	156-0598-00			MICROCIRCUIT,DI:BDC TO DEC DECODER,DRIVER	01295	SN74145J
U335	156-0553-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	01295	SN7410J
U341	156-0550-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7401J
U345	156-0559-00			MICROCIRCUIT,DI:4-BIT BISTABLE LATCHED	01295	SN7475J
U351	156-0559-00			MICROCIRCUIT,DI:4-BIT BISTABLE LATCHED	01295	SN7475J
U361	156-0587-00			MICROCIRCUIT,DI:TPL 3 INP,POST NAND GATE	01295	SN7412J
U365	156-0553-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	01295	SN7410J
U371	156-0555-00			MICROCIRCUIT,DI:8-INPUT POS NAND GATE	01295	SN7430J
U375	307-0387-00			RES.,FXD,FILM:13 RES.NETWORK,8200 OHM	73138	899-1-R8.2K
U381	156-0589-00			MICROCIRCUIT,DI:HEX BFR/DRVR,W/OPEN COLL HV	01295	SN7417J
U391	156-0597-00			MICROCIRCUIT,DI:1 OF 16 DATA SELECTOR/MUXER	01295	SN74150J
U401	156-0465-00			MICROCIRCUIT,DI:8-INPUT NAND GATE	01295	SN74LS30N
U415	156-0564-00			MICROCIRCUIT,DI:4 TO 16 LINE DECODER	01295	SN74154J
U431	156-0595-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	01295	SN74123J
U435	156-0592-00			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE	01295	SN7438J
U441	156-0589-00			MICROCIRCUIT,DI:HEX BFR/DRVR,W/OPEN COLL HV	01295	SN7414J
U445	156-0559-00			MICROCIRCUIT,DI:4-BIT BISTABLE LATCHED	01295	SN7475J
U451	156-0550-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7401J
U465	156-0558-00			MICROCIRCUIT,DI:DUAL D-TYPE W/POS EDGE TRIG	01295	SN7474J
U471	156-0585-00			MICROCIRCUIT,DI:HEX INVBFR/DRVR	01295	SN7416J
U475	156-0296-00			MICROCIRCUIT,DI:CHARACTER GENERATOR	33297	EA4001
U485	156-0293-02			MICROCIRCUIT,DI:ROM B,CHARACTER GENERATOR	33297	EA40000
Y47	158-0072-00			XTAL UNIT,QTZ:4.9152 MHZ,0.05%	01807	Z713PF

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A5	670-3883-01			CKT BOARD ASSY:TC2	80009	670-3883-01
C9	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C31	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	72982	301-000C0G0100F
C38	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	72982	301-000X5P0331K
C84	290-0162-00			CAP.,FXD,ELECT.:22UF,20%,35V	12954	D22C35M1
C88	285-0596-00			CAP.,FXD,PLSTC:0.01UF,1%,100V	56289	490P10311
C89	285-0596-00			CAP.,FXD,PLSTC:0.01UF,1%,100V	56289	490P10311
C90	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	72982	301-000X5U0471M
C149	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C171	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C174	285-0596-00			CAP.,FXD,PLSTC:0.01UF,1%,100V	56289	490P10311
C175	285-0596-00			CAP.,FXD,PLSTC:0.01UF,1%,100V	56289	490P10311
C176	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	72982	301-000X5U0471M
C201	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C202	290-0136-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	162D225X0020CD2
C209	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C241	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C282	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C286	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C296	283-0635-00			CAP.,FXD,MICA D:51PF,1%,100V	00853	D151E510F0
C296	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C298	283-0635-00			CAP.,FXD,MICA D:51PF,1%,100V	00853	D151E510F0
C299	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C301	283-0221-00			CAP.,FXD,CER DI:0.47UF,20%,50V W5R	72982	8141N077W5R474M
C329	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C330	281-0543-00			CAP.,FXD,CER DI:270PF,10%,500V	72982	301-055X5P1271K
C359	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C390	290-0162-00			CAP.,FXD,ELECT.:22UF,20%,35V	12954	D22C35M1
C397	290-0162-00			CAP.,FXD,ELECT.:22UF,20%,35V	12954	D22C35M1
CR180	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR181	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR182	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR183	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR185	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR186	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR187	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR188	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR189	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR190	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR283	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR285	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR350	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	14936	GD238
CR381	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR382	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR383	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR384	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR385	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR386	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR387	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR388	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152

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CR389	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
Q77	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q78	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q79	151-0459-00			TRANSISTOR:SILICON,PNP	04713	2N3251
Q80	151-1022-00			TRANSISTOR:SILICON,JFE,SEL FROM 2N4392	80009	151-1022-00
Q85	151-1022-00			TRANSISTOR:SILICON,JFE,SEL FROM 2N4392	80009	151-1022-00
Q273	151-1042-00			SEMICOND DVC SE:MATCHED PAIR FET	80009	151-1042-00
Q274	151-0459-00			TRANSISTOR:SILICON,PNP	04713	2N3251
Q275	151-0120-00			TRANSISTOR:SILICON,NPN	07263	2N2484
Q277	151-0459-00			TRANSISTOR:SILICON,PNP	04713	2N3251
Q278	151-0126-00			TRANSISTOR:SILICON,NPN	07263	2N2484
R20	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R29	311-1134-00			RES.,VAR,NONWW:TRMR,50K OHM,0.5W	73138	72XW-51-0-503M
R30	315-0244-00			RES.,FXD,CMPSN:240K OHM,5%,0.25W	01121	CB2445
R31	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R39	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R55	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R72	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R73	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R74	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R75	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R76	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R77	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R82	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	75042	CEATO-6192F
R83	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R86	308-0697-00			RES.,FXD,WW:32.14K OHM,0.1%,0.125W	91637	WWP2258032141B
R88	321-0403-00			RES.,FXD,FILM:154K OHM,1%,0.125W	75042	CEATO-1543F
R89	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	75042	CEATO-6192F
R90	315-0396-00			RES.,FXD,CMPSN:39M OHM,5%,0.25W	01121	CB3965
R175	315-0396-00			RES.,FXD,CMPSN:39M OHM,5%,0.25W	01121	CB3965
R176	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	75042	CEATO-6192F
R177	321-0403-00			RES.,FXD,FILM:154K OHM,1%,0.125W	75042	CEATO-1543F
R178	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	75042	CEATO-6192F
R182	308-0698-00			RES.,FXD,WW:16.046K OHM,0.1%,0.125W	91637	WWP225-A16046B
R183	308-0658-00			RES.,FXD,WW:4K OHM,0.01%,0.125W	91637	WWP225-A40000L
R186	308-0699-00			RES.,FXD,WW:8.0115K OHM,0.1%,0.125W	05347	203PA80111A
R187	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R191	322-0696-00			RES.,FXD,FILM:129 OHM,1%,0.25W	91637	MFF1421G12902F
R192	323-0510-00			RES.,FXD,FILM:2.00 MEG OHM,1%,0.5W	75042	CEATO-2004F
R193	322-0693-00			RES.,FXD,FILM:1.036 MEG OHM,1%,0.25W	91637	MFF1412G10363F
R194	322-0694-00			RES.,FXD,FILM:517K OHM,1%,0.25W	91637	MFF1421G51702F
R195	322-0697-02			RES.,FXD,FILM:64.37K OHM,0.5%,0.25W	91637	MFF1421D64371D
R196	322-0695-00			RES.,FXD,FILM:58K OHM,0.1%,0.25W	91637	MFF1421G25802F
R201	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R241	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R261	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R265	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R273	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R274	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R275	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R276	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R277	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735

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R278	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R280	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R28	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R284	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R283	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEAT0-5111F
R285	321-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.125W	75042	CEAT0-1501F
R286	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R287	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R288	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R289	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R290	321-0221-00			RES.,FXD,FILM:1.96K OHM,1%,0.125W	75042	CEAT0-1961F
R303	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R305	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R309	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R329	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R331	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R345	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R380	308-0697-00			RES.,FXD,WW:32.14K OHM,0.1%,0.125W	91637	WWP2258032141B
R381	308-0698-00			RES.,FXD,WW:16.046K OHM,0.1%,0.125W	91637	WWP225-A16046B
R382	308-0699-00			RES.,FXD,WW:8.0115K OHM,0.1%,0.125W	05347	203PA80111A
R387	308-0658-00			RES.,FXD,WW:4K OHM,0.01%,0.125W	91637	WWP225-A40000L
R391	322-0697-02			RES.,FXD,FILM:64.37K OHM,0.5%,0.25W	91637	MFF1421D64371D
R392	322-0696-00			RES.,FXD,FILM:129 OHM,1%,0.25W	91637	MFF1421G12902F
R393	323-0510-00			RES.,FXD,FILM:2.00 MEG OHM,1%,0.5W	75042	CEATO-2004F
R394	322-0693-00			RES.,FXD,FILM:1.036 MEG OHM,1%,0.25W	91637	MFF1421G0363F
R395	322-0694-00			RES.,FXD,FILM:517K OHM,1%,0.25W	91637	MFF1421G51702F
R396	322-0695-00			RES.,FXD,FILM:58K OHM,0.1%,0.25W	91637	MFF1421G25802F
U9	156-0558-00			MICROCIRCUIT,DI:DUAL D-TYPE W/POS EDGE TRIG	01295	SN7474J
U31	156-0595-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	01295	SN74123J
U39	156-0557-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7473J
U41	156-0561-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	01295	SN7493J
U49	156-0556-00			MICROCIRCUIT,DI:BDC TO DECIMAL DECODER	01295	SN7442J
U51	156-0563-00			MICROCIRCUIT,DI:J OR N DUAL IN LINE	01295	SN74151H
U59	156-0563-00			MICROCIRCUIT,DI:J OR N DUAL IN LINE	01295	SN74151H
U61	156-0565-00			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN COUNTER	01295	SN74193
U69	156-0565-00			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN COUNTER	01295	SN74193
U71	156-0565-00			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN COUNTER	01295	SN74193
U91	156-0077-00			MICROCIRCUIT,LI:OPTIONAL AMPLIFIER	27014	LM301AH
U92	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U109	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U129	156-0557-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7473J
U131	156-0557-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7473J
U139	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U141	156-0553-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	01295	SN7410J
U149	156-0553-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	01295	SN7410J
U151	156-0563-00			MICROCIRCUIT,DI:J OR N DUAL IN LINE	01295	SN74151H
U159	156-0563-00			MICROCIRCUIT,DI:J OR N DUAL IN LINE	01295	SN74151H
U161	156-0563-00			MICROCIRCUIT,DI:J OR N DUAL IN LINE	01295	SN74151H
U169	156-0559-00			MICROCIRCUIT,DI:4-BIT BISTABLE LATCHED	01295	SN7475J
U171	156-0558-00			MICROCIRCUIT,DI:DUAL D-TYPE W/POS EDGE TRIG	01295	SN7474J
U179	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U181	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393

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U189	156-0106-00			MICROCIRCUIT,LI:SIX DIODE ARRAY	86684	CA3039
U191	156-0106-00			MICROCIRCUIT,LI:SIX DIODE ARRAY	86684	CA3039
U201	156-0562-00			MICROCIRCUIT,DI:MONOSTABLE MULTIVIBRATOR	01295	SN74121J
U209	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U229	156-0557-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7473J
U231	156-0554-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NAND GATE	01295	SN7420J
U239	156-0551-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	01295	SN7402J
U241	156-0562-00			MICROCIRCUIT,DI:MONOSTABLE MULTIVIBRATOR	01295	SN74121J
U249	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U251	156-0552-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN7404J
U259	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U261	156-0587-00			MICROCIRCUIT,DI:TPL 3 INP,POST NAND GATE	01295	SN7412J
U271	156-0601-00			MICROCIRCUIT,DI:DUAL T-BIT BFR W/INVTD INP	18324	8201F
U291	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
U292	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
U301	156-0562-00			MICROCIRCUIT,DI:MONOSTABLE MULTIVIBRATOR	01295	SN74121J
U309	156-0592-00			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE	01295	SN7438J
U329	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400J
U331	156-0560-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	01295	SN7476J
U339	156-0592-00			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE	01295	SN7438J
U341	156-0550-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7401J
U349	156-0588-00			MICROCIRCUIT,DI:QUAD 1-INPUT POS NAND GATE	01295	SN7408J
U351	156-0592-00			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE	01295	SN7438J
U359	156-0592-00			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE	01295	SN7438J
U361	156-0565-00			MICROCIRCUIT,DI:SYN 4-BIT UP/DOWN COUNTER	01295	SN74193
U369	156-0565-00			MICROCIRCUIT,DI:SYN 4-BIT UP/DOWN COUNTER	01295	SN74193
U371	156-0565-00			MICROCIRCUIT,DI:SYN 4-BIT UP/DOWN COUNTER	01295	SN74193
U378	156-0552-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN7404J
U379	156-0552-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN7404J
U389	156-0106-00			MICROCIRCUIT,LI:SIX DIODE ARRAY	86684	CA3039
U391	156-0106-00			MICROCIRCUIT,LI:SIX DIODE ARRAY	86684	CA3039
A6	670-3917-00			CKT BOARD ASSY:H.V. AND Z AXIS	80009	670-3917-00
C15	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A(7-S2057)
C16	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A(7-S2057)
C64	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C65	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C79	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501651104M
C82	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C83	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501651104M
C135	283-0291-00			CAP.,FXD,CER DI:25PF,10%,6000V	72982	3878546C0G250K
C138	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C143	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C145	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C149	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C174	283-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
C181	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	72982	301-000Z5D0471K
C183	290-0308-00			CAP.,FXD,ELCTLT:1UF,20%,35V	12954	D1R0T35MI
C196	281-0500-00			CAP.,FXD,CER DI:2.2PF,+/-0.5PF,500V	72982	301-000C0J0229D
C209	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z

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C214	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C246	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C255	283-0367-00			CAP.,FXD,CER DI:4700PF,+80-20%,7.5KV	56289	112C120C87C
C268	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C288	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C294	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	72982	301-000C0G0100F
C315	290-0162-00			CAP.,FXD,ELECT.:22UF,20%,35V	12954	D22C35M1
C336	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C339	290-0308-00			CAP.,FXD,ELCTLT:1UF,20%,35V	12954	D1R0T35MI
C341	290-0308-00			CAP.,FXD,ELCTLT:1UF,20%,35V	12954	D1R0T35MI
C362	281-0510-00			CAP.,FXD,CER DI:22PF,+/-4.4PF,500V	72982	301-000C0G0220M
C363	281-0547-00			CAP.,FXD,CER DI:2.7PF,10%,500V	72982	301-000C0J0279C
C364	281-0541-00			CAP.,FXD,CER DI:6.8PF,10%,500V	72982	301-000C0H0689D
C373	290-0308-00			CAP.,FXD,ELCTLT:1UF,20%,35V	12954	D1R0T35MI
C375	290-0308-00			CAP.,FXD,ELCTLT:1UF,20%,35V	12954	D1R0T35MI
C397	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
CR1	152-0408-00			SEMICOND DVC DI:SILICON,10KV,5MA	83003	H345
CR5	152-0408-00			SEMICOND DVC DI:SILICON,10KV,5MA	83003	H345
CR21	152-0408-00			SEMICOND DVC DI:SILICON,10KV,5MA	83003	H345
CR25	152-0408-00			SEMICOND DVC DI:SILICON,10KV,5MA	83003	H345
CR45	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	12969	NDP341
CR53	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	12969	NDP341
CR72	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR73	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR74	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR75	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR76	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR79	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR81	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR87	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR94	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR177	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR178	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR189	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR198	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR201	152-0412-00			SEMICOND DEVICE:SILICON,50V,3A	04713	SR1936
CR249	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR273	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR286	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR311	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR332	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR334	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR349	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR361	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR362	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR367	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
DS32	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS33	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS34	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS41	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS48	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS51	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T

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DS53	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS55	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS74	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS173	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS244	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS246	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS249	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS257	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS258	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
DS259	150-0035-00			LAMP,GLOW:90V,0.3MA	08806	A1D-T
L173	108-0213-00			COIL,RF:2.5MH	76493	8862-2.5
L311	108-0234-00			COIL,RF:130UH	80009	108-0234-00
L318	108-0422-00			COIL,RF:80UH	80009	108-0422-00
Q91	151-0279-00			TRANSISTOR:SILICON,NPN	07263	S25381
Q175	151-0124-00			TRANSISTOR:SILICON,NPN,SEL FROM 2N3501	04713	SM8138
Q185	151-0279-00			TRANSISTOR:SILICON,NPN	07263	S25381
Q187	151-0270-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N3495	03877	ST30032
Q196	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q197	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q274	151-0279-00			TRANSISTOR:SILICON,NPN	07263	S25381
Q282	151-0279-00			TRANSISTOR:SILICON,NPN	07263	S25381
Q301	151-0256-00			TRANSISTOR:SILICON,NPN	16758	7305762
Q323	151-0334-00			TRANSISTOR:SILICON,NPN	80009	151-0334-00
Q329	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q333	151-1015-00			TRANSISTOR:SILICON,FE,N-CHANNEL	15818	U1635
Q357	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q358	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q378	151-1014-00			TRANSISTOR:SILICON,FE,N-CHANNEL	04713	FN389
Q379	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q383	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q389	151-1014-00			TRANSISTOR:SILICON,FE,N-CHANNEL	04713	FN389
Q391	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
R38	301-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.50W	01121	EB1015
R40	301-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.50W	01121	EB1015
R41	301-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.50W	01121	EB2735
R45	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R47	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R52	301-0395-00			RES.,FXD,CMPSN:3.9M OHM,5%,0.50W	01121	EB3955
R55	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R73	315-0202-02			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R77	305-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,2W	01121	HB1255
R82	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R83	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R85	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEAT0-1502F
R86	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	80294	3389F-P31-104
R87	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R91	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	80294	3389F-P31-104
R92	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R97	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R98	301-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.50W	01121	EB2225
R161	311-1323-00			RES.,VAR,NONWW:PNL,5 MEG OHM,1W	01121	11M039
R174	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

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R175	301-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.50W	01121	EB3935
R178	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R179	315-0301-02			RES.,FXD,COMP:300 OHM,5%,0.25W	01121	CB3015
R181	315-0471-03			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R183	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R185	315-0220-01			RES.,FXD,COMP:22 OHM,5%,0.25W	01121	CB2205
R186	315-0471-03			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R187	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R188	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R191	303-0513-00			RES.,FXD,CMPSN:51K OHM,5%,1W	01121	GB5135
R192	315-0104-03			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R193	321-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.125W	75042	CEATO-6191F
R194	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R195	321-0411-00			RES.,FXD,FILM:187K OHM,1%,0.125W	75042	CEATO-1873F
R196	321-0406-00			RES.,FXD,FILM:165K OHM,1%,0.125W	75042	CEATO-1653F
R197	321-0371-00			RES.,FXD,FILM:71.5K OHM,1%,0.125W	75042	CEATO-7152F
R202	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R227	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	80294	3389F-P31-503
R231	315-0104-03			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R233	321-0423-00			RES.,FXD,FILM:249K OHM,1%,0.125W	75042	CEATO-2493F
R236	315-0224-00			RES.,FXD,CMPSN:220K OHM,5%,0.25W	01121	CB2245
R238	315-0823-02			RES.,FXD,COMP:820K OHM,5%,0.25W	01121	CB8235
R241A	307-0314-00			RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0314-00
R241B	307-0314-00			RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0314-00
R251	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R253A	307-0316-00			RES.,FXD,FILM:15M OHM	80009	307-0316-00
R253B	307-0316-00			RES.,FXD,FILM:15M OHM	80009	307-0316-00
R261	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R269	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R271	308-0108-00			RES.,FXD,WW:15K OHM,5%,5W	63743	2470
R272	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R273	321-0241-00			RES.,FXD,FILM:3.16K OHM,1%,0.125W	75042	CEATO-3161F
R274	315-0303-03			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R275	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R276	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R277	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R278	315-0221-03			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R279	321-0330-00			RES.,FXD,FILM:26.7K OHM,1%,0.125W	75042	CEATO-2672F
R280	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R281	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R282	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	75042	CEATO-4421F
R283	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R284	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R285	315-0303-03			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R286	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R287	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R288	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R289	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R290	305-0473-00			RES.,FXD,CMPSN:47K OHM,5%,2W	01121	HB4735
R293	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEATO-8061F
R294	315-0335-00			RES.,FXD,CMPSN:3.3M OHM,5%,0.25W	01121	CB3355
R295	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R297	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	75042	CEATO-6981F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R298	305-0393-00			RES.,FXD,CMPSN:39K OHM,5%,2W	01121	HB3935
R310	308-0244-00			RES.,FXD,WW:0.3 OHM,10%,2W	91637	RS2B162ER3000K
R317	301-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.50W	01121	EB2725
R325	315-0221-03			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R327	304-0152-00			RES.,FXD,CMPSN:1.5K OHM,10%,1W	01121	GB1521
R329	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R330	315-0272-03			RES.,FXD,COMP:30K OHM,5%,0.25W	01121	CB2725
R338	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R342	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R346	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R351	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R355	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R364	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R366	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	75042	CEATO-4993F
R368	315-0335-00			RES.,FXD,CMPSN:3.3M OHM,5%,0.25W	01121	CB3355
R371	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R372	315-0220-01			RES.,FXD,COMP:22 OHM,5%,0.25W	01121	CB2205
R379	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEATO-8061F
R381	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R382	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	80294	3389F-P31-104
R386	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R387	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R389	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	80294	3389F-P31-104
R394	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R395	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R397	315-0220-01			RES.,FXD,COMP:22 OHM,5%,0.25W	01121	CB2205
T101	120-0826-00			XFMR,PWR,SDN/SU:30KHZ	80009	120-0826-00
U295	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U375	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
VR95	152-0022-00			SEMICOND DEVICE:ZENER,1W,25V,5%	04713	SZ12815
A7	----- -----[1]			CKT BOARD ASSY:DEFLECTION AMP		
C29	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K
C34	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z
C43	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K
C47	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131N075WR5223K
C75	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z
C83	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
C147	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K
C157	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C195	290-0260-00			CAP.,FXD,ELCTLT:50UF,+75-10%,200V	56289	34D506G200GL4
C225	290-0189-00			CAP.,FXD,ELCTLT:33UF,10%,35V	12954	033D351
C238	281-0622-00			CAP.,FXD,CER DI:47PF,1%,500V	72982	308-000C0G0470F
C262	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131N075WR5223K
C265	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K
C275	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	274C10
C334	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075W5R103M
C363	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K

[1]Available under 672-0504-00 only.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C395	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C482	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C483	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C484	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K
C493	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	72982	301-000X5P0121K
C535	290-0261-00			CAP.,FXD,ELCTLT:6.8UF,10%,35V	12954	D6R8B35K1
C538	290-0261-00			CAP.,FXD,ELCTLT:6.8UF,10%,35V	12954	D6R8B35K1
C541	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C543	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C544	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075W5R103M
C548	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075W5R103M
C551	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C555	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C561	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C582	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C584	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C588	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C589	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C596	283-0128-00			CAP.,FXD,CER DI:100PF,5%,500V	72982	871-536T2H101J
CR8	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR55	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR57	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR206	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR208	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR215	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR257	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR261	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR266	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR267	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR268	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR269	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR278	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR286	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR308	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR335	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR337	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR343	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR344	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR351	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR352	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR355	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR361	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR482	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR496	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR501	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR506	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR508	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR509	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR515	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR586	152-0107-00			SEMICOND DEVICE:SILICON,375V,400MA	80009	152-0107-00
CR588	152-0107-00			SEMICOND DEVICE:SILICON,375V,400MA	80009	152-0107-00
CR589	152-0107-00			SEMICOND DEVICE:SILICON,375V,400MA	80009	152-0107-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q50	151-0235-00			TRANSISTOR:SILICON,PNP	04713	2N4890
Q51	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
Q86	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q131	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q141	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q178	151-0126-00			TRANSISTOR:SILICON,NPN	07263	2N2484
Q181	151-0126-00			TRANSISTOR:SILICON,NPN	07263	2N2484
Q184	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q187	151-0126-00			TRANSISTOR:SILICON,NPN	07263	2N2484
Q257	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
Q258	151-0235-00			TRANSISTOR:SILICON,PNP	04713	2N4890
Q387	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q388	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q397	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q398	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q401	151-0460-00			TRANSISTOR:SILICON,NPN	07263	2N3947
Q445	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q461	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q471	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q472	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q487	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q488	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q505	151-0459-00			TRANSISTOR:SILICON,PNP	04713	2N3251
Q509	151-0459-00			TRANSISTOR:SILICON,PNP	04713	2N3251
Q515	151-0460-00			TRANSISTOR:SILICON,NPN	07263	2N3947
Q568	151-0149-00			TRANSISTOR:SILICON,NPN	02735	60010
R1	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R2	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R3	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R5	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R6	321-0705-00			RES.,FXD,FILM:41.7K OHM,1%,0.125W	75042	CEATO-4172F
R7	311-1288-00			RES.,VAR,NONWW:TRMR,200K OHM,0.5W	73138	62PAS-334-0
R9	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	75042	CEATO-2322F
R11	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R14	311-1287-00			RES.,VAR,NONWIR:1000 OHM,+/-10%,0.5W	73138	62PAS-333-0
R15	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R16	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	75042	CEATO-3241F
R21	311-1288-00			RES.,VAR,NONWW:TRMR,200K OHM,0.5W	73138	62PAS-334-0
R25	311-1287-00			RES.,VAR,NONWIR:1000 OHM,+/-10%,0.5W	73138	62PAS-333-0
R27	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R31	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEATO-4021F
R32	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R33	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R34	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R35	307-0124-00			RES.,THERMAL:5K OHM,10%	50157	1D1618
R36	311-1287-00			RES.,VAR,NONWIR:1000 OHM,+/-10%,0.5W	73138	62PAS-333-0
R37	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R38	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R39	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	75042	CEATO-1003F
R40	311-1287-00			RES.,VAR,NONWIR:1000 OHM,+/-10%,0.5W	73138	62PAS-333-0
R41	321-0204-00			RES.,FXD,FILM:1.3K OHM,1%,0.125W	75042	CEATO-1301F
R44	311-1277-00			RES.,VAR,NONWIR:100 OHM,10%,0.5W	73138	62PAS-328-0

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R46	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R51	311-1277-00			RES.,VAR,NONWIR:100 OHM,10%,0.5W	73138	62PAS-328-0
R55	307-0344-00			RES.,FXD,FILM:3 SECT,1.5 OHM EA SECT	80009	307-0344-00
R57	311-1287-00			RES.,VAR,NONWIR:1000 OHM,+/-10%,0.5W	73138	62PAS-333-0
R61	311-1287-00			RES.,VAR,NONWIR:1000 OHM,+/-10%,0.5W	73138	62PAS-333-0
R66	303-0361-00			RES.,FXD,CMPSN:360 OHM,5%,1W	01121	GB3615
R69	303-0241-00			RES.,FXD,CMPSN:240 OHM,5%,1W	01121	GB2415
R74	311-1283-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	80294	3329W-L58-103
R75	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R76	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R77	311-1283-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	80294	3329W-L58-103
R78	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R79	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	75042	CEATO-2322F
R80	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R84	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R87	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R132	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	75042	CEATO-7681F
R133	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R134	321-0304-00			RES.,FXD,FILM:14.3K OHM,1%,0.125W	75042	CEATO-1432F
R135	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	75042	CEATO-4221F
R136	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W		
R137	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R145	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEATO-8061F
R146	321-0204-00			RES.,FXD,FILM:1.3K OHM,1%,0.125W	75042	CEATO-1301F
R151	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R156	301-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.50W	01121	EB4725
R201	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R202	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R203	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R204	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	75042	CEATO-2741F
R205	321-0287-00			RES.,FXD,FILM:9.53K OHM,1%,0.125W	75042	CEATO-9531F
R209	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R212	321-0162-00			RES.,FXD,FILM:475 OHM,1%,0.125W	75042	CEATO-4750F
R214	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R216	301-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.50W	01121	EB2425
R231	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R234	321-0304-00			RES.,FXD,FILM:14.3K OHM,1%,0.125W	75042	CEATO-1432F
R237	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	75042	CEATO-7501F
R238	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	75042	CEATO-7501F
R240	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R241	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R242	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R243	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	75042	CEATO-4221F
R244	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	75042	CEATO-7681F
R245	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R246	321-0304-00			RES.,FXD,FILM:14.3K OHM,1%,0.125W	75042	CEATO-1432F
R247	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R248	321-0304-00			RES.,FXD,FILM:14.3K OHM,1%,0.125W	75042	CEATO-1432F
R249	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	75042	CEATO-7681F
R250	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R251	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	75042	CEATO-4221F
R252	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R262	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

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R263	321-0204-00			RES.,FXD,FILM:1.3K OHM,1%,0.125W	75042	CEATO-1301F
R264	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	75042	CEATO-1003F
R265	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R275	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R276	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R277	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R278	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R279	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R282	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R283	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R284	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R285	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R287	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R288	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R289	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R301	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R302	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R303	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R306	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R307	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R308	321-0705-00			RES.,FXD,FILM:41.7K OHM,1%,0.125W	75042	CEATO-4172F
R309	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	75042	CEATO-2322F
R311	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R312	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R313	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	75042	CEATO-3241F
R314	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R332	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R333	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R334	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R336	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R337	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	75042	CEATO-3322F
R338	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R339	321-0316-00			RES.,FXD,FILM:19.1K OHM,1%,0.125W	75042	CEATO-1912F
R341	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R342	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R343	307-0124-00			RES.,THERMAL:5K OHM,10%	50157	1D1618
R344	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R345	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R350	307-0124-00			RES.,THERMAL:5K OHM,10%	50157	1D1618
R351	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R352	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R353	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R354	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R361	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R362	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R364	321-0204-00			RES.,FXD,FILM:1.3K OHM,1%,0.125W	75042	CEATO-1301F
R365	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEATO-8061F
R374	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R375	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R376	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R377	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R378	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R379	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335

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R380	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R381	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R382	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R383	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	75042	CEATO-1542F
R384	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R385	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R387	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	75042	CEATO-6981F
R388	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R389	321-0363-00			RES.,FXD,FILM:59K OHM,1%,0.125W	75042	CEATO-5902F
R390	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R393	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R401	301-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.50W	01121	EB2425
R414	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R416	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R425	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R441	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R442	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEATO-4021F
R443	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R444	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEATO-5111F
R445	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEATO-5111F
R446	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R451	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R452	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R453	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	75042	CEATO-4221F
R454	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	75042	CEATO-7681F
R455	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R456	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R457	307-0124-00			RES.,THERMAL:5K OHM,10%	50157	1D1618
R464	321-0301-00			RES.,FXD,FILM:13.3K OHM,1%,0.125W	75042	CEATO-1332F
R465	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R468	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R469	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R471	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R474	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R476	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R475	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R477	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R478	323-0398-00			RES.,FXD,FILM:137K OHM,1%,0.50W	75042	CECT0137KF
R479	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R485	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R486	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R489	301-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.50W	01121	EB4745
R492	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R495	303-0224-00			RES.,FXD,CMPSN:220K OHM,5%,1W	01121	GB2245
R500	321-0162-00			RES.,FXD,FILM:475 OHM,1%,0.125W	75042	CEATO-4750F
R501	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	75042	CEATO-2741F
R502	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R503	321-0287-00			RES.,FXD,FILM:9.53K OHM,1%,0.125W	75042	CEATO-9531F
R504	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R505	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R506	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R511	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535

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R512	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R513	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R516	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R525	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R526	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R531	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R544	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R545	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R547	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R548	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R555	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R556	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R572	305-0683-00			RES.,FXD,CMPSN:68K OHM,5%,2W	01121	HB6835
R575	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R581	306-0124-00			RES.,FXD,CMPSN:120K OHM,10%,2W	01121	HB1241
R582	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R583	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R584	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R585	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R590	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R591	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R595	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R596	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R598	323-0452-00			RES.,FXD,FILM:499K OHM,1%,0.50W	75042	CECTO-4993F
U24	156-0603-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	01295	SN54123J
U44	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U71	156-0603-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	01295	SN54123J
U101	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U111	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U224	156-0586-00			MICROCIRCUIT,DI:DUAL 4 INP. POS NAND ST	01295	SN7413J
U235	155-0116-00			MICROCIRCUIT,LI:QUAD OPNL AMPL METAL-GLASS	80009	155-0116-00
U271	156-0551-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	01295	SN7402J
U324	156-0585-00			MICROCIRCUIT,DI:HEX INVBFR/DRV R,W/OPEN COIL	01295	SN7416V
U345	155-0116-00			MICROCIRCUIT,LI:QUAD OPNL AMPL METAL-GLASS	80009	155-0116-00
U368	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U371	156-0585-00			MICROCIRCUIT,DI:HEX INVBFR/DRV R,W/OPEN COIL	01295	SN7416V
U401	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U409	156-0049-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U424	156-0592-00			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE	01295	SN7438J
U434	156-0561-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	01295	SN7493AJ
U435	156-0585-00			MICROCIRCUIT,DI:HEX INVBFR/DRV R,W/OPEN COIL	01295	SN7416V
U524	156-0549-00			MICROCIRCUIT,DI:QUAD 2-INPUT AND GATE	03877	TG74S08J
VR155	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	81483	69-6512
VR576	152-0087-00			SEMICOND DEVICE:ZENER,1W,100V,5%	04713	1N3044B
VR585	152-0298-00			SEMICOND DEVICE:ZENER,1.5W,140V,5%	80009	152-0298-00
VR592	152-0059-00			SEMICOND DVC,DI:ZENER,1W,12.6V,5%	04713	SZ50601
A8	670-3920-00			CKT BOARD ASSY:HARD COPY	80009	670-3920-00
C65	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	72982	301-000Y5D0651J
C67	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	72982	301-000Y5D0651J

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C75	281-0512-00			CAP.,FXD,CER DI:27PF,+/-2.7PF,500V	72982	308-000C0G0270K
C85	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	72982	301-000Y5D0651J
C95	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C129	283-0194-00			CAP.,FXD,CER DI:4.7UF,20%,50V	72982	8151N080651475M
C131	283-0194-00			CAP.,FXD,CER DI:4.7UF,20%,50V	72982	8151N080651475M
C159	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
C179	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C185	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	72982	301-000Y5D0651J
C195	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C231	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501651104M
C235	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501651104M
C245	290-0285-00			CAP.,FXD,ELCTLT:4UF,+50-10%,200V	56289	30D1800
C275	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651104Z
C279	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
C281	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651104Z
C289	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
C291	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
CR105	152-0107-00			SEMICOND DEVICE:SILICON,375V,400MA	80009	152-0107-00
CR121	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	14099	SC6
CR145	152-0426-00			SEMICOND DEVICE:SILICON,400V,400MA	01295	G2017-1
L9	108-0422-00			COIL,RF:80UH	80009	108-0422-00
L19	108-0422-00			COIL,RF:80UH	80009	108-0422-00
L45	108-0146-00			COIL,RF:5UH	80009	108-0146-00
L229	108-0324-00			COIL,RF:10MH	76493	70F102A1
L238	108-0324-00			COIL,RF:10MH	76493	70F102A1
L251	108-0324-00			COIL,RF:10MH	76493	70F102A1
Q275	151-0134-00			TRANSISTOR:SILICON,PNP	04713	SM3195
R45	315-0681-03			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R65	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R67	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R75	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R95	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R137	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R138	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R139	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R149	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R165	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R166	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R167	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	80294	3389F-P31-103
R175	315-0513-03			RES.,FXD,COMP:51K OHM,5%,0.25W	01121	CB5135
R177	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R179	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R185	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R189	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R195	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R265	311-1251-00			RES.,VAR,NONWIR:200K OHM,20%,0.50W	80294	3389F-P35-204
R267	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R269	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	75042	CEATO-1651F
R275	301-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.50W	01121	EB1515
R277	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	75042	CEATO-2491F
R278	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5

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R281	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R285	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R297	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R135	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R295	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
T38	120-0827-00			XFMR,TOROID:THREE 12 TURN WINDINGS	80009	120-0827-00
U59	156-0162-00			MICROCIRCUIT,LI:DIFFERENTIAL VIDEO AMPL	07263	UA733DM
U79	156-0162-00			MICROCIRCUIT,LI:DIFFERENTIAL VIDEO AMPL	07263	UA733DM
U95	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U289	156-0562-00			MICROCIRCUIT,DI:MONOSTABLE MULTIVIBRATOR	01295	SN74121J
A9	670-3852-00			CKT BOARD ASSY:POWER SUPPLY	80009	670-3852-00
C5	290-0753-00			CAP.,FXD,ELCTLT:4500UF,+75-10%,30V	90201	20-36431
C33	290-0549-00			CAP.,FXD,ELCTLT:150UF,400VDC/250VDC	56289	68020193
C65	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	72982	301-000X5P0331K
C157	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	72982	301-000X5U0471M
C163	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z
C283	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C239	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	72982	855-535B222J
C241	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C254	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C255	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C261	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C267	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	72982	855-535B222J
C269	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C305	290-0753-00			CAP.,FXD,ELCTLT:4500UF,+75-10%,30V	90201	20-36431
C346	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C375	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
CR209	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR235	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR244	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
R250	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
CR251	152-0233-00			SEMICOND DEVICE:SILICON,85V,100MA	07910	CD61128
CR325	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR326	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR329	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR330	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR335	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR336	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR338	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
CR339	152-0423-00			SEMICOND DEVICE:SILICON,300V,3A	04713	1N5000
F221	159-0021-00			FUSE,CARTRIDGE:3AG,2A,250V,FAST-BLOW	71400	AGC2
F225	159-0021-00			FUSE,CARTRIDGE:3AG,2A,250V,FAST-BLOW	71400	AGC2
F381	159-0137-00			FUSE,CARTRIDGE:3AG,8 AMP,32V,FAST-BLOW	75915	311008
Q50	151-0337-00			TRANSISTOR:SILICON,NPN	21845	93SX287
Q73	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q81	151-0507-00			TRANSISTOR:SILICON	02735	2N3669
Q237	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A

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Q243	151-0134-00			TRANSISTOR:SILICON,PNP	04713	SM3195
Q253	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
R51	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	75042	CEATO-7500F
R53	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R55	321-0226-00			RES.,FXD,FILM:2.21K OHM,1%,0.125W	75042	CEATO-2211F
R57	311-1224-00			RES.,VAR,NONWIR:500 OHM,20%,0.50W	80294	3389F-P31-501
R158	321-0604-00			RES.,FXD,FILM:30K OHM,0.25%,0.125W	75042	CEAT2-3002C
R159	321-0603-00			RES.,FXD,FILM:15K OHM,0.25%,0.125W	75042	CEAT2-1502C
R161	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R165	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R166	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R227	304-0184-00			RES.,FXD,CMPSN:180K OHM,10%,1W	01121	GB1841
R229	303-0104-00			RES.,FXD,CMPSN:100K OHM,5%,1W	01121	GB1045
R231	303-0623-00			RES.,FXD,CMPSN:62K OHM,5%,1W	01121	GB6235
R240	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R245	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R250	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R253	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R259	308-0463-00			RES.,FXD,WW:0.3 OHM,1%,3W	91637	RS2B-ER3000F
R265	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R270	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R344	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R345	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R355	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R371	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R373	315-0472-03			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
U151	156-0699-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	723HM
U246	156-0700-00			MICROCIRCUIT,LI:OPERATING AMPLIFIER	27014	LM741
U267	156-0700-00			MICROCIRCUIT,LI:OEPRATING AMPLIFIER	07263	U5B7741393
VR233	152-0283-00			SEMICOND DEVICE:ZENER,0.4W,43V,5%	04713	1N976B
VR271	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	07910	1N751A

Section 6

CIRCUITS

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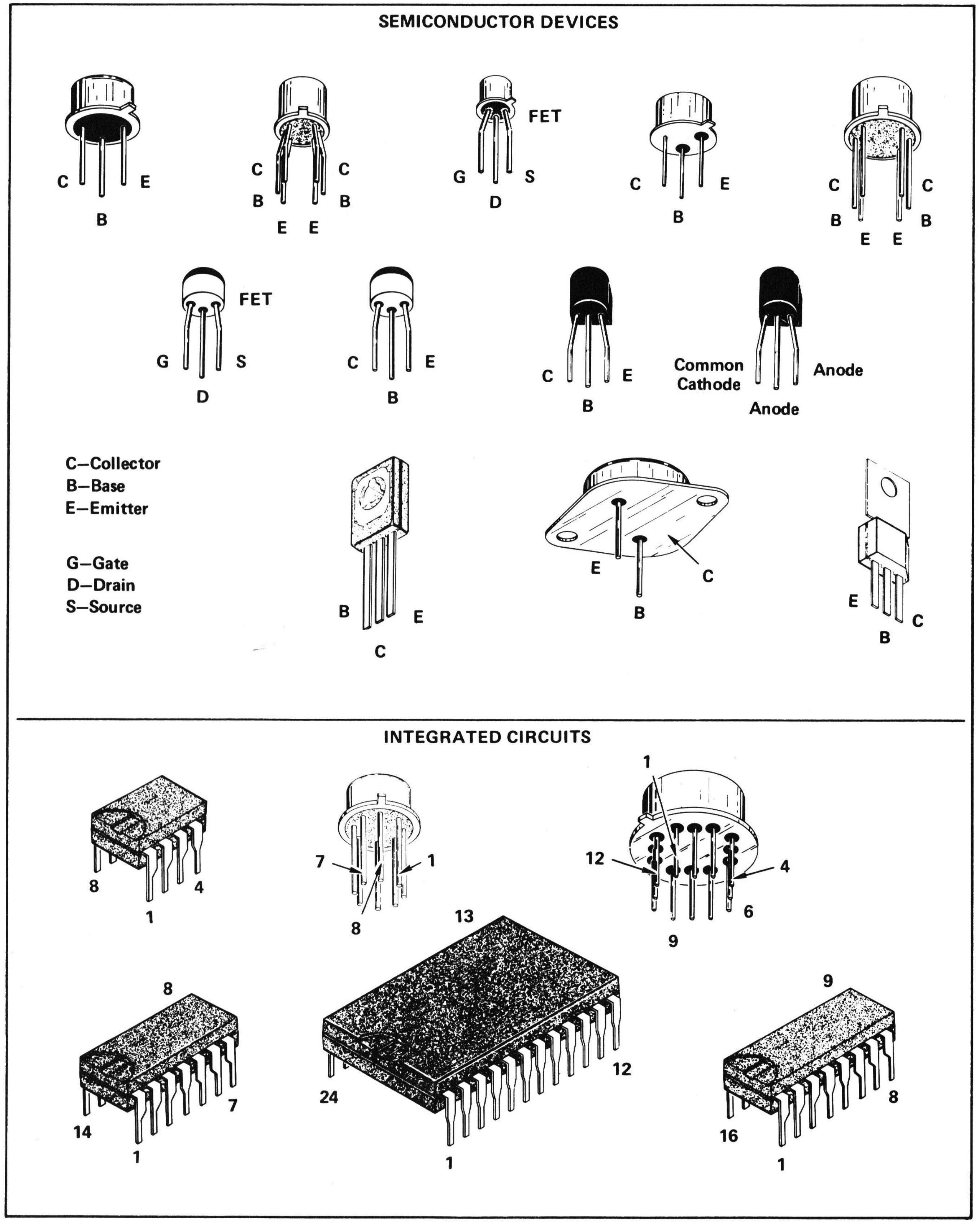

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Fig. 6-1. Semiconductor information.

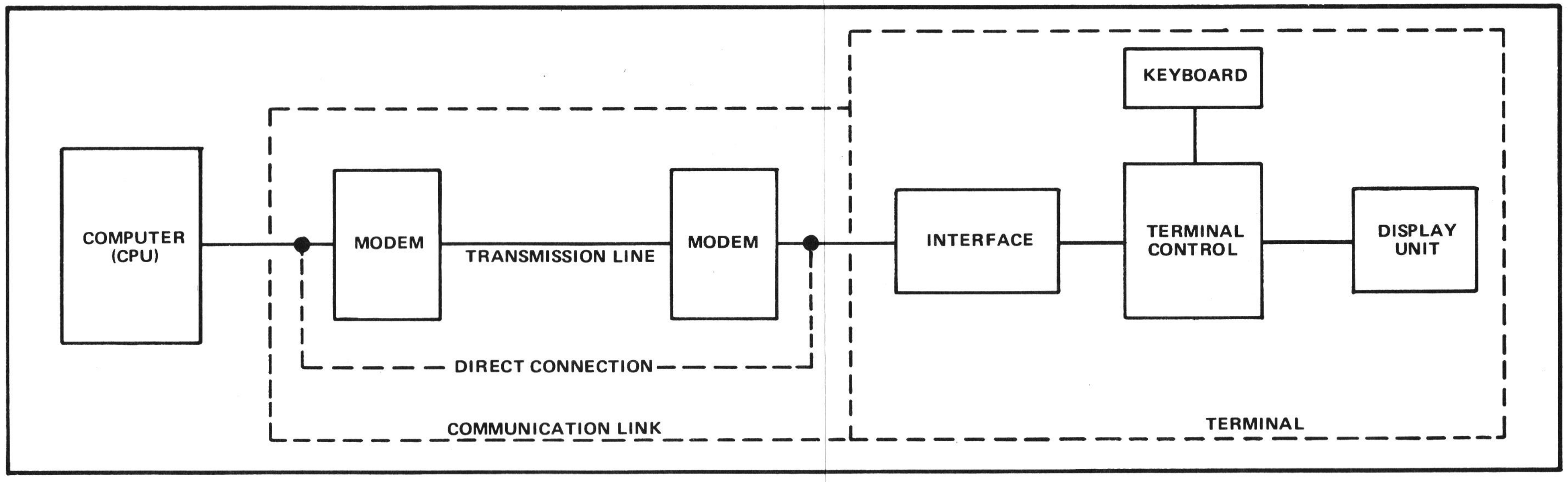

Fig. 6-2. Terminal/Computer Communications block diagram.

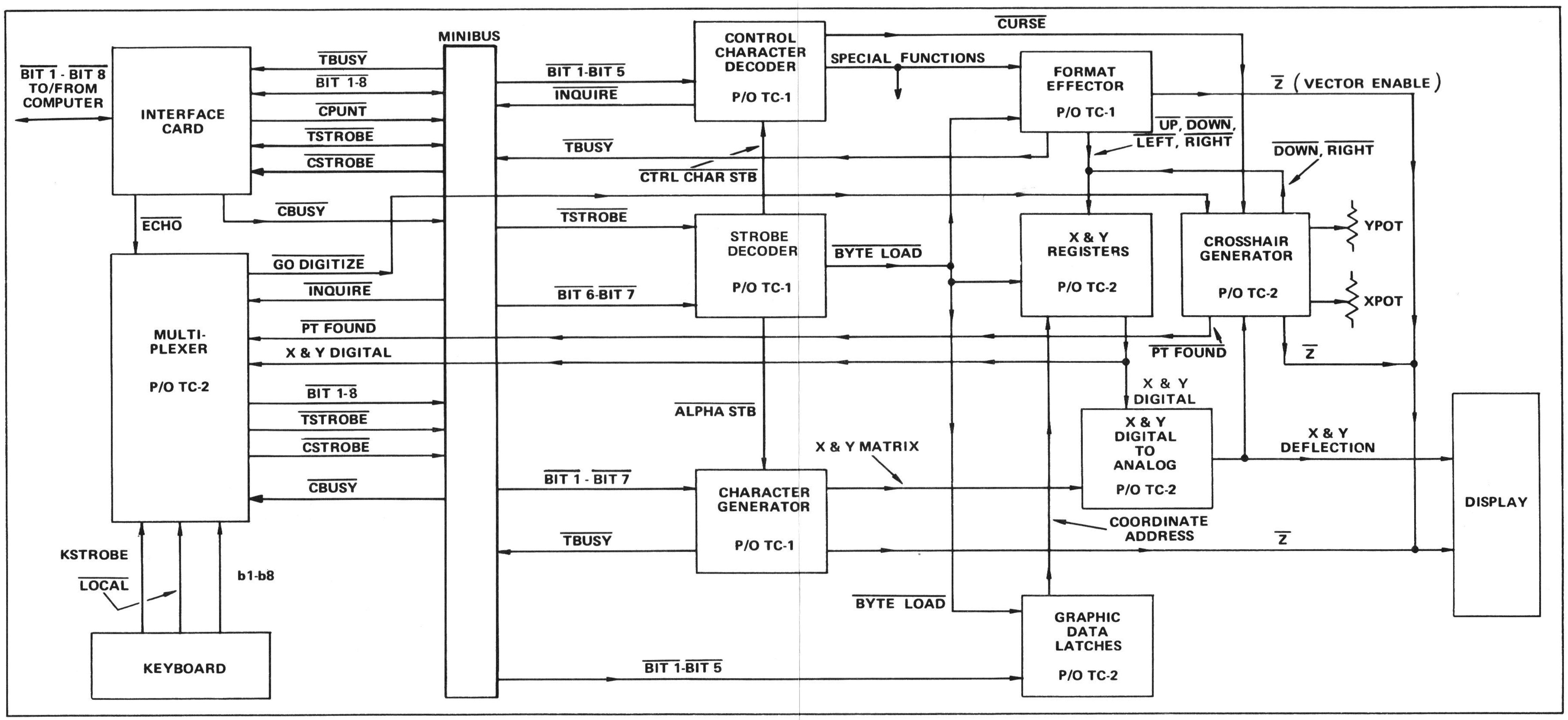

Fig. 6-3. Terminal Data Flow block diagram.

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GENERAL INFORMATION

Introduction

The description of Terminal concepts and circuit operation is interleaved with block diagrams and circuit schematics. This type of layout is conducive to a quick understanding of the Terminal. It also doubles as a troubleshooting aid. All electrical data associated with any one circuit board is in one general area. This excludes the block diagrams that are used to provide acquaintance with the basics of Terminal/Computer communications and Terminal data flow.

This section also contains Semiconductor Information and a Dictionary of Line Titles that will prove beneficial in understanding logic flow on the Mother Board minibus. The Dictionary of Line Titles should be read before any of the block diagram or circuit descriptions.

Diagrams and Circuit Description Information

The interleaving of the circuit descriptions with the block diagrams and schematics will allow those not familiar with Terminal operation to progress from a basic understanding to a fairly detailed understanding of Terminal concepts and operation. It is recommended that block diagrams and their respective descriptions be read in the following order.

1. **Terminal/Computer Communication Concepts.** This block diagram and description will provide acquaintance with the basics of Terminal/Computer operation. It will also introduce the basic electrical sections of the Terminal; namely the Keyboard, the Terminal Control section and the Display Unit.

2. **Data Flow Block Diagram and Description.** This block diagram explains the basic data flow within the Terminal. It shows the tie-in of the major electrical components for the Alphanumeric Mode, the Graphic Plot Mode, and the Graphic Input Mode.

3. **Alphanumeric Mode Block Diagram and Description.** This shows the operation and logic tie-in of TC-1 and TC-2 in the Alpha Mode.

4. **Graphic Modes Block Diagram and Description.** This provides the logic tie-in of TC-1 and TC-2 for Graphic Plot and Graphic Input (GIN) Mode operation.

5. **Display Block Diagram and Description.** This block diagram and description gives a basic understanding of the circuitry associated with the Display Section.

The above block diagrams and associated descriptions will, in most cases, aid in isolating a problem to a specific circuit card. In addition, they provide an indication of which individual circuits may be at fault.

The Display circuit descriptions are interleaved with block diagram descriptions and detailed circuit descriptions. Detailed block diagrams and descriptions are given for both TC-1 and TC-2. Turn to the TC-1 Block Diagram and unfold it; notice that the entire block diagram is located to the left of the block diagram description. Now, unfold the TC-1 schematic. Notice that the blocks given on the block diagram correspond to the blocks indicated on the schematic. The specific components can be located by referring to the component location on the apron of the schematic. This layout of block diagram, schematic, and description provides all the information needed to locate and identify a specific component. The part number of the specific component can be found by referring to the Electrical Parts List in Section 5. TC-2, high and low voltage power supplies, and the Display circuits follow the same general outline.

DICTIONARY OF LINE TITLES

The following is a description of interconnecting (minibus) signals. A signal's active state is indicated by the signal name; i.e.: those with overlines indicate that the source must pull the signal line low to cause that function to occur.

Minibus Signal Line Definitions

$\overline{\text{AUXSENSE}}$. Status bit line reserve for auxiliary device(s). Disables graphic lookahead. The HCU bus line may also be used by auxiliary device(s) if no Hard Copy Unit is connected and powered up. Open collector source.

$\overline{\text{BIT 1}}$—$\overline{\text{BIT 8}}$. Data to and from the Terminal/CPU. Open collector source; 48 mA load at 0.4 V.

$\overline{\text{BREAK}}$. Signal from the keyboard to the interface for computer signaling. Open collector source.

$\overline{\text{BTSUP}}$. Suppresses Terminal response to $\overline{\text{TSTROBE}}$. Should be asserted in response to $\overline{\text{CPUNT}}$ by devices (such as buffers used in error correction schemes) intended to intercept data on behalf of the Terminal. In such cases the assertion of $\overline{\text{BTSUP}}$ should be delayed 2 clock periods if it is desired to avoid interference with copy of locally generated data. Open collector source.

$\overline{\text{CBUSY}}$. Indicates that the CPU (interface) is busy accepting a character. Controls the timing of coordinate data transmitted to the CPU. A low on $\overline{\text{CBUSY}}$ will not inhibit the keyboard, allowing keyboard interrupts when $\overline{\text{CPUNT}}$ is not asserted. Interfaces that must lock out the keyboard should do so with $\overline{\text{KLOCK}}$. Open collector source; 48 mA load at 0.4 V.

$\overline{\text{CGZSUP}}$. Suppresses $\overline{Z}$ signal from TC-1. Caused by END COUNT into TC-1. Also generated by Fast Graph option.

@

CPUNT. Means data is about to be asserted by CPU (interface). Must be asserted at least 3.2 μs before data is placed on BIT 1—8 and must remain low until after the trailing edge of the strobe(s) associated with the transfer. Open collector source.

CR. Carriage return; high active signal.

CSTROBE. Strobes data to the CPU. Pulse width is 0.5 μs or more, synchronized to the clock. Must not occur more than 2 μs after CPUNT goes low. TSTROBE may be asserted simultaneously (from the same source) to provide local copy to the Terminal. Should not occur less than 0.5 μs after CBUSY goes false (+3 V). Open collector source; 48 mA load at 0.4 V.

CSUP. Inhibits the interface from accepting CSTROBE. This signal is used by devices such as line buffers, which need to intercept data destined for the CPU. Open collector source.

CURSE. ESC SUB control character sequence creates this signal, which causes the crosshair cursor to appear.

DOWN. Counting pulse for Y register. Open collector source.

DRBUSY. Asserted by the Hard Copy Unit to set up the display for hard copy readout. DRBUSY should be asserted before the trailing edge of MAKE COPY in order to hold the Terminal busy during the scan. Also asserted by the Display circuit for the duration of the erase cycle, during which information may not be written on the screen. Open collector source; 48 mA load at 0.4 V.

ECHO. Directs input sources to assert TSTROBE as well as CSTROBE when sending data to the CPU to provide a local copy on the screen of data entered into the CPU. Open collector source.

END COUNT. Disables register stepping circuits and suppresses Z signal from TC-1.

EOL. Indicates that the X Register is counting past the right margin. Used by the AUTO CR/LF logic. Asserting EOL will cause a CR/LF to be generated when in Alpha Mode. A Display Multiplexer could use this to shorten the right margin for small displays. In such use, EOL should not be asserted after CR is activated, to prevent random counting of registers. Open collector source.

FPAUSE. Indicates that the X register has folded over in the process of CR, FF, RESET, or normal counting (X Right). Used to generate the pause required for proper operation of the Auto Line Feed circuit when used with a clocked interface. Also used internally on TC-2 for Interactive Graphics.

$\overline{\text{FUZZ}}$. Active state causes a switch from the Character & Vector Focus circuit to the Cursor Focus circuit during Alpha cursor or crosshair cursor writing. Open collector source.

$\overline{\text{GIN}}$. When originated in TC-2, $\overline{\text{GIN}}$ indicates that the crosshair cursor is on, or that coordinate information is being transmitted to the CPU. Disables the Alpha cursor, Top-of-Page, and right margin CR/LF circuits. Sets Echoplex Suppression. Asserted by TC-1 or options when entering graphics, in order to ensure that the Character Generator is off (reset). Open collector source.

GND. Circuit ground.

$\overline{\text{GRAF}}$. Originates in TC-1 to indicate that Graphic Mode is set. Open collector source; 48 mA load at 0.4 V.

$\overline{\text{HCU}}$. Indicates that the Hard Copy Unit is capable of accepting a $\overline{\text{MAKE COPY}}$ request. Open collector source.

$\overline{\text{HIX}}$. Loads the HIGH X graphic byte into the X Register. Open collector source.

$\overline{\text{HIY}}$. Loads the HIGH Y graphic byte into the Y Register. Open collector source.

$\overline{\text{HOME}}$. Erases the display and selects Alpha Mode and Home position. Originated by keyboard HOME key or by TC-1. Open collector source; 48 mA load at 0.4 V.

$\overline{\text{INDICATOR 1}}$, $\overline{\text{INDICATOR 2}}$. Turns on the light-emitting diode (LED) indicators in the keyboard area. Open collector source; 48 mA load.

$\overline{\text{INQUIRE}}$. ESC ENQ control character sequence.

$\overline{\text{KLOCK}}$. Inhibits keyboard. Open collector source.

LCE. High active arming signal caused by ESC control character.

$\overline{\text{LEFT}}$. Counting pulse for X Register. Open collector source.

$\overline{\text{LOCAL}}$. Directs input sources to assert $\overline{\text{TSTROBE}}$, providing a screen display in the absence of computer echo. The interface(s) may also use this line. Originates in keyboard switch. Open collector source.

LOXE. Loads the LOW X graphic byte into the X Register and triggers vector drawing. Open collector source.

LOY. Loads the LOW Y graphic byte into the Y Register. Open collector source.

MAKE COPY. Copy request; 866 μs wide minimum. Caused by Copy button or by EXT ETB sequence. Open collector source.

MARG. Indicates that the Terminal is at Margin 1. With a directly connected interface, this corresponds to page full. High active.

NOLI. Suppresses Linear Interpolation vector drawing and timing circuitry on TC-1 and TC-2. Asserted by TC-1 unless in Graph Mode. Open collector source.

PAGE. Created by ESC FF control character sequence or PAGE key. Causes the display to erase the screen. Also sets Alpha Mode and "Homes" the cursor. Open collector source.

RIGHT. Counting pulse for X Register. Open collector source.

SEND 8. Directs the interface to accept full 8-Bit binary data instead of providing its own data for the 8th bit. The keyboard provides a fixed 8th bit that is true in standard factory-wired Terminals, but may be rewired false.

SHIFT. Contact closure of SHIFT key. Resets Hold to View.

SP1, SP2, SP3. Spare connections.

SPD 1. Spare connection.

SPEAK. Audio connection to the loudspeaker. Other terminal of speaker is at +5 volts. Bypassed by a 0.01 microfarad capacitor. Open collector source.

SW 1. Asserted by keyboard switch SW 1. Open collector source.

SW 2. Asserted by keyboard switch SW 2. Open collector source.

TAPEFETCH. A pulse typically provided by some small computer interfaces to cause a paper tape reader or analogous device to read one byte of data. Open collector source.

TBUSY. Indicates that the Terminal is busy executing a function such as writing, ringing the bell, etc. TBUSY controls the timing of data transmitted to the Terminal. Upon receipt of a byte of data, the Terminal will assert TBUSY by the trailing edge of TSTROBE if that byte is to make the Terminal busy. No condition, with the exception of MARG, will assert TBUSY except momentarily. (MARG can be patched out of TBUSY.) The Terminal will, however, accept data if TBUSY is high or low, although the results in the low case are not defined. TBUSY does not inhibit transmission of data from the keyboard to the CPU. Open collector source; 48 mA load at 0.4 V.

TSTROBE. Strobes data into the Terminal, for execution by the Terminal. It is a pulse of 0.5 μs or longer, synchronized to the 614 kHz clock. Should not occur less than 0.5 μs after TBUSY goes false (+3 V). Open collector source; 48 mA load at 0.4 V.

TSUP. Suppresses Terminal response to TSTROBE. TSUP should be used by devices that need to blank the Terminal to incoming data, such as a paper tape punch when punching binary data. Open collector source.

TTY MASTER. Used only when a dual communication interface installation exists.

UP. Counting pulse for Y Register. Open collector source.

VIEW. Controls the flood guns in the CRT. A high turns the guns on. As long as the Terminal is in GIN or HCU, and for about 90 seconds after the last information sent to the Terminal, TC-1 will allow a steady high on VIEW. Otherwise, TC-1 places the display in Hold status by placing a 1200 hertz signal with 12.5% duty factor on VIEW. An optional device may place the display in non-store by pulling VIEW low. Open collector source.

X. Analog signal from TC-2 to display. −5 to +5 volts covers the screen. Positive signal corresponds to left deflection. Zero volts represents the physical center of the screen.

XMAT. Analog signal representing the X location within the character matrix. Originates on TC-1.

Y. Analog signal from TC-2 to display. −5 to +5 volts covers the screen. Positive signal corresponds to down deflection. Zero volts represents the physical center of the screen.

YMAT. Analog signal representing the Y location within the character matrix. Originates on TC-1.

$\overline{\text{Z}}$. Z-Axis Information. Open collector source; 48 mA load at 0.4 V.

4.9 MHz. Clock signal.

614 kHz. Clock signal; sub-multiple of 4.9 MHz clock signal.

WIRING INFORMATION

The following interconnecting references are provided to facilitate signal tracing:

Connectors and Wiring Diagrams (Fig. 6-7)—Depicts locations and identity of connectors.

Mother Board Diagram (Fig. 6-11)—Shows connector locations on Mother Board and lists interconnecting lines.

Chassis Diagram (Fig. 6-8)—Shows chassis circuitry and Display Interconnection Board signal distribution.

From/To Addresses (contained on schematics)—List source or destination of subject signal. Does not list interconnecting points.

For most purposes, signal tracing consists of reading the address from the line on the schematic, and going to that location. Since all cards on the minibus are interchangeable, addresses for these are simply listed as TO or FROM A3-BUS, followed by the specific pin number. These lines are applicable to all cards which can be inserted into the minibus connectors (TC-1, TC-2, Interface, Optional Extender, Accessory Cards).

EXAMPLE 1. Follow LOY from TC-1 to its destination. Since LOY is on an interchangeable board, its K connector is common to pin K on all cards connected to the Mother Board. To determine if the signal goes elsewhere, look on the Mother Board diagram under Bus pin K. No other points are listed.

EXAMPLE 2. Follow $\overline{\text{MAKE COPY}}$, which is generated on TC-1. Again, it is a connection on the minibus and goes to pin $\overline{\text{C}}$ on all minibus connectors. Look on TC-2 and the interface card to determine if it is used there. Then check the Mother Board diagram. It shows that minibus pin $\overline{\text{C}}$ also goes to J37-3 on the Mother Board. At J37-3, it is discovered that a strap connects the signal to J37-3′ if no optional Display Multiplexer is installed. From J37-3′, the signal goes to J1-B where it goes to Deflection Amp and Storage board schematic A7/3. At J1-B, notice that $\overline{\text{MAKE COPY'}}$ also comes from J32-4 on the Mother Board. J32-4 derives its signal from the Terminal Copy button on the front panel, shown on diagram A1, Chassis. Returning to J1-B, follow the signal to A7/3. There it passes through the card, going through J1-6 to A1 J525-11. At schematic A1, it becomes available to a Hard Copy Unit at the Hard Copy connector.

EXAMPLE 3. On the Keyboard schematic (Fig. 6-9) locate KSTROBE on P90-6, where it indicates that it goes to A5 J21-2. Going to A5, notice that KSTROBE connects to J21-2 in the bottom-left corner.

BASIC CONCEPTS OF COMPUTER/TERMINAL COMMUNICATIONS

General

The Computer Display Terminal is a device that permits a person to deal directly with a computer. By using the keyboard (which is similar to a typewriter keyboard), a person can question or instruct the computer; the computer's response is returned to that person by way of the display screen, either alphanumerically or graphically (charts, graphs, pictures, etc.).

The Terminal/Computer Communications block diagram is shown in Fig. 6-2. The different sections are the Computer, the Terminal (which includes the Keyboard, the Display Unit, the Terminal Control circuitry, and the Communication Interface), and the Communication Link.

Computer

The job of the computer is to accept data from the Terminal (commands from the Keyboard or other input devices), act on it by performing the indicated instructions, and return its response to the Terminal.

Terminal

The Terminal acts as a translator between the operator and a computer. Its job is to take the data from the computer and translate it into a language or graphic form that makes the data understandable to the operator, and vice-versa.

Display Unit. The Display Unit presents data visually for both alphanumeric and graphic operation by accepting X and Y (writing beam position) and Z (writing beam on or off) signals from the Terminal Control circuitry. These signals combine in the Display circuits to give a visual representation on the display screen of the data interchange between the operator and the computer.

The Display section contains a storage-type CRT (cathode-ray tube). The data being displayed has only to be written once. The characteristics of the storage tube allow the image of the data to be retained fro a long period of time (up to one hour without damage to the display screen) without having to continually redraw it, as would be necessary if a television-type CRT were used.

Keyboard. The Keyboard provides the operator with a readily understandable means of inputting data to the computer. It is an electromechanical device which, as a result of the operator depressing any one of its keys, produces binary data that is distinctive for that key. This provides the Terminal Control and the computer circuits with a form of data they can understand.

Terminal Control. This circuitry accepts data from either the Interface or the Keyboard and provides synchronization so that the data is handled in the proper sequence. When data is accepted by the Terminal Control circuits, it routes this data to the computer and/or the Terminal Display circuits, depending upon the data source and the function requested by the data. The Terminal Control circuits interpret this data as either an alphabetic character or number, as a coordinate points on an X-Y axis (for beam positioning), as a special function to be performed (backspace, ring bell, etc.) or as mode control information. Another function of the Terminal Control is to allow the Terminal status and the X and Y coordinates of any point on the display area of the screen to be sent from the Terminal to the computer when commanded to do so.

Interface

Direct. When the computer is located near the Terminal (as in the same building), a direct hook-up is the most practical.

Modem (Telephone Hook-up). In most cases the computer will be located a considerable distance from the Terminal, making a direct connection impractical. In such cases, the transfer of information between the computer and Terminal must be by other means. The most convenient and readily available means of transmission is the standard telephone line. However, the Terminal and computer cannot be hooked directly to the telephone. The telephone hook-up consists of a modulator-demodulator (MODEM) which places the data on a voice frequency tone (modulation) for transmission over the lines and retrieves the data (demodulation) at the receiving end. Both the computer end and the Terminal end of the telephone line have MODEMS. Both ends operate the same. Thus, by the use of telephone lines and the MODEM, the distant computer can be reached as easily as dialing a next-door neighbor.

DATA FLOW
BLOCK DIAGRAM DESCRIPTION

General

Terminal logic operation is controlled by three logic cards. These are TC-1, TC-2, and Computer Interface. Each card has 72 interconnecting pins. Corresponding pins on each card are connected to one another by a connector board called a minibus. The minibus is designed to accommodate transmission between any devices connected to it.

Data is placed on eight data lines with open collector TTL buffers. The destination of data is determined by the use of strobe signals. Asserting a computer strobe ($\overline{\text{CSTROBE}}$) causes data to be transmitted to the computer via the Interface. Asserting a terminal strobe ($\overline{\text{TSTROBE}}$) causes data to be transmitted to the Terminal. Data may be sent to both by asserting $\overline{\text{CSTROBE}}$ and $\overline{\text{TSTROBE}}$ simultaneously. Strobe signals are normally synchronized with the system clock (614 kHz).

Timing of data is controlled by $\overline{\text{TBUSY}}$ (terminal busy), and $\overline{\text{CBUSY}}$ (computer busy). $\overline{\text{TBUSY}}$ and $\overline{\text{CBUSY}}$ control the rate of data transmission to devices responding to $\overline{\text{TSTROBE}}$ and $\overline{\text{CSTROBE}}$ respectively. The device receiving the data must enable its busy signal before the trailing edge of its respective input strobe, if it is to be considered busy. If the device transmitting the data does not sense a busy signal before the trailing edge, the transmitting device may presume that the data was accepted and could apply the next data immediately.

$\overline{\mathrm{CPUNT}}$ (controlled by the Interface), controls the interleaving of data transmission. (Interleaving is the process of data being transmitted to and from the computer on the same data lines.) Data from the computer is preceded by $\overline{\mathrm{CPUNT}}$ to inhibit the Terminal and any other device (other than the Interface card) from placing data on the minibus.

Transmitting Operation

Refer to the Data Flow Block Diagram in Fig. 6-3. When data is entered at the keyboard, the key pressed causes equivalent codes to be sent to the Multiplexer on seven parallel lines: b1—b7. An eighth bit accompanies them, and is always either high or low, depending on the way it is wired at the keyboard connector. A keyboard strobe signal termed KSTROBE accompanies the keyboard bits to the Multiplexer. KSTROBE causes the computer strobe signal ($\overline{\mathrm{CSTROBE}}$) to go active, and causes the Multiplexer to place the keyboard bits on the minibus as $\overline{\mathrm{BIT\ 1}}$—$\overline{\mathrm{BIT\ 8}}$. Then $\overline{\mathrm{CSTROBE}}$ strobes the bits into the Interface card, from where they are sent to the computer. If the $\overline{\mathrm{ECHO}}$ signal from the Interface card is low, $\overline{\mathrm{TSTROBE}}$ goes active along with $\overline{\mathrm{CSTROBE}}$. This allows the Terminal circuitry to generate a "local" copy of the data sent to the computer.

Receiving Operation; Alpha Mode

When the computer sends data to the Terminal, a $\overline{\mathrm{CPUNT}}$ signal occurs to prepare the Terminal. Then $\overline{\mathrm{BIT\ 1}}$—$\overline{\mathrm{BIT\ 8}}$ are received, accompanied by $\overline{\mathrm{TSTROBE}}$, which enters the Strobe Decoder. If a character is to be written, it is indicated by $\overline{\mathrm{BIT\ 6}}$ and $\overline{\mathrm{BIT\ 7}}$, which cause the circuit to generate an $\overline{\mathrm{ALPHA\ STB}}$ signal. This signal latches character code bits $\overline{\mathrm{BIT\ 1}}$—$\overline{\mathrm{BIT\ 7}}$ into the Character Generator. The Character Generator sends X and Y MATRIX signals to the X and Y Digital-to-Analog circuits. $\overline{\mathrm{TBUSY}}$ goes active at the same time, preventing reception of more data until the character is drawn. The X and Y DEFLECTION signals to the display change in accordance with the X and Y MATRIX signals. The decoded $\overline{\mathrm{BIT\ 1}}$—$\overline{\mathrm{BIT\ 7}}$ data bits cause $\overline{\mathrm{Z}}$ signals to write at those matrix positions that are necessary for forming the character.

If the data bits contain the code for a Control Character, it is indicated by the $\overline{\mathrm{BIT\ 6}}$—$\overline{\mathrm{BIT\ 7}}$ combination, and detected by the Strobe Decoder. The Strobe Decoder then outputs a $\overline{\mathrm{CTRL\ CHAR\ STB}}$ signal to the Control Character Decoder. This circuit decodes $\overline{\mathrm{BIT\ 1}}$—$\overline{\mathrm{BIT\ 5}}$ and inputs the indicated function signal. For example, if the data bits contain the code for a SPACE, the Control Character Decoder applies the SP signal to the Format Effector. The Format Effector outputs the required number of pulses on the $\overline{\mathrm{RIGHT}}$ line. At the same time, $\overline{\mathrm{TBUSY}}$ goes active until the function is completed, to prevent other activity. The $\overline{\mathrm{RIGHT}}$ pulses increment the digital output of the X Register, causing the output of the X and Y Digital-to-Analog circuit to change accordingly. Thus, the display beam moves right one character space.

Refer back to the keyboard. A signal termed $\overline{\mathrm{LOCAL}}$ inputs to the Multiplexer. If the Local/Line switch is in Local, $\overline{\mathrm{LOCAL}}$ goes active and $\overline{\mathrm{CSTROBE}}$ is inhibited. No data can be sent to the computer under this condition. Only TSTROBE will go active in response to keyboard inputs, and the results will be effectively the same as explained for Receiving Operation.

Receiving Operation; Graphic Plot Mode (Graph)

Graph Mode permits lines (vectors) to be drawn on the CRT by addressing the beam to a point on the display screen. As the beam moves to that point, the Z signal may go active to draw the vector.

Since the X and Y Registers each contain ten bits, twenty bits are required to address any position. These must be received in four bytes of five bits each, with each byte accompanied by two bits of steering data. The steering bits indicate X or Y, as well as whether the byte should be loaded as five most significant bits or five least significant bits. Data flow in the Graphic Plot Mode occurs in the following manner.

Refer to the Data Flow Block Diagram. When the Control Character bits for a GS (the signal that sets the Graph Mode) are received by the Interface card, TSTROBE and CPUNT go active. BIT 1—BIT 8 are then placed on the minibus. The Strobe Decoder is activated by TSTROBE and detects from BIT 6 and BIT 7 that a Control Character has been received. It then causes the CTRL CHAR STB signal to activate the Control Character Decoder, which then decodes the remaining data bits (BIT 1—BIT 5) and initiates the Special Function signals that set Terminal logic for Graph Mode. The next data bits received from the computer contain the first five bits of the coordinate address. BIT 6 and BIT 7 are decoded by the Strobe Decoder and the BYTE LOAD goes active, loading BIT 1—BIT 5 into the Graphic Data Latches. (BYTE LOAD will actually be one of the following in sequence given: HIY, LOY, HIX, LOXE.) The next two bytes are received and loaded into the Latches in the same manner. With the reception of the fourth byte, all twenty bits of data (the Coordinate Address) are loaded into the X and Y Registers (10 into the X Register, and 10 into the Y Register). This causes the X and Y DIGITAL output of the X and Y Registers to change suddenly to the value set by the twenty bits of input data, causing the X and Y DEFLECTION output of the X and Y Digital-to-Analog circuits to change accordingly. At the same time the 20 bits of data are loaded into the X and Y Registers, the fourth BYTE LOAD pulse from the Strobe Decoder enables the Format Effector to output a Z (Vector Enable) signal. This turns on the display beam while the X and Y DEFLECTION signals change, causing a vector to be written. When the Z signal goes active, TBUSY also goes active to prevent interference with vector drawing.

Graphic Input Mode (GIN)

GIN Mode is used to send the Terminal status and/or graphic data to the computer. This may entail the generation of a full-screen crosshair cursor that can be positioned to any point on the viewable display area. The positioning of the crosshair cursor is performed by the use of two position controls (potentiometers) which are located to the right on the keyboard.

Refer to the Data Flow Block Diagram, Fig. 6-3. The control character sequence (ESC SUB) that initiates the GIN Mode is received from the computer and causes the Control Character Decoder to output a CURSE signal that is sent to the Crosshair Generator. The crosshair cursor is then drawn on the screen of the CRT in the following manner.

When initialized by the CURSE signal from the Control Character Decoder, the Crosshair Generator circuit sends DOWN pulses to the Y Register. These pulses cause the Y Register to decrement, moving the display beam downward. As the Y Register decrements with each pulse from the Crosshair Generator, the Y Digital output changes accordingly. The Y Digital-to-Analog circuit converts the Y Digital input to its comparative analog value, outputting it as the Y DEFLECTION voltage to the Display Unit. After each pulse, the Crosshair Generator sets the Z line active to draw the point. Notice that the X and Y DEFLECTION voltages are being sampled by the Crosshair Generator. When the deflection voltage just passes the voltage being input from Y POT (Y Position Potentiometer), the Crosshair Generator switches the count to the X axis. The Y Register then maintains its value while the X Register is being incremented by RIGHT signals from the Crosshair Generator. Like the Y Register, it increments until the X Deflection voltage just passes the voltage input from X POT (X Position Potentiometer). When this occurs, the circuit once again switches to the Y Register. The above-stated sequence repeats itself until the Terminal receives a command to send the intersection point to the computer.

The sending of the data to the computer can be done under user control, or computer control. When the user wishes to send the intersection point, he strikes a keyboard key. The keyboard character bits go to the computer as explained in the description of Transmitting operation. The Terminal will not be affected, because the Multiplexer does not generate a TSTROBE signal. CBUSY goes active during the time that it takes the computer to receive the data bits. When the computer completes the receiving process, CBUSY goes inactive. This causes the Multiplexer to send an active GO DIGITIZE signal to the Crosshair Generator. The next time the Crosshair Generator reaches the intersection point, it stops the counting sequence. The X and Y Registers are held at the digital equivalent of the X and Y Position Potentiometer analog voltages. When the counting sequence stops, the Crosshair Generator sends a PT FOUND signal back to the Multiplexer. This causes the Multiplexer to send the 20 bits of X and Y Digital information to the minibus in four bytes. With each 5-bit byte, the Multiplexer sets BIT 6 high and BIT 7 low and generates the CSTROBE signal which causes the data to be sent to the computer.

The computer can also request the coordinates of the crosshair cursor by sending the control character ESC followed by the control character ENQ (Inquire). When ENQ is decoded by the Control Character Decoder, the INQUIRE signal to the Multiplexer goes high. The operation of the Graphic Input circuitry is then the same as if CBUSY went inactive after a keyboard character had been sent.

If GIN Mode is used to send the Terminal status and the Alpha cursor or Graph Mode beam position, the crosshair cursor is not employed. Receipt of ESC ENQ while in either Alpha or Graph Mode results in the following action. The Control Character Decoder sends the INQUIRE signal to the Multiplexer, which places Terminal status bits on the BIT 1—BIT 8 lines, and generates a CSTROBE signal. The Interface Card generates CBUSY while it sends the status bits to the computer. When through, CBUSY ends. Its trailing edge causes the Multiplexer to remove the status bit from the BIT 1—BIT 8 lines. Again CSTROBE is generated and the Interface generates CBUSY. When CBUSY ends, the second byte is sent and the operation repeats for the 3rd and 4th bytes. Since the Crosshair Generator was never turned on, the position register contents reflect either the Graph Mode beam position, or the Alpha cursor position, depending on the mode in which the Terminal is operating.

Regardless of what position information is sent (crosshair cursor, Alpha cursor, or Graph Mode beam), the Multiplexer may or may not send CR or EOT and CR, depending on option strap selection on

TC-2. These are sent in the same fashion as the status bytes. When the transmission is complete, the Terminal returns to Alpha Mode if the crosshair cursor position or Alpha cursor position was sent. If the Graph Mode beam position was sent, the Terminal returns to Graph Mode.

ALPHA MODE
BLOCK DIAGRAM DESCRIPTION

General

When operating in Alpha Mode, the Terminal displays data in the form of alphanumeric characters. Some of the characteristics of character generation are:

1. The characters are generated by an 8 X 16 matrix contained within the Read Only Memory (ROM) device. The Character Generator uses 9 of the 16 available "row" outputs and 7 of the 8 available "column" outputs to write dots for character generation. The DEL character is suppressed with no spacing or printing.

2. Alphanumeric data can be displayed on 35 lines, with each line containing as many as 74 characters.

3. The Alpha cursor is a pulsating 7 X 9 dot matrix that indicates where the next character will be displayed.

4. There are two margins, termed Margin Ø and Margin 1. Margin Ø is located at the left side of the display screen and Margin 1 is located at the vertical center line of the display screen.

5. The Terminal performs an automatic Carriage Return and Line Feed when spacing past the end of a line.

The main purpose of the Alpha Mode Description is to show how the Terminal processes alphanumeric data for display purposes.

Power Initialization

Refer to Fig. 6-4, the Alpha Mode Block Diagram. When power is first applied, the Home circuit (located near upper center on the diagram) applies a low on the $\overline{\text{HOME}}$ line, placing the Terminal in Alpha Mode. Further switching to Alpha Mode occurs in the following manner.

When $\overline{\text{HOME}}$ goes low, it causes the Graf Flipflop to set $\overline{\text{NOLI}}$ active. With $\overline{\text{NOLI}}$ active, the X Filter and Y Filter are disabled, permitting the X Analog and Y Analog voltages to pass through to the Deflection Amplifier circuitry unaffected. $\overline{\text{NOLI}}$ also enters the Strobe Decoder to allow the $\overline{\text{ALPHA STB}}$ signal to be generated.

Referring back to the HOME signal, notice that it also causes the output of U261C to go high. This sets the X Register to Ø and the Y Register to 767, causing the display beam to position to Home (upper-left corner of the display screen). A few milliseconds after initialization, when the power has stabilized, the HOME signal goes inactive.

The display screen "fades positive" at turn-on and must be erased before entering any data. This is accomplished by pressing the Page key. (For effect of PAGE on display circuits, refer to the Display Unit block diagrams and descriptions.)

Processing Control Characters

When the data bits of a Control Character are placed on the minibus, the TSTROBE signal is generated by the Multiplexer circuit (bottom-left corner). TSTROBE activates the TERM STB signal from the Terminal Strobe Gating circuit. The TERM STB signal enables the Strobe Decoder to process BIT 6 and BIT 7 (both are high when the data bits contain the code for a control character) and output an active control character strobe (CTRL CHAR STB) signal. This signal enables the Control Character Decoder. Data bits BIT 1—BIT 4, BIT 5, and the BIT 5 complement all input to the Control Character Decoder. The Control Character Decoder decodes the input data and activates the respective output line. For example, the Line Feed (LF) Control Character bits activate the LF signal.

The Escape circuit is shown as part of the Control Character Decoder circuit. This circuit makes it difficult to accidentally generate one of four signals — PAGE, CURSE, MAKE COPY and INQUIRE, which are the result of two-character control sequences. First, the Escape (ESC) control character is received to prepare the Escape circuit for the next control character. This is followed by the control character that selects the specific function. For example, to activate the MAKE COPY signal (which activates the Hard Copy Unit) an ESC ETB sequence must be received. The decoding of ETB by the Control Character Decoder causes the enabled Escape circuit to activate the MAKE COPY signal. The remaining four output signals from the Escape circuit are similarly activated: ESC FF activates PAGE; ESC SUB activates CURSE and ESC ENQ activates INQUIRE. The Escape circuit is cleared when the clear signal from the Terminal Strobe Gating circuit goes active. This occurs every time the TSTROBE signal ends, unless the ESC character is being input. This means that the character following ESC disarms the circuit, regardless of whether or not it contains one of the commands of execution.

To backspace the Alpha cursor, the BS control character must be sent to cause the Control Character Decoder to activate the BS signal. BS then causes the Format Effector to output 14 pulses on the LEFT line. These pulses decrement the output of the X Register 14 counts, causing the output of the X Digital-to-Analog circuit to change its analog output value accordingly. This new value of X ANALOG voltage passes unaffected through the X Filter circuit (the Filter circuits are inhibited by NOLI) and causes the X Deflection Amplifiers to deflect the display beam one space to the left. Similar action occurs when the Terminal receives an HT control character. The only difference is that when HT is decoded, the HT signal goes active, causing the Format Effector to pulse the RIGHT line 14 times. The X Deflection Amplifier then deflects the display beam one space to the right.

To move the display beam up or down, the Vertical Tab (VT) or the Line Feed (LF) control characters must be sent. VT causes the Format Effector to pulse the UP line 22 times. LF causes the Format Effector to pulse the DOWN line 22 times. The resultant action from the Y Register through the Y Digital-to-Analog and Y Filter circuits is similar to that of the X circuits. The end result is to move the display beam either up or down one line.

TBUSY is activated when any of the input lines to the Format Effector go active. TBUSY is used by the Computer Interface Card to stop transmission from the computer to allow the Terminal to process the data and complete the intended operation. When the function is completed, TBUSY returns high.

Control characters such as CR cause the Format Effector to activate TBUSY for a predetermined period of time. When the predetermined span of time has elapsed, the Format Effector ends TBUSY. The CR signal causes the Format Effector to output the CR signal and at the same time sets TBUSY active. CR inputs on the CLEAR input of the X Register, setting its outputs and the display beam to the predetermined margin position.

If GS has set the Graphic Plot Mode, the Alpha Mode can be re-established by sending any of the following Control Characters: US, CR, or ESC and FF (PAGE). Pressing the Page or Reset keys will also re-establish the Alpha Mode. The above signals are input to the Graf FF to set NOLI active and GRAF inactive. The Format Effector activates TBUSY to give the Terminal logic time to reset to the Alpha Mode.

Processing Character Generation Data

The Character Generator circuitry is capable of generating 94 distinct ASCII alphanumeric characters. When no characters are being generated, the Character Generator outputs WRITE DOT, XMAT, and YMAT signals that draw the Alpha cursor. (The Alpha cursor indicates the beam writing position.) The operation of the Character Generator is as follows.

When TSTROBE goes active upon receipt of a character, the Terminal Strobe Gating circuit activates the TERM STB signal. TERM STB causes the Alpha Cursor Suppress circuit to set the SUPPRESS signal active. The SUPPRESS signal presets the YMAT and XMAT signals to put the display beam in the proper position to begin drawing the character.

The TERM STB signal also activates the Strobe Decoder which decodes BIT 6 and BIT 7 and outputs the Alpha Strobe (ALPHA STB) signal. This allows the Character Generator to receive BIT 1—BIT 7, and at the same time sets the Character in Progress (CIP) signal active. The CIP signal causes the Format Effector to set TBUSY active, thus preventing the reception of more data until the drawing of the character is completed.

Each of the characters that the Character Generator can produce has its own 7 X 9 dot matrix within a Read Only Memory (ROM) device in the Character Generator. Data bits BIT 1—BIT 7 are used to address the matrix of the specified character or symbol within the ROM. Timing signals from the Format Effector then cause the Character Generator to scan through the matrix one dot at a time. As the Character Generator scans the matrix, it outputs the XMAT and YMAT analog voltages which describe the point's location. These voltages are input to their respective Digital-to-Analog circuits to cause the Deflection Amplifier circuitry to position the display beam through the matrix.

As the ROM matrix is scanned, it indicates if a dot is to be written or not. The dot to be written causes the WRITE DOT signal to the Format Effector to go active. The Format Effector then outputs an active Z signal that causes the display beam to write a dot. The composite of the unblanked matrix dots forms the specified character on the display screen.

When the Character Generator has completed scanning the matrix, the Character Complete (CHAR COMP) signal goes active. This causes the Format Effector to output 14 pulses on the RIGHT line, thus spacing the Alpha cursor to the next character position. The CIP signal ends, ending TBUSY. The Terminal can now receive the next byte of data.

View Signal Operation

The purpose of the View/Hold circuit and its associated VIEW signal is to prolong the life of the CRT. If now new data is being entered, after 90 seconds the VIEW signal is modulated by a 75 Hz, 12 1/2% duty cycle signal which reduces display intensity to put the Terminal in a Hold status. The Alpha cursor is suppressed during the Hold status. The View/Hold circuit operates in the following manner.

The View Multi is basically a one-shot multivibrator that, when triggered, allows the VIEW signal to remain high for approximately 90 seconds. The View Multi is triggered each time whenever any of its various input control signals pulse high. If no activity occurs within 90 seconds, the VIEW signal from the View Multi ends. This action places the 75 Hz signal on the VIEW line. A SHIFT signal entered at the keyboard can restore the VIEW signal, without otherwise affecting the Terminal.

Alpha Cursor Suppress

Four signals that suppress the Alpha cursor and hold VIEW high are:

DRBUSY—Asserted by the Hard Copy Unit during character processing.

GRAF—Asserted by the Graf Flipflop during graphic operation.

CIP—Asserted by the Character Generator during duration of ALPHA STB.

GIN—Asserted by the Multiplexer during GIN Mode.

During the active duration of the above signals, the XMAT and YMAT outputs hold the writing beam in the lower-left corner of the matrix.

GIN Echoplex Suppression

This circuit inhibits the Character Generator when $\overline{\text{GIN}}$ is active. ($\overline{\text{GIN}}$ remains active while GIN Mode is set.) This prevents the Character Generator from responding to the $\overline{\text{ALPHA STB}}$ signal caused by sending GIN Mode signals to the computer. For a more detailed explanation of the Graphic Input Mode, refer to the Graphic Operation Block Diagram Description. Refer also to the Description of the GIN Echoplex Suppress circuit in the Block diagram description of TC-1.

The $\overline{\text{LOCAL}}$ signal from the keyboard goes active when the Local/Line switch is in the Local position. This sets the $\overline{\text{CGSUP}}$ and $\overline{\text{CURSOR INH}}$ signals inactive, allowing the Character Generator to respond to alphanumeric data entered from the keyboard.

The $\overline{\text{TBUSY}}$ signal is also used to enable character generation. When the Graph Mode is activated, the GS signal momentarily pulls the $\overline{\text{GIN}}$ line low, causing the $\overline{\text{CGSUP}}$ and $\overline{\text{CURSOR}}$ INH signals to go active. If it is desired to display alphanumeric data after switching out of Graph Mode, the Character Generator must be enabled. This is done by sending the CR or US control character to the Terminal, switching it to Alpha Mode. (Sending US allows the first alphanumeric character or symbol to be displayed at the ending point of the last vector. CR sets the beam to the left margin oposite the last vector ending point; the beam may also move down one line from that point if the CR EFFECT option is at CR→LF.) The same US or CR that ends the Graph Mode sets $\overline{\text{TBUSY}}$ active, causing the $\overline{\text{CGSUP}}$ and $\overline{\text{CURSOR INH}}$ signals to go inactive, enabling the Character Generator to respond to $\overline{\text{ALPHA STB}}$ signals.

X Register

The X Register outputs 10 bits of BCD (Binary Coded Decimal) data, which provide a count from 0 to 1023. The register is capable of counting up or down to any number within this range. Each bit of data is input to the X Digital-to-Analog on its own line. (All ten lines are drawn as one on the block diagram.) In Alpha Mode operation, the signals that increment and decrement the X Register are $\overline{\text{RIGHT}}$ and $\overline{\text{LEFT}}$ respectively. Each pulse increments or decrements the count by one. The X Register is set to 0 when power is first applied ($\overline{\text{HOME}}$ goes active) or a $\overline{\text{PAGE}}$ or $\overline{\text{SHIFT}}$ signal is received. This causes the CLEAR signal from U239D to set all 10 output bits low, causing the display to position to the left hand margin. When the count increments past 1023 to 0, an End of Line ($\overline{\text{EOL}}$) signal is sent to the Format Effector. This causes the Format Effector to create a line feed signal. The display beam positions to the left hand margin, one line below where it was.

Y Register and Top-of-Page Detect Operation

The operation of the Y Register is similar to that of the X Register. The main differences are as follows: When the Y Register is cleared, all its outputs go high; Pulsing the $\overline{\text{DOWN}}$ line decrements the count; Pulsing the $\overline{\text{UP}}$ line increments the count. Because the display screen is not as high as it is wide, not all the 1024 points are viewable, as they are for the X Register. Therefore, when the Y Register is cleared, the Alpha cursor is positioned off-screen beyond the top of the page. The purpose of the Top-of-Page Detect circuit is to decrement the count from the Y Register by pulsing the $\overline{\text{DOWN}}$ line until the Top-of-Page position is reached. The Top-of-Page position represents a Y Register count of 767, and is know as the Home position for the Y Register. It operates in the following manner.

When the Y Register outputs a count greater than 767 (1023 when it is cleared), the two Most Significant Bits of the Y Register (2MSBY) are high. This activates the Top-of-Page Detect circuit which begins pulsing the $\overline{\text{DOWN}}$ line. When the count of 767 is reached, the 2nd MSB of the Y Register goes low, inhibiting the $\overline{\text{DOWN}}$ pulses. Thus, the Top-of-Page has been detected and the Alpha cursor is positioned in view at the top of the display screen.

Margin Shifter Operation

Left and Right margins are established by the lower and upper limits of the X Register. There is another margin that can be established at mid-page (X = 512) to provide for a two-column page. This effectively doubles the number of lines on which to enter data.

The Left Margin is referred to as Margin Ø and the center margin as Margin 1. Margin Ø is always established as a result of $\overline{\text{PAGE}}$ or $\overline{\text{HOME}}$ signals. The establishing of Margin 1 occurs in the following manner.

When the last line for Margin Ø has been reached and all desired data entered on that line, a CR and an LF code bit must be received by the Terminal to position the Alpha cursor to Margin 1. (The order in which they are sent is immaterial.) The LF causes the Y Register to space past the bottom line, which sets the MARG signal active. (The MARG signal is actually an eleventh bit from the Y Register that carries a BCD wieght of 1024.) When it goes active, it causes the MSB of the X Register (512) to remain high. This causes Margin 1 to be set. At the same time that LF causes MARG to go high, it causes the Top-of-Page circuit to activate. The combination places the Alpha cursor to the top center of the screen. (It should be noted that strap options can be selected so that either LF or CR can cause both line feed and carriage return to occur.)

CR signals will not clear the Margin 1 position. Margin 1 can be cleared by again spacing the Y Register past the bottom line of the page (unless PF BUSY is strapped IN). When this occurs, the MARG signal goes inactive. Margin 1 can also be cleared by activating the $\overline{\text{HOME}}$ or $\overline{\text{PAGE}}$ signals.

Digital-to-Analog Conversion

The X and Y Digital-to-Analog (D/A) converter circuits operate similar to each other. Their purpose is to convert the digital output of their respective registers into the equivalent analog voltage. These circuits also sum the XMAT and YMAT analog signals (from the Character Generator) with the X ANALOG and Y ANALOG signals, respectively. The outputs of these circuits pass directly through their respective Filter circuits (unaffected in Alpha Mode) and are input to the X and Y Deflection Amplifier circuitry to position the display beam.

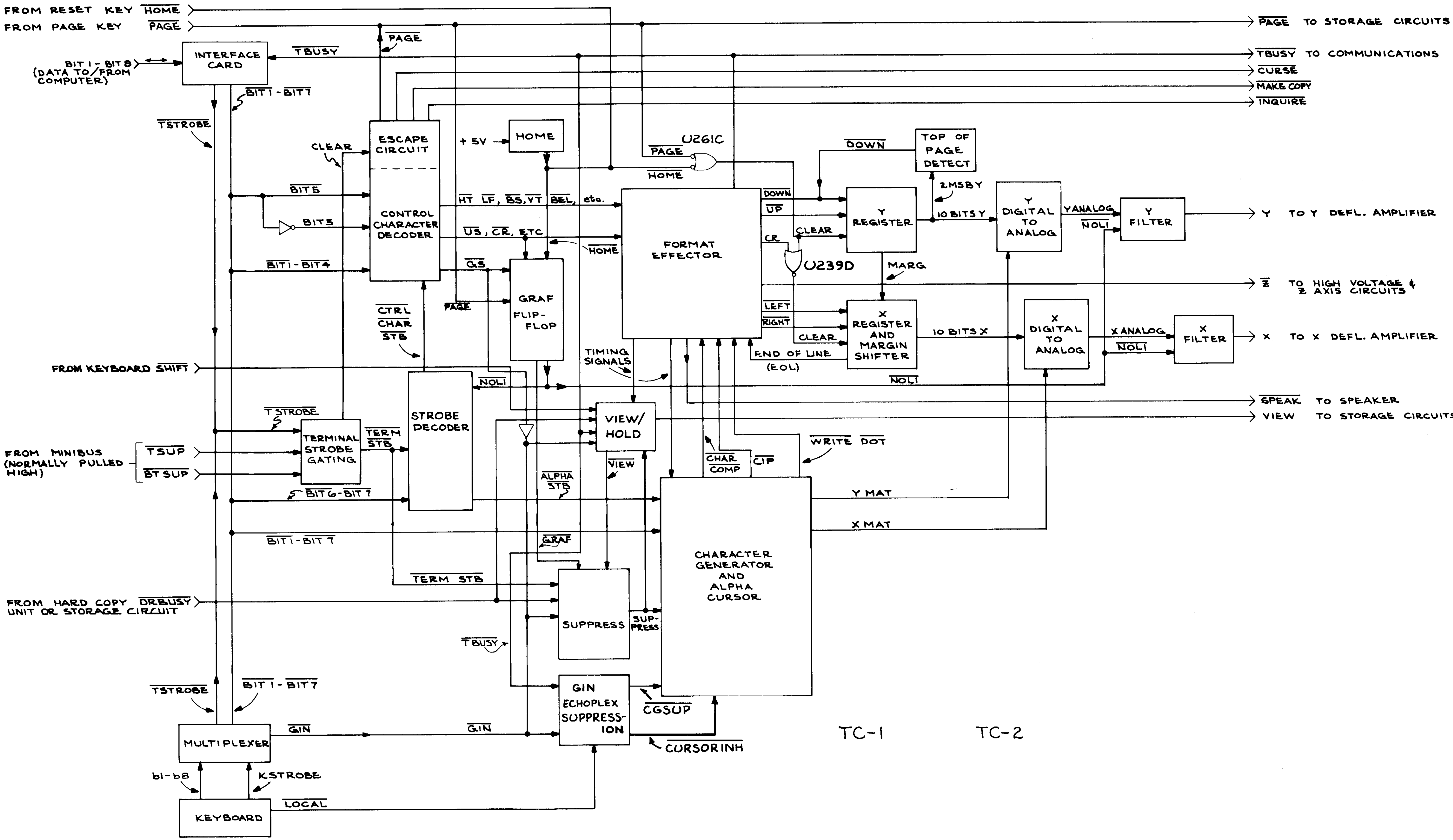

FIG. 6-4 ALPHA MODE BLOCK DIAGRAM

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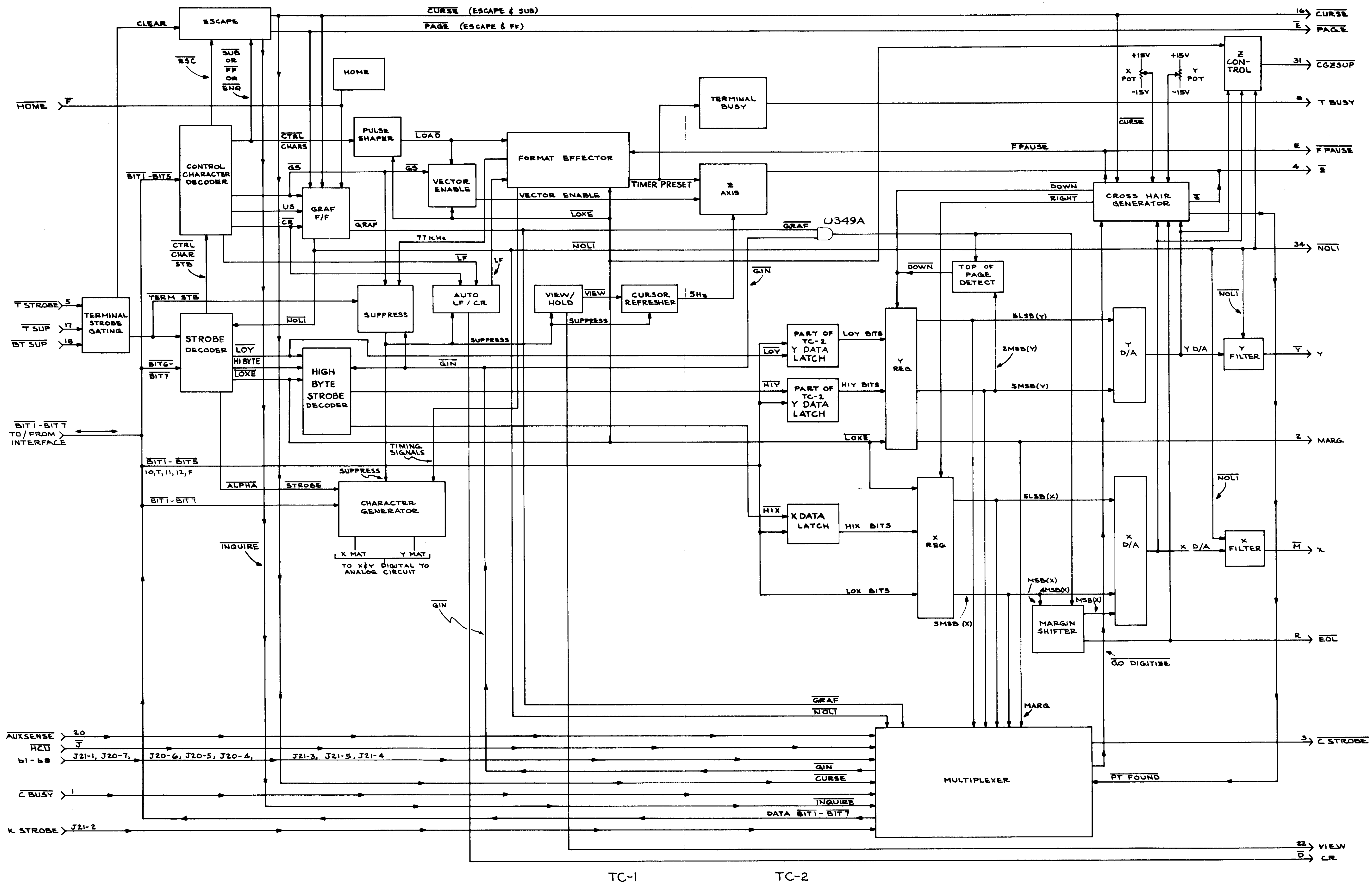


RE 4012

FIG. 6-5 GRAPHIC MODES BLOCK DIAGRAM

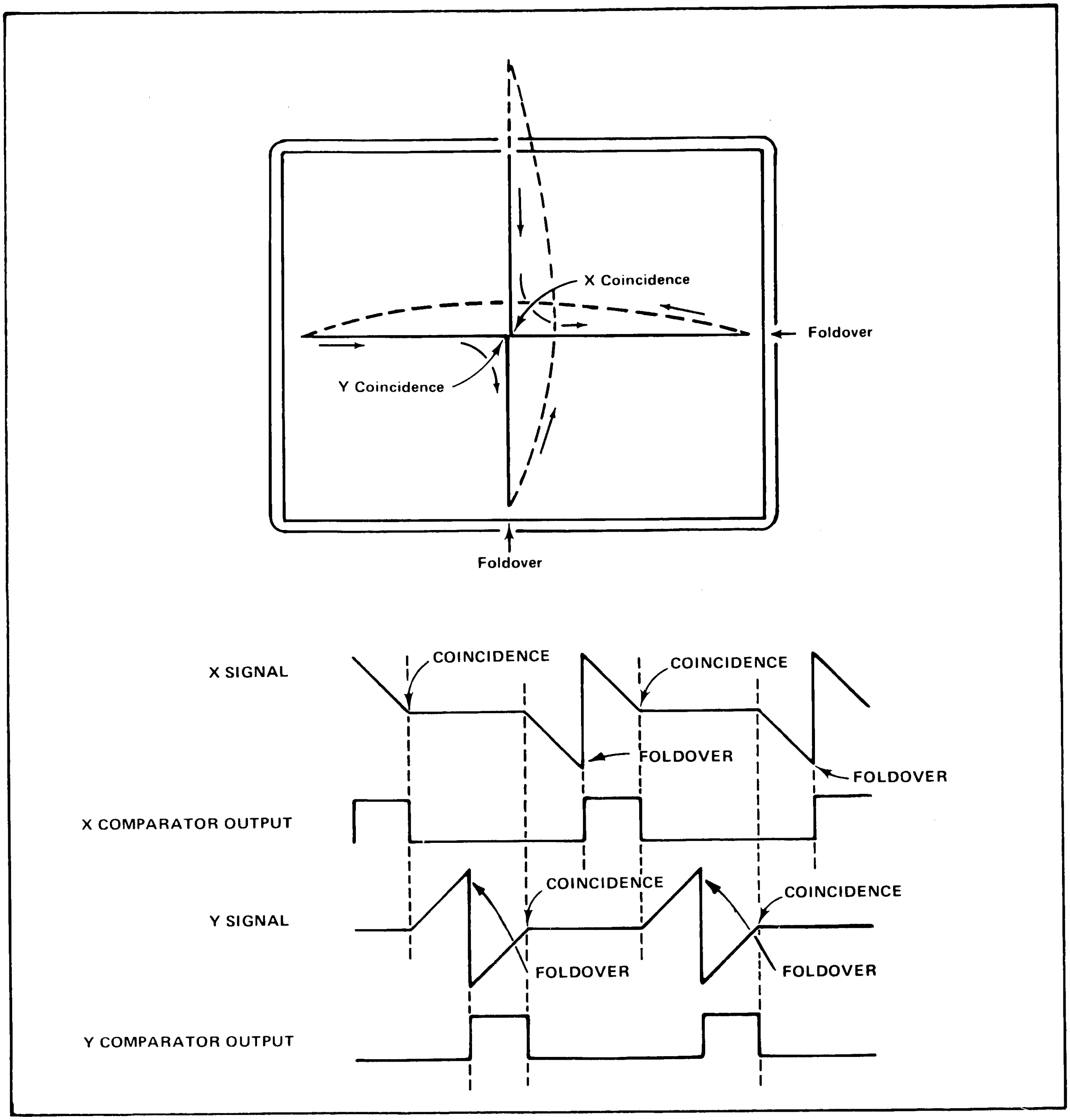


Fig. 6-6. Drawing a crosshair cursor display.

GRAPHIC MODES BLOCK DIAGRAM

General

The basic Terminal has two graphic modes. It can accept graphic data from the computer to draw vectors. This is termed Graphic Plot (Graph) Mode. It can send graphic data to the computer. This is known as Graphic Input (GIN) Mode.

Graphic data from the computer causes the Terminal to write vectors on the Display as specified by X and Y coordinate data. 20 bits of data are required to represent the axis address (10 bits for X and 10 bits for Y). The computer supplies this data to the Terminal as the five least significant bits of each of four 7-bit bytes. The two most significant bits are steering data.

Graph Mode Description

Refer to the Graph Mode Block Diagram in Fig. 6-5. Graph Mode operation is as follows.

Graph Mode Initialization. Terminal logic is designed so that when the Terminal is first turned on, the Home circuit sets all logic to the Alpha Mode. Notice the Home circuit of the Block Diagram (top-left corner). When power is first turned on (initialized), a $\overline{\text{HOME}}$ signal is generated. This causes the Graf Flipflop to output signals that set the Alpha Mode. $\overline{\text{GRAF}}$ goes high (inactive). $\overline{\text{NOLI}}$ goes low to inhibit the linear interpolation circuitry in TC-2. $\overline{\text{NOLI}}$ also inputs to the Column Decoder. Initialization of the Graph Mode begins with the control character GS. GS is usually entered under program control, but can be sent from the keyboard by pressing the CTRL and SHIFT and M keys simultaneously. For the purposes of this discussion, assume that the GS has been entered from the computer, and is placed on the minibus.

When the GS data is placed on the minibus, $\overline{\text{TSTROBE}}$ goes active to enable the Terminal Strobe Gating circuitry to input a low $\overline{\text{TERM STB}}$ signal to the Strobe Decoder. When $\overline{\text{TERM STB}}$ goes active, the $\overline{\text{CTRL CHAR STB}}$ signal is sent to the Control Character Decoder to allow it to process the GS contained on the $\overline{\text{Bit 1—BIT 5}}$ lines at its inputs. The Control Character Decoder outputs a low $\overline{\text{GS}}$ signal to the GRAF Flipflop. This action switches the output states of the Flipflop; $\overline{\text{GRAF}}$ goes low, and $\overline{\text{NOLI}}$ goes high. $\overline{\text{NOLI}}$ going high enables the X Filter and Y Filter circuits.

Even though the $\overline{\text{NOLI}}$ input to the Strobe Decoder is high, the proper combinations of $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$ will still generate the $\overline{\text{CTRL CHAR STB}}$. Thus, no matter whether operating in alpha or graphics, a $\overline{\text{CTRL CHAR STB}}$ can be generated to enable the Control Character Decoder.

Inhibiting the Alpha Circuits. In Graphic Plot Mode, the following Alpha Mode circuits are inhibited.

1. Character Generator
2. LF/CR
3. View/Hold
4. Cursor Refresher
5. Top-of-Page Detect
6. Margin Shifter
7. Margin 1

Explanations on how the above circuits are inhibited will be given in that order.

With $\overline{\text{NOLI}}$ set high, the Strobe Decoder is prevented from outputting an active $\overline{\text{ALPHA STB}}$ signal to the Character Generator. With the $\overline{\text{ALPHA STB}}$ inhibited, $\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$ cannot be input to the Character Generator. $\overline{\text{GRAF}}$ also enters the Suppress circuit to cause a high-going SUPPRESS signal that resets the Character Generator to the Column 0, Row 1 position of the Character Matrix. Thus, the Character Generator is prevented from applying any voltages to the X and Y Digital-to-Analog circuits that might cause displacement of the beam while drawing a vector.

The same SUPPRESS signal that disables the Character Generator also disables LF/CR and View/Hold circuits. As long as the SUPPRESS signal is high, $\overline{\text{LF}}$ signals from the Control Character Decoder will not activate an automatic carriage return and line feed function. The high SUPPRESS signal inhibits the View/Hold circuit. This allows the displayed vectors to remain visible continually. (The Terminal should be returned to Alpha Mode immediately after any plotting is finished to allow the View Multi to time the display into Hold.) The SUPPRESS signal is also input to the Cursor Refresher circuit to inhibit the generation of the Alpha cursor.

When $\overline{\text{GRAF}}$ goes low, the output of U349A inhibits the Top-of-Page Detect and Margin Shifter circuits.

Data Loading. $\overline{\text{BIT 1}}$—$\overline{\text{BIT 5}}$ are placed immediately at the input to the Y Data Latch with the arrival of the first coordinate data byte from the computer. $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$ are decoded by the Strobe Decoder and High Byte Strobe Decoder circuits. When the decoding occurs, $\overline{\text{HIY}}$ from the Graphic Byte Decoder goes low and strobes the five most significant bits of the Y coordinate address into the 5 MSB portion of the Y latch. As each following byte arrives on the minibus, $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$ are decoded to enable the Strobe Decoder and High Byte Strobe Decoder to strobe the LOY and HIX bytes into their appropriate latches. With the arrival of the LOX byte, $\overline{\text{LOXE}}$ goes low. Notice that there is no latch for the LOX bits. The LOX bits are strobed directly into the X Register. With the arrival of the LOX byte, the $\overline{\text{LOXE}}$ signal simultaneously loads all twenty bits of coordinate data into the X and Y Registers. When $\overline{\text{LOXE}}$ ends, the output of the X D/A and Y D/A immediately change to the new coordinate position. Now that the outputs of the X D/A and Y D/A are at the new position, the display beam is turned on and the X and Y Filters begin linearly changing the X and Y signals to the new values.

Vector Enabling. $\overline{\text{LOXE}}$ also enters the Format Effector, Pulse Shaper, and Vector Enable blocks. In the Format Effector, $\overline{\text{LOXE}}$ is used as a preset input to time the 2.6 ms TIMER PRESET signal that is used to activate the $\overline{\text{Z}}$ signal needed to draw the vector. The $\overline{\text{LOXE}}$ input to the Pulse Shaper generates the LOAD pulse that loads $\overline{\text{LOXE}}$ into the Format Effector. The first vector following a GS command is always dark because the VECTOR ENABLE output from the Vector Enable circuit is low, inhibiting the Z Axis circuit. With the arrival of the Low Order X bits of the next vector string, the VECTOR ENABLE signal goes high. This enables the Z Axis circuit to output an active $\overline{\text{Z}}$ signal to draw the vector. When the Format Effector has ended the 2.6 ms TIMER PRESET signal, the $\overline{\text{Z}}$ signal is inhibited. Thus, the $\overline{\text{Z}}$ signal, combined with the movement of the X and Y inputs from the Filter circuits, causes the vector to be drawn.

A Z Control circuit chops the $\overline{\text{Z}}$ signal during short vector drawing to reduce the vector intensity, making short vector intensity more consistent with long vector intensity. The $\overline{\text{LOXE}}$, $\overline{\text{NOLI}}$, X D/A, Y D/A, and three clock signals (not shown) are fed into the circuit to hold $\overline{\text{CGZ SUP}}$ high for vectors more than approximately one-half inch long, and to place a 12 1/2% duty cycle high on the $\overline{\text{CGZSUP}}$ line while vectors less than approximately one-half inch are being drawn.

Returning to Alpha Mode. When vector plotting is completed, it is best to return the Terminal to Alpha Mode. This allows the Terminal to time into Hold status to prevent possible damage to the Display Screen.

Alpha Mode is re-established by resetting the GRAF Flipflop. The following control characters will set Alpha Mode: CR, US, or ESC FF.

In addition, the following keyboard keys will reset the Terminal to Alpha Mode: Page or Reset.

GIN Mode Description

GIN Mode Initialization. Graphic Input Mode is set by the control character sequence ESC SUB. When it is received and decoded by the Control Character Decoder, the Escape circuitry outputs the $\overline{\text{CURSE}}$ signal. (See TC-1 discussion on Escape circuitry for description on operation of Escape.) $\overline{\text{CURSE}}$ inputs to the GRAF Flipflop to set $\overline{\text{NOLI}}$ low and $\overline{\text{GRAF}}$ high. $\overline{\text{NOLI}}$ going low inhibits the X & Y Filter circuits, thus allowing the outputs of the X & Y Filter circuits to pass directly through the Filter circuits unaffected. $\overline{\text{CURSE}}$ is processed in the Multiplexer circuitry, and causes the $\overline{\text{GIN}}$ output to go active. When $\overline{\text{GIN}}$ goes active it causes the SUPPRESS signal from the Suppress circuit to go high. The LF/CR, View/Hold, and Cursor Refresher circuits are inhibited as previously explained in Graph Mode operation. $\overline{\text{GIN}}$ also inhibits the High Byte Strobe Decoder during Graphic Input Mode. (The Strobe Decoder can still output the $\overline{\text{CTRL CHAR STB}}$ to the Control Character Decoder. Thus, control characters can still be processed.) The Top-of-Page Detect and the Margin Shifter circuits are also inhibited when $\overline{\text{GIN}}$ causes the output of U349A to go low. The Terminal logic circuitry is now set for GIN operation.

Crosshair Generator. When $\overline{\text{CURSE}}$ goes low, the Crosshair Generator becomes activated and begins sending $\overline{\text{DOWN}}$ pulses to the Y Register. Each time it pulses, it sends a short $\overline{\text{Z}}$ pulse to turn on the display beam. As the Y Register output decrements, it causes the output of the Y D/A to change accordingly. Thus, the display beam begins moving in the down direction. The output of the Y D/A is being sampled by the Crosshair Generator. When this voltage changes to the point where it just passes the voltage from the Y Position Potentiometer (Y POT), the counting pulses switch to the $\overline{\text{RIGHT}}$ line. This is known as "Y coincidence." The Y Register maintains its value while the X Register is incremented. The output of the X Register Increments once with each low $\overline{\text{RIGHT}}$ pulse, causing the output of the X D/A to change accordingly. When the analog voltage input to the Crosshair Generator equals the voltage from the X POT, "X Coincidence" is reached. The count once again switches to the Y Register. Fig. 6-6 contains an illustration of crosshair cursor generation.

Foldover. If the X Register begins counting to the right of the X Coincidence Point, the count continues to increment the X Register until count 1023 is reached. When this occurs, the Most Significant Bit (MSB) of the X Register causes the Margin Shifter to output an End of Line ($\overline{\text{EOL}}$) signal. This signal is input to the Crosshair Generator to inhibit the count of the X Register. This delay allows the display beam time to return to the left side of the display and stabilize before the count resumes. This is known as Foldover. The signal from the Crosshair Generator (as a result of this action) is $\overline{\text{FPAUSE}}$. It inputs to the Format Effector to inhibit its functions during the time $\overline{\text{FPAUSE}}$ is active (0.5 ms). The count then continues from 0 until X Coincidence is reached. When the count switches to the Y Register, the Crosshair Generator outputs $\overline{\text{DOWN}}$ pulses until the bottom of the page is reached. When this occurs, the beam folds over to the top of the page, but the Y Register continues to decrement with no Foldover Pause. No Foldover Pause is needed in the Y Axis, because Foldover positions the beam offscreen. By the time the beam appears in the display area of the screen, it has had time to stabilize. The Y Register continues decrementing until coincidence again occurs; the X Register starts incrementing and the cycle repeats itself until commanded to do otherwise.

Digitizing. When the user presses a key, keyboard bits b1—b8 are inverted by the Multiplexer and placed onto the minibus lines as $\overline{\text{BIT 1}}$—$\overline{\text{BIT 8}}$. KSTROBE (which accompanied the keyboard bits) then generates the $\overline{\text{CSTROBE}}$ signal that strobes the data bits through the Interface card and to the computer. After the character is accepted by the computer, the $\overline{\text{CBUSY}}$ line returns high, causing the $\overline{\text{GO DIGITIZE}}$ signal to go active. This causes the Crosshair Generator to stop the counting sequence when the next coincidence occurs. The digital representations of the voltages from the X and Y Position Pots are then held at the outputs of the X and Y Registers while the Crosshair Generator sends a $\overline{\text{PT FOUND}}$ signal back to the Multiplexer.

$\overline{\text{PT FOUND}}$ causes the Multiplexer to sample the 5 MSB X bits from the X Register and place them (along with code bits BIT 6 and BIT 7) on the minibus. Once again $\overline{\text{CSTROBE}}$ is generated and the byte is sent to the computer. When $\overline{\text{CBUSY}}$ again goes inactive, the 5 LSB X bits are sampled by the Multiplexer and the process repeats, sending the 5 MSB Y and then the 5 LSB Y bytes. These may be followed by CR or CR and EOT bytes if the circuit strap option is wired to do so. (EOT cannot be sent without CR.)

The computer can request the coordinates of the crosshair by sending an ESC SUB sequence (to initiate the GIN Mode as previously explained), followed by an ESC ENQ sequence. ENQ sets $\overline{\text{INQUIRE}}$

low, causing the Multiplexer to send the coordinates of the intersection point to the computer as previously explained. Note that the ESC SUB ESC ENQ sequence precludes transmission of the keyboard character.

The computer can also request the status of the Terminal by sending ESC plus ENQ while the Terminal is in Alpha or Graph Mode. In this case, only $\overline{\text{INQUIRE}}$ is activated and the Terminal status bits are sent in place of the keyboard character. They are followed by the location of the display beam (Graph Mode beam address or lower left corner of the Alpha cursor). The status bits appear on the $\overline{\text{BIT 8}}$—$\overline{\text{BIT 1}}$ lines as follows: 8 = Fixed by keyboard wire, 7 = Ø, 6 =1, 5 = Hard Copy Unit status (on is Ø), 4 = Vector status (1 indicates set for vectors), 3 = Graph Mode status (Ø says Graph Mode exists), 2 = Margin (1 indicates Margin 1), 1 = Auxiliary sensing (Ø means an auxiliary device is activated).

CHASSIS CIRCUITS

The diagram of the chassis circuits illustrates those components which are mounted directly on the chassis, and provides applicable interconnecting information.

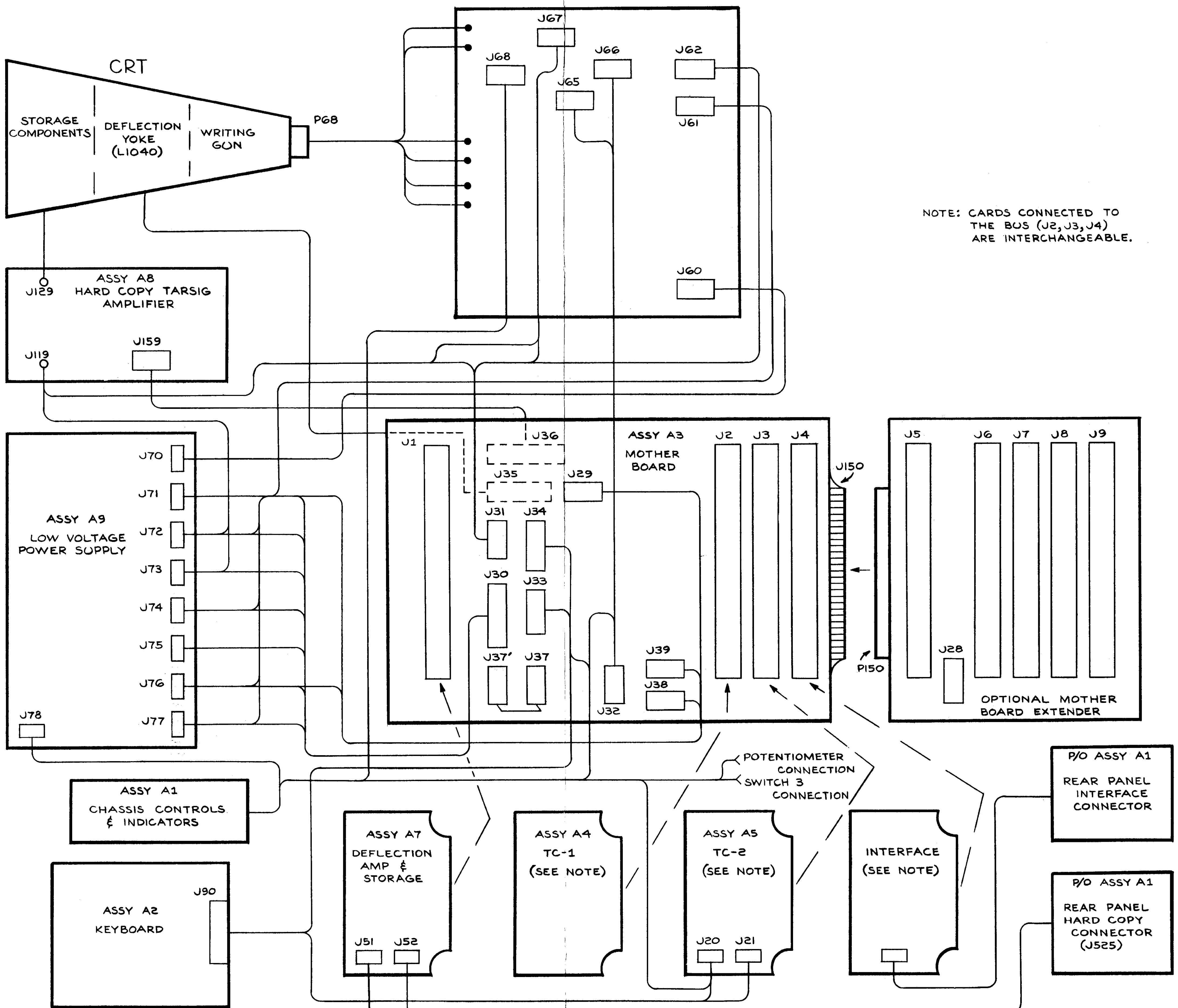
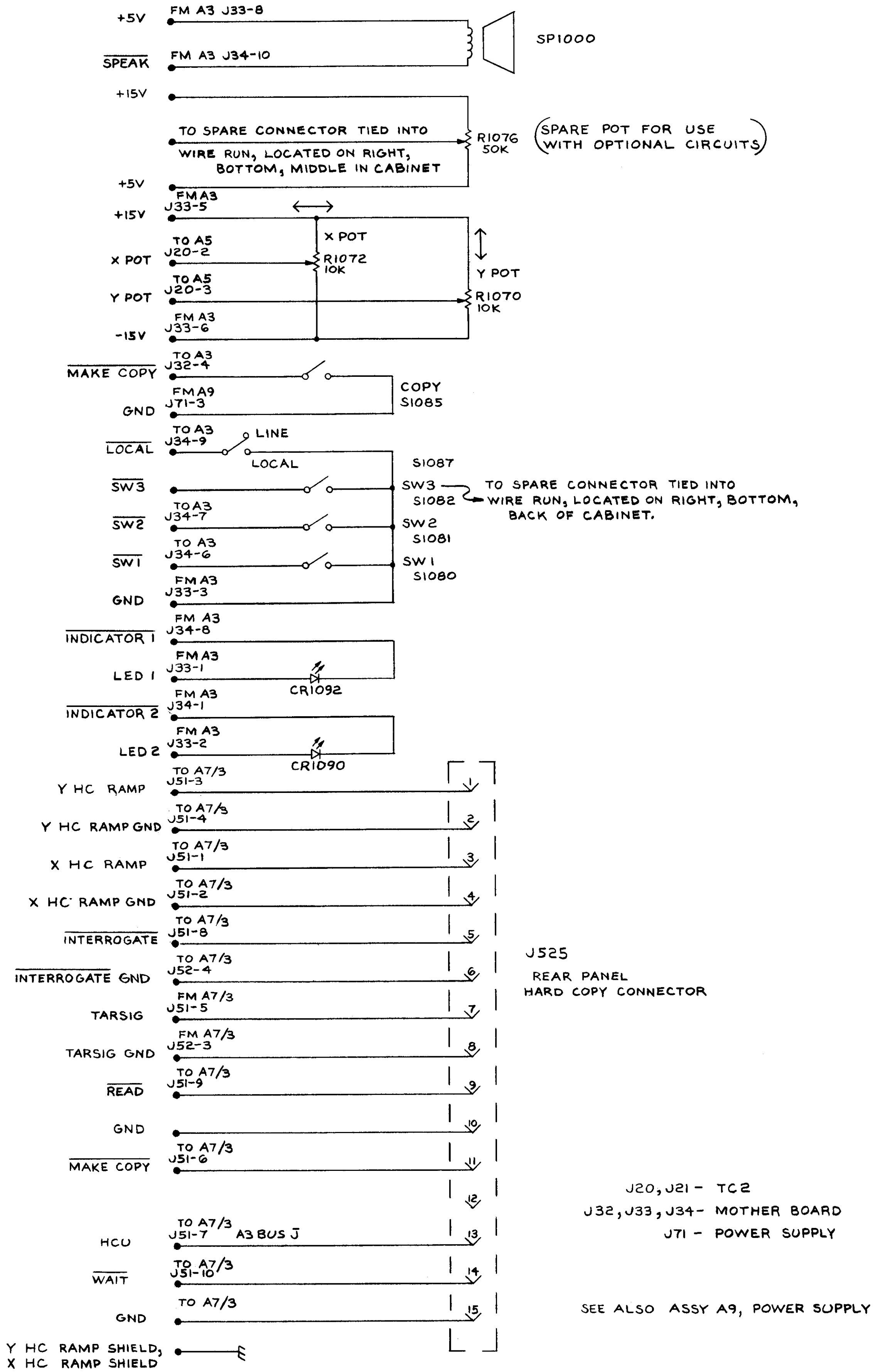


FIG. 6-7 CONNECTORS & WIRING DIAGRAM



RE4012

FIG. 6-8 ASSY A1 CHASSIS MISCELLANEOUS CIRCUITS

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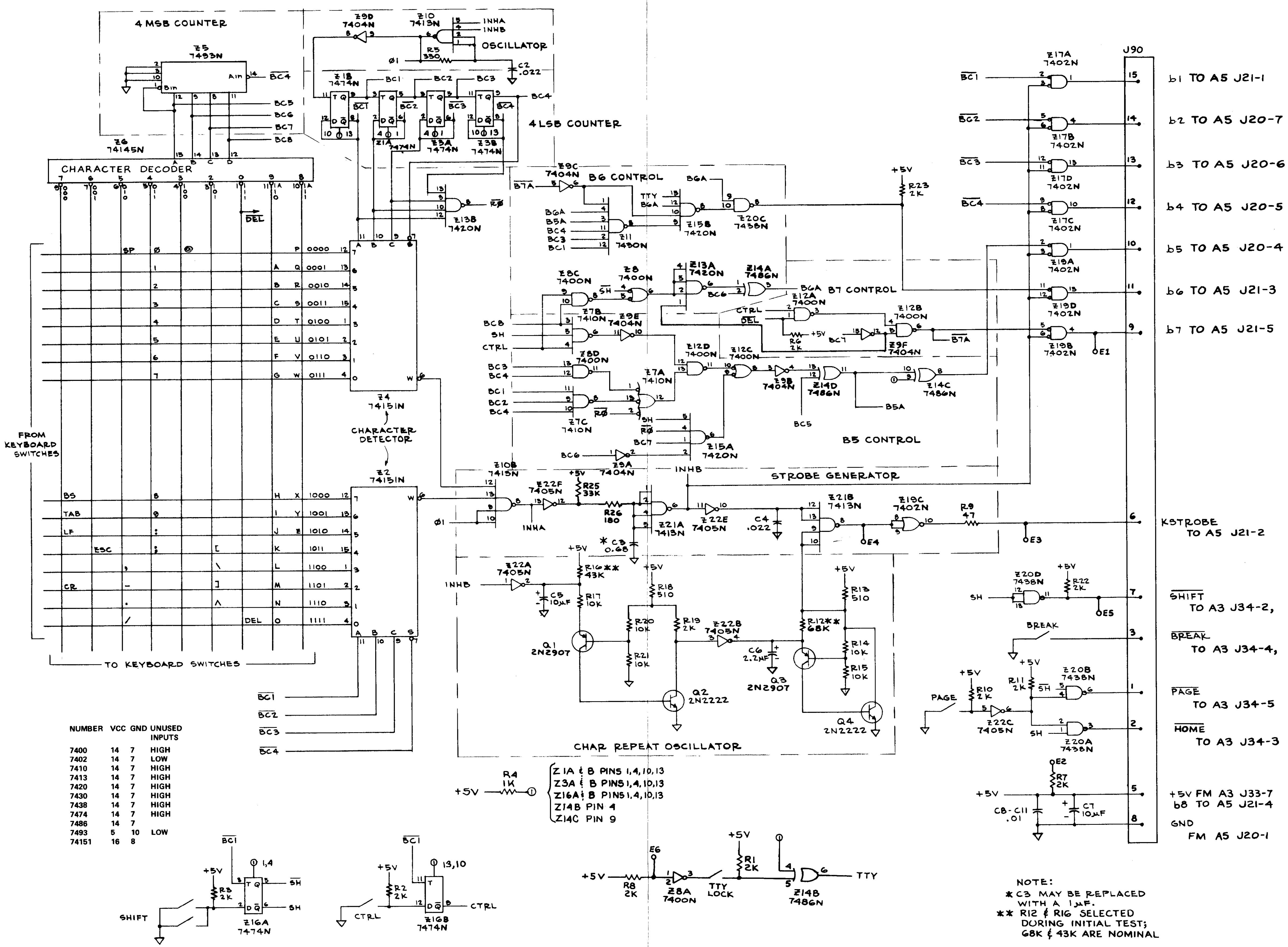

NUMBER	VCC	GND	UNUSED INPUTS
7400	14	7	HIGH
7402	14	7	LOW
7410	14	7	HIGH
7413	14	7	HIGH
7420	14	7	HIGH
7430	14	7	HIGH
7438	14	7	HIGH
7474	14	7	HIGH
7486	14	7	
7493	5	10	LOW
74151	16	8	

KEY TRONIC CORP.

RE4012 @ FIG. 6-9 ASSY A2 KEYBOARD

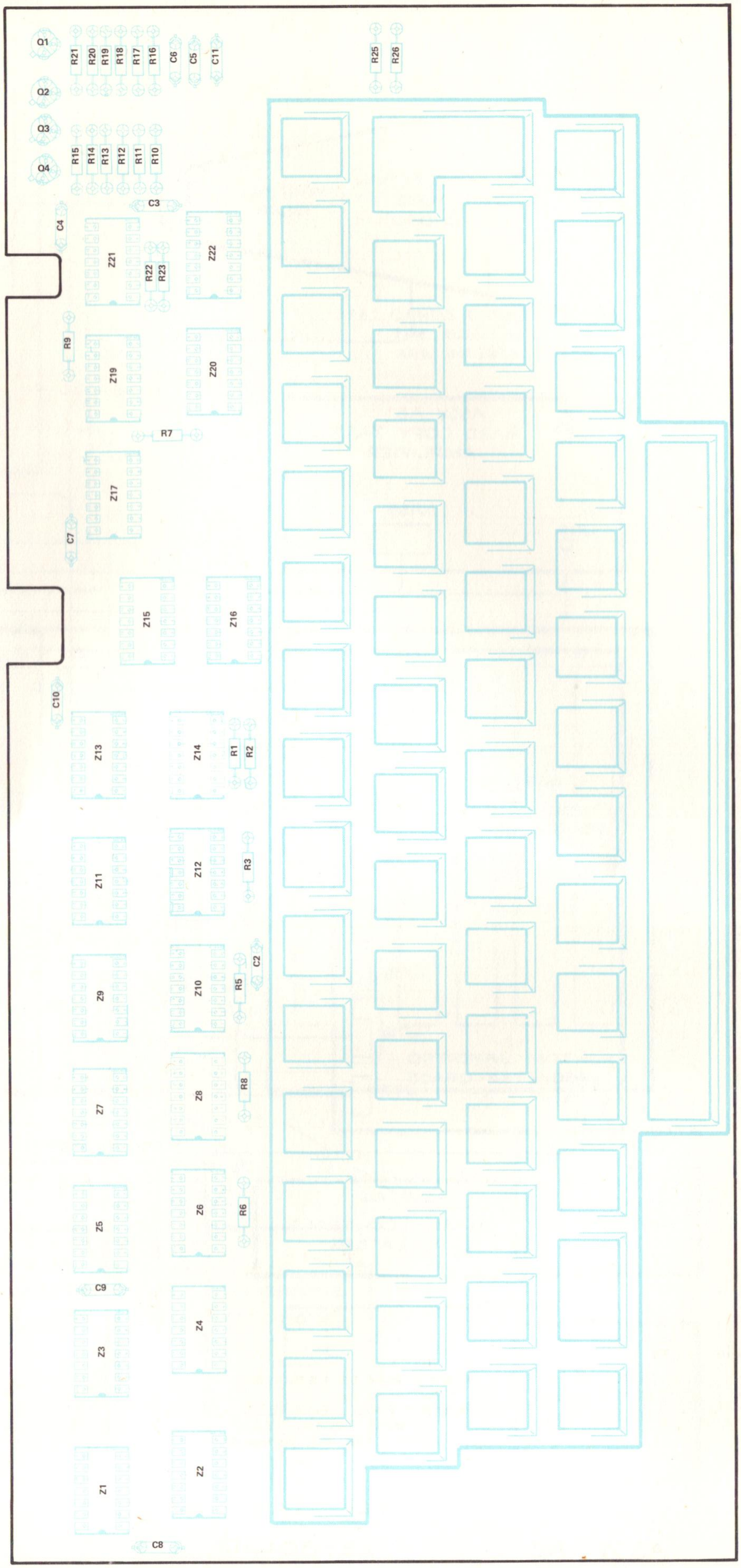

Fig. 6-10. Keyboard component locations.

KEYBOARD DESCRIPTION

General Description

Refer to the keyboard schematic. The keyboard consists of the following principal circuits: an oscillator, the 4 LSB Counter, the Character Detector, the 4 MSB Counter, the Character Decoder, the B5—B7 Control circuits, the Character Repetition Oscillator, and the Strobe Generator. Their combined purpose is to generate a coded character output on seven data lines labeled KB1 through KB7; to develop a strobe output labeled K STROBE (that accompanies the data bits); and to repeat the keyboard character at a 10 Hz rate when the key is held down more than 1/2 second.

Assume that characters are being entered at the keyboard. The oscillator generates a symmetrical output pulse which is applied to pin 11 of Z1 and pin 10 of Z10. Z1 causes the 4 LSB Counter to continuously cycle through its 16 counts. Each time it completes a cycle, it feeds a pulse to the 4 MSB Counter, causing it to advance one. The 4 MSB Counter eventually cycles through its 16 counts, and the entire performance is repeated. During this operation, the W output of one of the Character Detectors holds lows on the Z10 gate, causing the output of Z21 to remain high. This inhibits outputs from the Character Output Gates. KSTROBE is also held low during the operation.

When a character key is pressed, contact is made between an output of the Character Decoder and an input of the Character Detector. The output combination from the 4 MSB Counter into the Character Decoder eventually causes it to put a low output on the closed key. This places a low on one pin of a Character Detector. Since the 4 LSB Counter continues to cycle, the low is eventually gated through the Character Detector, causing its W output to go high. This high provides enabling voltage to Z10 in the Strobe Generator. Since only one Character Detector is enabled at a time, the output from the second Character Detector is also high. When the Ø1 output of the oscillator goes high, it causes a negative-going INHA pulse from Z10 to input to the oscillator to prevent additional clock pulses from affecting the 4 LSB Counter.

With the count from the 4 LSB and 4 MSB Counters frozen, the B5, B6, and B7 control circuits place the decoded equivalents of the $\overline{B5}$, $\overline{B6}$, and $\overline{B7}$ information on their respective output Gates. Approximately 22 ms later the INHB goes low, providing an enabling voltage for the Character Output Gates. This action places on the b1—b7 lines the representative bit combination of the selected character. $\overline{INHB}$, delayed slightly by C4, also enables the KSTROBE signal that accompanies the data bits.

$\overline{INHB}$ also triggers the Character Repeat Oscillator. If the same key is held down for more than approximately 0.5 second, the Character Repeat Oscillator strobes Z21 in the Strobe Generator at an approximately 10 Hz rate. This enables KSTROBE 10 times a second, thus enabling the terminal to process the character bits at that rate.

The keyboard circuitry maintains the above-stated condition as long as the keyboard key is held down. When the key is released, the high from the W output of the Character Detector is removed from Z10, permitting the Z10 output to return to its high state. This ends the b1—b7 and KSTROBE outputs.

Miscellaneous Functions

SHIFT, CONTROL, and TTY keys. Pressing one of these keys causes the outputs of the B5—B7 Control circuits to reflect the appropriate bit configuration for the character code desired. For example, pressing SHIFT in conjunction with an alpha key causes the output configuration of B1—B7 to represent the upper-case alpha character. Pressing the CONTROL (CTRL) key causes the output bit configuration to represent a control character. And pressing TTY permits only upper-case alpha bit configurations to be structured.

MOTHER BOARD CIRCUITS

The Mother Board schematic shows all circuitry permanently mounted on that board. It consists principally of connectors and pull-up resistors. Most pull-up resistors obtain their current through CR161, located in the upper left corner of the schematic. Interconnections within the board itself are not drawn out in detail, but are indicated by an arrow and an "address."

Note that comparable connectors on J2, J3, J4 and J150 are connected to each other via 72 electrically parallel lines, the composite being referred to as a "minibus" or "bus."

For convenience, the Optional Extender Board is also shown, although it is not a part of the standard instrument.

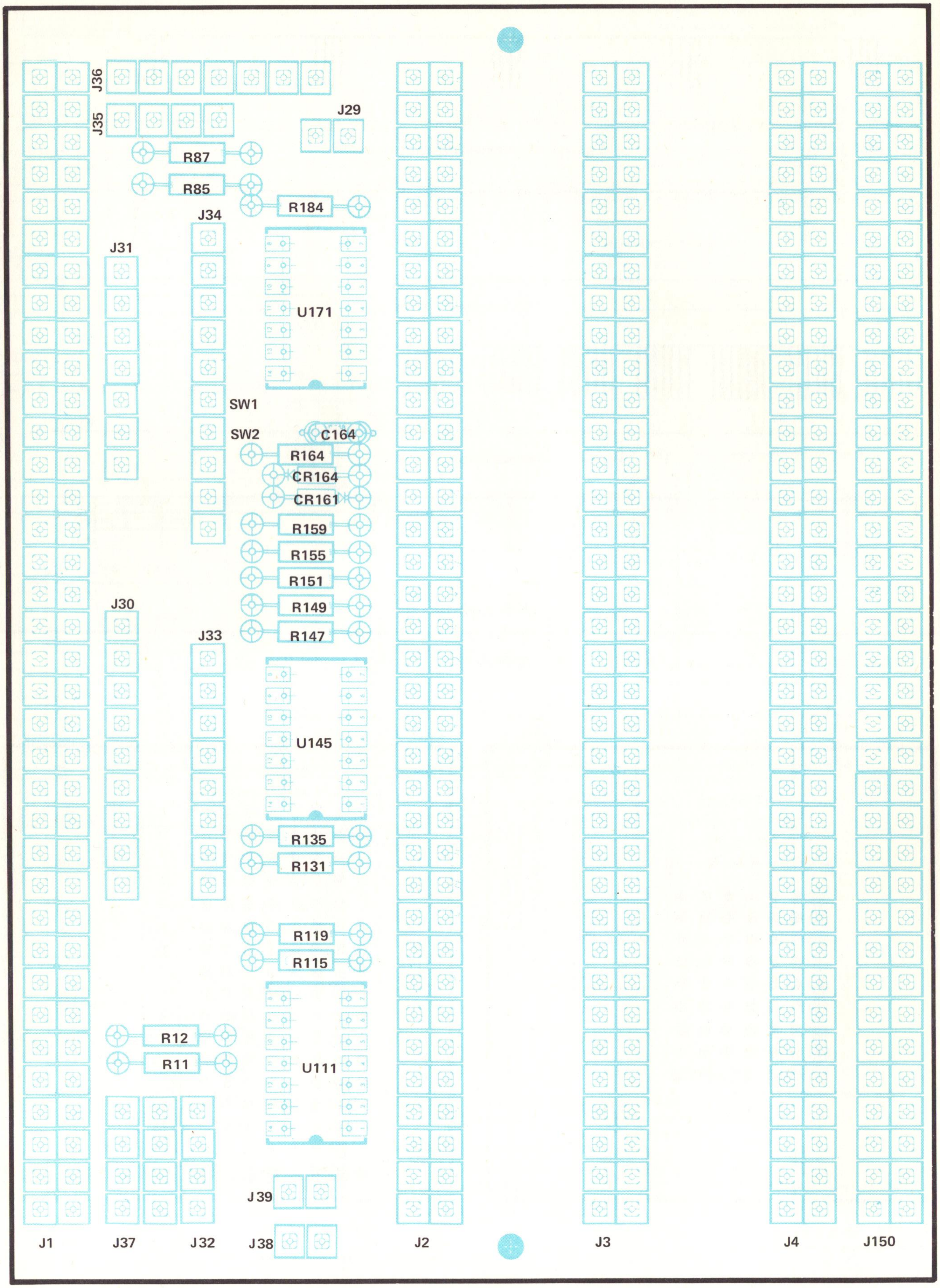

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Fig. 6-11. Mother board component locations.

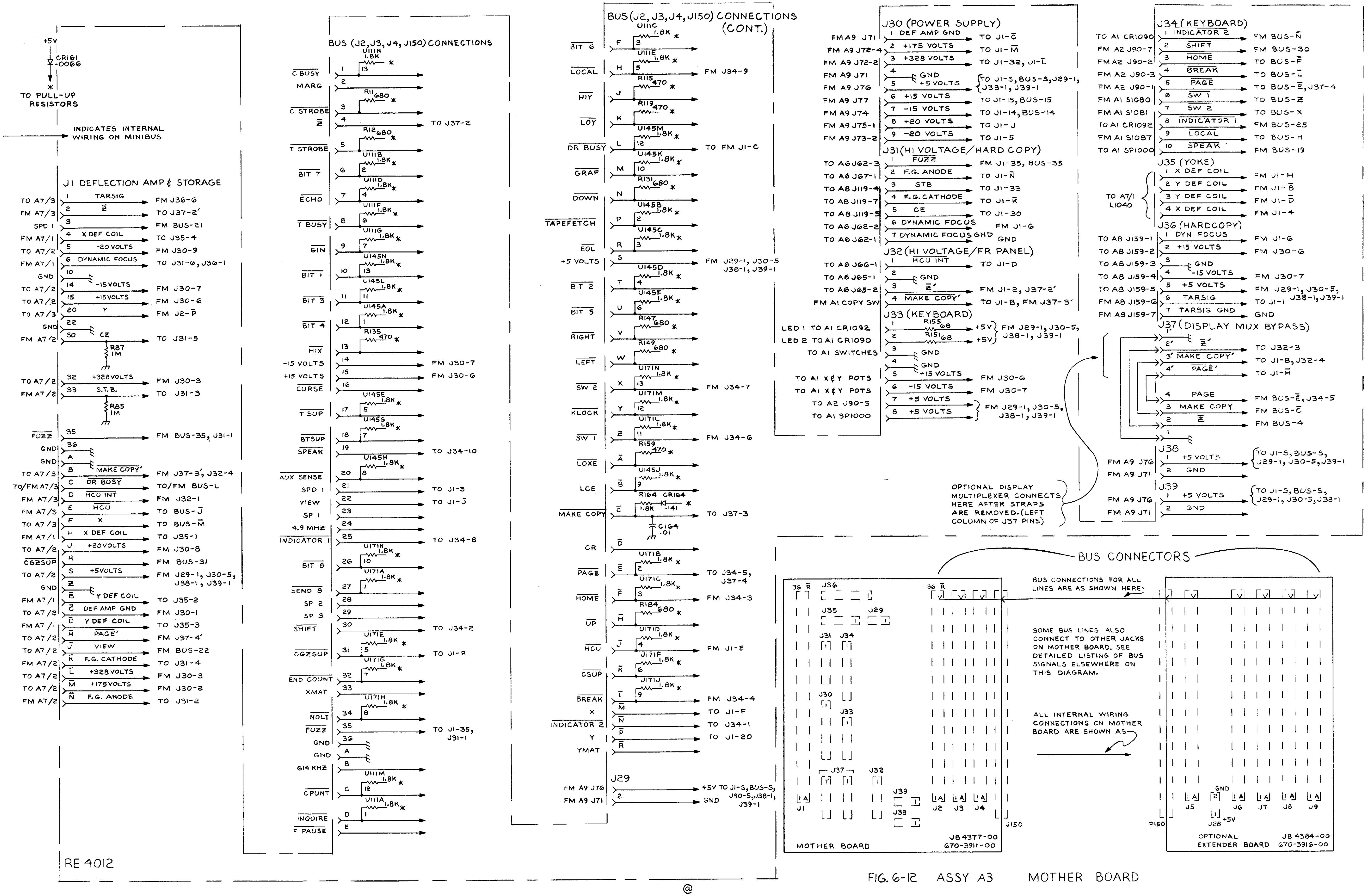


FIG. 6-12 ASSY A3 MOTHER BOARD

MOTHERBOARD A3

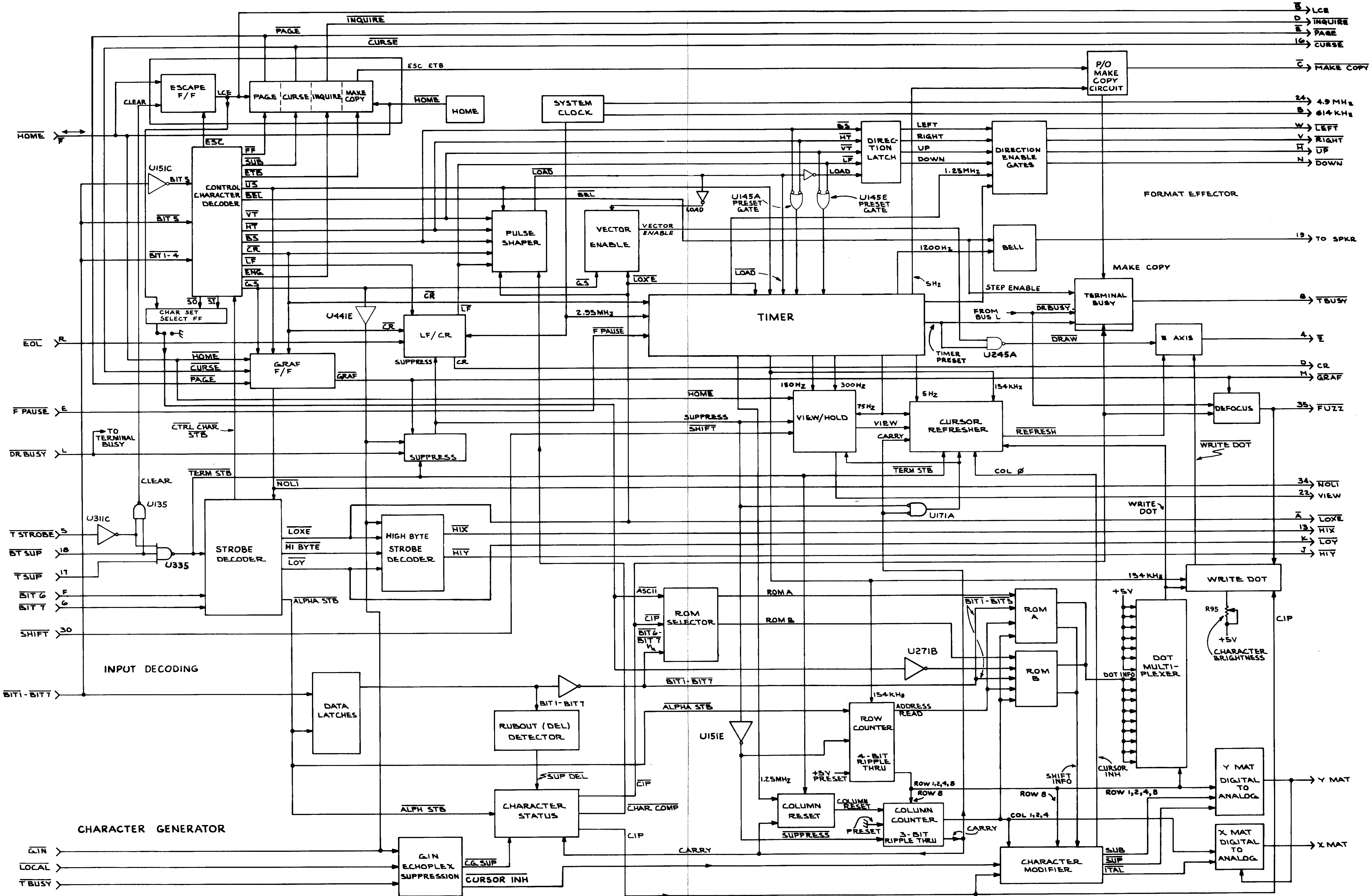


FIG. 6-13 TC-1 DETAILED BLOCK DIAGRAM

TC-1 BLOCK DIAGRAM

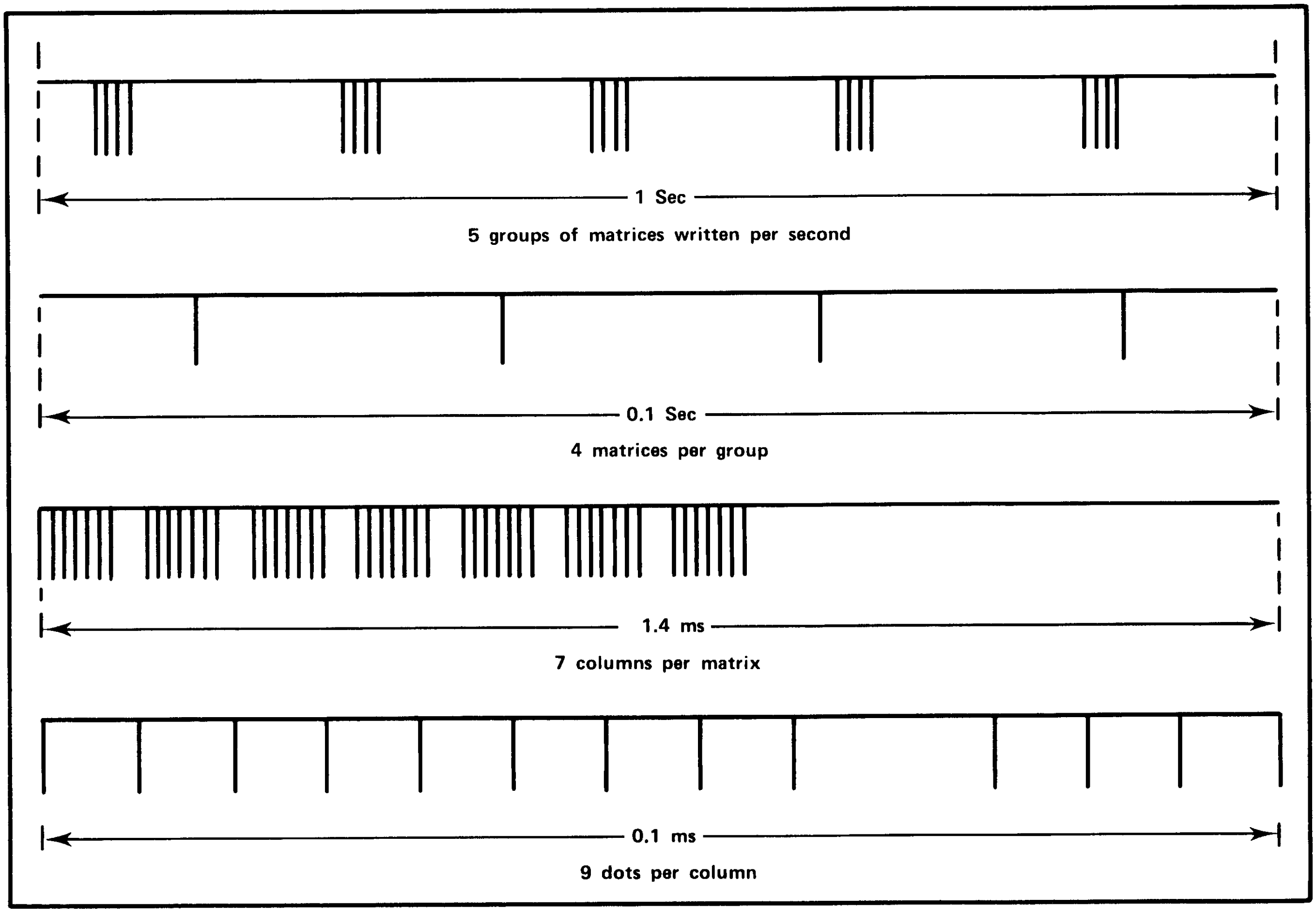


Fig. 6-14. Z axis signals during Alpha cursor refresh time.

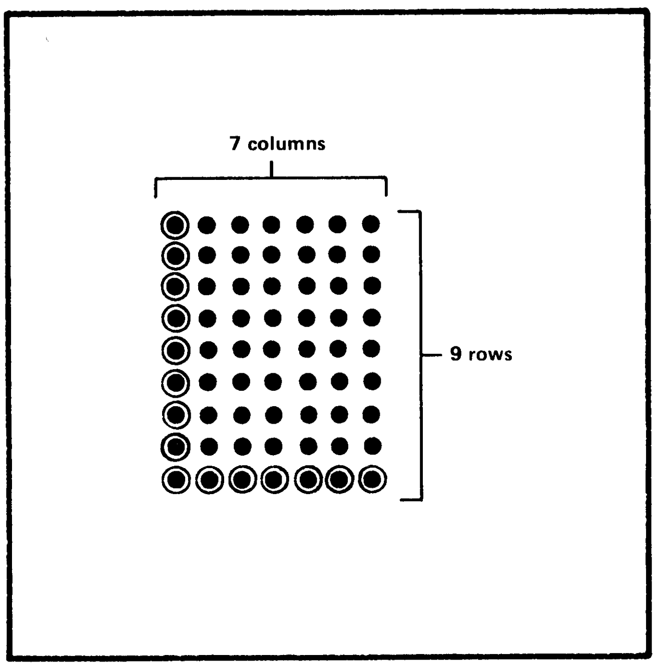


Fig. 6-15. Dots indicate matrix positions for character writing. Circles indicate which dots are written to form the letter L.

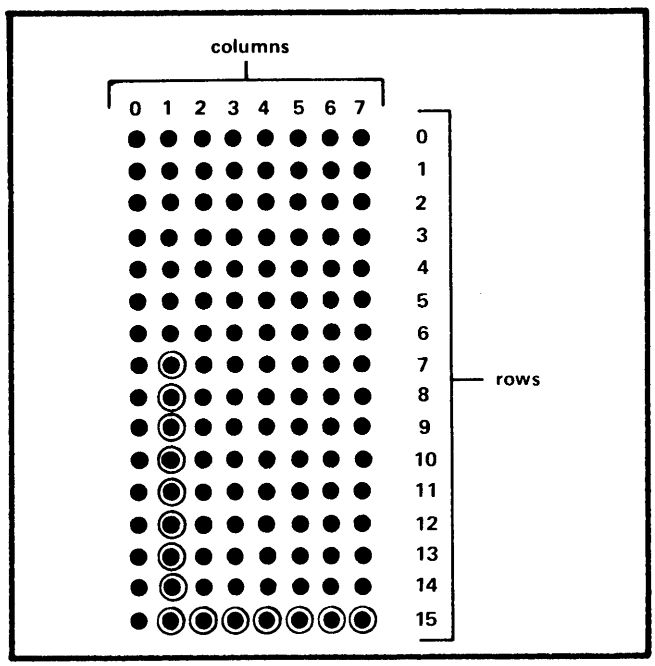


Fig. 6-16. Dots indicate the matrix generated by the Row Counter and Column Counter. No dots can be written when column 0 or row 0 through row 6 are selected.

TC-1 BLOCK DIAGRAM DESCRIPTION

Introduction

The operation of TC-1 can be best understood when it is broken down into three basic blocks of operation. These blocks are called Input Decoding, Format Effector, and Character Generator. The three sections will be discussed in detail, in that order. Basically, the Input Decoding section decodes the various input signals and data for Terminal operations. The Format Effector section is used to initiate a number of functions mainly associated with Alpha Mode. The Character Generator section generates the alphanumeric characters and symbols.

Input Decoding

General. Refer to TC-1 Block Diagram Fig. 6-13, and Schematic Fig. 6-18. The Input/Decoding section contains the following circuits:

Home—When power is turned on, this circuit outputs the HOME signal that sets Terminal logic to Alpha Mode.

Strobe Decoder—Generates signals that enable the Control Character Decoder, Character Generator, or High Byte Strobe Decoder circuits.

Control Character Decoder—Decodes control characters used by the Terminal.

Escape Flip-Flop—Prevents accidental activation of $\overline{\text{PAGE}}$, $\overline{\text{CURSE}}$, $\overline{\text{MAKE COPY}}$, and $\overline{\text{INQUIRE}}$ signals. Also used in character selection if option strap is in AB + BC position.

Page, Curse, Make Copy, and Inquire Circuits—Used in conjunction with Escape Flip-flop to prevent accidental activation of their respective outputs.

Graf Flip-Flop—Sets Graphic Plot Mode.

High Byte Strobe Decoder—Activated during Graphic Plot Mode to strobe coordinate address bytes into proper latch on TC-2.

The description of the Input Decoding section will be given in that order. For the purpose of the description, assume that data is present on the minibus.

Home. Refer to the upper left corner of the block diagram. The purpose of this circuit is to reset all logic to the Alpha Mode when power is turned on (initialized). When power is turned on, the Home circuit applies a low pulse on the HOME line. If a Hard Copy Unit is connected to the Terminal, HOME prevents voltage fluctuations from initiating a hard copy. Pulling the HOME line low resets Terminal logic to the Alpha Mode by inputting to the Graf Flipflop to set GRAF high and NOLI low. HOME also resets the X and Y Registers (in TC-2) to position the writing beam to the Home position (upper-left corner of display screen). After the power stabilizes, the Home circuit is deactivated.

Strobe Decoder. Basically, the Strobe Decoder is a binary-to-decimal decoder. The inputs to the Strobe Decoder are as follows:

1. TERMINAL STROBE (TERM STB) from U107B.

2. NOLI from Graf Flipflop.

3. BIT 7 from minibus.

4. BIT 6 from minibus.

For any of the outputs from the Strobe Decoder to be active, NOLI and TERM STB must be low. TERM STB goes low when TSTROBE is low if BTSUP and TSUP are high. This allows BIT 7 and BIT 6 to set the outputs. Referring to the Code Chart in Section 1, it can be seen that BIT 6 and BIT 7 determine which two columns of the chart are selected for operation.

Refer to Table 6-1. Note that either ALPHA STB or CTRL CHAR STB can be generated with NOLI low. Also note that CTRL CHAR STB can still be generated when NOLI goes high (Graph Mode), but the ALPHA STB signal is replaced by Graph commands LOY, LOXE, HIY, or HIX. The Strobe Decoder outputs LOY and LOXE directly, but outputs a HI BYTE signal to permit the High Byte Strobe Decoder to output HIY or HIX.

Control Character Decoder. Refer back to Fig. 6-13. The Control Character Decoder consists of two 4-line to 16-line decoders.

As a result of the enabling signals (CTRL CHAR STB and BIT 5) and the data (BIT 1—BIT 4), the Control Character Decoder will output low signals for the following control characters: US, BEL, VT, HT, BS, CR, LF, ENQ, GS, ESC, FF, SUB, ETB, SI, and SO. The control character signals are then processed by the applicable circuitry in TC-1 to perform the desired function. This circuit decodes all 32 ASCII control characters. However, only those mentioned above are used by the Terminal logic.

Escape. Six control characters are dependent upon a preparatory command to arm the circuitry before they can be executed. The preparatory command is Escape (ESC) and the dependent commands are

Form Feed (FF, which generates a PAGE signal to erase the display and set the Terminal to Alpha Mode, home position), Substitute (SUB, which initiates the Graph Input Mode and starts the Crosshair Cursor), End of Transmission Block (ETB, which activates the MAKE COPY pulse to turn on the Hard Copy Unit), Inquire (ENQ, which is sent to request Terminal status), Shift Out (SO, which selects the alternate character set if one is installed and the ROM SELECT option strap is at AB + BC), and Shift In (SI, which selects the ASCII character set if the ROM SELECT option strap is at AB + BC). The purpose of the Escape circuitry is to prevent accidental activation of these signals.

TABLE 6-1

Logic Decoder for Strobe Decoder and High Byte Strobe Decoder

INPUT SIGNAL					
TERM STB	**NOLI**	**BIT 7**	**BIT 6**	**RESULTANT SIGNAL**	**COLUMNS OF ASCII CODE CHART**
0	0	0	0	ALPHA STB	6 and 7 (LOWER CASE)
0	0	0	1	ALPHA STB	4 and 5 (UPPER CASE)
0	0	1	0	ALPHA STB	2 and 3 (SYMBOLS & NUMERALS)
0	0	1	1	CTRL CHAR STB	0 and 1 (CTRL CHARACTERS)
0	1	0	0	LOY	6 and 7 (5 LSB of Y ADDRESS)
0	1	0	1	LOXE	4 and 5 (5 LSB of X ADDRESS)
0	1	1	0	HIY	2 and 3 (5 MSB of Y ADDRESS)*
				HIX	2 and 3 (5 MSB of X ADDRESS)*
0	1	1	1	CTRL CHAR STB	0 and 1 (CTRL CHARACTERS)

***Preceding signal determines whether HIY or HIX goes active. HIY goes active following a GS or the LOXE signal; HIX goes active following the LOY signal.**

Assume that the ESC data bits are placed on the minibus. The Escape circuitry functions in the following manner. With BTSUP and TSUP inactive, TSTROBE (which accompanies the data bits) enables the Strobe Decoder to generate the CTRL CHAR STB signal. This signal permits the Control Character Decoder to decode BIT 1—BIT 5; the ESC signal goes active and "arms" the Escape Flipflop, setting LCE (Last Character to Escape) high. The arrival of the data bits for the next portion of the two-character sequence activates the required function. ETB activates MAKE COPY; FF activates PAGE; SUB activates CURSE; ENQ activates INQUIRE; SO sets ASCII high to select the alternate character set; SI sets ASCII low to select the ASCII character set. The positive-going CLEAR signal from U135 (which occurs whenever TSTROBE ends) disarms the Escape Flipflop unless the ESC character accompanies TSTROBE. Thus, the Escape Flipflop is always disarmed by the character following the ESC input, causing LCE to return low.

Page, Curse, Make Copy and Inquire. These four circuits comprise an additional portion of the Escape circuitry, and were generally explained under that topic. Some additional comments about the Make Copy circuit follow. The 5 Hz input from the Alpha Cursor Counter controls the width of the MAKE COPY pulse. HOME inhibits the Make Copy circuit when power is turned on. Notice that MAKE COPY inputs to the Terminal Busy circuit. This keeps the Terminal busy (TBUSY goes low) until the Hard Copy Unit asserts DRBUSY to sustain the busy condition. This holds the Terminal in a busy condition from the time MAKE COPY is activated to the time the Hard Copy Unit completes the copy and DRBUSY goes high.

Graf Flipflop. The Graf Flipflop switches the Terminal in and out of Graph Mode. The GS control character sets the Graph Mode. NOLI goes high to enable the Linear Interpolation circuitry in TC-2. GRAF goes low and sets other Terminal circuitry for Graph Mode operation. The signals PAGE, CURSE, and HOME reset the Graf Flipflop to the Alpha Mode. The control characters US and CR can also reset the Graf Flipflop to the Alpha Mode.

When GS sets GRAF low and NOLI high, NOLI enters the Strobe Decoder to disable generation of ALPHA STB and to permit graphic byte strobes (HIY, LOY, HIX, LOXE) to be generated.

High Byte Strobe Decoder. This circuit generates the graphic byte output signals HIY and HIX. These signals are used to load the high Y and high X graphic bytes into the Data Latches on TC-2. When the TErminal receives graphic plot data, it arrives in a sequence of 4 seven-bit bytes for each coordinate point addressed. Five of the bits contain coordinate information and two of the bits (bits 6 and 7) contain steering data. The steering data designates the specific byte as being either High Order Y (HIY), Low Order Y (LOY), High Order X (HIX), or Low Order X (LOX), received in that order. The Graphic Byte Decoder operates in the following manner.

When the Terminal receives a GS control character, it activates the GS signal from the Control Character Decoder. This signal sets the Graphic Plot Mode as previously explained. With NOLI inactive (high), the Strobe Decoder will now interpret BIT 6 and BIT 7 as LOXE, LOY or HI BYTE Strobes. The graphic byte code bits are as follows:

BYTE	BIT 7	BIT 6	Contents
HI Y	0	1	Most significant 5 bits of Y
LOY	1	1	Least significant 6 bits of Y
HIX	0	1	Most significant 5 bits of X
LOX	1	0	Least significant 5 bits of X

Notice that the HIY and HIX bits have the same bit 7 and bit 6 configuration. The problem of interpreting which byte is which is accomplished by the GS signal, the LOY byte, and the LOX byte. The GS signal sets the High Byte Strobe Decoder to interpret the first high order code as being HIY. The LOY code causes the High Byte Strobe Decoder to interpret the next high order code as HIX. Each time a vector is executed by the LOXE signal, the circuit resets to recognize the next high order byte as HIY.

Notice that the $\overline{\text{GIN}}$ signal inputs to the High Byte Strobe Decoder. It resets the decoder to interpret as HIY the next high byte received after a GIN Mode operation.

Format Effector

General. The Format Effector operates from a predetermined set of inputs to position the Alpha cursor over the face of the display screen. It also generates timing pauses when switching out of graphics, when initiating a Carriage Return, when ringing the bell, and when drawing a vector.

Its basic function is to take the decoded output of the Control Character Decoder and transform it into the desired result. For example, if the function desired is to move the Alpha cursor one space, the Format Effector will output 14 pulses on the $\overline{\text{RIGHT}}$ line. This will increment the X Register in TC-2, thus moving the Alpha cursor one space. Each pulse will increment the X Register one count. Each count from the Register will move the display beam one Tekpoint. (A Tekpoint refers to one of the 1024 programmable locations that are available in both the X and Y Axes.) Another example is a Carriage Return. With a Carriage Return, the Control Character Decoder outputs the $\overline{\text{CR}}$ signal. The Format Effector circuitry inverts the $\overline{\text{CR}}$ to CR, which sets the X Register back to zero. At the same time, the Format Effector generates a pause in Terminal operation, causing the Terminal to go to a "busy" condition. This pause is of sufficient length to allow the display beam to position back to the left side of the screen before the Terminal will accept and process further data.

The Format Effector contains the following circuits:

System Clock—Provides timing signals for Terminal operation.

Timer—Controls the timing of the Alpha cursor as well as various other functions.

Pulse Shaper—Provides a pulse that loads preset data into the Timer circuit.

Direction Latch—Controls the direction of cursor movement. Causes character spacing after each character writing. Its output changes when new direction command is received.

Direction Enable Gates—Enables $\overline{\text{LEFT}}$, $\overline{\text{RIGHT}}$, $\overline{\text{UP}}$, or $\overline{\text{DOWN}}$ lines dependent upon respective signals from Direction Latches and the enabling signals from the Timer.

Terminal Busy—Outputs a $\overline{\text{TBUSY}}$ signal until the Terminal operation being performed is completed.

Line Feed/Carriage Return (LF/CR)—Causes a line feed upon receipt of an EOL or LF signal. Can be strapped to cause a line feed upon receipt of CR. Can also be strapped to cause a carriage return any time a line feed occurs.

Vector Enable—Outputs signals that activate vector drawing.

Z Axis—Controls the state of the Z signal that turns the display beam on and off.

Bell—Provides the drive signal for the speaker that produces the audible "bell" tone.

View/Hold—Provides an enabling signal (VIEW) for the CRT flood guns so that data can be viewed. When in Hold operation, VIEW is set at a reduced duty factor, thus prolonging the life of the CRT.

Cursor Refresher—Provides logic that allows the 7 X 9 dot matrix of the Character Generator to be displayed but not stored, thus generating the Alpha cursor.

Defocus—Provides uniform focusing in Alpha and GIN Modes.

Basically, the operation of the circuits will be described in that order. However, in some cases it is more practical to combine the descriptions of several blocks.

System Clock. The System Clock is a crystal-controlled oscillator that outputs two square-wave frequencies to the minibus: 4.9 MHz and 614 kHz. It also outputs a 2.45 MHz square wave for use by the Timer and the LF/CR circuit.

Pulse Shaper. The Pulse Shaper generates a $\overline{LOAD}$ pulse that strobes data from the preset lines into the Timer. The $\overline{LOAD}$ pulse is shorter than any of the inputs to the Pulse Shaper circuit. This allows the $\overline{LOAD}$ pulse to come and go while the data on the preset lines is still valid. All inputs to the Pulse Shaper will activate the $\overline{LOAD}$ pulse. The $\overline{LOAD}$ pulse is inverted and input to the Vector Enable and Direction Latch circuits as a LOAD signal.

Timer, Direction Latch, and Direction Enable Gates. The Timer is composed of 4 four-bit counter elements. Depending upon preset inputs to the counter, it will determine the required number of pulses to support the function required by the Control Character Decoder. This circuit also generates pauses in Terminal operation, such as that required during Carriage Return, (as previously explained), and coming out of Graphic operation. It also provides a 2.6 ms activation pulse for the $\overline{Z}$ signal when drawing a vector. Finally, it provides various timing signals that are used by other TC-1 circuits.

The Clock input to the Timer is a 2.45 MHz square wave from the System Clock. The Timer counts continuously except when a low is applied on the $\overline{LOAD}$ input line. As the Timer is counting, it is putting out the following square-wave signals for use by other TC-1 circuits:

5 Hz. Used in the Cursor Refresher circuit and Make Copy circuit.

37 Hz. Used in the Cursor Refresher and View/Hold circuits.

75 Hz, 150 Hz, 300 Hz. Used in the View/Hold circuit.

1200 Hz. Used in the Bell circuit.

154 kHz. Used by the Cursor Refresher and Character Generator.

1.25 MHz. Used to increment the Direction Enable Gates and to clear Column Reset located in the Character Generator circuitry.

The Timer is a programmable counter, referred to as such because it contains a number of preset lines that "program" the Timer to output various signals that perform a specific function. The data loaded into the Timer from the preset lines determines a number that the Timer will start counting from. These preset inputs are: $\overline{\text{LOXE}}$ (Low Order X Enable), which sets the 2.6 ms pause that activates the $\overline{\text{Z}}$ signal to draw a vector; the $\overline{\text{CR}}$ input that initiates the pause needed to perform the Carriage Return; and finally $\overline{\text{BS}}$ (Backspace), $\overline{\text{HT}}$ (Horizontal Tab), $\overline{\text{VT}}$ (Vertical Tab), and $\overline{\text{LF}}$ (Line Feed). Notice that the same preset line is used for both directions of horizontal movement; similarly, one preset line is used for both directions of vertical movement. This is becuase for either a BS or an HT, the horizontal movement is 14 Tekpoints. For either a VT or an LF, the vertical movement is 22 Tekpoints. Each of the eight functions the Timer will perform corresponds to a definite value on the preset input lines. These lines determine how long it will take for the Timer to count up to the point where a zero-to-one transition is obtained on its $\overline{\text{STEP ENABLE}}$ output. If either a LEFT, RIGHT, UP, or DOWN signal is being output by the Direction Latch, this length of time determines how many 1.25 MHz pulses are placed on the $\overline{\text{LEFT}}$, $\overline{\text{RIGHT}}$, $\overline{\text{UP}}$, or $\overline{\text{DOWN}}$ line, as well as how long $\overline{\text{TBUSY}}$ stays active. In all cases, the $\overline{\text{STEP ENABLE}}$ signal being low determines how long it will take for a Terminal pause, as reflected by the $\overline{\text{TBUSY}}$ signal.

For an example of how the Format Effector processes a direction command, assume that Control Character HT (space) has been received by the Terminal. $\overline{\text{HT}}$ inputs to the Pulse Shaper circuit and causes the $\overline{\text{LOAD}}$ pulse to go low. LOAD then strobes the $\overline{\text{HT}}$ signal into the Direction Latch, activating the RIGHT signal; $\overline{\text{LOAD}}$ simultaneously loads the preset data into the Timer causing the $\overline{\text{STEP ENABLE}}$ signal to go low. $\overline{\text{TBUSY}}$ goes active and the 1.25 MHz signal clocks the Direction Enable Gates. With the RIGHT signal from the Direction Latch high, every time the 1.25 MHz signal goes low, a low-going transition takes place on the $\overline{\text{RIGHT}}$ line, incrementing the X Register in TC-2. After 14 positive-to-negative transitions of the 1.25 MHz signal, the $\overline{\text{STEP ENABLE}}$ signal goes high. This prevents the 1.25 MHz signal from enabling further $\overline{\text{RIGHT}}$ pulses. It also ends the $\overline{\text{TBUSY}}$ signal.

The $\overline{\text{FPAUSE}}$ signal is an output of TC-2. Its purpose is to disable the Timer circuit when the X Register in TC-2 resets from 1023 back to 0. Here it is used to generate the pause required for proper operation of the LF/CR circuit when used with a clocked interface. It does not cause the $\overline{\text{STEP ENABLE}}$ signal to go low. It simply stops the counting sequence for approximately 0.5 ms.

Terminal Busy. Any of the following functions will cause $\overline{\text{TBUSY}}$ to go active low: when an alphanumeric character is being generated ($\overline{\text{CIP}}$); when a $\overline{\text{BEL}}$ command is present; when a Hard Copy is being generated ($\overline{\text{MAKE COPY}}$ and $\overline{\text{DRBUSY}}$); and when the $\overline{\text{TIMER PRESET}}$ output of the Timer is high. (TIMER PRESET is active for various periods of time after occurrence of $\overline{\text{US}}$, $\overline{\text{VT}}$, $\overline{\text{LOXE}}$, BS, HT, $\overline{\text{CHAR COMP}}$, $\overline{\text{LF}}$ and CR.)

Automatic Carriage Return/Line Feed. When the Control Character Decoder outputs an $\overline{\text{LF}}$ signal, the Auto CR/LF circuit will, in turn, output an $\overline{\text{LF}}$ signal to the Pulse Shaper and Direction Latch circuits to cause the Line Feed to occur. Notice that the control character signal $\overline{\text{CR}}$ also inputs to this circuit. This signal is inverted and outputs on the CR line. The Auto CR/LF circuit can be strapped (see Strappable Options section of the manual) to generate both an LF and a CR signal when $\overline{\text{LF}}$ goes active.

The $\overline{\text{EOL}}$ (End of Line) input (from TC-2) activates a line feed when spacing past the end of the line. An active SUPPRESS signal from the Alpha Cursor Suppress circuit inhibits the operation of the automatic CR/LF circuit during Graph and GIN Modes.

Vector Enable. Circuitry within the Vector Enable circuit keeps the VECTOR ENABLE signal to U245A low for the first vector following GS. This is known as a "Dark Vector". With the receipt of the next vector, the $\overline{\text{LOXE}}$ signal causes the Vector Enable circuit to set the VECTOR ENABLE signal high. VECTOR ENABLE provides an enabling voltage to one side of Vector Enable Gate U245A. The $\overline{\text{LOXE}}$ signal also inputs to the Timer to preset the inputs for a 2.6 ms pause. The $\overline{\text{LOAD}}$ signal then sets the TIMER PRESET line to U245A high. U245A sends a low $\overline{\text{DRAW}}$ signal to the Z Axis circuit. This action sets the $\overline{\text{Z}}$ signal low to draw the vector. 2.6 ms later, the TIMER PRESET line goes low, disabling the Z Axis circuit.

Z Axis. The Z Axis circuitry enables or disables the $\overline{\text{Z}}$ signal. $\overline{\text{Z}}$ is an active low signal that is used to turn the writing beam on. The effect that $\overline{\text{DRAW}}$, $\overline{\text{TOP ROW SUPPRESS}}$, $\overline{\text{WRITE DOT}}$, and $\overline{\text{REFRESH}}$ have upon Z Axis operation is described in the block from which they originate.

Bell. When the control character BEL is received, $\overline{\text{BEL}}$ goes low from the Control Character Decoder. It enters the Bell and Terminal Busy circuits. The pulse generates $\overline{\text{TBUSY}}$ for the duration of the $\overline{\text{BEL}}$ command. In the Bell circuit, the $\overline{\text{Q}}$ output of a one-shot multivibrator is enabled for approximately 300 ms, during which time a 1200 Hz output from the Timer is applied to the speaker. Note that the Terminal is not held busy during speaker output.

View/Hold. The purpose of the View/Hold circuit is to prolong the life of the display tube. In the Alpha Mode, as long as data is being entered into the Terminal, the VIEW signal is high, allowing data to be displayed. However, if no new data is entered for a period of about 90 seconds, the VIEW signal becomes modulated by a combination of 75, 150 and 300 Hz signals from the Timer. This action provides a 12 1/2% duty time for the VIEW signal, thus dimming the display. This is know as "Hold" status. The display can be returned to normal viewing level by entering new data, or by pressing the SHIFT key. SUPPRESS and CARRY must both be low before Hold status can occur.

Notice that this circuit inputs a signal called VIEW to the Cursor Refresher circuit. When the 90 second VIEW period elapses, VIEW' goes low to inhibit the Alpha cursor during the time the Terminal is in Hold.

If either the $\overline{\text{GRAF}}$, $\overline{\text{GIN}}$, $\overline{\text{DRBUSY}}$, or $\overline{\text{TERM STB}}$ signals go active, the SUPPRESS signal from the Alpha Cursor Suppress circuit goes high. This keeps the view signal active while SUPPRESS is high and for approximately 90 seconds thereafter.

Cursor Refresher. The Alpha cursor is a pulsating display of a 7 X 9 dot matrix. When the Terminal is in the Alpha Mode, the Character Generator continuously cycles through the character dot matrix. If no character is being written and VIEW' is high, the 5 Hz, 37 Hz and 154 kHz timing pulses combine to cause the $\overline{\text{REFRESH}}$ signal to clock the Z line. The CARRY signal causes the $\overline{\text{Z}}$ pulses to be inhibited one matrix out of every two. In addition, the COLUMN Ø signal and the WRITE DOT signal combine to prevent writing the COLUMN Ø and row Ø through 6 positions.

When a character is received, $\overline{\text{TERM STB}}$ resets the Cursor Refresher, which becomes inhibited until the character is written and CARRY pulses high.

SUPPRESS goes high during GRAPH and GIN modes to hold the Cursor Refresher disabled during those times.

A conceptual drawing of the $\overline{\text{Z}}$ output pulses during Alpha cursor writing appears in Fig. 6-14.

Defocus. The Defocus circuit generates the $\overline{\text{FUZZ}}$ signal, which goes high during character generation, Graph Mode, and while making a hard copy, to provide optimum focus. In GIN Mode, and during Alpha cursor generation, $\overline{\text{FUZZ}}$ goes low to provide focus control of the crosshair and Alpha cursors, independent of character and vector focus.

Character Generator

General. The Character Generator performs several operations during character writing to provide the display screen with necessary information. The principal operations are:

1. Sequentially place the writing beam to each of 16 vertical positions (rows) in each of 8 horizontal positions (columns) to form a 16Y by 8X matrix in which is contained the 9Y by 7X character writing matrix. See Fig. 6-15 and 6-16.

2. Examine the Read Only Memory circuits at each position to see if a dot is to be written. (The dot information is dependent upon the character being executed.)

3. Turn the writing beam on at positions indicated by the ROM. The combination of written dots forms the character being written. See Fig. 6-15 and 6-16.

4. Generate a busy signal until character writing is complete.

5. Shift the matrix position up or down (or leave it unshifted) as required by the character being writen. Generally the operation is performed in the following manner. Refer to Figs. 6-13 and 6-16 as necessary.

(1) A writing character is strobed into the circuit.

(2) The circuit is preset to its starting point (row Ø column Ø). The dot information for column Ø, rows 7 through 15 is made available to the Dot Multiplexer on 9 separate lines. The Character Modifier circuit takes note of the shift information from the ROM. If the line is high, it indicates either a normal or subscript character. If the line is low, it indicates superscript or italics. Column 1 must be examined before final determination can be made, so the column Ø shift information is stored in a memory circuit. (No superscript information is contained in standard instrument ROMs.)

(3) The Row Counter steps through the 16 rows. Since no dot information ever appears in column Ø, no dots are written.

(4) The Column Counter shifts to column 1 and the X Axis is deflected to the next column. Its dot information is made available to the Dot Multiplexer on the row 7 through row 15 lines. The column 1 shift information is also made available to the Character Modifier. If a high signal exists, it indicates either a normal or italic character; if low, it indicates either a superscript or a subscript. This is compared against the column Ø memory and the circuit is influenced accordingly. (If column Ø says normal or subscript and column 1 says normal or italic, normal prevails.)

(5) The Row Counter steps through from row Ø to row 6 while the circuitry settles. Although beam deflection takes place, no dot writing can occur, since beam unblanking is inhibited. The Row Counter continues to step through row 7 through row 15. If any dots are indicated by the row 7 through 15 lines from the ROM, they permit a dot to be written when the counter reaches their position.

(6) After stepping through column 1 row 15, the Column Counter is advanced to column 2 and the Row Counter to row Ø. Column 2 dot information is now made available on the row 7 through 15 lines from the ROM, and shift information continues to be made available to the Character Modifier circuit. (The column 2 shift information is always the same as the column 1 shift information, as is the shift information in columns 3 through 7.)

(7) The operation continues in like manner, stepping through all columns until column 7 has been scanned and writing is complete.

(8) The Cursor Refresher circuit then becomes enabled. The Column and Row Counters continue to cycle, and each dot in row 7 through 15 of column 1 through 7 is written (as previously described) until another writing character is received, or Hold status occurs, or another operating mode is selected.

The following principle circuits make up the Character Generator.

ROM A, ROM B—ROM A and ROM B provide character writing information for all writing characters in the ASCII code. The selected ROM is programmed by the character being processed ($\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$). (ROM C is not installed in this instrument.)

ROM Selector—Selects either ROM A or ROM B.

Character Status—Activates the generation of a character. Sets $\overline{\text{TBUSY}}$ active; completes the character generation process by sending a signal to the Format Effector to space to the next character position.

ROW Counter—Cycles through 16 binary counts at each column selection; its output causes the CRT beam to deflect in the Y direction; it also causes the ROM Dot Multiplexer to sequentially examine the dot writing information being emitted by the selected ROM.

Column Counter—Sequentially selects column 0 through 7, causing the CRT beam to deflect in the X direction; selects the appropriate column information from the selected ROM.

Character Modifier—Provides character modifying signals to the X Mat Digital-to-Analog and Y Mat Digital-to-Analog circuits to establish normal italics, subscript, or superscript writing. (Superscript does not occur in this instrument.)

Write Dot—Provides write dot information pulses to control the Z Axis circuit.

Dot Multiplexer—Sequentially examines the dot information from the ROM as the Row Counter steps through the rows. The Write Dot output is dependent upon the ROM outputs and controls the Z Axis writing via the Write Dot circuit.

Suppress—Momentarily generates the SUPPRESS signal after $\overline{\text{TSTROBE}}$ in Alpha Mode to reset circuits. Continuously generates SUPPRESS in GIN or Graph Modes to do the following: prevent $\overline{\text{EOL}}$ from causing line feeds; hold Terminal in View status; disable Character Generator, hold Matrix Generator output (X MAT, Y MAT) in a reference position.

Data Latches—Latches character bits into the Character Generator.

Y Matrix Digital-to-Analog—Converts the digital output of the Row Counter into its analog equivalent for display beam positioning.

X Matrix Digital-to-Analog—Converts the digital output of the Column Counter into its equivalent analog voltage for display beam positioning.

Column Reset—Resets the Column Counter to column 0 of the character matrix.

GIN Echoplex Suppression—Inhibits character generation.

Selecting the ROM. The Character Generator produces the full ASCII writing character set by using two selectable Read Only Memory (ROM) devices, ROM A and ROM B. If a third ROM (ROM C) is installed to produce an alternate character set, it can also be selected if the CHAR SET SELECT option strap is at AB + BC. This instrument does not use this feature. The CHAR SET SELECT strap is left at AB and ROM C is not installed.

Refer to the TC-1 Block Diagram. Four inputs to the ROM Selector control ROM selection by sending a high to enable the desired ROM. The input signals are $\overline{\text{CIP}}$ (Character in Progress), BIT 6, BIT 7 and ASCII, and they control selection in accordance with Table 6-2.

Note that ROM selection is inhibited when the most significant input ($\overline{\text{CIP}}$) is high (inactive). $\overline{\text{CIP}}$ enables the ROM selector only when a character is being generated, enabling ROM selection in accordance with the three least significant inputs.

Presetting the Character Generator. When the data bits for a character are received by the Terminal, $\overline{\text{TSTROBE}}$ activates the $\overline{\text{TERM STB}}$ signal. $\overline{\text{TERM STB}}$ causes the Column Reset circuit to output a $\overline{\text{COLUMN RESET}}$ pulse that sets the Column Counter to zero.

When $\overline{\text{TERM STB}}$ goes active, it causes the Strobe Decoder to output an active $\overline{\text{ALPHA STB}}$ signal. This signal loads $\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$ into the Data Latches to make them available to the Character Generator circuitry. $\overline{\text{ALPHA STB}}$ also causes the Character Status circuit to set the $\overline{\text{CIP}}$ signal active. Its complement, CIP, goes high and enters the Character Modifier and Write Dot circuits. With $\overline{CIP}$ active, the ROM Selector can select the appropriate ROM device as per the ASCII, BIT 6 and BIT 7 inputs. $\overline{CIP}$ also enters the Terminal Busy circuit, causing $\overline{TBUSY}$ to remain active during the writing of a character (approximately 860 microseconds).

TABLE 6-2

ROM SELECTOR TRUTH TABLE

INPUTS				ROM SELECTED		
CIP	**ASCII**	**BIT 7**	**BIT 6**	**ROM A**	**ROM B**	**ROM C**
0	0	0	0	0	0	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	0	1	0
0	1	0	0	0	0	0
0	1	0	1	0	0	1
0	1	1	0	0	1	0
0	1	1	1	0	0	1
1	0	0	0	0	0	0

Notice that the $\overline{ALPHA\ STB}$ signal enters the Row Counter circuit. In this circuit it provides a clear function, setting the binary-coded-decimal outputs of the Row Counter low. The low-going outputs of the Row Counter cause the Address Read signal to go active. Address Read causes the output of the Column Counter to be loaded into the ROMs, selecting the column Ø dot information. The low-going outputs of the Row Counter also cause the Y MAT signal to deflect the writing beam up to the top of the matrix.

When $\overline{TSTROBE}$ ends, so does $\overline{TERM\ STB}$ and $\overline{ALPHA\ STB}$. The next negative-going edge of the 1.25 MHz square wave causes the Column Reset signal to go inactive. The Row Counter circuit begins counting on the next trailing edge of the 154 kHz clock pulse.

Scanning the Character Matrix. After the Row Counter outputs are cleared to zero and $\overline{ALPHA\ STB}$ goes inactive, the Row Counter can begin counting. The Row Counter counts 7 consecutive times before the Dot Multiplexer begins sampling dot information contained in the ROMs. (No Write Dot information is contained in column Ø.) The seventh through fifteenth counts result in the Dot Multiplexer's sampling the dot information for each row in the writing matrix.

After the Row Counter clocks through the nine dot positions of the first column, the next 153 kHz clock pulse causes the Row Counter outputs to once again go low, setting the Y MAT signal to row Ø position. The low-going edge of the Row 8 output clocks the Column Counter, causing its output to select column 1 of the addressed character. The X Matrix Digital-to-Analog circuit output (X MAT) changes to reflect the beam's new horizontal position. When the outputs of the Row Counter went low, they caused the output of the Y Matrix Digital-to-Analog to shift the writing beam up to row Ø position. However, because of the frequency response of the beam deflection circuits, the writing beam cannot position from the bottom of one column to the top of the next column as rapidly as the Counters can indicate this new position. Therefore, beam settling time is provided by not using row Ø through 6 for dot writing. Row 7 through 15 selections cause the Multiplexer to examine the dot information from the ROMs as before. Since column 1 is now selected, dot writing commands can be expected for any character writing that requires a dot (or dots) in column 1. (See Fig. 6-16.) The $\overline{\text{FUZZ}}$ and CIP signals enable the Write Dot circuit during character writing.

The 154 kHz clock negative edge that causes row counting also starts a Multivibrator in the Write Dot circuit. The Multivibrator output pulse duration can be adjusted by R95 Character Brightness, and performs two functions. It allows the circuitry to settle down while and after the Row Counter moves to a new row, and controls dot writing time. If the multiplexer discloses that a dot is to be written, a Write Dot pulse is sent to the Z Axis circuit, ending on the next negative transition of the 154 kHz clock.

Refer once again to Fig. 6-16 and notice that the letter "I" is shown in the matrix. Nine clock pulses provide nine successive $\overline{\text{WRITE DOT}}$ pulses to the Z Axis circuit when scanning column 1. The Z Axis signal is turned on and off to write the dots as the Row Counter steps through all rows in column 1, with the Y MAT changing the beam to each new position.

When the row count once again switches from 15 to Ø, the Row 8 line once again clocks the Column Counter, causing its output to indicate column 2. The new column code, in combination with the active Address Read signal, selects column 2 dot information from the ROM. The scanning sequence repeats itself until all seven columns of the character have been scanned and the remaining Character dots written.

Resetting the Character Generator. When the Row Counter counts past the row 15 dot of column 7, the low-going Row 8 line clocks the Column Counter once more. This time the column outputs (COL 1, 2, 4) go low, and a signal called CARRY goes high. CARRY actually signifies a binary count of 8 from the Column Counter. It inputs to the Character Status circuit to generate the $\overline{\text{CHAR COMP}}$ (Character Complete) signal. $\overline{\text{CHAR COMP}}$ enters the Pulse Shaper circuit, where it causes the Format Effector circuitry to advance the display beam one character space.

The CARRY signal also enters the Column Reset circuit. Here it causes the $\overline{\text{COLUMN RESET}}$ signal to go active on the next trailing edge of the 1.25 MHz clock. $\overline{\text{COLUMN RESET}}$ clears the Column Counter, terminating the CARRY signal. When CARRY goes low, $\overline{\text{CIP}}$ (that is holding the Terminal busy) ends. Its complement (CIP) also ends, inhibiting the Write Dot circuitry. The $\overline{\text{CHAR COMP}}$ signal also ends, completing the resetting of the Character Generator.

GIN Echoplex Suppress Circuit. When either the GIN or the Graph Mode is selected, the $\overline{\text{CGSUP}}$ and $\overline{\text{CURSOR INH}}$ outputs of the Echoplex Suppress circuit becomes active. The $\overline{\text{CGSUP}}$ signal's purpose is to prevent the Character Status circuit from responding to the $\overline{\text{ALPHA STB}}$ signal in GIN and Graph Modes. The $\overline{\text{CURSOR INH}}$ signal also inputs to the Character Modifier circuit, where it causes the COL Ø signal to go high which prevents the Cursor Refresher circuit from refreshing the Alpha cursor during GIN or Graph Modes.

$\overline{\text{GIN}}$ pulses low in response to the $\overline{\text{GS}}$ which initiates Graph Mode, or goes low and stays low in GIN Mode. In either case, a flip flop causes the afore-mentioned active outputs. These outputs are reset inactive by the $\overline{\text{LOCAL}}$ and $\overline{\text{TBUSY}}$ signals. $\overline{\text{TBUSY}}$ occurs automatically when switching from Graph to Alpha Mode. However, $\overline{\text{TBUSY}}$ does not automatically occur as explained in the operation information in this manual.

Rubout Detector Circuit. When the data input lines contain the code for the Rubout (DEL) character, the Rubout Detector activates a low-going $\overline{\text{SUP DEL}}$ (Suppress Delete) signal. $\overline{\text{SUP DEL}}$ inhibits the $\overline{\text{CHAR COMP}}$ output of the Character Status circuit. This prevents the Format Effector from spacing to the next character space when the Delete character is detected.

Suppress in Graph Mode. During Graph Mode, or when making a copy of the display, the SUPPRESS signal is active. It loads preset inputs into the Row and Column Counters. The Preset input selects row 16 for the Row Counter and Column 1 for the Column Counter. These cause X MAT and Y MAT to select the bottom left corner of the character writing matrix.

Character Modifier Circuit. This circuit generates the following X and Y Digital-to-Analog Matrix modifier signals: SUB (for Subscript), $\overline{\text{SUP}}$ (for Superscript), and $\overline{\text{ITAL}}$ (for Italics). These signals are dependent on the $\overline{\text{DOT}}$ shift information from the selected ROM, which is, in turn, dependent upon the Character Input. ($\overline{\text{SUP}}$ and $\overline{\text{ITAL}}$ are not generated in this instrument.)

The Character Modifier circuit becomes enabled by the $\overline{\text{CIP}}$ signal from the Character Status circuit. Its complement, CIP, clears the outputs of the Character Modifier so that each new character received can determine the output.

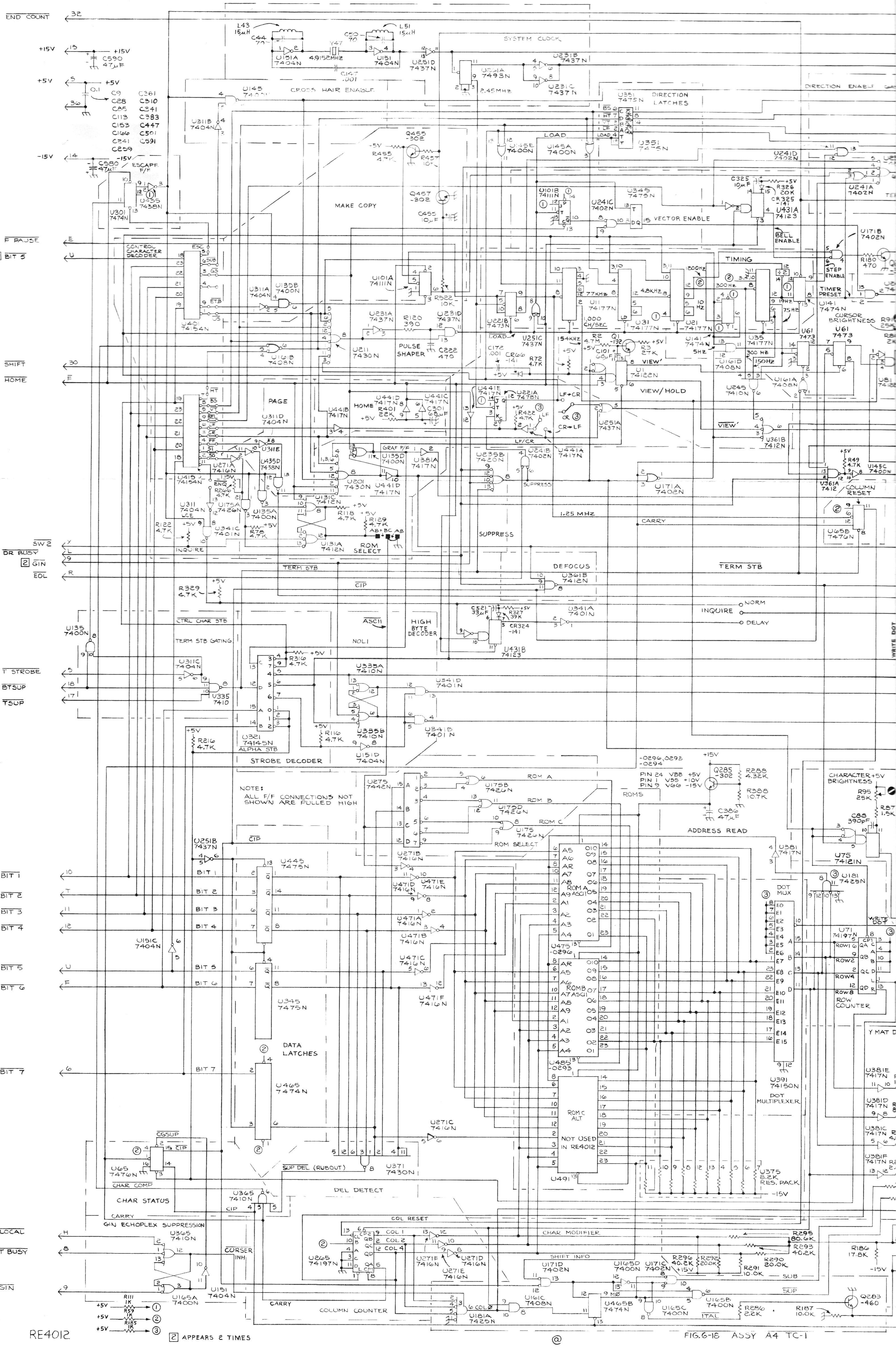
When a character is received and the Column Counter is cleared by the $\overline{\text{COLUMN RESET}}$ signal, the Character Modifier senses the low state of the COL 1, 2, 4 output lines of the Column Counter. When Row 8 is reached by the Row Counter, the positive going Row 8 output of the Row Counter (in conjunction with the column Ø detected output of the Column Counter) clocks the column Ø Shift Information into a memory in the Character Modifier circuit. When column Ø is completely scanned, the Row 8 output from the Row Counter goes low and clocks the Column Counter, addressing column 1. The column 1 shift information from the ROM is immediately felt at the Character Modifier input, where it is compared against the stored column Ø shift information. The comparison results in an output on the SUB, $\overline{\text{SUP}}$, or $\overline{\text{ITAL}}$ line if shifting is to occur, or it results in those three lines remaining inactive if no shifting is indicated. The shift information in Column 2 through 7 is identical to the column 1 shift information, maintaining the same shift instructions throughout writing of a character. The combinations of shift information signals required to activate the various shift conditions are as shown in Table 6-3.

SUB goes true whenever ASCII lower-case characters g, j, p, q, and y are detected. It causes the Y MAT signal to shift the writing matrix down slightly, writing the tails of the characters below the alphanumeric baseline.

TABLE 6-3

Writing Selection

Column 0 Shift Info.	Columns 1—7 Shift Info.	Signal Activated	Writing Selected
LOW	LOW	SUP	Superscript
LOW	HIGH	ITAL	Italics
HIGH	LOW	SUB	Subscript
HIGH	HIGH	Normal	Normal



RE4012

[2] APPEARS 2 TIMES

FIG. 6-18 ASSY A4 TC-1

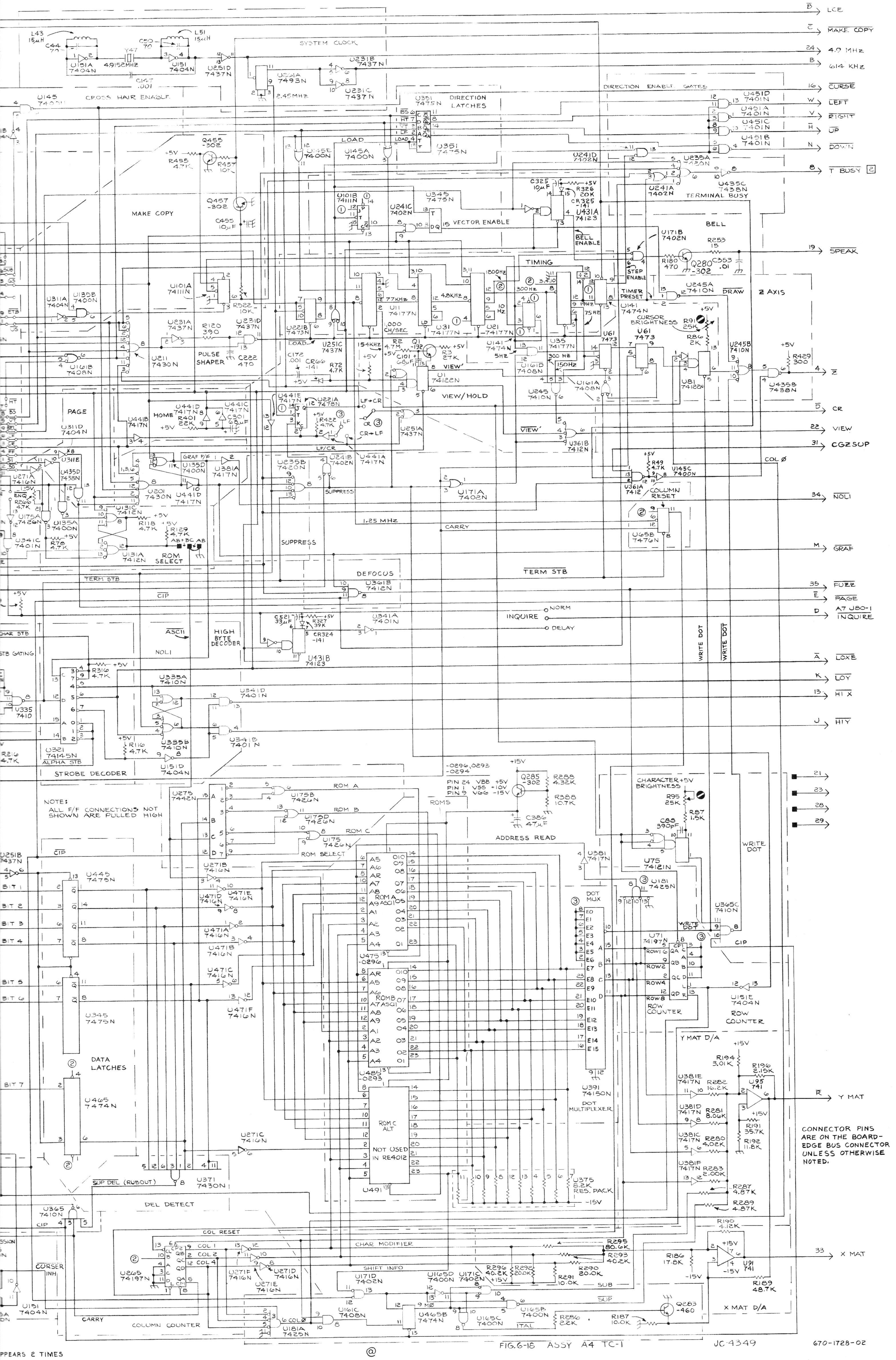


FIG. 6-18 ASSY A4 TC-1

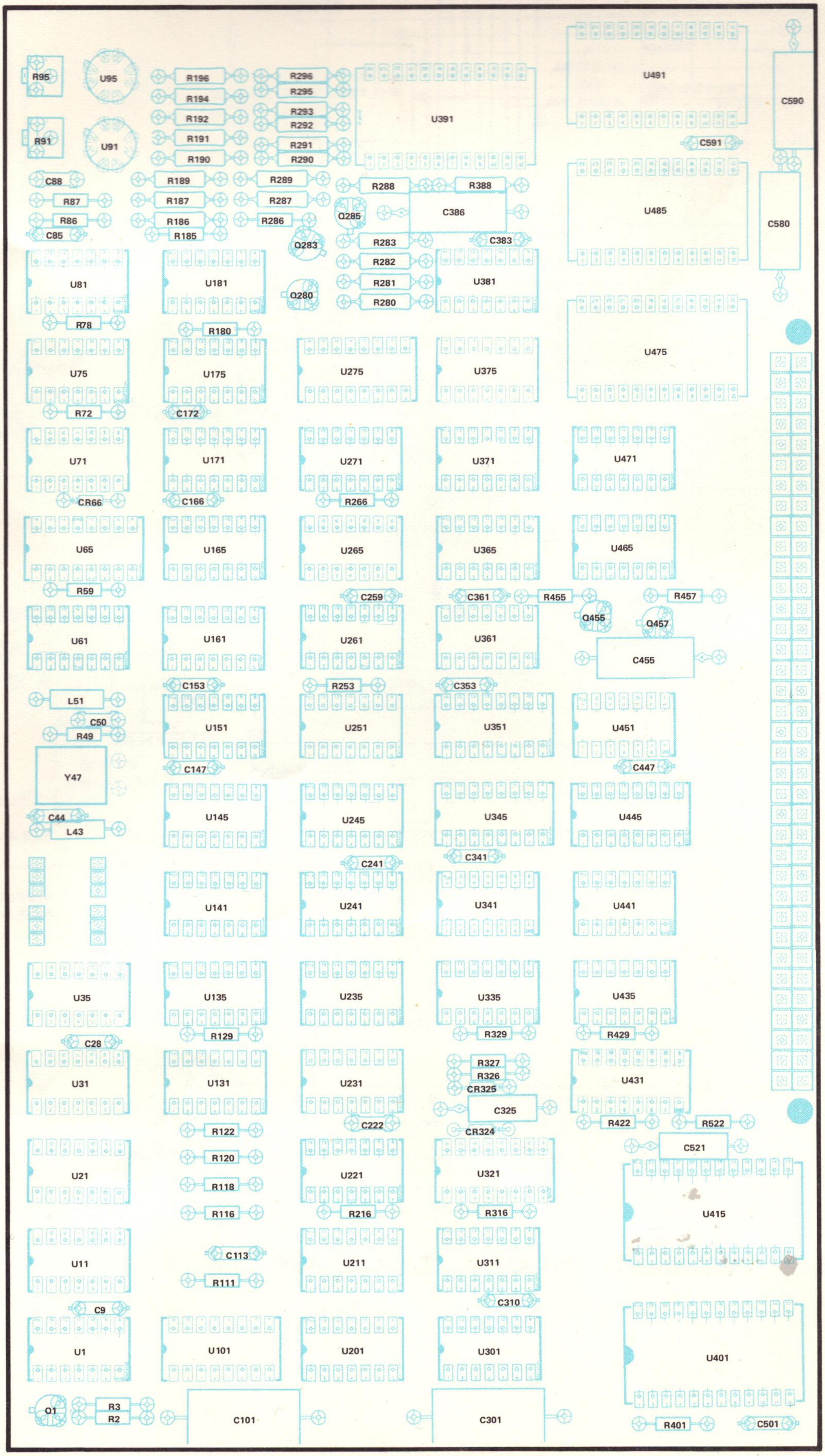
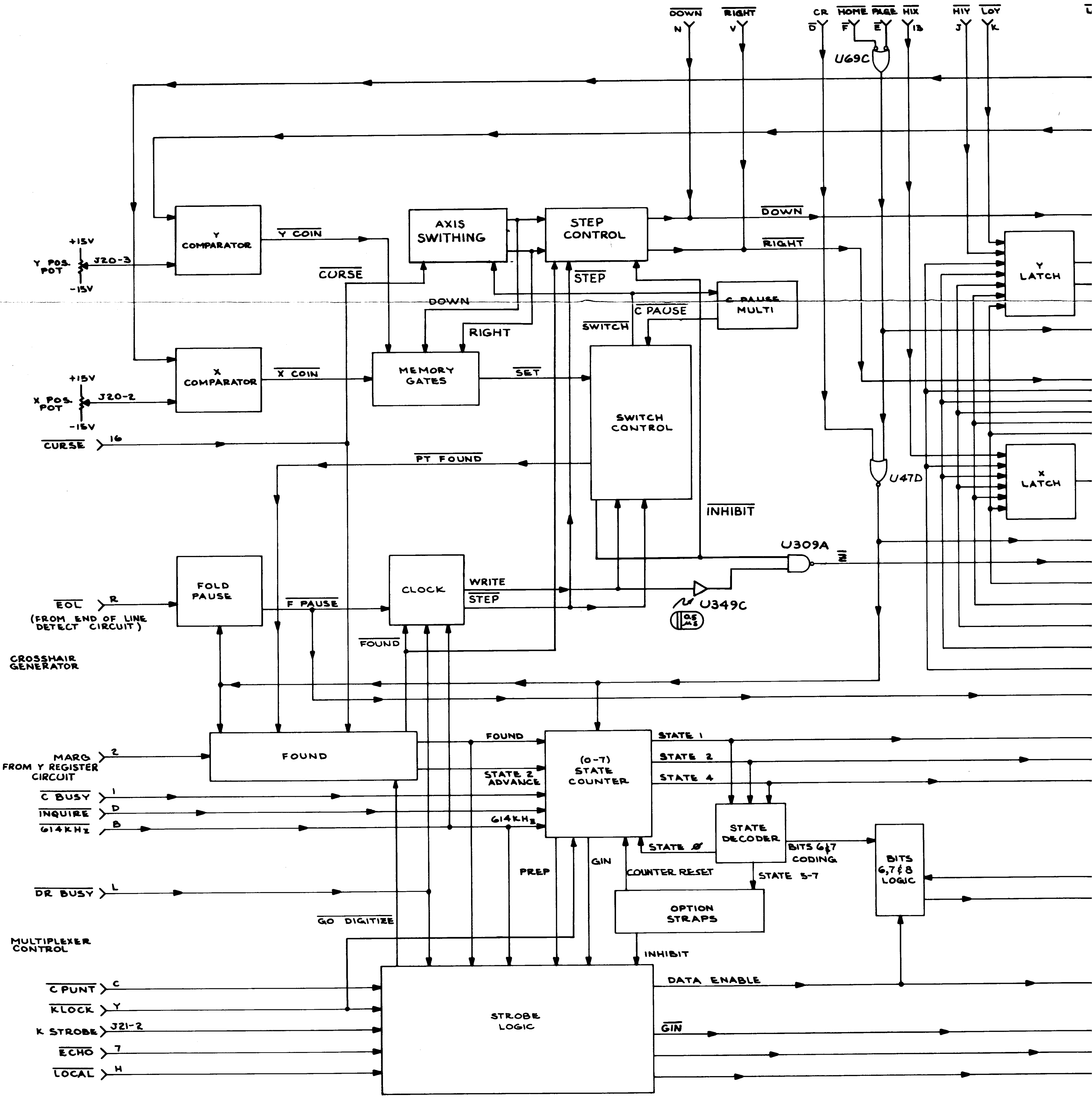


Fig. 6-17. TC-1 component locations.



DOWN
RIGHT
CR
HOME
PAGE
HIX
HIY
LOY
N
V
D
F
E
13
J
K
U69C
Y COMPARATOR
Y COIN
AXIS SWITHING
STEP CONTROL
DOWN
RIGHT
Y LATCH
+15V
Y POS. POT
J20-3
-15V
CURSE
STEP
DOWN
C PAUSE MULTI
C PAUSE
SWITCH
RIGHT
X COMPARATOR
X COIN
MEMORY GATES
SET
SWITCH CONTROL
+15V
X POS. POT
J20-2
-15V
CURSE
16
PT FOUND
U47D
X LATCH
INHIBIT
U309A
FOLD PAUSE
CLOCK
WRITE
STEP
U349C
EOL
R
(FROM END OF LINE DETECT CIRCUIT)
F PAUSE
FOUND
CROSSHAIR GENERATOR
MARG
2
FROM Y REGISTER CIRCUIT
FOUND
FOUND
(0-7) STATE COUNTER
STATE 1
STATE 2
STATE 4
STATE 2 ADVANCE
C BUSY
1
INQUIRE
D
614KHz
B
614KHz
STATE DECODER
BITS 6&7 CODING
BITS 6,7&8 LOGIC
STATE Ø
PREP
GIN
COUNTER RESET
STATE 5-7
DR BUSY
L
OPTION STRAPS
GO DIGITIZE
MULTIPLEXER CONTROL
INHIBIT
DATA ENABLE
C PUNT
C
KLOCK
Y
K STROBE
J21-2
ECHO
7
LOCAL
H
STROBE LOGIC
GIN

RE 4012

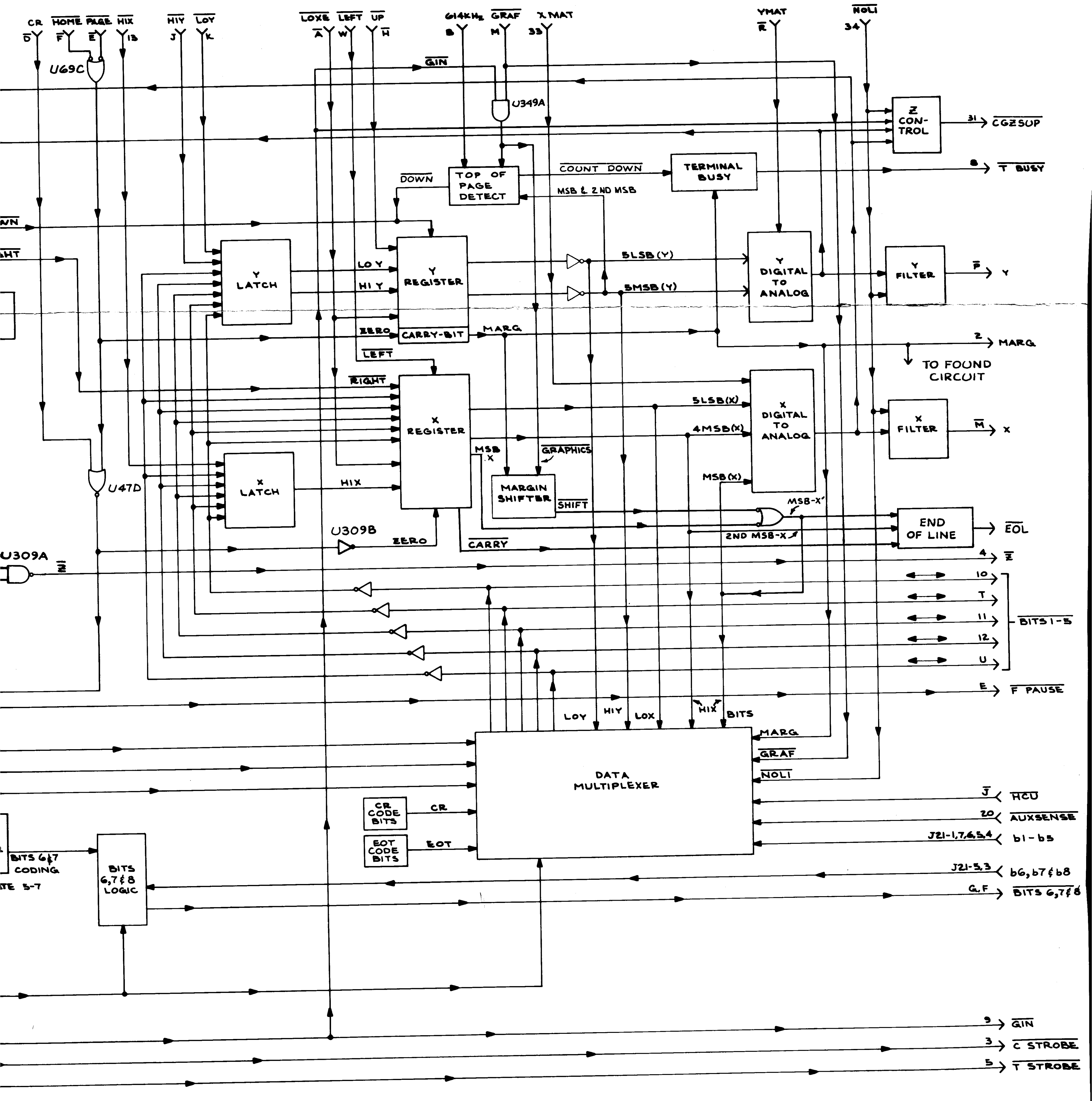


FIG. 6-19 TC-2 DETAILED BLOCK DIAGRAM

TC-2 BLOCK DIAGRAM DESCRIPTION

Introduction

Refer to Fig. 6-19. As in the case of TC-1, TC-2 can be divided into blocks that perform specific functions. When possible, each block will be described as a separate entity. However, in some cases, it is difficult to obtain an over-view of circuit operation by discussing an individual block; in such cases, groups of blocks are described in a sequence of operations (such as those needed to generate the crosshair cursor).

Below is a list of blocks that contain the greater part of TC-2 circuitry. A short description of each is given.

X Latch, Y Latch—data latches used when operating in the Graphic Plot Mode; provide storage for three 5-bit bytes of the 20-bit coordinate address.

X and Y Registers—each register contains three 4-bit up-down counters, whose 10 bits of output data can be set by serial or parallel inputs.

Top-of-Page Detect Circuit—in the Alpha Mode, this circuit keeps the display beam in the viewable area of the Y Axis.

Margin Shifter—sets Margin Ø (left side of Display) or Margin 1 (center of Display).

End of Line—Detects when X register has stepped past last register position, and outputs EOL in response thereto.

Terminal Busy—places the Terminal in a "busy" condition, inhibiting the placing of data on the minibus by the keyboard, computer, or any other device that might be connected to the minibus.

Z Control Circuit—Controls vector intensity when vectors less than approximately one-half inch long are being drawn.

X and Y Digital-to-Analog (D/A) Circuits—convert the digital outputs of the X and Y Registers into their equivalent analog voltage.

X and Y Filters—in the Graphic Plot Mode, these circuits provide a linear rate of change for the X and Y signals. These circuits have no effect on the D/A outputs in Alpha Mode.

Data Multiplexer—depending upon the output of the Multiplexer Control circuit, the Data Multiplexer will place one of eight data bytes onto the minibus.

Strobe Logic—provides a signal that enables the Data Multiplexer to place the data bytes onto the minibus; also provides strobe signals to enable the computer and/or the Terminal to accept and process data.

Bits 6, 7 and 8 Logic—places the complement of keyboard bits 6, 7 and 8 onto their respective minibus data lines; also codes $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$ with each 5-bit byte of data from the Data Multiplexer when operating in the GIN Mode.

Multiplexer Control—controls the output of the Data Multiplexer; also inputs various signals to the Strobe Logic circuit to aid in the generation of the strobe signals, and aid in the digitization of the voltage from the X and Y Position Pots.

Crosshair Generator Circuitry—generates the crosshair cursor by sending a sequence of pulses that increment the X and Y Registers. With each register increment, a Z Axis pulse is generated to refresh the point. Rapidly counting through the Registers provides a crosshair-type cursor, bright enough to be visible, yet dim enough so as not to store.

Block Description

X and Y Latches. The X Latch and Y Latch are used in the Graph Mode to provide storage for three of the coordinate address bytes. In this mode of operation, data is sent from the computer to draw graphics (charts, figures, etc.) on the Display screen. It takes twenty bits of data to establish a new coordinate address. However, only seven bits of data are accepted from the computer at any one time; therefore each coordinate address is divided into 4 seven-bit bytes. Two of the bits contain code data, and are used to develop load signals ($\overline{\text{HIY}}$, $\overline{\text{LOY}}$, $\overline{\text{HIX}}$, and $\overline{\text{LOXE}}$) on TC-1. The $\overline{\text{HIY}}$, $\overline{\text{LOY}}$, and $\overline{\text{HIX}}$ signals load their respective 5 bits of coordinate data into the appropriate Y or X latches. The High Order Y bits must be received first. The $\overline{\text{HIY}}$ signal decoded from the two most significant code bits loads the remaining five data bits into the five Most Significant Bit (MSB) portion of the Y Data Latch. In like manner, the Low Order Y and High Order X bits are loaded into their respective latches. When the fourth byte (low Order X) is received from the computer, $\overline{\text{LOXE}}$ parallel loads all 20 bits into the X and Y Registers. Notice that no storage is needed for the Low Order X inputs because they accompany the $\overline{\text{LOXE}}$ signal and are loaded directly into the registers.

X Register. The X Register is a ten-bit, up-down counter. It is serially operated in Alpha Mode by the $\overline{\text{LEFT}}$ and $\overline{\text{RIGHT}}$ signals, and in GIN Mode by the $\overline{\text{RIGHT}}$ signal. Each low-going $\overline{\text{LEFT}}$ or $\overline{\text{RIGHT}}$ signal will decrement or increment the output one count. It can be parallel loaded by the ten parallel inputs that contain the X coordinate address in Graph Mode operation. The 10 output bits provide a count from 0 to 1023, permitting the display to be positioned to any one of 1024 separate locations (Tekpoints) in the X Axis.

The CR (Carriage Return), HOME, or PAGE signal can reset the X Register to zero. HOME goes active when Terminal power is initialized or when the Reset key is pressed. PAGE goes active when the Page key is pressed, or control character sequence ESC FF is received by the Terminal.

Y Register and Top-of-Page Detect. Similar to the X Register, the Y Register is serially operated by UP or DOWN, or is parallel loaded by receiving 10 bits of data from the Y Latch. This register is also capable of outputting a count of 0 to 1023. All 1024 of the X Register's Tekpoints are viewable. In the Y Axis, only 780 of the 1024 Tekpoints are viewable. When a PAGE or HOME signal zeroes the Y Register, inverters cause the register zeroing to be accepted as a 1023 count and the beam is positioned off the top of the screen. Since Page and Home reset Alpha Mode, a Top-of-Page Detect circuit becomes active as soon as the HOME or PAGE signal ends to reset the beam to home position at the top-left in the viewing area.

When the Y Register is zeroed by PAGE or HOME, the outputs from the inverters go high, positioning the display beam off-screen at a count of 1023. The two most significant bits (MSB and 2nd MSB) from the inverters are sensed by the Top-of-Page Detect circuit. When both go high, the Top-of-Page Detect circuit places the 614 kHz square wave on the DOWN line, and immediately the display beam begins moving in the down direction. When the count from the Y Register has incremented 256 counts, the 2nd MSB goes low, inhibiting the Top-of-Page Detect circuit and removing the 614 kHz signal from the DOWN line. Thus, the count is stopped at 767 (1023 minus 256 = 767). Notice that incrementing the Y Register results in decrementing the position count. This is true because of the inverters on the output lines.

The MARG signal output is actually an eleventh bit of the Y Register. When the Register decrements one point past the Ø Tekpoint position, MARG goes high while the inverter outputs return the beam to the 1023Y Tekpoint position. When the Y Register again decrements through the Ø Tekpoint position (or when reset by Home or Page), MARG returns low. This signal inputs to the Terminal Busy, Multiplexer, Margin Shifter, and Found circuits (part of Crosshair Generator circuits). Its purpose can be found in the descriptions of each of those blocks.

Terminal Busy. This circuit operates only in Alpha Mode. When activated, it holds the Terminal in a "busy" condition. TBUSY goes active low when the COUNT DOWN signal from the Top-of-Page Detect circuit goes low. This action prevents the reception of data when the Register is counting down to the Home position. This circuit also contains a strappable option that works in conjunction with the MARG signal from the Y Counter. The hardware strap on TC-2 can be installed to make TBUSY go active when MARG is high. To clear the condition, the user must send the PAGE or HOME signals by pressing the PAGE or RESET keys (respectively) on the keyboard, or control character sequence ESC FF must be received by the Terminal. The condition is also cleared when sufficient line feeds are received to cause MARG to return low.

Margin Shifter. Margin 1 is set in the following manner. When in the Alpha Mode, both GIN and GRAF will be inactive and an inactive GRAPHICS signal is input to the Margin Shifter circuit. When MARG goes high, MARG and GRAPHICS combine to put a high on the SHIFT input to U259B. This enables the X D/A circuit to output a voltage level that corresponds to the center of the Display Screen. Repeated Carriage

Returns will not set the MSB-X' bit low as long as the MARG and $\overline{\text{GRAPHICS}}$ signals are high since MSB-X is over-ridden. $\overline{\text{PAGE}}$ or $\overline{\text{HOME}}$ will cancel Margin 1 by resetting the Y Register to zero.

End of Line. The combination of active MSB-X', 2nd MSB-X and CARRY signals create a momentary $\overline{\text{EOL}}$ signal which is used elsewhere to create a pause during register reset.

X and Y Digital-to-Analog (D/A) Circuits. These circuits convert the digital outputs of the Registers into their respective analog values. Both consist of a diode switching network. The D/A circuits cause a voltage change to occur at their outputs, dependent upon the logic state of the Registers. Notice also, that the X and Y Matrix signals (X MAT, Y MAT) from the Character Generator in TC-1 sum with the register outputs in their respective D/A circuits.

X and Y Filters. The outputs of the X and Y D/A circuits are input to their respective filters. When operating in the Alpha or GIN Mode, $\overline{\text{NOLI}}$ (No Linear Interpolation) will be low. This allows the X and Y analog voltages to pass directly through the circuit to minibus pins M and P.

The Filter circuits are put in use when drawing vectors in the Graph Mode. When the Graph Mode is set, $\overline{\text{NOLI}}$ goes high, activating linear filters within the circuits.

When $\overline{\text{LOXE}}$ simultaneously loads the 20 bits of data into the X and Y Registers, it causes an almost instantaneous change in voltage to occur at the outputs of the X and Y Digital-to-Analog circuits. This sudden change in voltage cannot be sent directly to the Display Amplifiers because the rate of change is non-linear. In other words, the vector drawn might be very fast at the start and very slow at the end, thus hardly storing at the beginning and storing very bright at the end; the vector probably will not be straight and may even over-shoot the defined end point. The filter network overcomes these problems. It provides a linear rate of change in the X and Y output voltages to feed the Deflection Amplifier circuitry.

Data Multiplexer. The Data Multiplexer selects data to be placed on the minibus, outputting five bits (one byte) of data at a time. There are 8 different bytes of data that the Multiplexer can place on the minibus. These include the keyboard bits (b1—b5), Terminal status bits, High Order X bits, Low Order X bits, High Order Y bits, Low Order Y bits, Carriage Return bits, and End of Transmission (EOT) bits. The type of byte being placed on the minibus depends on the output of the 0—7 State Counter circuit.

When data is being sent from the keyboard, the 0—7 State Counter is in its "0" state. This causes the multiplexer to place the complement of the 5 least significant bits of the keyboard character onto the minibus lines. Thus, for this type of operation, it acts as a keyboard to minibus interface. Keyboard data cannot be placed onto the minibus lines until the DATA ENABLE signal from the Strobe Logic circuit goes high. This happens when KSTROBE goes high. (More will be explained about KSTROBE in the description of the Strobe Logic circuit.) The other types of data bytes are used in the Graphic Input Mode, and will be covered in the descriptions of circuits to follow.

$\overline{\text{BIT 6}}$, $\overline{\text{BIT 7}}$, and $\overline{\text{BIT 8}}$ are placed on the minibus through a special gating network labeled BITS 6, 7, and 8 Logic. When data is being sent from the keyboard, the Step Counter is in State 0. This state allows the circuit to place the complements of keyboard bits 6, 7 and 8 on the minibus when the DATA ENABLE signal goes high, as explained for $\overline{\text{BIT 1}}$—$\overline{\text{BIT 5}}$. ($\overline{\text{BIT 8}}$ is always high or low as wired at the keyboard.)

Strobe Logic. This circuit mainly controls the various strobe signals associated with Terminal and/or computer operation. KSTROBE goes active high when data is entered from the keyboard. In response to KSTROBE, $\overline{\text{CSTROBE}}$ is generated when $\overline{\text{LOCAL}}$ is high; $\overline{\text{TSTROBE}}$ is generated when $\overline{\text{LOCAL}}$ or $\overline{\text{ECHO}}$ are low; both $\overline{\text{CSTROBE}}$ and $\overline{\text{TSTROBE}}$ are generated when $\overline{\text{LOCAL}}$ is high and $\overline{\text{ECHO}}$ is low. $\overline{\text{ECHO}}$ can be pulled low by a hardwire strap on the Interface card. $\overline{\text{LOCAL}}$ originates from the Local/Line switch on the keyboard. $\overline{\text{CSTROBE}}$ causes data to be sent to the computer; $\overline{\text{TSTROBE}}$ causes data to be executed by the Terminal. The DATA ENABLE signal goes high prior to and during $\overline{\text{TSTROBE}}$ or $\overline{\text{CSTROBE}}$ to allow the Data Multiplexer outputs and $\overline{\text{BIT 6}}$, $\overline{\text{BIT 7}}$, and $\overline{\text{BIT 8}}$ to be placed on the minibus.

$\overline{\text{KLOCK}}$ is normally held high on the minibus. Should the user ever have need to inhibit the keyboard, pulling $\overline{\text{KLOCK}}$ low will prevent KSTROBE from affecting the Strobe Logic circuit, thus providing a keyboard lock.

$\overline{\text{CPUNT}}$ is asserted by the Interface Card to prepare the Terminal for data reception from the computer. $\overline{\text{DRBUSY}}$ is asserted during hard copy making or during erase cycles, inhibiting the Strobe Logic circuitry until the operation is complete.

BITS 6, 7, and 8 Logic. When sending data from the keyboard, this circuit places the complements of keyboard bits b6, b7, and b8 onto their respective minibus lines. When operating in the Graphic Input Mode, coding signals from the State Decoder set $\overline{\text{BIT 6}}$ high and $\overline{\text{BIT 7}}$ low; $\overline{\text{BIT 8}}$ is arbitrary, being dependent upon the wiring connection of the Terminal keyboard.

Z Control. This circuit is used only in Graph Mode while drawing vectors. It is then enabled by a high $\overline{\text{NOLI}}$ signal. When $\overline{\text{LOXE}}$ initiates a vector, the circuit becomes armed and a 10 μs delay is initiated. If the vector being drawn is less than approximately one-half inch, the three clock pulses (307 kHz, 153 kHz, and 77 kHz) combine to hold $\overline{\text{CGZSUP}}$ low for 11.4 μs out of every 13 μs. The 1.6 μs pulses generated while $\overline{\text{CGZSUP}}$ is high cause dots to be written on the screen. These dots are close enough together to appear as a continuous line. If the vector being drawn is more than approximately one-half inch long, the X D/A or Y D/A signal is large enough to reset the circuit before the 10 μs delay elapses, preventing $\overline{\text{CGZSUP}}$ from going low. The beam is then permitted to be left on during vector drawing.

Crosshair Generator. The Crosshair Generator contains the circuitry needed to generate the crosshair cursor. Its purpose is to determine the digital equivalent of the voltages selected by the X & Y Position Pots, and set the X and Y Registers to that value. The crosshair cursor is generated by alternately incrementing the X Register and decrementing the Y Register. This alternately sweeps the display beam left-to-right and top-to-bottom on the CRT.

The Crosshair Generator is activated when $\overline{\text{CURSE}}$ goes active. $\overline{\text{CURSE}}$ inputs to the Found circuit and sets FOUND high and $\overline{\text{FOUND}}$ low. The high $\overline{\text{FOUND}}$ enables the Clock and the Step Control circuits. The Clock circuit starts sending $\overline{\text{STEP}}$ signals to the Step Control and Switch Control circuits, and sends WRITE signals to the Switch control and U349C circuits. The FOUND signal going low causes the 0—7 State Counter circuit to send GIN to the Strobe Logic circuit to output a low active $\overline{\text{GIN}}$ signal which inputs to U349A, thus inhibiting the Top-of-Page Detect and Margin Shifter circuits. The low FOUND signal into the Strobe Logic circuit inhibits the circuit from outputting erroneous point information. $\overline{\text{CURSE}}$ also presets the Axis Switching circuit to output a DOWN Pulse which causes the Step Control circuit to output a $\overline{\text{DOWN}}$ pulse each time the $\overline{\text{STEP}}$ output of the Clock circuit pulses low. Each time the DOWN line pulses low, the Y register decrements, causing the display beam to move down one Tekpoint. With each beam movement, the 77 kHz WRITE pulse initiates a slight delay, after which a $\overline{\text{Z}}$ signal writes (but does not store) the new point.

As the Y Register decrements and moves the display beam downward, the output from the Y D/A circuit changes accordingly and is monitored by the Y Comparator circuit in the Crosshair Generator. When the Y Register has decremented to the point where the voltage from the Y D/A equals, or slightly passes, the voltage from the Y Position Pot, the Y Comparator sends a low $\overline{\text{Y COIN}}$ (Y coincidence) signal to the Memory Gates. While the $\overline{\text{DOWN}}$ line is pulsing, the DOWN signal from the Axis Switching circuit to the Memory Gates is high. When $\overline{\text{Y COIN}}$ goes low, the Memory Gates output a low $\overline{\text{SET}}$ signal to the Switch Control circuit. The next positive-going edge of the $\overline{\text{STEP}}$ pulse clocks the low SET signal into the Switch Control circuit, causing the $\overline{\text{INHIBIT}}$ signal to U309A and the Step Control circuit to go low. This inhibits further $\overline{\text{DOWN}}$ and $\overline{\text{Z}}$ signals. On the next positive going WRITE pulse, the $\overline{\text{SWITCH}}$ signal goes high. When the positive portion of the WRITE pulse ends, the $\overline{\text{SWITCH}}$ signal goes low, putting a low on the DOWN line and a high on the RIGHT line.

At the same time $\overline{\text{SWITCH}}$ goes low, the $\overline{\text{INHIBIT}}$ signal to U309A and the Step Control Circuit goes high. Once again, STEP pulses go to the Step Control circuit. This time the $\overline{\text{RIGHT}}$ line is being pulsed because of the high on the RIGHT line. Again Z pulses follow each step after a brief delay.

$\overline{\text{RIGHT}}$ pulses continue until the X Digital to Analog voltage reaches or slightly passes the X Pot value. Then $\overline{\text{X COIN}}$ occurs, generates $\overline{\text{SET}}$, and causes the circuit to similarly switch back to $\overline{\text{DOWN}}$ pulses.

Foldover. Each time the X Register counts through 1023 to 0, the display beam repositions to the left side of the screen and $\overline{\text{SET}}$ returns high. The Register can reset much faster than the display beam can be positioned to the left. Therefore, the counting sequence is interrupted for a short period of time to allow the beam to position to the left and stabilize. When the X Register reaches a count of 1023 the Margin Shifter circuit outputs a low $\overline{\text{EOL}}$ (End of Line) signal. This signal is felt by the Fold Pause circuit in the Crosshair Generator. $\overline{\text{EOL}}$ triggers a one-shot multivibrator within the Fold Pause circuit, causing $\overline{\text{FPAUSE}}$ to go low for 0.5 ms. $\overline{\text{FPAUSE}}$ then inhibits the output of the Clock circuit, preventing further $\overline{\text{RIGHT}}$ pulses. When $\overline{\text{FPAUSE}}$ ends, the X Register continues to increment.

$\overline{\text{SET}}$ also returns high during Y foldover. However, no pause is needed, because the display beam is positioned off-screen when the Y Register resets from 0 to 1023. By the time the Y Register increments enough to bring the display beam into view, it has had adequate time to stabilize.

The above operation of the Crosshair Generator continues until the mode is changed or until the 0 to 7 State Counter is incremented.

Multiplexer Control and Digitization. The Crosshair Generator reflects the digital equivalent of the X and Y Position Pots at the outputs of the X and Y Registers. The process of obtaining the digital equivalent of the Position Pot voltages and sending this to the computer in digital form is known as "digitization". Digitization occurs in a set sequence that is controlled by the Multiplexer Control circuit.

To begin with, assume that the crosshair cursor is running as explained in the preceding description. The $\overline{\text{CURSE}}$ signal, which started the crosshair, also placed a low on the FOUND line to the 0 to 7 State Counter circuit, permitting it to advance on the trailing edge of $\overline{\text{CBUSY}}$ signals. The 0 to 7 State Counter output is at State 0. When it is decided to send the point at which the crosshairs intersect, the user strikes a keyboard key. This causes the keyboard bits to be placed on the minibus by the Multiplexer and sent to the computer (see Table 6-4). When the computer has finished receiving the keyboard data, $\overline{\text{CBUSY}}$ goes high. The next two negative-going transitions of the 614 kHz line advance the State Counter to State 1 and send a PREP pulse to the STROBE Logic circuit. The State Decoder circuit then outputs a low on the STATE line, feeding it back to hold the State Counter enabled.

TABLE 6-4

Data Multiplexer Output Control
(Pertains to each multiplexer device U51, U161, U159, U151, U59)

0—7 State Counter Status	Byte Being Transmitted	Multiplexer Input Control Line Status			Multiplexer Y Output (Pin 5) Controlled by
		C (Pin 9)	B (Pin 10)	A (Pin 11)	
0	Keyboard Character	0	0	0	D0 (Pin 4)
1	Terminal Status	0	0	1	D1 (Pin 3)
2	High X Bits	0	1	0	D2 (Pin 2)
3	Low X Bits	0	1	1	D3 (Pin 1)
4	High Y Bits	1	0	0	D4 (Pin 15)
5	Low Y Bits	1	0	1	D5 (Pin 14)
6	CR	1	1	0	D6 (Pin 13)
7	EOT	1	1	1	D7 (Pin 12)

The end of the PREP pulse causes the Strobe Logic to output a low $\overline{\text{GO DIGITIZE}}$ signal to the Found circuit. The next time the Crosshair Generator reaches coincidence, the Switch Control circuit sends a $\overline{\text{PT FOUND}}$ pulse to the Found circuit. The end of $\overline{\text{PT FOUND}}$ causes $\overline{\text{FOUND}}$ to go low, inhibiting the output of the Clock and stopping the count at the Coincidence Point. The outputs of the X and Y Registers then reflect the digital equivalent of the voltage selected by the Position Pots. The $\overline{\text{PT FOUND}}$ signal also causes STATE 2 ADVANCE to go low. The end of $\overline{\text{PT FOUND}}$ ends STATE 2 ADVANCE, advancing the State Counter to State 2. FOUND goes high at the same time, permitting GIN information output.

After PREP ends and the FOUND goes high, CSTROBE and DATA ENABLE from the Strobe Logic circuit will activate. With DATA ENABLE high and State 2 selected, the Multiplexer samples the 5 Most Significant Bits of the X Register (high Order X) and sends them along with $\overline{\text{BIT 6}}$, $\overline{\text{BIT 7}}$, and $\overline{\text{BIT 8}}$ to the computer. When the bits are received by the computer, $\overline{\text{CBUSY}}$ once again goes high advancing the State Counter to State 3 and again initiating CSTROBE and DATA ENABLE action. In turn, the Low Order X, High Order Y, and Low Order Y bits are sent to the computer. The State Counter has now advanced to State 5. At this point, if CR or EOT have not been selected for transmission (by option straps), a COUNTER RESET signal is sent to the 0 to 7 State Counter to return it to 0 and the action ends. If CR has been selected for transmission, the Counter advances to State 6 after the Low Order Y bits are accepted by the computer and $\overline{\text{CBUSY}}$ goes high. CR is strobed to the computer. Again, if EOT has not been selected for transmission, COUNTER RESET ends the action by setting the Counter to 0; otherwise, EOT is sent just as CR was, and the Counter advances to 0 to end the cycle.

The computer can request the coordinates of the crosshair cursor independent of the user. First it must send ESC plus SUB, causing $\overline{\text{CURSE}}$ to go low to initiate the Crosshair Generator. The computer can then send ESC plus ENQ, causing $\overline{\text{INQUIRE}}$ to pulse low, and the circuitry responds just as though $\overline{\text{CBUSY}}$ had been received after a keyboard character was sent, as previously described. However, a 20 millisecond delay must occur between ESC SUB and ESC ENQ in order for valid X Coordinate data to be generated. Provision for this delay is provided as a strap option on TC-1.

The computer can also request another form of Graphic Input data, independent of the user. This is known as Terminal Status information. If the Terminal is in either Alpha or Graph Mode and the computer sends ESC ENQ, $\overline{\text{INQUIRE}}$ goes low. Since the Counter is at 0 and the crosshair cursor is not running, this causes the State Counter to advance to State 1. The Terminal Status bits MARG, $\overline{\text{GRAF}}$, $\overline{\text{NOLI}}$, $\overline{\text{HCU}}$, and $\overline{\text{AUXSENSE}}$ are sent to the computer as the first byte of the transmission. This is followed by the contents of the X and Y Register and CR and EOT in a manner similar to that previously described. The principal difference is that since the crosshair was not running, no digitization is required and the Multiplexer simply sends the current address of the Alpha cursor or of the Graph beam.

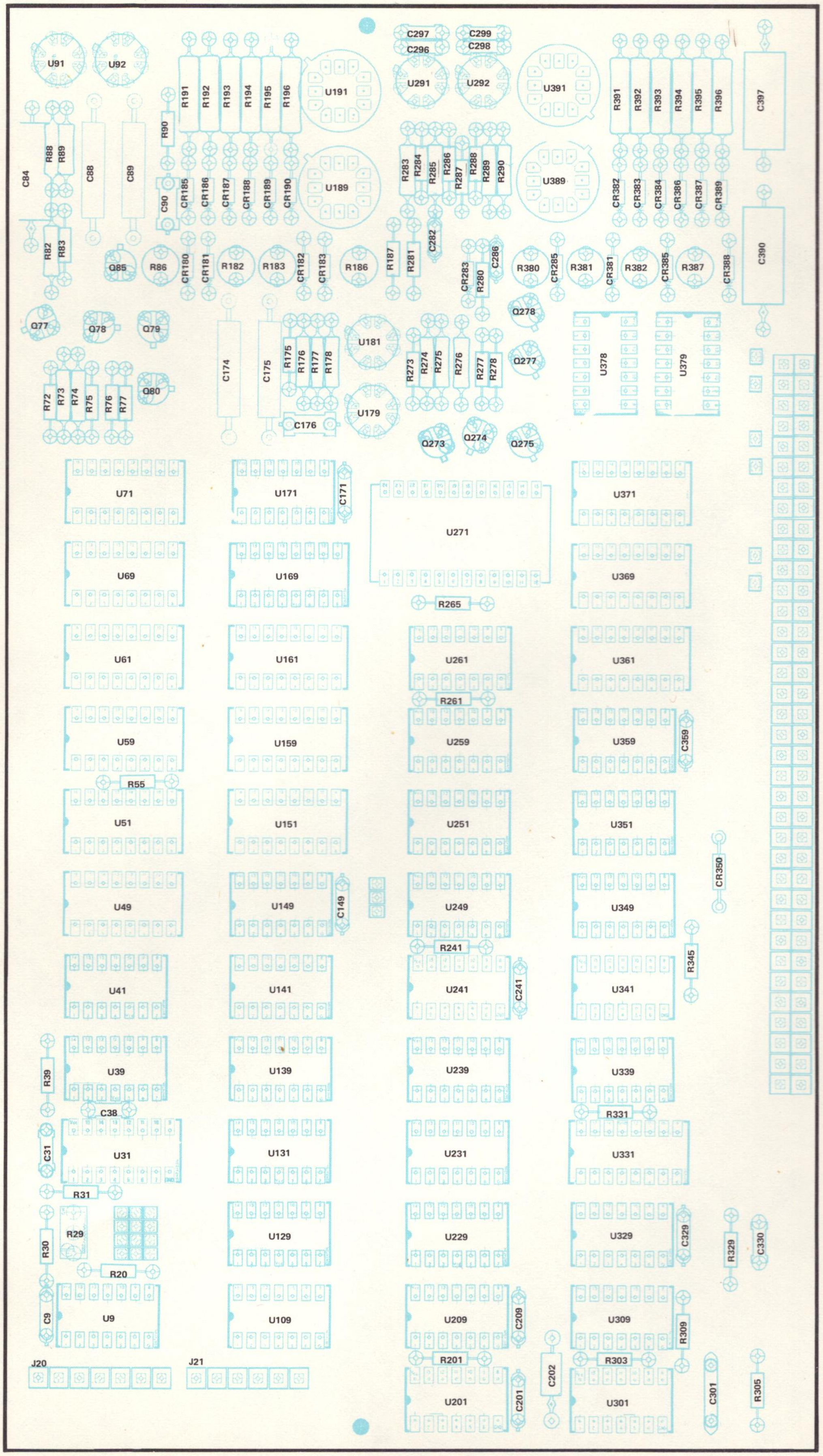


Fig. 6-20. TC-2 component locations.

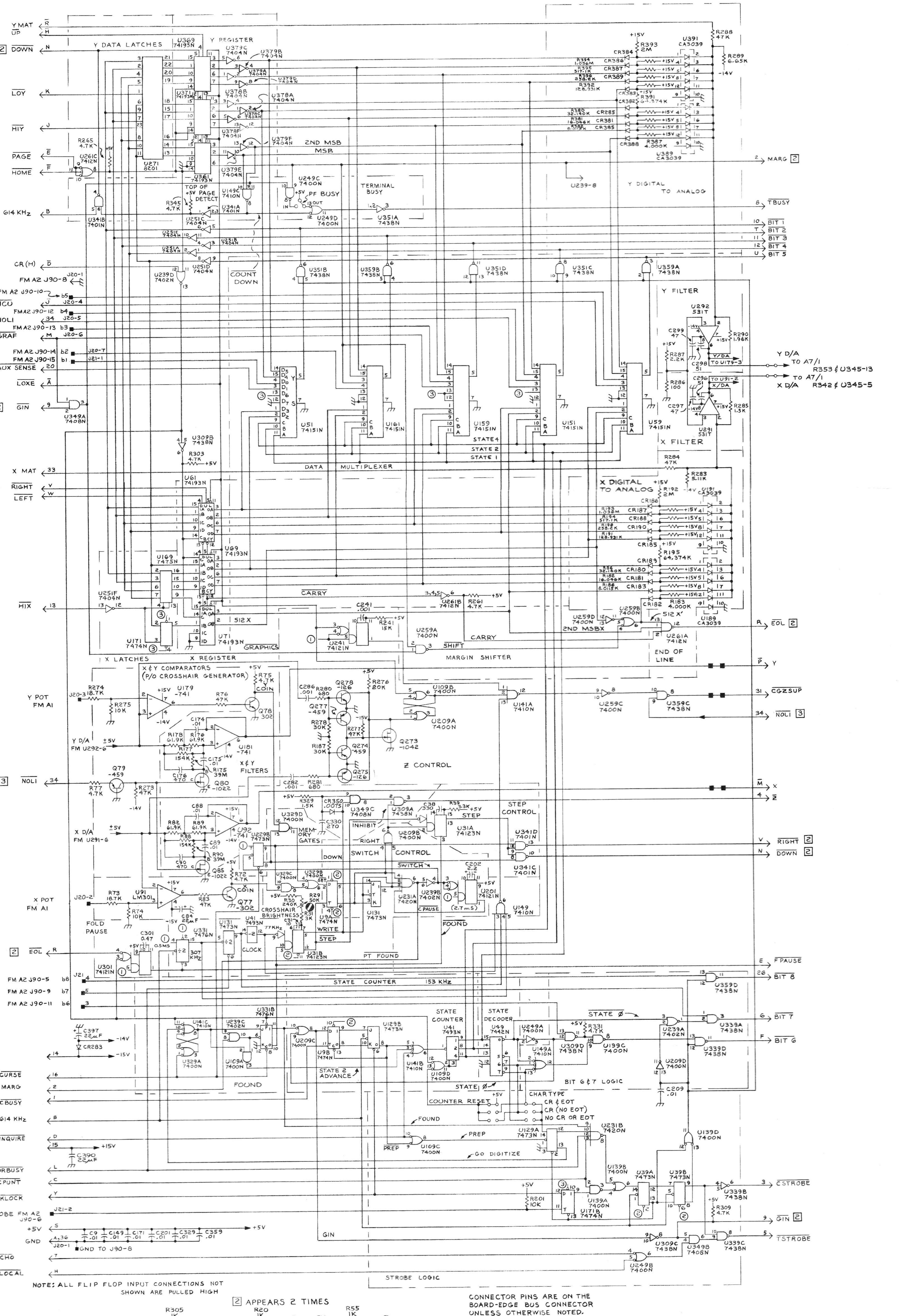


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FIG. 6-21 ASSY A5 TC2

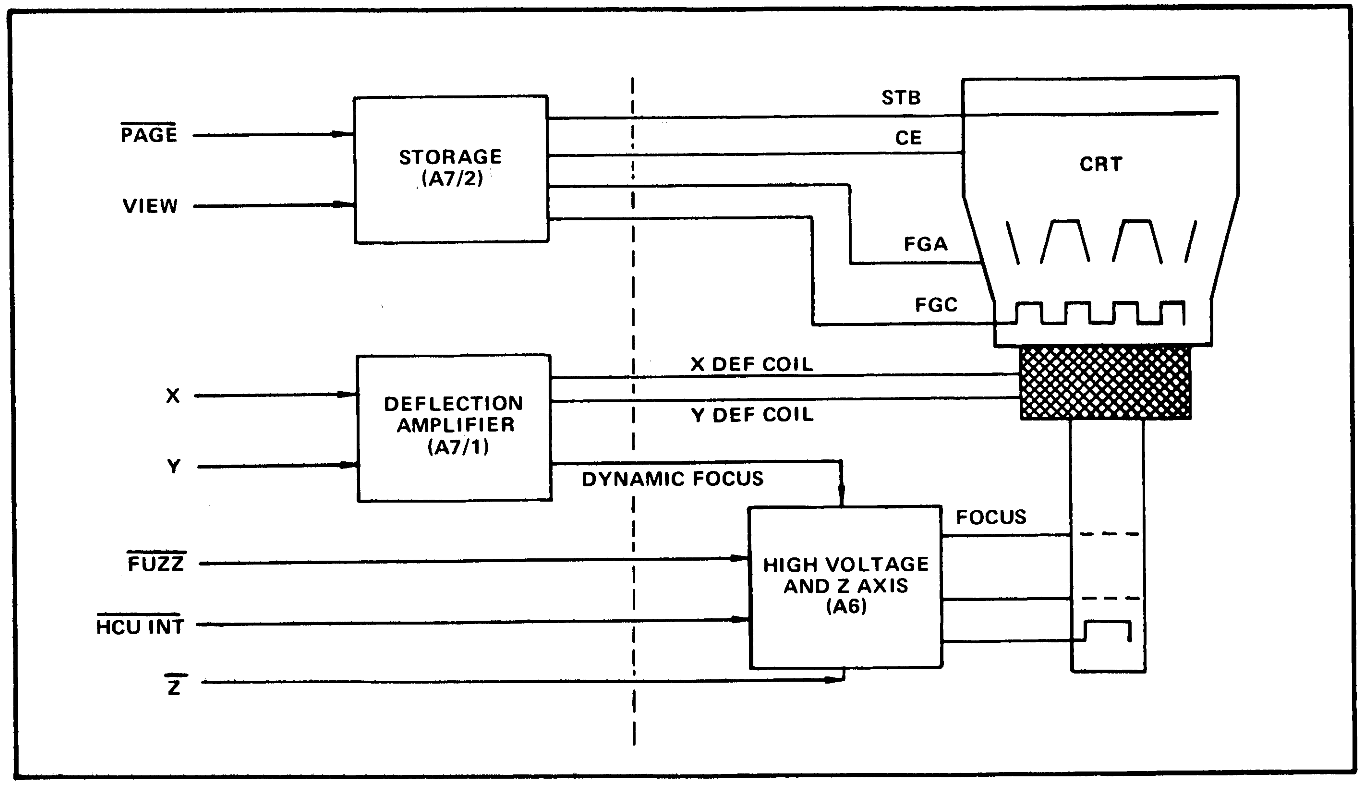

Fig. 6-22. Display block diagram.

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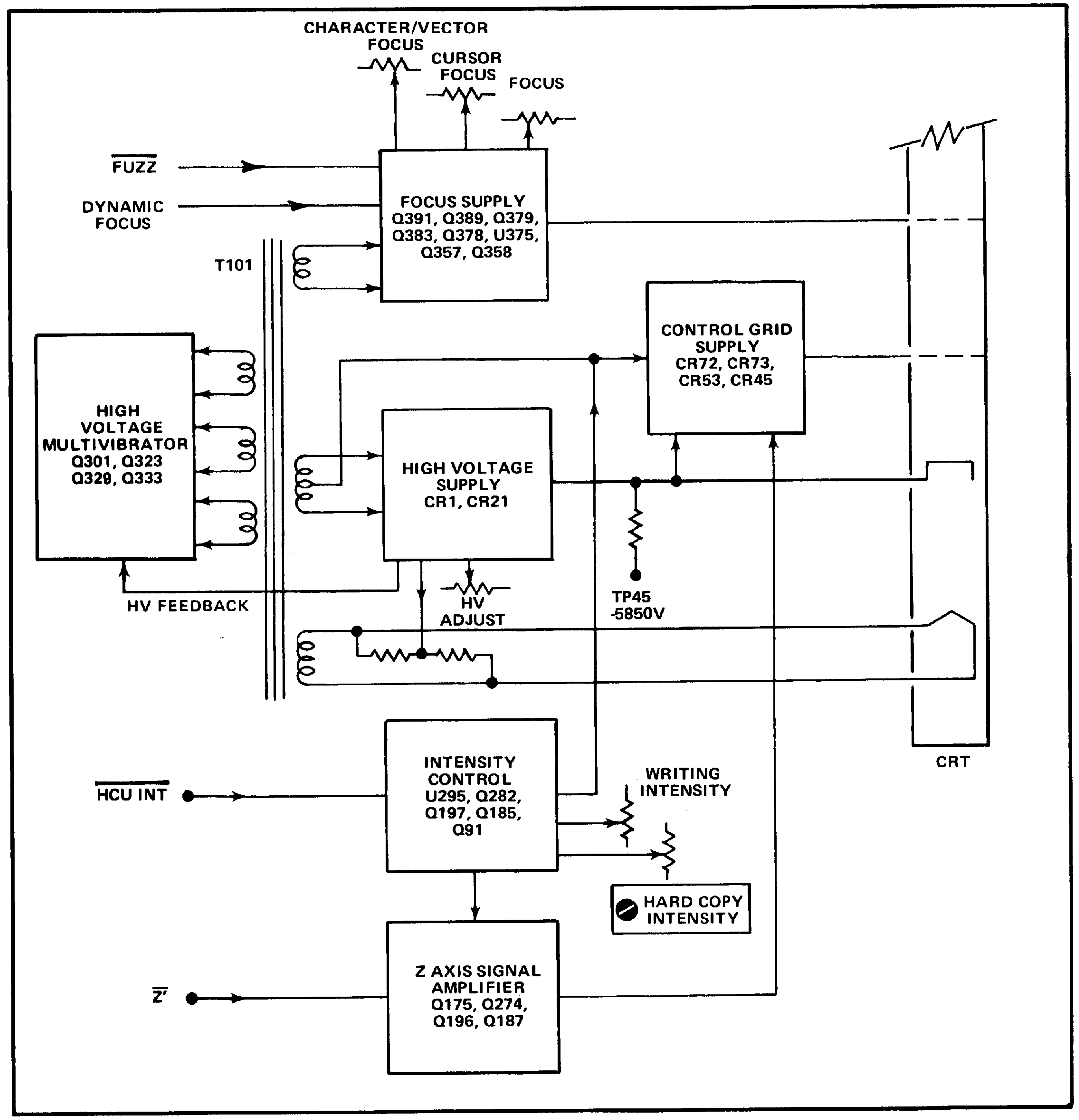

Fig. 6-23. High Voltage & Z Axis block diagram.

DISPLAY CIRCUITS

Display Block Diagram Description

A block diagram of the Display circuits is shown in Fig. 6-22. The writing portion of the Display consists of a High Voltage and Z Axis circuit, a Deflection Amplifier circuit, X and Y Deflection Coils, and the writing components of the CRT — namely the Cathode, Control Grid, and Focus Anode. The storage section consists of the Storage circuitry and the storage components of the CRT — the Flood Gun Cathode (FGC), the Collimation Electrode (CE), the Flood Gun Anode (FGA), and the Storage Backplate (STB). The writing portion of the Display controls beam positioning and writing, while the storage portion controls and maintains the intensity of stored information.

Positioning information is received in the form of X and Y analog signals into the Deflection Amplifiers. These generate a positioning current in the X deflection coil and Y deflection coil, and also cause a DYNAMIC FOCUS signal to be sent to the High Voltage and Z Axis circuit. This DYNAMIC FOCUS signal is minimum for center screen position, and maximum for edge position. (Dynamic Focus is necessary because focusing is partially dependent on beam travel distance, and the beam must travel further in reaching the edges of the CRT than it does in reaching the center of the CRT.) The $\overline{\text{FUZZ}}$ signal is LOW during Alpha cursor generation and GIN Mode to provide optimum focusing for those refreshed displays. During Alpha character writing time, and in Graph Mode, $\overline{\text{FUZZ}}$ goes high to permit separate focusing for stored writing. The $\overline{\text{Z}}$ signals into the High Voltage and Z Axis circuit control the Grid Bias. The $\overline{\text{HCU INT}}$ signal modifies the CRT intensity to accommodate hard copy operation. Additional information regarding hard copy writing is available elsewhere in this section.

The storage circuitry responds to two input signals and provides the cathode-ray tube with four operating voltages. Assuming that $\overline{\text{PAGE}}$ and VIEW are both high, the Flood Gun Cathode continuously emits electrons that are accelerated by the Flood Gun Anode. These strike the Storage Backplate, where they continuously reinforce the stored information. If no inputs are received by the Terminal for approximately 90 seconds, the VIEW signal goes low, causing the Flood Gun Anode voltage to drop to a level below that of the cathode. This reduces the flow of electrons from the Flood Gun Cathode and drops the CRT Intensity below viewing level.

The $\overline{\text{PAGE}}$ signal causes the CRT and Storage circuits to go through an Erase cycle. The four storage signals then cycle through a change in voltages, which causes the CRT to become totally written and then to completely erase.

High-Voltage and Z Axis Circuits

Block Diagram Description. Refer to the block diagram of the High-Voltage circuits, which is shown in Fig. 6-23. These circuits control the filament supply, the cathode supply, the control grid supply, and the focus supply for the writing gun of the CRT. A High Voltage multivibrator drives a transformer to produce the various voltages required by the circuits. The multivibrator receives drive from one of the secondary windings, and also receives biasing voltage for its control amplifier from a secondary winding. In addition, a high voltage feedback signal is applied to the multivibrator to keep the high voltage at a given value. CR1 and CR21 help to provide a −5850 cathode voltage supply, and filament voltage is obtained from a secondary winding of T101. The Control Grid circuit and Filament circuit are both referenced to the −5850 power supply.

A tap from a secondary winding (which powers the high-voltage supply) sends additional voltage to the control-grid supply to enable it to provide a control-grid voltage which is more negative than the cathode voltage. The actual difference between the two is a function of the Intensity Control circuit and the Z Axis Signal Amplifier. If the $\overline{\text{HCU INT}}$ and $\overline{\text{Z}}$ signals are high, this difference is approximately 100 volts. When $\overline{\text{HCU INT}}$ is low, this difference increases to approximately 115 volts. When $\overline{\text{HCU INT}}$ is high and $\overline{\text{Z}}$ is low, this difference becomes approximately 50 volts, permitting stored writing to occur.

Another secondary winding of T101 provides the Focus Supply circuit with enough drive to develop negative high voltage for the focus anode. Focus Adjust permits optimum overall focusing. A dynamic focus amplifier works in conjunction with the high voltage focus supply. The DYNAMIC FOCUS signal compensates for defocusing due to the writing beam deflection from CRT center to CRT edge. There are two dynamic focus adjustments. Character/Vector Focus provides for uniform focusing throughout the display area during Alpha Mode character Writing and during Graph Mode. Cursor Focus permits optimum focusing during Alpha cursor and Crosshair Cursor Generation when $\overline{\text{FUZZ}}$ is low.

High-Voltage Oscillator. Refer to the High-Voltage and Z Axis schematic diagram, Fig. 6-25. Oscillator Q301 provides current to the primary winding of T101. When current in this winding is increasing, a secondary winding provides positive voltage to the base of Q301. When Q301 collector current reaches Beta times its base drive, Q301 unsaturates and the primary winding voltage decreases. Thus, the positive voltage to the base of Q301 decreases. When the voltage at the base of Q301 becomes sufficiently low, Q301 stops conduction, causing a further decrease in the primary voltage. This causes a negative voltage to be applied to the base of Q301, driving this transistor further into cut-off. When C209 discharges sufficiently, the voltage at the collector of Q323 rises and the cycle repeats itself. The Q301 drive current is obtained by charging capacitor C209. However, part of the C209 charging current is also obtained from Q323. Therefore, changes in Q323 collector current affect the drive to Q301. Q323 current is controlled by a feedback from the high-voltage circuit, adjustable by R227.

High-Voltage Supply. Power for this supply is provided by the 8—13 winding. Voltage from this secondary is doubled by C16, CR1, CR21, and C138. The filtered −5850 volts is then applied to the cathode of the CRT. The unfiltered high voltage is connected through R38 and R40 to the two sides of the filament supply, elevating it to the proximity of the voltage on the Cathode.

Control Grid Supply. The −5850 cathode voltage is felt on C65, via CR45, R47, and R55. Assuming that pin 14 of the transformer is at zero volts, C65 charges to 5850 volts. With $\overline{\text{HCU INT}}$ high, the voltage at the wiper of R86 is at approximately 100 volts. During one-half cycle of operation, pin 14 of T101 goes positive; CR74 and CR79 go into conduction and limit the voltage to about 100 volts at the CR74-CR79 junction. This causes C65 to charge an additional 100 volts, ending up with about 5950 volts across it. Assume the $\overline{\text{HCU INT}}$ and $\overline{\text{Z}}$ signals are both high. The voltage at the top of DS74 is then about +5 volts. When pin 14 of T101 swings negative, CR72 conducts and clamps the bias signal from going below +4.5

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volts. However, the 95 V decrease on one side of C65 causes the other side to decrease by an equal amount. As the high voltage side of C65 goes negative to −5945 V, CR45 becomes back-biased. CR53 conducts and C64 charges toward −5945 V; the control grid voltage is placed 95 volts below the cathode voltage, blanking the writing beam. The circuit then acts as a peak detector and maintains the blanking bias value until writing is commanded.

Intensity Control Circuit. A regulated +250 V for the Intensity Control circuit is supplied by series regulator Q197. The 250 V at its emitter is sampled by the R195-R193 voltage divider. Any voltage deviation felt at pin 13 of U295 (a high-gain operation amplifier) sends a correction voltage to Q282. The resultant change in drive signal to the base of Q197 holds the +250 V supply within design limits.

Q185 and Q91 are supplied by the +250 V from Q197 and from a dual Intensity Control circuit. With $\overline{\text{HCU INT}}$ high, Q185 is allowed to conduct, where approximately 100 volts is selected at the wiper of R86. (This is variable between +15 and +215 volts due to CRT bias requirements.) This voltage then controls the CRT grid bias as explained in the Control Grid Supply description.

When a hard copy is commanded, the $\overline{\text{HCU INT}}$ line goes low, turning Q185 off and allowing Q91 to conduct. This permits C65 in the Control Grid Supply to charge to a higher value, as set by R91, when a hard copy is requested. With the voltage at the top of DS74 still at +5 volts, C64 is permitted to increase its charge accordingly, increasing the voltage difference between the Control Grid and the cathode of the CRT. This increase in bias is necessary for hard copy operation.

Z Axis Signal Amplifier. The beam writing voltage at the top of DS74 is controlled by the $\overline{Z}$ signal. When $\overline{Z}$ is active, the voltage is about 75 volts and writing is permitted. When $\overline{Z}$ is inactive, the voltage remains at +5 V. When $\overline{Z}$ is high, Q175 is turned on via bias network R179, R183, R280, R181, and R281. Q175's collector pulls down to about +6 volts. Diode CR178 keeps Q175 from saturating, for turn-off speed considerations. This voltage is felt through emitter-follower Q274, and is used as a reference voltage for the Control Grid Supply circuit as previously explained.

When $\overline{Z}$ goes low to command the beam to write, Q175 cuts off and its collector rises toward 175 volts. However, notice that the biasing voltage of Q196 holds the emitter voltage of Q187 at about 75 volts. This voltage is felt on the cathode of CR177. As long as the anode of CR177 is held below 75 volts, CR177 cannot conduct. This is the case with the $\overline{Z}$ signal inactive. Now, when the collector of Q175 rises to about 75 V, CR177 goes into conduction and holds the collector of Q175 at that value. Approximately +75 V appears on the emitter of Q274 and replaces the +5 volts previously present at the top of DS74.

The change in voltage at the top of DS74 has an effect on the CRT Control Grid Bias. When the bias signal at the CR74-CR79 junction drops to approximately 75 volts, CR72 and CR73 go into conduction and holds it at that value rather than permitting it to go to +5 V as before. The voltage swing at the CR73-C65 junction is therefore limited to 20 volts. Since the high voltage side of C65 follows suit, the voltage difference between grid and cathode decreases to approximately 20 volts, permitting information to be written on the CRT. L173 (in the Q175 collector circuit) helps the switching action during writing time, by helping overcome the capacitance inherent in the Control Grid circuit.

Focus Circuit. The Focus circuit is designed to provide optimum focusing in all modes of operation. The circuit consists of a floating Focus High-Voltage Power Supply, Alpha and Vector Focusing Adjust circuits, a Constant Current circuit, an Operational Amplifier, and a grounded-base amplifier used as a logic switch.

Operation of the circuit during Alpha Mode with the cursor in a corner of the CRT will be explained first. Under this circumstance, approximately 8 volts of focus correction signal is received at the DYNAMIC FOCUS input. Since this 8 volts is applied to voltage divider R379 and R371, it causes approximately 0 volts at the negative input of amplifier U375. U375 drives Q358 until the Q358 collector voltage is sufficiently positive to drive the positive input of U375 to 0 volts to balance it with the negative input. With the positive input at 0 volts, no current can flow through Q378 or Q389, since their sources are also at 0 volts. Constant Current circuit Q383 causes 0.3 milliampere to enter the circuit through the Q383 collector. The 0.3 mA is the only current flowing through feedback resistor R366, setting the R366-R355 junction (via feedback operation) to 150 volts. Approximately 150 volts is therefore felt at the emitter of Q357, providing a reference voltage for one side of the Focus High Voltage Power Supply. The Focus High Voltage Power Supply generates approximately −5850 volts, just as the cathode circuit high voltage winding does. A portion of this voltage is picked off by the Focus Adjust potentiometer and applied to the Focus Grid of the CRT.

When generating a character or drawing a vector, $\overline{\text{FUZZ}}$ is high, turning Q389 on and Q378 off. This enables Character/Vector Focus Adjust R389. Note that with Q379 cut off and 0 volts on both sides of R389, neither the Character/Vector Focus or the Cursor Focus has any control; focusing is totally dependent upon the position of R161 for CRT corner focus. When the beam is moved to the center of the CRT, the Dynamic Focus voltage returns to approximately 0 V. The R379-R371 voltage divider applies approximately −5 volts to the negative input of U375. This causes U375 to drive Q358 until its collector is sufficiently low to permit the positive input of U375 to reach the value present on the negative input, approximately −5 volts. With $\overline{\text{FUZZ}}$ high, Q389 acts as a short circuit. With the Character/Vector Focus potentiometer near midrange, R389 and R387 now demand approximately 0.08 mA of current. With 0.3 mA available from Q383, this leaves approximately 0.22 mA available to flow through R366, indicating that the collector of Q358 must be at approximately +105 volts. The focus reference voltage at the emitter of Q357 is therefore approximately +105 volts. Since current now is flowing through R389, the Character/Vector Focus Control is effective, and can be made to set the Q357 voltage to any value between approximately 85 and 115 volts, thereby controlling the focusing of the display near center of the CRT.

When generating an Alpha or crosshair cursor, $\overline{\text{FUZZ}}$ goes low and turns Q389 off and Q378 on. This causes Q378 to act as an effective short circuit, supplying current for the Cursor Focus potentiometer. As with the Character/Vector Focus control, Cursor Focus R382 only has effect on the display when the CRT beam is not located at any of the extreme corners of the CRT.

In summary, the circuit allows R161 (Focus Adjust) to adjust for good corner focus, R389 (Character/Vector Focus) to adjust for best Alpha and Vector Focus ($\overline{\text{FUZZ}}$ high), and R382 (Cursor Focus) to adjust for best center screen focus ($\overline{\text{FUZZ}}$ low).

Miscellaneous Components. Neon lamps appear in various parts of the High Voltage circuit. These lamps are intended primarily as arc protection devices. At any time a radical change occurs in the voltage of any section of the High Voltage circuit, these lamps fire and cause the remainder of the circuitry to stay electrically close together to avoid breakdown between the circuits.

HIGH VOLTAGE & Z AXIS

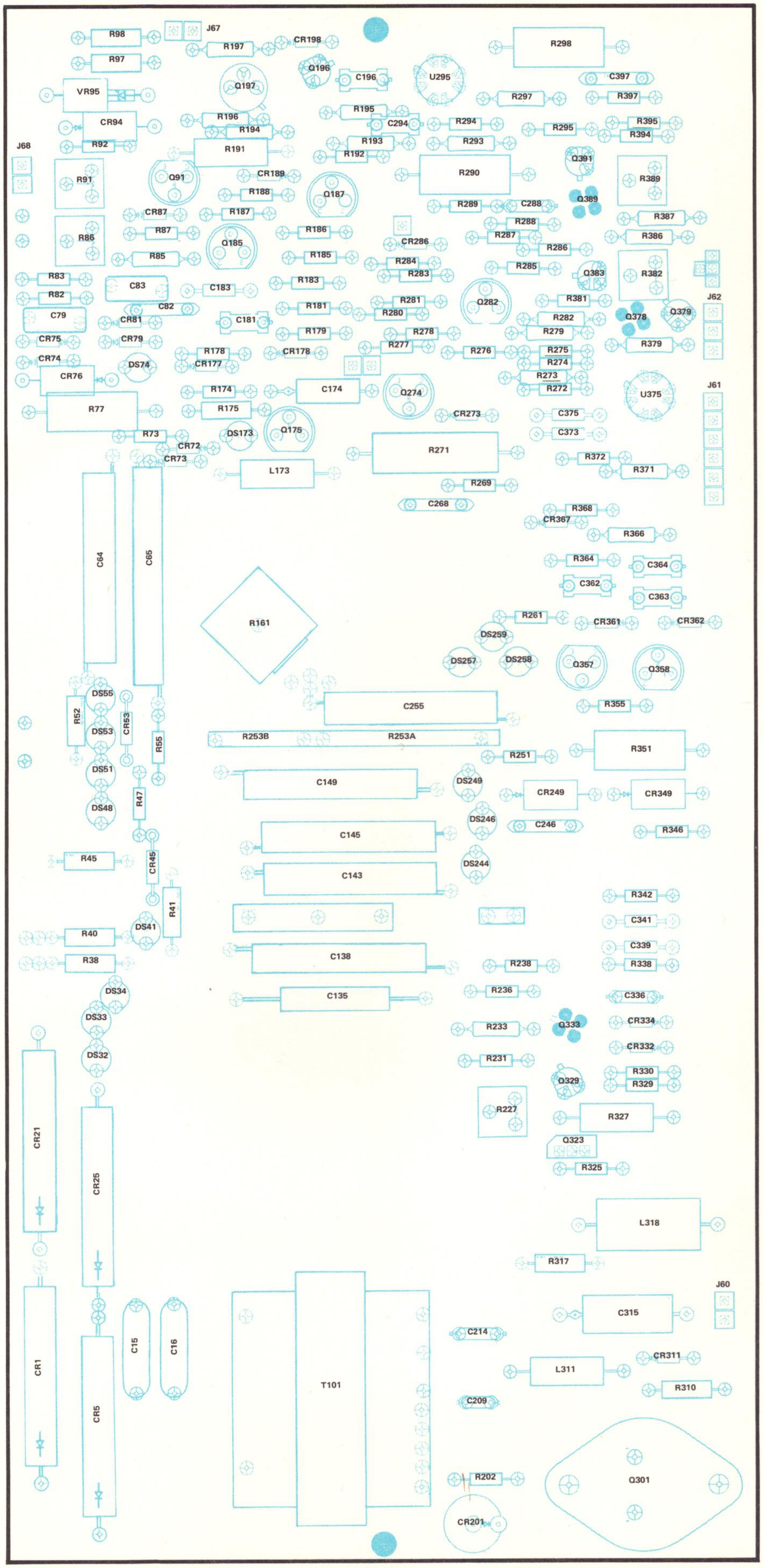

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Fig. 6-24. High Voltage & Z Axis component locations.

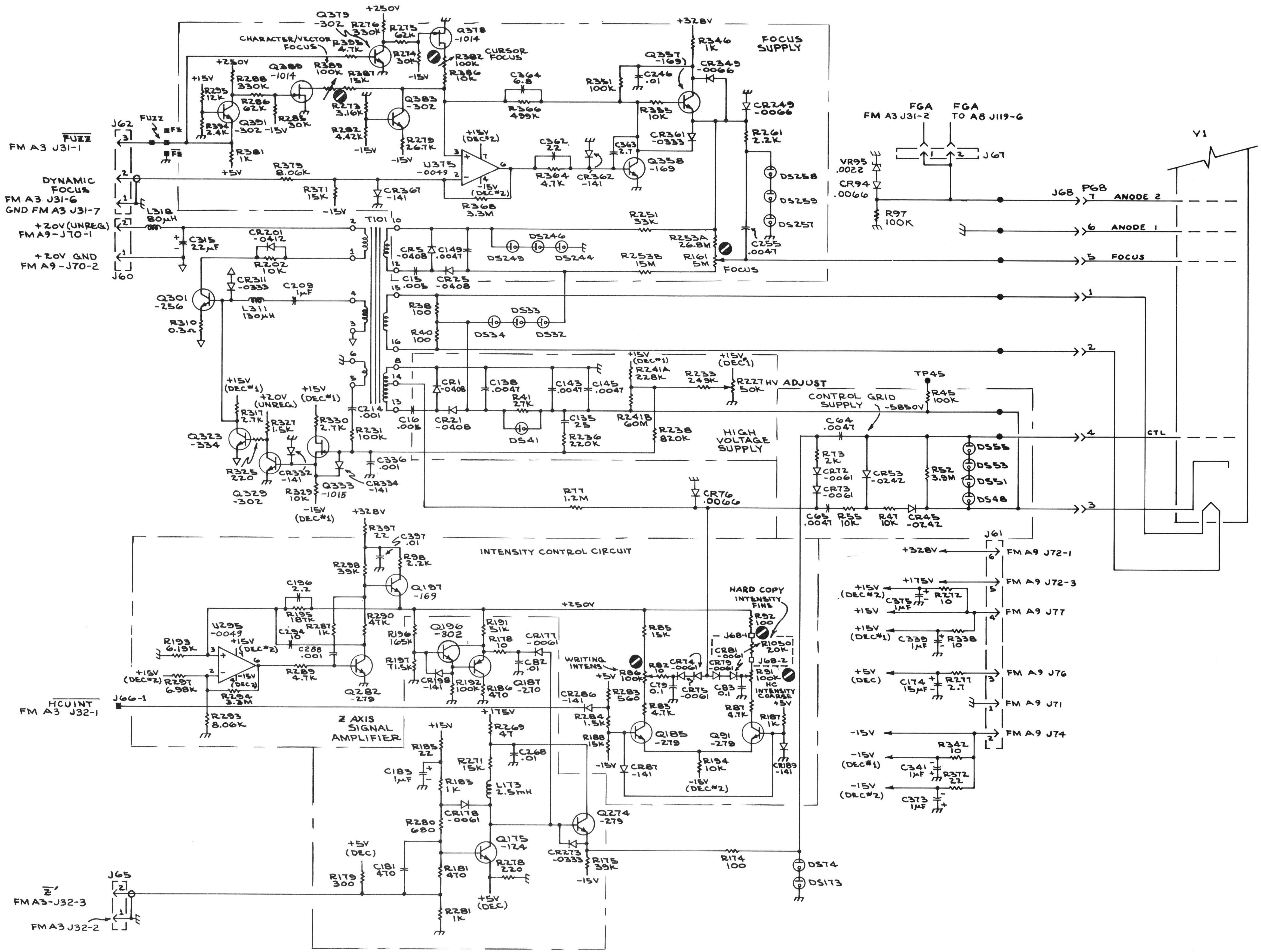

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FIG. 6-25 ASSY A6 HIGH VOLTAGE & Z AXIS
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JA 4385-00

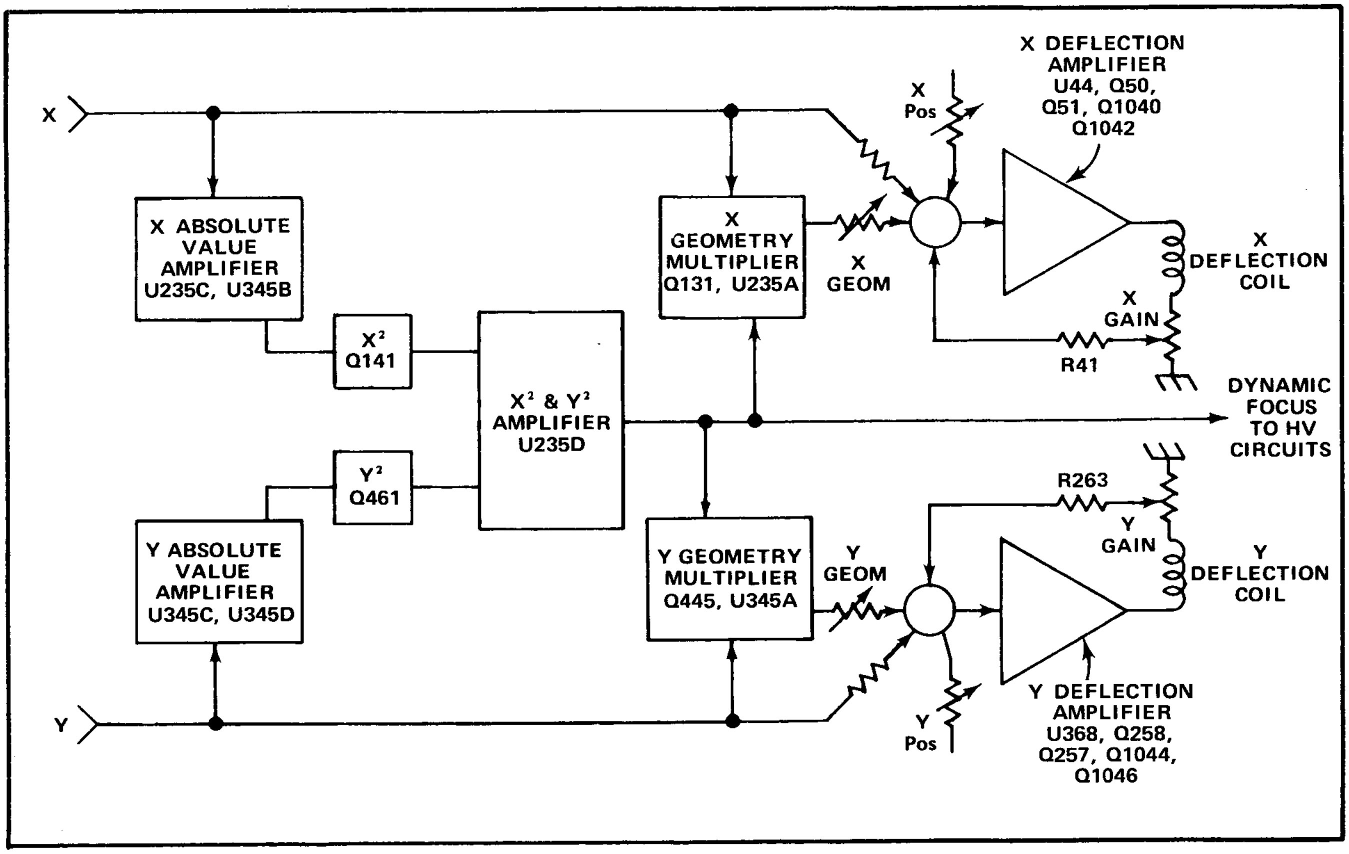

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Fig. 6-26. Deflection Amplifier block diagram.

Deflection Amplifiers Description

General. The Deflection Amplifier circuit uses the X and Y analog voltages and amplifies them to provide the drive signals to the X and Y deflection coils. This circuit also generates a dynamic focus signal that is used in the High-Voltage circuit.

Block Diagram Description. Refer to the block diagram in Fig. 6-26. The circuits making up the deflection amplifiers are the X Absolute Value Amplifier, the Y Absolute Value Amplifier, the X^2 and Y^2 circuits, the $X^2 + Y^2$ Amplifier, the X Geometry Multiplier, the Y Geometry Multiplier, the X Deflection Amplifier, and the Y Deflection Amplifier.

The X and Y signals are each applied to three circuits within the deflection amplifiers. The X signal goes to the X Absolute Value Amplifier to generate a positive output signal regardless of the polarity of the X Input signal. Then it is squared and applied to the $X^2 + Y^2$ Amplifier. It is combined with the positive signal from the Y^2 circuit to develop the Dynamic Focus signal, which goes to the X Geometry Multiplier and the Y Geometry Multiplier, as well as going to the High Voltage circuits. The X input signal is also applied to the X Geometry Multiplier circuit, where it combines with the Dynamic Focus signal to generate an X Geometry signal. The X signal, X Geometry signal, and a Feedback signal from the X Deflection Amplifier combine at the summation point at the input to the X Deflection Amplifier. The output of the X Deflection Amplifier provides the drive for the X Deflection coil. The Y Deflection Amplifier circuit functions in a similar manner.

Detailed Description. Refer to the Deflection Amplifier schematic, Fig. 6-28. Because of the similarity between the X circuitry and the Y circuitry, only the X circuits will be explained here. The X Absolute Value Amplifier consists of two operational amplifiers, each of which has one input referenced to ground. If a negative X signal is applied, U235C develops a positive-going output which back-biases CR335 and forward-biases CR337, permitting the signal to be felt at the emitter and base of Q141. The negative X signal is simultaneously applied to the positive input of U345B, causing its output to go negative. CR343 becomes back-biased, preventing the signal from affecting the output. CR344 becomes forward-biased, permitting feedback to pin 6 to offset the input signal. If the X input goes positive, U345B develops a positive output, forward-biasing CR343 and transmitting the signal to Q141. The positive X applied to U235C causes its output to go negative, back-biasing CR337 and forward biasing CR335, holding pin 10 at ground potential.

X^2 amplifier Q141 is cut off under no-signal conditions. Positive voltages applied to R244 cause the transistor to conduct. However, the same positive voltage being applied to R244 is also applied to the R242-R241 voltage divider. This causes the current through one side of Q141 to be less than the current through the side that has its base grounded. The difference between the output signals taken from the collectors of Q141 is then approximately proportional to the square of the input voltage. The signals combine with the signals from Q461 in the Y^2 Amplifier, with the resultant signal being applied to the inputs of U235D. U235D develops an $X^2 + Y^2$ output, which it applies to the emitters of Q131. Q131 has a portion of the X input signal applied to the base of one-half of the transistor, causing the difference outputs at the collectors of Q131 to be approximately equal to $KX(X^2 + Y^2)$. These are applied to amplifier U235A, developing an output signal which is used as geometry correction. A portion of this is picked off by R36, which demands current through R38 from the summation point at pin 3 of U44. The X input signal also demands current via R37, while the positioning potentiometer R40 demands current through R39. U44 responds by developing an in-phase output signal at pin 6. Q50 amplifies and inverts the output of U44, applying it to complementary emitter-followers Q1040 and Q1042. A portion of the signal from Q1040 and Q1042 is felt at R44, which supplies the current demanded by R38, R39, and R37, while permitting pin 3 of U44 to remain near zero volts as dictated by pin 2 of U44.

Under no-signal conditions, the R366-R55 junction is at zero volts, resulting in no current through the X Deflection Coil. If U44 outputs a negative voltage, Q50 develops a positive voltage at its collector, which is felt through emitters of Q1040 and Q1042. The R366-R55 junction goes positive, causing electron flow up through the coil. If the pin 6 output of U44 goes positive, Q50 delivers a negative through the base-emitter junctions of Q1040 and Q1042, causing electron flow down through the X Deflection Coil. Q51 provides relatively constant current to Q50 to optimize its operation.

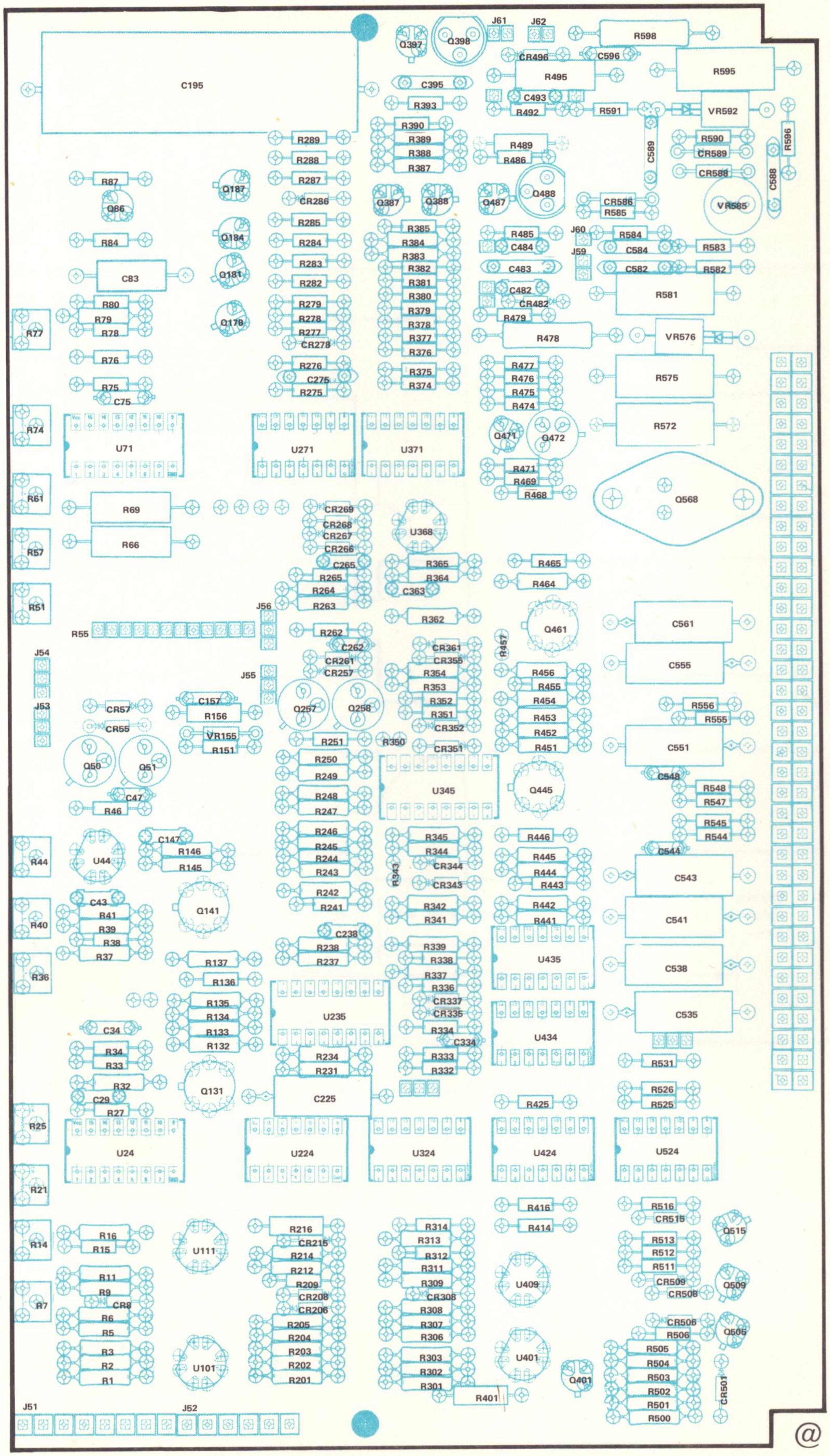
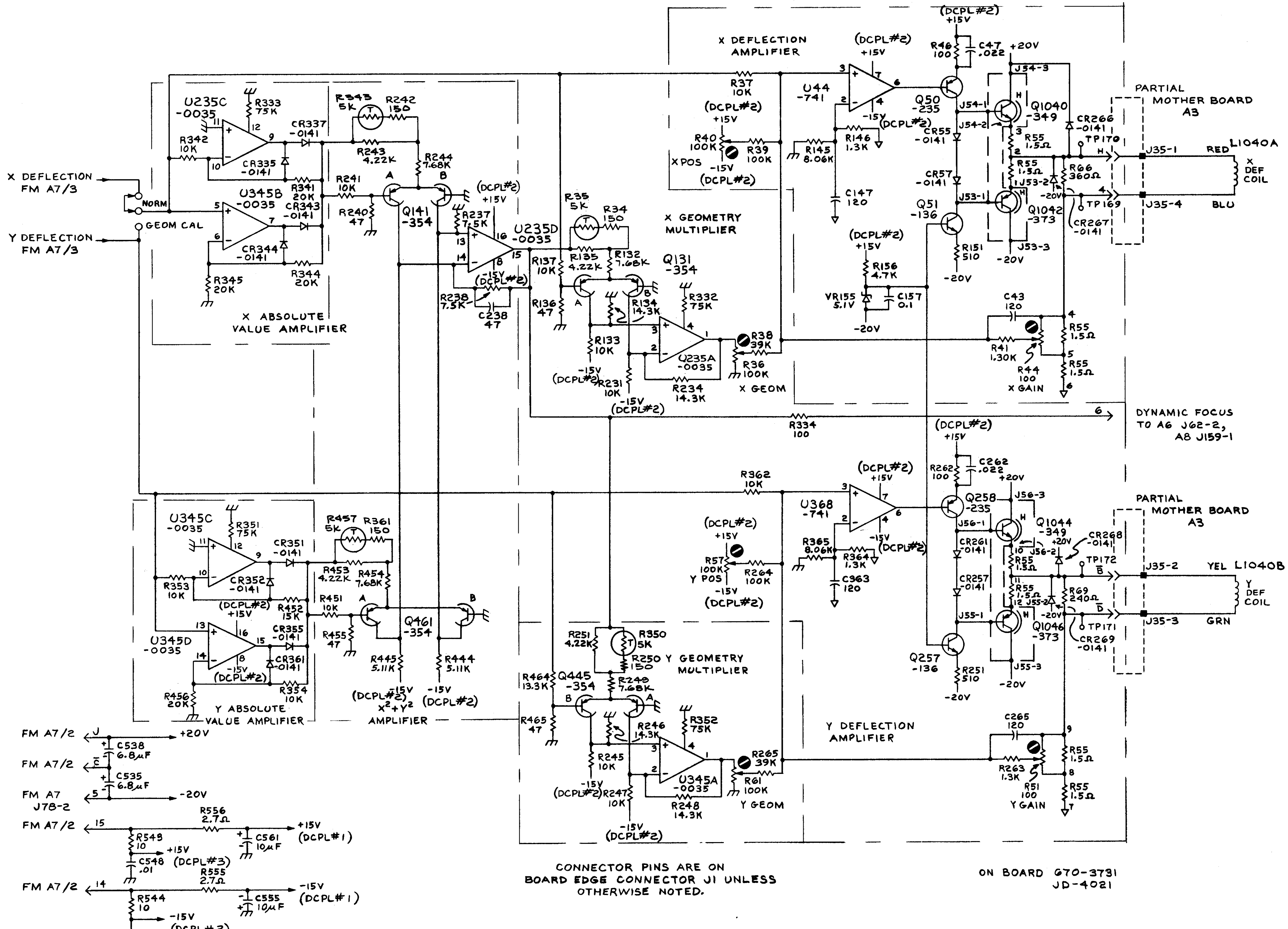


Fig. 6-27. Deflection Amp & Storage board component locations.



DEFLECTION AMPLIFIER & STORAGE BOARD (PARTIAL)

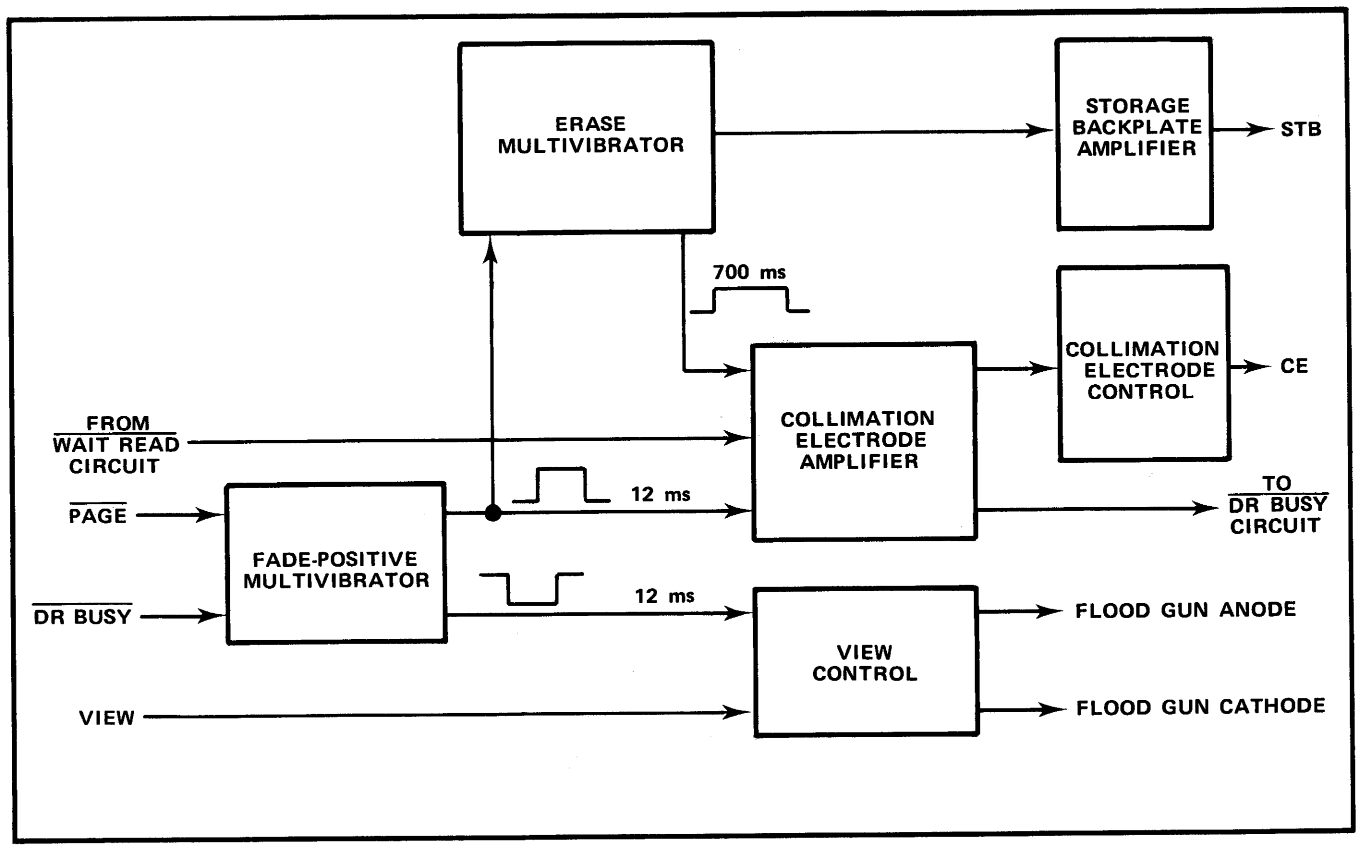


Fig. 6-29. Storage Circuit block diagram.

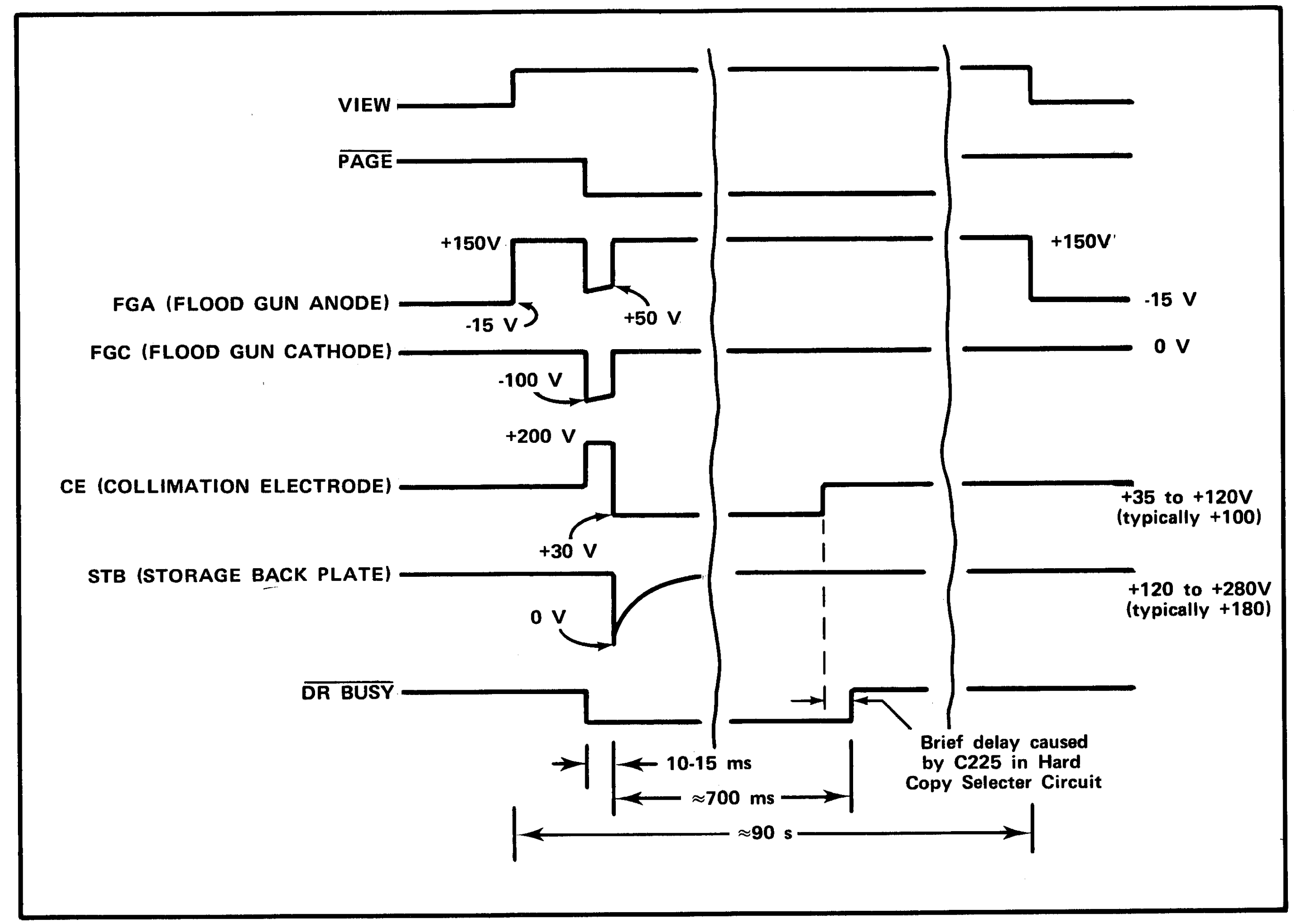


Fig. 6-30. Storage Circuit waveforms.

Storage Circuits

Block Diagram Description. The Storage circuit controls the storage and erasure of data on the face of the CRT. The Storage circuit consists of the following sections: The Fade-Positive Multivibrator, the Erase Multivibrator, Storage Backplate Amplifier, Collimation Electrode Control, Collimation Electrode Amplifier, and View Control.

A block diagram of the circuit is shown in Fig. 6-29. Waveforms associated with the circuit's operation appear in Fig. 6-30.

The sequence that causes erasing starts with the low-going $\overline{\text{PAGE}}'$ signal arriving at the Fade-Positive Multivibrator. If view is not already high, it will be sent high by the $\overline{\text{PAGE}}$ signal (in another circuit). Note that when VIEW goes high, the Flood Gun Anode voltage rises to +140 V, its normal viewing and writing level. $\overline{\text{PAGE}}$ causes a 12 millisecond low pulse to go to the View Control circuit, causing the anode and cathode to decrease their voltage by approximately 100 volts as shown in the waveform diagram. Simultaneously, the Fade-Positive Multivibrator applies a 12 millisecond high pulse to the Collimation Electrode Control circuit, where it initiates a negative-going $\overline{\text{DRBUSY}}$ signal. ($\overline{\text{DRBUSY}}$ is actually generated in the Hard Copy Selector circuit.) $\overline{\text{DRBUSY}}$ is applied to the Fade-Positive Multivibrator to disable it until the erase cycle is completed. The 12 ms high pulse also causes the Collimation Electrode Amplifier to output a 12 millisecond positive-going pulse on the Collimation Electrode (CE) Line.

When the 12 millisecond pulse from the Fade-Positive Multivibrator ends, the anode and cathode voltages from the View Control circuit return to their quiescent value. The negative transmission into the Erase Multivibrator causes a signal to return to the Collimation Electrode Control to sustain the $\overline{\text{DRBUSY}}$ signal and to change the Collimation Electrode Voltage to a value below that which occurs at quiescence. At the same time, the Erase Multivibrator causes the Storage Backplate Amplifier to drive the Storage Backplate Voltage (STB) to zero, from where it rises exponentially toward its previous voltage.

The signal from the Erase Multivibrator ends after approximately 700 milliseconds, causing the Collimation Electrode Control to set the Collimation Electrode Voltage back to its quiescent value. DRBUSY continues to be held low for a short additional time.

Refer to the waveform diagram in Fig. 6-30. The positive-going Collimation Electrode Voltage and the negative-going voltage on the Flood Gun Anode and Cathode together cause flooding of the CRT Faceplate, providing uniform storage over the entire area. After the 12 millisecond pulse elapses, the collimation electrode returns to a value lower than quiescence to prevent any storing from occurring until the end of the cycle. At the same time that the voltage pulses end, the Storage Backplate Voltage goes to zero to erase the face of the CRT. 700 milliseconds later, the Storage Backplate Voltage has returned to normal; the Collimation Electrode Voltage returns to normal. The $\overline{\text{DRBUSY}}$ signal returns high after a short additional period, indicating that erasing has been completed.

Detailed Description. Refer to the schematic of the Storage circuit, Fig. 6-32. The Erase Multivibrator and Storage Backplate Amplifier (which determine the backplate voltage) will be discussed first. Under quiescent conditions, −15 volts is applied through R285, R287 and CR286 to hold Q184 in conduction. This causes Q291 to be in conduction with approximately −14.8 volts on its collector. The voltage at the R287, R285 junction is approximately −2.4 volts, causing C83 to charge approximately 12.4 volts. The base of Q187 is held at approximately −1.2 volts by the Q184 base-to-emitter junction and by CR286. This holds the emitter of Q187 at −1.8 volts, which holds the emitter of Q86 at −1.2 volts. Referring to Q398, it can be seen that its emitter holds its base at approximately +0.6 volt, holding the base of Q397 at zero volts. 1.2 volts thus exists between the emitter of Q86 and the base of Q397. With the Op Level control at mid-position, about 1/3 of a milliampere flows between the emitter of Q86 and the base of Q397. Very little of his passes through the Q397 base-emitter junction, leaving the majority of it to flow through R498. Multiplying this 1/3 milliampere by the R598 value (499 kΩ) provides approximately +180 volts at the emitter of Q1032. The Q397, Q398, Q1030, and Q1032 circuit serves as a driver amplifier to sustain this voltage. The +180 volts at the emitter of Q1032 is felt at the Storage Backplate (STB) anode of the CRT.

After $\overline{\text{PAGE}}$ has been applied to U71B and the 12 millisecond multivibrator pulse expires, the negative transition is felt through C275 into Q178, turning this transistor off. Its collector goes toward zero volts. Since C83 has a 12.5 volt charge on it, the right side of this capacitor goes positive and the capacitor attempts to discharge through R278-R285. The C83-R285 junction rises to approximately 12 volts and turns Q184 off. With Q184 cut off, its collector goes toward −15 volts, holding Q178 cut off. The positive voltage at the CR286-R287 junction is felt through the base-emitter circuit of Q187 and the tmitter-base circuit of Q86. The positive potential at the emitter of Q86 causes zero volts to appear at the R79-R80 junction. With zero volts at the base of Q397, no current is demanded through R77, and therefore none flows through R598. This causes the operational amplifier to place a zero volt output on the Storage Backplate (STB) anode.

During the next 700 ms, C83 discharges exponentially, changing the voltage being applied to the base of Q187. The STB voltage changes toward 180 V. After approximately 700 milliseconds, C83 discharges to the point where the voltage at the cathode of CR286 drops to about −1 volt, causing it and Q184 to go back into conduction. When this happens, the Storage Backplate voltage has been returned to its quiescent level. With Q184 in conduction, Q178 goes back into conduction, permitting C83 to again charge to its quiescent value.

The Collimation Electrode Control circuit will be discussed next. Under quiescent conditions, both inputs to U271C are low, placing a low at Pin 3 of U271A. The low from U71B pin 5 is also applied to U241D, pin 11. The second inputs to U241A and U271D are supplied by the Hard Copy Selector circuit and are low except during copy making. The U271A output is therefore high, holding Q387 cut off. With Q387 cut off, the circuit connected to its collector circuit delivers about one-third of a milliampere of current to the null point at the base of Q487 in the Collimation Electrode Amplifier.

The two low inputs to U271D cause a low out of U371E; Q388 is turned on. This holds about −0.2 V on the Q388 collector, delivering about 0.3 mA to the null point at Q487. In addition, R389 current flows into this point and is equal to about 0.25 mA. The combined currents flowing through R478 cause the output of the operational amplifier to be at approximately 80 volts.

When $\overline{\text{PAGE}}$ is received and the pin 5 output of U71B goes high, U271C, U371F, and U371A cause $\overline{\text{DRBUSY}}$ to occur. This is routed back to disable U71B so that no additional $\overline{\text{PAGE}}$ signals can affect the circuit until the erase cycle ends. Highs appear at the pin 3 input of U271A and pin 11 input of U271D. This causes Q387 to turn on and Q388 to turn off. The emitter circuit of Q387 now delivers about 0.13 mA to the base of Q487. Again, this current combines with that from R389 and flows through R478, causing the output of Q1034 to reach approximately 200 volts, which is applied to the Collimation Electrode of the CRT. When the 12 millisecond pulse from U71B expires, the high is removed from pin 11 of U271D, causing Q388 to go into conduction. Since Q181 (in the Erase Multivibrator circuit) delivers a high to pin 8 of U271C, a high is maintained on pin 3 of U271A, holding Q387 in conduction. With both transistors in conduction, Q387 delivers about 0.13 mA while Q388 delivers about .03 mA. These combine with the 0.25 mA from R389. The current through R478 causes the Collimation Electrode Voltage to drop to approximately 30 volts.

The just-described situation continues until the 700 ms erase period ends, and Q181 is again put in conduction. At this time, pin 8 of U271C goes low, applying a low at pin 3 of U271A, and at pin 9 of U371A. The high at pin 3 of U271A permits the Collimation Electrode Control and the Collimation Electrode Amplifier circuits to return to quiescent operating conditions. Although the output of U371A goes high, $\overline{\text{DRBUSY}}$ remains low for a short period. (This is due to C225, shown on the Hard Copy Selector schematic.) Note that the effect of the $\overline{\text{WAIT}}$ and $\overline{\text{READ}}$ signals are applied to inputs of U271A and U271D. When a Hard Copy request occurs, the outputs of those devices go low. This causes the Collimation Electrode Voltage to go to +200 Volts during Hard Copy operation.

The View Control circuit quiescently holds the Flood Gun Cathode at approximately zero volts and the anode at about 140 volts. A voltage divider in the base of Q1036 includes diode CR586, which conducts to hold the cathode near zero volts. Zener diode VR585 conducts to raise the voltage at the base of Q1036 to approximately +140 volts. This is felt through the base-to-emitter circuit of Q1036, where it is applied to the anode of flood guns. Since U71B (in the Fade-Positive Multivibrator) has its pin 12 high under quiescent conditions, U371B delivers a low to the base of Q568, holding that transistor cut off. Zener diode VR576 conducts and causes +100 volts to be placed on the left plate of C195. With the anode of CR586 very near ground potential, C195 charges to approximately 100 volts.

When a $\overline{\text{PAGE}}$ signal is received, pin 12 of U71B goes low, causing U371B to deliver a high to the base of Q568. This transistor conducts and places the left plate of C195 near ground potential. With the left plate going negative by 100 V, the right plate is driven negative by an equal amount, placing a −100 V signal on the cathode of the flood guns. Since VR585 is still conducting, the voltage on the base of Q1036 drops to +40 V. The cathode of Q1046 and the CRT flood gun anode are thus caused to change in step with the CRT cathode voltage. After the 12 ms pulse from U71B elapses, the voltages return to their previous levels, 0 and +140 volts.

Under viewing conditions, the VIEW signal is high, holding Q471 cut off, which holds Q472 cut off and permits the just-described situation to exist. However, when the viewing period has elapsed and the VIEW signal goes low, Q471 goes into conduction, causing Q472 to conduct. This back-biases CR589 and places approximately −15 volts on the base of Q1036. The Q1036 emitter voltage and flood gun anode voltage drop to about −15.6 V. With the flood gun cathode at 0 V, the flood gun decreases conduction and drops the CRT intensity below the viewing level.

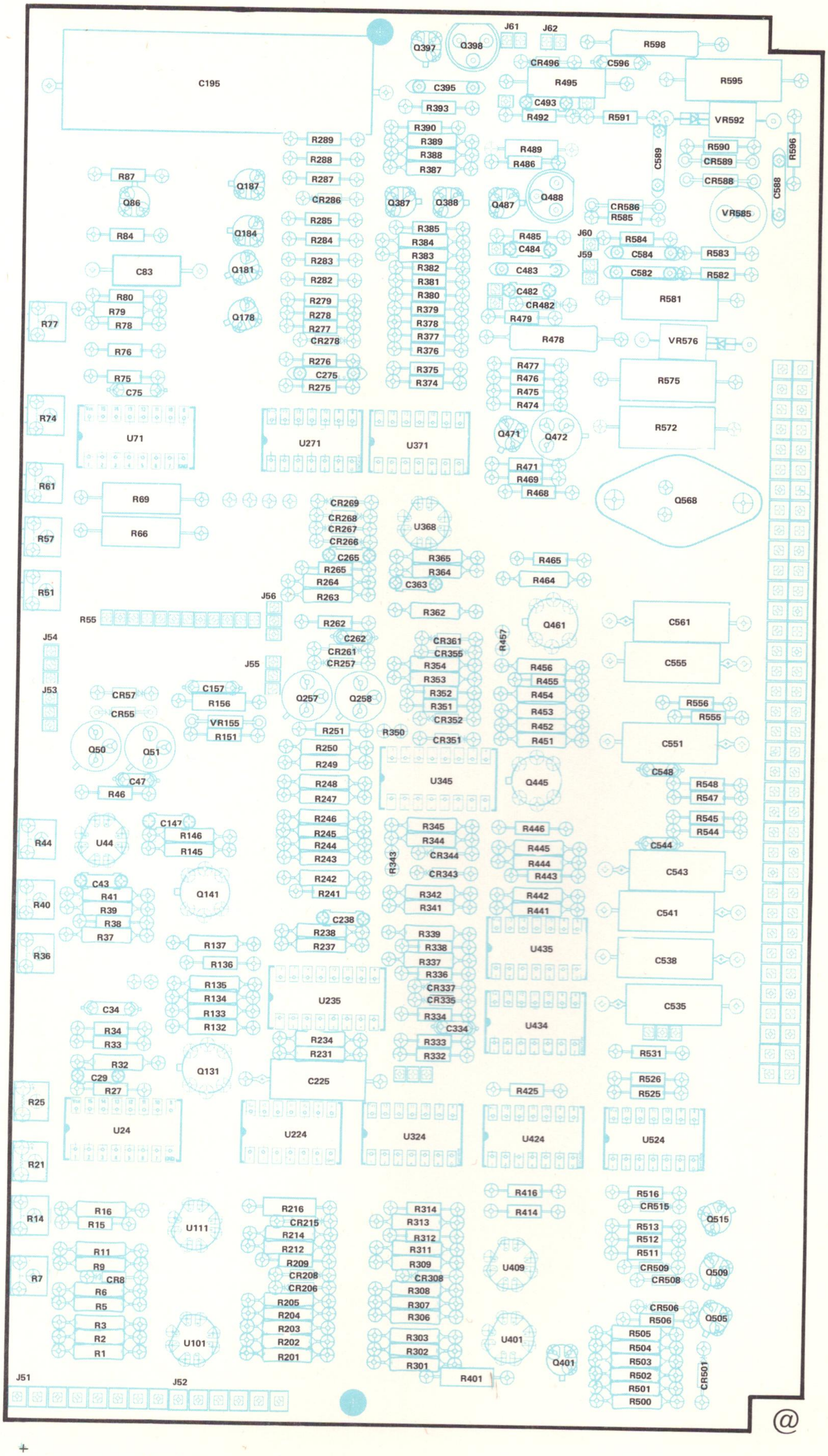


Fig. 6-31. Deflection Amp & Storage board component locations.

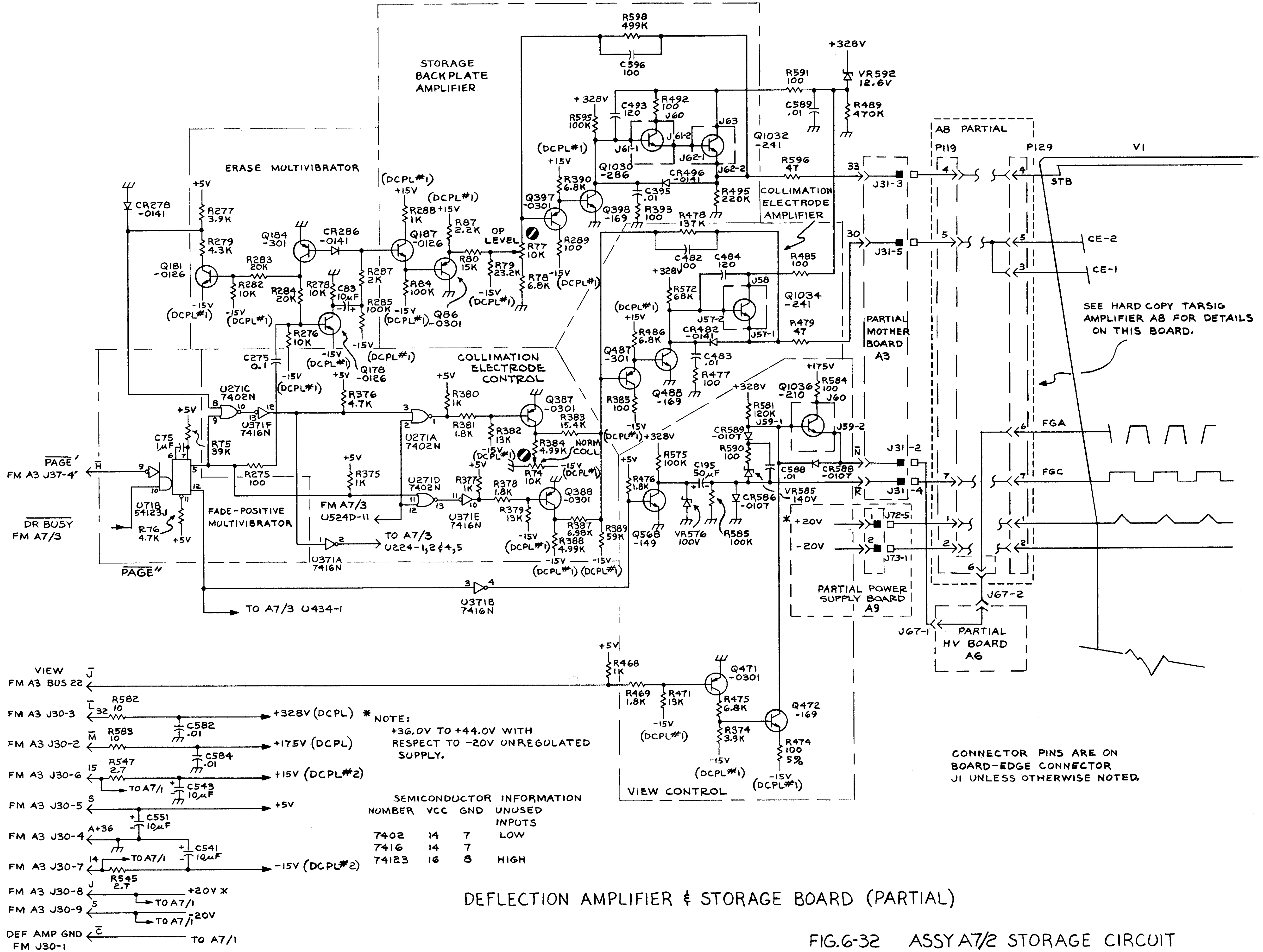


FIG.6-32 ASSY A7/2 STORAGE CIRCUIT
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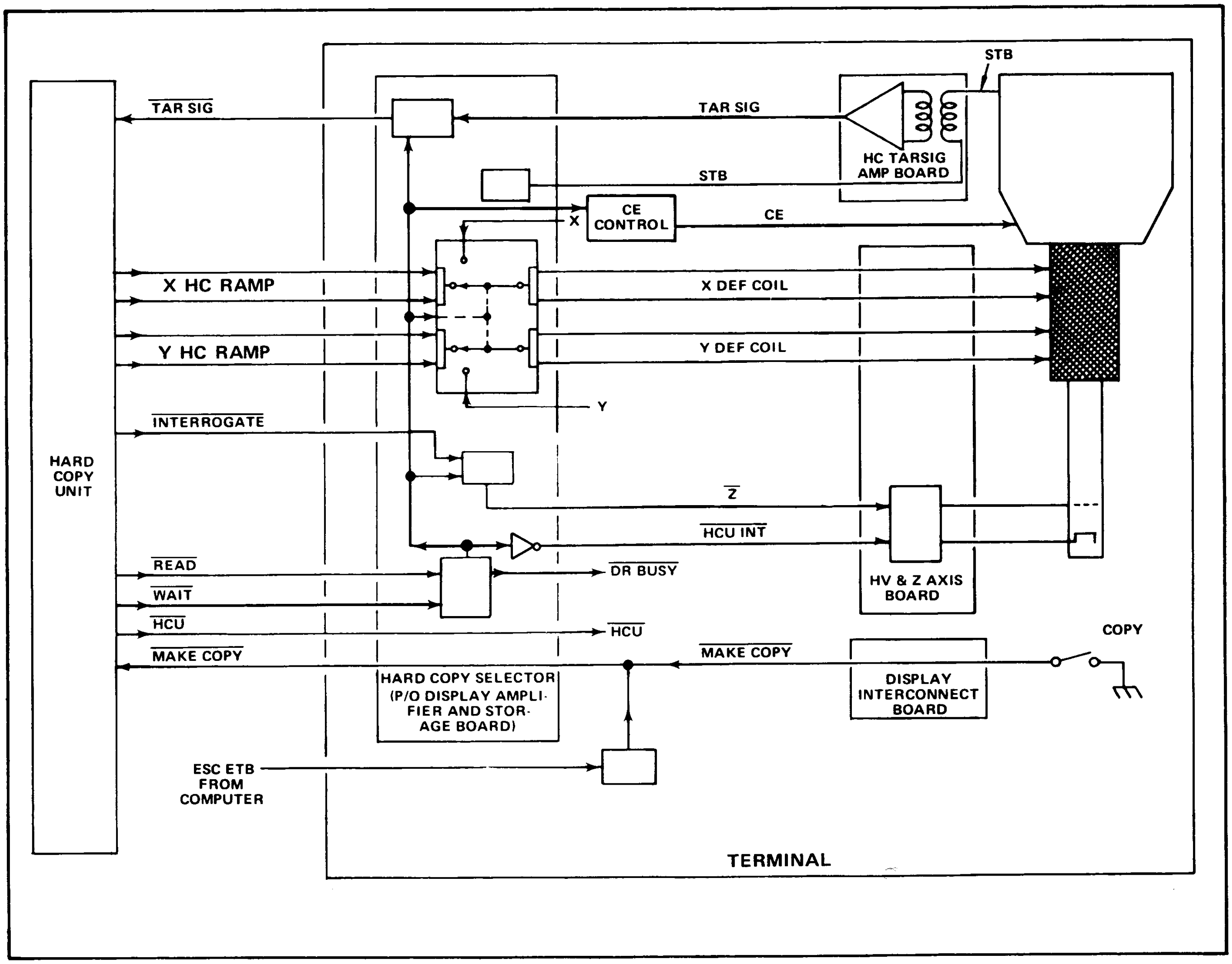


Fig. 6-33. Hard Copy Operation block diagram.

Hard Copy Circuits

Block Diagram Description. The overall purpose of the Hard Copy Selector is to provide the Hard Copy Unit with a command for initiating a hard copy, then supplying the Hard Copy Unit with writing information that represents the data stored on the CRT. Additionally, the Hard Copy Selector circuit contains an Origin Shifter circuit which shifts the page position slightly each time the display is erased. Sequential selection of any one of eight writing positions is automatically achieved, thereby extending tube life.

Refer to Fig. 6-33. Whenever the Hard Copy Unit is attached and energized, an $\overline{\text{HCU}}$ signal is presented to the Terminal to advise of its availability. Whenever a $\overline{\text{MAKE COPY}}$ signal is initiated at the Terminal, or is initiated by an ESC ETB sequence from the computer, the $\overline{\text{MAKE COPY}}$ command is applied to the Hard Copy Unit where it causes several outputs. A $\overline{\text{READ}}$ signal and a $\overline{\text{WAIT}}$ signal are applied to the Terminal to indicate that a hard copy is being made. This causes the Terminal to generate a $\overline{\text{DRBUSY}}$ signal to disable keyboard and computer inputs to the Terminal. The Terminal also generates an $\overline{\text{HCU INT}}$ signal to modify the cathode and control grid voltages of the writing circuits. $\overline{\text{READ}}$ causes the Deflection circuits to select X and Y inputs from the Hard Copy Unit rather than from the Terminal circuits. In addition, the $\overline{\text{READ}}$ signal causes enabling voltages to be placed on the Z Axis circuit and the TARSIG circuits within the Deflection Amplifier and Storage board. The CE Voltage to the Storage circuits is also modified by the $\overline{\text{READ}}$ signal effects, adjusting the display to an intensity compatible with copy making.

The Hard Copy Unit provides a positive-going Y HC RAMP to the Y Deflection circuits in the Terminal to cause the Terminal to sweep vertically one time. As it sweeps, a succession of X HC RAMPS is supplied to the X Deflection circuits. This causes repetitive horizontal sweeps during the vertical sweep. The ramp signals are supplied to the Readout circuits in the Hard Copy Unit at the same time they are being provided to the Terminal, permitting both units to be evaluating the same point on the display. (Note: Hard Copy X and Y functions may be interchanged, dependent upon the Hard Copy Unit in use, and its option selections.)

During each fast ramp, the Hard Copy Unit supplies repetitive $\overline{\text{INTERROGATE}}$ signals to the Terminal. These cause $\overline{\text{Z}}$ signals to be sent to the High Voltage & Z Axis board. There they turn the writing beam on. If writing exists on the storage backplate in the position indicated by the deflection coils, the resultant current in the Storage Backplate circuit causes a TARSIG signal to be generated on the Hard Copy TARSIG Amplifier board. This is gated through by the $\overline{\text{READ}}$ signal. This results in $\overline{\text{TARSIG}}$ being sent to the Hard Copy Unit. The Hard Copy Unit then writes a point at the position commanded by the X HC RAMP and Y HC RAMP. When the Y HC RAMP ends, Hard Copy operation is discontinued and all signal lines except $\overline{\text{HCU}}$ return to their inactive status. Control of the Deflection circuit is returned to the X and Y signals from the Terminal.

Detailed Circuit Description. Refer to the Hard Copy Selector schematic, Fig. 6-35. The X and Y outputs are each the output of one of two amplifiers, as selected by the Q505 circuit. With Hard Copy not selected, the $\overline{\text{WAIT}}$ and $\overline{\text{READ}}$ signals are high, placing a high on the base of Q509 via Q515. This causes Q505 to place lows at the CR206-CR208 and the CR501-CR506 junctions. CR206 and CR501 are forward-biased, placing lows at the positive inputs of U101 and U401. Their outputs are driven sufficiently low to back-bias CR8 and CR308, disconnecting the amplifiers from the output circuit. At the same time, diodes CR208 and CR506 become back-biased, preventing Q505 from affecting either U111 or U409. This permits the X and Y signals to control the X and Y outputs to the Deflection Amplifier circuit. Each amplifier has a gain of approximately one.

When a Hard Copy is commanded, $\overline{READ}$ goes low, causing the emitter of Q505 to go high. This places highs at the negative inputs of U111 and U409, causing their outputs to go low. CR215 and CR509 become back-biased, preventing U111 and U409 from affecting the X and Y outputs. CR206 and CR501 are also reverse-biased, permitting the X HC RAMP and Y HC RAMP to control the X and Y outputs to the Deflection Amplifiers. The output amplitudes can be controlled by adjusting R7 and R21, which determine the amount of voltage being presented to the amplifiers. R14 and R25 provide X and Y positioning adjustments for the X HC RAMP and Y HC RAMP, respectively. A strap option on the Deflection Amplifier schematic permits the X and Y Deflection Amplifiers to both be controlled by the Y signal. This permits simultaneous application of equal drive signals to both axes for calibration purposes.

U524D also controls U24B, U524C, U424B, and U424A. When $\overline{READ}$ and $\overline{WAIT}$ are high, the outputs of these circuits rest at their inactive state. When $\overline{READ}$ or $\overline{WAIT}$ go low, the following happens: $\overline{HCU\ INT}$ goes low, $\overline{DRBUSY}$ goes low, $\overline{TARSIG}$ is put under the control of the TARSIG input signal, and $\overline{Z'}$ is placed under the control of $\overline{INTERROGATE}$; U24B causes a $\overline{Z'}$ pulse to occur in response to each $\overline{INTERROGATE}$ signal. When $\overline{READ}$ or $\overline{WAIT}$ return high, C255 holds a low on U224C for a short time, holding $\overline{DRBUSY}$ low for that additional period. The $\overline{WAIT}$ signal is an input from the Hard Copy Unit (if the Hard Copy Unit is equipped with the Multiplexer option). If the Hard Copy Unit is copying another Terminal's display, the $\overline{WAIT}$ signal holds the waiting Terminal inactive until the Hard Copy Unit gets around to copying its display. When the copy is completed, $\overline{WAIT}$ and $\overline{READ}$ go inactive.

The Origin Shifter circuit is simply a divide-by-eight counter, clocked by the PAGE" signal from the Storage Circuit. Its outputs are applied to a digital-to-analog circuit which shifts the reference positions of the X and Y amplifiers which are selected during Terminal writing. Each time the Display is erased, U434 advances its output and the X and Y reference positions change slightly. A strap option permits selection of a fixed position during adjustment.

Refer to the Hard Copy TARSIG Amplifier schematic diagram, Fig. 6-36. The Hard Copy TARSIG Amplifier board permits the STB current to be monitored. Since this current reflects whether a written or non-written area is being scanned, it provides information for hard copy writing. Filtering is provided to the remaining CRT lines to minimize circuit noise.

The storage backplate signals are coupled through T38 and applied to differential amplifier U59, which has a gain of approximately 400. Its output is amplified by approximately 10 in U79 and applied to comparator U95. U95 provides a negative output pulse in response to STB signals of an amplitude determined by threshold potentiometer R167. R167 permits the voltage at the positive input of U95 to be set between 0 and +3.3 volts. The Dynamic Threshold adjustment (R265) provides a correction voltage that gives optimum uniformity of separation between the signal levels on TP85 and TP195 as the scanning signals monitor the entire screen area. This provides U95 with a more uniform pulse, regardless of where on the CRT the STB pulse originated. The U95 output pulses are applied to one-shot multivibrator U289, which responds by generating 0.4 μs (approximate) positive-going TARSIG pulses.

@

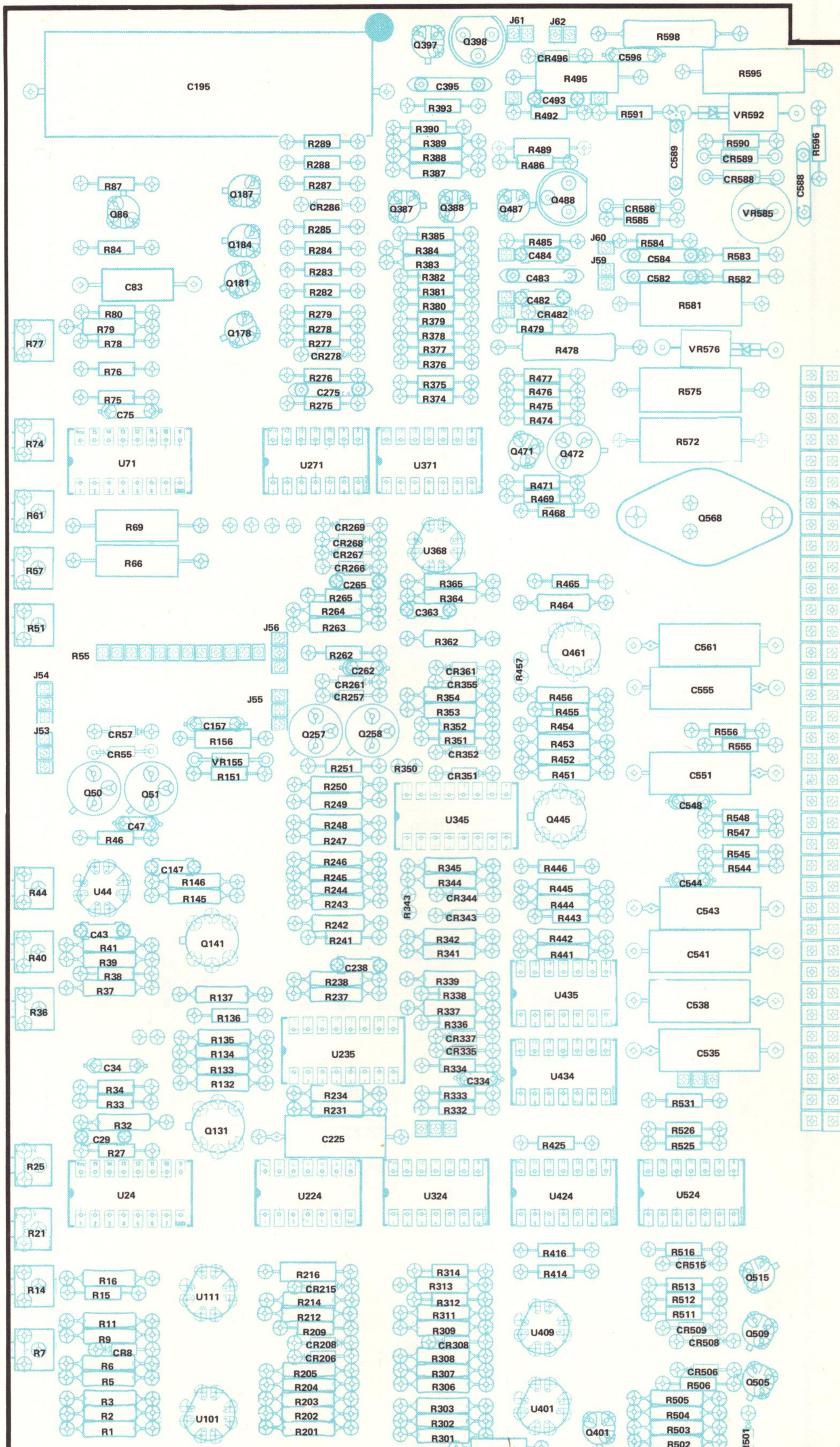
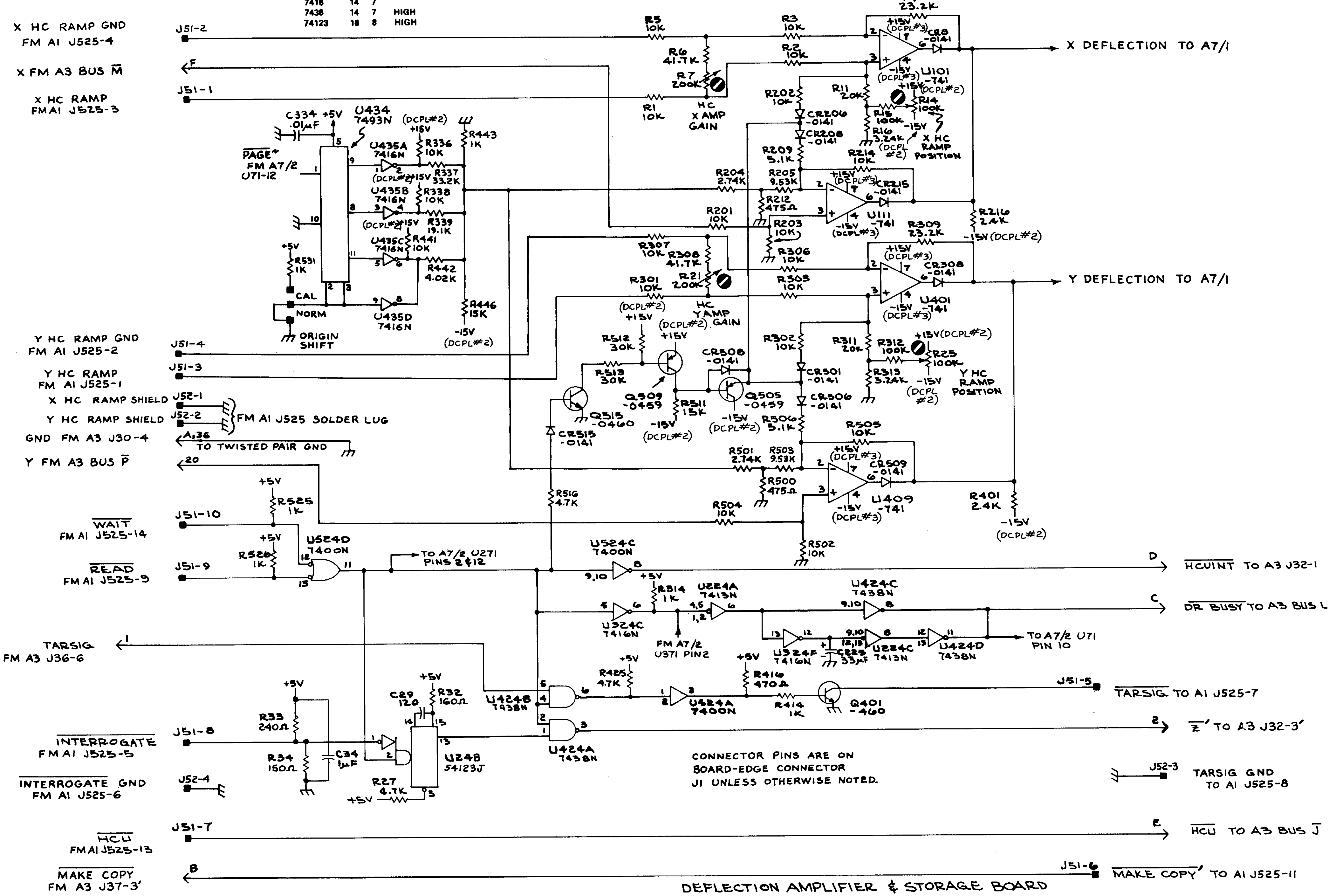


Fig. 6-34. Deflection Amp & Storage board component locations.

HARD COPY SELECTOR
SCHEMATIC A-7/3

Semiconductor Information

NUMBER	VCC	GND	UNUSED INPUTS
7400	14	7	HIGH
7413	14	7	HIGH
7416	14	7	
7438	14	7	HIGH
74123	16	8	HIGH



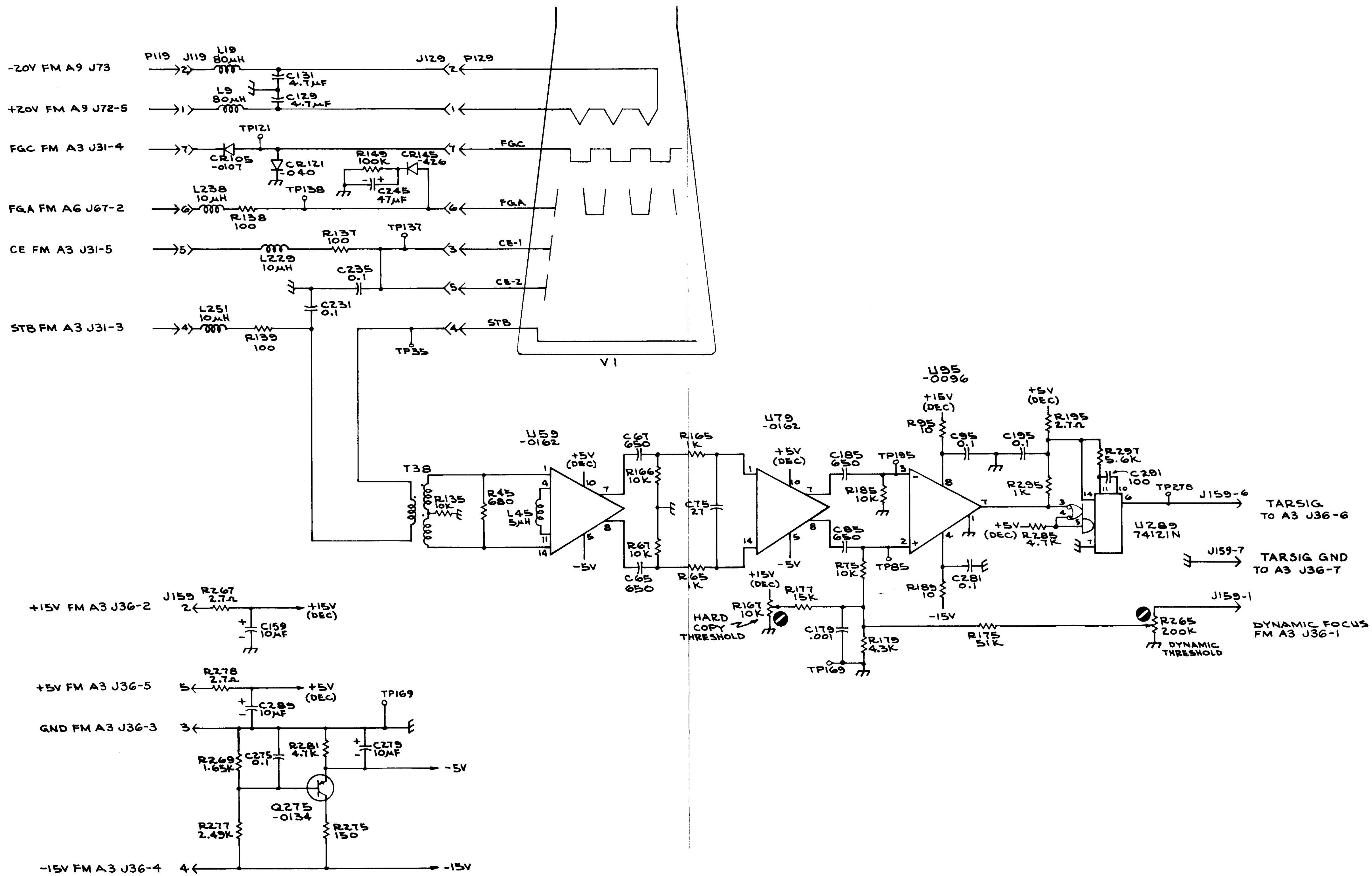
DEFLECTION AMPLIFIER & STORAGE BOARD (PARTIAL)

SEE A7/1 AND A7/2 FOR OPERATING VOLTAGES.

RE4012 @ FIG. 6-35 ASSY A7/3

REV APR 1974
HARD COPY SELECTOR
DAS BOARD # 670-3731
JD-4201-00

HARD COPY SELECTOR SCHEMATIC A-7/3



Semiconductor Information

NUMBER	VCC	GND	UNUSED INPUTS
74121	14	7	HIGH

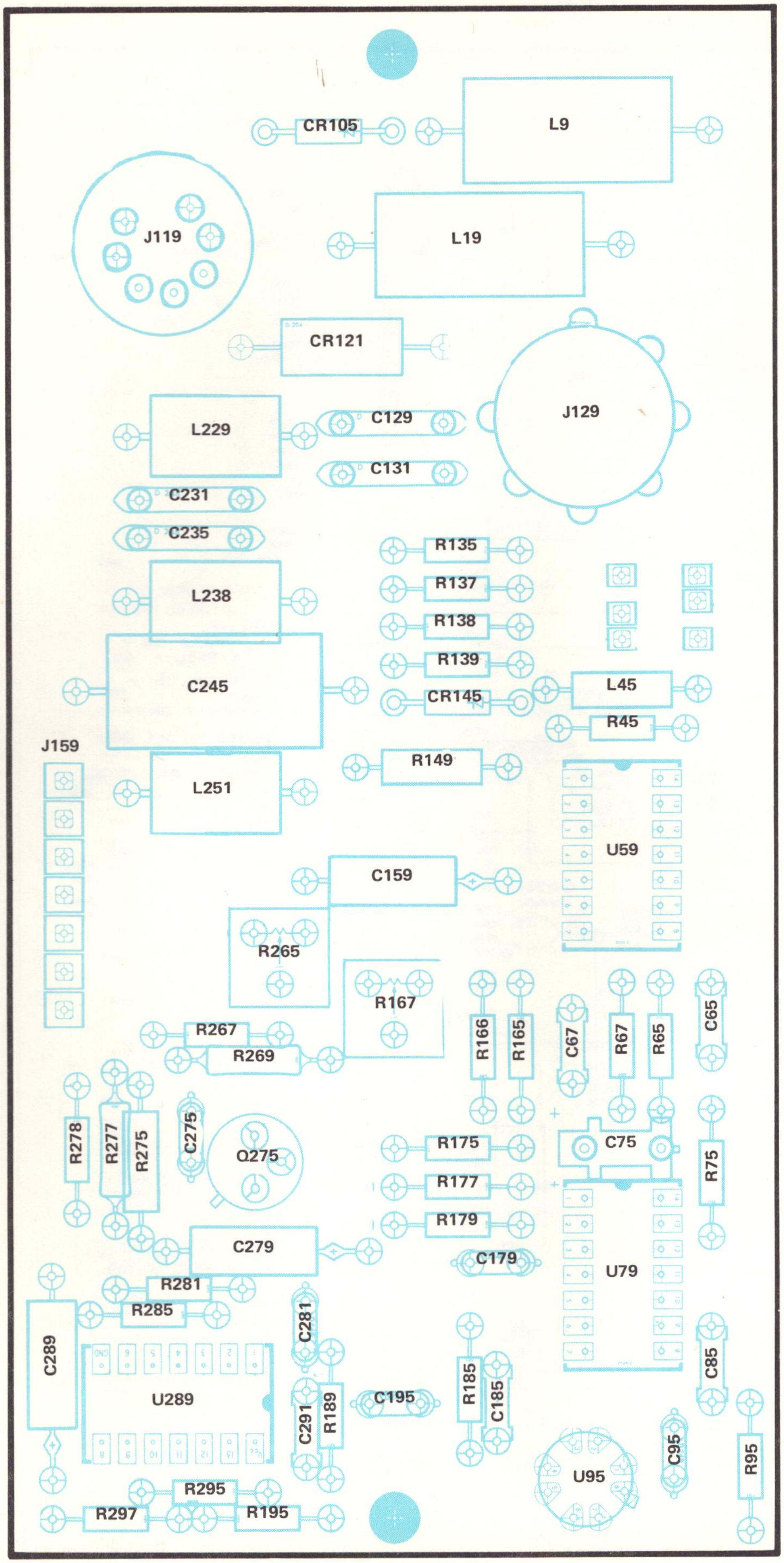
3-133

HARD COPY TARSIG AMPLIFIER SCHEMATIC A-8

FIG. 6-36 ASSY A8 HARD COPY TARSIG AMPLIFIER

JA-4387-00
670-3920-00

@



@ Fig. 6-37. Hard Copy TARSIG Amplifier board component locations.

LOW-VOLTAGE POWER SUPPLY

Refer to the Low-Voltage Power Supply schematic, Fig. 6-38. This power supply has regulated outputs of −15 volts, +5 volts, and +15 volts. It also has unregulated outputs of −20 volts, +20 volts, +175 volts, and +328 volts.

Unregulated Supplies. All of these, except for +175 volts, obtain their power from conventional, full-wave bridge rectifier circuits. The +175 volt supply uses a full-wave center-tapped transformer configuration. The sources for the +328 volts, +175 volts, and +20 volts are connected in series-aiding, with each supply being referenced to the next lower supply. For example, two windings are in series to provide power for the +328 volt circuit.

Three fuses provide protection for the power supply circuits. F21 fuses the +15 volt and +20 volt supplies. F41 fuses the +5 volt supply and F61 fuses the −20 volt and −15 volt supplies.

Regulated Supplies. U151 pin 4 develops the voltage reference that is used for the +15 volt and +5 volt supplies. A portion of this is picked off by R57 and is applied as reference to the positive inputs of U151 and U267. The regulated +15 volt output is applied through a voltage divider to the negative input of U151 to provide regulating drive to that amplifier. The pin 6 output from U151 is applied to Q253 to control the drive current to series regulator Q1002.

The voltage across current-sensing resistor R259 is sensed between pins 1 and 6 of U151. When an abnormal load increases the current through R259 and Q1002 to an excessive level, the U151 pin 6 output restricts the Q1002 current to a non-destructive value.

The regulated +5 volts is applied through R265 to the negative input of U267. U267 compares this against the voltage at the positive input to generate a regulating output voltage, which is applied to Q1004 to control the drive current to series regulator Q1005. Q73 and Q81 provide the +5 volt circuits with over-voltage protection, limiting it to approximately +7 volts. Under normal conditions, the +5 volts applied to the emitter of Q73 is insufficient to cause the device to conduct, since its base is held at approximately 6.4 volts by the R51-R57 junction. If the +5 volt line should go as high as 7 volts, Q73 conducts. When the voltage at the gate of Q81 reaches 1.2 volts, Q81 conducts and immediately lowers the +5 volt line to approximately 1 volt. The associated surge of current causes F381 to open up, removing power from the circuit.

The −15 Volt regulator uses ground for a reference at the input of U246. The negative input receives its signal from a comparison between the +15 volt supply and the −15 volt supply applied through voltage divider R250 and R253. Any deviations on the −15 volt line cause drive to U246, which provides a signal to the error amplifier Q243. This controls the drive to Q1005, regulating the −15 volt supply.

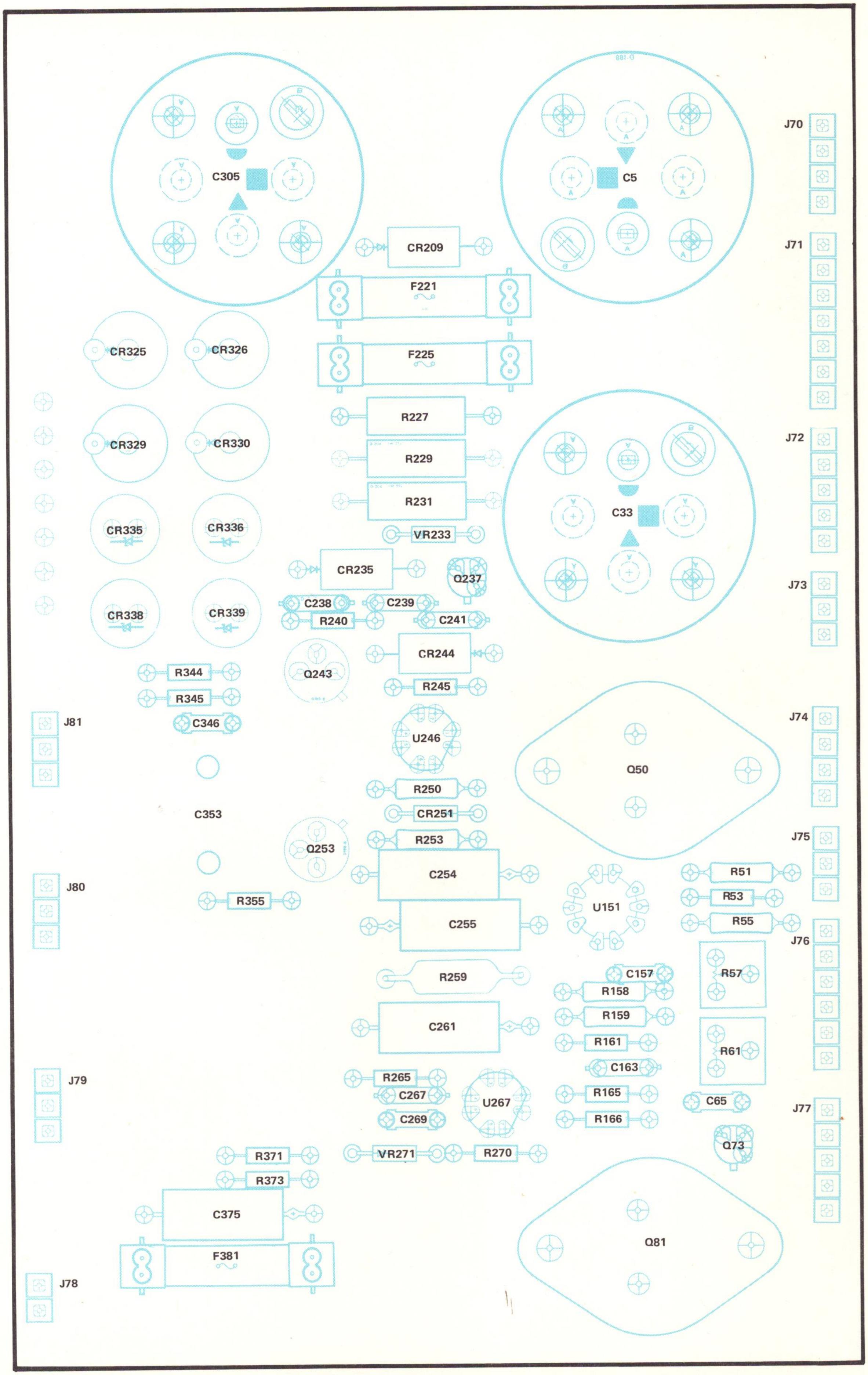
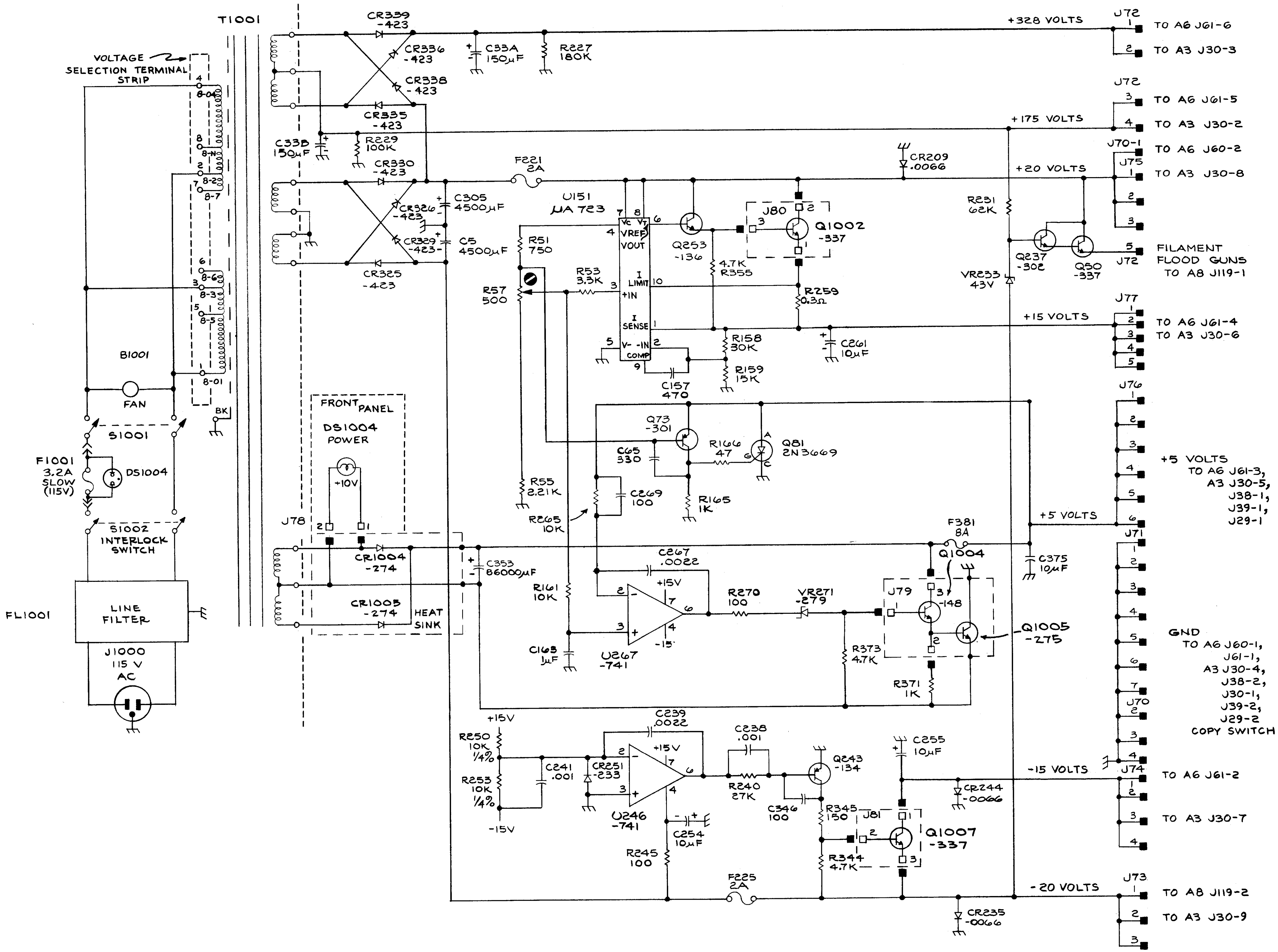


Fig. 6-38. Low Voltage Power Supply board component locations.



RE4012

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FIG.6-39 ASSY A9 POWER SUPPLY
JD 4321-00
670-3852-00

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
--- * ---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
--- * ---
Parts of Detail Part
Attaching parts for Parts of Detail Part
--- * ---

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol --- * --- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
00779	AMP, INC.	P. O. BOX 3608	HARRISBURG, PA 17105
01139	GENERAL ELECTRIC CO., SILICONE PROD DEPT.		WATERFOR, NY 12188
02107	SPARTA MFG. CO.	ROUTE NO. 2, BOX 128	DOVER, OH 44622
02735	RCA CORP., SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04963	MINNESOTA MINING AND MFG. CO., ADHESIVES COATINGS AND SEALERS DIVISION	3M CENTER	ST. PAUL, MN 55101
05820	WAKEFIELD ENGINEERING, INC.	AUDUBON ROAD	WAKEFIELD, MA 01880
06982	MOORE, HOWARD J., CO.	105 E. 16TH ST.	NEW YORK, NY 10003
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
10389	CHICAGO SWITCH, INC.	2035 WABANSIA AVE.	CHICAGO, IL 60647
12327	FREEWAY CORP.	9301 ALLEN DR.	CLEVELAND, OH 44125
16428	BELDEN CORP.	P. O. BOX 1101	RICHMOND, IN 47374
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
26365	GRIES REPRODUCER CO., DIV. OF COATS AND CLARK INC.	125 BEECHWOOD AVE.	NEW ROCHELLE, NY 10802
27264	MOLEX PRODUCTS CO.	5224 KATRINE AVE.	DOWNERS GROVE, IL 60515
28520	HEYMAN MFG. CO.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
52833	KEYTRONICS CORP.	BLDG. 14 SPOKANE INDUSTRIAL PK	SPOKANE, WA 99216
56878	STANDARD PRESSED STEEL CO.	BOX 608 BENSON EAST	JENKINTOWN, PA 19046
59730	THOMAS AND BETTS CO., THE	36 BUTLER ST.	ELIZABETH, NJ 07207
70276	ALLEN MFG. CO.	P. O. DRAWER 570	HARTFORD, CT 06101
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71124	BRAND-REX CO., A PART OF AKZONA, INC.	P. O. BOX 498, RT. 32	WILLIMANTIC, CT 06226
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71468	ITT CANNON ELECTRIC	666 E. DYER RD.	SANTA ANA, CA 92702
71785	TRW ELECTRONIC COMPONENTS, CINCH CONNECTOR OPERATIONS	1501 MORSE AVE.	ELK GROVE VILLAGE, IL 60007
72653	G. C. ELECTRONICS CO., A DIVISION OF HYDROMETALS, INC.	400 S. WYMAN ST.	ROCKFORD, IL 61101
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
77969	RUBBERCRAFT CORP. OF CALIF., LTD.	1800 W. 220TH ST.	TORRANCE, CA 90507
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
80009	TEKTRONIX, INC.	P. O. BOX 500	BEAVERTON, OR 97077
83309	ELECTRICAL SPECIALITY CO., SUBSIDIARY OF BELDEN CORP.	213 E. HARRIS AVE.	SOUTH SAN FRANCISCO, CA 9408
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
89663	REESE, J. RAMSEY, INC.	71 MURRAY ST.	NEW YORK, NY 10007
95354	METHODE MANUFACTURING CORP.	1700 SO. HICKS RD.	ROLLING MEADOWS, IL 60008
95937	FEDERAL TELEVISION DIV., CARDWELL CONDENSER CORP.	80 E. MONTAUK HWY.	LINDENHURST, NY 11757
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-	610-0348-00			1	CHASSIS ASSY:KEYBOARD	80009	610-0348-00
					(ATTACHING PARTS)		
-1	211-0584-00			4	SCR,CAP,SOC HD:6-32 X 0.250 INCH LG,STL	74445	OBD
					- - - * - - -		
	----- -----			-	. CHASSIS ASSY INCLUDES:		
-2	----- -----			4	. SWITCH,LEVER:(SEE S1080,1081,1082,1087 EPL)		
					(ATTACHING PARTS FOR EACH)		
-3	210-0473-00			1	. NUT,PLAIN,DODEC:0.469-32 X 0.638 INCH,BRS	80009	210-0473-00
-4	354-0055-00			1	. WASHER,KEY:0.469 ID X 0.688 INCH OD,STL	80009	354-0055-00
					- - - * - - -		
-5	----- -----			2	. LAMP,LED:(SEE CR1092,1090 EPL)W/HOLDER		
-6	----- -----			1	. LOUDSPEAKER,PM:(SEE SP1000 EPL)		
					(ATTACHING PARTS)		
-7	210-0858-00			1	. WASHER,FLAT:0.171 ID X 0.500 OD INCH	80009	210-0858-00
-8	210-0046-00			1	. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-9	366-0128-01			2	. KNOB:	80009	366-0128-01
	----- -----			-	. . EACH KNOB INCLUDES:		
-10	213-0140-00			2	. . SETSCREW:2-56 X 0.094 INCH,HEX.SOC STL	70276	OBD
-11	----- -----			2	. RES.,VAR,NONWIR:(SEE R1070,1072 EPL)		
					(ATTACHING PARTS FOR EACH)		
-12	210-0583-00			2	. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20319-402
-13	210-0046-00			1	. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-14	407-0994-00			1	. BRACKET,ANGLE:	80009	407-0994-00
					(ATTACHING PARTS)		
-15	210-0586-00			2	. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
					- - - * - - -		
	----- -----			1	. CKT BOARD ASSY:KEYBOARD(SEE A2 EPL)		
					(ATTACHING PARTS)		
-16	211-0517-00			8	. SCREW,MACHINE:6-32 X 1 INCH,PNH,STL	83385	OBD
					- - - * - - -		
	----- -----			-	. . CKT BOARD ASSY INCLUDES:		
-17	366-1553-00			1	. . SET,KEYTOP:60 KNOBS	52833	66-0929-01
	366-1555-01			1	. . . PUSHBUTTON SET:A THRU Z	52833	GLWW0101000099000101
	366-1555-02			1	. . . . PUSHBUTTON:A	52833	GLWW01010000A0010101
	366-1555-03			1	. . . . PUSHBUTTON:B	52833	GLWW01010000B0010101
	366-1555-04			1	. . . . PUSHBUTTON:C	52833	GLWW01010000C0010101
	366-1555-05			1	. . . . PUSHBUTTON:D	52833	GLWW01010000D0010101
	366-1555-06			1	. . . . PUSHBUTTON:E	52833	GLWW01010000E0010101
	366-1555-07			1	. . . . PUSHBUTTON:F	52833	GLWW01010000F0010101
	366-1555-08			1	. . . . PUSHBUTTON:G	52833	GLWW01010000G0010101
	366-1555-09			1	. . . . PUSHBUTTON:H	52833	GLWW01010000H0010101
	366-1555-10			1	. . . . PUSHBUTTON:I	52833	GLWW01010000I0010101
	366-1555-11			1	. . . . PUSHBUTTON:J	52833	GLWW01010000J0010101
	366-1555-12			1	. . . . PUSHBUTTON:K	52833	GLWW01010000K0010101
	366-1555-13			1	. . . . PUSHBUTTON:L	52833	GLWW01010000L0010101
	366-1555-14			1	. . . . PUSHBUTTON:M	52833	GLWW01010000M0010101
	366-1555-15			1	. . . . PUSHBUTTON:N	52833	GLWW01010000N0010101
	366-1555-16			1	. . . . PUSHBUTTON:O	52833	GLWW01010000O0010101
	366-1555-17			1	. . . . PUSHBUTTON:P	52833	GLWW01010000P0010101
	366-1555-18			1	. . . . PUSHBUTTON:Q	52833	GLWW01010000Q0010101
	366-1555-19			1	. . . . PUSHBUTTON:R	52833	GLWW01010000R0010101
	366-1555-20			1	. . . . PUSHBUTTON:S	52833	GLWW01010000S0010101
	366-1555-21			1	. . . . PUSHBUTTON:T	52833	GLWW01010000T0010101
	366-1555-22			1	. . . . PUSHBUTTON:U	52833	GLWW01010000U0010101
	366-1555-23			1	. . . . PUSHBUTTON:V	52833	GLWW01010000V0010101
	366-1555-24			1	. . . . PUSHBUTTON:W	52833	GLWW01010000W0010101
	366-1555-25			1	. . . . PUSHBUTTON:X	52833	GLWW01010000X0010101
	366-1555-26			1	. . . . PUSHBUTTON:Y	52833	GLWW01010000Y0010101
	366-1555-27			1	. . . . PUSHBUTTON:Z	52833	GLWW01010000Z0010101
	366-1555-28			1	. . . PUSHBUTTON SET:1 THRU 9	52833	GLWW0101000099020801
	366-1555-29			1	. . . PUSHBUTTON:ZERO	52833	GLWW0101000010100101

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-	366-1553-01			1	. . . PUSHBUTTON:ASTERISK OVER COLON	52833	GLWW010100000010110802
	366-1553-31			1	. . . PUSHBUTTON:EQUAL OVER MINUS	52833	GLWW010100010380802
	366-1555-32			1	. . . PUSHBUTTON:PLUS OVER SEMICOLON	52833	GLWW010100010370802
	366-1555-33			1	. . . PUSHBUTTON:LESS THAN OVER COMMA	52833	GLWW010100010340802
	366-1555-34			1	. . . PUSHBUTTON:GREATER THAN OVER PERIOD	52833	GLWW010100010350802
	366-1555-35			1	. . . PUSHBUTTON:QUESTION MARK OVER SLASH	52833	GLWW010100010140802
	366-1553-02			1	. . . PUSHBUTTON:RESET PAGE	52833	GGWW01010000R4441101
	366-1555-37			1	. . . PUSHBUTTON:LEFT BRACE OVER LEFT BRACKET	52833	GGWW010100010850802
	366-1555-38			1	. . . PUSHBUTTON:ESC	52833	GGWW01010000E3890701
	366-1555-39			1	. . . PUSHBUTTON:TILDE OVER CARET	52833	GGWW010100010640802
	366-1555-40			1	. . . PUSHBUTTON:TAB	52833	GGWW01010000T5990701
	366-1555-41			1	. . . PUSHBUTTON:CTRL	52833	GGWW01010000C3560701
	366-1555-42			1	. . . PUSHBUTTON:TTY LOCK	52833	GGWW01010000T4931101
	366-1553-03			1	. . . PUSHBUTTON:SHIFT	52833	GGWW02030000S5771101
	366-1555-44			1	. . . PUSHBUTTON:RIGHT BRACE OVER RIGHT BRACKET	52833	GGWW010100010860802
	366-1555-45			1	. . . PUSHBUTTON:BACK SPACE	52833	GGWW01010000B3211101
	366-1555-46			1	. . . PUSHBUTTON:GRAVE ACCENT OVER AT	52833	GGWW010100010790802
	366-1555-47			1	. . . PUSHBUTTON:LF	52833	GGWW01010000L4780701
	366-1555-48			1	. . . PUSHBUTTON:VERT DASHES OVER BACK SLASH	52833	GGWW010100010870802
	366-1555-49			1	. . . PUSHBUTTON:RUB OUT	52833	GGWW25020000R4431101
	366-1555-50			1	. . . PUSHBUTTON:BREAK	52833	GGWW01010000B3310701
	366-1553-04			1	. . . PUSHBUTTON:RETURN	52833	GGWW09060000R4450701
	366-1555-52			1	. . . PUSHBUTTON:SHIFT	52833	GGWW020200005770701
	366-1553-05			1	. . . PUSHBUTTON:SPACE BAR	52833	GGGG120100010900000
-18	----- -----			1	. . ACTUATOR ASSY:9 OZ SGL UNIT W/MECH ALT ACT	52833	061-00261-009
-19	----- -----			5	. . ACTUATOR ASSY:6 UNIT	52833	061-00036-034
-20	----- -----			1	. . ACTUATOR ASSY:6 UNIT,W/6 OZ IN POS #1	52833	061-00036-060
-21	----- -----			4	. . ACTUATOR ASSY:4 UNIT	52833	061-00034-031
-22	----- -----			2	. . ACTUATOR ASSY:SINGLE UNIT	52833	061-00051-003
-23	----- -----			1	. . ACTUATOR ASSY:5 UNIT W/POS #5 VACANT	52833	061-0045-047
-24	----- -----			1	. . ACTUATOR ASSY:9 OZ SINGLE UNIT	52833	061-0021-008
-25	----- -----			36	. . NUT,PLAIN,HEX:	52833	047-00001-001
-26	----- -----			2	. . BRKT,SPACE BAR:	52833	044-00003-000
					(ATTACHING PARTS FOR EACH)		
-27	----- -----			2	. . SCREW,MACHINE:	52833	047-00005-002
-28	----- -----			2	. . NUT,PLAIN,HEX:	52833	047-00001-001
					- - - * - - -		
-29	----- -----			2	. . LEG SPACER BAR:	52833	044-00001-000
-30	----- -----			1	. . BAR,LEVELING:	52833	049-00002-000
-31	----- -----			1	. . CKT BOARD ASSY:KEYBOARD	52833	065-01125-002
-32	179-2327-00			1	. WIRING HARNESS:KEYBOARD	80009	179-2327-00
-33	131-0621-00			27	. . CONTACT,ELEC:0.577"L,22-26 AWG WIRE	22526	46231
	131-0622-00			1	. . CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
	131-0707-00			5	. . CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
	131-0792-00			1	. . CONTACT,ELEC:0.577"L,18-20 AWG WIRE	22526	46221
-34	343-0549-00			1	. . STRAP,TIEDOWN:0.091 W X 3.62 L,ZYTEL	59730	TY23M
-35	352-0171-00			1	. . CONN BODY,PL,EL:1 WIRE BLACK	80009	352-0171-00
-36	352-0169-00			2	. . CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
-37	352-0202-01			1	. . CONN BODY,PL,EL:6 WIRE BROWN	80009	352-0202-01
-38	352-0203-00			1	. . CONN BODY,PL,EL:7 WIRE BLACK	80009	352-0203-00
-39	352-0204-03			1	. . CONN BODY,PL,EL:8 WIRE ORANGE	80009	352-0204-03
-40	352-0206-04			1	. . CONN BODY,PL,EL:10 WIRE YELLOW	80009	352-0206-04
-41	386-3190-00			1	. PANEL,KEYBOARD:	80009	386-3190-00
-42	252-0571-00			FT	RUB.SPL SHAPED:CHANNEL,1.250 FEET LONG	77969	1353
-43	380-0433-00			1	HOUSING,KYBD:	80009	380-0433-00
					(ATTACHING PARTS)		
-44	212-0004-00			7	SCREW,MACHINE:8-32 X 0.312 INCH,PNH STL	83385	OBD
-45	210-0008-00			7	WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
					- - - * - - -		
-46	610-1034-00			1	CRT ASSEMBLY:	80009	610-1034-00
					(ATTACHING PARTS)		
-47	212-0615-00			6	SCREW,CAP:10-32 X 0.625",SCH,STL BD OXD	56878	OBD
					- - - * - - -		
	----- -----			1	. COIL,TUBE DEFL:(SEE L1040 EPL)		
	348-0012-00			1	. . GROMMET,RUBBER:0.500 ID X 0.780 INCH OD	72653	1043-1M
-48	131-0621-00			4	. . CONTACT,ELEC:0.577"L,22-26 AWG WIRE	22526	46231
-49	352-0200-00			1	. . CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0200-00

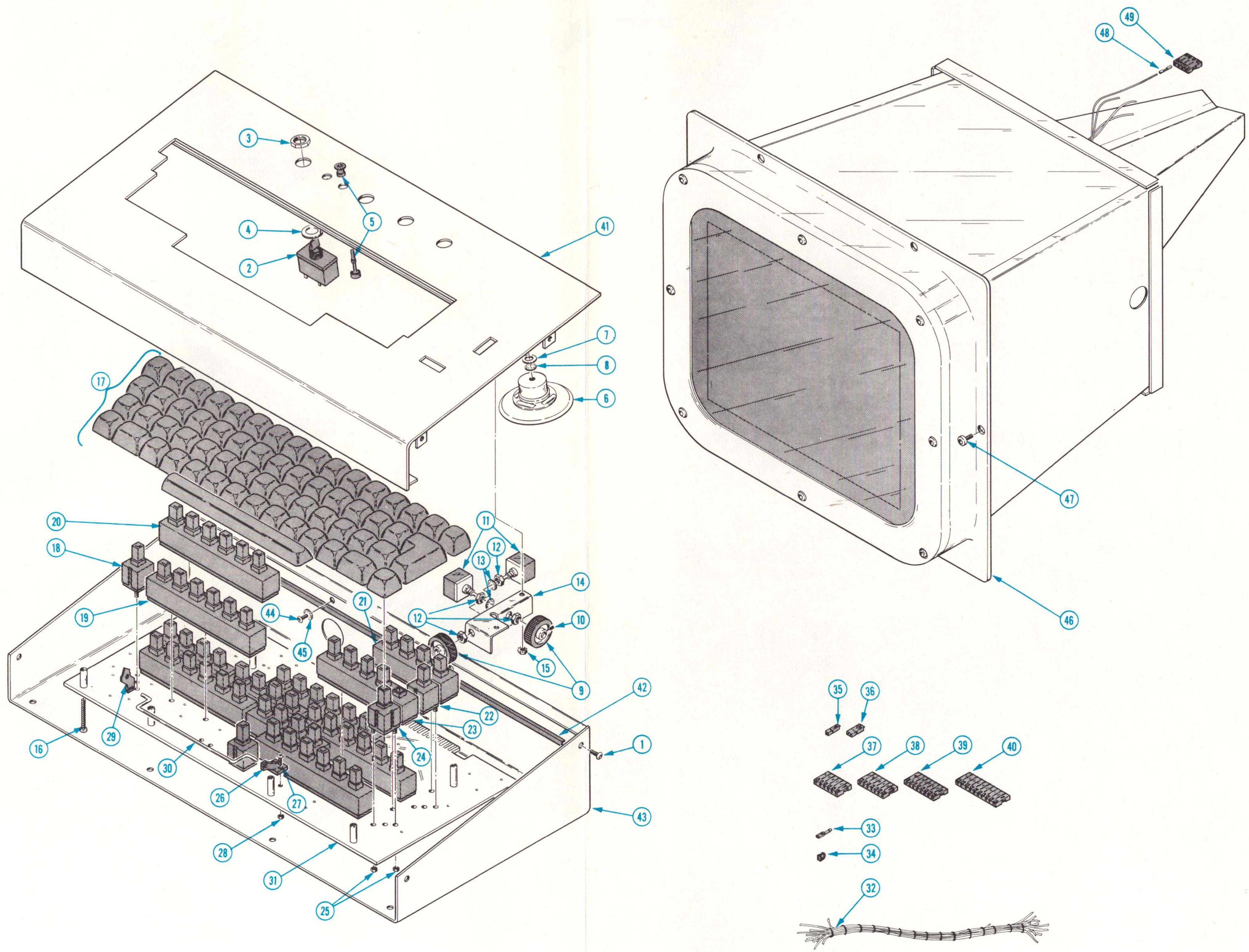
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FIG. 2. CKT BOARDS & CHASSIS

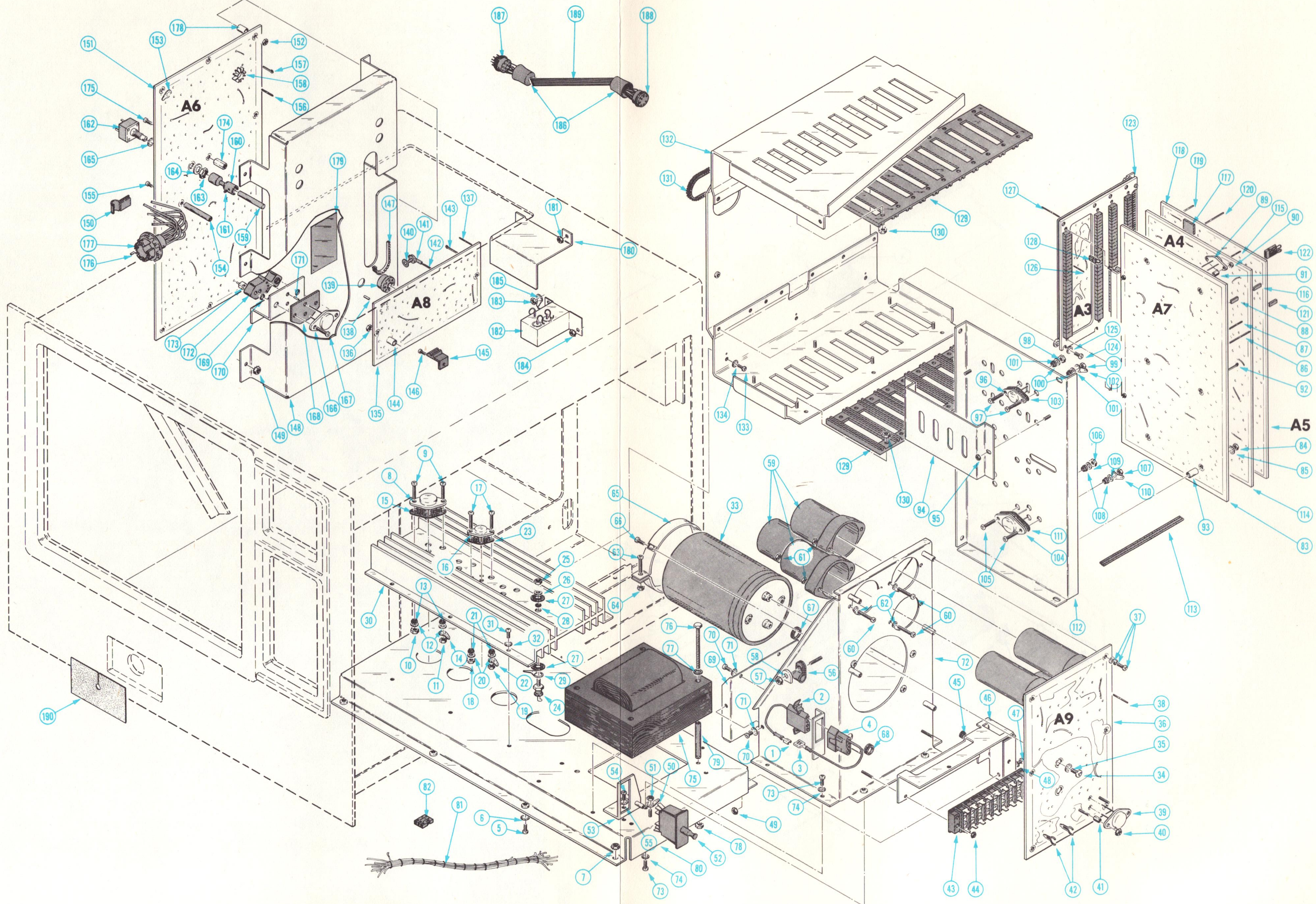

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-1	131-0861-00			4	CONTACT,ELEC:QUICK DISCONNECT	00779	42617-2
	131-0948-00			4	CONTACT,ELEC:FEMALE,0.093 ID X 0.865" L	27264	02-09-1103
-2	131-0946-00			2	CONNECTOR BODY,:FEMALE,4 CONTACT	27264	03-09-2041
-3	131-1159-00			4	CONTACT,ELEC:250 FASTEN	00779	60041-2
	131-0945-00			4	CONTACT,ELEC:MALE,0.093 DIA X 0.865" L	27264	02-09-2103
-4	131-0947-00			2	CONNECTOR BODY,:MALE,4 CONTACT	27264	03-09-1041
	620-0245-00			1	POWER SUPPLY:LOW VOLTAGE	80009	620-0245-00
					(ATTACHING PARTS)		
-5	212-0033-00			6	SCREW,MACHINE:8-32 X 0.750 INCH,PNH STL	83385	OBD
-6	210-0008-00			6	WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
-7	210-0458-00			2	NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL	83385	OBD
					- - - * - - -		
	----- -----			-	. POWER SUPPLY INCLUDES:		
-8	----- -----			3	. TRANSISTOR:(SEE Q1002,1005,,1007 EPL)		
					(ATTACHING PARTS FOR EACH)		
-9	211-0578-00			2	. SCREW,MACHINE:6-32 X 0.438 INCH,PNH STL	83385	OBD
-10	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-11	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-12	210-0803-00			2	. WASHER,FLAT:0.15 ID X 0.375 INCH OD,STL	12327	OBD
-13	210-0967-00			2	. WSHR,SHOULDERED:0.157 ID X 0.375 INCH OD	80009	210-0967-00
-14	210-0202-00			1	. TERMINAL,LUG:SE #6	78189	2104-06-00-2520N
					- - - * - - -		
-15	386-0978-00			3	. INSULATOR,PLATE:0.002 INCH MICA,FOR TO-3	80009	386-0978-00
-16	----- -----			1	. TRANSISTOR:(SEE Q1004 EPL)		
					(ATTACHING PARTS)		
-17	211-0578-00			2	. SCREW,MACHINE:6-32 X 0.438 INCH,PNH STL	83385	OBD
-18	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-19	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-20	210-0803-00			1	. WASHER,FLAT:0.15 ID X 0.375 INCH OD,STL	12327	OBD
-21	210-0967-00			1	. WSHR,SHOULDERED:0.157 ID X 0.375 INCH OD	80009	210-0967-00
-22	210-0202-00			1	. TERMINAL,LUG:SE #6	78189	2104-06-00-2520N
					- - - * - - -		
-23	386-0143-00			1	. INSULATOR,PLATE:0.002 INCH MICA,FOR TO-2	02735	DF31A
-24	----- -----			2	. SEMICOND DEVICE:(SEE CR1004 AND CR1005 EPL)		
					(ATTACHING PARTS FOR EACH)		
-25	210-0410-00			1	. NUT,PLAIN,HEX.:10-32 X 0.312 INCH,BRS	73743	2X20003-402
-26	210-0805-00			1	. WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
-27	210-0909-00			2	. WASHER,FLAT:0.196 ID X 0.625 INCH OD,MICA	83309	OBD
-28	210-0910-00			1	. WASHER,NONMETAL:0.188 ID X 0.313" OD,TEFLON	02107	1704B863
-29	210-0224-00			1	. TERMINAL,LUG:#10 NON LOCKING	78189	2501-10-00-2220N
					- - - * - - -		
-30	214-2225-00			1	. HEAT SINK,XSTR:LOW VOLTAGE	80009	214-2225-00
					(ATTACHING PARTS)		
-31	211-0507-00			6	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-32	210-0006-00			6	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-33	----- -----			1	. CAP.,FXD,ELCTLT:(SEE C353 EPL)		
					(ATTACHING PARTS)		
-34	212-0507-00			2	. SCREW,MACHINE:10-32 X 0.375 INCH,PNH STL	83385	OBD
-35	210-0010-00			2	. WASHER,LOCK:INT,0.20 ID X0.376" OD,STL	78189	1210-00-00-0541C
					- - - * - - -		
-36	----- -----			1	. CKT BOARD ASSY:POWER SUPPLY(SEE A9 EPL)		
					(ATTACHING PARTS)		
-37	211-0207-00			6	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. . CKT BOARD ASSY INCLUDES:		
-38	131-0589-00			48	. . CONTACT,ELEC:0.46 INCH LONG	22526	47350
-39	----- -----			2	. . TRANSISTOR:(SEE Q50 AND Q81 EPL)		
					(ATTACHING PARTS FOR EACH)		
-40	210-0586-00			2	. . NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
-41	355-0159-00			2	. . TERMINAL,STUD:0.156 HEX X 0.580 INCH LONG	80009	355-0159-00
					- - - * - - -		
-42	344-0154-00			6	. . CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-43	124-0282-00			1	. TERMINAL STRIP,:GROUND	80009	124-0282-00
					(ATTACHING PARTS)		
-44	210-0586-00			2	. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
					- - - * - - -		
-45	348-0093-00			1	. GROMMET,RUBBER:0.375 INCH	70485	MOLDCM6368
-46	407-1605-00			1	. BRACKET,CONN:REAR	80009	407-1605-00
					(ATTACHING PARTS)		
-47	211-0507-00			1	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-48	210-0006-00			1	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
-49	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-50	210-0201-00			1	. TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
					(ATTACHING PARTS)		
-51	210-0586-00			1	. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
					- - - * - - -		
-52	----- -----			1	. SWITCH,PUSH-PUL:(SEE S1002 EPL)		
-53	407-1607-00			1	. BRACKET,SWITCH:	80009	407-1607-00
					(ATTACHING PARTS)		
-54	211-0507-00			2	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-55	210-0006-00			2	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-56	343-0004-00			1	. CLAMP,LOOP:0.312 INCH DIAMETER,PLSTC	95987	5-16-6B
					(ATTACHING PARTS)		
-57	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-58	210-0863-00			1	. WSHR,LOOP CLAMP:FOR 0.50" WIDE CLAMP,STL	95987	C191
					- - - * - - -		
-59	432-0048-01			3	. BASE,CAP.MTG:1.355 ID X 2.375" L,DELRIN	80009	432-0048-01
					(ATTACHING PARTS FOR EACH)		
-60	211-0513-00			2	. SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
-61	210-0407-00			2	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-62	210-0006-00			2	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-63	211-0513-00			1	. SCREW,MACHINE:6-32 X 0.625",PNH,STL	83385	OBD
-64	210-0457-00			1	. NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
-65	343-0067-01			1	. CLAMP,LOOP:3.062 INCH DIA		
					(ATTACHING PARTS)		
-66	211-0504-00			3	. SCREW,MACHINE:6-32 X 0.25",PNH STL	83385	OBD
	210-0005-00			3	. WASHER,LOCK:#6	78189	1106-00-00-0541C
					- - - * - - -		
-67	348-0005-00			3	. GROMMET,RUBBER:0.50 INCH DIA	70485	230
-68	348-0004-00			1	. GROMMET,RUBBER:0.281 ID X 0.563 INCH OD	70485	763
-69	337-2145-00			1	. SHIELD,XFMR:REMOVABLE	80009	337-2145-00
					(ATTACHING PARTS)		
-70	211-0507-00			7	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-71	210-0006-00			7	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-72	386-3195-00			1	. SUPPORT,CKT BD:POWER SUPPLY	80009	386-3195-00
					(ATTACHING PARTS)		
-73	211-0507-00			6	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-74	210-0006-00			6	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-75	----- -----			1	. XFMR,PWR,SDN/DU:(SEE T1001 EPL)		
					(ATTACHING PARTS)		
-76	212-0517-00			4	. SCREW,MACHINE:10-32 X 1.750",HEX HD STL	83385	OBD
-77	210-0812-00			4	. WASHER,NONMETAL:#10,FIBER	06982	OBD
-78	220-0410-00			4	. NUT,EXTENDED WA:10-32 X 0.375 INCH,STL	83385	OBD
-79	166-0434-00			4	. SPACER,SLEEVE:2.250 INCH LONG,POLTHN	80009	166-0434-00
					- - - * - - -		
-80	441-1267-00			1	. CHASSIS,TERM:LOW VOLT POWER SUPPLY	80009	441-1267-00
-81	179-2328-00			1	. WIRING HARNESS:HEAT SINK	80009	179-2328-00
	131-0621-00			9	. . CONTACT,ELEC:0.577"L,22-26 AWG WIRE	22526	46231
-82	352-0199-00			1	. . CONN BODY,PL,EL:3 WIRE BLACK	80009	352-0199-00
	352-0199-01			1	. . CONN BODY,PL,EL:3 WIRE BROWN	80009	352-0199-01
	352-0199-09			1	. . CONN BODY,PL,EL:3 WIRE WHITE	80009	352-0199-09

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-	672-0504-00			1	CKT BOARD ASSY:DEFLECTION AMP	80009	672-0504-00
					(ATTACHING PARTS)		
	211-0507-00			5	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
	210-0006-00			5	WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-83	----- -----			1	. CKT BOARD ASSY:DEFLECTION AMP(SEE A7 EPL)		
					(ATTACHING PARTS)		
-84	210-0407-00			6	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-85	210-0006-00			6	. WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
	----- -----			-	. . CKT BOARD ASSY INCLUDES:		
-86	131-0589-00			14	. . CONTACT,ELEC:0.46 INCH LONG	22526	47350
-87	131-0608-00			6	. . CONTACT,ELEC:0.365 INCH LONG	22526	47357
-88	131-0993-00			2	. . LINK,TERM.CONNE:JUMPER	00779	530153-2
-89	----- -----			1	. . TRANSISTOR:(SEE Q568 EPL)		
					(ATTACHING PARTS)		
-90	210-0586-00			2	. . NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
-91	355-0159-00			2	. . TERMINAL,STUD:0.156 HEX X 0.580 INCH LONG	80009	355-0159-00
					- - - * - - -		
-92	214-0579-00			4	. . TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-93	166-0034-00			6	. SPACER,SLEEVE:0.18 ID X 0.438" L ALUMINUM	80009	166-0034-00
-94	337-2182-00			1	. SHIELD,ELEC:DEFLECTION AMP TRANSISTOR	80009	337-2182-00
					(ATTACHING PARTS)		
-95	210-0586-00			2	. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
					- - - * - - -		
-96	----- -----			4	. TRANSISTOR:(SEE Q1030,1032,1034,1036 EPL)		
					(ATTACHING PARTS FOR EACH)		
-97	211-0578-00			2	. SCREW,MACHINE:6-32 X 0.438 INCH,PNH STL	83385	OBD
-98	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-99	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-100	210-0967-00			2	. WSHR,SHOULDERED:0.157 ID X 0.375 INCH OD	80009	210-0967-00
-101	210-0803-00			2	. WASHER,FLAT:0.15 ID X 0.375 INCH OD,STL	12327	OBD
-102	210-0202-00			1	. TERMINAL,LUG:SE #6	78189	2104-06-00-2520N
					- - - * - - -		
-103	386-0143-00			4	. INSULATOR,PLATE:0.002 INCH MICA,FOR TO-2	02735	DF31A
-104	----- -----			4	. TRANSISTOR:(SEE Q1040,1042,1044,1046 EPL)		
					(ATTACHING PARTS FOR EACH)		
-105	211-0578-00			2	. SCREW,MACHINE:6-32 X 0.438",PNH,STL	83385	OBD
-106	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-107	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-108	210-0967-00			2	. WSHR,SHOULDERED:0.157 ID X 0.375 INCH OD	80009	210-0967-00
-109	210-0803-00			2	. WASHER,FLAT:0.15 ID X 0.375 INCH OD,STL	12327	OBD
-110	210-0202-00			1	. TERMINAL,LUG:SE #6	78189	2104-06-00-2520N
					- - - * - - -		
-111	386-0978-00			4	. INSULATOR,PLATE:0.002 INCH MICA,FOR TO-3	80009	386-0978-00
-112	441-1268-00			1	. CHASSIS,TERM:DEFLECTION AMP	80009	441-1268-00
-113	175-0526-00			FT	. WIRE,ELECTRICAL:5.833 FEET LONG,3 RIBBON WIRE	71124	OBD
-114	----- -----			1	CKT BOARD ASSY:TC1(SEE A4 EPL)		
-115	131-0608-00			12	. CONTACT,ELEC:0.365 INCH LONG	22526	47357
-116	131-0993-00			4	. LINK,TERM.CONNE:JUMPER	00779	530153-2
-117	253-0135-00			FT	. PLASTIC STRIP:0.005 FEET LONG	80009	253-0135-00
-118	----- -----			1	CKT BOARD ASSY:TC2(SEE A5 EPL)		
-119	131-0608-00			15	. CONTACT,ELEC:0.365 INCH LONG	22526	47357
-120	131-0589-00			13	. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-121	131-0993-00			1	. LINK,TERM.CONNE:JUMPER	00779	530153-2
-122	131-1207-00			1	. LINK,TERM.CONNE:	80009	131-1207-00
	131-0707-00			4	. . CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
	352-0162-00			1	. . CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0162-00
-123	----- -----			1	CKT BOARD ASSY:MOTHER BOARD(SEE A3 EPL)		
					(ATTACHING PARTS)		
-124	211-0507-00			8	SCREW,MACHINE:6-32 X 0.312",PNH,STL	83385	OBD
-125	210-0006-00			8	WASHER,LOCK:INTL,0.146 ID X 0.283" ID ST	78189	1206-00-00-0541C
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-126	131-0589-00			52	. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-127	131-0787-00			11	. CONTACT,ELEC:0.64 INCH LONG	22526	47359
-128	131-1334-00			4	. LINK,TERM.CONN:	80009	1311334-00
	----- -----			-	. . EACH CONN INCLUDES:		
	131-0621-00			2	. . CONTACT,ELEC:0.577"L,22-26 AWG WIRE	22526	46231
	352-0198-00			1	. . CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0198-00
-129	351-0238-04			2	GUIDE,CKT BD:	80009	351-0238-04
					(ATTACHING PARTS FOR EACH)		
-130	210-0457-00			6	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-131	255-0334-00			FT	PLASTIC CHANNEL:12.75 INCHES LONG	80009	255-0334-00
-132	441-1266-00			1	CHASSIS,CKT BD:	80009	441-1266-00
					(ATTACHING PARTS)		
-133	211-0510-00			9	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-134	210-0006-00			9	WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-135	----- -----			1	CKT BOARD ASSY:HARD COPY(SEE A8 EPL)		
					(ATTACHING PARTS)		
-136	210-0457-00			2	NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-137	131-0589-00			7	. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-138	131-1233-00			7	. CONTACT,ELEC:0.340 INCH LONG	80009	131-1233-00
-139	136-0058-00			1	. SOCKET,PLUG-IN:7 PIN	71785	111-51-11-014
-140	210-1014-00			1	. WASHER,NONMETAL:0.094 ID X 0.312" OD,TEFLON	80009	210-1014-00
-141	352-0125-00			1	. HOLDER,TOROID:MOLD ACETAL	80009	352-0125-00
-142	214-0506-00			1	. CONTACT,ELEC:0.045 SQ X 0.375 INCH L	80009	214-0506-00
-143	214-0579-00			8	. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-144	166-0033-00			2	SPACER,SLEEVE:0.18 ID X 0.375 L ALUMINUM	80009	166-0033-00
-145	344-0131-00			2	CLIP,SPG TENS:CIRCUIT BOARDMOUNTING	80009	344-0131-00
					(ATTACHING PARTS FOR EACH)		
-146	213-0088-00			1	SCR,TPG,THD CTG:4-24 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-147	255-0571-00			FT	PLSTC MLDG MATL:SILICONE RUBBER SE	01139	SE-436U
-148	337-2160-00			1	SHIELD,ELEC:HIGH VOLTAGE	80009	337-2160-00
					(ATTACHING PARTS)		
-149	210-0457-00			6	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-150	343-0298-00			1	CLAMP,LOOP:PLASTIC,W/ADHESIVE BACK	95937	HPC25
-151	----- -----			1	CKT BOARD ASSY:HV/Z AXIS(SEE A6 EPL)		
					(ATTACHING PARTS)		
-152	210-0457-00			7	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
	211-0040-00			1	SCREW,MACHINE:4-40 X 0.25",BDCH PLSTC	26365	OBD
-153	210-0201-00			1	TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-154	129-0369-00			3	. INSULATOR,STDF:4-40 X 1.370 INCH LONG	80009	129-0369-00
					(ATTACHING PARTS FOR EACH)		
-155	211-0040-00			1	. SCREW,MACHINE:4-40 X 0.25",BDCH PLSTC	26365	OBD
					- - - * - - -		
-156	131-0589-00			22	. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-157	214-0579-00			1	. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-158	214-1292-00			3	. HEAT SINK,ELEC:TRANSISTOR	05820	205-AB
-159	129-0369-00			1	. INSULATOR,STDF:4-40 X 1.370 INCH LONG	80009	129-0369-00
-160	376-0011-00			1	. CPLG,SHAFT,INSU:	80009	376-0011-00
-161	213-0048-00			2	. . SETSCREW:4-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-162	----- -----			1	. RES.,VAR,NONWW:(SEE R161 EPL)		
					(ATTACHING PARTS)		
-163	210-0413-00			1	. NUT,PLAIN,HEX.:0.375-32 X 0.50 INCH,STL	73743	3145-402
-164	210-0840-00			1	. WASHER,FLAT:0.39 ID X 0.562 INCH OD,STL	89663	644R
-165	210-0012-00			1	. WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-166	----- -----			1	. TRANSISTOR:(SEE Q301 EPL)		
					(ATTACHING PARTS)		
-167	211-0513-00			2	. SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
					- - - * - - -		
-168	214-1610-00			1	. HEAT SINK,ELEC:TRANSISTOR,CERAMIC	80009	214-1610-00
-169	166-0203-00			1	. WASHER,FLAT:0.18 ID X 0.0621 PLASTIC	80009	166-0203-00
-170	214-2224-00			1	. HEAT SINK,XSTR:METAL	80009	214-2224-00
-171	136-0384-00			2	. CONTACT,ELEC:FOR 0.04 DIAMETER PIN	00779	52120
-172	136-0361-00			1	. SOCKET,PLUG-IN:NYLON,BLACK	80009	136-0361-00
					(ATTACHING PARTS)		
-173	131-0847-00			2	. TERMINAL STUD:6-32 X 0.435 INCH LONG	80009	131-0847-00
					- - - * - - -		
-174	384-0616-00			1	. SPACER,POST:0.187 HEX X 1.370 INCH LONG	80009	384-0616-00
					(ATTACHING PARTS)		
-175	211-0008-00			1	. SCREW,MACHINE:4-40 X 0.250,PNH	83385	OBD
					- - - * - - -		
	136-0635-00			1	. SOCKET ASSY,CRT:7 LEAD,18 AWG HV	80009	136-0635-00
	136-0278-00			1	. . SOCKET,PLUG-IN:WITH PINS	80009	136-0278-00
-176	214-0464-00			7	. . . CONTACT,ELEC:0.485 INCH LONG	80009	214-0464-00
-177	204-0322-00			1	. . . BODY,CRT SOCKET:GRAY,ACETAL RESIN	80009	204-0322-00
-178	166-0037-00			5	SPACER,SLEEVE:0.180ID X 0.250D X 0.56" L	80009	166-0037-00
	384-0531-00			1	SPACER,POST:0.250 OD X 0.438 INCH LONG	80009	384-0531-00
-179	342-0289-00			1	INSULATOR,FILM:VARIABLE RESISTOR	80009	342-0289-00
-180	337-2181-00			1	SHIELD,ELEC:LINE FILTER	80009	337-2181-00
					(ATTACHING PARTS)		
-181	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
					- - - * - - -		
-182							
	----- -----			1	FILTER,RAD INT:(SEE FL1001 EPL)		
					(ATTACHING PARTS)		
-183	210-0551-00			1	NUT,PLAIN,HEX.:4-40 X 0.25 INCH,STL	83385	OBD
-184	210-0586-00			1	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
-185	210-0201-00			1	TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
					- - - * - - -		
	136-0636-00			1	SKT,PL-IN ELEK:7 CONDUCTOR,ANODE	80009	136-0636-00
-186	131-1187-00			2	. COVER,CONN,PLUG:VINYL RUBBER	95354	C-850-1V
-187	131-1188-00			1	. CONNECTOR,PLUG,:7 PIN,MINIATURE	95354	MM-850
-188	136-0271-00			1	. SOCKET,PLUG-IN:7 PIN	71785	111-01-10-012
-189	175-0830-00			FT	. WIRE,ELECTRICAL:7 WIRE RIBBON	08261	TEK-175-0830-00
-190	337-2196-00			1	SHLD,GSKT,ELEK:KEYBOARD EMI	80009	337-2196-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-1	----- -----			1	SWITCH,LEVER(SEE S1001 EPL)		
					(ATTACHING PARTS)		
-2	210-0473-00			1	NUT,PLAIN,DODEC:0.469-32 X 0.638 INCH,BRS	80009	210-0473-00
-3	210-0902-00			1	WASHER,FLAT:0.470 ID X 0.656 INCH OD,STL	12327	OBD
-4	210-0021-00			1	WASHER,LOCK:INTL,0.476 ID X 0.60"OD STL	78189	1222-01-00-0541C
-5	210-0414-00			1	NUT,PLAIN,HEX.:0.468-32 X 0.562 INCH,BRS	73743	3167-402
					- - - * - - -		
-6	----- -----			1	SWITCH,PUSH:(SEE S1085 EPL)W/HDWR		
-7	333-2008-00			1	PANEL,FRONT:UPPER	80009	333-2008-00
					(ATTACHING PARTS)		
-8	213-0055-00			2	SCR,TPG,THD FOR:2-32 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-9	136-0463-03			1	LIGHT,INDICATOR:GREEN	10389	33-891-159
					(ATTACHING PARTS)		
-10	210-0008-00			1	WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
-11	210-0458-00			1	NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL	83385	OBD
					- - - * - - -		
-12	----- -----			2	RES.,VAR,NONWIR:(SEE R1076,R1050 EPL)		
					(ATTACHING PARTS FOR EACH)		
-13	129-0290-00			1	SPACER,POST:0.312 HEX X 0.635 INCH LONG	80009	129-0290-00
-14	210-0046-00			1	WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-15	358-0342-00			1	BSHG,MACH THD:0.250-32 X 0.312 INCH LONG	80009	358-0342-00
					- - - * - - -		
-16	352-0147-00			1	FUSEHOLDER:WITH HARDWARE	71400	FHL-1761
-17	386-3176-00			1	SUBPANEL,FRONT:UPPER	80009	386-3176-00
					(ATTACHING PARTS)		
-18	211-0541-00			6	SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-19	333-2007-00			1	PANEL,FRONT:LOWER	80009	337-2007-00
					(ATTACHING PARTS)		
-20	213-0055-00			4	SCR,TPG,THD FOR:2-32 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-21	386-3175-00			1	SUBPANEL,FRONT:LOWER	80009	386-3175-00
					(ATTACHING PARTS)		
-22	211-0541-00			8	SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-23	367-0076-00			2	HANDLE,CARRYING:5.5 INCH LONG	80009	367-0076-00
					(ATTACHING PARTS FOR EACH)		
-24	212-0507-00			2	SCREW,MACHINE:10-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
	253-0160-00			FT	TAPE:PRESS SENS ADH,0.062 THK X 0.25W,3' LONG	04963	H116 TYPE A
-25	390-0458-00			1	CAB,SIDE,TERM:	80009	390-0458-00
					(ATTACHING PARTS)		
-26	211-0511-00			22	SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CABINET SIDE INCLUDES:		
-27	348-0440-00			2	. CUSHION,CKT BD:2.03W X 3.875" L,ST	80009	348-0440-00
-28	351-0313-00			1	GUIDE,RACKMOUNT:19.218 INCH LONG,PAIR	80009	351-0313-00
					(ATTACHING PARTS FOR EACH)		
-29	212-0023-00			6	SCREW,MACHINE:8-32 X 0.375 INCH,PNH STL	83385	OBD
-30	210-0008-00			6	WASHER,LOCK:INTL,0.172 ID X 0.331" OD,STL	78189	1208-00-00-0541C
					- - - * - - -		
-31	391-0061-00			2	BLOCK,SUPPORT:	80009	391-0061-00
					(ATTACHING PARTS FOR EACH)		
-32	211-0559-00			2	SCREW,MACHINE:6-32 X 0.375"100 DEG,FLH STL	83385	OBD
-33	212-0534-00			2	SCREW,MACHINE:10-32 X 1 INCH,PNH STL	83385	OBD
					- - - * - - -		
-34	175-1649-00			1	CA ASSY,SP,ELEC:	80009	175-1649-00
					(ATTACHING PARTS)		
-35	131-0890-00			2	SCREW ASSY,CONN:4-40 X 0.312" L	71468	D 20418-2
					- - - * - - -		
	----- -----			-	. CABLE ASSY INCLUDES:		
-36	131-0458-00			1	. CONNECTOR,RCPT,:15 PIN,FEMALE	71468	DA1S

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-	131-0622-00			2	. CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
	131-0792-00			4	. CONTACT,ELEC:0.577"L,18-20 AWG WIRE	22526	46221
-38	343-0549-00			4	. STRAP,TIE DOWN:0.091 W X 3.62" L,ZYTEL	59730	TYB23M
	352-0200-02			1	. CONN BODY,PL,EL:4 WIRE RED	80009	352-0200-02
	352-0206-01			1	. CONN BODY,PL,EL:10 WIRE BROWN	80009	352-0206-01
-40	378-0840-00			1	DUCT,AIR:INLET-EXHAUST	80009	378-0840-00
					(ATTACHING PARTS)		
-41	211-0507-00			6	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
	210-0006-00			6	WASHER,LOCK:INTL,0.146 ID X 0.283" ID ST	78189	1206-00-00-0541C
					- - - * - - -		
-42	380-0436-00			1	FR,AIR INL-OUT:INTAKE	80009	380-0436-00
					(ATTACHING PARTS)		
-43	211-0516-00			4	SCREW,MACHINE:6-32 X 0.875 INCH,PNH STL	83385	OBD
					- - - * - - -		
-44	378-0065-00			1	FILTER,ELEM,AIR:5.95 X 5.2",NON-WOVEN,PLASTIC	80009	378-0065-00
-45	378-0068-00			1	FILTER,EMI:6.35 X 5.6 " ALUMINUM	80009	378-0068-00
-46	380-0435-00			1	FR,AIR INL-OUT:OUTPUT	80009	380-0435-00
					(ATTACHING PARTS)		
-47	211-0516-00			4	SCREW,MACHINE:6-32 X 0.875 INCH,PNH STL	83385	OBD
					- - - * - - -		
-48	378-0066-00			1	FILTER ELEM AIR:7.05 X 6.15",NON-WOVEN,PLASTIC	80009	378-0066-00
-49	378-0067-00			1	FILTER,EMI:7.45 X 6.55" ALUMINUM	80009	378-0067-00
-50	161-0033-07			1	CABLE ASSY,PWR:3 WIRE,92 INCH LONG	16428	KH8002
					(ATTACHING PARTS)		
-51	358-0161-00			1	BSHG,STRAIN RLF:FOR 0.50 INCH HOLE,PLASTIC	28520	SR5P4
					- - - * - - -		
-52	200-1771-00			1	COVER,ACCESS:HOUSING	80009	200-1771-00
					(ATTACHING PARTS)		
-53	211-0510-00			12	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
-54	343-0005-00			2	CLAMP,LOOP:0.438 INCH	95987	7-16-6B
					(ATTACHING PARTS)		
-55	211-0507-00			1	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-56	210-0457-00			1	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-57	210-0863-00			1	WSHR,LOOP CLAMP:FOR 0.50" WIDE CLAMP,STL	95987	C191
					- - - * - - -		
-58	386-3268-00			1	SUPPORT,CABLE:KEYBOARD	80009	386-3268-00
					(ATTACHING PARTS)		
-59	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-60	210-0006-00			2	WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-61	----- -----			1	FAN,TUBEAXIAL:(SEE B1001 EPL)		
					(ATTACHING PARTS)		
-62	211-0511-00			4	SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
-63	210-0457-00			4	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-64	210-0006-00			1	WASHER,LOCK:INTL,0.146 ID X 0.283" OD,STL	78189	1206-00-00-0541C
-65	210-0201-00			1	TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
					- - - * - - -		
-66	386-3210-00			1	SUPPORT,FAN:	80009	386-3210-00
					(ATTACHING PARTS)		
-67	211-0507-00			6	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-68	210-0006-00			6	WASHER,LOCK:INTL,0.146 ID X 0.283"OD,STL	78189	1206-00-00-0541C
					- - - * - - -		
-69	255-0334-00			FT	PLASTIC CHANNEL:12.75 INCHES LONG	80009	255-0334-00
-70	426-1195-00			1	FRAME,TERMINAL:	80009	426-1195-00
-71	179-2326-00			1	WIRING HARNESS:MAIN	80009	179-2326-00
-72	131-0621-00			64	. CONTACT,ELEC:0.477" L,22-26 AWG WIRE	22526	56231
	131-0622-00			4	. CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	56241
	131-0707-00			1	. CONNECTOR,TERM:0.48"L,22-26 AWG WIRE	22526	47439
	131-0792-00			6	. CONTACT,ELEC:0.577"L,18-20 AWG WIRE	22526	46221
-73	131-1187-00			1	. SHLD,ELEC CONN:VINYL RUBBER	95354	C-850-1V
-74	136-0271-00			1	. SKT,PL-IN ELEK:7 CONTACT	71785	111-01-10-012
-75	343-0549-00			1	. STRAP,TIEDOWN:0.091 W X 3.62"L,ZYTEL	59730	TY23M

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-76	352-0171-00			1	. CONN BODY,PL,EL:1 WIRE BLACK	80009	352-0171-00
-77	352-0197-06			1	. CONN BODY,PL,EL:1 WIRE BLUE	80009	352-0197-06
-78	352-0198-00			1	. CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0198-00
	352-0198-05			1	. CONN BODY,PL,EL:2 WIRE GREEN	80009	352-0198-05
	352-0198-06			1	. CONN BODY,PL,EL:2 WIRE BLUE	80009	352-0198-06
	352-0198-08			2	. CONN BODY,PL,EL:2 WIRE GRAY	80009	352-0198-08
	352-0198-09			2	. CONN BODY,PL,EL:2 WIRE WHITE	80009	352-0198-09
-79	352-0199-02			1	. CONN BODY,PL,EL:3 WIRE RED	80009	352-0199-02
	352-0199-03			1	. CONN BODY,PL,EL:3 WIRE ORANGE	80009	352-0199-03
	352-0199-05			1	. CONN BODY,PL,EL:3 WIRE GREEN	80009	352-0199-05
-80	352-0200-00			1	. CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0200-00
	352-0200-04			1	. CONN BODY,PL,EL:4 WIRE YELLOW	80009	352-0200-04
-81	352-0201-02			2	. CONN BODY,PL,EL:5 WIRE RED	80009	352-0201-02
	352-0201-07			1	. CONN BODY,PL,EL:5 WIRE VIOLET	80009	352-0201-07
-82	352-0202-01			1	. CONN BODY,PL,EL:6 WIRE BROWN	80009	352-0202-01
	352-0202-06			1	. CONN BODY,PL,EL:6 WIRE BLUE	80009	352-0202-06
-83	352-0203-01			1	. CONN BODY,PL,EL:7 WIRE BROWN	80009	352-0203-01
-84	352-0206-00			1	. CONN BODY,PL,EL:10 WIRE BLACK	80009	352-0206-00

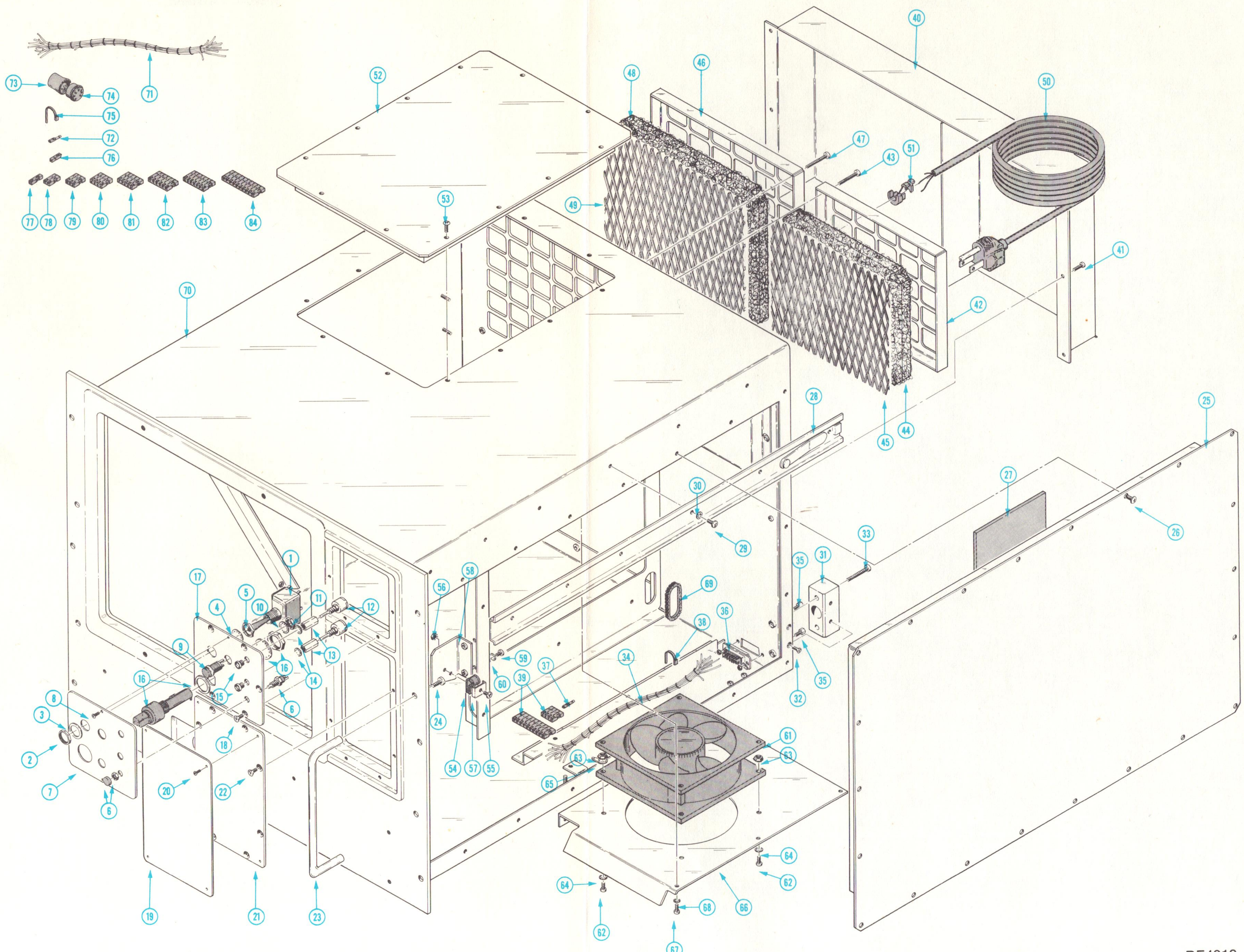

FIG. 3. CABINET

FIG. 4. ACCESSORIES & REPACKAGING

ACCESSORIES

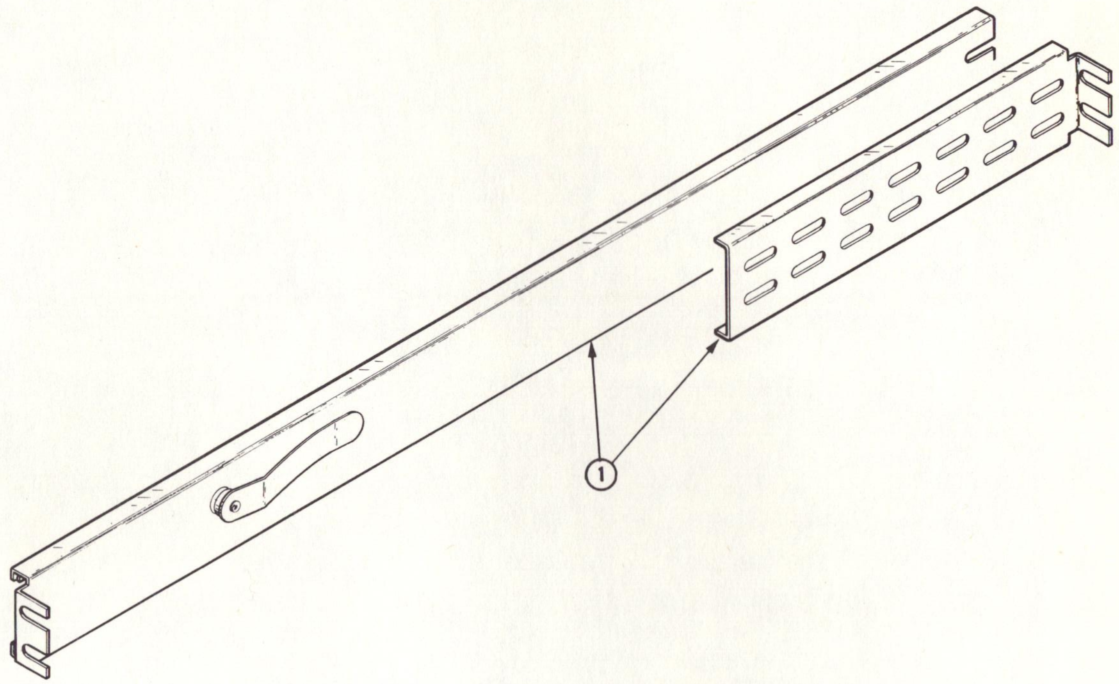

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
					STANDARD ACCESSORIES		
4-1	351-0241-00			1	SLIDE,DWR,EXT:	80009	351-0241-00
	021-0160-00			1	INTERFACE:GP SYNCHRONOUS SERIAL	80009	021-0160-00
	016-0333-00			1	HDW KIT,ELEK EQ:REAR SUPPORT	80009	016-0333-00
					OPTIONAL ACCESSORIES		
	070-1893-00			1	MANUAL,TECH:INSTRUCTION,RE4012	80009	070-1893-00
	021-0159-01			1	INTERFACE:GENERAL PURPOSE PARALLEL	80009	021-0159-01
	018-0099-00			1	CKT BOARD ASSY:MOTHER BOARD	80009	018-0099-00
	018-0104-00			1	CKT BOARD ASSY:DISPLAY MULTIPLEXER	80009	018-0104-00
	670-3987-00			1	CKT BOARD ASSY:72 PIN EXTENDER	80009	670-3987-00
	018-0100-00			1	CKT BD ASSY:TC-2 FAST VECTOR,VECTOR GEN	80009	018-0100-00
	006-1744-01			1	COATING INSUL:HUMISEAL TYPE 1B31	80009	006-1744-01

REPACKAGING

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
					REPACKAGING		
	065-0251-00			1	SHPNG CTN KIT:RE4012	80009	065-0251-00

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

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MANUAL CHANGE INFORMATION

PRODUCT RE4012

070-1893-00

CHANGE REFERENCE C1/475

DATE 4-8-75

CHANGE:	DESCRIPTION

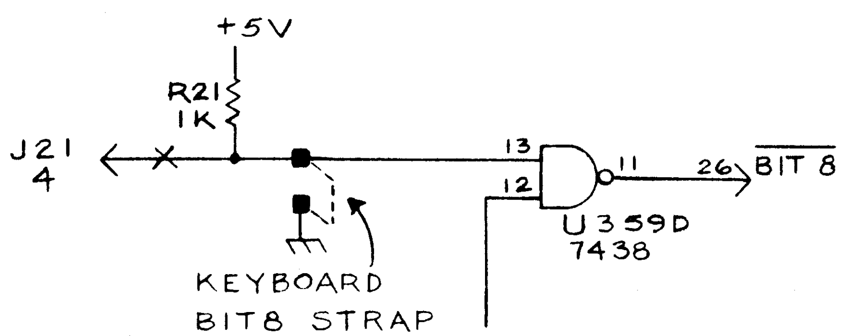
Pilot Change #15

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

ADD:

R21	315-0102-00	RES.,FXD,COMP:1K OHM, 5%, 0.25W

DIAGRAM TC-2 (670-3883-01) - Partial



MANUAL CHANGE INFORMATION

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PRODUCT RE4012
070-1893-00

CHANGE REFERENCE C2/475
DATE 4-17-75

CHANGE:	DESCRIPTION

TEXT CORRECTION

Page 2-27 under OPTIONAL ACCESSORIES

CHANGE: Display Multiplexer Instruction Manual 070-1993-00

Page 2-22, Fig. 2-1

Page 3-31, Fig. 3-7

CHANGE: The callout on the TOP illustration to read:

ACCESS PANEL (HI VOLT & CRT)

CHANGE: The callout on the RIGHT illustration to read:

ACCESS PANEL (LOW VOLT & CARDS)

MANUAL CHANGE INFORMATION

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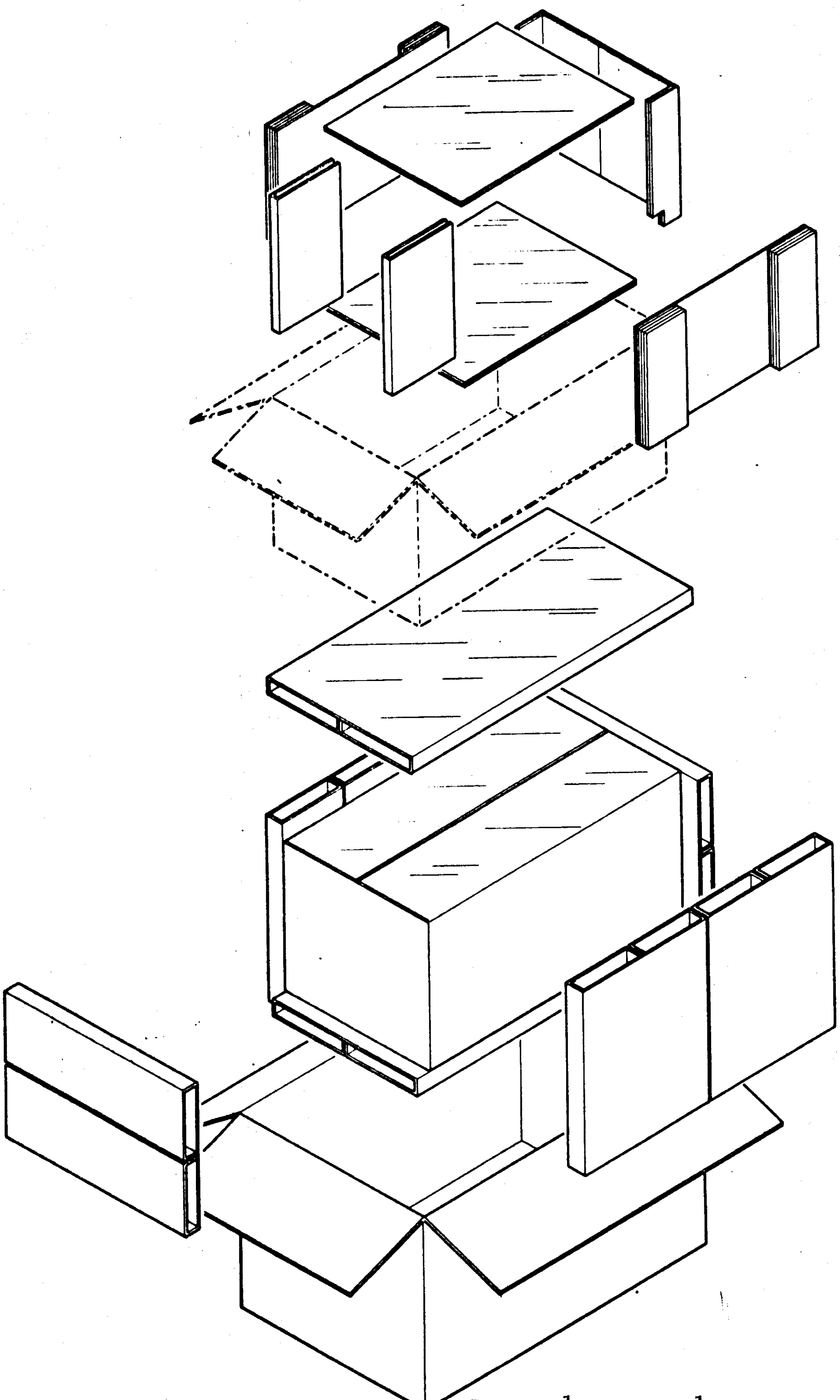
PRODUCT RE4012
070-1893-00

CHANGE REFERENCE C3/475
DATE 4-18-75

CHANGE:	DESCRIPTION

ADD: Repackaging illustration to pullout page, Fig. 4 ACCESSORIES & REPACKAGING

REPACKAGING



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MANUAL CHANGE INFORMATION

PRODUCT GENERAL

CHANGE REFERENCE S23351

DATE 4-10-75

CHANGE:	DESCRIPTION

POWER CORD CHANGES

The 1974 National Electrical Code permits the use of IEC (International Electrotechnical Commission) power cord color codes. As production permits, we are changing the entire Tektronix product line to comply with IEC power cord color code requirements. As a result, the power cord on Tektronix instruments may conform to either IEC or the older NEC requirements. The change consists of the following:

Conductor	NEC	IEC
Line	Black	Brown
Neutral	White	Light Blue*
Safety Earth	Green w/Yellow Stripe	Green w/Yellow Stripe

*Tinned copper conductor.

MANUAL CHANGE INFORMATION

TEKTRONIX®
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PRODUCT RE4012
070-1893-00

CHANGE REFERENCE M24,151
DATE 1-27-76

CHANGE:	DESCRIPTION

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGE

CHANGE TO:

A9	670-3852-01	CKT BOARD ASSY:POWER SUPPLY
C65	283-0142-00	CAP.,FXD,CER DI:2700PF,5%,200V

C65 is located on Fig. 6-39 ASSY A9 POWER SUPPLY diagram.

MANUAL CHANGE INFORMATION

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PRODUCT RE4012
070-1893-00

CHANGE REFERENCE C4/376
DATE 3-3-76

CHANGE:	DESCRIPTION

TEXT CORRECTION

Page 2-27 TABLE 2-14

SERVICING ACCESSORIES

DELETE: Test Graticule 067-0771-00

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MANUAL CHANGE INFORMATION

PRODUCT RE4012 070-1893-00

CHANGE REFERENCE M24,115

DATE 3-23-76

CHANGE:	DESCRIPTION

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

A6	670-3917-01	CKT BOARD ASSY:H.V. AND Z AXIS
C64	285-1141-00	CAP.,FXD,PLASTIC:0.0047UF,20%,10KV
C65	285-1141-00	CAP.,FXD,PLASTIC:0.0047UF,20%,10KV
C138	285-1141-00	CAP.,FXD,PLASTIC:0.0047UF,20%,10KV
C143	285-1140-00	CAP.,FXD,PLASTIC:0.01UF,20%,10KV
C149	285-1141-00	CAP.,FXD,PLASTIC:0.0047UF,20%,10KV
C174	283-0013-00	CAP.,FXD,CER DI:0.01UF,+100-0%,1000V
C255	285-1141-00	CAP.,FXD,PLASTIC:0.0047UF,20%,10KV

REMOVE:

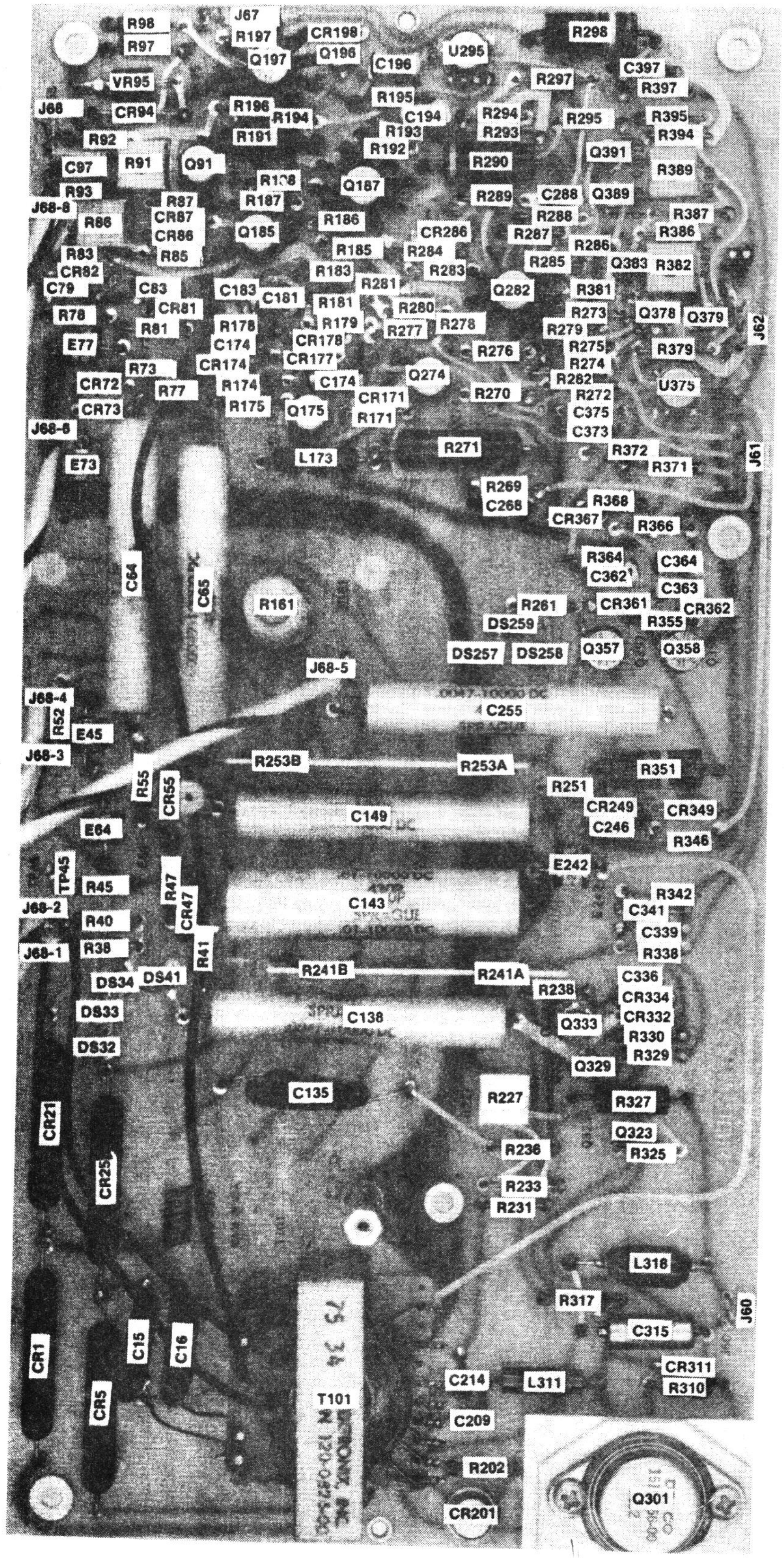
C82	283-0013-00	CAP.,FXD,CER DI:0.01UF,+100-0%,1000V
CR45	152-0242-00	SEMICOND DEVICE:SILICON,225V,200MA
CR53	152-0242-00	SEMICOND DEVICE:SILICON,225V,200MA
CR189	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR273	152-0333-00	SEMICOND DEVICE:SILICON,55V,200MA
R82	315-0100-02	RES.,FXD,CMPSN:10 OHM,5%,0.25W

ADD:

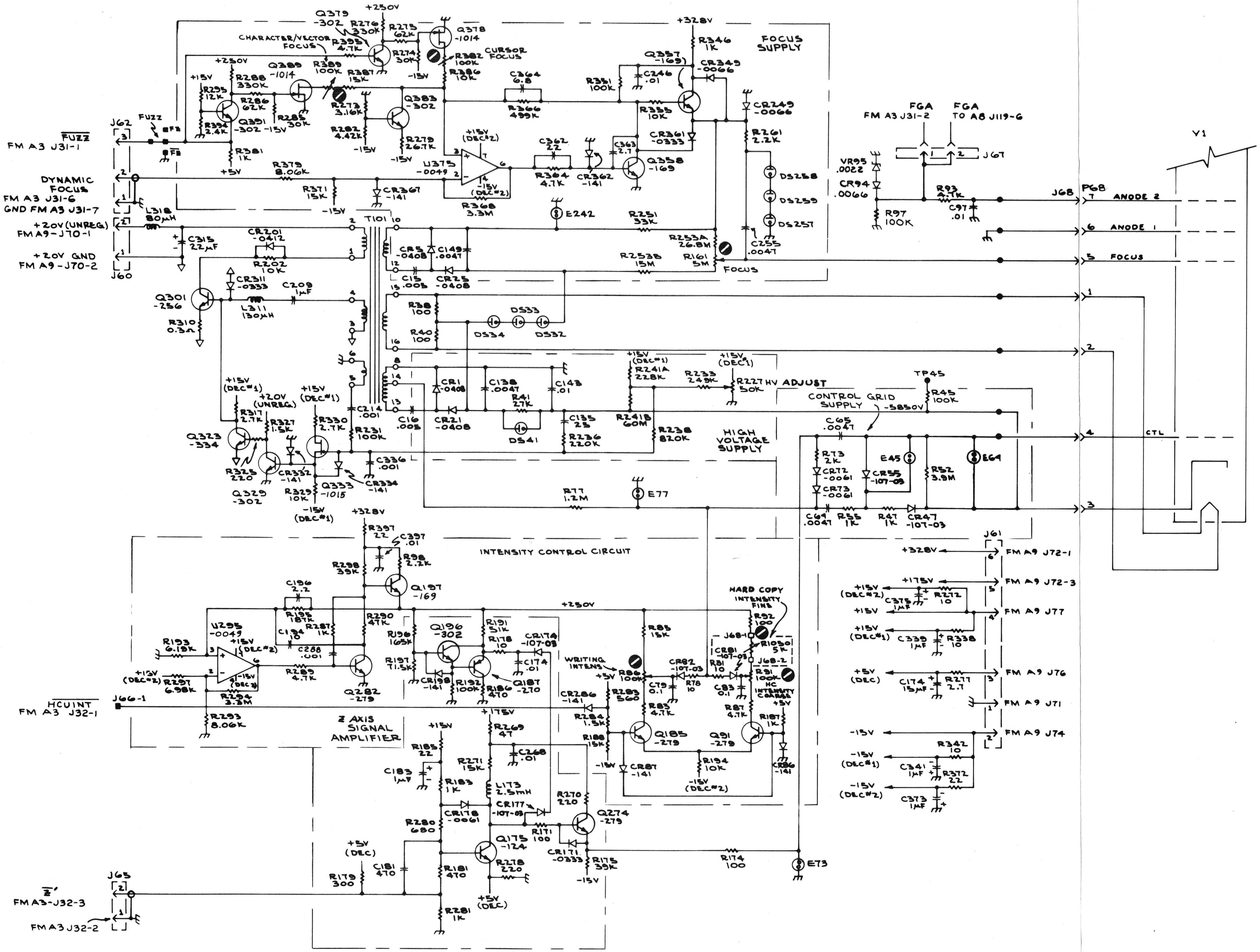
CR47	152-0107-03	SEMICOND DEVICE:SILICON,375V,400MA
CR55	152-0107-03	SEMICOND DEVICE:SILICON,375V,400MA
CR86	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR171	152-0333-00	SEMICOND DEVICE:SILICON,55V,200MA

PRODUCT RE4012 CHANGE REFERENCE M24,115 DATE 3-26-76

CHANGE:	DESCRIPTION



6-24A. A6—High Voltage & Z Axis Component locations. 670-3917-01



RE4012

@

FIG. 6-25A ASSY A6

HIGH VOLTAGE & Z AXIS
670-3917-01 M24,115
J 4385-01 PAGE 3 OF 3