Tektronix®
COMMITTED TO EXCELLENCE

4014, 4014-1, 4015, 4015-1

SN B050000 and UP

COMPUTER DISPLAY TERMINAL

SERVICE MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

MANUAL PART NO.
070-2303-00

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WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

WARRANTY

This Tektronix product is warranted against defective materials and workmanship, under normal use, for a period of one year from date of initial shipment. Tektronix will repair or replace, at its option, those products determined to be defective within the warranty period and returned, freight prepaid, to a Tektronix service center.

In addition, in those areas where Tektronix has service centers available for this product, on-site warranty repair is provided at no charge during the first ninety (90) days from date of initial shipment.

There is no implied warranty for fitness of purpose.

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Fig. 1-1. 4014 Computer Display Terminal.

SECTION 1

INSTALLATION AND OPERATION

Introduction

The Computer Display Terminal interfaces between man and computer by permitting inputs through an integral keyboard and providing a display (alphanumeric or graphic) of computer output data. In addition, the Terminal can relay data bi-directionally between peripheral devices and a computer. An Interface Unit must be installed in the Terminal and connected to the computer — either directly or through a modem (modulator-demodulator) — to permit information interchange. Copies can be made of the 4014-1 and 4015-1 terminal displays, via a Hard Copy Unit.

Documentation Note

This manual is a part of the following set of documents which describe the 4014, 4014-1, 4015 and 4015-1 Computer Display Terminals:

4014 and 4014-1 USERS MANUAL, Tektronix Part No. 070-1647-00.

4015 and 4015-1 USERS MANUAL, Tektronix Part No. 070-1649-00.

Contents—An explanation of how to operate and program the Terminal.

4014, 4014-1, 4015, and 4015-1 SERVICE MANUAL, Tektronix Part No. 070-2303-00.

Contents—A comprehensive explanation of the Terminal. It includes operation, characteristics, servicing, adjustment, circuit diagrams, circuit descriptions, and parts lists.

This manual meets the maintenance documentation requirements of the 4014, 4014-1, 4015 and 4015-1 Computer Display Terminals. The greater part of the information herein is common to all the aforementioned Terminals. The main differences are the hard copy information, pertinent to the 4014-1 and 4015-1 Terminals; and the APL information, pertinent to the 4015 and 4015-1 Terminals. Each Terminal has an identification tag in the lower right corner of the keyboard. Thus, you can determine which areas of the manual are pertinent to your Terminal. For example, if you have a 4014 Terminal, you may disregard all hard copy and APL information. If you have a 4015-1, all hard copy and APL information applies.

In addition to the above, service information is included for Option 34, the Enhanced Graphics Module. This module is a factory installed option for the above mentioned Terminals. Information pertinent to Option 34 is identified in each section and should be included as part of your regular service documentation, if your Terminal contains this option. To determine if your instrument contains Option 34, refer to the Enhanced Graphics Module information in this section. Other optional items used with the Terminal are explained in separate manuals.

INSTALLATION

General

The two main sections of the Terminal are the pedestal and the display unit. The pedestal section provides support for the display unit. It contains the power supply, control circuits, and optional circuits. The display unit contains the keyboard, the display storage tube, and related circuits.

Pedestal-Mounting the Display Unit

Mounting of the Display Unit on the Pedestal requires two people. It includes the following steps:

1. Lift the Display Unit over the Pedestal and secure it with eight machine screws up through the Pedestal top. (Fig. 1-2a.)

2. Remove the display cover by removing the three machine screws on each side of the display cover. Set the cover aside.

3. Unbolt the Display connector from the stand-off mounts on the Display back panel. (Fig. 1-2b).

4. Connect the Display connector to the Pedestal connector in the top of the Pedestal. The connectors are keyed to fit together only one way. Be careful not to bend the pins as the Display connector is pressed down all the way onto the Pedestal connector. (Fig. 1-2c).

5. Replace the display cover and secure it with six machine screws, three on each side.

6. Adjust the four feet to level the Terminal, and secure the lock nuts to hold them in position.

Desk-Mounting the Display Unit (Optional)

To desk-mount the Display Unit, the optional Desk-Top Mounting Kit (012-0511-00) must be ordered. It includes a 10-foot interconnect cable and miscellaneous hardware.

1. Carefully place the Display Unit on a table or other sturdy, flat surface. (Fig. 1-2d.)

2. Remove the display cover and set it aside. It is fastened with six machine screws, three on each side.

3. Unbolt and remove the back cover plate. It is fastened with four machine screws on the back of the Display Unit. Mount the Display connector on the stand-off mounts over the opening on the back of the Display Unit (Fig. 1-2b.)

4. Connect the 10-foot interconnect cable to the Pedestal connector on top of the Pedestal, and to the Display connector just mounted on the back of the Display Unit.

5. Replace the display cover. It is mounted with six machine screws, three on each side.

Pedestal Circuitry Access

The pedestal is equipped with a hinged front cover. The upper section can be loosened and swung down to permit access to the minibus, into which the Terminal Control cards, interface cards and optional accessory cards are installed. Lowering of the top half permits access to the Terminal strap options without exposing dangerous voltages. The cover must be removed completely for access to the low voltage power supply and line voltage transformer. Fully removing the lower section of the cover automatically opens a power switch. This is a three-position switch that provides a closed path for line current when the cover is installed. Removing the cover permits the switch to be returned to the center (open) position. The switch actuator can be pulled out (locked position) to permit the Terminal to be operated with the cover fully removed.

WARNING

Dangerous voltages exist in the lower section of the pedestal when the line cord is connected. Servicing should be done only by qualified technicians.

Strappable Options

Strappable options on circuit cards in the pedestal should be placed in the desired position upon installation. Refer to Table 2-16 for details.

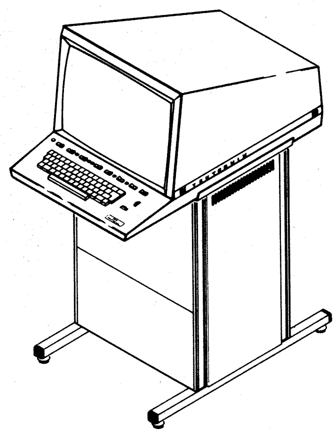
Interfacing

Connect the Interface Unit to the computer or modem, as appropriate. The Interface Unit is installed in the pedestal section of the Terminal and interconnecting cables(s) and plug(s) egress through the back of the pedestal unit. The configuration varies with the type of Interface Unit. The standard Terminal contains a Data Communication Interface No. 021-0065-00. The Optional Data Communication Interface No. 021-0074-00 or the TTY Port Interface may be supplied as options in place of the standard Data Communication Interface. Refer to the appropriate Interface documentation for specific installation instructions.

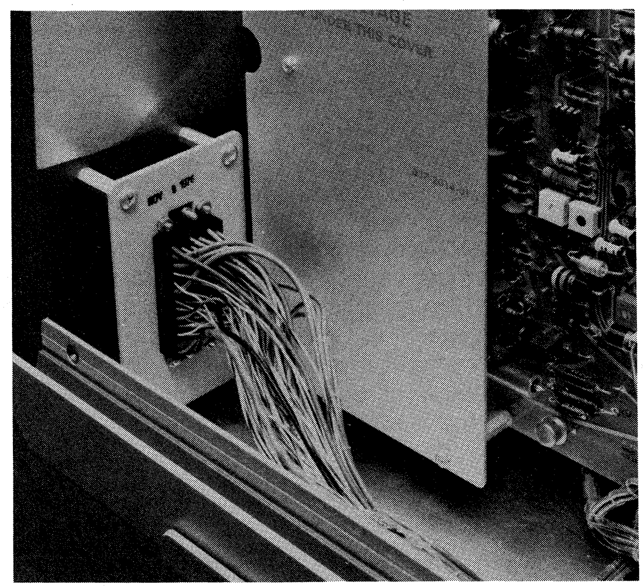
Optional Accessories

Refer to the documentation on the specific accessory for installation instructions. One exception is that Option 34, the Enhanced Graphics Module, is described in this manual.

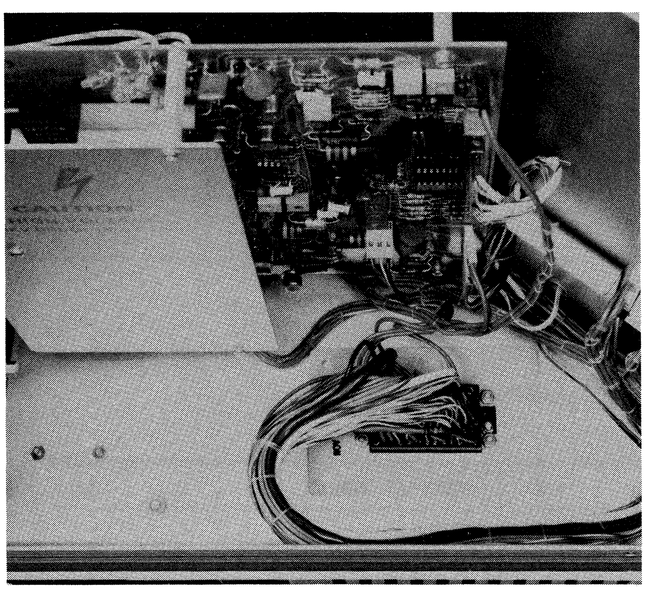
To determine if your instrument contains the Enhanced Graphics Module, refer to the Enhanced Graphics Module information in this section.



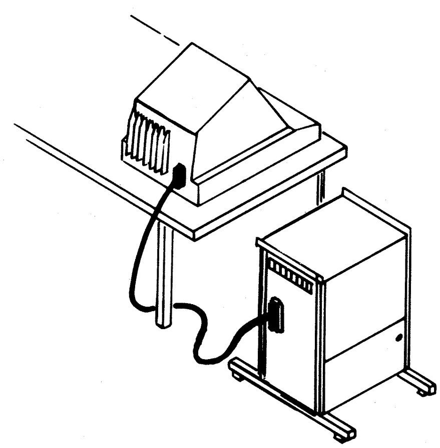
(a) Pedestal Mounting.



(b) Display Connector as shipped.



(c) Display to pedestal connection.



(d) Desk-Mounted Display.

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Fig. 1-2. Installation.

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 complies with the National Electrical Code (ANSI CI-1968).

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

The Terminal can be operated from either 110 or 220-volt nominal line voltage source. A jumper arrangement on the transformer permits the Terminal to be modified to suit the supply. The fuse and applicable fuse size notation, are

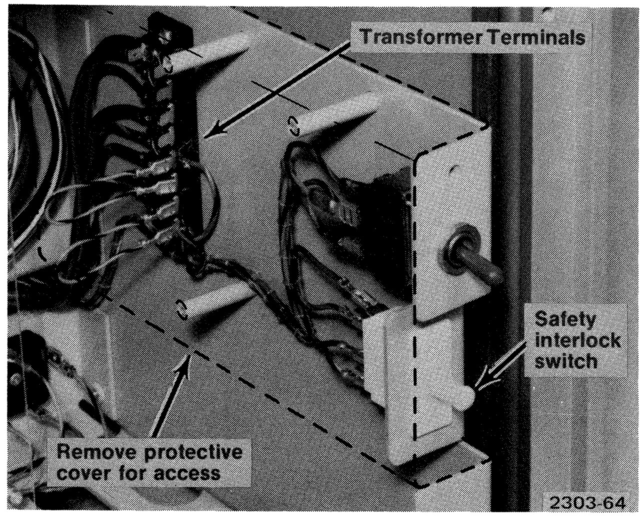
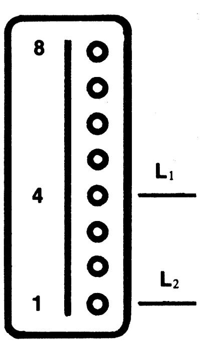


Fig. 1-3. Transformer terminals location.

located on the back panel near the power cable. The transformer jumper arrangement is located in the bottom-right of the pedestal, as shown in Fig. 1-3. Wiring instructions are contained on the inside of the front cover. Wiring instructions are repeated in Fig. 1-4 for convenience. Line frequency may be between 48 and 440 Hz.

WARNING

Dangerous potentials exist in the lower section of the pedestal. Disconnect the Terminal from the power source before changing transformer connections.



LINE CORD ALWAYS ATTACHED TO 1 & 4

JUMPER ARRANGEMENT

VOLTAGE ±10%	100	115	120	200	220	230	240
TERMINAL NO.	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			

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Fig. 1-4. Transformer terminals and jumper arrangement.

OPERATION

INDICATORS AND CONTROLS

General

With the exception of the Power switch, all operator controls and indicators are located on the display unit. The Power switch is located on the lower right front surface of the pedestal. The Hard Copy Intensity and Write-Thru Intensity adjustments are on the right side of the display unit.

Indicators

Power lamp	Illuminated by the +7 V supply when the Power switch is turned on. Light remains on if any fuse other than line fuse is blown.
Indicator 1 Indicator 2 Indicator 3	Multiple use lamps whose functions are determined by the accessories and optional equipment used with the Terminal. Indicator 1 and 2 make connections via the minibus. Indicator 3 makes connection through a wire and pin connector that is tied to the main cable assembly within the Pedestal. Low signals are required to light the lamps. (For LED 3 connection, see Wire List, P1000, pin 47.)
ALT (4014 and 4014-1)	Lights when the alternate character set is selected, either by switch or program control. Will not illuminate unless an alternate character set has been installed as a custom modification at the factory.
APL (4015 and 4015-1)	Lights when the APL character set is selected, either by switch or program selection.
FULL	Lights when a Page Full condition exists. See description of Margin Control switch.

Switches

Power	Applies power to the Terminal. Located on the lower right front surface of the pedestal.
LOCAL/LINE	A two-position rocker switch. LOCAL position isolates the Terminal from the computer and permits keyboard inputs to be displayed or otherwise executed by the Terminal. Disables Bypass Condition. 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.
Switch 1 Switch 2 Switch 3	Two-position rocker 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 that is tied to the main cabling assembly within the pedestal. (For SW-3 connection, see Wire List, P1000, pin 15.)
ASCII/ALT (4014 and 4014-1)	A three position switch that controls character set selection. Because the standard 4014 or 4014-1 contain but one character set, this switch is wired at the factory to be inoperative. If an alternative character set has been installed, operation is similar to that described for the ASCII/APL switch.

ASCII/APL (4015 and 4015-1)	A three position switch that controls character set selection. ASCII allows ASCII characters to be written; APL allows APL characters to be written. The center position allows program select of either the ASCII or APL characters.
1 OFF 2 (Page Full Control)	A three position switch that controls when the Page Full signal occurs. Position 1 (Margin 1) states that the Page Full signal occurs when line feeding past the last alpha line of Margin 1. Position 2 (Margin 2) states that the Page Full signal occurs when line feeding past the last alphanumeric line of Margin 2. The OFF (center) position prevents a Page Full from occuring.
RELEASE	A momentary switch that cancels the Page Full signal.
AUTO PRINT/ COPY	A three position switch that controls hard copy operation for the 4014-1 and 4015-1 Terminals. AUTO PRINT is a stable position that results in a hard copy being generated (by attached Hard Copy Unit) when a Page Full is generated as selected by the Page Full Control switch. The COPY position is a momentary position that initiates a copying command. Switch returns to the OFF position when released from the COPY position.

Adjustments

Hard Copy Intensity	An adjustment knob located on the right side of the Display Unit (used with the 4014-1 and 4015-1. For hard copy operation, turn the control up to the point where the Hard Copy Unit scanning signal stores on the Terminal screen, then back off the adjustment to a point just below the storing level.
Write-Thru Intensity	A screwdriver adjustment located on the right side of keyboard, just in front of the Hard Copy Intensity Adjustment. Changes Write-thru intensity.

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.

KEYBOARD

Character Keys

4014 and 4014-1 Keyboard Entry. The keyboard shown in Fig. 1-5 inputs 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.

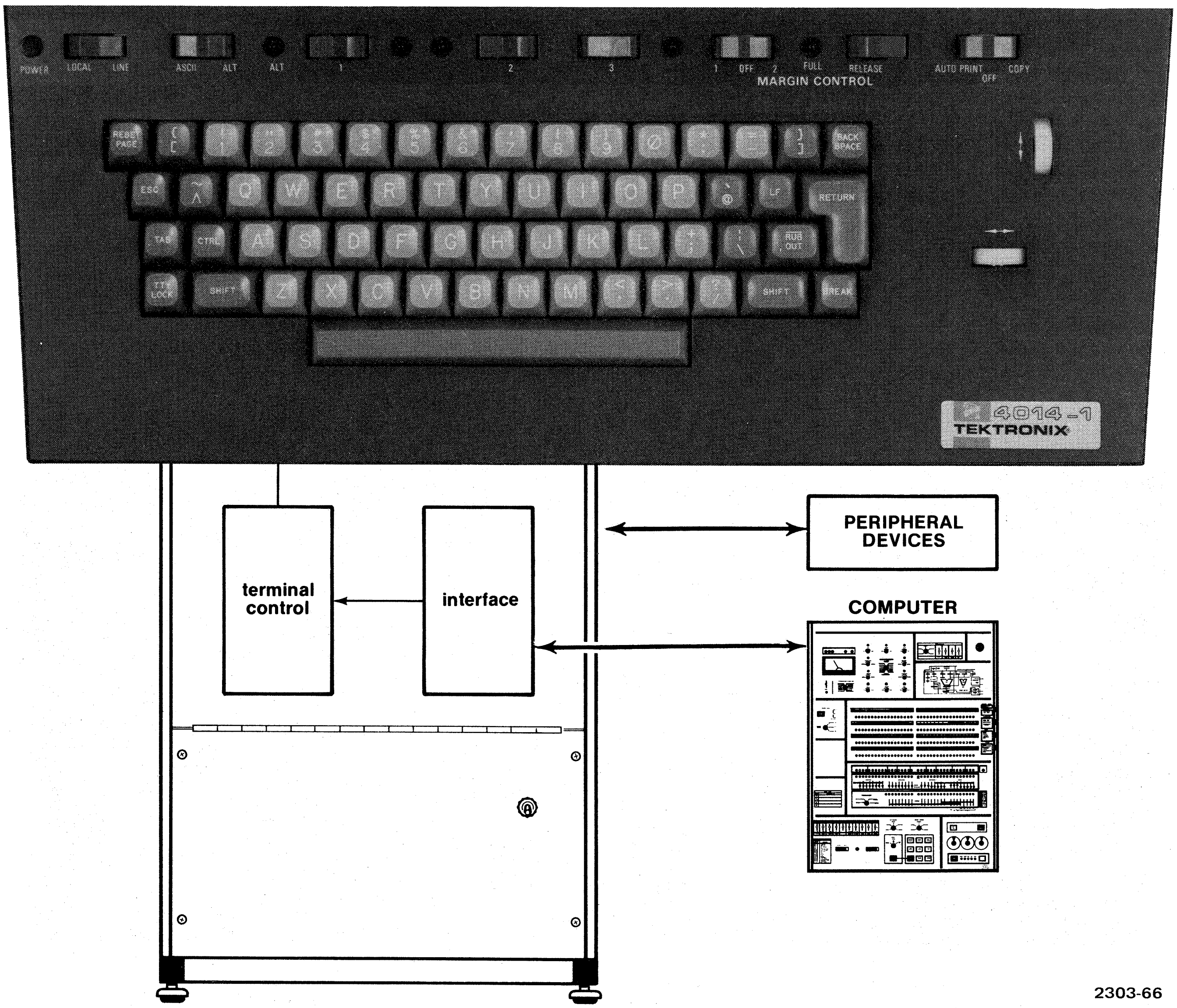

Fig. 1-5. 4014 and 4014-1 Keyboard.

4015 and 4015-1 APL Keyboard Entry. The keyboard shown in Fig. 1-6 inputs APL, ASCII or TTY codes. APL characters are shown on the top surface of the key caps, and are represented by the key code whenever the ASCII/APL switch is in the APL position. They may also be selected by ESC SO program command when the switch is in the center position. (The actual key code is not changed by switch selection; however, a change is made in the selection of the character writing circuits.) ASCII operation is selected if the ASCII/APL switch is in the ASCII position. If the Terminal is in the center position, and is switched to APL by an ESC SO command, ASCII can be regained by an ESC SI command, and can also be regained by a keyboard RESET command. (RESET is entered while holding down the SHIFT key.)

ASCII characters are indicated on the keys as follows:

Letter keys	Unshifted provides lower case; shifted provides upper case.
Number keys	Unshifted provides numeral; shifted provides character shown on front surface of key.

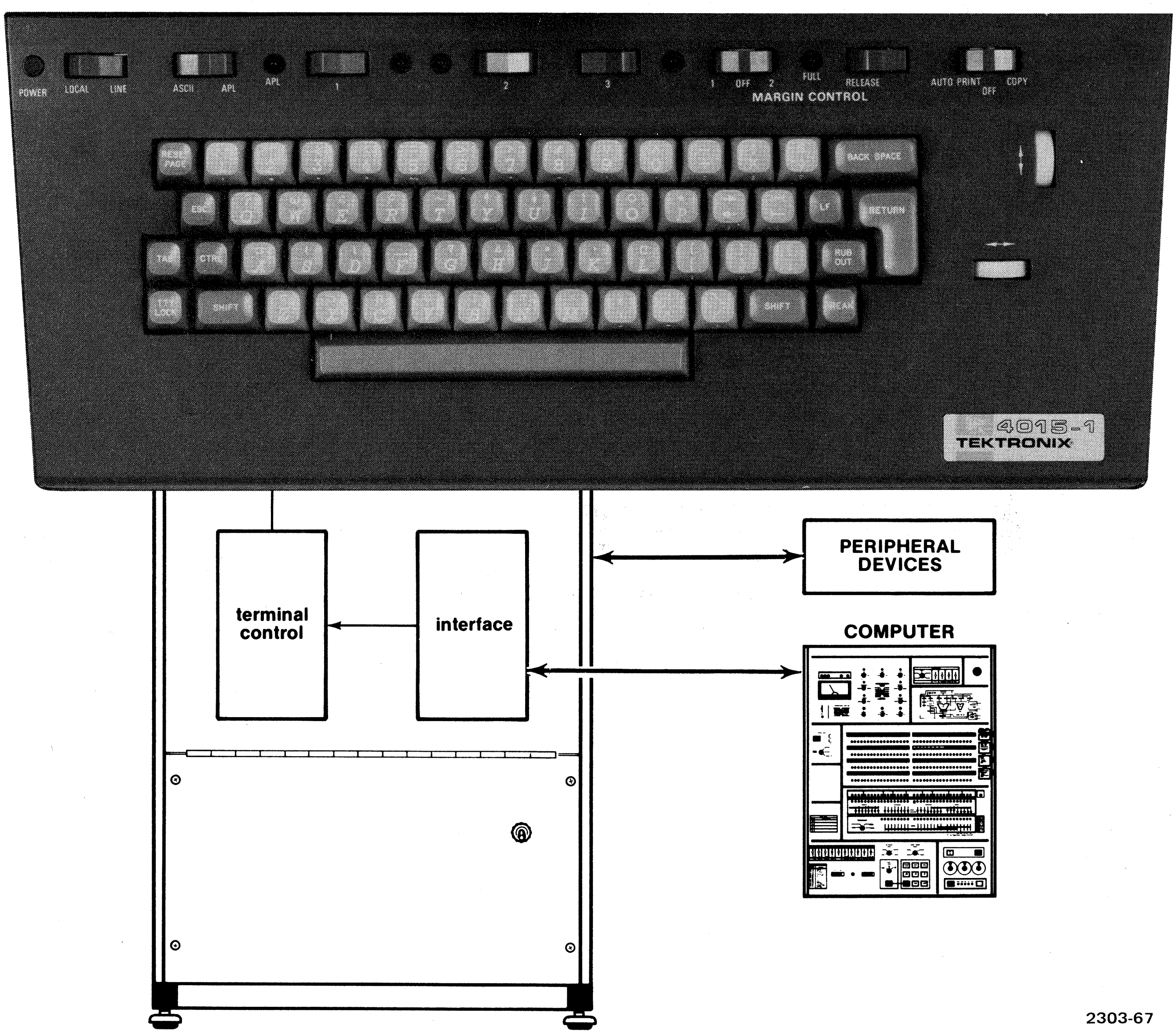

Fig. 1-6. 4015 and 4015-1 Keyboard.

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Control Character keys	Indicated control characters are transmitted regardless of SHIFT key position.
} {	Unshifted (lower) or shifted (upper) as shown on top surface of key cap.
, . /	Shifted characters as shown on front surface of key caps.
All others	Unshifted (lower) or shifted (upper) characters as shown on front surface of key caps.

Repeat Entries. 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.

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, resets to Margin 1 and cancels Bypass Condition. Pressed while SHIFT is held down, it creates a HOME (or RESET) 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 reset 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 (4014 and 4014-1)	Causes letter keys to transmit upper case letters, regardless of position of SHIFT key. TTY LOCK also inhibits transmission of the following: \` { ¦ ~
TTY LOCK (4015 and 4015-1)	Causes letter keys to transmit upper case letters if ASCII operation is selected, regardless of position of SHIFT key. (ASCII is selected by placing the ASCII/APL switch to ASCII; or by program command ESC SI, if the ASCII/APL switch is in center position.) TTY LOCK inhibits transmission of those characters shown under the TTY LOCK description for the 4014 and 4014-1 Terminals. Transmission of data is not affected if APL is selected.
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 the ASCII, APL (4015 and 4015-1) or 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.

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 D	SYN	CTRL V
ESC	ESC or CTRL SHIFT K	US	CTRL SHIFT O
ETB	CTRL W	VT	CTRL K
ETX	CTRL C		
FF	CTRL L		

Both Alpha and Graph Modes can operate in Write-Thru status, a type of display operation that enables dynamic (changing) information to be written over previously stored information.

NOTE

Optional receiving Modes provided by the Enhanced Graphic Module (Option 34) are Point Plot, Special Point Plot, and Incremental Plot.

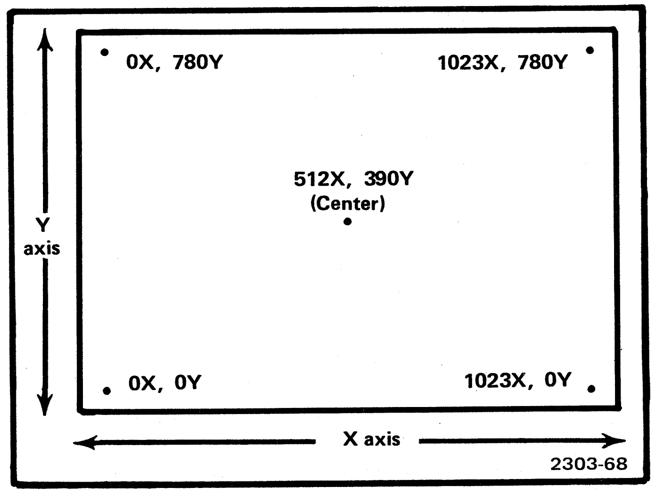

Fig. 1-7. Basic address positions on the display screen.

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 interpreted as APL (4015 and 4015-1) or ASCII writing characters in accordance with program or keyboard switch selection. Alphanumeric characters are written as received and control characters are executed as received. The Terminal goes into a reduced intensity status (Hold) after approximately 90 seconds of inactivity and returns to View status upon keyboard entry or upon receipt of data from the computer. Graph mode causes received 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. 1-7. Control characters are executed as received.

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—When the keyboard LOCAL/LINE switch is placed in the LOCAL position, the Terminal is isolated from the computer. Keyboard entries are displayed or otherwise executed by the Terminal.

Hard Copy—The 4014-1 or 4015-1 Terminals have 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 an AUTO PRINT/COPY key on the Terminal keyboard or by a switch on the Hard Copy Unit.

Transmitting

4014 and 4014-1. If the keyboard switch is at LINE position, data entered at the keyboard is transmitted in coded form to the computer. The ASCII character set and its accompanying code is shown in Fig. 1-8.

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	∧ 94	n 11Ø	~ 126
1	1	1	1	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	RUBOUT (DEL) 127

Fig. 1-8. ASCII/TTY Code Chart. (Shaded areas are not included in TTY Code.)

APL CODE CHART

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	* 8Ø	◇ 96	*P* 112
Ø	Ø	Ø	1	SOH 1	DC1 17	•• 33	1 49	α 65	? 81	*A* 97	*Q* 113
Ø	Ø	1	Ø	STX 2	DC2 18	) 34	2 50	⊥ 66	⍴ 82	*B* 98	*R* 114
Ø	Ø	1	1	ETX 3	DC3 19	< 35	3 51	∩ 67	⌈ 83	*C* 99	*S* 115
Ø	1	Ø	Ø	EOT 4	DC4 2Ø	≤ 36	4 52	⌊ 68	~ 84	*D* 1ØØ	*T* 116
Ø	1	Ø	1	ENQ 5	NAK 21	= 37	5 53	∊ 69	↓ 85	*E* 1Ø1	*U* 117
Ø	1	1	Ø	ACK 6	SYN 22	> 38	6 54	— 7Ø	∪ 86	*F* 1Ø2	*V* 118
Ø	1	1	1	BEL 7 BELL	ETB 23	] 39	7 55	∇ 71	⍵ 87	*G* 1Ø3	*W* 119
1	Ø	Ø	Ø	BS 8 BACK SPACE	CAN 24	∨ 40	8 56	Δ 72	⊃ 88	*H* 1Ø4	*X* 12Ø
1	Ø	Ø	1	HT 9	EM 25	∧ 41	9 57	⍳ 73	↑ 89	*I* 1Ø5	*Y* 121
1	Ø	1	Ø	LF 1Ø LINE FEED	SUB 26	≠ 42	(58	∘ 74	⊂ 9Ø	*J* 1Ø6	*Z* 122
1	Ø	1	1	VT 11	ESC 27	÷ 43	[59	' 75	← 91	*K* 1Ø7	{ 123
1	1	Ø	Ø	FF 12	FS 28	, 44	; 60	⎕ 76	⊢ 92	*L* 1Ø8	⊣ 124
1	1	Ø	1	CR 13 RETURN	GS 29	+ 45	× 61	| 77	→ 93	*M* 1Ø9	} 125
1	1	1	Ø	SO 14	RS 3Ø	. 46	: 62	⊤ 78	≥ 94	*N* 11Ø	$ 126
1	1	1	1	SI 15	US 31	/ 47	\ 63	○ 79	_ 95	*O* 111	RUBOUT (DEL) 127

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Fig. 1-9. APL Code Chart.

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4015 and 4015-1. If the keyboard switch is at LINE position, data entered at the keyboard is transmitted in coded form to the computer. When the 4015 or 4015-1 keyboard switch is at APL, the code generated by the keys represents APL characters. (In actuality, the ASCII/APL selection does not affect key transmission, which remains the same regardless of the selected code. The change is in the character set which is selected within the receiving circuits, causing ASCII or APL writing.) APL characters are also selected when the keyboard switch is at the center position and an ESC SO command is received.

ASCII code is represented by the key outputs when the keyboard switch is at ASCII and the Terminal is initialized, or the switch is in the center position and a SHIFT RESET is entered, or when a program ESC-SI command is received.

The two character sets (ASCII and APL) and their accompanying codes are shown in Fig. 1-8 and 1-9.

TTY LOCK. The TTY LOCK key is intended for use when ASCII operation is selected, locking out ' { ¦ ~ and lower case letters. Upper case letter transmission then occurs when a letter is entered, regardless of the SHIFT key position. (Unlike the APL selection on the 4015 and 4015-1, the TTY LOCK key affects the keyboard transmission circuits, not the receiving circuits.) The shaded characters in Fig. 1-8 show those that can't be transmitted with TTY LOCK on.

Eighth Bit. 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 characters are written on the display screen, essentially as shown in Fig. 1-8 and 1-9 (4015 and 4015-1). 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 Tables 2-1 and 2-2. Optional accessories may respond to other commands or sequences as determined by the optional accessory. Refer to Tables 2-3 through 2-5 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 2-7 and 2-8. The Terminal can still respond to control characters and control character sequences as explained in Tables 2-1 and 2-2. Graph Mode ends and Alpha Mode occurs upon receipt of control characters US, CR, or control character sequence ESC FF. Graph Mode 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. Finally, Graph Mode can be ended by receipt of the LF control character if LF is strapped to generate a carriage return on TC-1. Refer to Table 2-6 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 (or after about 350 ms delay[1]) of the Terminal status and the address of the point at the lower left corner of the Alpha cursor. CR or CR and EOT or NONE will automatically be transmitted immediately after the address, if selected by a strap option on TC-2. (EOT cannot be sent without CR.) Operation of Bypass Condition is enabled during GIN Mode. (Bypass suppresses terminal response to all but a few character codes. See Bypass Condition topic in Section 2.) 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, CR, ESC ETB, ESC FF, LF, US, or SI. 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.

[1]**With TC-1 670-3091-03 and up, strap ANSWER BACK in DELAYED position.**

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 should 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; Bypass Condition prevents the echoed status and address bytes from changing 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) or optional joystick 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, CR, ESC ETB, ESC FF, LF, US, or SI. Refer to Table 2-9 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.

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 checkout 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 strappable options. For Enhanced Graphics Module checkout, refer to the Enhanced Graphics Module information, this section.

Preliminary

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

WARNING

Dangerous voltage exists in the lower section of the pedestal. 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 voltage written on the tag which is attached to the Terminal. If it does not, remove the front cover of the pedestal after removing the screws, and change the transformer wiring so that it agrees with the power source. Wiring instructions appear inside the pedestal cover. Change the fuse size so that it also agrees with the power source. The line fuse and fuse size information are located on the back panel near the line cord. The tag information should be changed when the wiring is changed. Replace the front cover.

Power. Plug the power cord into the power source and turn the Terminal Power switch ON. The switch is located on the lower front surface of the pedestal.

Power Lamp. Check that the Power lamp on the left of the keyboard illuminates, and the display screen becomes bright.

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). Simultaneously press SHIFT RESET to ensure large character size selection.

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 KEYBOARD IS SIMPLY BEING USED AS A SOURCE OF DATA FOR THE RECEIVING CIRCUITS WHILE IN LOCAL OPERATION.*

Alpha Mode

ASCII Character Transmission and Effect. On the 4015 and 4015-1, place the ASCII/APL switch to ASCII.

NOTE

On the 4014 and 4014-1, this switch is called the ASCII/ALT switch. It is wired at the factory to have no effect on Alpha Mode operation. However, an alternative character set can be ordered at the factory as a custom modification. If the alternative character set is installed it is selected by setting the ASCII/ALT switch to ALT.

On the 4015 and 4015-1 Terminals, placing the three position ASCII/APL switch at either the ASCII or center position enables the Terminal to initialize with the full ASCII character set selected. The center position enables program selection of either the ASCII or APL character sets. More information on character set selection can be found under APL Character Transmission and 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 as follows.

PAGE/RESET—Causes no transmission. When pressed alone, it selects Alpha Mode, erases the display, 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, selects Alpha Mode "home" position, and reset 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, entering ESC and CTRL L causes 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 (approximately 1 — 2 minutes after terminal inactivity). Then press SHIFT and note the effect. When SHIFT is used with 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.

BACKSPACE—Transmits control character BS, causing the cursor to move back one space. Enter a space command and then press BACKSPACE 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. The LF→CR position also resets Graph Mode to Alpha Mode.

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 1". The second is near the horizontal center of the screen, and is referred to as "Margin 2". Margin 2 is automatically selected each time the Terminal line-feeds past the last line while Margin 1 exists. Margin 1 is selected when the Terminal line-feeds past the last line while Margin 2 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 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 1 or Margin 2.

Margins. Enter a PAGE command and note the cursor position at the left edge (Margin 1) of the display. Hold the LF key down until the cursor disappears past the bottom of the display screen, and note that it reappears at the top-center of the display, in Margin 2 position. Hold the LF key down until the cursor moves past the bottom of the display; it will reappear at the top in Margin 1 positon. *THE EFFECTIVE MARGIN CONDITION CHANGES EACH TIME THE DISPLAY LINE-FEEDS PAST THE LAST LINE.*

Again arrive at the Margin 2 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 2. Now enter enough characters to space past the end of the line. Note that the cursor returns to Margin 2. *CR, RETURN, OR AUTOMATIC CARRIAGE RETURN SETS THE CURSOR BACK TO THE EFFECTIVE MARGIN POSITION.*

Press SHIFT RESET to set Margin 1. Now enter characters until a line is fully written and an automatic line feed — carriage return occurs. Note that character writing ignores Margin 2 position or Margin 2 information while Margin 1 exists. *IF TWO-COLUMN FORMATTING IS TO OCCUR, MARGIN 2 INFORMATION MUST BE KEPT TO ONE HALF OR LESS OF THE CHARACTERS PER LINE. FOR EXAMPLE, IF THE LARGEST CHARACTER SIZE IS SELECTED, 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 the tube life, and occurs in Alpha Mode only. *THEREFORE, THE TERMINAL SHOULD ALWAYS BE PLACED IN ALPHA MODE WHEN ENERGIZED, BUT NOT IN USE.*

Character Size Selection. Alpha Mode can display written characters in one of four program selectable character sizes. The program commands for character size selection are:

ESC 8—Selects largest character size, providing 74 characters per line and 35 lines per page.

ESC 9—Selects second character size, providing 81 characters per line and 38 lines per page.

ESC :—Selects third character size, providing 121 characters per line and 58 lines per page.

ESC ;—Selects fourth (smallest) character size, providing 133 characters per line and 64 lines per page.

The Terminal initializes with the largest character size selected. If a smaller size has previously been selected, the largest character size can be selected by program command ESC 8 or by keyboard reset (SHIFT RESET) command. The PAGE command does not change the selected character size even though the screen is erased.

Write-Thru Operation. Selecting Write-Thru Operation in Alpha Mode provides a means whereby dynamic (changing) information can be displayed concurrent with stored information. Write-Thru prevents data currently being written from storing and must therefore be "refreshed" by the computer or auxiliary device to be useful. To increase the amount of data that can be written before flicker becomes objectional, the Character writing capability of the Terminal is increased to 4,000 characters per second (up from 1,000 characters per second). To check out Write-Thru Operation, send ESC p (4014) or ESC * (4015) from the keyboard, then enter a keyboard character. Note that previously entered characters remain stored, while characters currently being entered do not store; also note that the alpha cursor goes away for about 1/2 second after each character.

Defocused Alpha Operation. The two larger character sizes are defocused to fill the space between the written dots of the character matrix that forms the character. Because of the smaller space between the written dots of the two smaller character sizes, they are not defocused. However, the two smaller character sizes can be defocused by sending ESC h, a defocus command.

Select the smaller character size by entering ESC ; (4014) or ESC [(4015) from the keyboard then key in a few characters. Next send ESC h (4014) or ESC *H* (4015) and once again enter a few more characters. Note the slight defocusing of the character. Enter SHIFT RESET to re-establish initial condition.

APL Character Transmission and Character Effect for 4015 and 4015-1. Except for character types, the Terminal operation in APL is the same as explained for ASCII. Move the ASCII/APL switch to the APL position. *IF THE ASCII/APL SWITCH IS AT APL, THE APL CHARACTER SET IS SELECTED UPON INITIALIZATION.* Enter several H characters and note that the Terminal is in APL, as indicated by the upper case italic letters. Place the ASCII/APL switch in the center position. Enter SHIFT RESET and again enter an H. Now note that a lower case h occurs, indicating that the Terminal is in full ASCII mode. If an upper case H is written instead of a lower case h, check the TTY LOCK key. If actuated, press it once to release the lock and then enter another h and check for lower case writing. IF THE ASCII/APL SWITCH IS AT THE CENTER POSITION, THE TERMINAL ATTAINS FULL ASCII MODE UPON INITIALIZATION OR UPON KEYBOARD ENTRY OF A SHIFT RESET COMMAND.

4015 and 4015-1 Program Character Set Selection. Place the ASCII/APL switch to the Center position. Then send ESC SO to the receiving circuits by entering ESC CTRL N. Then enter an H and note that the Terminal is again in APL. *APL OPERATION IS OBTAINED BY PROGRAM COMMAND ESC SO WHENEVER THE ASCII/APL SWITCH IS AT THE CENTER POSITION. CAPABILITY FOR CONTROL CHARACTER TRANSMISSION AND EXECUTION IS RETAINED IN APL OPERATION, JUST AS EXPLAINED IN ASCII OPERATION.*

Send ESC SI to the receiving circuits by entering ESC CTRL O. Enter another h and note that the Terminal is again in full ASCII as indicated by the lower case h which is written. *ASCII OPERATION OCCURS IN RESPONSE TO PROGRAM COMMAND ESC SI, AS WELL AS IN RESPONSE TO INITIALIZATION OR SHIFT RESET INPUT WHEN THE ASCII/APL SWITCH IS IN THE CENTER POSITION.*

TTY Character Transmission and Character Effects. The Terminal operation with TTY LOCK selected (ASCII/APL switch at center position with ASCII selected, TTY LOCK key activated) is essentially the same as for ASCII. The difference is that a truncated character set is available for transmission; all letters are transmitted as upper case, regardless of the position of the SHIFT key.

With the ASCII/APL switch at the center position, enter SHIFT RESET. Then 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. Note, however, that the SHIFT key still exercises control over other characters. *ALTHOUGH LOWER CASE LETTERS CANNOT BE TRANSMITTED WITH THE TTY LOCK KEY DEPRESSED, THEY CAN BE WRITTEN BY THE TERMINAL UPON RECEIPT OF THE APPROPRIATE ASCII CODE. TTY OPERATION IS INHIBITED WITH THE ASCII/APL SWITCH AT APL.*

Graph Mode

Release the TTY LOCK key and then 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. 1-10 through 1-13. They equate to + DEL Ø @ in ASCII code and ÷ DEL Ø ¯ in APL code.

Enter at the keyboard the following. (RUBOUT key transmits DEL.)

(4014) + RUBOUT Ø @

(4015) ÷ RUBOUT Ø ¯

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 @ or ¯ (as applicable to Terminal). 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 @ or ¯ contains the code for a Low Order X byte, that causes vector execution.) Now, from the keyboard, send the address for 32Y, 32X. This equates to

(4014) ! ' ! @

(4015) " ◇ " ¯

Note that nothing happens until the Low X (last command) is entered. Then a vector is drawn from the center to the lower left corner.

COORDINATE CONVERSION CHART

Low Order X			X or Y Coordinate								Low Order Y		
APL	ASCII	DEC.									DEC.	ASCII	APL
—	@	64	0	32	64	96	128	160	192	224	96	`	◊
∝	A	65	1	33	65	97	129	161	193	225	97	a	*A*
⊥	B	66	2	34	66	98	130	162	194	226	98	b	*B*
∩	C	67	3	35	67	99	131	163	195	227	99	c	*C*
⌊	D	68	4	36	68	100	132	164	196	228	100	d	*D*
∊	E	69	5	37	69	101	133	165	197	229	101	e	*E*
_	F	70	6	38	70	102	134	166	198	230	102	f	*F*
∇	G	71	7	39	71	103	135	167	199	231	103	g	*G*
∆	H	72	8	40	72	104	136	168	200	232	104	h	*H*
⍳	I	73	9	41	73	105	137	169	201	233	105	i	*I*
∘	J	74	10	42	74	106	138	170	202	234	106	j	*J*
'	K	75	11	43	75	107	139	171	203	235	107	k	*K*
⎕	L	76	12	44	76	108	140	172	204	236	108	l	*L*
|	M	77	13	45	77	109	141	173	205	237	109	m	*M*
⊤	N	78	14	46	78	110	142	174	206	238	110	n	*N*
○	O	79	15	47	79	111	143	175	207	239	111	o	*O*
*	P	80	16	48	80	112	144	176	208	240	112	p	*P*
?	Q	81	17	49	81	113	145	177	209	241	113	q	*Q*
⍴	R	82	18	50	82	114	146	178	210	242	114	r	*R*
⌈	S	83	19	51	83	115	147	179	211	243	115	s	*S*
∼	T	84	20	52	84	116	148	180	212	244	116	t	*T*
↓	U	85	21	53	85	117	149	181	213	245	117	u	*U*
∪	V	86	22	54	86	118	150	182	214	246	118	v	*V*
⍵	W	87	23	55	87	119	151	183	215	247	119	w	*W*
⊃	X	88	24	56	88	120	152	184	216	248	120	x	*X*
↑	Y	89	25	57	89	121	153	185	217	249	121	y	*Y*
⊂	Z	90	26	58	90	122	154	186	218	250	122	z	*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	}	}
≥	Λ	94	30	62	94	126	158	190	222	254	126	~	$
—	—	95	31	63	95	127	159	191	223	255	127	RUBOUT (DEL)	RUBOUT (DEL)
DEC. ⟶			32	33	34	35	36	37	38	39			
ASCII ⟶			SP	!	"	#	$	%	&	'			
APL ⟶			SP	¨	)	<	≤	=	>	]			
			High Order X & Y										

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Fig. 1-10. 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 or ASCII or APL 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, 38X equals 38 104 33 80 in decimal code, equals & h ! P in ASCII code, and equals < H " * in APL code.

COORDINATE CONVERSION CHART
(cont)

Low Order X			X or Y Coordinate								Low Order Y		
APL	ASCII	DEC.									DEC.	ASCII	APL
¯	@	64	256	288	320	352	384	416	448	480	96	`	◊
α	A	65	257	289	321	353	385	417	449	481	97	a	*A*
⊥	B	66	258	290	322	354	386	418	450	482	98	b	*B*
∩	C	67	259	291	323	355	387	419	451	483	99	c	*C*
⌊	D	68	260	292	324	356	388	420	452	484	100	d	*D*
ϵ	E	69	261	293	325	357	389	421	453	485	101	e	*E*
_	F	70	262	294	326	358	390	422	454	486	102	f	*F*
∇	G	71	263	295	327	359	391	423	455	487	103	g	*G*
Δ	H	72	264	296	328	360	392	424	456	488	104	h	*H*
ι	I	73	265	297	329	361	393	425	457	489	105	i	*I*
∘	J	74	266	298	330	362	394	426	458	490	106	j	*J*
'	K	75	267	299	331	363	395	427	459	491	107	k	*K*
⎕	L	76	268	300	332	364	396	428	460	492	108	l	*L*
I	M	77	269	301	333	365	397	429	461	493	109	m	*M*
⊤	N	78	270	302	334	366	398	430	462	494	110	n	*N*
○	O	79	271	303	335	367	399	431	463	495	111	o	*O*
*	P	80	272	304	336	368	400	432	464	496	112	p	*P*
?	Q	81	273	305	337	369	401	433	465	497	113	q	*Q*
ρ	R	82	274	306	338	370	402	434	466	498	114	r	*R*
⌈	S	83	275	307	339	371	403	435	467	499	115	s	*S*
~	T	84	276	308	340	372	404	436	468	500	116	t	*T*
↓	U	85	277	309	341	373	405	437	469	501	117	u	*U*
∪	V	86	278	310	342	374	406	438	470	502	118	v	*V*
ω	W	87	279	311	343	375	407	439	471	503	119	w	*W*
⊃	X	88	280	312	344	376	408	440	472	504	120	x	*X*
↑	Y	89	281	313	345	377	409	441	473	505	121	y	*Y*
⊂	Z	90	282	314	346	378	410	442	474	506	122	z	*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	}	}
≥	Λ	94	286	318	350	382	414	446	478	510	126	~	$
–	—	95	287	319	351	383	415	447	479	511	127	RUBOUT (DEL)	RUBOUT (DEL)
DEC. →			40	41	42	43	44	45	46	47			
ASCII →			(	)	*	+	,	–	.	/			
APL →			∨	∧	≠	÷	,	+	.	/			
			High Order X & Y										

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Fig. 1-11. 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		
APL	ASCII	DEC.									DEC.	ASCII	APL
¯	@	64	512	544	576	608	640	672	704	736	96	`	◊
α	A	65	513	545	577	609	641	673	705	737	97	a	*A*
⊥	B	66	514	546	578	610	642	674	706	738	98	b	*B*
∩	C	67	515	547	579	611	643	675	707	739	99	c	*C*
⌊	D	68	516	548	580	612	644	676	708	740	100	d	*D*
ε	E	69	517	649	581	613	645	677	709	741	101	e	*E*
_	F	70	518	550	582	614	646	678	710	742	102	f	*F*
∇	G	71	519	551	583	615	647	679	711	743	103	g	*G*
∆	H	72	520	552	584	616	648	680	712	744	104	h	*H*
⍳	I	73	521	553	585	617	649	681	713	745	105	i	*I*
∘	J	74	522	554	586	618	650	682	714	746	106	j	*J*
'	K	75	523	555	587	619	651	683	715	747	107	k	*K*
□	L	76	524	556	588	620	652	684	716	748	108	l	*L*
|	M	77	525	557	589	621	653	685	717	749	109	m	*M*
⊤	N	78	526	558	590	622	654	686	718	750	110	n	*N*
○	O	79	527	559	591	623	655	687	719	751	111	o	*O*
*	P	80	528	560	592	624	656	688	720	752	112	p	*P*
?	Q	81	529	561	593	625	657	689	721	753	113	q	*Q*
ρ	R	82	530	562	594	626	658	690	722	754	114	r	*R*
⌈	S	83	531	563	595	627	659	691	723	755	115	s	*S*
~	T	84	532	564	596	628	660	692	724	756	116	t	*T*
↓	U	85	533	565	597	629	661	693	725	757	117	u	*U*
∪	V	86	534	566	598	630	662	694	726	758	118	v	*V*
ω	W	87	535	567	599	631	663	695	727	759	119	w	*W*
⊃	X	88	536	568	600	632	664	696	728	760	120	x	*X*
↑	Y	89	537	569	601	633	665	697	729	761	121	y	*Y*
⊂	Z	90	538	570	602	634	666	698	730	762	122	z	*Z*
←	[	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	}	}
≥	Λ	94	542	574	606	638	670	702	734	766	126	~	$
–	_	95	543	575	607	639	671	703	735	767	127	RUBOUT (DEL)	RUBOUT (DEL)
DEC. →			48	49	50	51	52	53	54	55			
ASCII →			Ø	1	2	3	4	5	6	7			
APL →			Ø	1	2	3	4	5	6	7			
			High Order X & Y										

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Fig. 1-12. 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		
APL	ASCII	DEC.									DEC.	ASCII	APL
¯	@	64	768	800	832	864	896	928	960	992	96	`	◊
α	A	65	769	801	833	865	897	929	961	993	97	a	*A*
⊥	B	66	770	802	834	866	898	930	962	994	98	b	*B*
∩	C	67	771	803	835	867	899	931	963	995	99	c	*C*
⌊	D	68	772	804	836	868	900	932	964	996	100	d	*D*
ε	E	69	773	805	837	869	901	933	965	997	101	e	*E*
_	F	70	774	806	838	870	902	934	966	998	102	f	*F*
∇	G	71	775	807	839	871	903	935	967	999	103	g	*G*
Δ	H	72	776	808	840	872	904	936	968	1000	104	h	*H*
⍳	I	73	777	809	841	873	905	937	969	1001	105	i	*I*
∘	J	74	778	810	842	874	906	938	970	1002	106	j	*J*
'	K	75	779	811	843	875	907	939	971	1003	107	k	*K*
⎕	L	76	780	812	844	876	908	940	972	1004	108	l	*L*
|	M	77	781	813	845	877	909	941	973	1005	109	m	*M*
⊤	N	78	782	814	846	878	910	942	974	1006	110	n	*N*
○	O	79	783	815	847	879	911	943	975	1007	111	o	*O*
*	P	80	784	816	848	880	912	944	976	1008	112	p	*P*
?	Q	81	785	817	849	881	913	945	977	1009	113	q	*Q*
⍴	R	82	786	818	850	882	914	946	978	1010	114	r	*R*
⌈	S	83	787	819	851	883	915	947	979	1011	115	s	*S*
~	T	84	788	820	852	884	916	948	980	1012	116	t	*T*
↓	U	85	789	821	853	885	917	949	981	1013	117	u	*U*
∪	V	86	790	822	854	886	918	950	982	1014	118	v	*V*
⍵	W	87	791	823	855	887	919	951	983	1015	119	w	*W*
⊃	X	88	792	824	856	888	920	952	984	1016	120	x	*X*
↑	Y	89	793	825	857	889	921	953	985	1017	121	y	*Y*
⊂	Z	90	794	826	858	890	922	954	986	1018	122	z	*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	}	}
≥	Λ	94	798	830	862	894	926	958	990	1022	126	~	$
−	—	95	799	831	863	895	927	959	991	1023	127	RUBOUT (DEL)	RUBOUT (DEL)
DEC. →			56	57	58	59	60	61	62	63			
ASCII →			8	9	:	;	<	=	>	?			
APL →			8	9	(	[	;	X	:	\			
			High Order X & Y										

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Fig. 1-13. Coordinate conversion chart, part 4 of 4. (Refer to part 1 for interpretation instructions.)

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 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.

Resetting With RESET. First send a GS from the keyboard (CRTL SHIFT M). Then press the SHIFT and RESET keys at the keyboard. Note that 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.

Graph Memory. Once again send GS from the keyboard (CTRL SHIFT M). Send the same Low X command as was last used by again entering @ (4014) or ¯ (4015) at the keyboard. The beam will move unseen back to the end of the preceding vector because of the Graph Mode Memory circuits. This can be confirmed by entering a second @ (4014) or ¯ (4015) 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. If the LF EFFECT strap is at LF→CR, Graph Mode can be reset by sending an LF to the receiving circuits. The cursor is then placed at the left margin, 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 H (4014) or △ (4015) 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.

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 as sent in the last address which contained them. Table 2-8 specifies the minimum bytes that can be sent in any one situation.

TABLE 1-2

Shortened Address Illustration

Address & Comment	Send: ASCII	Send: APL
543Y, 543X. (Initial address; send 4 bytes.)	Ø DEL Ø _	Ø DEL Ø ¯
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 @	SP ¯
29Y, 0X. (Hi X changes; send Lo Y, Hi X, Lo X.)	} SP @	} SP ¯
543Y, 0X. (Hi Y and Lo Y change; send Hi Y, Lo Y, Lo X.)	Ø DEL @	Ø DEL ¯
31Y, 543X. (Hi Y, Hi X, and Lo X change; send 4 bytes.)	SP DEL Ø _	SP DEL Ø ¯

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.*

Graph Mode Write-Thru. Vectors can also be displayed in the Write-Thru mode. Like alpha characters, they must be continually "refreshed" by the computer or auxiliary device to be useful. Enter PAGE then enter a few characters onto the screen. Now enter ESC p (4014) or ESC *P* (4015). Next enter (CTRL SHIFT M) followed by:

(4014) ` ! @ 8 RUBOUT ? _

(4015) " ◇ " ¯ 8 RUBOUT \ _

Note that a non-storing vector is drawn from the lower left corner of the display to the upper right.

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 thumbweels 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 demonstrated with the keyboard switch at LOCAL position. Refer to the Operating Modes information at the beginning of this section, or refer to Table 2-9 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 MAKE 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 drop-out occurs, the Hard Copy Intensity control on the right side 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.

ENHANCED GRAPHICS MODULE—OPTION 34

Identification

To determine if your Terminal contains this option, attempt to draw a dotted vector. First, erase the page, and then enter Graph Mode by pressing CTRL SHIFT M (GS). Follow this with ESC a (4014) or ESC *A* (4015). Now send the following coordinates:

(4014) SPACE RUBOUT SPACE @ 8 RUBOUT ? _

(4015) SPACE RUBOUT SPACE ¯ 8 RUBOUT \ —

If your Terminal contains the Enhanced Graphics Module, a dotted vector will be drawn from the lower left to the upper right corner of the display. If your Terminal does not contain this factory installed option, ignore the remainder of text in this section.

General

The Enhanced Graphics Module is installed at the factory. It consists of an additional circuit card (termed the Discrete Plot Card) and modifications to existing Terminal hardware. It offers increased graphic capabilities that include the following:

1. 12-bit graphic resolution (4096Y by 4096X addressable points) that increases the address resolution by a factor of four over the standard 1024X by 1024Y. 4096 addressability requires the use of a fifth "Extra" byte in the graphic address.

2. Vector Line Formats that in addition to the solid line vectors include:

a. Dotted vectors

b. Short-dashed vectors

c. Long-dashed vectors

d. Dot-dashed vectors

3. Incremental Plot Mode that enables the Terminal to plot in one of eight directions (in written or unwritten increments) in response to a specific increment character.

4. Point Plot Mode that enables the Terminal to plot the end point of the vector; hence, the term point plot. The address data is identical to Graph Mode data.

5. Special Point Plot Mode is similar to Point Plot in that the end points of the vectors are drawn. In addition, the intensity of the plotted point can be controlled by an "intensity" character that must immediately precede each point address.

6. Outputs are available to drive the majority of mechanical plotters in use today.

INSTALLATION

General installation of the Enhanced Graphics Module is performed at the factory. Therefore, on-site procedures consist of selecting strap options, connecting the Discrete Plot Card to an outboard mechanical plotter (if used), and adjusting the Discrete Plot Card to match the mechanical plotter. The mechanical XY plotter may be connected to the Discrete Plot Card by means of an optional cable (Tektronix Part Number 012-0410-00) which connects to the J5 pins and exits through the cable opening at the rear of the pedestal. A clamp secures the cable to the sill of the opening.

Without XY Mechanical Plotter

Two strap options on the Discrete Plot Card should be checked to ensure they are in the 4014 position. These are the WRITE and TIMING (settling) straps. Fig. 1-14 shows strap locations. The GREY SCALE adjustment is used to adjust the intensity of the plotted point when operating in Special Point Plot mode. Fig. 1-14 also shows the location of this adjustment.

With XY Mechanical Plotter

Installation procedures are similar for most plotters that the Enhanced Module (EGM) is designed to interface with. Similar procedures include performing, as required, the information provided in the above ("Without Plotter") information. In addition, the Discrete Plot card needs to be connected to the plotter and specific adjustments and straps need to be checked.

Cabling

Fig. 1-15 shows the optional interconnecting cable pin assignments. The plotter cable connects to J5 on the Discrete Plot circuit card that connects to the Terminal minibus. The cable is then routed through the opening in the back of the pedestal and fastened to the sill with a cable clamp. The other end of the cable is connected to the plotter. Apply power to equipment and make any necessary adjustments. See below for information on strap options and adjustments.

Strap Options

Fig. 1-14 for location of straps. In addition to the WRITE and TIMING straps previously mentioned, other straps are pertinent for operation with a plotter. These are:

REMOTE SELECT—IN or OUT. The Remote Select Strap allows the plotter to control its on-line status. While in Incremental Plot Mode, the Terminal may act as a rapid XY plotter or will operate as a slow XY plotter when providing parallel information from the J5 pins to a suitable mechanical plotter. With the REMOTE SELECT strap in the IN position, the plotter may control which of these plotting conditions exists by feeding appropriate information to J5 pins 1 and 2. With the REMOTE SELECT strap in the OUT position, control of these functions is transferred to one of the spare Terminal keyboard switches or a signal applied to pin J6-1 as selected by the PLOTTER SELECT strap.

PLOTTER SELECT—SW1, SW2, SW3 or OUT. With the Remote Select strap in the OUT position and the Plotter Select strap in the OUT position, the plotter is removed from the system. Placing the PLOTTER SELECT strap in the SW1 or SW2 position allows the Terminal keyboard switch 1 or 2 to place the plotter on line by the operator depressing the right side of the selected switch.

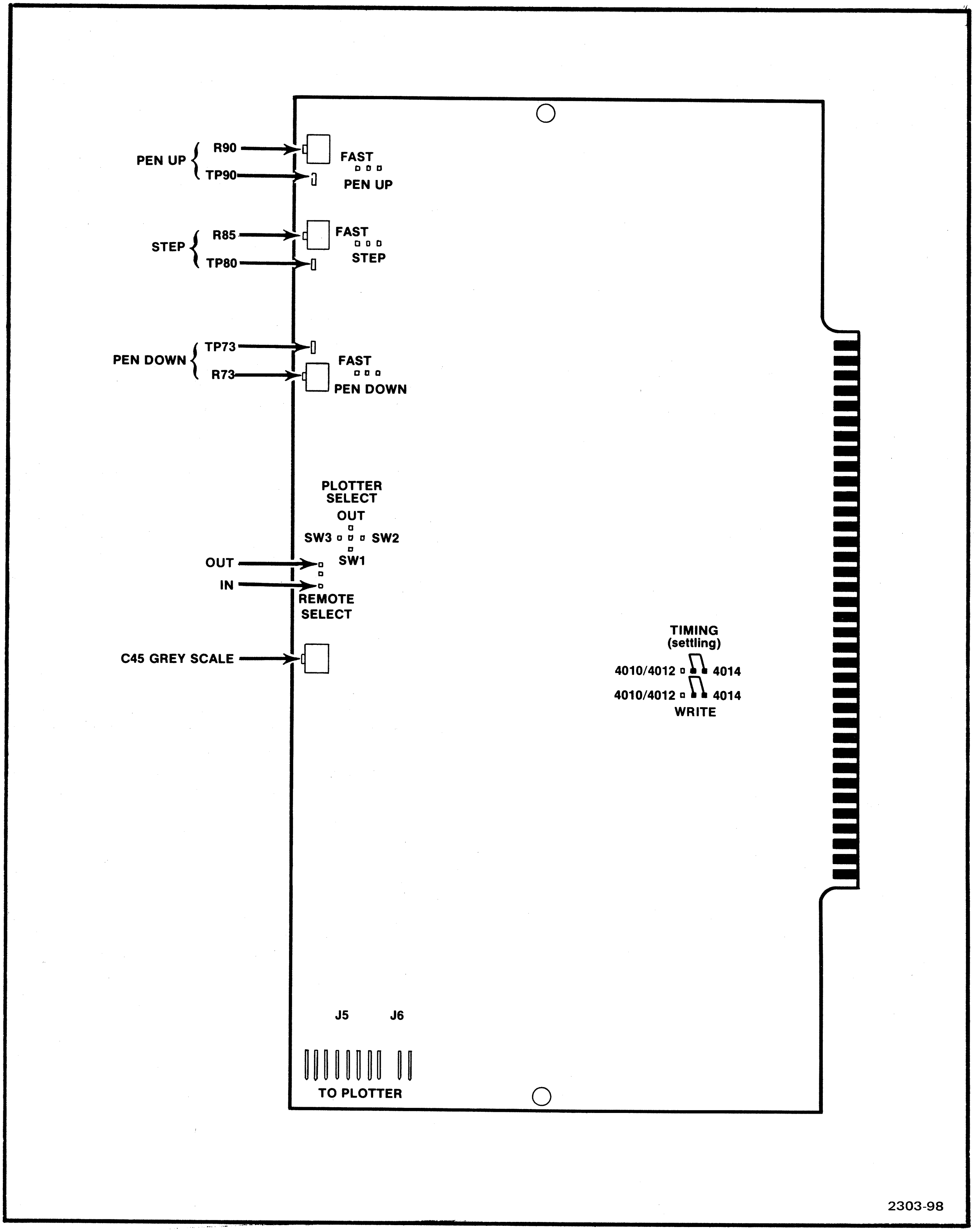

Fig. 1-14. Discrete Plot Card strap options and adjustment locations.

Placing the PLOTTER SELECT strap in the SW3 position allows the plotter status to be controlled by pin J6-1, much in the same way as J5-2 discussed earlier. This additional control of plotter status is provided for use in systems other than already described. For initial installation, set this strap to SW1 or SW2, whichever is available on the Terminal.

Two other straps, PEN DOWN and PEN UP, are for adjustment use and are described in the following Adjustment Procedure.

Adjustment

This procedure allows adjustment of the rate at which data is fed to a mechanical plotter during Incremental Plot mode operation. An adjustment is also provided to shift the display intensity scale available during Special Point Plot mode.

An oscilloscope of low bandwidth (1 kHz) may be used.

1) Disconnect the Terminal power supply.

2) Remove the front cover of the pedestal held in place by two thumbscrews.

3) Locate the Discrete Plot card in the minibus. Refer to Fig. 1-14 for adjustment and test point locations.

4) Connect the oscilloscope to test point 73 (PEN DOWN time).

5) Place the Terminal in LOCAL.

6) Turn on the Terminal power supply.

7) Place the Terminal in Incremental Plot mode by entering an RS command at the keyboard (CTRL SHIFT N).

8) Depress the P (4014) or * (4015) key periodically. Observe on the oscilloscope a pulse of duration controlled by potentiometer R73. Adjust this pulse width to correspond to the plotter's specified Pen Down time.

9) Transfer the oscilloscope probe to test point 80 (STEP time). Depress the A (4014) or ∝ (4015) key periodically. Observe on the oscilloscope a pulse of duration controlled by potentiometer R85. Adjust pulse width to correspond to the plotter's specified Step time.

10) Transfer the oscilloscope probe to test point 90 (Pen Up time). Depress the SPACE key periodically. Observe on the oscilloscope a pulse of duration controlled by potentiometer R90. Adjust to correspond to the plotter's specified pen up time.

11) Return the Terminal to Alpha mode operation (PAGE, CR, ESC FF, US, etc.) and then transfer to Special Point Plot mode with an ESC FS (ESC key followed by CTRL SHIFT L). Transmit intensity character @ (4014) or ¯ (4015) setting intensity at the lowest level and then return to Incremental Plot mode with RS (CTRL SHIFT N).

12) Depress an upper case P (4014) or * (4014) followed by a repetitively pulsed A (4014) or ∝ (4015) and observe on the screen how the Terminal is beginning an incremental plot beginning at that point where the cursor appeared while previously in Alpha mode. Because an A (or *) contains active bit 1 in the absence of other step commands, movement to the right occurs.

Because an intensity character @ (or ¯) was input during Special Point Plot mode, the plot observed is at the lowest of the 32 intensity levels stored by the Discrete Plot Card. Now adjust the trimming capacitor C45 (adjacent to U41) (see Fig. 1-15) and notice that it has an effect on the intensity of subsequently written points. When the intensity reaches the desired minimum value, leave the capacitor at that setting. The minimum intensity in Table 2-23 has been estalished.

This ends the Adjustment procedure, and the Discrete Plot Card may now be permanently installed in a vacant pedestal slot. The cable to the mechanical plotter, attached to the J5 Connector pins, exits through the opening on the rear of the pedestal and is secured by the cable clamp (optional accessories).

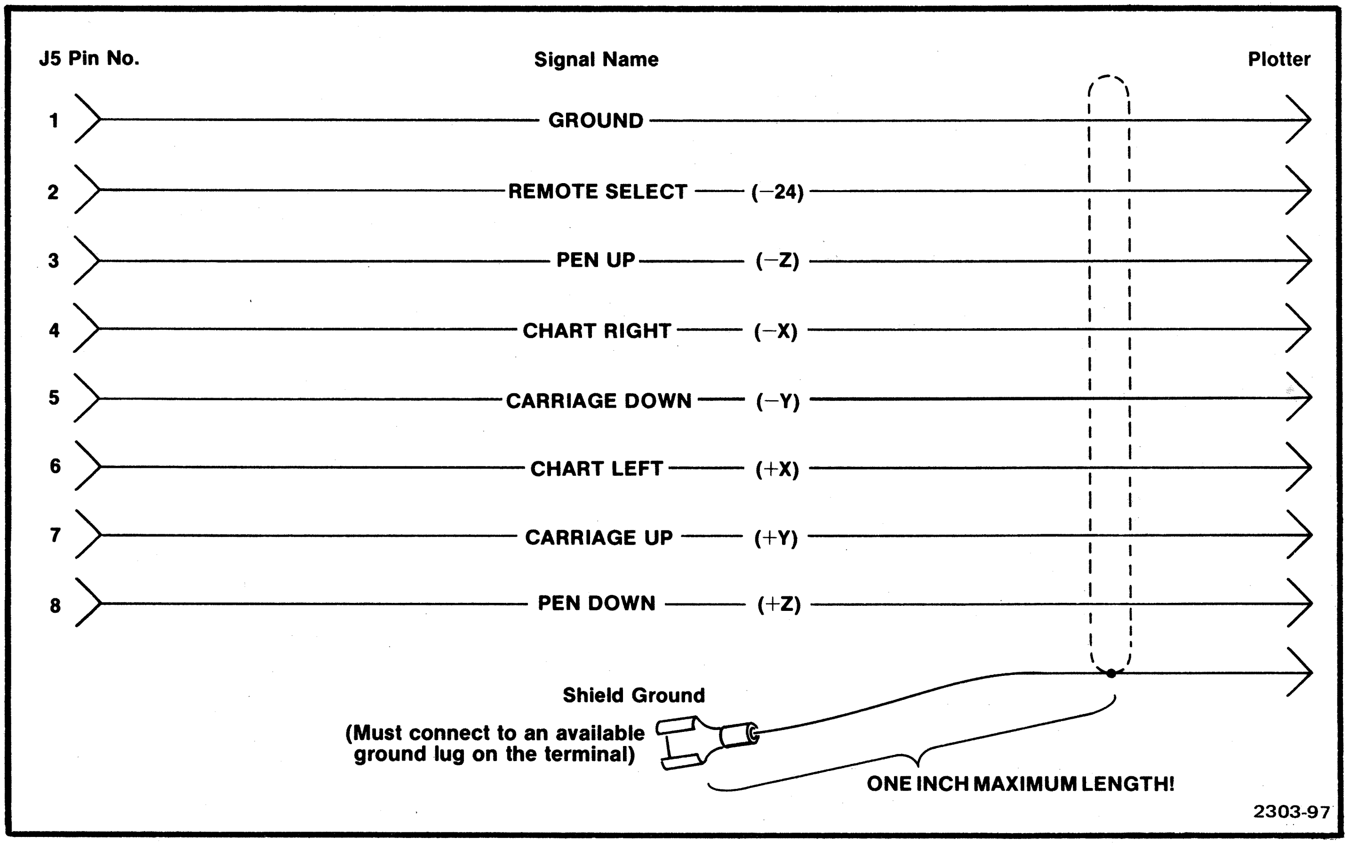

Fig. 1-15. Plotter connector (J5) pin assignments.

OPERATION

4096 Resolution (12-Bit Addressing)

General. To establish an address in the addressable point grid of 4096X by 4096Y, 12 bits of X and 12 bits of Y data (24 bits total) must be transmitted to the Terminal. This necessitates the use of an "Extra" 7-bit byte in the vector address. The transmission order is shown in Table 2-21, which also shows the byte content.

This system of address transmission is both upward and downward compatible with the Tektronix 4010-series Computer Display Terminal, 10 bit addressability software. That is, if the 4014/4015 is driven from a program written for a 4010/4012/4013, the 4014/4015 will default to a 1024X by 1024Y addressable condition and the plot will appear full screen, (therefore magnified by the ratio of screen sizes). Furthermore, if a 4010/4012/4013 is driven from a program written for the 4014/4015 with Enhanced Graphics Module installed, the plot will simply appear full screen on the 4010, (therefore reduced by the ratio of screen sizes).

The Extra Byte need not be sent, but when it is, the Low Order Y byte must always be sent. The rules for shortened address transmission only change (over that of the standard Terminal as mentioned in preceding text) as the Extra Byte changes. In which case, send the Extra, Low Y, and Low X bytes. Also refer to Table 2-21.

Operational Check. To checkout 12-bit addressing, enter GS (CTRL SHIFT M) at the keyboard followed by the following address

(4014) ,` ` Ø @

(4015) , ◊ ◊ Ø ¯

Repeat the last character entry of the address and note a written point near display center. Enter

(4014) , o ~ Ø @

(4015) , O $ Ø ¯

Note a minute beam movement about the width of two written points up and to the left of the original point. Enter

(4014), ` ` Ø @

(4015) , ◇ ◇ Ø ‾

Note that the beam has positioned back over the first written point. Enter SHIFT RESET to return the Terminal to Alpha Mode.

Vector Formats

General. Additional vector formats of dotted, dot-dashed, short-dashed, and long-dashed can be program controlled as can the focused, defocused and write-thru states of each of the types. Code information is provided in Table 2-19. Because focused, defocused and write-thru vectors have been discussed in preceding text, these operational features will not be discussed here.

Operational Check. Operational checkouts for the vector types are as follows.

1. Dotted Vectors — Enter GS (CTRL SHIFT M) at the keyboard followed by:

   (4014) , ` Ø @

   (4015) , ◇ Ø ‾

   repeat the last character of the address to disclose beam position near display center. Now enter a dotted vector command of ESC a (4014) or ESC *A* (4015). Then enter

   (4014) SP DEL SP @

   (4015) SP DEL SP ‾

   Note a dotted vector drawn from the center of the display to the lower left corner.

2. Dot-Dashed Vectors — Enter ESC b (4014) or ESC *B* (4015). Then enter

   (4014) SP DEL ? _

   (4015) SP DEL \ —

   Note a dot-dashed vector drawn across the lower edge of the screen.

3. Short-Dashed Vectors — Enter ESC c(4014) or ESC *C* (4015) the enter

   (4014) 8 ` ? —

   (4015) 8 ◇ \ —

   Note a dashed vector drawn along the right side of the screen.

4. Long-Dashed Vectors — Enter ESC d (4014) or ESC *D* (4015) then enter

   (4014) 8 ` SP @

   (4015) 8 ◇ SP ‾

   Note solid vector along the top of the screen.

5. Return to normal vectors — Enter ESC ` (4014) or ESC ◇ (4015) then enter

   (4014) SP DEL SP @

   (4015) SP DEL SP ‾

   Note solid vector along the left side of the screen.

Enter PAGE to erase the display and return to Alpha Mode. PAGE, as well as SHIFT RESET, CR, ESC FF, and LF if strapped to provide a carriage return, will clear not only Graph Mode but also the vector-type memory. A vector-type character can be retained in memory by exiting Graph Mode with US. Graph Mode may then be reselected with the preceding vector type displayed.

Point Plot, Special Point Plot, and Increment Plot Modes

General. These Enhanced Graphics modes have one common characteristic — beam intensity can be program controlled. Beam intensity control is provided by Special Point Plot and its use, in conjunction with Point Plot and Incremental Plot, provides a "grey scale" capability that approximates that of newspaper photographs. Special Point Plot Mode is discussed first.

Point Plot. Point Plot is entered by sending the Terminal the FS control character. Beam intensity is controlled by an intensity setting performed in Special Point Plot Mode as previously discussed. If the Intensity Character memory has been cleared by an initializing function (Power on or SHIFT RESET), beam intensity defaults to a pre-determined intensity. Beam addressing data is identical to normal Graph Mode addressing.

Special Point Plot. Special Point Plot Mode is entered by sending the Terminal the two-character sequence of ESC FS. The character that immediately follows FS and must precede each point address thereafter, must be an Intensity Character. The Intensity Character sets the on-time of the display beam, and in this manner controls the dot size and brightness. Table 2-23 shows the percentage of on-time of the beam for a given Intensity Character.

As previously mentioned, each point address while in Special Point Plot must be preceded by an Intensity Character. However, Point Plot or Incremental Plot can be selected following the Intensity Character. The intensity thus set in Special Point Plot will be retained in Point and Incremental Plot modes until either Terminal power is turned off or the SHIFT and RESET keys (Reset Function) are pressed; at which time the beam intensity returns to a default intensity setting. Special Point Plot uses the same graph address sequence as normal Graph Mode.

Incremental Plot. This mode is entered by sending the Terminal the RS control character. This mode inhibits the normal "byte" loading that occurs during the other graph modes, and instead reads the data as a command to pulse the X and Y counters in one of eight directions and to unblank or blank the writing beam as the beam is incremented. Beam intensity is controlled by an Intensity Character loaded into a memory circuit during Special Point Plot Mode.

Operational Check. Operation checkouts of the aforementioned modes of operation are listed in Table 1-3.

This tabular checkout procedure allows the user to explore the range of system capabilities.

A mechanical plotter may be connected to the J5 pins, as outlined in the preceding text.

While following the procedure, it will be helpful to refer to Fig. 2-5 (Terminal modes diagram).

TABLE 1-3

Action	Effect
1) Power Up Terminal (and plotter if connected to Discrete Plot Card).	Terminal enters Alpha Mode, and alphanumerics may be written.
2) Enter Graph Mode with a GS (CTRL SHIFT M).	The Alpha cursor disappears.
3) Enter a point address of Y=575, X=545 by depressing the key sequence (4014) 1 DEL 1 A (4015) 1 DEL 1 α	Screen remains dark.
4) Repeat last key depressed (A or α), hold momentarily.	Point appears at 575Y, 545X on the display.
5) Transmit another point, Y=31, X=26 with the sequence (4014) SP DEL SP Z (4015) SP DEL SP $\subset$	A line segment appears between points 575Y, 545X and 31Y, 26X
6) Return to Alpha Mode with the PAGE key.	The Screen is erased; the Alpha cursor reappears.
7) Enter Point Plot mode by sending an FS command (CTRL SHIFT L).	The cursor disappears.
8) Enter again the address (575Y, 545X) with the aforementioned keyboard sequence.	The point is written instantly, without need of repeating the last character.
9) Enter again the address (31Y, 26X) with the keyboard sequence previously mentioned.	The point is written, and no connecting line segment appears as it did in Graph Mode.
10) Enter Special Point Plot mode with the control character sequence ESC FS (ESC CTRL SHIFT L).	Screen remains the same.
11) Depress the @ (4014) or $^{-}$(4015) key momentarily.	Screen remains the same.

TABLE 1-3 (cont)

Action	Effect
12) Transmit the point 351Y, 346X with the sequence (4014) * DEL * Z (4015) ≠ RUBOUT ≠ ⊂	A point of low intensity appears at 351Y, 346X, which may be too dim to store.
13) Depress the w (4014) or *W* (4015) key momentarily.	Screen remains the same.
14) Transmit the point 351Y, 186X with the sequence (4014) * DEL % Z (4015) ≠ DEL = ⊂	A point of higher intensity appears to the left of that previously written. As is discussed in the text, Special Point Plot mode operation allows an Intensity Character to precede each point address. In this procedure the @ (or ¯) sets a low intensity, and w (or *W*) sets a high intensity.
15) Send the Command RS (CTRL SHIFT N) establishing Incremental Plot mode.	No change to screen.
16) Send a CHART LEFT command A (4014) or ∝ (4015), holding the key for a few seconds.	No change to screen.
17) Send a PEN DOWN command P (4014) or * (4015) and then CHART LEFT command as before.	The display acts as an incremental plotter, and a line grows toward the right of the screen.
18) Transmit the Incremental Plot commands as shown in Fig. 1-16.	Observe that the pen up/down commands are "remembered", and need not be input prior to each step command.
19) Return to Alpha Mode with a US (CTRL SHIFT O).	The Alpha cursor appears at the last entered address.
20) Go to Special Point Plot mode with the ESC FS sequence (ESC CTRL SHIFT L).	The cursor vanishes.
21) Enter the Intensity Character @ (4014) or ¯ (4015) establishing the lowest intensity level.	No change to screen.
22) Return to Incremental Plot mode with RS (CTRL N). Assert a PEN DOWN command of P (4014) or * (4015), then hold down the CARRIAGE UP command of D (4014) or L (4015).	The beam pulses upwards at a weak intensity (perhaps too low to store).
23) Route through Alpha Mode back to Special Point Plot mode with sequence US ESC FS (CTRL SHIFT O ESC CTRL SHIFT L).	No change to screen.
24) Enter intensity character w (4014) or *W* (4015) establishing the highest intensity level.	No change to screen.
25) Return to incremental Plot mode with the RS command (CTRL SHIFT N). Insert a PEN DOWN command of P (4014) or * (4015). Then assert and hold CARRIAGE UP. (4014) D (4015) L	A line of higher intensity continues and grows from the tip of of the low intensity line (if stored) written in Step 22. (This intensity range may be varied, as described in the Adjustments section.)

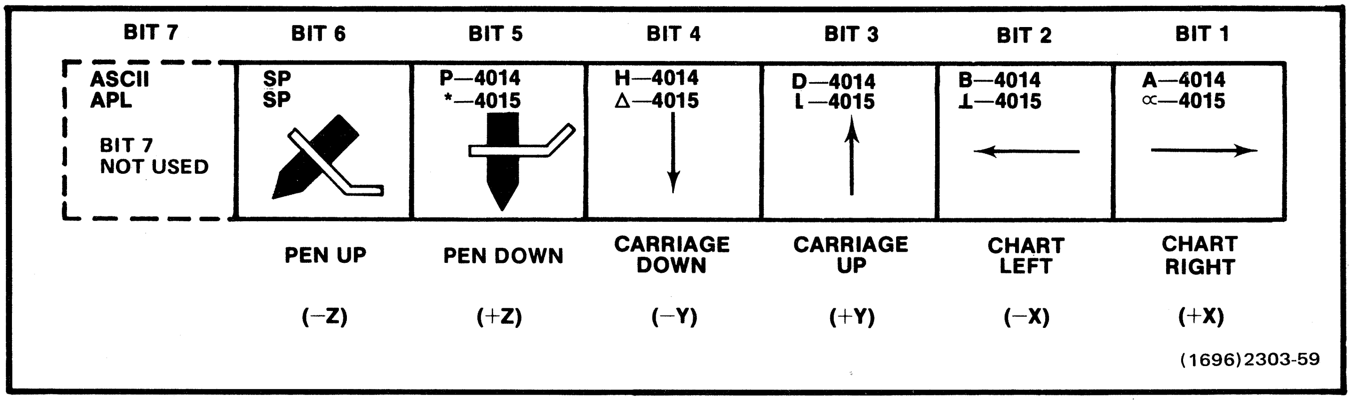

Fig. 1-16. Interpretation of the Incremental Plot Mode Word. Each of BIT1 through BIT6 has a particular effect on the plotter as shown above. For example, the word 1011010 (ASCII z) would cause a combined down and left step with the pen enabled. The ASCII and APL character corresponding to each command is shown.

SECTION 2

CHARACTERISTICS

Introduction

The characteristics 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.

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 do not apply to Local operation. Refer to the Local Operation specification for qualifying information.

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

The characteristics included in the alphabetic listing are as follows:

Accessories
Address
Alpha Mode
Arming
Bypass Condition
Carriage Return
Character Effect on Terminal
Character, Lower Case
Character Matrix
Character Size
Character Transmission in Alpha Mode
Character Transmission in GIN Mode
Character Type
Character Writing
Character Writing Rate
Character Writing Suppression
Clock
Control Character Execution
Control Character Sequence
Cursor, Alpha
Cursor, Crosshair
Dark Vector
Data Transfer Rate
Defocus, Program
Display Formatting
Display Measurement Unit
Display Size
Display Unit Specifications
Echoplex
Enhanced Graphic Module (Option 34)
Environmental Specifications
GIN Mode
Graph Mode
Graphic Address
Graphic Mode Memory
Graph Mode Vector Drawing
Hard Copy Operation
Hold Status

Alphabetic Listing

Accessories. See Table 2-17.

Address. A display position with reference to a grid of 1024 X 1024 points with 0,0 being at the bottom left. Standard Terminal Point density is about 70 points per inch horizontal or vertical with Terminal adjusted as outlined in the adjustment procedure. With the Enhanced Graphics Module (Option 34) installed, points per inch increases by a factor of four to about 280 points per inch horizontal or vertical.

Alpha Mode. A Terminal writing mode in which characters are written on the display screen. See Character Effect on Terminal and Tables 2-2 and 2-3 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". Included in the "Character Effect on Terminal" are execution commands for the Enhanced Graphics Module (Option 34). In addition, other accessory devices may use other execution commands as explained in the accessory device instruction manual.

Bypass Condition. Occurs upon receipt of ESC CAN sequence to prevent character generator from responding to data, placed on the minibus. Occurs automatically in GIN mode to over-ride the ECHO signal from the interface unit, thus inhibiting echoplex operation. This permits the coded position data to be sent to the computer without being written by the Terminal, despite condition of the ECHO signal. See Table 2-9 for additional details.

Carriage Return. Return of writing beam to the left or center margin (depending on effective margin position). Occurs on receipt of CR or RETURN. Also occurs on receipt of LF if the LF effect strap on TC-1 is in the LF→CR position. Occurs automatically when beam spaces past 1023 address in Alpha Mode. The CR character also causes a line feed to occur if the CR EFFECT strap option on TC-1 is in the CR→LF position.

@

Character Effect On Terminal. The 4014 and 4014-1 Terminals recognize all characters in ASCII Code. The 4015 and 4015-1 Terminals recognize all characters contained in APL or ASCII Code, depending on which one has been selected for operation. 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. Table 2-19 shows the control character sequences that operate the vector control for the Enhanced Graphics Module. 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, Lower Case. Lower case ASCII characters are accepted and written while ASCII is selected during Alpha Mode. Lower case letters cannot be transmitted from the keyboard while the TTY LOCK key is depressed.

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 in ASCII. In APL on the 4015 and 4015-1 it is shifted up to write an overline and dieresis, and shifts down to write underline. In addition, it is shifted to a slanted format to write italic letters in APL.

Character Size. Limits determined by character matrix, whose size can be displayed in one of four program selectable sizes. See Table 2-4 for specifics.

Character Transmission in Alpha Mode. Depending upon the terminal and the operation selected, the code for ASCII, APL, 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 are transmitted to the computer in response to a control character sequence from the computer. See GIN Mode for details.

Character Type. For the 4015 and 4015-1 Terminals the character type used on the display is dependent upon the ASCII/APL switch position and on program commands. ASCII writing is selected in the ASCII position. APL writing is selected in APL position. With the switch at the center position, the Terminal initializes with ASCII selected, and returns to ASCII in response to a SHIFT RESET entry; program selection of APL or ASCII occurs in response to ESC SO and ESC SI, respectively. The standard 4014 and 4014-1 Terminals character types is ASCII. The ASCII/ALT switch is wired to be inoperative, unless an additional alternate character set has been ordered at the factory as a custom modification. In this case selection of the character sets is as explained for the ASCII and APL character sets.

Character Writing. The 4015 and 4015-1 Terminals have writing capability for all ASCII and APL characters. The 4014 and 4014-1 have writing capability for ASCII. Since TTY is a subset of ASCII, TTY writing capability is included. Character writing time is a maximum of 1.0 ms.

Character Writing Rate. The effective writing rate is interface-dependent. Maximum limitation is imposed by the write parameters of the Terminal. The Terminal is capable of writing up to 1000 characters per second or, with Write-Thru Status enabled, up to 4000 characters per second.

Character Writing Suppression. The character generator is suppressed in GIN and Graph modes. The Alpha cursor and 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, CR, ESC ETB, ESC FF, LF, US, SI from the computer, or PAGE, SHIFT RESET, LOCAL or MAKE COPY from the keyboard.

Bypass Condition is a program selectable suppression of the Character Generator. It is set when the ESC CAN sequence is received by the Terminal and is also cleared as mentioned above for GIN Mode.

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

Control Character Execution. With minor exceptions, the Terminal can execute control characters or control character sequences while the Terminal is in any mode except Hard Copy. One exception is that GS cannot be executed while the crosshair cursor is being displayed in GIN Mode. Another exception is that control characters cannot be executed during GIN Mode transmissions. See Character Effect on Terminal.

Control Character Sequence. See Character Effect on Terminal.

Cursor, Alpha. Flickering, non-storing eight-by-nine dot matrix which indicates position of writing beam. Occurs in Alpha Mode, during View status. 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. During the counting process the Z Axis is pulsed at a rapid rate to draw the cursor. The duration of the Z Axis pulses are short enough so as not to store the cursor. The intersect point can be moved to any point within 4-1023X and 0-779Y 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.

Dark Vector. A dark vector is an unwritten vector, which always occurs upon execution of the first vector to be received after a GS command (see Written Vector).

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

Defocus, Program. Display writing for both Alpha and Vectors can be programmed to be defocused by sending an ESC character sequence. See Table 2-2.

Display Formatting. Display formatting is controlled by the following:

Program Commands

ESC FF selects home and erases.

CR returns the cursor to the left margin; it may also cause line feed if selected by strap option on TC-1.

LF causes line feed; it may also cause carriage return if selected by strap option on TC-1.

HT causes the cursor to move right one space.

BS causes the cursor to move left one space. Backspacing past the left margin causes the cursor to move to the right side of the screen.

VT causes the cursor to move up one line.

Automatic Commands

Home is selected upon initialization, as are large size characters.

Line feed and carriage return occur after entering a writing character or a space in the last character position on any line.

A line feed (automatic or program command) past the bottom line causes a change between Margin 1 and Margin 2 as controlled by the MARGIN CONTROL switch.

Display Measurement Unit. Tekpoint. Equivalent to four increments of X or Y position register. Approximately 70 points per inch and .014 inch between centers of horizontally or vertically adjacent points. The standard Terminal has 1024X points addressable and viewable; 1024Y addressable, 780Y points viewable. (Terminal adjusted as outlined in adjustment procedure.) A Terminal with the Enhanced Graphics Module installed has display measurement points equivalent to one increment of X or Y position register. Approximately 280 points per inch and 0.0045 inch between centers of adjacent points. 4096X points addressable and viewable, 4096Y points addressable and 3120Y points viewable (Terminal adjusted as outlined in adjustment procedure).

Display Size. 14.5 inches horizontal by 10.9 inches vertical with its center within 0.25 inch of crt faceplate center. See Fig. 2-1 for more specific information on display size.

Display Unit Specifications. Refer to Table 2-12.

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

Enhanced Graphics Module. An option (Option 34) that adds increased graphic capability to the Terminal. See the summary of Enhanced Graphics Module characteristics in Tables 2-18 through 2-24.

Environmental Specifications. See Table 2-15.

GIN Mode. An interactive graphic mode that 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 immediately (or with about a 350 ms delay[1]) 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 15 ms must occur between ESC SUB and ESC ENQ. The 15 ms delay can be ignored under several circumstances, as follows: (1) Whenever operating slower than 1000 baud; (2) Whenever only the Y address is required (X will always be sent, but may not be valid if the 15 ms delay is not used); and (3) If the Terminal is addressed to Y 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 ØY address, the Terminal need only be given a GS and a Low X byte to move the beam to ØY. See Table 2-9 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 2-6, 2-7, and 2-8 for Graph Mode details.

Graphic Address. A combination of X and Y register values which, on the standard terminal, indicates a position on the display (X Ø-1023, Y Ø-779) or off the display (Y 780-1023). Address of bottom-left corner of display is ØX, ØY; address of top-right corner of display is 1023X, 779Y. On a Terminal with the Enhanced Graphics Module, the above values are increased by a factor of four. See Tables 2-7, 2-8, 2-21, and 2-22 for information about sending an address to the Terminal.

[1]**With TC-1 670-3091-03 and up, strap ANSWER BACK in DELAYED position.**

Graphic 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. See Tables 2-7 and 2-8 for operation of the Standard Terminal's Graph Mode Memory. For variations caused by the use of the Enhanced Graphics Module, refer to Tables 2-21 and 2-22.

Graph Mode Vector Drawing. See Tables 2-6 and 2-21.

Hard Copy Mode. Hard copies can be made while the 4014-1 or 4015-1 Terminal is in any mode. Inputs to the Terminal are disabled while the copy is made. Copy quality is affected by the Terminal's Hard Copy intensity control. Neither the Alpha nor crosshair can be copied, since they are removed from the display during copying. Placing the Copy switch to AUTOPRINT causes a hard copy to be printed at page full, as controlled by the MARGIN CONTROL switch.

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 ØX, 767Y (3071Y with Enhanced Graphics Module). 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.

Initial Status. At turn on, the Terminal is in Alpha Mode with the cursor at the home position. A stored condition may exist on the screen, which can be cleared by pressing the PAGE key. Normal large character size is selected.

Interface Specification. See documentation pertaining to specific interface unit.

Line, Alpha Mode. Refer to Tables 2-4 and 2-5 for details.

Line Feed. Moves writing beam down 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. See Table 2-5 for specifics on line feed spacing.

Line Length, Graphic. Maximum line lengths within the quality display area are approximately 14.5 inches horizontal, 10.9 inches vertical, 19 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 2-10 for details.

Margin, Horizontal. Margin 1 is located at ØX; Margin 2 is located at 512X. Margins alternate automatically when line-feeding past the last alphanumeric line. Carriage return resets the beam to selected margin. ESC FF resets the Terminal to Margin 1. Terminal also resets to Margin 1 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 and Wire List in the Circuits section for details.

Mode Changes. See Fig. 2-2 and 2-5 for permissable Mode changes. Fig. 2-5 includes those modes for the Standard Terminal and the Enhanced Graphics Module.

Modes. Alpha (Alphanumeric), Graph (Graphic Display), GIN (Graphic Input), Hard Copy. See Specific mode descriptions for details. The Enhanced Graphics Module (Option 34) provides additional Graphics modes of Point Plot, Special Point Plot, and Incremental Point Plot.

Options, Strappable. See Table 2-16 for strappable options for the basic Terminal; see interface unit documentation for strap option information pertaining to interface units. See Fig. 2-6 for strappable options for the Enhanced Graphics Module.

Origin Shifting. Each erasure repositions the writing beam within a few Tekpoints of its preceding position. This permits greater usage of display surface, prolonging life of crt.

Pagefull. A condition occurring in Alpha Mode when line-feeding past the last line of either Margin 1 or 2 is selected by the MARGIN CONTROL switch.

Physical Characteristics. See Table 2-14.

Plotting Speed. If using the Enhanced Graphics Module (Option 34), see Table 2-24.

Point (Tekpoint). The basic unit of measurements for Graph and GIN Modes. The Standard Terminal has 1024X (Ø-1023) and 1024Y (Ø-1023) points addressable; 1024X and 780Y (Ø-779) viewable. Point spacing is approximately .014 inch. (Approximately 70 points per inch.) (Terminal adjusted as outlined in the adjustment procedure.)

For a terminal with the Enhanced Graphics Module, 4096X (Ø-4095) and 4096Y (Ø-4095) points addressable; 4096X and 3119Y viewable. Point spacing is approximately .0045 inch. (Approximately 280 points per inch. Terminal adjusted as outlined in the adjustment procedure.)

Power Supply Specifications. See Table 2-13.

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

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 2 status. It would be better to permit transmission of address and ignore it at the computer to ensure that the Terminal returns to Margin 2 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 2-9 for details.

Resetting Graph to Alpha Mode. Graph Mode is cancelled and Alpha Mode reset 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 the last line if Margin 2 exists and the 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 2 to Margin 1. Margin 2 (horizontal center of display) resets to Margin 1 (left edge of display) in response to ESC FF from the computer, or in response to an LF (line feed) past the last line. Margin 2 also occurs in response to PAGE or SHIFT RESET entered at the keyboard. Resetting to Margin 1 from Margin 2 when at LINE depends on the position of the Margin Control Switch. See Switch description in Operations section of manual.

Space. An Alpha Mode measurement made from a reference point in a character to the same reference point in a horizontally adjacent character. See Tables 2-4 and 2-5 for specifics.

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. 1 indicates that the Terminal is set up to draw vectors.

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

Bit 2 = Margin indicator. 1 indicates that Margin 2 exists. Ø indicates Margin 1. If the Margin bit is 1 (true), it indicates that the Alpha cursor is on the right half of the screen. If the transmitted X address is less than 512, it must be increased by 512 to indicate its position with respect to the left side 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.

Stappable options. Optional operating features that can be selected by connectors within the Terminal. See Table 2-16.

Tekpoint. A unit of measurement associated with Tektronix Terminals. It consists of the distance between two adjacent points in the horizontal and vertical grid provided by the X and Y registers. See Point.

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

Time, Character Writing. Approximately 1.0 ms.

Time, Vector Drawing. The time required to write a vector is dependent on vector length. The shortest vector (one Tekpoint) requires about 12 μs. The longest vector (about 19 inches full screen diagonal) requires about 3.25 ms. As another example, a 14 inch vector can be drawn in about 2.5 ms. This is equivalent to a vector writing rate of 5000 vector-inches per second.

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 ESC ENQ from the computer, or in response to a keyboard character entered while the crosshair cursor is displayed. Refer to Table 2-9 for details.

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

Vector. Synonomous with Graph Mode. Vectors can be either written or not written (dark). See Written Vector and Dark Vector.

Vector Drawing Time. See Time, Vector Drawing.

Vector Dynamic Geometry Error. Deviation (due to geometry error of crt) from mean straight line does not exceed 0.5% worst case (45° line).

Vector Set-Up Time. The time required to receive and establish the vector address, exclusive of vector writing time. It is equal to or less than 6 microseconds.

Vector Writing Rate. More than 5,000 inches per second.

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.

Write-Thru. A natural phenomenon of the bistable storage tube that will satisfy most needs for refreshed graphics displays while maintaining the operating flexibility of normal storage modes. Write-thru enables the normal display of static (stored) information while enabling overlays of changing or dynamic elements. In other words, high density background data must be stored, with foreground data under control of the host computer. Write-thru is accomplished by limiting the "on-time" of the writing beam to the point where the image "glows" but does not store. Whether operating write-thru in Alpha or Graphics Modes, the "refresh" capability is limited by the interface baud selection and the hardware limitations of the display unit.

Written Vector. Normally, the second and any subsequent address received after a GS command results in a written vector.

NOTE

The Alpha cursor, the crosshair cursor, and the Hard Copy scan (4014-1 and 4015-1 only) are always displayed in the Write-Thru Mode and cannot be program controlled. This is a design characteristic of the Terminal.

TABLE 2-1

Control Character Effect

Control characters are coded signals which are sent back and forth between the computer, Terminal, and accessory devices to control operation. Their use is relatively standard. The control characters, their keyboard equivalent, and their effect upon the basic Terminal are listed here. The transmission and effect is independent of ASCII or TTY selection.

NOTE

Keying control characters from the keyboard requires two (and in some cases three) key closures. In the following table, a superscript C followed by a letter character indicates that the control character is formed by first pressing the CTRL and then the indicated letter key. A superscript C and S, e.g. ^{CS}O, indicates the control character (in this case, US) is formed by first pressing the CTRL and SHIFT keys and then the O key.

Control	Keyboard Equivalent	Effect Upon Basic Terminal
ACK	^{C}F	
BEL	^{C}G	Rings bell; clears Bypass Condition.
BS	BACKSPACE or ^{C}H	Backspaces.
CAN	^{C}X	As second character in ESC CAN sequence, it selects Bypass Condition to inhibit Terminal response to echoed data.
CR	RETURN or ^{C}M	Carriage return; resets Terminal from Graph to Alpha Mode; cancels crosshair cursor, setting Alpha Mode but leaving the Terminal in an undefined margin (page full) status; clears Bypass Condition. A strap on the TC-1 card can be set so CR also causes line feed. *NOTE* *As the second character in an ESC sequence, CR will not be responded to. This can be used to advantage when it is required that the Terminal not respond to CR's. Any further CR's will be ignored. To get out of the ESC condition, send BEL, or some other non-operative control character that will not change the mode selected.*
DC1	^{C}Q	
DC2	^{C}R	
DC3	^{C}S	
DC4	^{C}T	
DLE	^{C}P	
EM	^{C}Y	

TABLE 2-1 (cont)

Control Character Effect

Control	Keyboard Equivalent	Effect Upon Basic Terminal
ENQ	^{c}E	As second character in ESC ENQ sequence, it causes Bypass Condition and creates one of the following Gin Mode situations: 1) Causes Terminal status and address of lower left corner of the Alpha Cursor to be sent to the computer if received while the Terminal is in Alpha Mode. 2) Causes Terminal Status and address of the display beam to be sent to the computer if received while the Terminal is in Graph Mode. Polling the Terminal with an ESC ENQ immediately, or with about a 350 ms delay[1], following a hard copy request results in a Terminal response after copying is completed.
EOT	^{c}D	
ESC	ESC or ^{cs}K	Terminal "arming" character which makes the Terminal sensitive to certain control characters received immediately after ESC; see ENQ, ETB, FF, SI, SO, SUB. Other characters may be used in sequence with ESC for Terminal and peripheral device control. See other ESC sequences at the end of this Table.
ETB	^{c}W	As second character in ESC ETB sequence, it creates a Make Copy signal, which causes a hard copy of the display to be made if an energized Hard Copy Unit is attached. ESC ETB also clears Bypass Condition. Not effective while crosshair cursor is displayed.
ETX	^{c}C	
FF	^{c}L	As second character in ESC FF sequence, it erases the screen, selects Alpha Mode, sets the cursor to home position, sets Margin 1, and clears Bypass Condition.
FS	^{cs}L	Used with Enhanced Graphic Module to select Point Plot mode. As second character in ESC FS sequence it selects Special Point Plot mode.
GS	^{cs}M	Sets Terminal to Graph Mode; sets circuitry for dark vector.
HT	TAB or ^{c}I	Spaces one space to right. Spacing past end of a line causes an automatic line feed/carriage return.
LF	LF or ^{c}J	Cursor moves down one line; if cursor moves past the bottom of the display, it "wraps around" and appears at the top of the display, selecting the alternate margin. Also clears Bypass Condition. A strap on TC-1 can be set so LF also causes carriage return. See Margin Control switch description for further effects of line feeds past bottom line of display. If LF is proceded by an ESC, LCE is set.

[1]**With TC-1 670-3091-03 and up, strap ANSWER BACK in DELAYED position.**

TABLE 2-1 (cont)

Control Character Effect

Control	Keyboard Equivalent	Effect Upon Basic Terminal
NAK	^{c}U	
NUL	^{cs}P	
RS	^{cs}N	For use with the Enhanced Graphic Module, Option 34. Sets Incremental Plot Mode.
SI	^{c}O	As second character in ESC SI sequence, it selects the ASCII character set if the CHARACTER SET SELECT switch is at the center (PROGRAM SELECT) position. Clears Bypass Condition.
SO	^{c}N	As second character in ESC SO sequence, it selects the alternate character set if the CHARACTER SET SELECT switch is at the center (PROGRAM SELECT) position. (Requires factory installation of optional, alternate character set ROM.)
SOH	^{c}A	
STX	^{c}B	
SUB	^{c}Z	As second character in ESC SUB sequence, it sets GIN Mode and starts the crosshair cursor. Clears Graph Mode and activates Bypass Condition.
SYN	^{c}V	
US	^{cs}O	Resets Terminal from Graph to Alpha Mode; clears Bypass Condition.
VT	^{c}K	Causes reverse line feed

The following ESC sequences are followed by some character other than a control character. These ESC sequences are used for controlling the character size and display writing characteristics. (For descriptions of ESC control character sequences, see preceding descriptions of control characters, ENQ, ETB, FF, SI, SO, and SUB.)

ESC 8	ESC 8	Selects 74 characters, 35 lines.
ESC 9	ESC 9	Selects 81 characters, 38 lines.
ESC :	ESC :	Selects 121 characters, 58 lines.
ESC ;	ESC ;	Selects 133 characters, 64 lines.
ESC 96_{10} through ESC 126_{10}	See Table 2-2	Provide program selectable display operating modes such as Normal, Write-Thru, and Defocused. Refer to Table 2-19 for more information if the Optional Enhanced Graphics Module is installed in the Terminal.

TABLE 2-2

Character Versus Function for Normal, Defocus and Write-Thru Displays
(See Table 2-19 for additional effects when a Terminal has the Enhanced Graphics Module installed.)

ASCII CHARACTER	APL CHARACTER	DECIMAL EQUIV	FUNCTION PERFORMED
ESC	ESC ◊	96	Normal Z axis
a	*A*	97	Normal Z axis
b	*B*	98	Normal Z axis
c	*C*	99	Normal Z axis
d	*D*	100	Normal Z axis
g	*G*	103	Normal Z axis
h	*H*	104	Defocused Z axis
i	*I*	105	Defocused Z axis
j	*J*	106	Defocused Z axis
k	*K*	107	Defocused Z axis
l	*L*	108	Defocused Z axis
o	*O*	111	Defocused Z axis
p	*P*	112	Write-thru mode
q	*Q*	113	Write-thru mode
r	*R*	114	Write-thru mode
s	*S*	115	Write-thru mode
t	*T*	116	Write-thru mode
w	*W*	119	Write-thru mode

Note: In Alpha Mode, the focused condition is automatic in the two smaller character sizes and they can be defocused under program by the characters indicated in Table 2-2. The two larger character sizes have their own focus control and only the Write-Thru mode can be programmed using Table 2-2.

TABLE 2-3

	Alpha Mode Specification
Writing Area	See Fig. 2-1.
Character Writing Position	Indicated by pulsating cursor (8 x 9 dot matrix), size dependent on character size selection.
Character Recognition	4015 and 4015-1, complete ASCII or APL code is recognized, depending on ASCII/APL selection. 4014 and a 4014-1, complete ASCII recognition.
Character Size	See Table 2-4.
Character Writing Time	Approximately 1.0 ms, providing at least 1000 characters per second; with Write-Thru enabled 4000 characters per second.
Characters Per Line	See Table 2-4.
Space	See Table 2-5.
Number of Lines	See Table 2-4.
Line Feed Spacing	See Table 2-5.

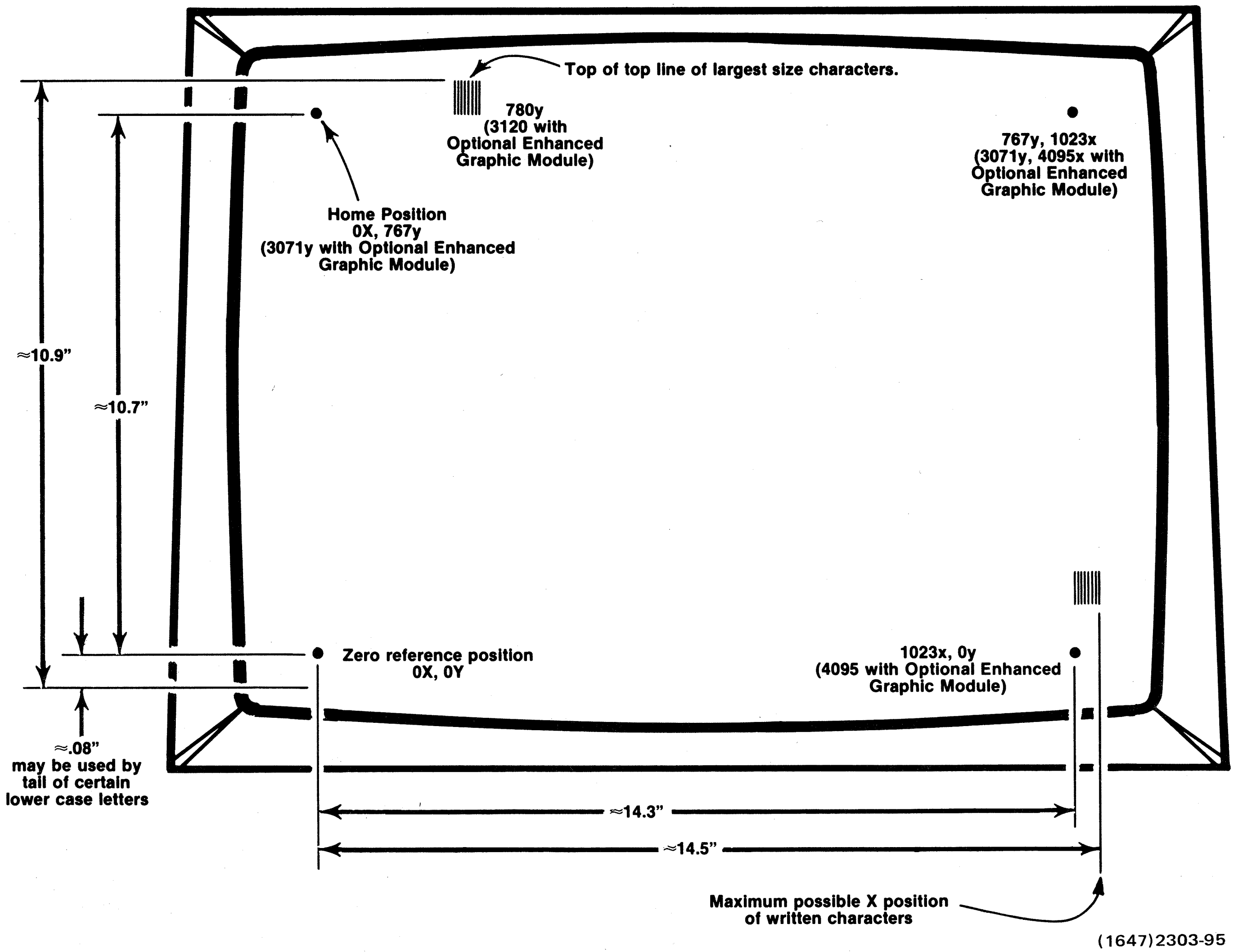

Fig. 2-1. Display writing area.

	TABLE 2-3 (cont)
Carriage Return/Line Feed	Automatically occurs after character is written at end of line. Strap option can be set to cause carriage return to occur in response to programmed line feed.
Margin	Margin 1 (left edge) and Margin 2 (horizontal center) alternately occur when line-feeding past the bottom line.
Rubout	Does not print or space.
Home	Top-left corner of display (ØX, 767Y).
Pagefull Busy	Occurs when line-feeding past last line with Margin 1 set or Margin 2 set as controlled by Margin Control switch.

	TABLE 2-3 (cont)
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). With Write-Thru enabled, writing rate increases by a factor of four.
Cursor	Non-storing, pulsating 8 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	On 4014 or 4014-1, Full ASCII Code can be transmitted. On 4015 or 4015-1, APL or ASCII Code can be transmitted. TTY LOCK key causes letter keys to transmit ASCII Code for upper case letters, regardless of the SHIFT key position.
Receiving	On the 4014 or 4014-1, ASCII characters can be written. On the 4015 or 4015-1, APL or ASCII characters are written, depending on the position of the ASCII/APL switch and on the ESC SO/ESC SI program selection.
Character Write-Thru Display	With Write-Thru enabled, 4000 hardware characters per second can be written. This is four times the normal character writing speed. Thus, any TTY Port with a baud capability greater than 40,000 will match the Terminal's character writing capability. To provide a flicker free display, the data must be refreshed at least 30 times a second. Refresh calculations must include control characters necessary for mode selection and format effectors such as LF, CR, BS, HT, and VT. See user's manual for "Refresh" calculations.

TABLE 2-4

Alpha Mode Character Size and Format

Characters Per Line	Character Size (mils)	Lines Per Page	Characters Per Display	Selected By
74	160 x 195	35	2590	Initializing or Reset or ESC 8
81	145 x 175	38	3078	ESC 9
121	95 x 115	58	7018	ESC :
133	90 x 110	64	8512	ESC ;

TABLE 2-5

Alpha Mode Character Spacing

Characters Per Line	Space Size		Line Feed Size	
	Tekpoints	Mils	Tekpoints	Mils
74	14.0	196	22.0	315
81	12.75	178.5	20.50	287
121	8.5	119	13.25	185.5
133	7.75	108.5	12	168

TABLE 2-6

Graph Mode Specification

(See Enhanced Graphics Module Characteristics at the end of this section for other graphic mode characteristics)

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. (4096X by 4096Y points with Enhanced Graphics Module installed).
Display Capability	1024X by 780Y points. (4096X by 3120Y points with Enhanced Graphics Module installed).
Display Address Orientation	0,0 at bottom-left of display; 1023X, 779Y (4095X, 3119Y with Enhanced Graphics Module) at top right.
Display Area	See Fig. 2-1.
Vector Writing Time	Dependent on vector length. 19 inch vector $\approx$3.25 ms. 14 inch vector $\approx$2.5 ms.
Vector Dynamic Geometry Error	Deviation from prescribed path does not exceed 0.5% of total line length. This is due to geometry error of crt.
Display Scale Factor	Approximately .014 inch, point center to point center (approximately 70 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 by displayed in View status for up to 15 minutes without damage to the display screen.)
Vector Drawing Commands	See Tables 2-7 and 2-8.

TABLE 2-6 (cont)

Mode changes	See Fig. 2-2.
Margin	Margins are 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.
Vector Drawing Rate	>5000 inches per second.
Vector Set up time	The time required to receive and establish the vector address exclusive of vector writing time is <6 microseconds.
Vector Write-Thru "Refresh" Display	With Write-Thru enabled, the maximum number of vectors possible is limited by (1) the baud at which the minicomputer and interface operate, and (2) a Terminal hardware limitation of 5000 inches of vectors drawn per second. See Terminal user's manual for examples in calculating "refresh" vectors. Refresh Calculations must include control characters necessary for mode selection and format effectors such as LF, CR, BS, HT, and VT.

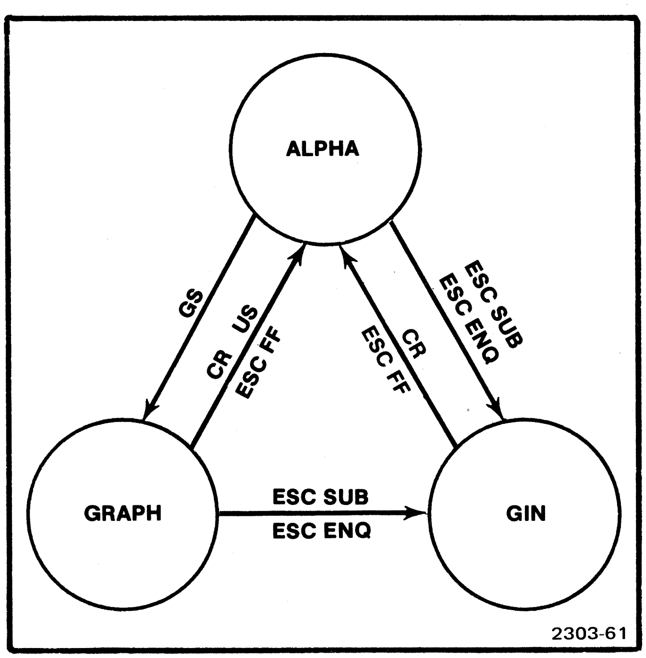

Fig. 2-2. Permissable mode changes.

TABLE 2-7

Graph Mode Vector Drawing

(See Enhanced Graphics Module characteristics at end of this section for changes to the following.)

(1)	GS Places the Terminal in Graph (Vector) Mode.
(2)	The Terminal can be addressed to any position within Ø-1023X and Ø-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 Ø 1 (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 1 1 (as bits 7 and 6) to the 5 LSB of the ten digits of the Y coordinate.

 @

TABLE 2-7 (cont)

	(D) Form a Hi X byte by affixing Ø 1 (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 1 Ø (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) in the sequence B, C, D, 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 2-8 specifies the minimum byte transmission that is required for any 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 2-8

Bytes Required for Graphic Addressing

(See Enhanced Graphics Module characteristics at end of this section for changes to the following.)

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 2-9

	GIN Mode Specifications
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 Character Writing Suppression. Note that if CR is echoed, it resets the cursor to the effective margin position. Use of Enhanced Graphics Module (Option 34) does not affect operation of GIN Mode.

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

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 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 15 ms delay must exist between ESC SUB and ESC ENQ. The 15 ms delay can be ignored under several circumstances, as follows: (1) Whenever operating slower than 1000 baud; (2) Whenever only the Y address is required. (X will always be sent, but may not be valid if the 15 ms delay is not used); and (3) If the Terminal is addressed to ØY before sending the Terminal an ESC SUB.

[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 without sending CR. A third position, NONE, transmits neither CR nor EOT.

[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 2-9 (cont)

Transmit Crosshair Intersect Address (cont)	
In Response to Keyboard Character Entry	With crosshair displayed, a keyboard character entry causes the Terminal to transmit the keyboard character, and then to transmit 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 character writing suppression.
Address	
Basic Unit of Measurement	Point (Tekpoint).
Alpha Cursor	
Limits	Ø to 1023X, Ø to 767Y, inclusive. With Enhanced Graphics Module (Option 34) Ø to 4095Y, Ø to 3071Y, 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, Ø to 779Y, inclusive. If sending a Y address greater than 767, Bypass Condition becomes undefined.
Controlled by	Horizontal and vertical thumbwheels at right on keyboard panel, or optional Joystick.
Transmission Accuracy	Within ±1 point of actual position of crosshair cursor intersect point. If the Enhanced Graphics Module (Option 34) is installed, the crosshair intersect point accuracy becomes referenced to a grid of 4096 by 4096. The accuracy then becomes +4 or −7. The Enhanced Graphics Module does not change the number of bytes that are transmitted in response to an ESC ENQ. The extra byte only appears on the received data from the computer.
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 2 exists; Ø indicates Margin 1. See note 2.
	Bit 1 = Auxiliary device indicator. Ø indicates that some optional auxiliary device is activated.

TABLE 2-9 (cont)

Bypass Condition	Automatically set during GIN mode to over-ride local echoing and disable character generator. 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, CR, ESC ETB, ESC FF, LF, US or SI from the computer, or by entering PAGE, RESET, or MAKE COPY at the keyboard. Resetting is not required in Graph Mode.
Byte Format	8 bits. In Terminals equipped with a Data Communication Interface 021-0065-00, bit 8 is determined by a strap on the keyboard which is factory-wired to 1, but may be changed to zero. In other interface units, bit 8 may be controlled by the keyboard strap or by the interface unit.

[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 2-10

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 2-6, 2-7, and 2-8. 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 2-11

	Hard Copy Mode Specification (4014-1 and 4015-1 Terminals)
Function	Display is scanned by signals from the Hard Copy Unit, providing readout information to the Hard Copy Unit.
Initiated By	WAIT or READ signal from Hard Copy Unit. (WAIT or READ occurs in response to a Make Copy command from the keyboard, a copy command from the Hard Copy Unit, or an ESC ETB sequence from the computer.)

TABLE 2-11 (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.

TABLE 2-12

Display Unit Specifications

Characteristics	Performance Requirements	Supplemental Information
Display Quality Area	15.05 inches horizontal by 10.725 inches vertical, whose center is within 0.25 inch of the crt face-plate 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	Within 0.5% deviation from mean straight line (inside the specified display area).	This is a function of the geometry error of the crt.
Geometry		
Orthogonality	$\leqslant 1°$	
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 horizontal line. Difference between lengths of horizontal lines should be within 2% of length of a vertical line.

TABLE 2-13

Power Supply Specifications

Characteristics	Performance Requirements			Supplemental Information
Line Voltage Ranges	110 V AC	220 V AC		Wiring connections are listed on the inside surface of the pedestal's front cover.
Low	100 V ±10%	200 V ±10%		
Medium	115 V ±10%	220 V ±10% 230 V ±10%		
High	120 V ±10%	240 V ±10%		
Power Consumption				420 watts maximum.
Line Frequency Range	48 to 440 Hz.			
Fuses	6.25 A slo blo for 110 volt operation. 3.2 A slo blo for 220 volt operation.			
Current Rating of Regulated Supplies	Standard Terminal	With EGM*	Maximum	
+5 V dc	5.5 A	6.0 A	9.0 A	
+15 V dc	300 mA	300 mA	1.5 A	
−15 V dc	450 mA	450 mA	1.5 A	

Specific current drain on the listed supplies caused by optional plug-in circuit cards can be found in the users manual applicable to the optional accesory.
***Enhanced Graphic Module.**

TABLE 2-14

Physical Characteristics

Finish	Metal and plastic painted cabinet.
Weight (in lbs.)	
Pedestal	72
Display	84
Shipping Weight	
Pedestal	99
Display	100
Dimensions, Overall	See Fig. 2-3
Height	About 42 inches
Width	About 20 inches
Length	About 33 inches

TABLE 2-15

Environmental Specifications

Temperature	
Non-operating	−40°C to +65°C
Operating	+10°C to +40°C
Altitude	
Non-operating	To 50,000 feet
Operating	To 15,000 feet
Vibration (Non-operating)	Complete terminal: Not specified. Display Only: 10-40-10 c/s @ .010 inch total displacement. Pedestal Only: 10-40-10 c/s @ .010 inch total displacement.
Shock (Non-operating)	To 20 Gs, 1/2 sine, 11 ms duration.
Transportation	Meets National Safe Transit Committe type of test when packaged as shipped by factory.

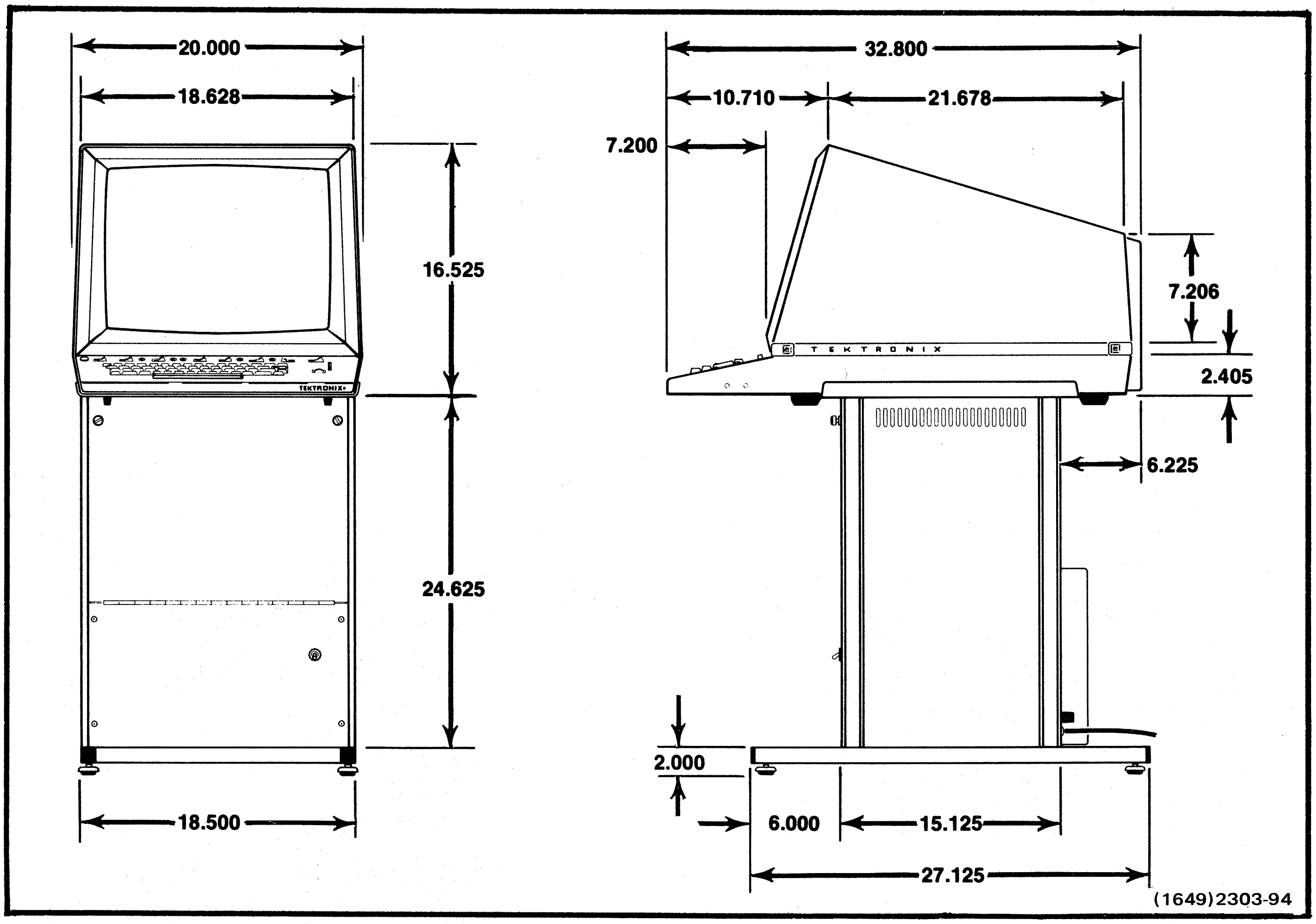

Fig. 2-3. Overall dimensions.

TABLE 2-16

Strappable Options of Basic Terminal (See Fig. 2-4)

Feature	Location	Choice	Effect
LF Effect	TC-1, Top row		LF causes Line Feed only; LF→CR causes Line Feed and Carriage Return. LF generated carriage return will reset Graph Mode.
CR Effect	TC-1, Top row		CR causes Carriage Return only; CR→LF causes Carriage Return and Line Feed.
DEL Implies LOY	TC-1 approx center		Available for those systems that cannot use DEL as a Lo Y code. DEL→LOY selection is the standard strap setting that permits RUBOUT (DEL) to be used as LOY. DEL selection permits the two-character sequence of ESC ? to be substituted for the DEL code. Thus ESC ? allows the Graph circuits to function just as though DEL were being used.

TABLE 2-16 (cont)

Feature	Location	Choice	Effect
Graphic Input Terminators	TC-2, Top row		CR & EOT transmits CR & EOT in Gin Mode; CR transmits CR in GIN Mode; NONE transmits neither CR nor EOT in GIN Mode.
Switch 3 and Indicator 3 (LED 3) connections	Two-pin harmonic connector tied to wire bundle beside motherboard	(1) Disconnected; (2) Connected to optional circuitry	(1) No effect (2) Provides ground connections via Switch 3 from keyboard and provides 0 V to Indicator 3 (LED 3) on keyboard, which lights the LED.

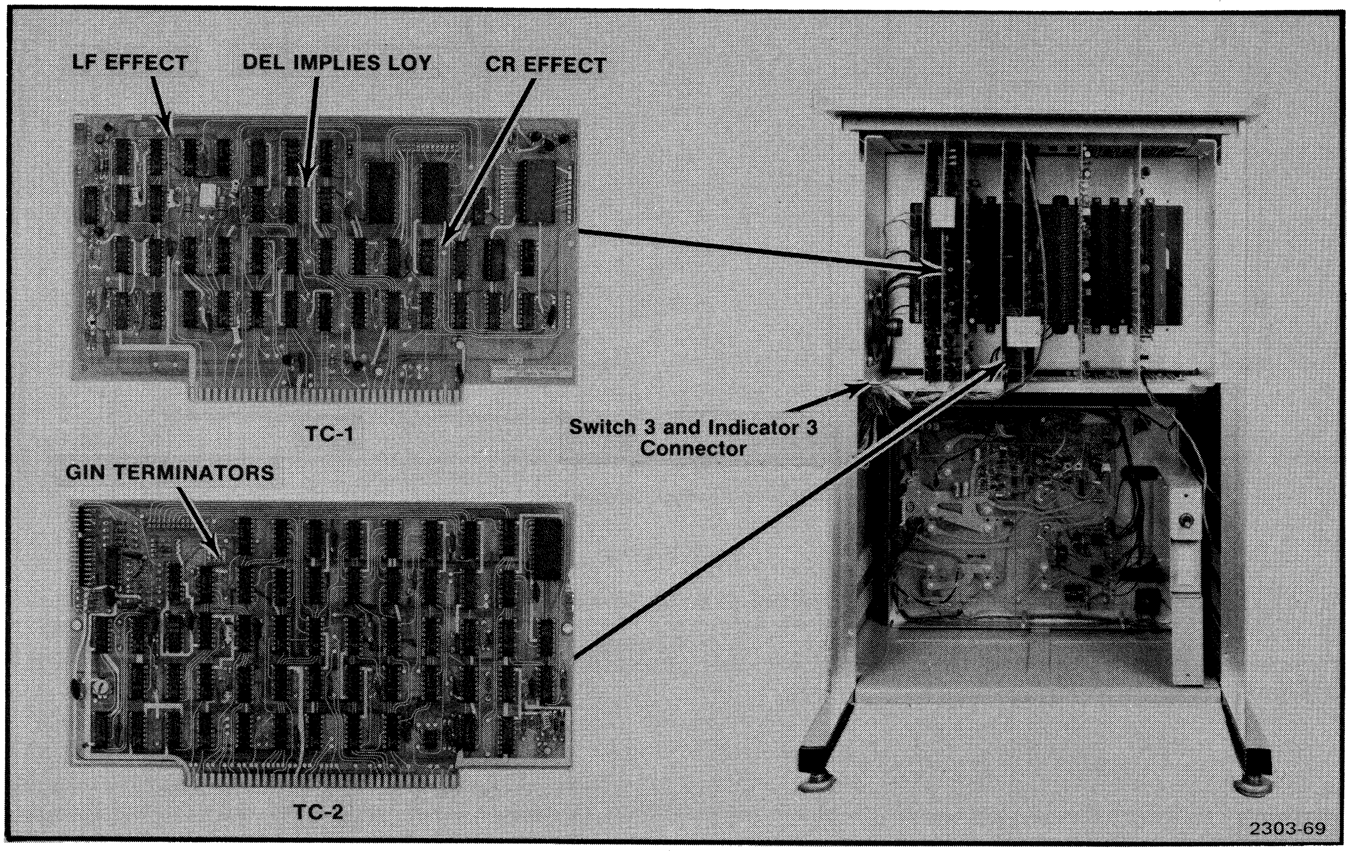

Fig. 2-4. Location of strappable options. Additional strappable option information is given in Table 2-16.

TABLE 2-17

Accessories for the Terminal

Item	Part No.
STANDARD ACCESSORIES	
Data Communication Interface	021-0065-00
Data Communication Instruction Manual	070-1458-00
4014 and 4014-1 Users Manual or 4015 and 4015-1 Users Manual	070-1647-00 / 070-1649-00

TABLE 2-17 (cont)

Item	Part No.
OPTIONAL ACCESSORIES	
4014, 4014-1, 4015, and 4015-1 Service Manual	070-2303-00
Optional Data Communication Interface Option 1	021-0074-01
TTY Port Interface	Part No. varies with computer
Desk-Top Mounting Kit	021-0511-00
Enhanced Graphics Module Option 34	018-0122-00
Minibus Extender Option 30	018-0069-02
Display Multiplexer	018-0067-02
Logic Extender Card	067-0653-00
72-pin Extender Card	067-0664-00
Extender Cable	175-1469-00
Copy Holder	016-0291-01
Auxiliary Card	018-0065-01
Terminal Auxiliary Card	018-0068-00
Wheel Kit	040-0714-00
View Hood (for Terminals with SN B01XXXX)	040-0744-00
View Hood (for Terminals with SN B02XXXX)	016-0599-00
PERIPHERALS	
4610 and 4631 Hard Copy Unit	
4662 Interactive Digital Plotter	
4911 Paper Tape Reader/Perforator	
4921 Flexible Disc Memory (Single Disc Unit)	
4922 Flexible Disc Memory (Dual Disc Unit)	
4923 Digital Cartridge Tape Recorder	
4931 Modem	
4952 Joystick	
4953 Graphics Tablet (11 in. X 11 in.)	
4954 Graphics Tablet (40 in. X 30 in.)	

TABLE 2-18

4010-Series Options and Compatability

Option	Field Kit	Manual	Description
1	021-0074-01	070-2188-XX	Optional Data Communication I/F[1]
2	021-0068-00	070-1354-XX	TTY I/F, DEC PDP-11 w/KL11[2]
3	021-0067-00	070-1353-XX	TTY I/F, DEC PDP-8/I,L PDP-12,15[2]
4	021-0072-00	070-1356-XX	TTY I/F, Data General[2]
6	021-0071-00	070-1355-XX	TTY I/F, HP2100 w/12531[2]
15	021-0119-01	070-1615-XX	APL I/F, 2741 Correspondence Code[1]
16	021-0068-01	070-1592-XX	TTY I/F, DEC PDP-11 w/DL11[2]
17	021-0066-01	070-1451-XX	TTY I/F, DEC PDD-8/E w/KL8-EA[2]
20	021-0135-01	070-2026-XX	CDC 6000-Series Synchronous I/F[1 and 4]
21	021-0126-00	070-1702-XX	Calcualtor Terminal I/F[1]
22	021-0201-00	070-2280-XX	2741 Correspondence Code I/F w/EGM Support[1 and 7]
23	021-0201-00	070-2280-XX	2741 Correspondence Code I/F, 2K Buffer[1]
30	018-0069-02	n/a	Minibus Extender[3]
31	018-0067-02	070-1992-XX	Display Multiplexer[4]

See following page for footnotes.

TABLE 2-18 (cont)

Option	Field Kit	Manual	Description
34	018-0122-00	070-1648-XX	Enhanced Graphics (4014-15 only)[4]
36	n/a	070-1651-XX	Dual Interface Capability[5]
37	018-0114-00	070-2180-XX	Integral Modem, 300 baud FD[4]
38	018-0115-00	070-2180-XX	Integral Modem, 1200 baud HD[4 and 6]
39	018-0116-00	070-2180-XX	Integral Modem, 1200/5 baud HD[4 and 6]

[1]Replaces Standard Data Communication 021-0065-00.
[2]Replaces Data Communication (unless Option 36), one TTY I/F per unit.
[3]Requried when more than I/F board is installed.
[4]Requires Option 30.
[5]Consists of one TTY I/F, Option 1 and Option 30.
[6]Requires Option 1.
[7]Not compatible with 4010 and 4010-1 Terminal.

TABLE 2-19

Enchanced Graphics Module (Option 34) General Specification

Basic Unit of Measurement	Minipoint
Address Capability	4096X by 4096Y
Display Capability	4096X by 3120Y
Vector Types	In addition to solid vectors includes dashed, dot-dashed, short-dashed, and long-dashed. See Table 2-19 for coding.
Display Address Orientation	Ø,Ø at bottom left; 4095X, 3119Y at top right.
Display Scale Factor	Approximately .045 inch, point center to point center (approximately 280 points per inch).
Mode Changes	Fig. 2-5 shows permissable mode changes between various Terminal modes.
Additional Graph Mode Specifications	
Point Plot	Set by Terminal receipt of FS control character. Address data is identical to Graph Mode. Only addressed point is written. Intensity of plotted point can be program controlled by using Special Point Plot Mode.

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	TABLE 2-19 (cont)
Incremental Plot Mode	Set by Terminal receipt of RS control character enables Terminal to duplicate an XY mechanical plotter. (Parallel outputs are available to drive an outboard mechanical plotter). The character that follows RS must be a Beam Off, or Beam On command. The write command is followed by an increment command that consists of one character. Table 2-21 shows the action that would result from characters received in Incremental Plot Mode.
Special Point Plot	Set by ESC FS sequence. Similar to Point Plot. Difference being that an "Intensity" character must precede each point address. However, either Point Plot or Incremental Point Plot may be selected after receiving an intenstiy character in Special Point Plot Mode and the intensity setting will be retained until a RESET function occurs. Percentage of beam on time for a given intensity character can be controlled by the Grey Scale adjustment on the Discrete Plot card. See Fig. 1-14 for adjustment location. Table 2-25 shows percentage of beam on time for a given Grey Scale intensity. If the intensity settings are changed by a small percent it may not be discernible with the naked eye. (See Fig. 2-6 intensity code chart.) Refer to User manual Appendix F for detailed description.

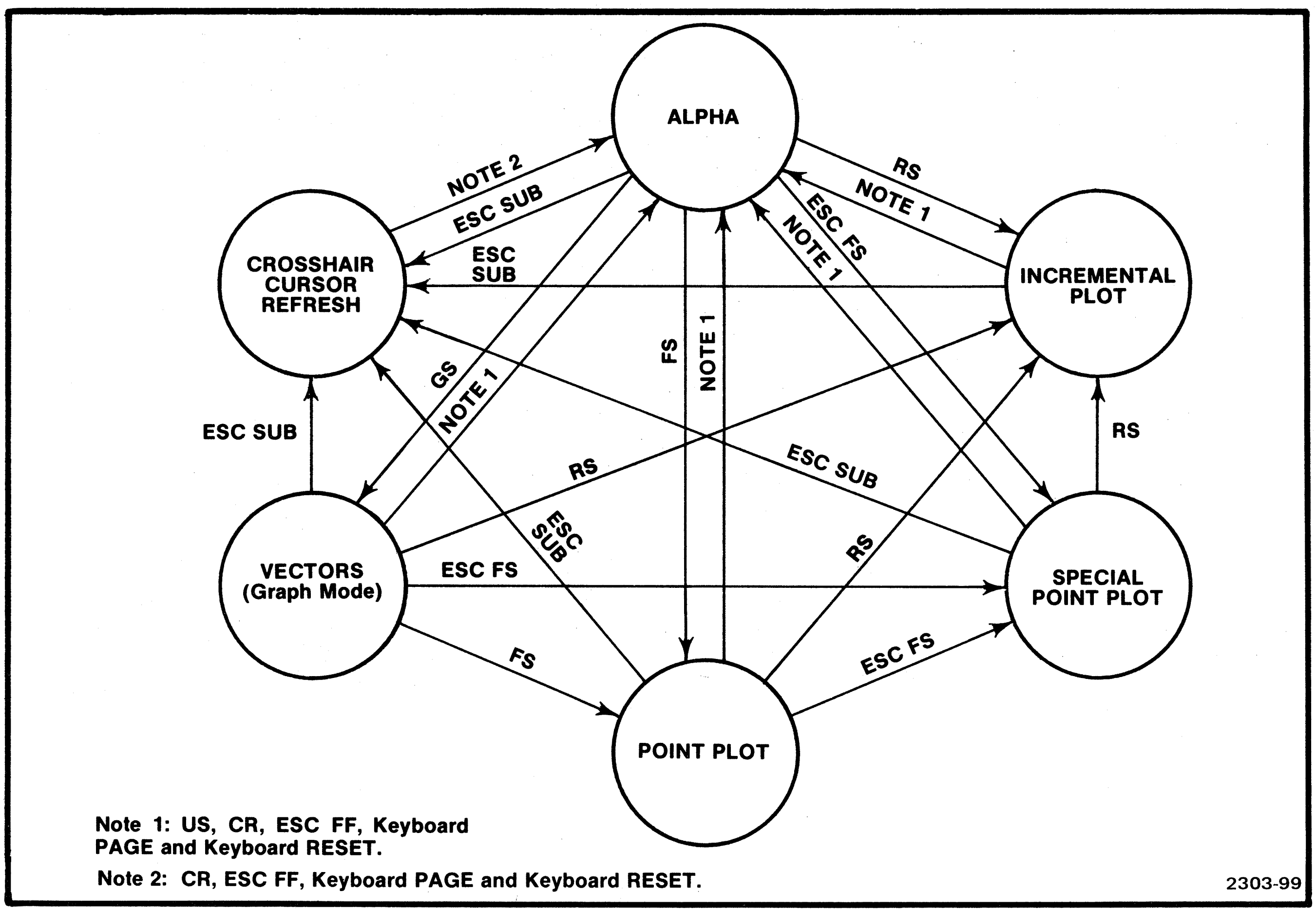

Fig. 2-5. Permissable mode changes for a Terminal with an Enhanced Graphics Module. Terminal modes are depicted as circles, and the transitions between them are shown by arrows and accompanying control commands needed to make the mode change.

TABLE 2-20

Enhanced Graphics Module (Option 34) Coding for Focusing, Write-Thru and Vector Type

ASCII CHARACTER	APL CHARACTER	DECIMAL EQUIV	FUNCTION PERFORMED
ESC '	ESC ◇	96	Normal Z axis and normal vectors or alpha.
a	*A*	97	Normal Z axis and dotted line vectors.
b	*B*	98	Normal Z axis and dot-dashed vectors.
c	*C*	99	Normal Z axis and short-dashed vectors.
d	*D*	100	Normal Z axis and long-dashed vectors.
g	*G*	103	Normal Z axis.
h	*H*	104	Defocused Z axis and normal vectors or alpha.
i	*I*	105	Defocused Z axis and dotted vectors.
j	*J*	106	Defocused Z axis and dot-dashed vectors.
k	*K*	107	Defocused Z axis and short-dashed vectors.
l	*L*	108	Defocused Z axis and long-dashed vectors.
o	*O*	111	Defocused Z axis.
p	*P*	112	Write-thru mode and normal vectors or alpha.
q	*Q*	113	Write-thru mode and dotted vectors.
r	*R*	114	Write-thru mode and dot-dashed vectors.
s	*S*	115	Write-thru mode and short-dashed vectors.
t	*T*	116	Write-thru mode and long-dashed vectors.
w	*W*	119	Write-thru mode.

TABLE 2-21

Incremental Plot Mode Characters

ASCII	APL	BITS 7	6	5	4	3	2	1	INDICATED ACTION
SP	SP	0	1	0	0	0	0	0	*BEAM OFF (PEN UP)
P	#	1	0	1	0	0	0	0	*BEAM ON (PEN DOWN)
D		1	0	0	0	1	0	0	N
E		1	0	0	0	1	0	1	NE
A		1	0	0	0	0	0	1	E →
I		1	0	0	1	0	0	1	SE →
H		1	0	0	1	0	0	0	S ↓
J		1	0	0	1	0	1	0	SW ↓
B		1	0	0	0	0	1	0	W ←
F		1	0	0	0	1	1	0	NW ←

***Not required when operating in Incremental Plot without a mechanical plotter.**

TABLE 2-22

Graph Mode Vector

Drawing for 4096 Addressability

1. GS places Terminal in Graph Mode.

2. The Terminal writing beam can be addressed to any display position within Ø-4095X and Ø-4095Y as follows.

(A) Convert Y coordinate to 12 binary digits; convert X coordinate to 12 binary digits.

Example:

	5 MSB	5 Int. Bits	2 LSB
2500Y =	1 0 0 1 1	1 0 0 0 1	1 0
2048Y =	1 0 0 0 0	0 0 0 0 0	0 0

(B) Form Hi Y byte by affixing Ø1 (as bits 7 and 6) to the 5 MSB of the 12 digits of the Y coordinate.

Hi Y	5 MSB Y		
0 1	1 0 0 1 1	=	3 (4014) 3 (4015)

(C) Form the extra byte by affixing 1 1 (as bits 6 and 7) to the 2 least significant bits (LSB) of the Y and X coordinates in the order shown.

Extra Byte								
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1		
1	1	0*	1	0	0	0	=	((4014) v (4015)
*1 (high sets Margin)			2 LSB of Y coordinate		2 LSB of X coordinate			

(D) Form the Lo Y Byte by affixing 1 1 (as bits 7 and 6) to the 5 intermediate digits of the Y coordinate.

Lo Y	5 Int. Bits of Y		
1 1	1 0 0 0 1	=	q (4014) Q (4015)

TABLE 2-22 (cont)

(E) Form the Hi Y Byte by affixing Ø 1 (as bits 7 and 6) to the 5 MSB of the X coordinate.

Hi X	5 MSB of X		
0 1	1 0 0 0 0	=	Ø (4014) Ø (4015)

(F) Form the Lo X Byte by affixing 1 Ø (as bits 7 and 6) to the 5 intermediate digits of the X coordinate.

Lo X	5 Int. Bits of X		
1 0	0 0 0 0 0	=	@ (4014) – (4015)

(G) Send the five bytes as formed in (B) through (F).

(4014) 3 (q Ø @
(4015) 3 v Q Ø –

Table 2-23 summarizes the Byte Content for 4096 addressing. Note that Bits 7 and 6 of the Extra Byte must be ones. Bit 5 can be used to set Margin 2, if desired. Bits 4 and 3 contain the 2 LSB of the 12-bit Y address, and Bits 2 and 1 contain the 2 LSB of the 12 Bit X address.

The remainder of Graph Mode vector drawing is the same as that from Item (3) through Item (8) in Table 2-7. The only area of change is in the minimum byte transmissions for varying addresses and is the topic of the next paragraph.

This system of addressing the Terminal is both upward and downward compatible with 1024X and 1024Y addressability software. The Extra Byte need not be sent and if not, the Terminal defaults to 1024X by 1024Y resolution. However, the LO Y Byte must always be sent if the Extra Byte is sent. Other rules for shortened address transmission only change (over those of the standard Terminal, as shown in Table 2-8) as the Extra Byte changes, in which case, send the Extra and Lo Y bytes.

TABLE 2-23

Graph Address Byte Content For 4096 Addressing

7-BIT ASCII CHARACTER

BYTE NAME	TAG BITS		ADDRESS BITS				
	7	6	5	4	3	2	1
High Order Y (HIY)	0	1	5 MSB of Y Address				
Extra Byte	1	1	Margin Control	2 least significant bits of Y address		2 least significant bits of X address	
Low Order Y (LOY)	1	1	5 Intermediate bits of Y address				
High Order X (HIX)	0	1	5 MSB of X Adress				
Low Order X (LOX)	1	0	5 Intermediate bits of X address				

Note that Bits 7 and 6 of the Extra Byte must be one's. Bit 5 can be used to set Margin 2. Bits 4 and 3 contain the two least significant bits of the 12-bit Y address, and Bits 2 and 1 contain the two least significant bits of the 12-bit X address.

TABLE 2-24

Plotting Speeds

Mode	Time
Incremental:	
Plotter Off	2 μs plus Z on time
Plotter On	Pen Down 5 ms to 200 ms Pen Up 5 ms to 200 ms Increment 0.5 ms to 5 ms
Point Plot:	10 μs to 200 μs nominal

TABLE 2-25

WRITE INTENSITY CODE CHART
Intensity Settings provided by Special Point Plot Mode

BITS B4	B3	B2	B1	B7 Ø B6 Ø B5 Ø	B7 Ø B6 Ø B5 1	B7 Ø B6 1 B5 Ø	B7 Ø B6 1 B5 1	B7 1 B6 Ø B5 Ø	B7 1 B6 Ø B5 1	B7 1 B6 1 B5 Ø	B7 1 B6 1 B5 1
				CONTROL		DEFOCUSED INTENSITY SETTINGS		FOCUSED INTENSITY SETTINGS			
Ø	Ø	Ø	Ø	NUL Ø	DLE 16	SP 32 14%	Ø 48 56%	@ 64 0%	P 8Ø 4%	` 96 14%	p 112 56%
Ø	Ø	Ø	1	SOH 1	DC1 17	! 33 16%	1 49 62%	A 65 1%	Q 81 4%	a 97 16%	q 113 62%
Ø	Ø	1	Ø	STX 2	DC2 18	" 34 17%	2 50 69%	B 66 1%	R 82 4%	b 98 17%	r 114 69%
Ø	Ø	1	1	ETX 3	DC3 19	# 35 19%	3 51 75%	C 67 1%	S 83 5%	c 99 19%	s 115 75%
Ø	1	Ø	Ø	EOT 4	DC4 2Ø	$ 36 20%	4 52 81%	D 68 1%	T 84 5%	d 1ØØ 20%	t 116 81%
Ø	1	Ø	1	ENQ 5	NAK 21	% 37 22%	5 53 88%	E 69 1%	U 85 5%	e 1Ø1 22%	u 117 88%
Ø	1	1	Ø	ACK 6	SYN 22	& 38 23%	6 54 94%	F 7Ø 1%	V 86 6%	f 1Ø2 23%	v 118 94%
Ø	1	1	1	BEL BELL 7	ETB 23	' 39 25%	7 55 100%	G 71 2%	W 87 6%	g 1Ø3 25%	w 119 100%
1	Ø	Ø	Ø	BS BACK SPACE 8	CAN 24	(40 28%	8 56 56%	H 72 2%	X 88 7%	h 1Ø4 28%	x 12Ø 56%
1	Ø	Ø	1	HT 9	EM 25	) 41 31%	9 57 62%	I 73 2%	Y 89 8%	i 1Ø5 31%	y 121 62%
1	Ø	1	Ø	LF 1Ø	SUB 26	* 42 34%	: 58 69%	J 74 2%	Z 9Ø 9%	j 1Ø6 34%	z 122 69%
1	Ø	1	1	VT 11	ESC 27	+ 43 38%	; 59 75%	K 75 2%	[91 10%	k 1Ø7 38%	{ 123 75%
1	1	Ø	Ø	FF 12	FS 28	, 44 41%	< 60 81%	L 76 3%	\ 92 11%	l 1Ø8 41%	¦ 124 81%
1	1	Ø	1	CR RETURN 13	GS 29	– 45 44%	= 61 88%	M 77 3%	] 93 12%	m 1Ø9 44%	} 125 88%
1	1	1	Ø	SO 14	RS 3Ø	. 46 47%	> 62 94%	N 78 3%	∧ 94 12%	n 11Ø 47%	~ 126
1	1	1	1	SI 15	US 31	/ 47 50%	? 63 100%	O 79 3%	_ 95 13%	o 111 50%	RUBOUT (DEL) 127

2303-116

Note: Circuitry on the Discrete Plot Card prohibits the use of the shaded areas as Intensity Characters.

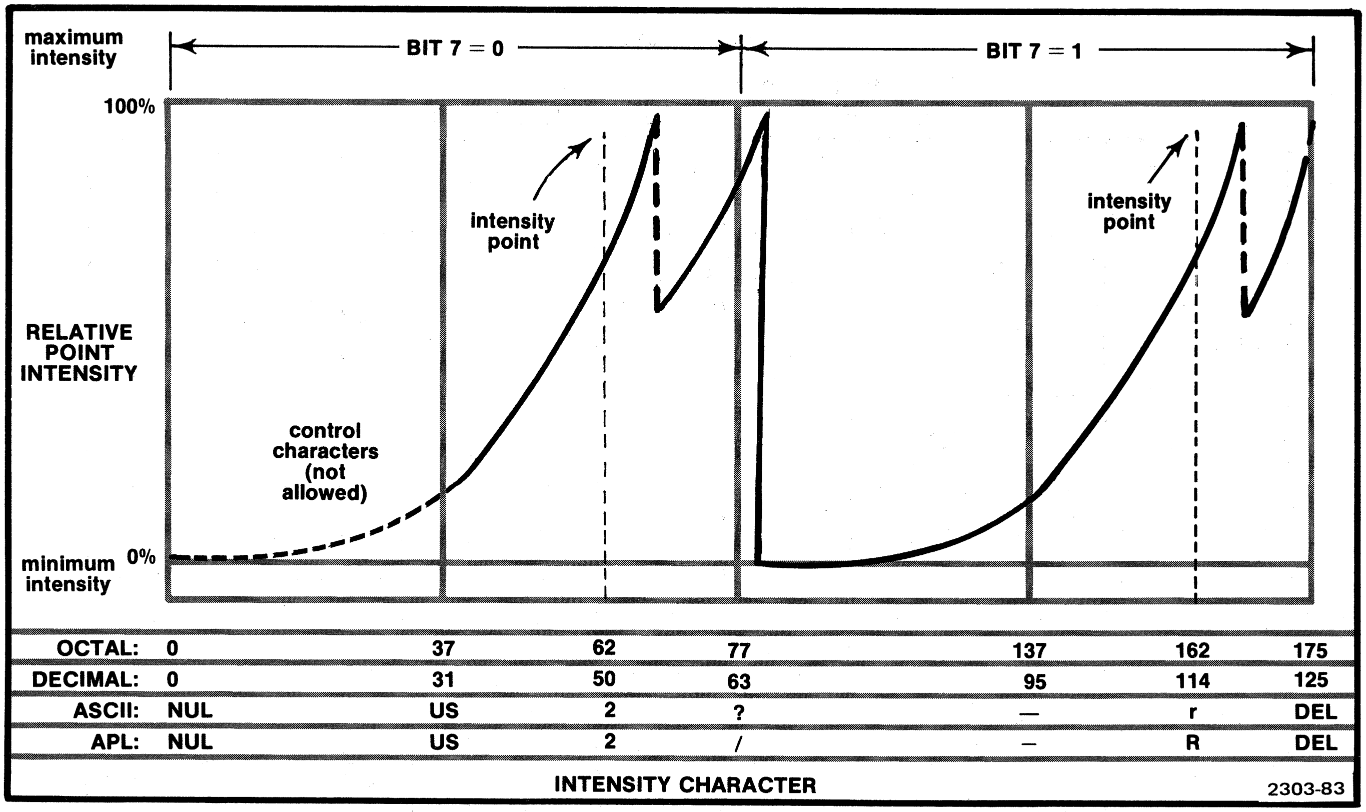

Fig. 2-6. Intensity Code Chart.

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SECTION 3

MAINTENANCE

INTRODUCTION

Beyond the need for occasional cleaning of the face of the display and other outer surfaces of the Terminal, there is virtually no need for routine servicing of the Terminal. It has no lubrication points, no air filters, 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 servicing schedule and procedure is desired, a one-year interval and the "Routine Maintenance" portion of this section are recommended. The disassembly and assembly instructions contained in this section should be referred to as necessary. The Mechanical Parts List diagrams may also facilitate assembly and disassembly.

ROUTINE MAINTENANCE

Cleaning the instrument, performing a visual inspection, and doing a performance check on the Terminal should be all that is necessary in a routine maintenance program.

Cleaning

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

The exterior of the instrument may be cleaned using a soft cloth dampened with a mild detergent and water solution.

Before cleaning the interior of the instrument, disconnect the line cord from the power source. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. Dust also damages the components by preventing the necessary heat dissipation during equipment operation. The best way to clean the interior is with a vacuum cleaner. Remove any dirt which remains with a soft-bristled brush (i.e. a paint brush) or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

For cleaning the face of the crt, refer to the CRT Filter Removal and Cleaning section of the CRT Replacement Procedure.

Visual Inspection

The Terminal should be inspected occasionally for such defects as broken connections, damaged or improperly installed circuit cards, heat-damaged parts, and tightness of bolts.

The crt mounting brackets require special caution. Refer to the CRT Replacement Procedure for appropriate details.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the unit. It is important that the cause of overheating be corrected to prevent recurrence of the damage.

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 ensures 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.

Interconnecting Wire Lists. A listing of cables, jacks and plugs, as well as an explanation of their use, is provided at the beginning of the Diagrams section. Wire colors are also provided, using the standard code for resistors.

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 all 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

A Logic Extender Card, Tektronix Part No. 067-0653-00, is an efficient tool for circuit analysis. This card can be used as an independent plug-in card to make all minibus signals available to the technician, providing level indicators for most of the lines. In addition, it provides a feature for injecting high or low level logic signals into the signal lines. The card can also be used as an extender for other circuit cards, and then permits interruption of any or all signals to the card which is attached to it.

Another extender card is available under Tektronix Part No. 067-0664-00. 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 +600 V dc voltmeter and a 10 MHz bandwidth 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.

Circuit Access Information

For access to terminal control circuitry in the Pedestal, loosen the two thumbscrews on top of the front pedestal cover.

For access to display circuitry in the Display Unit, remove the display cover and set it aside. It is fastened by six machine screws, three on each side of the Display Unit.

For access to the Power supply, secure the two thumbscrews on top of the front pedestal cover. Remove the six screws from the lower portion of the front pedestal cover. Remove the front cover by loosening the two thumbscrews.

WARNING

Dangerous voltages exist within the Display Unit and Pedestal. Normal electrical precautions should be observed whenever working within those units while the covers are removed.

Turn off the Terminal power switch (on front of the pedestal) before removing any circuits or circuit connections. To obtain power at the Terminal when the lower front pedestal cover is removed, pull out on the power interconnect switch.

PARTS REPLACEMENT

Entire circuit cards or boards, including all soldered-on components, can be replaced. Mechanical assemblies can also be replaced. Part numbers are given in the Electrical Parts List and the Mechanical Parts List.

WARNING

Disconnect the Terminal from the power source before removing or replacing circuit cards and components.

Circuit Card Replacement

The circuit cards connected to the motherboard in the Pedestal are held in place by friction. All other circuit cards in the Terminal are mounted in place using machine screws or bolts. Jack numbers for multi-pin connections appear on the printed circuit card. Pin 1 is accompanied by a small arrow on both the printed circuit card and its connector strap. Documented strap options may be counter to this rule.

Semiconductor Replacement

Replacement of semiconductors should be of the original type or a direct replacement. All transistor sockets are wired for standard basing as used for metal case transistors. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing.

Numerous high-power semiconductors are located on the heat sinks on the back of the Terminal. These semiconductors are insulated from the chassis by mica insulators. The mica insulators have silicon grease applied to both sides to improve heat dissipation. Replacement components should receive a similar application of silicon grease prior to installation. Adequate safety precautions should be observed in the handling of the silicon grease.

WARNING

Silicon grease can cause severe eye irritation. Wash hands thoroughly after contact with it.

Keyboard Repair

Remove the 6 screws from underneath the keyboard.

Pull the keyboard forward and then up as far as the cables will allow. Then turn the keyboard over.

The top surface of the circuit board can be accessed by removing the six screws which hold the keyboard assembly to the keyboard panel.

Key caps can be removed by pulling them directly away from the keyboard. Use of a large pair of tweezers or a forceps is recommended.

Keys utilize reed switches whose solder contacts are accessible on the underside of the keyboard circuit board. Once the wires are unsoldered, the reeds can be extracted through the holes. Reverse the procedure for replacement.

Groups of keys are installed in assemblies which can be removed once the nuts are removed from the underside of the circuit board.

Power Supply Removal

Disconnect the Display from the power source. Remove the cables which connect the power supply circuits to the rest of the Terminal.

At the back of the Pedestal, remove the four screws holding the Power Supply assembly in place, and withdraw the Power Supply out the back.

The cable plugs are color coded, from 0 to 9, to match the last digit of the jack number to which the plug is connected.

CRT Filter Removal and Cleaning

Disconnect the Display from the power source.

Remove the Display cover. It is secured by three screws on each side of the instrument.

Remove the Display bezel (mask) and attached brackets which are secured by two nuts on each side. See Fig. 3-1.

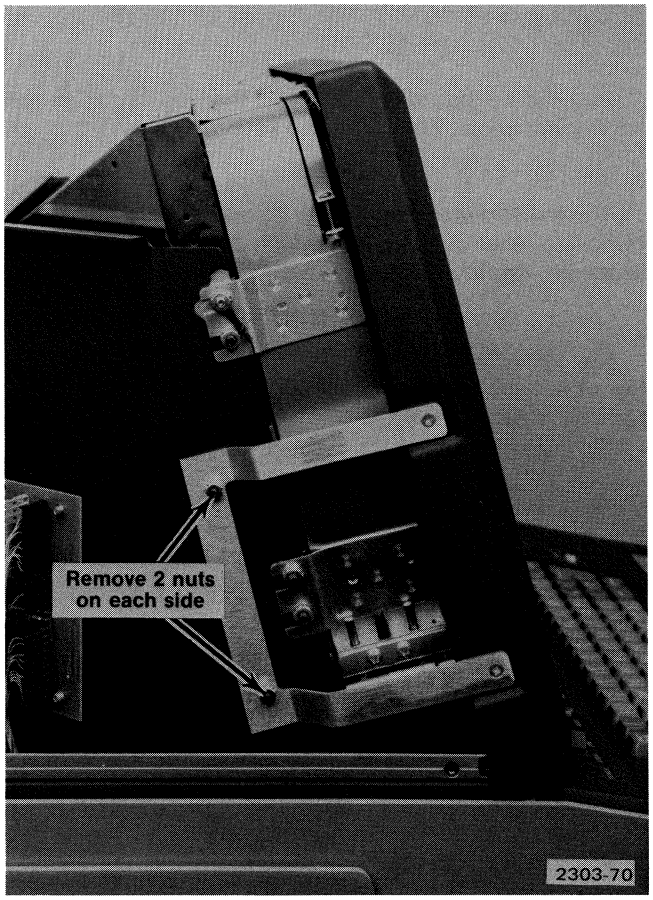


Fig. 3-1. Display bezel removal.

Loosen the screws (one on each side) from the crt band tabs providing support on the upper corners of the crt filter. See Fig. 3-2. Do not tighten or loosen the Allen bolt on the CRT Band as it is factory set with 95 inch-lb. +5 inch-lb. of torque for crt implosion protection.

Remove the two angle brackets from the top of the crt band.

Loosen (do not remove) the nuts on the angle brackets holding the bottom of the filter.

Carefully lift the filter from the lower angle brackets and away from the crt. Use caution to avoid hitting the crt since a sharp blow to the crt may cause it to implode. Before reassembly, the underside of the filter and the face of the crt may be cleaned with a soft cloth and a solution of mild detergent and water.

Reverse the previous steps to replace the filter.

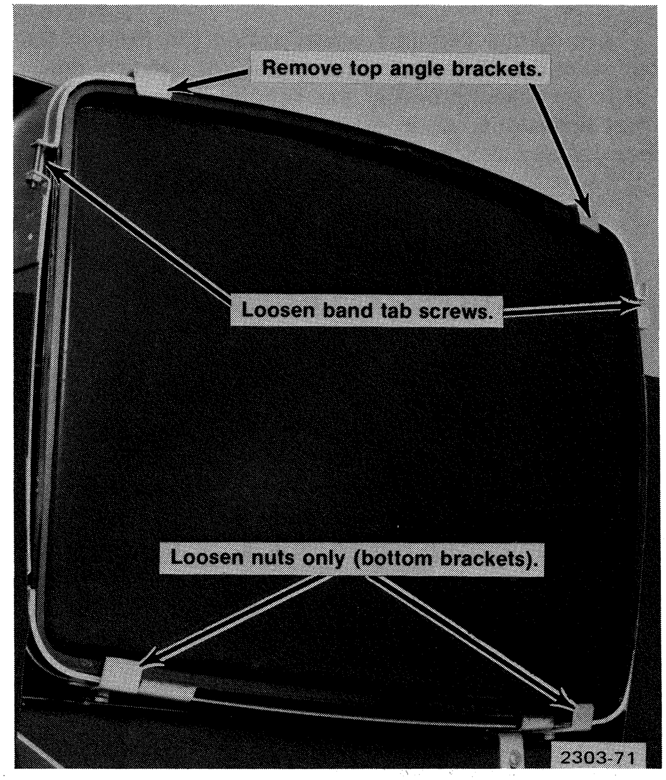


Fig. 3-2. CRT filter removal.

CRT and Shield Assembly Removal

This procedure requires two people and should be carried out only by qualified service personnel. A crt is a high vacuum device and is dangerous if not handled properly. Wear safety clothing and a face shield. A suitable workspace should be available where the crt can be placed face down on a cushioning and non-abrasive surface, such as a foam pad. Cardboard is not adequate. Refer to the Replaceable Mechanical Parts List as necessary.

WARNING

THE CRT BAND IS NOT TO BE REMOVED FROM THE CRT. The crt may implode if it is scratched or struck severely. Do not handle the crt by its neck. Wear protective clothing and a face shield when handling the crt.

Disconnect the Display unit from the power source.

Remove the Display unit. It is secured by three screws on each side of the instrument.

Remove the display bezel (mask) and attached brackets, which are secured by two nuts on each side. See Fig. 3-1.

Remove the keyboard. It is secured by six screws on the bottom near the front of the Display Unit. See Fig. 3-3. Disconnect the cable connecting the keyboard to the Display Interconnect Board, and J73 on the High Voltage and Z Axis Board. Lift the right side of the keyboard and remove the circuit board edge connector. Remove the keyboard.

NOTE

When disconnecting cables, note the location and jack numbers for reference during reassembly. The cable plugs are color coded, from 0 to 9, to match the last digit of the jack number to which the plug is connected.

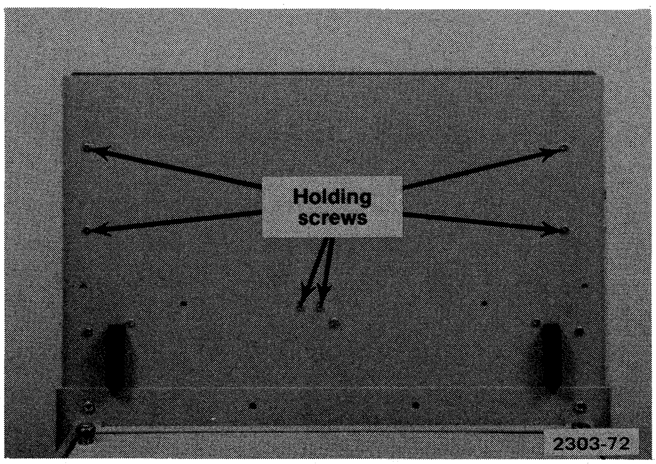


Fig. 3-3. Keyboard holding screws.

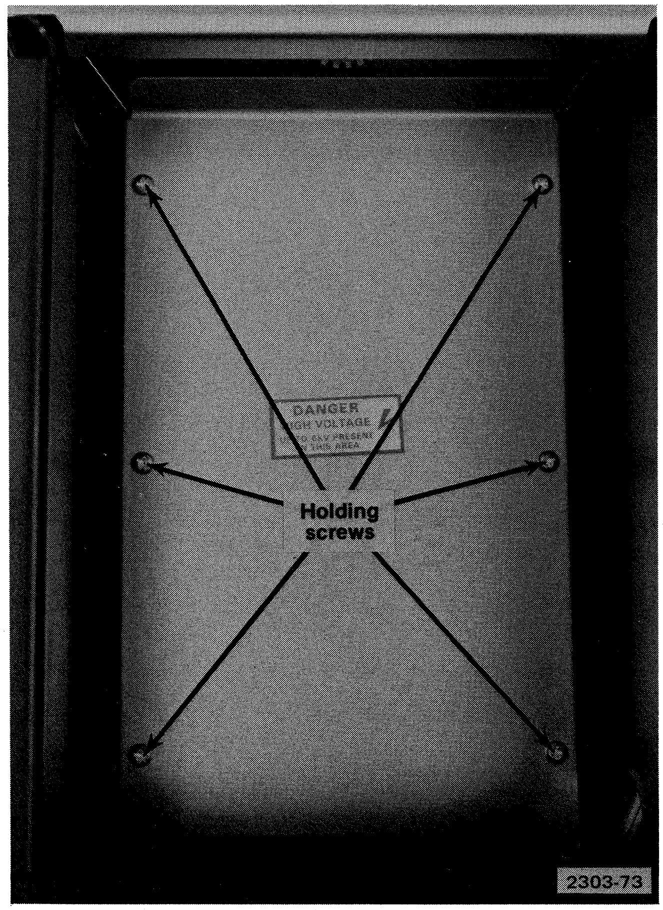


Fig. 3-4. CRT neck shield.

Remove the shield cover over the crt neck which is held with six (6) screws. See Fig. 3-4.

Remove the writing gun connector from the end of the neck of the crt. Use caution to push the connector straight off to avoid bending the pins in the base or breaking the neck of the crt.

Remove the deflection yoke cables from J56 and J59 on the Deflection Amplifier board (right rear of Display Unit), and from the three retainer clips above the board.

Remove the crt cables from the Hard Copy Amplifier Board (J133 and J134). Board is located on right side top of Display Unit.

Remove the top support chassis, which is attached by 4 screws.

Next free the crt band and shield assembly. See Fig. 3-5. Remove one screw that is holding the tab on the bottom of the crt band (in front). Loosen four (4) nuts on each side of the display (remove the one nut necessary to remove the ground wire lug).

It is best if two people remove the crt and shield assembly. Each should grasp the lower front of the crt with one hand, and the shield opening, for the yoke, with the other hand. Remove the entire assembly and place it face down on a padded, non-abrasive surface. Be careful of cables when removing the crt and shield assembly as they have to be fed through holes in the shield assembly. Be careful of scratching paint with the bracket on the front of the band.

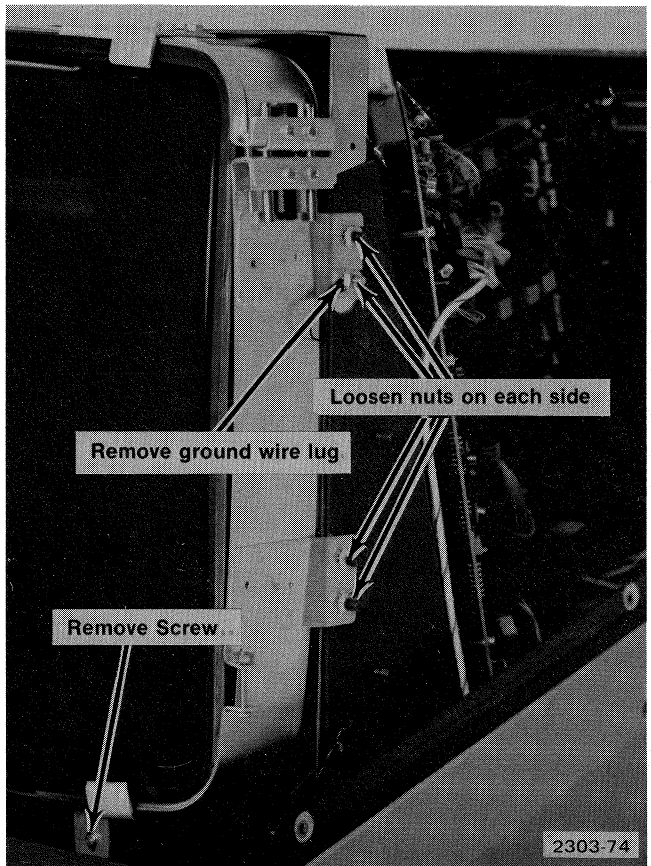


Fig. 3-5. CRT shield assembly removal.

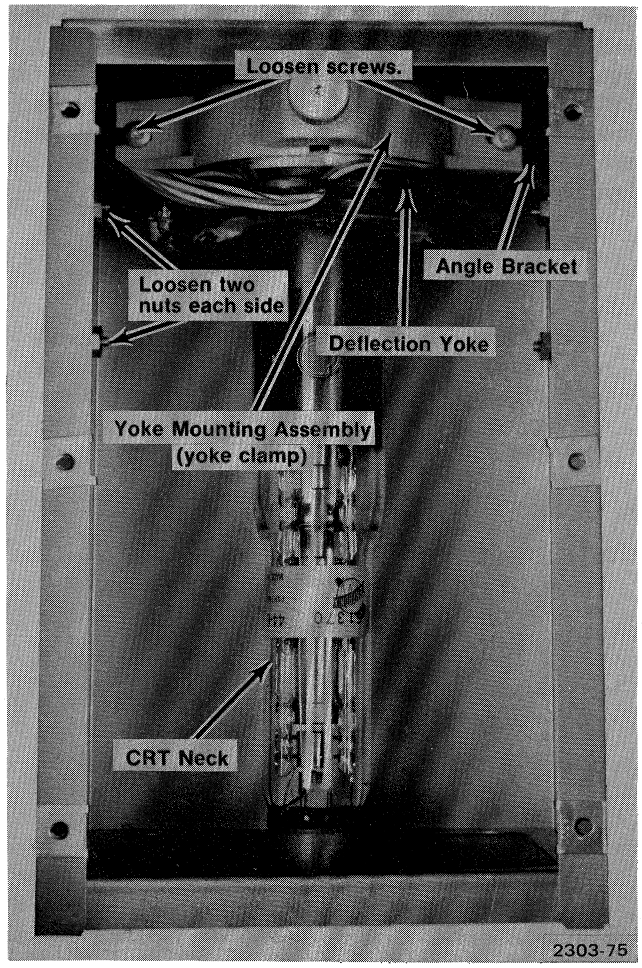


Fig. 3-6. Deflection yoke assembly.

CRT Replacement

Loosen two nuts on each angle bracket of the deflection yoke (Fig. 3-6). These nuts enable the yoke assembly to move horizontally to accept a new crt.

Slightly loosen the two screws holding the yoke clamp to the angle brackets. The screws permit the yoke assembly to move vertically to accept a new crt.

NOTE

Do not loosen the single knurled nut on the deflection yoke assembly. It is used during calibration to permit rotation of the writing beam on the face of the crt. See ADJUSTMENT PROCEDURE under Yoke Adjustment for Display Rotation in Section 4.

Remove the four screws connecting the shield to the crt band, and carefully lift the shield from the tube.

NOTE

Be careful of the crt cable when removing the shield as it has to be fed through a hole in the shield. Avoid side pressure against the crt neck.

Remove the eight nuts and washers holding the four angle brackets, which hold the front implosion shield in place.

Remove the four screws (near each corner) from the crt band tabs providing support on the corners of the crt filter.

NOTE

Do not tighten or loosen the Allen bolts on the crt band. They are factory set with 95 inch-lb. ±5 inch-lb. of torque for crt implosion protection.

Remove the small angle bracket on the lower front of the crt band. It is held by 2 small nuts.

The crt can be lifted free of the colored implosion shield (filter). Remove the 4 small ground clips in each corner of the crt band that were originally under the implosion shield filter and place the crt in a shipping carton.

WARNING

The crt may implode if it is scratched or struck severely. Do not handle the crt by its neck. Wear protective clothing and a face shield when handling the crt.

Carefully replace the metal shield assembly over the new crt, avoiding side pressure against the crt neck. During this step, remember to pass the crt cable (with yellow and orange connectors) through the hole in the crt shield.

NOTE

The open side of the neck shield after the crt is installed must be facing up. Therefore, install the crt shield so that the open side of the neck shield is on the opposite side of the crt CE-1 (clip with green-white wire).

Replace the four screws holding the crt band to the shield assembly.

After sliding the yoke on the tube as far as possible, tighten the two nuts on each of the two angle brackets of the deflection yoke mount. See Fig. 3-6.

Tighten the two screws holding the yoke clamp to the angle brackets. See Fig. 3-6.

Attach the small angle bracket on the lower front of the crt. This goes on the crt band opposite the opening in the crt neck shield. Use grade B LOCKTITE® compound, to ensure the tightness of these nuts.

For the remaining steps, the crt and shield assembly should be in a horizontal altitude, with the top of the crt on either side.

The crt face should be cleaned with a soft cloth moistened with a solution of mild detergent and water.

Place the four ground clips in the corners of the crt band.

After cleaning the underside of the colored implosion shield/filter with a soft cloth and a solution of mild detergent with water and drying, place it carefully against the crt face.

Attach the four angle brackets with the eight nuts and washers.

Attach the four screws on the crt band tabs providing support on the upper corners of the crt filter. Note that the two smaller machine screws and nuts go in the upper left and lower right positions. The larger machine screws (without the nuts) go in the upper right and lower left corners. Do not tighten or loosen the two Allen bolts. They are factory set with 95 inch-lb. ±5 inch-lb. of torque for crt implosion protection.

The crt and shield assembly can now be placed into the Display Unit. It is best if two people accomplish this, each grasping the lower front of the crt with one hand, and the shield opening for the yoke with the other hand.

Crt and Shield Assembly Installation

To complete the crt and shield installation, reverse the steps discussed previously under CRT AND SHIELD ASSEMBLY REMOVAL, except that the writing gun connector on the base of the crt should be replaced before the shield assembly is properly seated all the way back in the Display Unit.

SECTION 4

PERFORMANCE CHECK/ADJUSTMENT

PERFORMANCE CHECK

GENERAL

This procedure can be used under normal operating conditions with all circuit cards installed. Since, for the most part, it 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 pedestal 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 in line with the point being observed.

For those Terminals that contain the Enhanced Graphics Module (Option 34), a performance checkout procedure is contained in Section 1.

TABLE 4-1

Activity	Results	Circuit/Adjustment
Turn the Terminal on	Indicator on left of keyboard glows	Power Supply (Steps 1 and 2)
Wait 30 seconds and then press PAGE	Erase cycle occurs	Storage circuits (Step 7)
Wait 3 minutes and again press PAGE	Alpha cursor appears in top-left of display, approximately 1/2 inch from left edge and from top edge of display area	High Voltage and Z Axis circuits; Deflection circuits (Steps 5, 6 and 15) Terminal Control (TC) circuits
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 7) Character brightness (Step 15)
Wait 5 minutes and press SHIFT	Check for fade-positive and drop-out effects	Storage circuits (Step 7)
Enter LINE FEED	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

TABLE 4-1 (cont)

Activity	Results	Circuit/Adjustment
Press PAGE	Erase cycle occurs; cursor goes home	TC
Enter 34 LINE FEEDs	Cursor goes to bottom-left corner of display	
Enter 35th LINE FEED	Cursor moves to Margin 2 position at top-center of display	TC
Enter thirty-seven 8s	8s written and stored; cursor moves to next line and back to Margin 2	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
On the 4015 Terminals, set the ASCII/APL switch to APL.	Check for proper writing and focus of APL characters	Keyboard; TC; Focus (Step 13)
Enter each written character indicated on the keyboard, including shifted characters		
Enter PAGE	Display erases; cursor goes home	
Put the ASCII/APL switch to ASCII. Enter each written character indicated on keyboard, including shifted characters	Check for proper writing and focus of ASCII characters	Keyboard; TC
Enter PAGE	Display erases; cursor goes home	
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. All other characters are unshifted	Keyboard
Press the TTY LOCK key	Lock releases	
Enter PAGE	Display erases; cursor goes home	
Enter ESC 9	Cursor decreases slightly in size	TC
Enter characters to complete a line (81 characters)	Cursor resets to next line and to margin at left of display	TC

TABLE 4-1 (cont)

Activity	Results	Circuit/Adjustment
Press PAGE	Erase cycle occurs; cursor goes home	TC
Enter 38 LINE FEEDs	Cursor moves to Margin 2 position at center of Page	TC
Press PAGE	Erase cycle occurs; cursor goes home	TC
Enter ESC : (4014) or ESC ((4015)	Cursor decreases appreciably in size	TC
Enter characters to complete a line (121 characters)	Cursor resets to next line and to Margin 2 at left of display	TC
Enter 57 LINE FEEDs	Cursor moves to Margin 2 position at center of page	TC
Press PAGE	Erase cycle occurs; cursor goes home	TC
Enter ESC ; (4014) or ESC [(4015)	Cursor decreases slightly in size	TC
Enter characters to complete a line (133 characters)	Cursor resets to next line and to margin at left of page	TC
Enter 63 LINE FEEDs	Cursor moves to Margin 2 position at center of page	TC
Press SHIFT RESET	Cursor goes home; largest character size is selected as indicated by large size of cursor	TC
Set LOCAL/LINE switch to LINE. Check the Interface card to obtain an "ECHO" of keyboard inputs. Refer to your Interface Users manual to find how to do this for your particular interface. **CAUTION** *Do not attempt to remove any card from the pedestal motherboard with power applied.*	Echoing of keyboard data is evident by keyboard inputs being written on the display	TC, Interface

TABLE 4-1 (cont)

Activity	Results	Circuit/Adjustment
Enter a few keyboard characters to ensure an echo condition exists		
Enter ESC followed by CTRL X. Then enter some more characters from the keyboard	Keyboard entries do not print. The cursor remains stationary. Bypass Condition, as selected, prevents the Character Generator from responding to echoed data	TC
Enter CTRL M followed by more keyboard entries	Cursor moves to left margin. Display of echoed date is once again enabled	TC
Reselect LOCAL and restore the Interface card to its original configuration		
Press PAGE	Erase cycle occurs; Cursor goes home	TC
Enter a few keyboard characters	Keyboard entries are stored	TC
Enter ESC a (4014) or ESC p (4015), then enter some more keyboard characters	Previously entered characters remain stored while characters being entered do not store. This checks write-thru operations. The ALPHA cursor goes away for ≈1/2 s after each character.	TC
Press PAGE	Display Erases; cursor goes home	
Enter ESC CTRL Z	Crosshair cursor appears but does store	TC; Crosshair Cursor Intensity or Focus (Steps 6 and 13)
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	
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 (Steps 11 and 12)
Check horizontal line straightness	Distance between any point on the line and the mean path of the line should not exceed 0.5% of line length from mean straight line	Deflection Amplifier (Steps 11 and 12)

TABLE 4-1 (cont)

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% of the mean path of the line	Deflection Amplifier (Steps 11 and 12)
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 cursor appears at top-left corner	TC
Enter CTRL SHIFT M	Cursor disappears	TC
Enter (4014) SPACE ` SPACE @ (4015) SPACE ◇ SPACE ‾	Dark vector is executed; cannot be observed	TC
Enter (4014) @ (4015) ‾	Dot appears in lower-left corner	TC
Enter (4014) 8 k 8 L (4015) 8 *K* 8 ▯	40° diagonal line appears, starting from bottom-left corner	TC
Check line focus	Should be sharply focused	Step 3
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
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; may also return to margin in the LF	TC
Enter CTRL K (VT)	Cursor moves up one line EFFECT option is at LF→CR	TC

TABLE 4-1 (cont)

Activity	Results	Circuit/Adjustment
Enter CTRL SHIFT M (GS)	Selects Graph Mode; cursor disappears	TC
Enter (4014) SPACE RUBOUT SPACE @ + RUBOUT Ø @ (4015) SPACE RUBOUT SPACE ‾ ÷ RUBOUT Ø ‾	Vector appears	TC
Enter ESC CTRL W (ESC ETB)	Copy of display is made if Hard Copy Unit is energized and attached to a 4014-1 or 4015-1	TC; Hard Copy TARSIG Amp; Hard Copy Selector; High Voltage and Z Axis circuit; Storage circuit; Steps 17 through 19
Enter ESC CTRL L (ESC FF)	Display erases; Alpha cursor homes	TC
Enter CTRL SHIFT M (GS)	Cursor disappears	TC
Enter (4014) @ @ (4015) ‾ ‾	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 (4014) @ _ (4015) ‾ -	A 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
Enter CTRL SHIFT M followed by (4014) SPACE ` SPACE D D (4015) SPACE ◊ SPACE L L	A dot should appear at bottom-left corner	TC
Enter CTRL SHIFT M followed by (4014) 8 k ? _ _ (4015) 8 *K* \ - -	A dot should appear at upper-right corner	TC
Enter ESC CTRL Z (ESC SUB)	Alpha cursor disappears; 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, ØY	TC
Move intersect point to dot at top right of display	Intersect point is positioned to 1023X, 779Y	TC

TABLE 4-1 (cont)

Activity	Results	Circuit/Adjustment
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 30 minute warmup period. In the following, reference is made to ASCII and APL character entries. APL character entries are available only on the 4015 and 4015-1 Terminals.

EQUIPMENT REQUIRED

Variable ac voltage source. An autotransformer which has an output capability of at least 5 A at 100, 115, or 120 V ac, or at least 2.5 A at 200, 220, 230, or 240 V ac. The autotransformer output should be variable to at least plus and minus 10% from the stated value.

Oscilloscope. Dual trace with vertical deflection factors of 50 mV, 0.5 V, 2 V, 5 V, and 50 V per division, and sweep rates of 0.1 μs, 0.5 μs, 10 μs, 1 ms, and 10 ms per division. Bandwidth should be from dc to at least 10 MHz.

Voltmeter. Range at least −30 V dc to +600 V dc; accurate within at least .05% at +15 V, 0.1% at −15 V, 0.1% at +5 V, and at least 1% at all other voltages. High voltage range to −6000 V dc is required.

Screwdriver. 1/8 inch tip; non-conductive, at least six inches overall length.

Hard Copy Unit. Used for adjusting copy-making circuitry, on the 4014-1 and 4015-1 Terminals. This circuitry must be adjusted if the Terminal is to be used with a Hard Copy Unit. Allow Hard Copy warmup time of at least 30 minutes before making hard copy adjustments.

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: ____________________

1. Low Voltage Power Supply Check/Adjustment (R197 and R27 on Power Supply Board in Pedestal). Page 4-17

This is an operational voltage check of the low voltage power supplies found in the Pedestal, and the +290 V supply on the Storage Board. R197 sets the +15 V power supply voltage. It also provides a reference voltage for the +5 V supply and influences the voltage of the −15 V supply. For additional information refer to Tables 4-2 and 4-3.

2. +5 V Over-Voltage Crowbar Adjustment (R191 on the Power Supply) Page 4-19

Adjust R191 for +4.67 V measured at the R55-C141 junction.

3. Flood Gun Filament Voltage Check/Adjustment Page 4-19

Adjust R190 on the Power Supply for a voltage difference of 26.8 V dc measured between TP71 and TP75 on the Storage Board.

4. +290 V Check/Adjustment (R411 on the Storage Board) Page 4-21

Adjust R411 for +290 V measured at TP550.

5. High Voltage Check/Adjustment (R341 on the High Voltage and Z Axis Board) Page 4-21

Adjust R341 for −5950 V measured at TP61.

6. Preadjust Cursor Intensity and Focus. Adjust Writing Intensity. (Cursor Intensity on Display Control card in Pedestal; Focus and Writing Intensity adjustments on High Voltage & Z Axis Board in Display Unit). Page 4-21

Alpha and Crosshair cursors are adjusted for intensity and focus. Writing Intensity (BIAS, R342) is adjusted until spot in lower left corner of cursor just disappears.

7. Storage Check/Adjustments (R140, R221, and R341 on the Storage Board) Page 4-24

Check the operating voltages previously established for the Target, CE-2, and CE-1. R140 (OP LEV) establishes the Target Operating Voltage. It is set just below the threshold of fade-positive effects. R221 (CE-2) is used to set the CE-2 Operating Voltage. R341 (CE-1) is used to set the CE-1 Operating Voltage. CE-2 and CE-1 are adjusted to provide consistent flood gun coverage over the face of the crt.

8. Erase Check/Adjustment (R223 and R343 on the Storage Board) Page 4-26

R223 (CE-2P) and R343 (CE-1P) are adjusted to provide the consistent and bright erase beam coverage over the face of the crt.

9. Geometry Correction and Dynamic Focus Multipliers Adjustments on the Deflection Amplifier Board Page 4-27

These nine adjustments are factory set and should not be moved. The settings require a special precision square wave generator. For additional information see the Detailed Adjustment Procedure.

10. Yoke Adjustment for Display Rotation Page 4-29

This procedure is to be carried out with caution. It involves rotating the deflection yoke on the neck of the crt. Excessive pressure on the neck of the crt may cause it to implode.

11. Preliminary Page Size Adjustments (X POS, X GAIN, Y POS, and Y GAIN on the Deflection Amplifier Board) Page 4-29

Check the page margins with the crosshair cursor and adjust if margins appear grossly excessive or are nonexistent.

12. Vector Linearity Check/Adjustment (X GEOM and Y GEOM on the Deflection Amplifier Board) Page 4-30

Adjust R242 (Y GEOM) and R243 (X GEOM) to obtain straight horizontal and vertical lines by comparing the straightness of the crosshair cursor lines to the edges of the screen.

13. Focus Adjustments (on the High Voltage and Z Axis Board) Page 4-32

Set R692, DEFOCUS, fully CCW. Move the alpha cursor to the center of the screen and adjust the CENTER focus, on the back of the Display Unit for optimum cursor focus. Erase the screen and adjust R484, CORNER, for optimum cursor focus. R692, DEFOCUS, determines the width of Defocused Vectors.

14. Graphic Intensity Check/Adjustment Page 4-32

The VECTOR INTENSITY adjustment, R536 on the High Voltage and Z Axis board, is set to the minimum intensity at which complete vectors are drawn without exhibiting dropout.

15. Character Intensity Check/Adjustment Page 4-33

The Write-Thru intensity adjustment is located to the right of the keyboard and adjusted for a non-storing display.

R542, ALPHA intensity, on the High Voltage board determines the smaller 2 character size intensity level.

R544, BRITE INTENSITY, also on the High Voltage board determines the larger 2 character size INTENSITY Level.

16. Final Deflection Check/Adjustment (Y GAIN, Y POS, X GAIN, and X POS on the Deflection Amplifier Board) Page 4-33

First set the top and bottom margins using R92 (Y GAIN) and R56 (Y POS). Adjust R273 (X GAIN) so that a square, drawn with a height and width of equal tek points, has equal height and width on the screen. Then adjust the left and right margins using R270 (X POS).

This completes the adjustment procedure for the 4014 and 4015 Terminals. Skip Steps 17-19 and perform Step 20. If your Terminal is a 4014-1 or 4015-1 continue with Step 17.

17. Hard Copy Amplitude and Position Check/Adjustment (YHC POS, YHC GAIN, XHC POS, and XHC GAIN on the Deflection Amplifier Board) Page 4-34

Adjust YHC POS and YHC GAIN so the scan bar is within the visible portion of the screen and covers a page of written characters. Reverse the connections on J50 and adjust XHC POS and XHC GAIN so the scan bar extends 1/4 inch beyond the left and right margins of a page of characters. Restore J50 to its original position.

18. Hard Copy Threshold Adjustment (R26 on the Hard Copy Amplifier Board) Page 4-35

With no information on the screen, adjust R26 to the threshold where TARSIG signals no longer appear at TP116.

19. Hard Copy Check Page 4-36

With no information on the display the copy paper should not write up or become dark.

Write a page of characters on the screen and make five successive copies of the display. All five copies should be satisfactory.

20. Restore Initial Conditions Page 4-36

Remove all test equipment from the Terminal.

Restore the interface cards and strap options for computer operation.

Restore the power supply if it was rewired for testing.

Replace all covers on the Terminal.

DETAILED ADJUSTMENT PROCEDURE

Circuit Access

For access to terminal control circuitry in the Pedestal, loosen the two thumbscrews on top of the front pedestal cover.

For access to display circuitry in the Display Unit, remove the display cover and set it aside. It is fastened by six machine screws, three on each side of the Display Unit.

For access to the Power supply, secure the two thumbscrews on top of the front pedestal cover. Remove the six screws from the lower portion of the front pedestal cover. Remove the front cover by loosening the two thumbscrews.

Turn off the Terminal power switch (on front of the pedestal) before removing any circuits or circuit connections. To obtain power at the Terminal when the lower front pedestal cover is removed, pull out on the power interconnect switch. (See Fig. 4-1 for location.)

Circuit Locations

The following can serve as a guide for rapid location of major circuits within the Terminal.

Terminal Control — upper Pedestal (Fig. 4-1)

- Character Generator Card
- TC-1
- TC-2
- TC-3
- Display Control Card
- Communications Interface
- Optional Cards
  - Discrete Plot
  - Display Multiplexer
  - Optional Interfaces
  - Peripheral Control Cards

NOTE

TC-1 and the Character Generator cards are strapped together; likewise for TC-2 and TC-3.

Power Supply — lower Pedestal (Fig. 4-1)

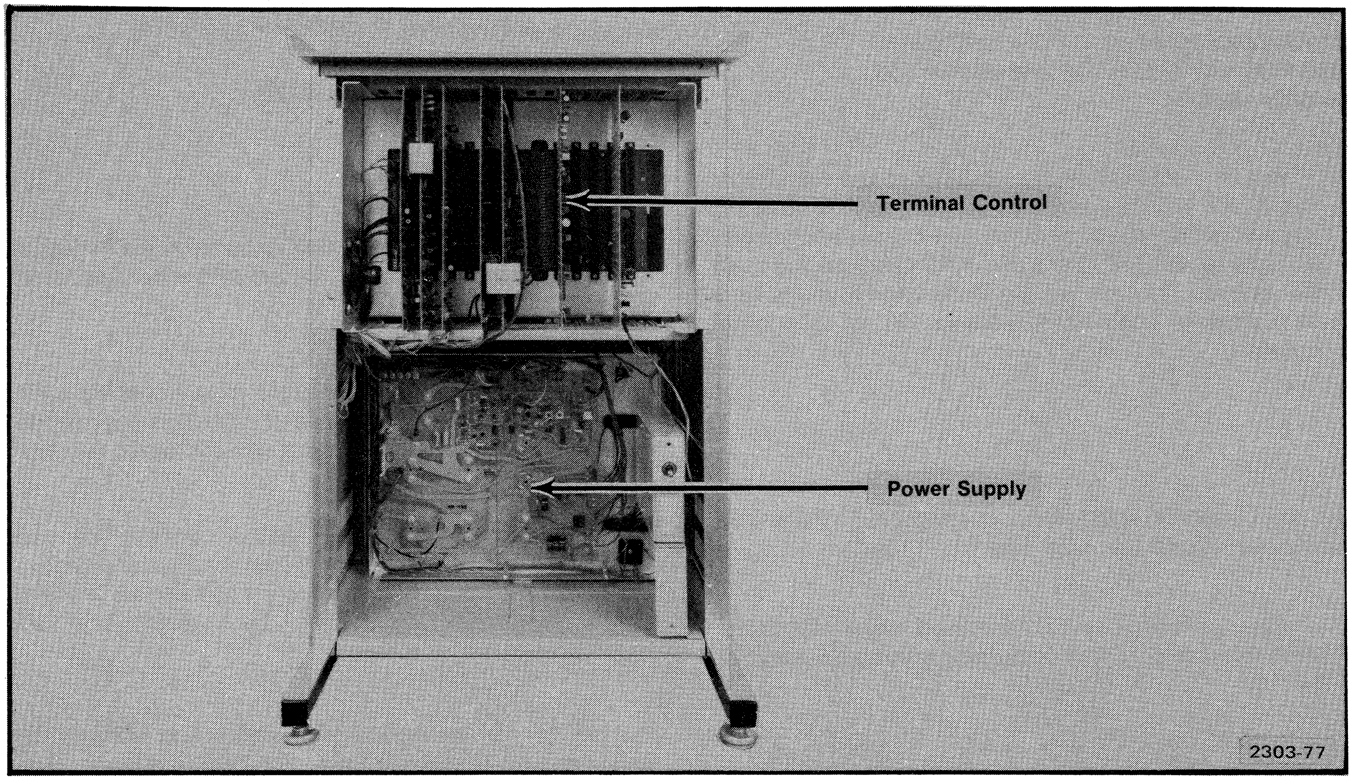


Fig. 4-1. Pedestal circuit locations.

Display Circuitry — Display Unit (Fig. 4-2)

Deflection Amplifier	— right side
Display Interconnect	— left side
Hard Copy Amp.	— right side
High Voltage and Z Axis	— left side
Storage	— right side

Preliminary Setup

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

WARNING

Dangerous voltages exist within the Terminal display unit and pedestal. Normal electrical precautions should be observed whenever working within those units while the covers are removed.

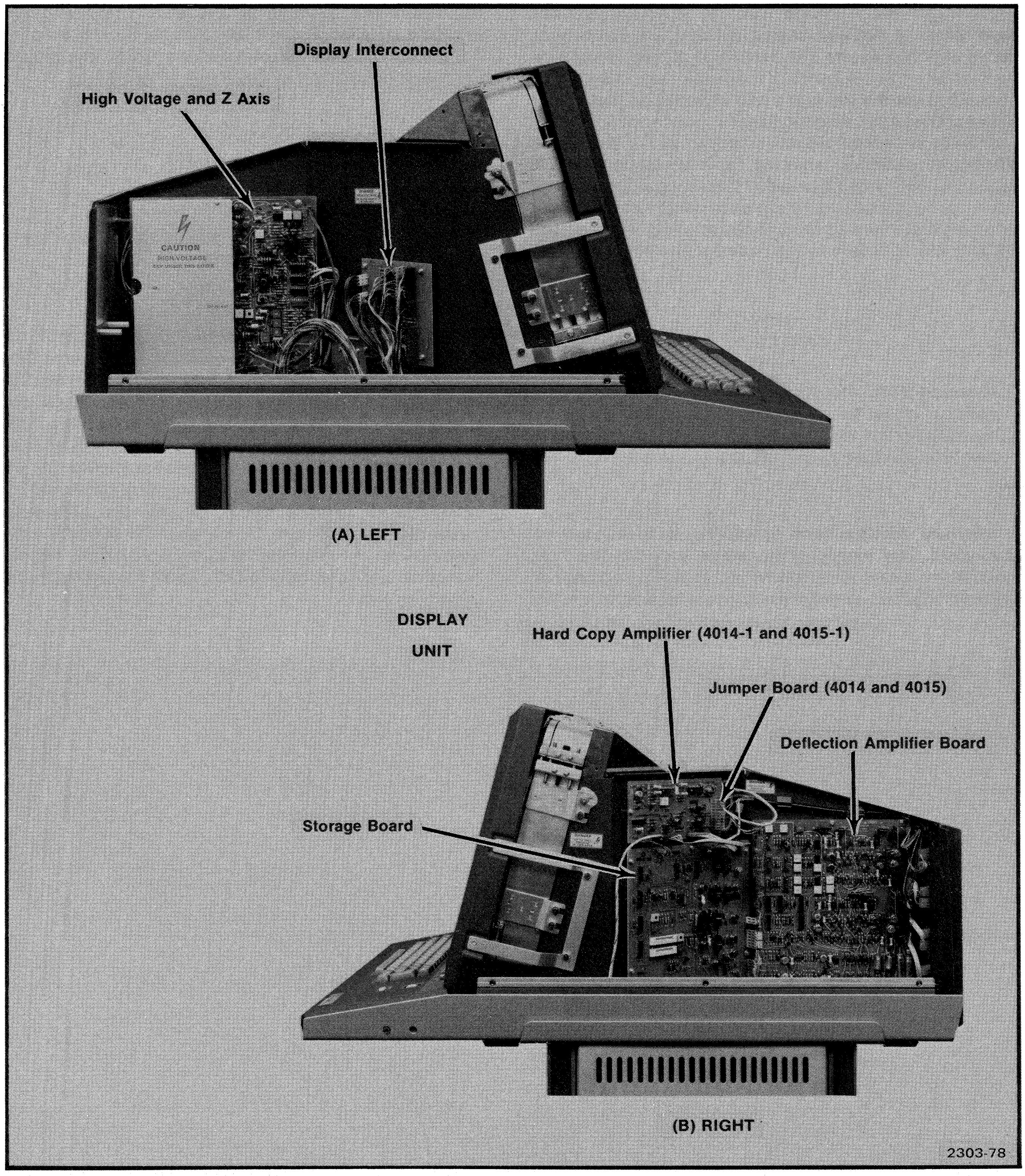


Fig. 4-2. Display Unit circuit locations.

Although the Terminal can be adjusted without separating the display unit and pedestal, it is much more convenient if they are separated and placed along side each other on a work bench. If the pedestal and display are connected via the ten foot cable provided as part of the optional Desk Mounting Kit, bench mounting of both units can be easily accomplished as shown in Fig. 4-3. If the display is pedestal mounted, and an optional Desk Mounting Kit is not available, it is suggested that the Terminal be placed on an elevated surface (approximately one foot above floor surface) as shown in Fig. 4-4. This will provide easier access to the pedestal circuitry.

CAUTION

If the pedestal feet have been replaced with the optional wheel kit (castors), take adequate safety measures (such as removing the castors) to prevent the Terminal from rolling off the elevated surface.

Interface modifications to rapidly write a page of characters. The following procedure provides the Terminal with a means to rapidly fill the display with a page of written characters. It is necessary, in some cases to modify the straps and settings on the Data Communication Interface installed. Record the changes for restoring the Terminal to original adjustment or operating configuration upon completion of this mode of operation.

CAUTION

Turn off the power before removing or replacing circuit cards and connections.

Determine the type of Interface card installed: If the Interface card is a Data Communication Interface 021-0065-00, check it against Fig. 4-5 and change the straps as necessary, recording the original setting. Then disconnect the cable from J360, and strap J360 pin 1 to J360 pin 7 on the card. Connect $\overline{\text{T STROBE}}$ to $\overline{\text{C STROBE}}$; an extender card can be placed between the minibus (on the Motherboard) and the Interface card, with minibus pin 3 connected to minibus pin 5; or U67 pin 10 can be connected to U67 pin 11 on the 021-0065-00 Data Communication Interface card by first connecting an integrated circuit test clip to U67. Install the Interface card in the minibus.

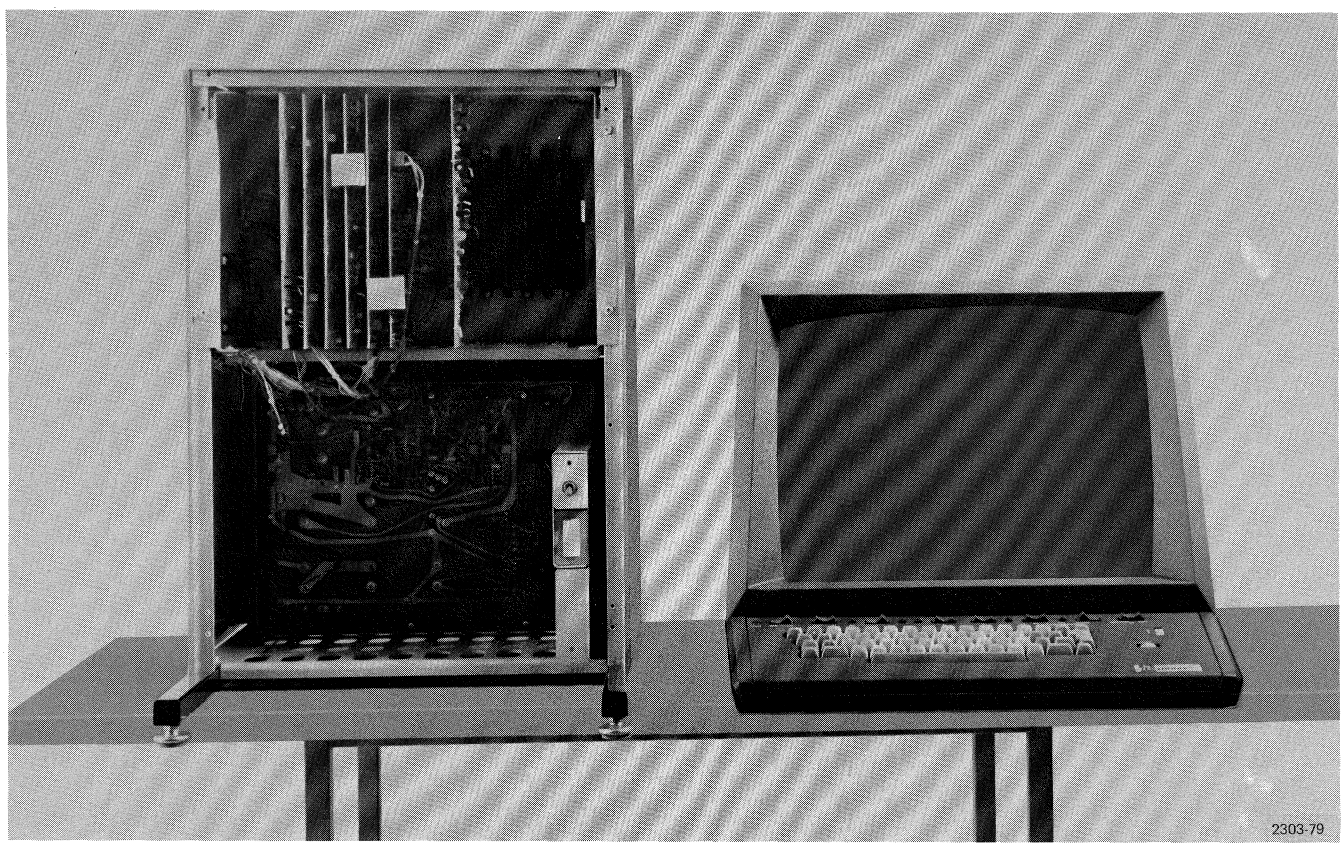


Fig. 4-3. Bench mounting using optional Desk Mounting kit.

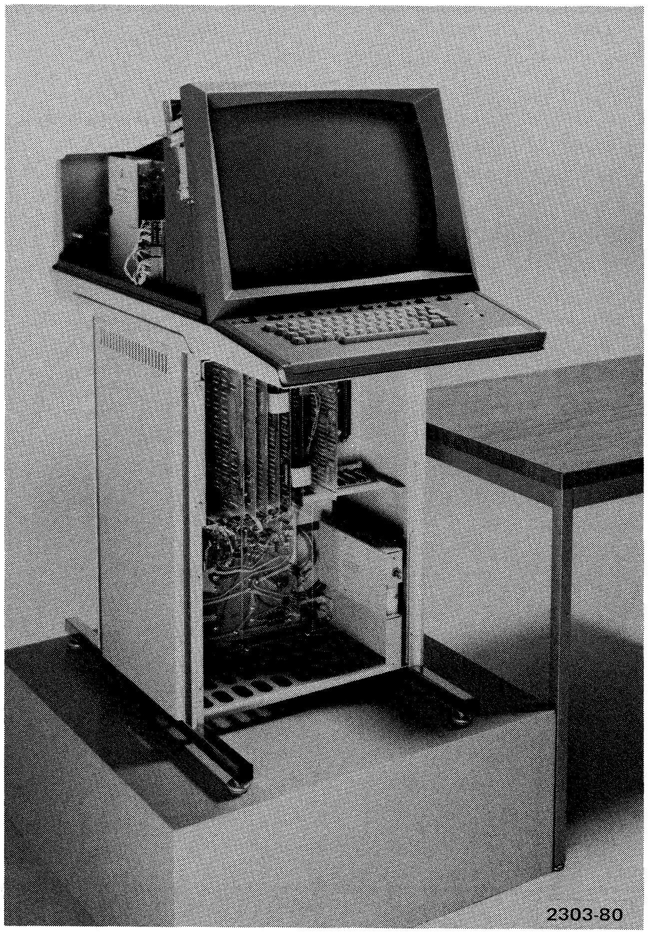


Fig. 4-4. Platform mounting.

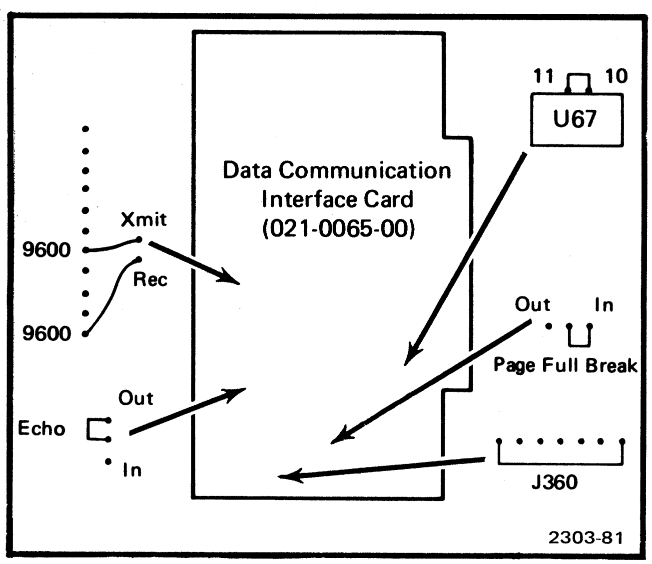


Fig. 4-5. Data Communication Interface (021-0065-00) strappable option and jumper positions for adjusting the terminal.

Record the previous positions for later reference. If the Interface is an Optional Data Communication Interface 021-0074-00, set the selector switch (rear panel) to the LOOP BACK position. Set the TRANSMIT BAUD RATE switch and the RECEIVE BAUD RATE switch both to 9600. Connect the PF BREAK (Page Full) jumper to the IN position. Check against Fig. 4-6. Connect $\overline{\text{T STROBE}}$ to $\overline{\text{C STROBE}}$ either by using an extender card and connecting minibus pin 3 to pin 5, or by using two integrated circuit test clips and connecting U68 pin 6 to U47 pin 9. Install the Interface card in the minibus.

If the Interface is an Optional Data Communication Interface, 021-0074-01 (Fig. 4-7) disconnect J1. Then, connect J1-1 to J1-7 and J1-2 to J1-3. Set the TRANSMIT BAUD RATE switch and the RECEIVE BAUD RATE switch both to 9600. Record strap positions for later reference. Set PF BREAK (Page Full) jumper to the IN position. Set any cut strap that have been changed back to the original conditions. Set CLK to X16. Connect $\overline{\text{C STROBE}}$ to $\overline{\text{T STROBE}}$, either by connecting minibus pin 3 to pin 5 or by shorting the "C" test pad to the "T" test pad (near minibus pin A).

If a TTY Port Interface (4010 Series) is installed, disconnect the Relay Card cables from the J161 and J163 connectors on the Control Card. Record the original positions of any straps that have been changed. Set the card straps as shown in Fig. 4-8. Connect J162 pin 2 to J162 pin 3; connect J161 pin 6 to J162 pin 7. Connect $\overline{\text{T STROBE}}$ to $\overline{\text{C STROBE}}$, either by using an extender card and connecting minibus pin 3 to pin 5, or by using an integrated circuit test clip and connecting J81 pin 3 to U81 pin 6. Install the Interface card in the minibus.

To write a page of characters after modifying the appropriate communication interface, turn on the power; place the Margin Control Switch to the 1 position; erase the screen; place the LOCAL/LINE switch to the LINE position; and enter a character.

To draw vectors, change the character size, or perform any activity other than filling a page with characters, the LOCAL/LINE switch should be in the LOCAL position.

CAUTION

Do not put the Terminal in Graph Mode at any time while the $\overline{\text{T STROBE}}$ to $\overline{\text{C STROBE}}$ strap is connected and the LOCAL/LINE switch is at LINE. Damage to the crt will occur.

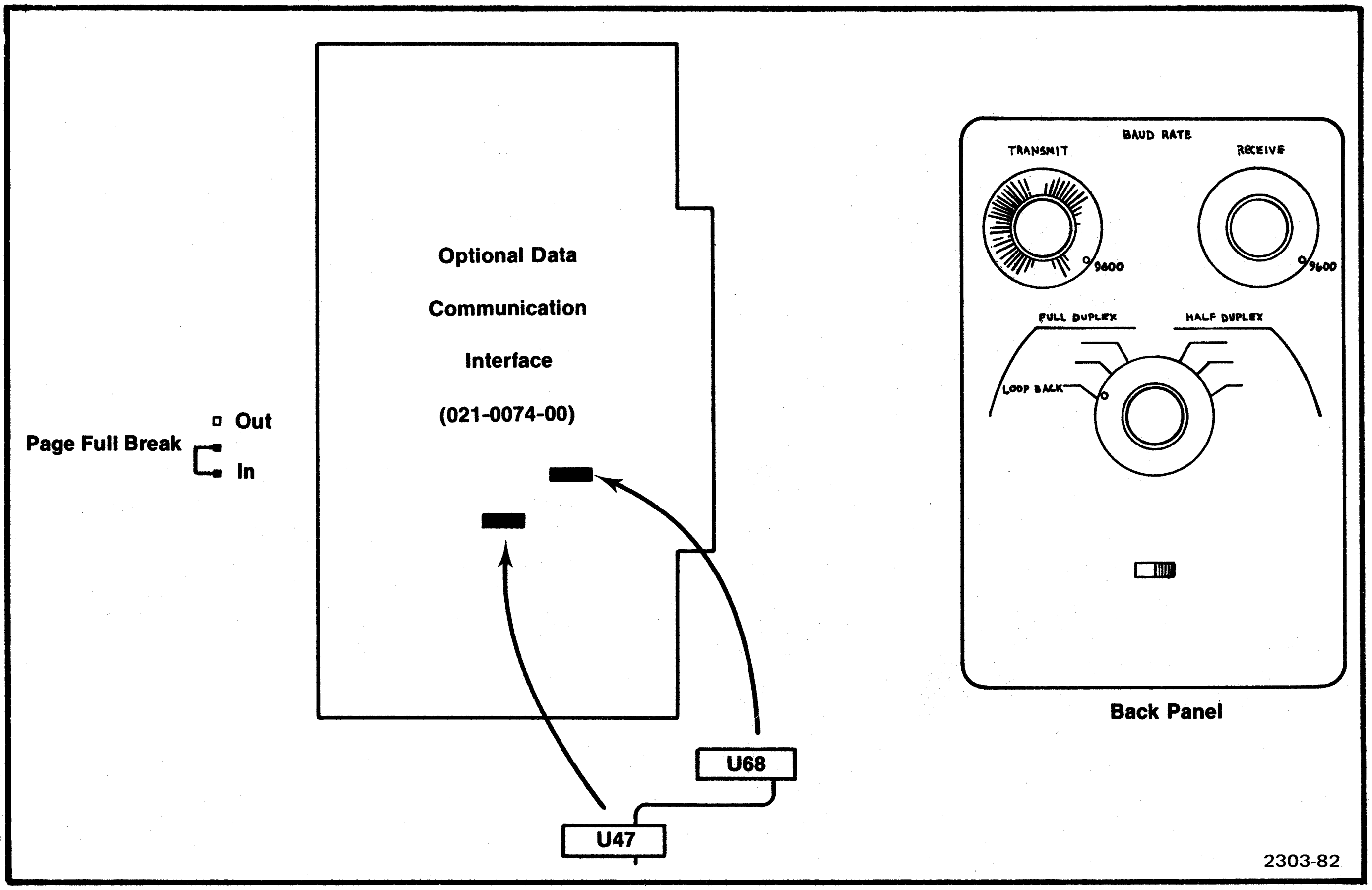
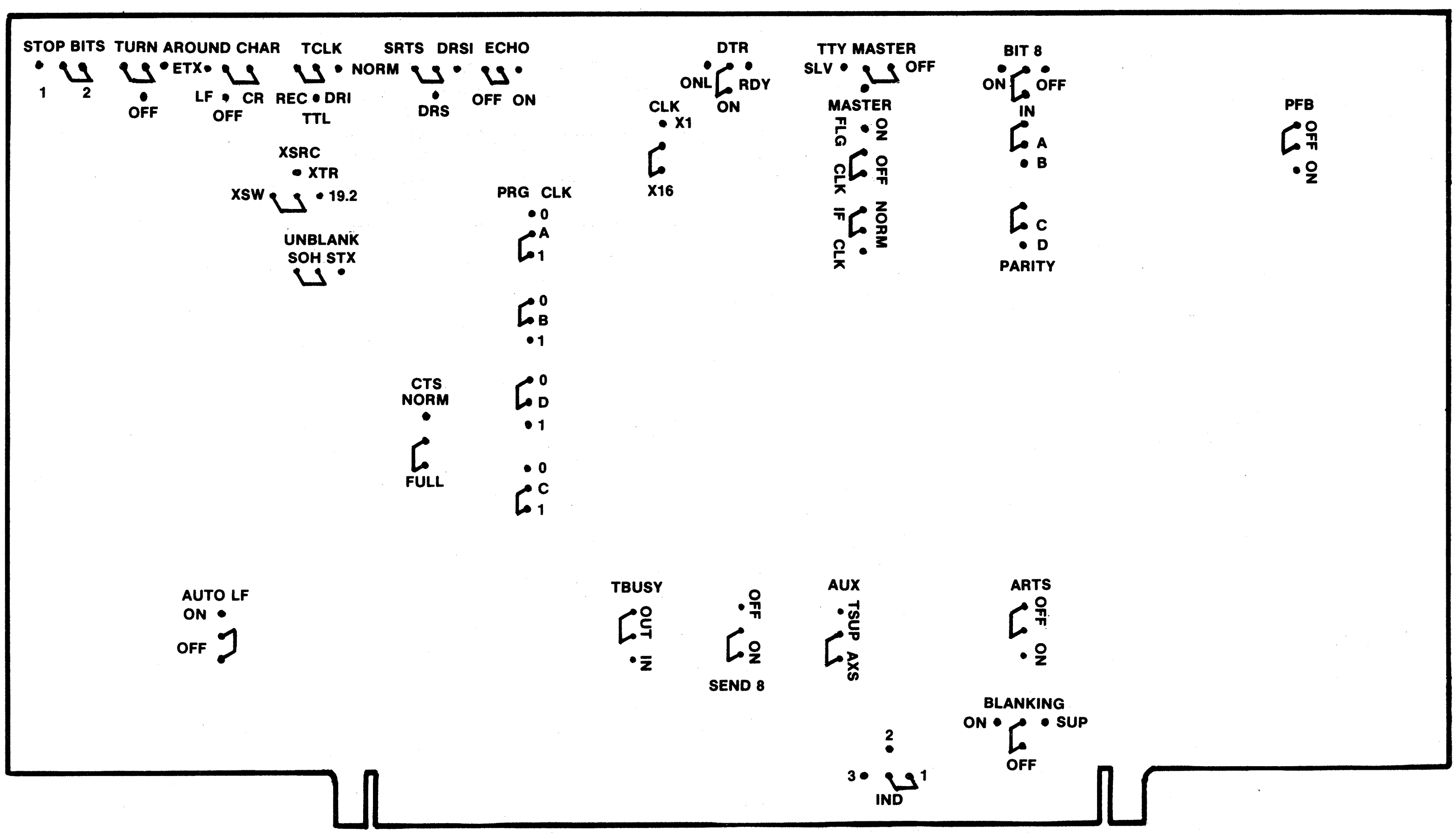
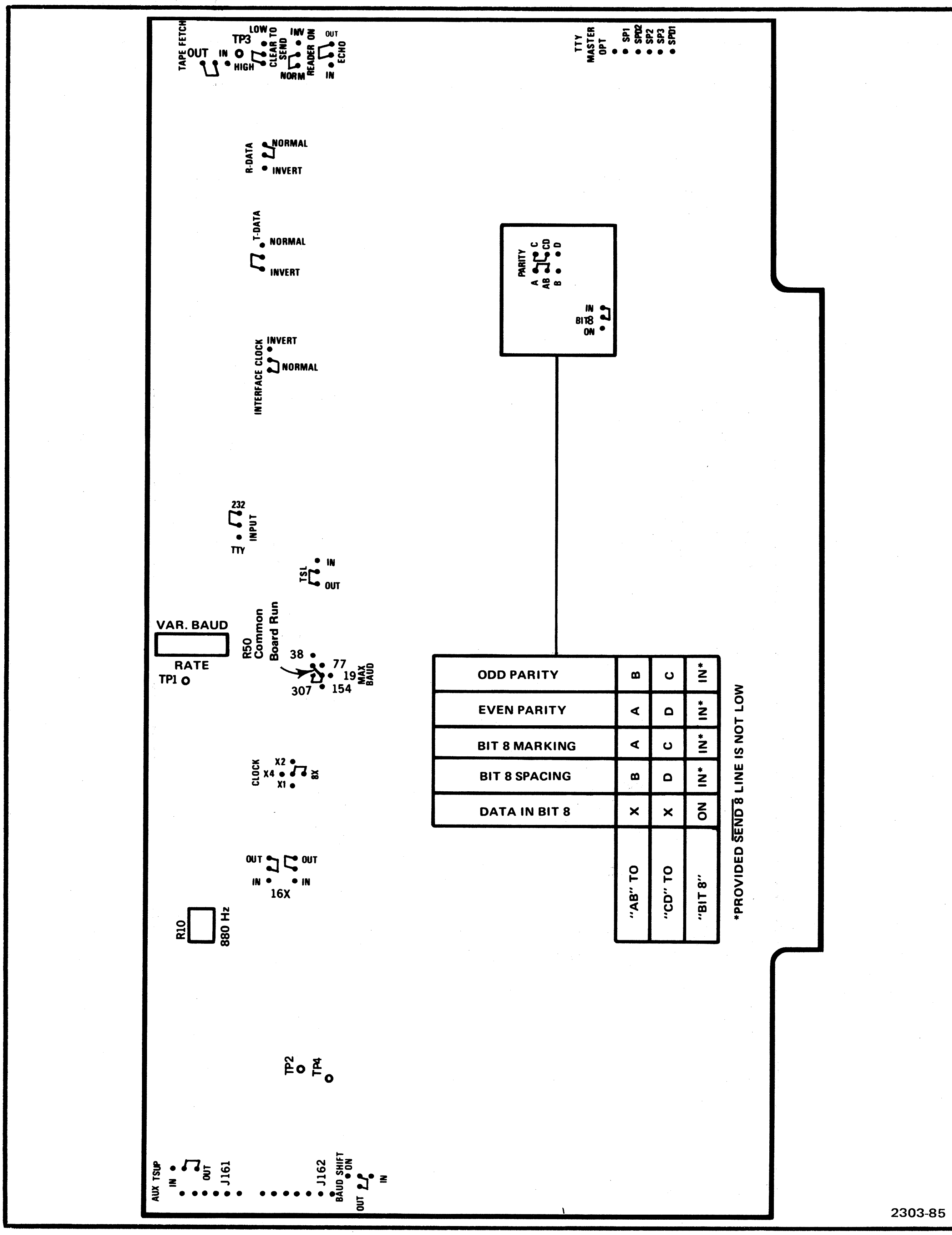


Fig. 4-6. Optional Data Communications Interface (021-0074-00) setting and straps for adjusting the terminal.



2303-84

Fig. 4-7. Optional Data Communications Interface (021-0074-01) strap positions.



	DATA IN BIT 8	BIT 8 SPACING	BIT 8 MARKING	EVEN PARITY	ODD PARITY
"AB" TO	X	B	A	A	B
"CD" TO	X	D	C	D	C
"BIT 8"	ON	IN*	IN*	IN*	IN*

*PROVIDED $\overline{\text{SEND 8}}$ LINE IS NOT LOW

Fig. 4-8. TTY Port Interface strap position for calibrating the Terminal.

@

Power supply preliminary setup: At the lower right corner of the pedestal, remove the shield which covers the switch and transformer terminals (see Fig. 4-9). It is held in place by four screws.

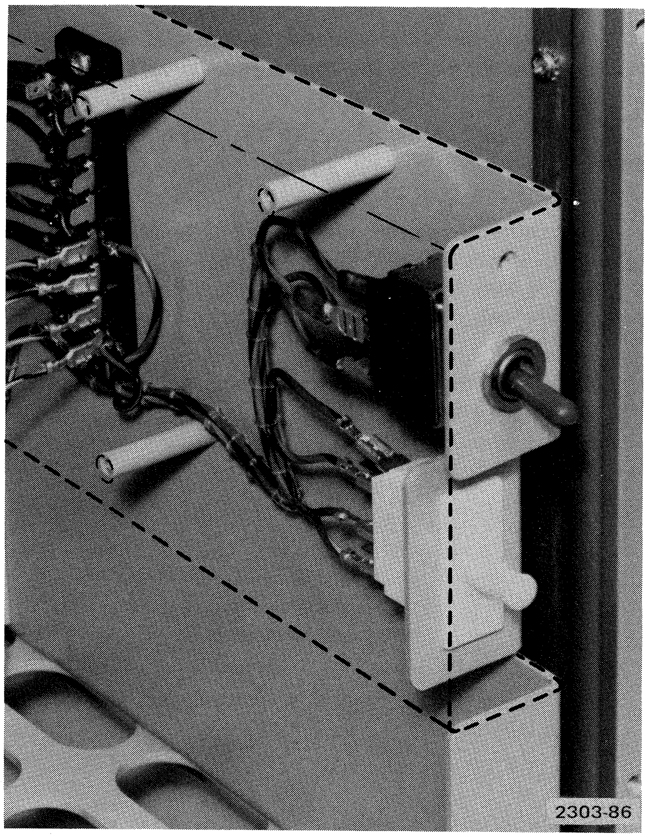


Fig. 4-9. Transformer Terminals and Power Switch Assembly.

Determine for what voltage the transformer is wired by comparing the transformer terminal connections against the jumper arrangement diagram, Fig. 4-10. Set the variable ac power supply to the voltage for which the Terminal is wired. Replace the shield to minimize shock danger.

Remove the plastic shield from the Power Supply Circuits and check the fuses.

List of Fuses

Line Fuse (back of Pedestal)

100-120 V operation	6.25 A Slow Blow
200-240 V operation	3.2 A Slow Blow

Power Supply Circuits

F137	15 A Fast Blow
F161	5 A Fast Blow
F191	5 A Fast Blow
F302	1 A Fast Blow
F371	0.3 A Slow Blow
F386	0.3 A Slow Blow
F490	0.3 A Slow Blow

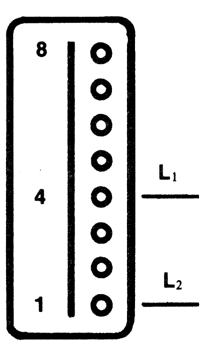
Deflection Amplifier Board

F681	5 A Fast Blow
F685	5 A Fast Blow

Detailed Procedure

1. Low Voltage Power Supply Check/Adjustment (R27, Reg Voltage on Power Supply Board in Pedestal)

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. Also be sure that the fuse size is proper.



LINE CORD ALWAYS ATTACHED TO 1 & 4

JUMPER ARRANGEMENT

VOLTAGE ±10%	100	115	120	200	220	230	240
TERMINAL NO.	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			

2303-96

Fig. 4-10. Transformer Terminals and jumper arrangement.

b. Turn the Terminal Power switch ON and place the LOCAL/LINE switch to LOCAL.

c. Connect the voltmeter reference lead to the ground point (TP207).

NOTE

All voltage measurements in the power supply circuits are to be made with respect to TP207. Test point and component locations can be found by referring to Fig. 4-11.

d. Using a voltmeter accurate to 0.05% at +15 V, adjust R197 for +15 V measured at TP84.

e. Measure the various power supply voltages as listed in Table 4-2. Record all voltages in Table 4-3. (Make duplicate copies of Table 4-3 for future use.) R197 may have to be readjusted to bring the +15 V, +5 V, and −15 V suppies within the specified limits as shown in Table 4-2.

f. Check for +5 V at TP141. This is the +5 V supply voltage returned by sense line from the Terminal control circuits and is used as negative feedback for the +5 V voltage regulator.

g. Using the test oscilloscope, check that ripple voltages do not exceed those values given in Table 4-2. If ripple appears excessive or marginal, move the voltage reference lead to the ground bus at J99 and recheck.

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

i. Measure and record the supply voltages, again using Tables 4-2 and 4-3. Then check the ripple of each supply.

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

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

l. 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 4-3.

m. Set the line voltage to the center voltage for which the transformer is wired.

WARNING

There may still be some residual high voltage at some of the test points and elsewhere in the power supply circuitry.

TABLE 4-2
Power Supply Voltage Limits

Supply	Test Point	Voltage Limits	Ripple (P-P)	Comments
+15 V	TP84	+14.925 to +15.075	10 mV	Adjust R197 for 15.00 V; readjust if necessary to compromise so that +15, +5, and −15 V supplies are all within limits with line voltages at mid-positions as well as at high and low limit.
+5 V	TP31	+4.9 to +5.1	10 mV	
−15 V	TP83	−14.850 to −15.150	10 mV	
+290 V	TP391	+287.1 to +292.9	10 mV	Developed on Storage Board
+490 V	TP392	+413 to +527	8 V	Unregulated
+350 V	TP494	+304 to +386	6 V	Supplies—
+175 V	TP491	+154 to +196	6 V	non-adjustable
+20 V	TP85	+20 to +25.2	1.5 V	
−20 V	TP82	−20 to −25.2	1.5 V	
+7 V	J96-1	+7 to +10.5	1.5 V	
−7 V	J95-1	−7 to −10.5	1.5 V	

TABLE 4-3

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%
+290 V						1.0%
+490 V				NOT APPLICABLE		
+350 V						
+175 V						
+20 V						
−20 V						
+7 V						
−7 V						

2. +5 V Over-Voltage Crowbar Adjustment (R191 on the Power Supply)

a. Using a voltmeter with 0.1% accuracy at 5 V, adjust R191 for +4.67 V measured at the junction of R55 and C141.

b. Recheck the +5 V supply voltage at TP83.

c. Turn off the power and replace the plastic shield over the Power Supply circuits.

3. Flood Gun Filament Voltage Check/Adjustment

a. Remove the cover from the Display Unit, if not previously removed. It is fastened with six screws, three on each side.

b. Place voltmeter probes on TP71 and TP75 (on the Storage board) to measure a voltage difference of 26.8 V dc between the test points (refer to Fig. 4-12).

c. Adjust R190 on the Power Supply circuits for a voltage reading of 26.8 V (see Fig. 4-11).

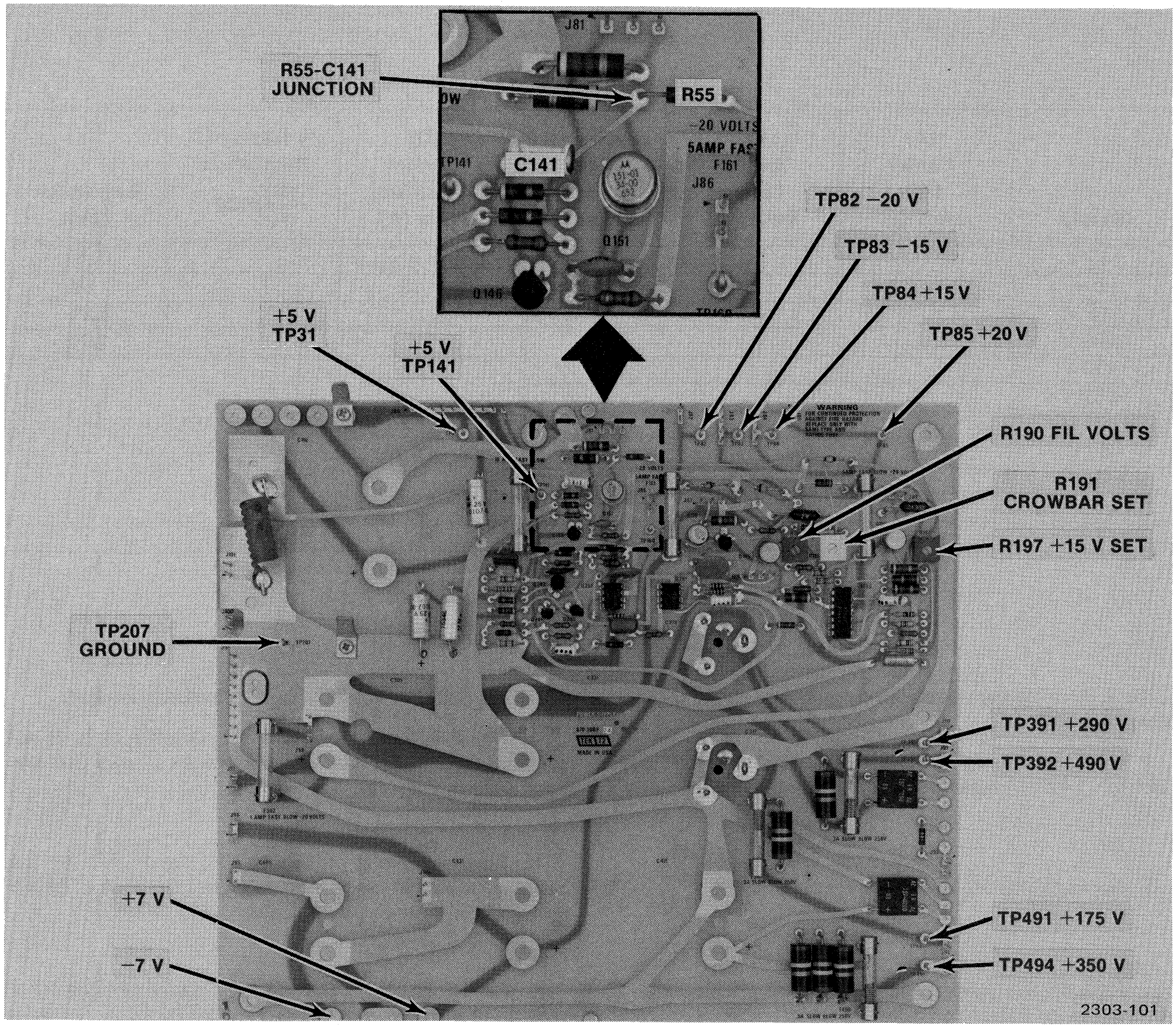


Fig. 4-11. Low-Voltage Power Supply test and adjustment locations.

4. +290 V Check/Adjustment (R411 on the Storage Board)

a. Using a voltmeter set to measure 300 V with an accuracy of 1%, adjust R411 for +290 V measured at TP550 with respect to the ground point. See Fig. 4-12 for locations.

b. Recheck the voltage of the +490 V unregulated supply if major adjustment of the +290 V supply was necessary.

5. High Voltage Check/Adjustment (R341 on the High Voltage and Z Axis Board)

a. Turn off the power switch (on front of Pedestal).

b. Using a high voltage voltmeter with 1% accuracy set to read −6000 V dc, place the negative probe on TP61 and the positive probe on the chassis for ground. Refer to Fig. 4-13.

c. Turn on the power and adjust R341 (H.V.) for −5950 V dc at TP61.

d. Turn off the power and remove the probes.

WARNING

Be careful of residual voltages when removing probes.

6. Preadjust Cursor Intensity and Focus. Adjust Writing Intensity (Alpha Cursor Intensity on Display Control Card in Pedestal; Focus Adjust and Writing Intensity on High Voltage and Z Axis Board in Display Unit).

a. Turn the Terminal on and after approximately one minute, press the PAGE key to initiate an erase cycle.

b. 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.

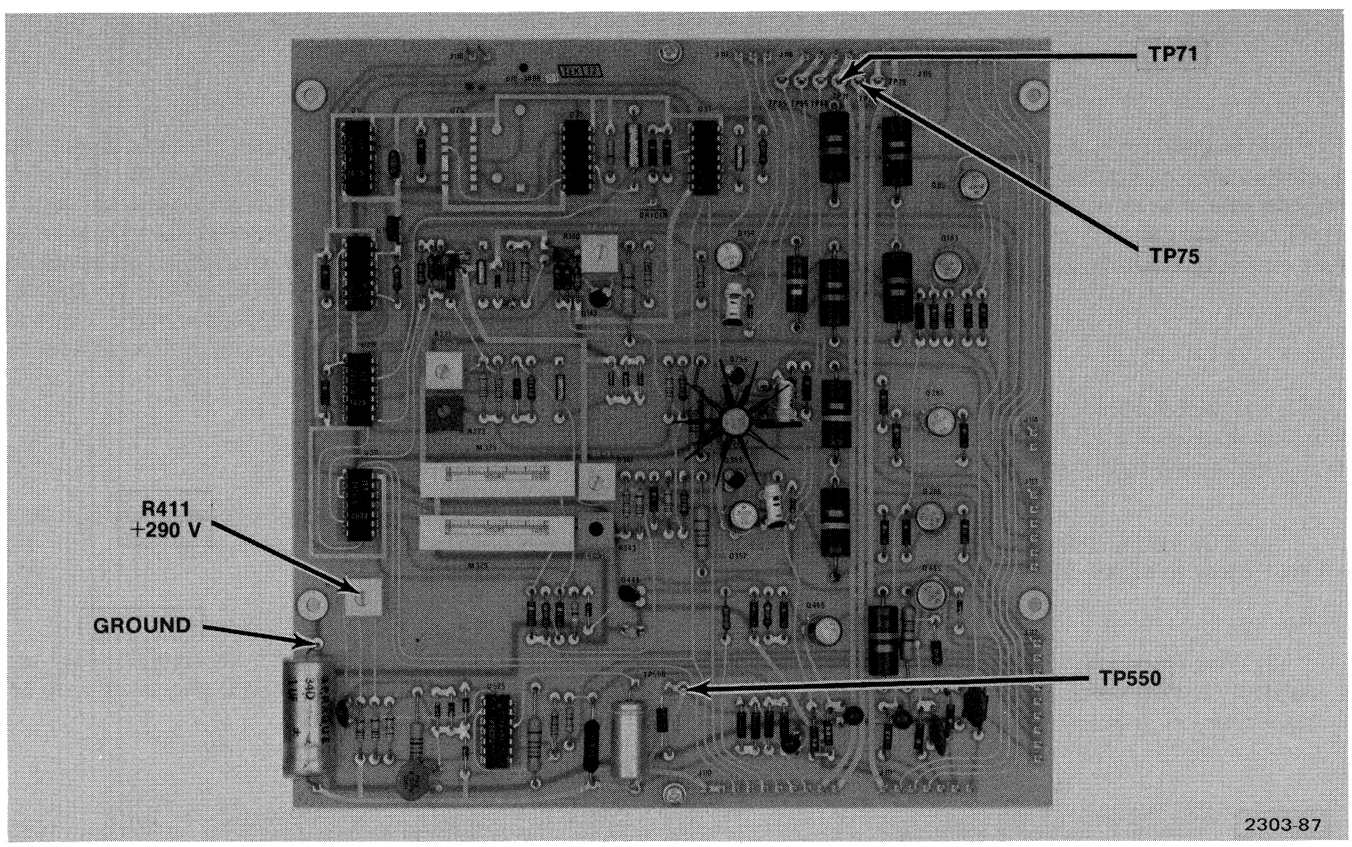


Fig. 4-12. Storage Board showing Flood Gun Filament test points and +290 V adjustment.

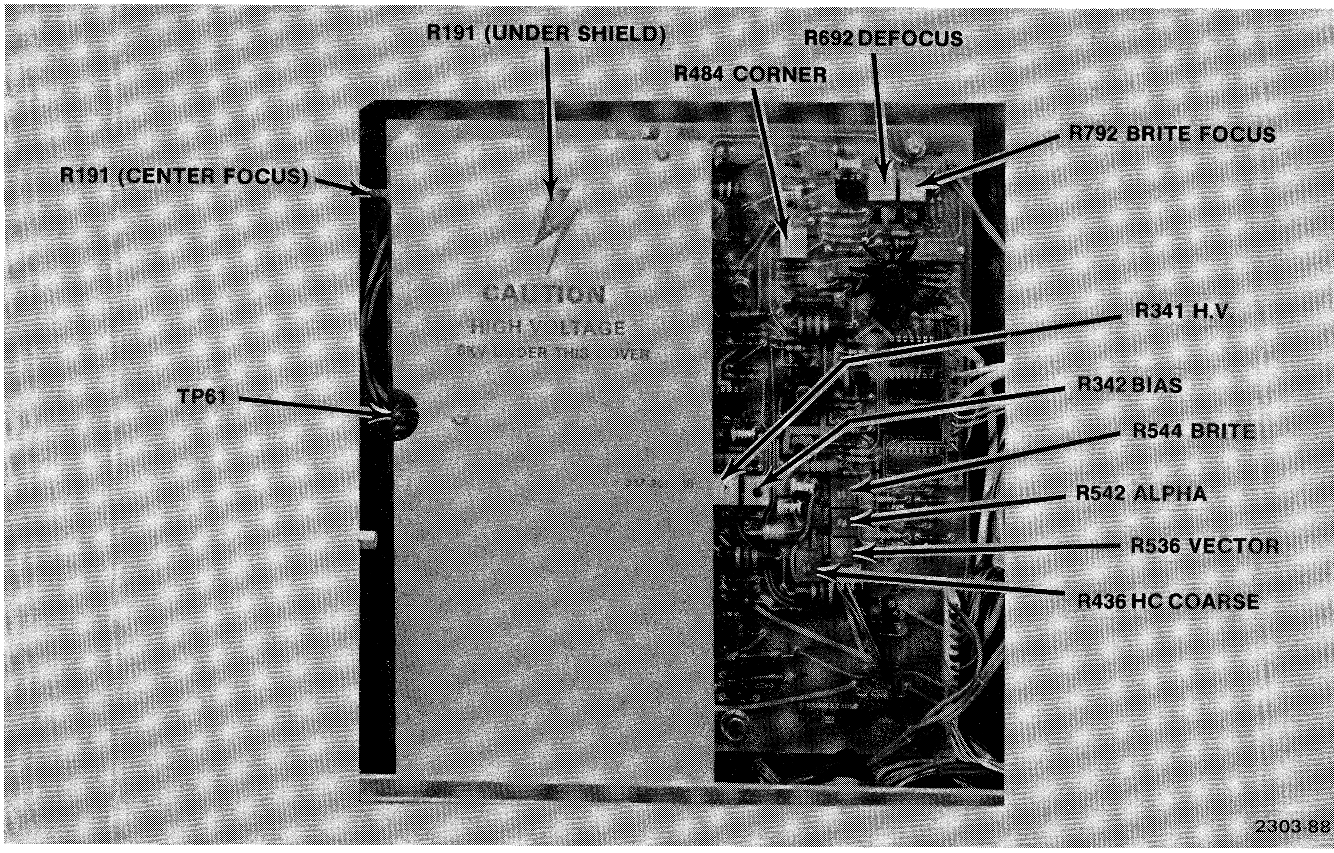


Fig. 4-13. High voltage adjustments.

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. 4-17), turn the OP LEV (on the Storage Board, Fig. 4-16) fully counterclockwise. (OP LEV will be adjusted in a later step.)

d. The alpha cursor should be visible in the Home position (upper left of display). Absence of the cursor could be caused by a number of things.

(1) The Terminal may be in Hold Status. Press the SHIFT key to regain View Status.

(2) The Cursor Intensity adjustment, R31, on the display Control card may be set too low. Turn it clockwise to increase cursor intensity. (Fig. 4-14).

(3) The Deflection Amplifier circuits could be maladjusted causing the cursor to be beyond the top or left of the screen. Entering SPACE commands and LF commands at the keyboard should cause the cursor to appear. If it does, refer to corrective adjustments pertaining to the GAIN and POSITION on the Deflection Amplifier Board (R56, R92, R270, and R273) and adjust as necessary to bring the cursor into view when at the home position..

(4) There could be an absence of High Voltage. See the High Voltage Check/Adjustment.

(5) The ALPHA INTENSITY adjustment R542 on the High Voltage and Z Axis Board (Fig. 4-13) may be set too low. Turn it clockwise.

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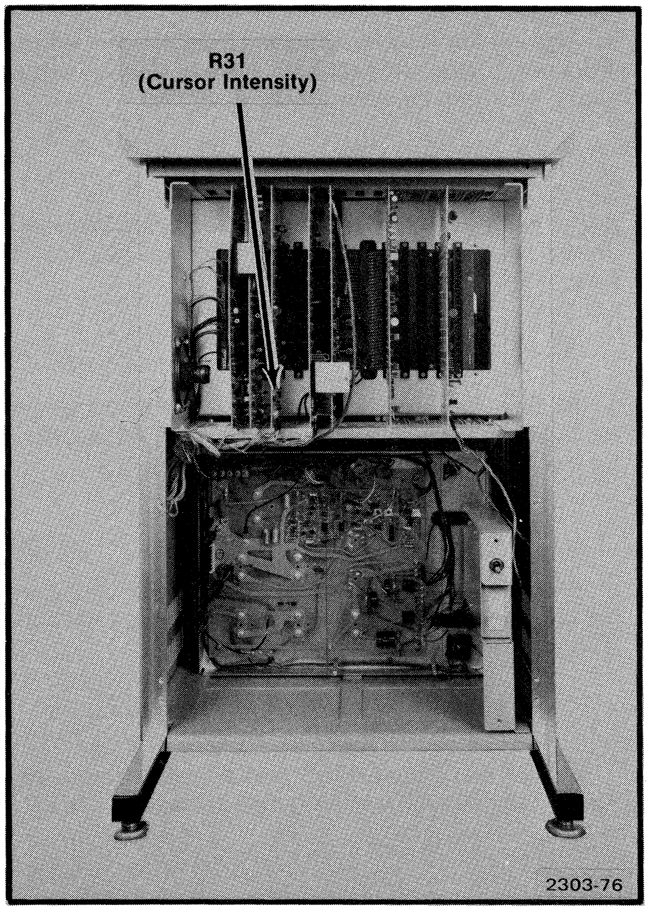


Fig. 4-14. Pedestal circuit card information.

Before proceeding with the next step, reset the Terminal for Large Character size.

(6) The BIAS adjustment, R342, on the High Voltage and Z Axis board (Fig. 4-13) may be set too low. Turn R342 clockwise while looking at the screen to prevent inadvertent burning of the crt phosphors.

(7) The Storage Circuits could be maladjusted.

e. With the cursor at the home position, press PAGE and check for the momentary appearance of a dot at the bottom-left corner of the cursor. The dot may appear just before the cursor comes back into view. Adjust R342 (BIAS) until no spot shows in the bottom left corner of the cursor while erasing the display (before the cursor becomes visible). To adjust, bring the spot into view with the adjustment; then increase the bias until it no longer appears. Refer to Fig. 4-15.

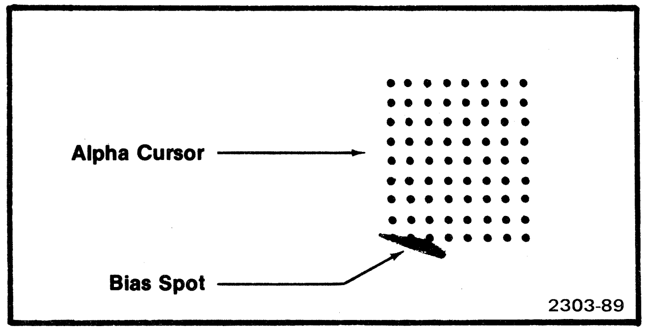


Fig. 4-15. Alpha Cursor and Bias Spot.

f. Position the cursor to center screen by entering 37 SPACE commands and 17 LF commands.

g. Adjust R21 on the Display Control card (Fig. 4-14) until the cursor is at minimum brightness consistant with good viewing. (Final intensity will be done later in the procedure.)

h. On the High Voltage and Z Axis board adjust R191 (CENTER focus) to obtain a reasonably focused cursor. R191 adjustment is made available by an opening in the back panel of the Display Unit. (See Fig. 4-13).

i. 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, readjust R31 (on the Display Control Card) 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 thumbwheel to check for storing.

j. Press PAGE. With the cursor at the home position, adjust R484 (CORNER focus) to obtain a reasonably focused cursor. (Final focusing will be done later in the procedure.)

7. Storage Check/Adjustment (OP LEV, CE-1, CE-2 on Storage Board)

a. Perform the checks in this Step (7a) for adjusting a Terminal in which the crt has not been changed.

(1) Note the Operating Level voltage value written on the tag attached to the top surface of the crt shield in the display unit. Check for that value at TP65 on the Storage board (Fig. 4-16), with the Terminal in View Status. (Press SHIFT to regain View Status.)

(2) Adjust R140 (OP LEV) to obtain that value at TP65.

(3) Note the value for Collimination 1 (CE-1) on the tag. Adjust R341 (CE-1) to obtain that value at TP68.

(4) Note the value for Collimination 2 (CE-2) on the tag. Adjust R221 (CE-2) to obtain that value at TP66.

(5) Put the LOCAL/LINE switch at LINE and the Margin Control switch at 1, then go to Part c of Step 7.

b. Perform this step for adjusting a Terminal in which new operating voltages for the crt storage electrodes are required, and for adjusting replacement crts.

(1) Note the initial voltage value for Operation Level on the tag supplied with the replacement crt. Adjust R140 (OP LEV) for that value at TP65.

(2) Note the initial voltage value for CE-1 written on the tag supplied with the replacement crt. Adjust R341 for that value at TP68.

(3) Note the initial voltage value for CE-2 written on the tag supplied with the replacement crt. Adjust R221 (CE-2) for that value at TP66.

(4) Put the LOCAL/LINE switch at LINE and the Margin Control switch at 1, then go to Part c of Step 7.

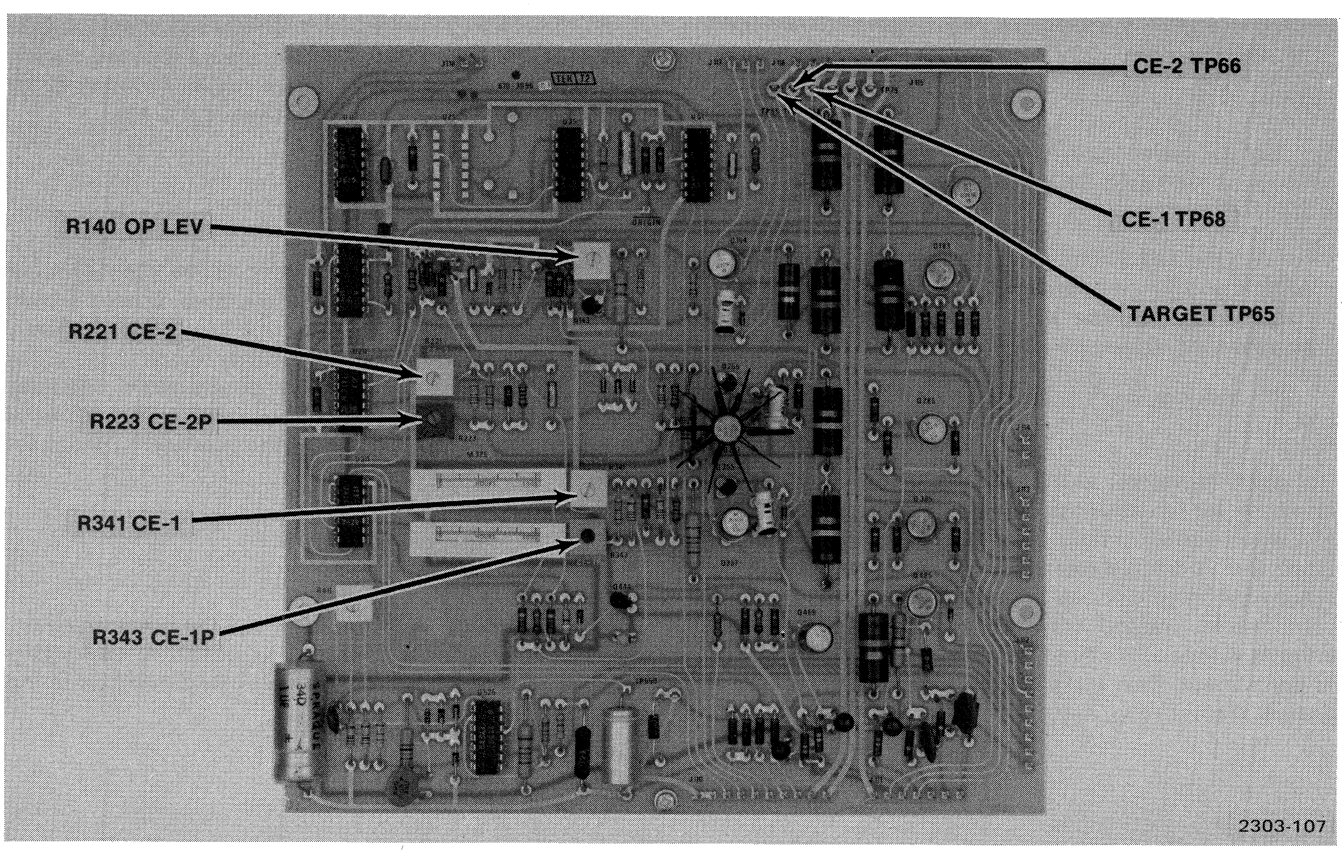


Fig. 4-16. Storage Board adjustment locations.

c. For checkout of the above adjustments and for optimizing the storage adjustments, procede with the following.

(1) With the LOCAL/LINE switch at LINE and the Margin Control switch at 1, press the 8 key. The display should fill with 8s. Wait approximately 5 minutes and view the display, checking for fade-positive or drop-out conditions. (Fig. 4-17 shows these conditions.) If either of these conditions occur, continue with the following.

NOTE

The following parts of this adjustment/check can best be done in a dimly lit room, or at minimum, use a crt shield over the display to cut down on glare.

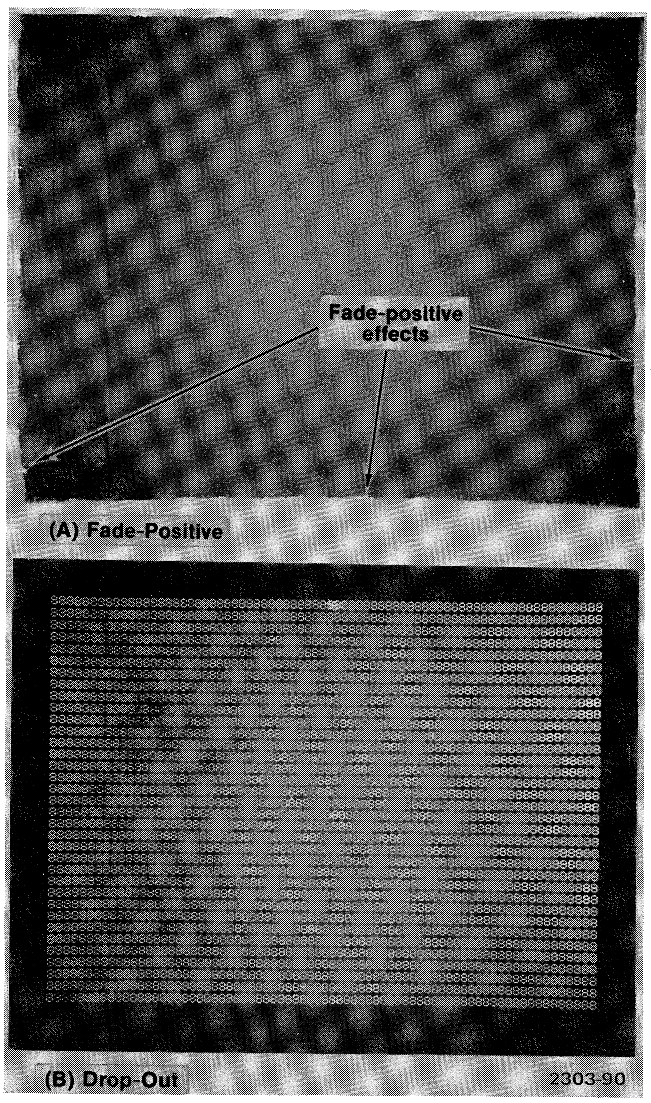


Fig. 4-17. Display conditions.

(2) Erase the screen and see if it fades-positive. (See Fig. 4-17A.) Using R140 (OP LEV) and measuring the Target voltage at TP65, increase the Target voltage in 10 volt increments, erasing after each increment, until the screen just begins to fade-positive.

(3) Decrease the Operation Voltage by 15 V. Record for future reference. It may be readjusted later.

(4) Turn R140 (OP LEV) clockwise all the way to write the screen completely up, then counterclockwise back to the operating voltage recorded in Step 3.

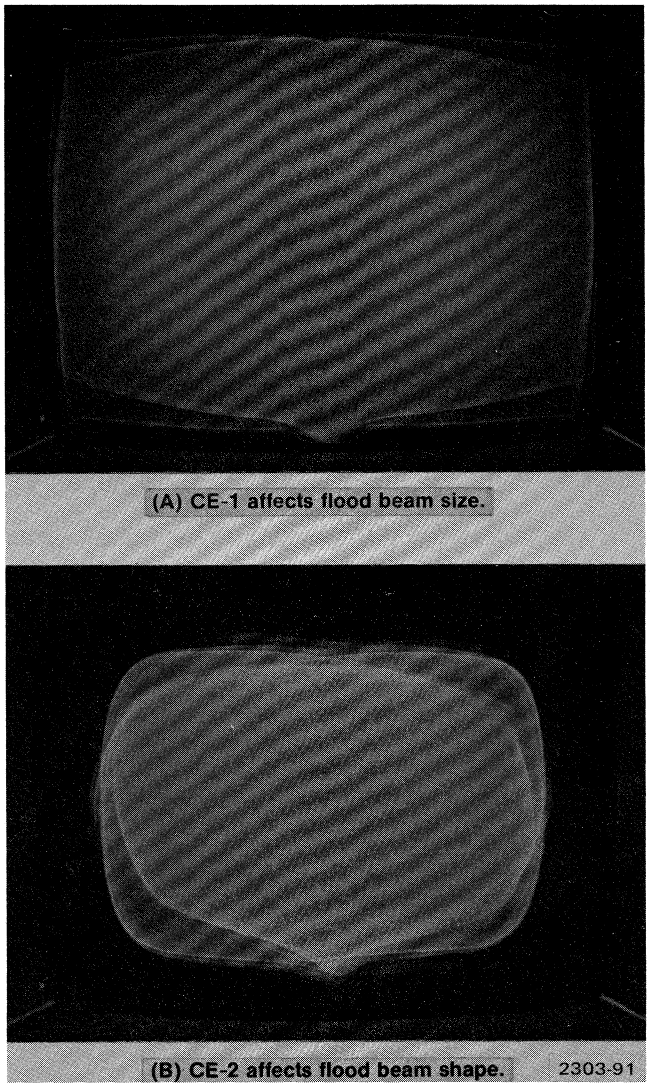
(5) Adjust R341 (CE-1) and R221 (CE-2), while looking at the display, to obtain a consistent flood beam coverage over the entire screen surface. (Fig. 4-18A and B illustrate the effects of the CE-1 and CE-2 voltages. Try to match the perimeter of the flood beam to the edge of the screen if possible. Do not sacrifice even screen intensity to obtain a perfect fit. An oscillating display intensity indicates a maladjustment, usually of R341 (CE-1).

(6) Erase the screen and perform fine adjustments on R341 (CE-1) and R221 (CE-2) to obtain even flood beam coverage over the crt screen, erasing the screen after each increment of adjustment.

(7) Observe the overall brightness and uniformity of the screen. This is controlled to a great extent by the CE-1 and CE-2 adjustments. These affect uniformity of storing, drop-out, focus, and hard copy. If the overall screen brightness appears too uneven, CE-1 and CE-2 can be experimented with to achieve better results.

(8) Once again fill the display with 8s, wait 5 minutes and check for fade-positive or drop-out conditions. If fade-positive occurs, adjust the OP LEV in 5 volt negative increments and repeat the check. If drop-out occurs, adjust in 5 volt positive 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. The fade-positive areas will age to conform to the drop-out areas if given enough time.)

d. Upon completion of Step c, measure the voltage at TP65 and write the value opposite OPERATION LEVEL on the tag on the crt shield. . .cross out the old value.



(A) CE-1 affects flood beam size.

(B) CE-2 affects flood beam shape.

Fig. 4-18. Flood beam adjustment effects.

e. Record the selected voltages for CE-1 and CE-2 (at TP68 and TP66, respectively) on the tag attached to the crt shield. If the crt has not been replaced, do not obliterate the old voltage values. Simply draw a line through them and write the new value alongside. The new value will not differ greatly from the old one. If the case of a replacement crt, obliterate the old value and write in the new one. The new voltages normally will not differ greatly from that supplied with the crt.

f. Place the LOCAL/LINE switch back to LOCAL, and remove the $\overline{\text{T STROBE}}$ — $\overline{\text{C STROBE}}$ jumper installed in the preliminary procedure.

8. Erase Check/Adjustment (R223 and R343 on the Storage Board)

a. While erasing the screen, a bright flash appears. R223 (CE-2P) controls its shape and R343 (CE-1P) controls its size. While looking at the display and erasing the screen, adjust R223 and R343 to obtain consistent erase beam coverage over the entire screen surface. See Fig. 4-16 for adjustment locations. Try to match the perimeter of the erase beam to the edge of the screen if possible.

9. Geometry Correction and Dynamic Focus Multipliers Adjustments on the Deflection Amplifier Board

These nine adjustments (see Fig. 4-19 for locations) are factory set and should not be moved. The settings require a special precision square wave generator. These adjustments compensate for operational discrepancies in the analog multiplier integrated circuits (U5, U105, U115, and U215) in the Geometry Correction and Dynamic Focus circuitry. If there is reason to reset these adjustments (i.e. an analog multiplier is replaced by someone other than authorized Tektronix service personnel) the following procedure is used. Otherwise go to Step 10 (Yoke Adjustment for Display Rotation.)

Equipment Needed:

Laboratory oscilloscope, with a vertical sensitivity of 50 mV/div. or better.

Square wave generator. Single output, ±5 V (±5%) on either side of a reference voltage (namely signal ground). The waveform is to be centered to a tolerance of 0.25%. Frequency is not critical, preferably 5 kHz or less.

Ramp generator (optional). Output, a ramp from −5 V to +5 V. Frequency is not critical, preferably 5 kHz or less.

Circuit connector. A two-position square-pin connector to be used with the signal generators.

NOTE

For this section, voltage measurements are made with an oscilloscope referenced to signal ground (signal ground can be obtained on Pin 1 of J52 on the CAL side). All Test points, jumper straps, and adjustments are found on the Deflection Amplifer Board.

a. R4 Adjustment Procedure:

(1) Set the oscilloscope for an ac input signal with a vertical sensitivity of 50 mV/div.

(2) Connect the oscilloscope probe to TP35.

(3) Put the J54 jumper to the CAL position.

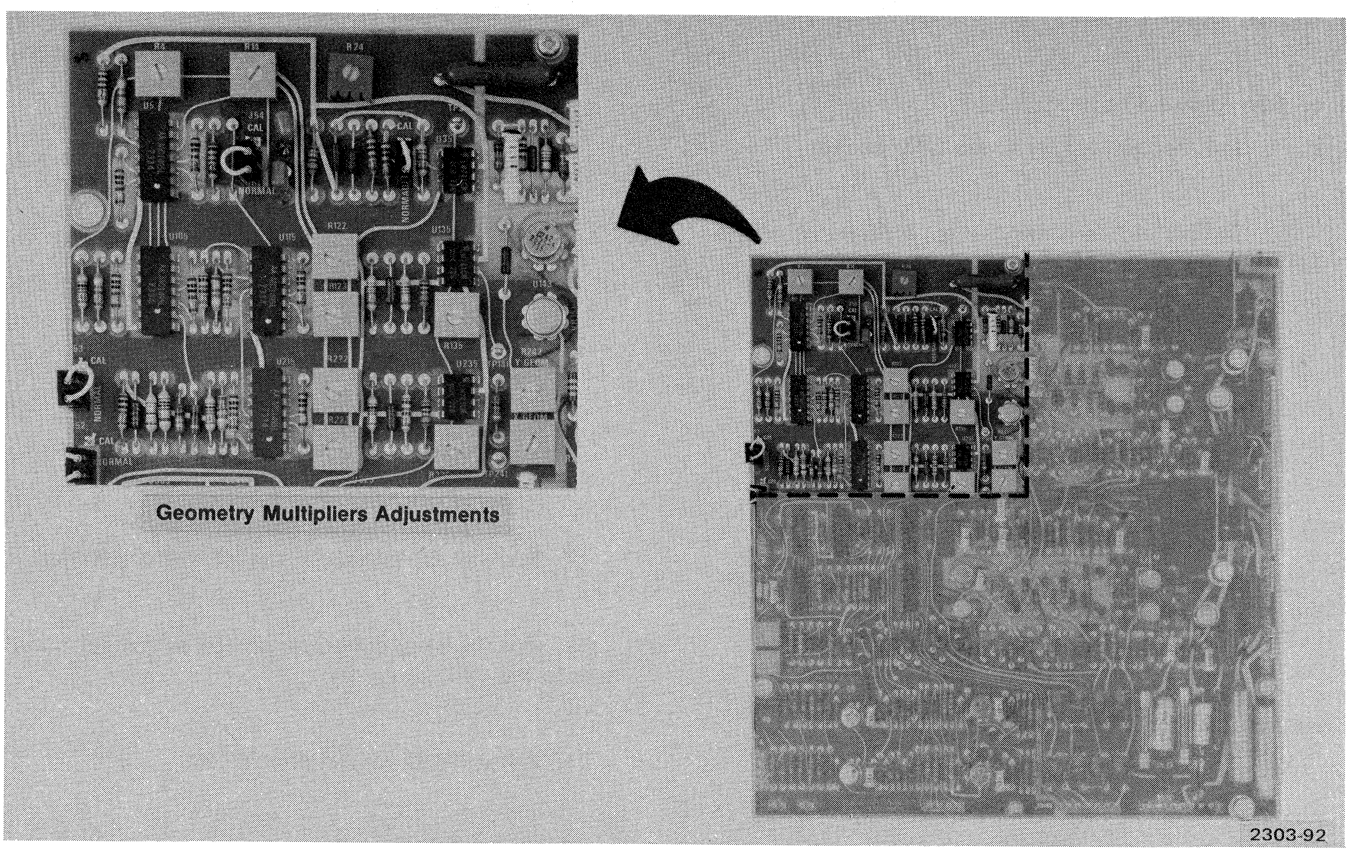


Fig. 4-19. Geometry Multipliers adjustment locations.

(4) Remove the J53 jumper, with the ground lead of the square wave generator on pin 1 (CAL) of J53, feed a +5 V and −5 V square wave from the signal generator into J53-2.

(5) Be sure the generator is set for square-wave output.

(6) Adjust R4 for a null at TP35.

(7) Remove the square wave generator plug from J53.

b. R14 Adjustment Procedure:

(1) Put the J53 jumper to the CAL position.

(2) Remove J54. Put the square wave generator plug on J54-2 with the ground lead to the CAL side.

(3) Adjust R14 for a null at TP35.

(4) Remove the square wave generator plug.

c. R24 Adjustment Procedure:

(1) Put the J54 jumper to the CAL position.

(2) Switch the oscilloscope for a dc input with a vertical sensitivity of 50 mV/div.

(3) Adjust R24 for zero volts at TP35.

d. R123 Adjustment Procedure:

(1) Put the J55 jumper to the CAL position.

(2) Connect the ±5 V ramp generator to J54 with the ground lead to the CAL side.

(3) Switch the oscilloscope to ac input with a vertical sensitivity of 50 mV/div.

(4) Connect the oscilloscope probe to TP141.

(5) Adjust R123 for a null at TP141.

(6) Remove the signal generator.

e. R122 Adjustment Procedure:

(1) Put the J54 jumper to the CAL position.

(2) Put the ramp generator on J53 with the ground lead to the CAL side.

(3) Put the J55 jumper to the NORMAL position.

(4) Adjust R122 for a null at TP141.

f. R135 Adjustment Procedure:

(1) Switch the oscilloscope for a dc input with a vertical sensitivity of 50 mV/div.

(2) Put the J55 jumper to the CAL position.

(3) Adjust R135 for zero volts at TP141.

g. R223 Adjustment Procedure:

(1) Switch the oscilloscope for an ac input with a vertical sensitivity of 50 mV/div.

(2) Put the oscilloscope probe on TP241.

(3) Adjust R223 for a null at TP241.

(4) Remove the ramp generator from J53.

h. R222 Adjustment Procedure:

(1) Put the J53 jumper to the CAL position.

(2) Put the J55 jumper to the NORMAL position.

(3) Put the ramp generator on J54 with the ground lead to the CAL side.

(4) Adjust R222 for a null at TP241.

i. R235 Adjustment Procedure:

(1) Put the J55 jumper to the CAL position.

(2) Switch the oscilloscope for a dc input with a vertical sensitivity of 50 mV/div.

(3) Adjust R235 for zero volts at TP241.

j. Restore NORMAL conditions:

(1) Remove the oscilloscope and signal generator from the circuits.

(2) Return J53, J54, and J55 jumpers to their NORMAL position.

10. Yoke Adjustment for Display Rotation

a. Turn off the power.

b. Remove the top metal shield covering the neck of the crt and Deflection Yoke assembly. It is secured by six screws.

c. Loosen (do not remove) the single knurled nut allowing rotation of the Deflection Yoke mounting assembly (see Fig. 4-20).

WARNING

Excessive pressure on the neck of the crt may cause it to implode.

d. Turn on the power.

e. Obtain the crosshair cursor by entering the GIN Mode. The Terminal must be in LOCAL. Keyboard entry is (ESC CRTL Z).

f. Rotate the Deflection Yoke to correct for display rotation.

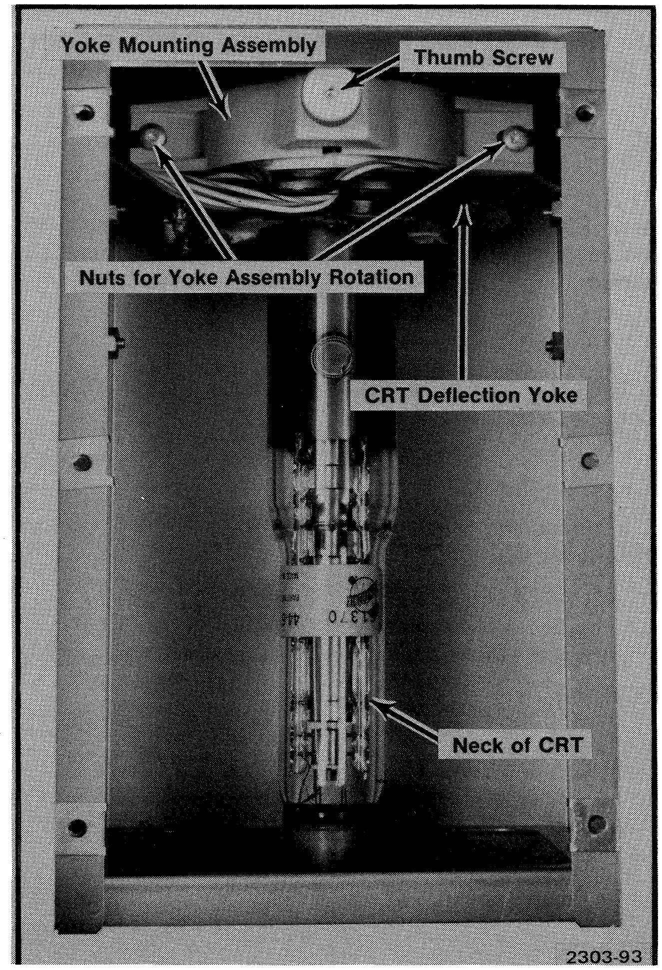


Fig. 4-20. Deflection Yoke Assembly.

g. Turn off the power.

h. Using your thumb, tighten the knurled nut on the crt Deflection Yoke assembly and recheck display rotation.

i. Replace the top metal shield over the neck of the crt. Secure it with six screws.

11. Preliminary Page Size Adjustments (X POS, X GAIN, Y POS, and Y GAIN on the Deflection Amplifier Board)

a. Turn on the power.

b. Place the Terminal in the GIN Mode by entering via the keyboard ESC CTRL Z and obtaining the crosshair cursor.

Cursor intensity is adjusted by R31 on the Display Control Card in the Pedestal.

c. Place the vertical thumbwheel in the top position and the horizontal thumbwheel to midrange.

d. Refer to Fig. 4-21 for deflection adjustment locations.

e. Adjust X POS, X GAIN, Y POS, and Y GAIN on the Deflection Amplifier board to obtain the crosshairs and the approximate margins as illustrated in Fig. 4-22. R270 (X POS) centers the displayed page on the horizontal axis. R273 (X GAIN) determines the page width. R56 (Y POS) centers the displayed page on the vertical axis. R92 (Y GAIN) determines the page height. The crosshair lines may not be straight if the geometry correction needs adjustment.

f. Erase the screen by pressing the PAGE/RESET key.

12. Vector Linearity Check/Adjustment (X GEOM and Y GEOM on the Deflection Amplifier Board)

a. Place the Terminal in GIN Mode by entering ESC CTRL Z via the keyboard, thereby obtaining the crosshair cursor.

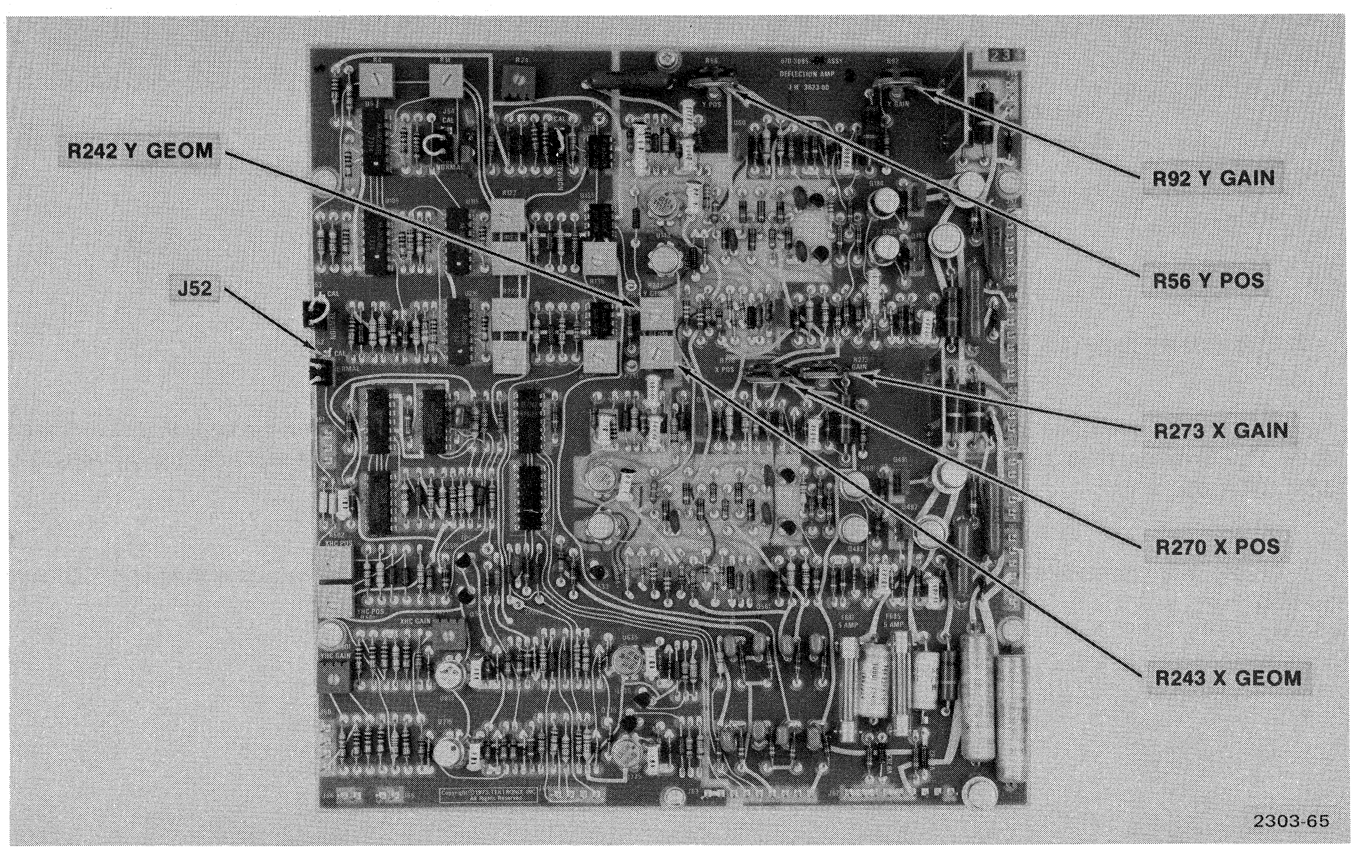


Fig. 4-21. Deflection Adjustments.

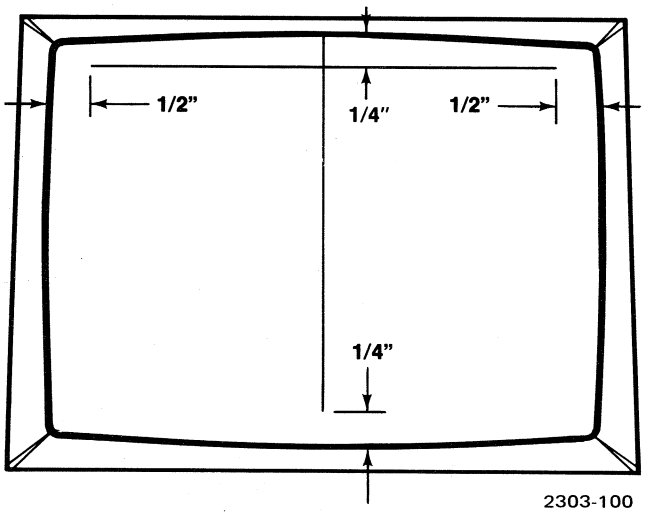


Fig. 4-22. Margins.

b. Adjust R242, Y GEOM, (Fig. 4-22) to obtain a straight, horizontal line with respect to the top edge of the screen. Move the horizontal line to the bottom of the screen and recheck its linearity. The horizontal line may disappear from the bottom of the screen causing the vertical line to increase in intensity.

c. Move the vertical line to a side edge and adjust R243, X GEOM, (Fig. 4-22) to obtain a straight line. The vertical line may disappear from the edge of the screen causing the horizontal line to increase in intensity. Move the vertical line to the other side and recheck its linearity.

d. Erase the screen by pressing the PAGE/RESET key.

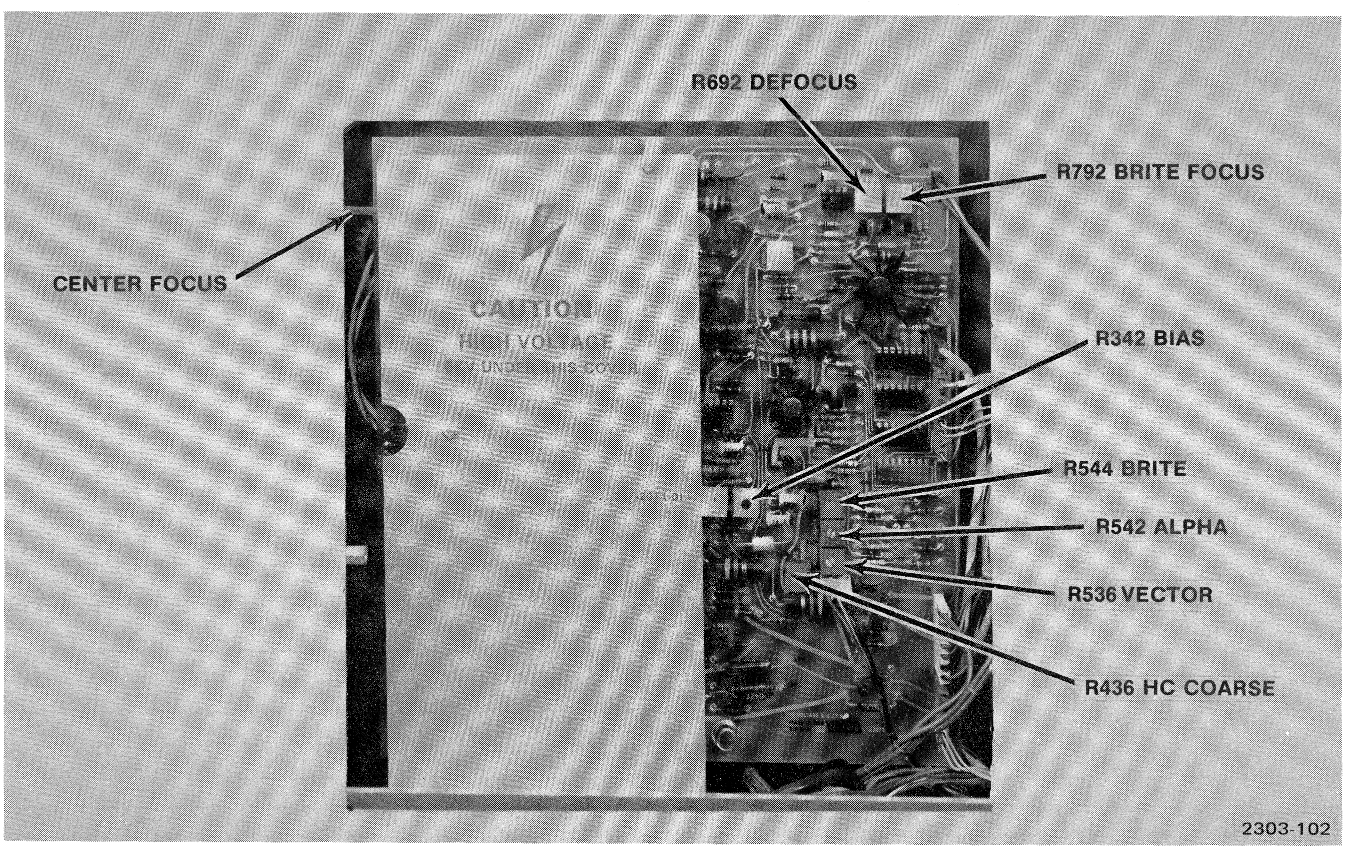


Fig. 4-23. Focus and Intensity Adjustments on the High Voltage and Z Axis Board.

13. Focus Adjustments (on the High Voltage and Z Axis Board)

a. Erase the screen by pressing the PAGE/RESET key.

b. Obtain the largest character set by entering ESC 8 sequence on the keyboard. It may be necessary to readjust the cursor intensity using R31 on the Display Control Card located in the Pedestal. See Fig. 4-14.

c. Refer to Fig. 4-23 for Focus adjustment locations on the High Voltage and Z Axis board.

d. Adjust R342, BIAS until dot appears in the home position during an erase. Now turn R342 until the dot just disappears during an erase.

e. Set DEFOCUS R692 adjustment extreme counterclockwise. The DEFOCUS adjustment R692 determines the width of Defocused Vectors. This will be adjusted in step 14 part h.

f. Move the alpha cursor to the center of the display by entering spaces and line feeds via the keyboard. Adjust R191, CENTER FOCUS, on the back back of the instrument, for clear round dots in cursor matrix.

g. Press PAGE to erase the screen. The cursor goes home.

h. Adjust R484, CORNER, for optimum cursor focus. Adjust for optimum dot roundness.

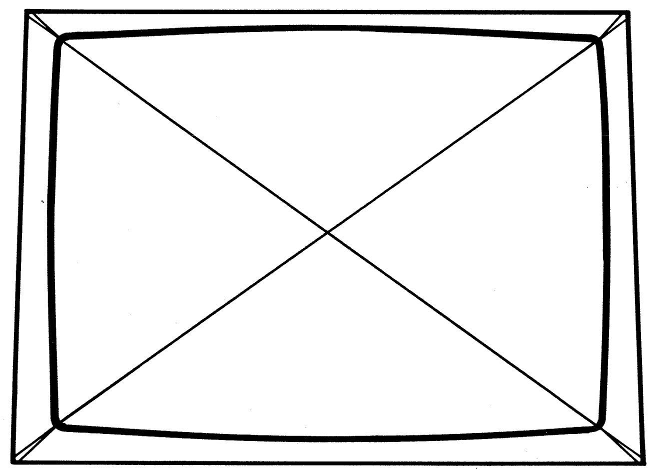
i. Adjust R792, BRITE FOCUS, for optimum focus of the large characters.

14. Graphic Intensity Check/Adjustment

a. A Graphic Test Pattern is used in this section. It may be programmed into a computer or Terminal peripheral for playback to the Terminal. The following steps, however, pertain to keyboard entry with the Terminal in LOCAL Mode.

b. VECTOR adjustment R536, on the High Voltage and Z Axis board, sets an intensity level to which most of the other intensity adjustments are dependent. See Fig. 4-23.

c. Using the graphic test pattern coordinates shown in Table 4-4, draw the test pattern shown in Fig. 4-24.



2303-103

Fig. 4-24. Graphic Test Pattern.

TABLE 4-4

APL CHARACTERS	ASCII CHARACTERS	COORDINATE Y	COORDINATE X
SP ◊ SP¯	SP ` SP @	ØY	ØX
SP ◊ \ -	SP ` ? _	ØY	1023X
8 *K* \ -	8 k ? _	779Y	1023X
8 *K* SP¯	8 k SP @	779Y	ØX
SP ◊ SP¯	SP ` SP @	ØY	ØX
8 *K* \ -	8 k ? _	779Y	1023X
SP ◊ \ -	SP ` ? _	ØY	1023X
8 *K* SP¯	8 k SP @	779Y	ØX

d. The abbreviated Graphic Test Pattern entry in ASCII is: SP ` SP @ `. ? _8 k _k SP @ SP ` @ 8 k ? _ SP ` _8 k SP @. The abbreviated Graphic Test Pattern entry in APL is: SP ◊ _SP ¯ ◊ ` -8 *K* - *K* SP ¯ SP ◊ ¯ 8 *K* \ - SP ◊ - 8 *K* SP ¯ .

e. Before entering the Graphic Test Pattern coordinates, erase the screen and enter CTRL SHIFT M via the keyboard to obtain the Vector Mode. While entering the Graphic Test Pattern, adjust GRAPHIC INTENSITY (R536) on the High Voltage and Z Axis Board (see Fig. 4-23). The intensity should be as low as possible and still maintain continuous vectors exhibiting no drop-out. Intensity increases with clockwise rotation of R536. Repeat the Graphic Test Pattern for each increment of GRAPHIC INTENSITY adjustment until brightness of all vectors has become satisfactory. To rewrite the test pattern, erase the screen, enter CTRL SHIFT M then the Graphic Test Pattern coordinates.

f. While typing large characters adjust BRITE R544, for focused large character.

g. Repeat the Focus Adjustments (Step 13).

h. Set R692 to about center range. Type a few large characters.

15. Character Intensity Check/Adjustment

a. Erase the screen by pressing the PAGE/RESET key.

b. Obtain the smallest character set by entering ESC ; (4014) or ESC [(4015) via the keyboard.

c. Adjust R31 on the Display Control Card in the Pedestal for a pleasing cursor intensity. It should be visible and non-storing. Fig. 4-14 shows R31 location.

d. While typing small characters adjust ALPHA R542 (Fig. 4-14) on the High Voltage board for a pleasing character intensity. Check the intensity with a complex character such as an 8. Check that characters are dark as possible without filling in.

e. If the characters tend to fill in or fade away, the OP LEV adjustment (R140) on the Storage Board needs to be readjusted. If the characters fill in, reduce the Operation Level (OP LEV) Voltage by 5 V. If the characters continually fade away, increase the Target Voltage by 5 V. For the appropriate adjustment and measurements, refer to the step on Storage Adjustments. Update the Target Operating Voltage if necessary.

f. Obtain the largest character set by entering ESC 8. The intensity should also be adequate for good viewing. If needed, readjust BRIGHT (R544) for a pleasing large character intensity.

g. The Write-Thru intensity adjustment is a screwdriver adjustment located to the right of the keyboard (Fig. 4-25). While in the Write-Thru Mode, it is adjusted for a non-storing display. It is normally adjusted by the operator under operating conditions.

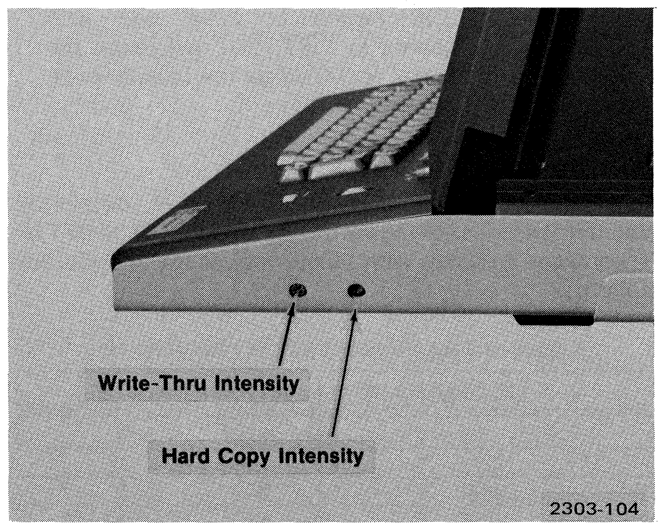


Fig. 4-25. Intensity adjustments on keyboard.

h. Adjust R381 on the Display Control Card for a small gap at the start of a write-thru VECTOR to eliminate storing of the intensified portion.

16. Final Deflection Check/Adjustment (Y GAIN, Y POS, X GAIN, and X POS on the Deflection Amplifier Board)

a. Refer to Fig. 4-22 for adjustments used in this section.

R92 (Y GAIN) determines page height.
R56 (Y POS) determines vertical position.
R273 (X GAIN) determines page width.
R270 (X POS) determines horizontal position.

b. Disable the Origin Shifter. This is done by placing the strap of J52 in the CAL position.

c. Reinstall the $\overline{\text{T STROBE}}$ — $\overline{\text{C STROBE}}$ jumper as described in the preliminary procedure.

d. Switch the Terminal to LINE and fill the page with Large characters. Adjust Y GAIN and Y POS to obtain 1/4 inch margins on the top and bottom of a written page of characters. Erase the screen and recheck the margins after each increment of adjustment.

e. Switch the Terminal to LOCAL.

CAUTION

Do not procede with the next step until the Terminal has been switched to LOCAL. Drawing vectors with the LOCAL/LINE switch at LINE and with T STROBE jumpered to C STROBE will cause the execution character (LOX) to be continually sent, and may burn the crt.

f. With the LOCAL/LINE switch at LOCAL, obtain the Vector Mode by entering via the keyboard CTRL SHIFT M. Then enter a square with height and width of equal tek points.

A Square Test Pattern that may be used is:

Y COORDINATE	X COORDINATE
50 Y	200 X
650 Y	200 X
650 Y	800 X
50 Y	800 X
50 Y	200 X

Abbreviated ASCII entry
! r & H 4 j H j 9 @ ! r @ r & H

Abbreviated APL entry
.. R >Δ 4 J Δ J 9 ¯ .. R ¯ R >Δ

g. The square should be of equal width and height.

h. To adjust the width, erase the screen, and rotate X GAIN, R273. Draw the square again and recheck.

i. Switch the Terminal back to LINE and enter a page full of characters. Center the page of written characters on the screen using the X POS adjustment.

Replace the strap on J52 to the NORMAL position.

This completes the adjustment procedure for the 4014 and 4015 Terminals. If your Terminal is either of these go on to Step 20, and restore initial conditions.

If your Terminal is either a 4014-1 or 4015-1 continue with Step 17.

17. Hard Copy Amplitude and Position Check/Adjustment (YHC POS, YHC GAIN, XHC POS, and XHC GAIN on the Deflection Amplifier Board)

a. Refer to Fig. 4-26 for adjustment locations.

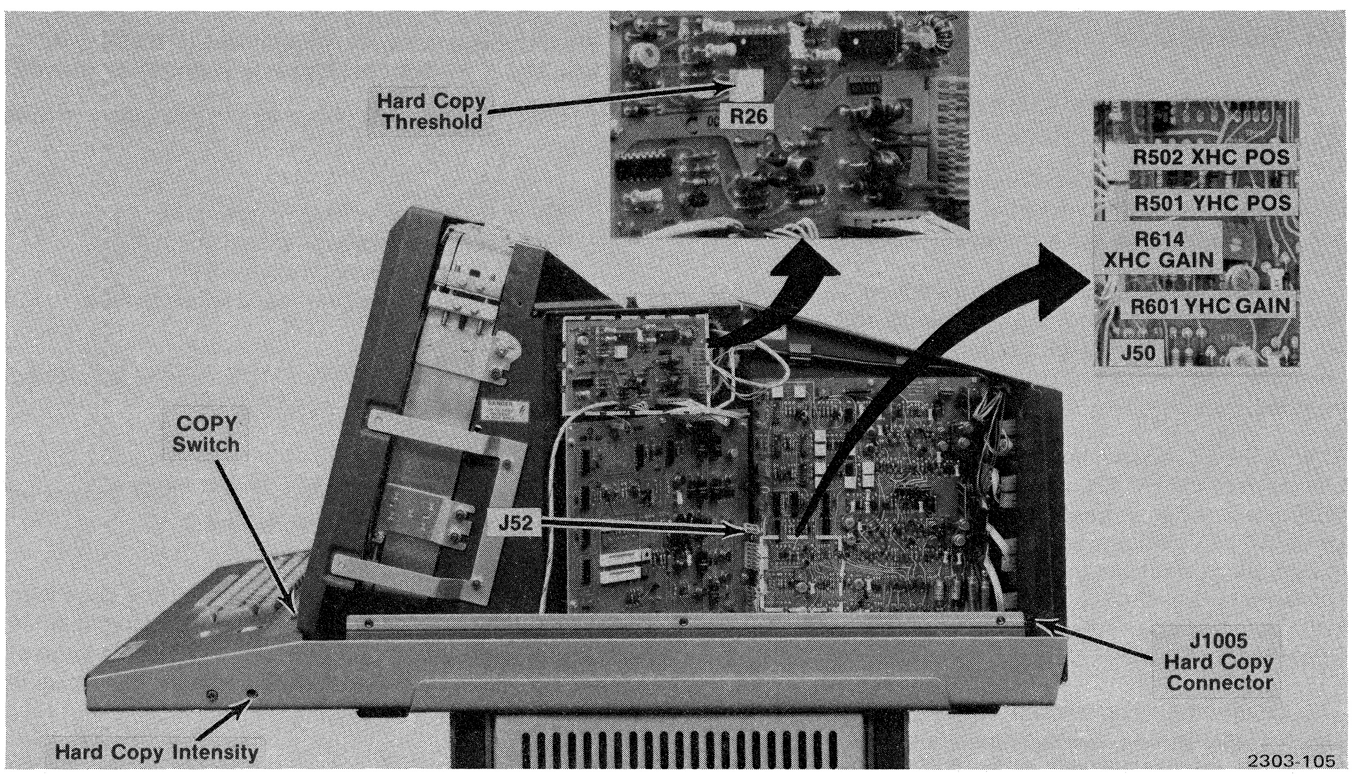


Fig. 4-26. Hard Copy Adjustments.

b. Remove the copying paper (or disable the paper drive) at the Hard Copy Unit 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 connector (J1005) on the back of the Display Unit.

d. Turn on the Hard Copy Unit and wait 30 minutes for warmup.

e. Disable the Origin Shifter by placing the jumper on J52 to the CAL position.

f. Set the Hard Copy Intentisy adjustment (Fig. 4-26) to center range. Press the COPY switch to obtain a vertical scan bar. Adjust R436, HC COARSE, on the High Voltage board, for a scan bar as bright as possible without storing at any point across the screen. Press the COPY switch and use the Hard Copy Intensity (side panel adjustment) as a fine adjustment. Press COPY switch and repeat until desired results are obtained.

g. Erase the screen and write a page of characters to determine the page boundaries.

h. Press the COPY switch to obtain a vertical scan bar. Adjust YHC GAIN (R601) and YHC POS (R501) on the Deflection Amplifier Board so the scan bar extends approximately 1/8 inch beyond the top and bottom margins of written information.

i. Reverse the connections of J50 on the Deflection Amplifier Board by rotating the jack 180°.

j. Press the COPY switch to obtain a horizontal scan bar. Adjust XHC GAIN (R614) and XHC POS (R502) on the Deflection Amplifier Board so the scan bar extends approximately 1/4 inch beyond the side margins of written information.

k. Return J50 on the Deflection Amplifier Board to its original position by rotating it 180°.

l. Enable the Origin Shifter by placing the J52 jumper to the NORMAL position.

18. Hard Copy Threshold Adjustment (R26 on the Hard Copy Amplifier Board)

a. Set the oscilloscope to a vertical sensitivity of 50 mV/division on channel 1, and 2 V/division on channel 2. Set the sweep rate to 0.5 μs/division.

b. Connect the oscilloscope external trigger by a 1X probe to TP769 on the High Voltage and Z Axis Board.

c. Use ground clips on the oscilloscope probes for channel 1 and channel 2 of the oscilloscope. Connect these ground clips to TP1 on the Hard Copy Amplifier Board.

d. Connect the oscilloscope probe from channel 1 to TP13 on the Hard Copy Amplifier Board (TP12 and TP13 are on input lines to a comparator). Connect the oscilloscope probe from channel 2 to TP116 (TARSIG).

e. Erase the screen.

f. Press the COPY switch. Adjust R26 on the Hard Copy Amplifier Board so that the voltage on TP13 (channel 1) is as low as possible without a target signal (TARSIG) appearing on TP116 (channel 2). See Fig. 4-27 for waveforms.

g. Write a page of characters and press the COPY switch. TARSIG signals should appear on TP116.

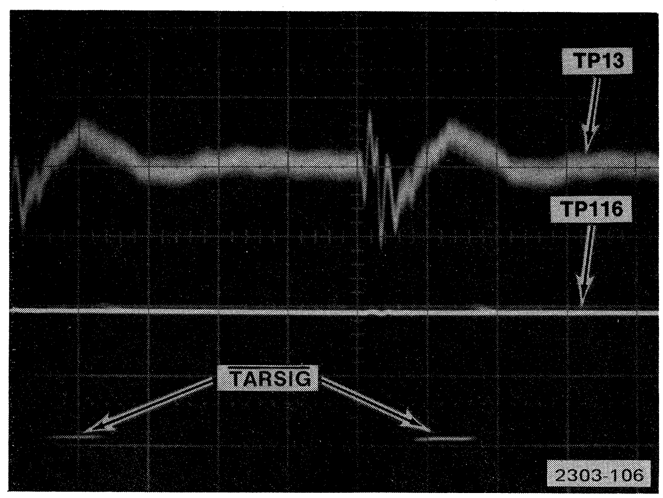


Fig. 4-27. Hard Copy Waveforms. Sweep rate: 0.5 μs/division. Vertical sensitivity; TP13 50 mV/division; TP116 2 V/division.

19. Hard Copy Check

a. Enable the paper drive or replace the paper in the Hard Copy Unit.

b. Refer to Step 21 for setting up the oscilloscope.

c. The oscilloscope probe on TP13 (channel 1) affects the adjustment of R26. Remove this probe before making a hard copy. If R26 needs further adjustment, reconnect this probe for a reference when resetting the threshold voltage.

d. Erase the screen and press the COPY switch. The hard copy should be white with no noise appearing as black spots. If black spots or black areas appear, the Hard Copy Threshold voltage, set by R26, may be too low.

e. Write a page of characters on the screen and press the COPY switch. The display should be copied on the paper from the Hard Copy Unit. If there is information drop-out, the Hard Copy Threshold voltage may be set too high. The temperature of the developing plate in the Hard Copy Unit also affects the intensity of the hard copy. If characters at the margins are missing, the XHC GAIN and YHC GAIN adjustments are set too low (see Fig. 4-26).

f. Disconnect all oscilloscope probes from the Terminal.

g. Write a page of characters on the screen and make five successive copies. All five copies should be satisfactory.

h. Restore the Communication Interface card, in the Pedestal, for computer operation if necessary.

20. Restore Initial Conditions

a. Remove all test equipment from the Terminal.

b. Restore the interface cards and strap options for computer operation.

c. Restore the power supply if it was rewired for testing.

d. Replace all covers on the Terminal.

SECTION 5
CIRCUIT DESCRIPTION

TABLE OF CONTENTS

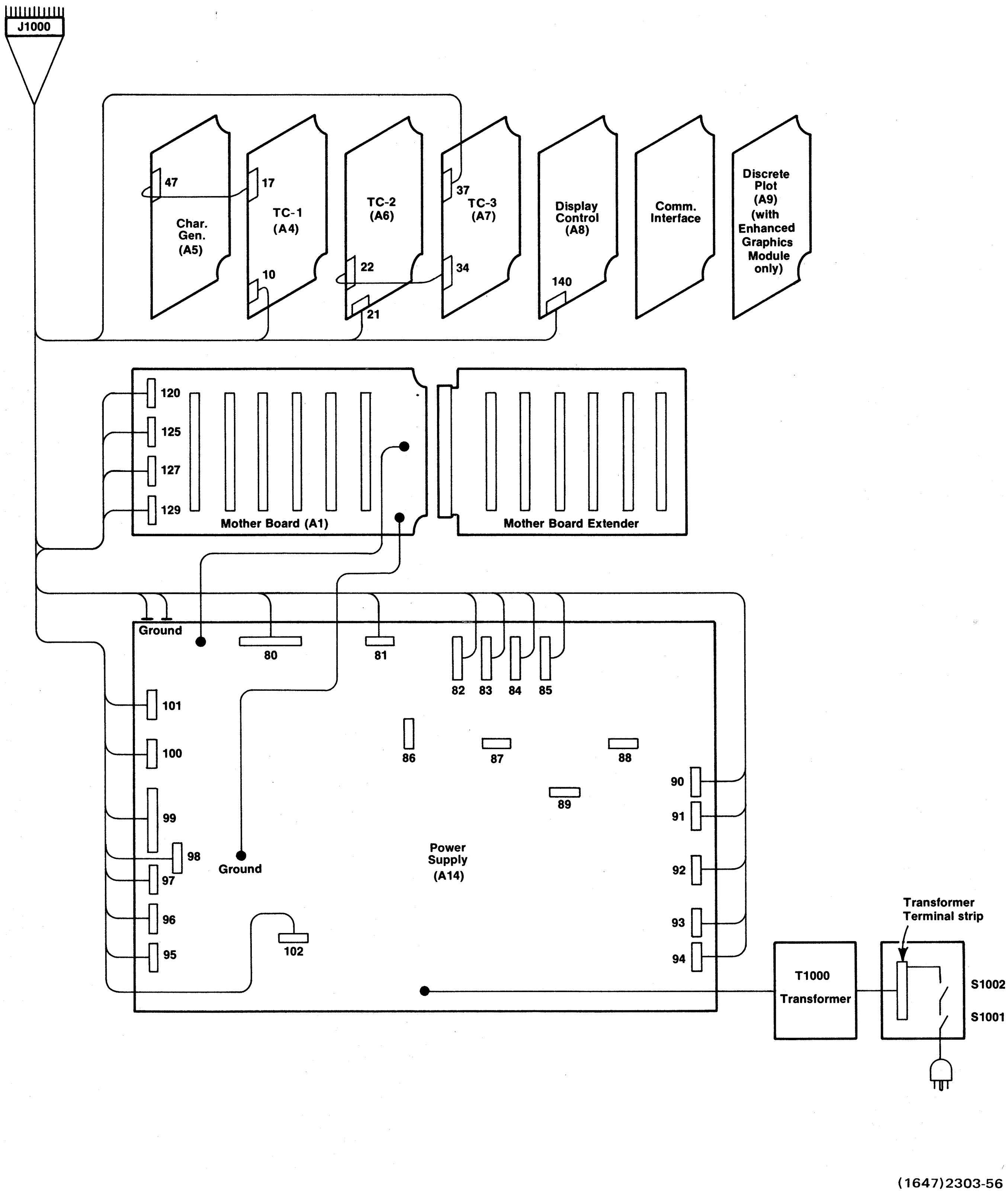


Fig. 5-1A. Pedestal Connectors and Wiring.

INTRODUCTION

About This Section

The description of Terminal concepts and circuit operation is separate from the block diagrams and circuit schematics. This allows the reader to have the diagram available while reading the text. When troubleshooting, select the proper schematic diagram for the board number installed in your instrument. Assembly numbers (Ax) on the schematic diagrams and the board numbers (670-xxxx-xx) are a guide to the parts listing for the board in the Replaceable Electrical Parts list. Assembly numbers are also given on the Connectors and Wiring Diagram Fig. 5-1A and B. This section also contains a Wire List and a Dictionary of Line Titles.

Wire List—Detailed listing of Terminal wiring. A wire list explanation shows how to use the Wire List.

Dictionary of Line Titles—Provides the technician with an understanding of functional signals common to all boards connected to the minibus. The Display Unit circuit descriptions are also preceded by a dictionary of line titles of those signals common to the Display Unit.

The Dictionary of Line Titles should be read before any of the block diagram or circuit descriptions. The Wire List explanation should be read before attempting to trace signals between schematics.

Diagrams and Circuit Description Information

The circuit description coupled with the block diagrams and schematics, in Section 7, allows 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 respecitve descriptions be read in the following order.

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

2. **Pedestal Data Flow Block Diagram and Description.** This block diagram with its description explains the basic data flow within the Terminal. It shows the tie-in of the major electrical components for Alpha Mode, Graph Mode, and Graphic Input (GIN) Mode. It also includes data flow for the Enhanced Graphics Module—Option 34.

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

4. **Block Diagrams and Circuit Descriptions.** Detailed block diagrams and descriptions are given for all standard logic cards that plug into the minibus located in the pedestal. In addition, a block diagram and circuit description is provided for the Discrete Plot card that is included as part of the Enhanced Graphics Module—Option 34.

Notice that the blocks given on the block diagrams correspond to the blocks indicated on the schematics. The specific components on the card can be located by referring to the component location (board illustration) on the apron of the scematic. This layout of block diagram, schematic, description, and component locations 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 Replaceable Electrical Parts list in Section 6.

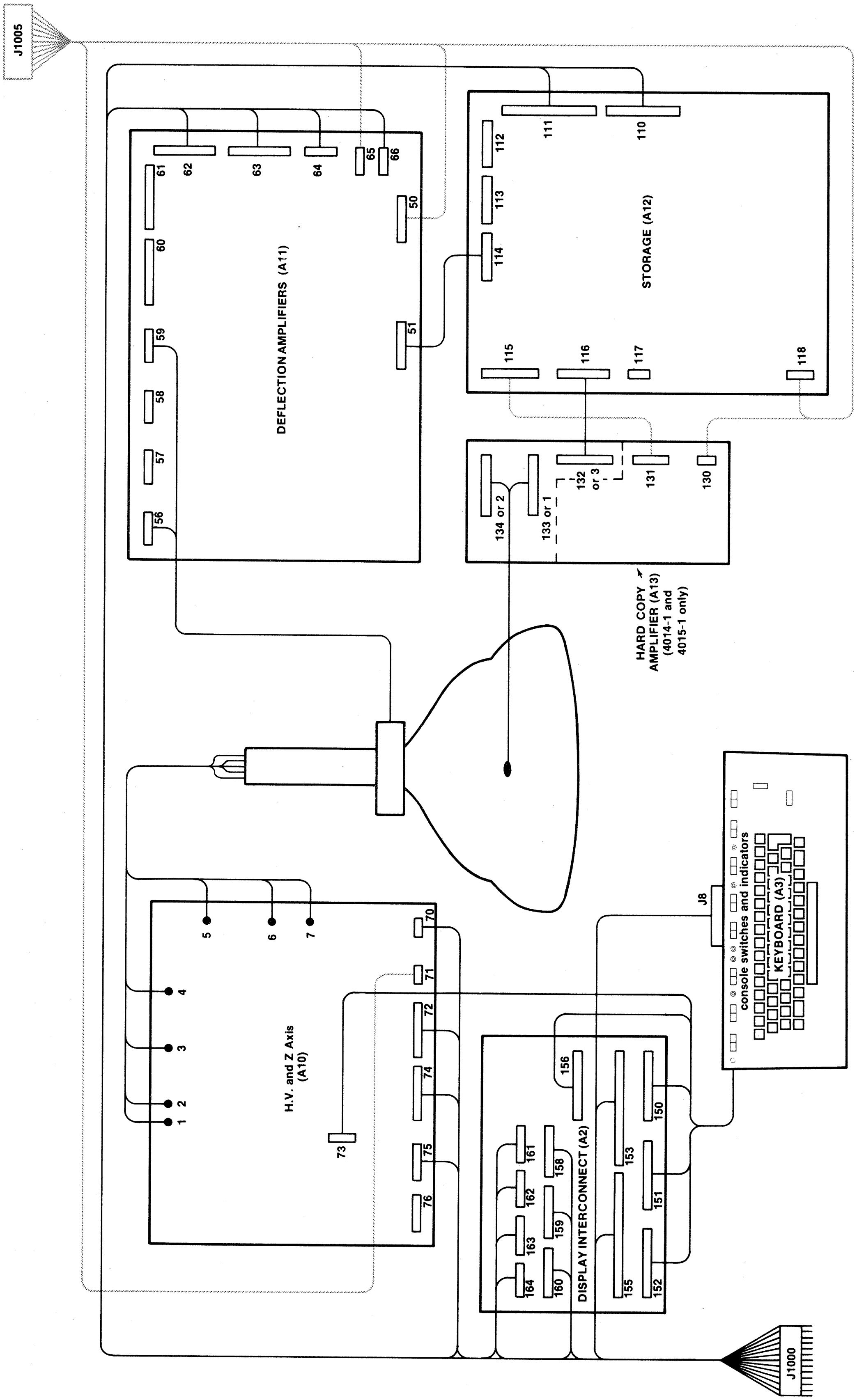


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Fig. 5-1B. Display Unit Connectors and Wiring. Gray colored cables on 4014-1 and 4015-1 Terminals only.

@

SIGNAL DETAILS

The Minibus

The Standard Terminal has a "minibus" board which has six card connectors or "jacks" on it. Corresponding points on each of the jacks are connected together, and are connected to the Terminal's signals lines. These lines or "busses" are thus available for use by any or all installed cards. The minibus board also has a facility for connecting a minibus extender board to it, to permit more than the standard six cards to have access to the signal lines. This board is available under Tektronix Part No. 018-0089-00.

Fig. 5-2 depicts the connector orientation for each jack on the minibus. Note that letters identify signal lines on the component side of an installed circuit card, while numbers identify the signal lines on the "under" side of the board.

Minibus Signal Line Definitions

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. Unless otherwise indicated, sources are totem-pole configured, and loads are 16 mA at 0.4 V.

CODE: $ = Open collector bussed logic signals (otherwise totem-pole).

% = Sources must sink 48 mA to 0.4 V (otherwise 16 mA).

$\overline{\textbf{AUXSENSE}}$. ($) Status bit line reserved for auxiliary device(s). DISABLES GRAPHIC LOOKAHEAD. (The $\overline{\text{HCU}}$ bus line may also be used by auxiliary device(s) if no Hard Copy Unit is connected and powered up.

$\overline{\textbf{BIT 1}}$—$\overline{\textbf{BIT 8}}$. ($%) Data to and from the Terminal/CPU.

$\overline{\textbf{BREAK}}$. ($) Signal from the keyboard to the interface for computer signalling.

$\overline{\textbf{BTSUP}}$. ($) Suppress 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.

$\overline{\textbf{CBUSY}}$. ($%) 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 which must lock out the keyboard should do so with $\overline{\text{KLOCK}}$.

$\overline{\textbf{CGZSUP}}$. Suppresses $\overline{\text{Z}}$ signal from TC-1.

$\overline{\textbf{CPUNT}}$. ($) Means data is about to be asserted by CPU (interface). Must be asserted ⩾3.2 microseconds before data is placed on $\overline{\text{BIT 1}}$—$\overline{\text{8}}$ and must remain low until after the trailing edge of the strobe(s) associated with the transfer.

CR. CARRIAGE RETURN; high active signal.

$\overline{\textbf{CSTROBE}}$. ($%) Strobes data to the CPU. Pulse width ⩾0.5 microseconds sync'd to the clock. Must not occur more than 2 microseconds after $\overline{\text{CPUNT}}$ goes low. $\overline{\text{TSTROBE}}$ may be asserted simultaneously (from the same source) to provide local copy to the Terminal. Should not occur <0.5 μs after $\overline{\text{CBUSY}}$ goes false (+3 V).

$\overline{\textbf{CSUP}}$. ($) Inhibits the interface from accepting $\overline{\text{CSTROBE}}$. This signal is used by devices such as line buffers, which need to intercept data destined for the CPU.

$\overline{\textbf{CURSE}}$. ($) Goes active when Terminal received the ESC SUB control character sequence. Used to turn on crosshair cursor.

$\overline{\textbf{DOWN}}$. ($) Counting pulse for Y register.

$\overline{\textbf{DRBUSY}}$. ($%) If not during an erase cycle: Asserted by the Hard Copy Unit to set up the display for hard copy readout. $\overline{\text{DRBUSY}}$ should be asserted before the trailing edge of $\overline{\text{MAKE COPY}}$ in order to hold the Terminal in BUSY during the scan. ($\overline{\text{DRBUSY}}$ is also asserted by some scan converters.

If during an erase cycle: Asserted by the display for the duration of the erase cycle (≈1 second) during which information may not be written on the screen.

$\overline{\textbf{ECHO}}$. ($) Directs input sources to assert $\overline{\text{TSTROBE}}$ as well as $\overline{\text{CSTROBE}}$ when sending data to the CPU to provide a LOCAL copy on the screen of data entered into the CPU.

Under Side	Pin	Pin	Component Side
GND	36	R	Y MAT
$\overline{\text{FUZZ}}$	35	P	Y ANALOG
$\overline{\text{NOLI}}$	34	N	$\overline{\text{LED 2}}$
X MAT	33	M	X ANALOG
$\overline{\text{END COUNT}}$	32	L	$\overline{\text{BREAK}}$
$\overline{\text{CGZSUP}}$	31	K	$\overline{\text{C SUP}}$
$\overline{\text{SRH}}$	30	J	$\overline{\text{HCU}}$
$\overline{\text{WRITE}}$	29	H	$\overline{\text{UP}}$
$\overline{\text{SELW}}$	28	F	$\overline{\text{HOME}}$
$\overline{\text{SEND 8}}$	27	E	$\overline{\text{PAGE}}$
$\overline{\text{BIT 8}}$	26	D	CR
$\overline{\text{LED 1}}$	25	C	$\overline{\text{MAKE COPY}}$
4.9 MHz	24	B	LCE
$\overline{\text{TTY MASTER}}$	23	A	$\overline{\text{LOXE}}$
VIEW	22	Z	$\overline{\text{SW 1}}$
SPD1	21	Y	$\overline{\text{KLOCK}}$
$\overline{\text{AUX SENSE}}$	20	X	$\overline{\text{SW 2}}$
$\overline{\text{SPEAK}}$	19	W	$\overline{\text{LEFT}}$
$\overline{\text{BTSUP}}$	18	V	$\overline{\text{RIGHT}}$
$\overline{\text{T SUP}}$	17	U	$\overline{\text{BIT 5}}$
$\overline{\text{CURSE}}$	16	T	$\overline{\text{BIT 2}}$
+15 V	15	S	+5 VOLTS
−15 V	14	R	$\overline{\text{EOL}}$
$\overline{\text{HI X}}$	13	P	$\overline{\text{TAPE FETCH}}$
$\overline{\text{BIT 4}}$	12	N	$\overline{\text{DOWN}}$
$\overline{\text{BIT 3}}$	11	M	$\overline{\text{GRAF}}$
$\overline{\text{BIT 1}}$	10	L	$\overline{\text{DR BUSY}}$
$\overline{\text{GIN}}$	9	K	$\overline{\text{LO Y}}$
$\overline{\text{T BUSY}}$	8	J	$\overline{\text{HI Y}}$
$\overline{\text{ECHO}}$	7	H	$\overline{\text{LOCAL}}$
$\overline{\text{BIT 7}}$	6	F	$\overline{\text{BIT 6}}$
$\overline{\text{T STROBE}}$	5	E	$\overline{\text{F PAUSE}}$
$\overline{\text{Z}}$	4	D	$\overline{\text{INQUIRE}}$
$\overline{\text{C STROBE}}$	3	C	$\overline{\text{C PUNT}}$
MARG	2	B	614 kHz
$\overline{\text{C BUSY}}$	1	A	GND

(1647)2303-58

Fig. 5-2. Minibus Connector Wire List.

$\overline{\text{END COUNT}}$. Disables register stepping circuits and suppresses $\overline{Z}$ signal from TC-1.

$\overline{\text{EOL}}$. ($) Indicates that the X register is counting past the right margin. Used by the AUTO CR/LF logic. Asserting $\overline{\text{EOL}}$ will cause a CR/LF to be generated when in ALPHA. A Display Multiplexer could use this to shorten the right margin for small displays. In such use, $\overline{\text{EOL}}$ should not be asserted after CR is activated to prevent wild and random counting of registers.

$\overline{\text{FPAUSE}}$. ($) Indicates deflection amp is slewing (BUSY). Also briefly asserted by TC-2 to allow for D/A response time.

$\overline{\text{FUZZ}}$. ($) Shifts crt resolution by defocusing and increasing writing current. For large characters, fat vectors.

$\overline{\text{GIN}}$. ($) When originated in TC-2, 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 Bypass Condition.

GND. Circuit ground.

$\overline{\text{GRAF}}$. ($%) Originates in TC-1. Asserting a low on $\overline{\text{GRAF}}$ will set Graf Mode.

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

$\overline{\text{HIX}}$. ($) Used to load the HIGH X graphic byte into the X register.

$\overline{\text{HIY}}$. ($) Used to load the HIGH Y graphic byte into the Y register.

$\overline{\text{HOME}}$. ($%) Master reset for all logic. Origin in keyboard (RESET key) and TC-1.

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

$\overline{\text{KLOCK}}$. ($) Inhibits keyboard. Asserted by function keyboard to delay coordinate transmission.

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

$\overline{\text{LED1}}$, $\overline{\text{LED2}}$. ($) Turns on the light emitting diode (LED) indicators in the keyboard area.

$\overline{\text{LEFT}}$. ($) Counting pulse for X register.

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

$\overline{\text{LOXE}}$. ($%) Used to load the LOW X graphic byte into the X register and to trigger the vector drawing.

$\overline{\text{LOY}}$. ($) Used to load the LOW Y graphic byte into the Y register.

$\overline{\text{MAKE COPY}}$. ($) Copy request: 866 microseconds wide minimum. Caused by COPY switch or by ESC ETB sequence.

MARG. Indicates that the FULL LED is on. With a directly connected interface, this corresponds to page full. High active.

$\overline{\text{NOLI}}$. ($) Suppresses Linear Interpolation vector drawing and timing circuitry on TC-1 and TC-3. Asserted by TC-1 unless in GRAF. The Discrete Plot card (part of Option 34) can also assert this signal.

$\overline{\text{PAGE}}$. ($) ESC FF control character sequence; also PAGE key. Causes the display to erase the screen.

$\overline{\text{RIGHT}}$. ($) Counting pulse for X register.

SELW. Goes active when Write-Thru selected. Sets character generator to faster speed; places character Z axis width under control of Display Control card.

$\overline{\text{SEND 8}}$. ($) 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 whose polarity is determined by wire strap in the keyboard.)

SPD 1. Spare.

$\overline{\text{SPEAK}}$. ($) Audio connection to the loudspeaker. Other terminal of speaker is at +5 volts. Bypassed by a 0.01 microfarad capacitor.

$\overline{\text{SRH}}$. Contact closure for KEYBOARD SHIFT key. Resets "HOLD Mode".

$\overline{\text{SW 1}}$. Asserted by keyboard switch SW 1.

$\overline{\text{SW 2}}$. Asserted by keyboard switch SW 2.

$\overline{\text{TAPEFETCH}}$. ($) A pulse provided by (typically) some small computer interfaces to cause a paper tape reader or analogous device to read one byte of data.

$\overline{\text{TBUSY}}$. ($%) Terminal is busy writing a character or vector, etc. $\overline{\text{TBUSY}}$ controls the timing of data transmitted to the Terminal. Upon receipt of a byte of data, the Terminal will assert $\overline{\text{TBUSY}}$ by the trailing edge of $\overline{\text{TSTROBE}}$ if that byte is to make the Terminal busy. No condition, with the exception of MARG and copy making shall assert $\overline{\text{TBUSY}}$ except momentarily. (MARG can be patched out of $\overline{\text{TBUSY}}$.) The Terminal will, however, accept data if $\overline{\text{TBUSY}}$ is high or low although the results in the low case are not defined. $\overline{\text{TBUSY}}$ does not inhibit transmission of data from the keyboard to the CPU.

$\overline{\text{TSTROBE}}$. ($%) Strobes data into the Terminal, to be displayed on the screen, etc. ⩾0.8 microsecond pulse synchronized to the 614 kHz clock. Should not occur <0.5 μs after $\overline{\text{TBUSY}}$ goes false (+3 V). $\overline{\text{TSTROBE}}$ is not inhibited by GIN. Serrated $\overline{\text{TSTROBES}}$ should be avoided since they may cause improper operation.

$\overline{\text{TSUP}}$. ($) Suppress Terminal response to $\overline{\text{TSTROBE}}$. $\overline{\text{TSUP}}$ should be used by devices which need to blank the Terminal to incoming data, such as a paper tape punch when punching binary data.

$\overline{\text{TTY MASTER}}$. Used only when a dual communication interface installation exists.

$\overline{\text{UP}}$. ($) Counting pulse for Y register.

VIEW. Controls the flood guns in the crt display unit. A high turns the guns on. As long as the Terminal is in GIN ($\overline{\text{GIN}}$ active) Graph ($\overline{\text{GRAF}}$ active) or making a copy ($\overline{\text{MAKE COPY}}$ active) 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 Mode" by placing a 1200 hertz signal with 12.5% duty factor on VIEW.

$\overline{\text{WRITE}}$. Asserted any time a character, point, or unblanked vector is being drawn in any display mode. $\overline{\text{WRITE}}$ will activate selective write in the scan converter driver option.

XANALOG. Analog signal from TC-3 to display. −5 to +5 volts covers the screen. Positive signal corresponds to left deflection. Ø volts represents the physical center of the screen.

XMAT. Analog signal representing the X location within the character matrix. Originates on the Character Generator.

YANALOG. Analog signals from TC-3 to display. −5 to +5 volts covers the screen. Positive signal corresponds to down deflection. Ø volts represents the physical center of the screen.

YMAT. Analog signal representing the Y location within the character matrix. Originates on the Character Generator.

$\overline{\text{Z}}$. ($%) Z axis information on the minibus that is changed into Z Axis Display ($\overline{\text{Z DIS}}$) information by the Display Control card.

4.9 MHz. (%).

614 kHz. (%).

Display Unit Signal Line Definitions

$\overline{\text{BRITE}}$. When low, it selects a bright writing beam intensity. This state is usually in conjunction with FOCUS being high.

$\overline{\text{CENTER}}$. This signal is externally applied to the Origin Shifter in the Deflection Multiplexer circuit. When low it inhibits and resets the operation of the Origin Shifter counter.

$\overline{\text{COPY}}$. This signal is synonymous to the MAKE COPY command used by the Hard Copy Unit to initiate the making of a hard copy. $\overline{\text{COPY}}$ is asserted either by the Pedestal or the COPY key on the keyboard.

D BUSY. Whe low, it indicates the Display Unit is busy. It is asserted either during an erase cycle or while making a hard copy.

DYNAMIC FOCUS. This signal modifies the focus electrode voltage to maintain a consistently focused writing beam over the display screen.

$\overline{\text{ERASE}}$. This signal, from the Display Control Card in the Pedestal, initiates the erase cycle in the Storage Board circuits.

FAST RAMP. This is the analog deflection voltage from the Hard Copy Unit controlling vertical deflection.

$\overline{\text{FOCUS}}$. This signal selects either the Normal or the Defocused mode of operation by causing the writing beam to be narrow or broad. When low, the Normal mode is selected. When high, the Defocused mode is selected.

H.C. INTER. This is the display interrogation pulse from the Hard Copy Unit. As a result, the writing beam is pulsed and a target information signal, $\overline{\text{TARSIG}}$, is developed.

H.C.S. The Hard Copy Switch (H.C.S.) enables operation of hard copy circuitry within the Display Unit. It is asserted by either $\overline{\text{READ}}$ or $\overline{\text{WAIT}}$ (from the Hard Copy Unit) going low.

$\overline{\text{INT OFF}}$. This signal is asserted by the Deflection Amplifier circuits to turn off the writing beam due to lack of deflection control.

$\overline{\text{ORIGIN}}$. This is the trigger signal that occurs during the erase cycle from the Storage Board to trigger the Origin Shifter counter in the Deflection Multiplexer circuit.

$\overline{\text{READ}}$. This signal, initiated by the Hard Copy Unit, asserts H.C.S. to activate the hard copy circuitry in the Display Unit.

SLOW RAMP. This is the analog deflection voltage from the Hard Copy Unit controlling horizontal deflection.

$\overline{\text{SLU}}$. Initiated by the Deflection Amplifiers, it indicates a temporary wait while the Deflection Amplifiers are rapidly establishing a new deflection current in the deflection yoke.

$\overline{\text{TARSIG}}$. This is a display information signal from the Target sent to the Hard Copy Unit when a hard copy is being made.

VIEW. When high, it activates the flood guns making the stored information visible.

$\overline{\text{WAIT}}$. This signal is from the multiplexer option in the Hard Copy Unit to hold the Terminal inactive while the Hard Copy Unit processes the display of another Terminal or display device.

X ANALOG. This is the analog deflection voltage from the Pedestal controlling horizontal deflection.

X COORD. This is the horizontal deflection voltage from the Deflection Multiplexer circuit providing input to the X deflection amplifier. This signal is synonymous with X ANALOG from the Pedestal or SLOW RAMP from the Hard Copy Unit.

X GEOM. This is an anlog geometry correction signal made available to the X deflection amplifier.

Y ANALOG. This is the analog deflection voltage from the Pedestal controlling vertical deflection.

Y COORD. This is the vertical deflection voltage from the Deflection Multiplexer circuit providing input to the Y deflection amplifier. This signal is synonymous with Y ANALOG from the Pedestal or FAST RAMP from the Hard Copy Unit.

Y GEOM. This is an analog geometry correction signal made available to the Y deflection amplifier.

$\overline{\text{Z DIS}}$. This signal causes blanking of the writing beam. The writing beam turns on when $\overline{\text{Z DIS}}$ goes low.

WIRING INFORMATION

The following interconnecting references are provided to facilitate signal tracing:

1. Wire List—Explains signal paths through cables.

2. Connectors and Wiring Diagrams—Fig. 5-1A and B. Depicts locations and identity of connectors.

3. Motherboard Diagrams—Shows connector locations on minibus and lists interconnecting lines.

4. Display Interconnect Diagram—Shows chassis circuitry and Display Interconnection Board signal distribution. Shows distribution of keyboard console switches, indicators and adjustment signals.

5. From/To Addresses (contained on schematics)—Lists source (FM) or destination (TO) 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 by the specific pin number or letter. These lines are applicable to all cards that can be inserted into the minibus connectors. Normally, signals entering at the left edge of a schematic are from the minibus; signals exiting at the right edge of a schematic are to the minibus.

In the event of cable trouble, it may be necessary to trace signals from point-to-point through all connectors. Start with the connector and pin number. If it is a harmonica connector, go to that connector in the Wire List. If it is a board-edge connector, go to that connector on the Motherboard diagram. Opposite the connector and pin number is listed in interconnecting point or points.

The cable plugs are color coded, from 0 to 9, to match the last digit of the jack number to which the plug is connected.

EXAMPLE 1. Follow $\overline{\text{HIY}}$ from TC-1 to its destination. Since $\overline{\text{HIY}}$ is on an interchangeable board, its J card-edge connector is common to pin J on all cards connected to the minibus. To determine if the signal goes elsewhere, look on the Motherboard diagram under minibus pin J. No other points are listed.

EXAMPLE 2. Follow MAKE COPY, which is generated on TC-1. Again, it is a connection on the minibus and goes to pin C on all minibus connectors. Look on the schematics of other cards that plug into the minibus to determine if it is used there. Then check the Motherboard diagram. It shows that minibus pin C also connects to J125-3. Going to the Wire List, J125-3 shows that pin 3 connects to J1000 pin 21, the Display/Pedestal Connector. Refer to J1000 in the Wire List, and it shows that pin 21 goes to P153-4. Refer to P153-4 on the Display Interconnect diagram. This diagram also shows that P153-4 also connects through P150-2 to the COPY switch, which also is a source for the signal. The Interconnect Diagram also shows the signal going to P65-2. The Wire List shows P65-2 connecting to J66-2, which connects to J1005-11. The Wire List shows that J1005 is the Hard Copy connector on the back of the Display Unit.

EXAMPLE 3. On the Keyboard schematic locate KSTROBE on P8-6. Go to the Wire List and find that it connects to P1000-37. P1000-37 shows it connecting to P21-7 on TC-2. Referring to the TC-2 schematic confirms this.

TABLE 5-1

WIRE LIST FOR
CRT "WRITING GUN" BASE CONNECTOR

PLUG or JACK	PIN	SIGNAL NAME	TO		FROM		MISCELLANEOUS	WIRE COLOR CODE
			PLUG and/ or JACK	PIN	PLUG and/ or JACK	PIN		
	1	W.G. FIL			T111-23		To the CRT from the High Voltage and Z Axis Board	9-1
	2	W.G. FIL			T111-24			9-2
	3	BEAM CATHODE			T111-26			9-3
	4	CONTROL GRID			CR76			9-4
	5	FOCUS			R191			9-5
	6	W.G. ANODE 1			GND			9-6
	7	W.G. ANODE 2			+290 VDC			9-7

WIRE LIST FOR

Keyboard and Console
P8

PLUG or JACK	PIN	SIGNAL NAME	TO		FROM		MISCELLANEOUS	WIRE COLOR CODE
			PLUG and/ or JACK	PIN	PLUG and/ or JACK	PIN		
P8	1						Empty	
	2						Empty	
	3	$\overline{\text{BREAK}}$	P1000	44				9-18
	4	−15 VDC			P1000	56		7-1
	5	+5 VDC			P1000	30	Strapped to Pin E	2-0
	6	$\overline{\text{K STROBE}}$	P1000	37			Twisted Pair 8-55	2-N
	7	$\overline{\text{APL}}$			P153	1,2		9-25
	8	GND			P1000	71		0-N
	9	K BIT 8	P1000	34				9-12
	10							E
	11	K BIT 6	P1000	57				9-35
	12						Empty	
	13						Empty	
	14						Empty	
	15						Empty	
	A	$\overline{\text{PAGE}}$	P1000	42				9-27
	B	$\overline{\text{RESET}}$	P1000	26				9-38
	C						Empty	
	D						Empty	
	E	+5 VDC			P1000	30	Strapped to Pin 5	2-0
	F	K STROBE	P1000	40			Twisted Pair 8-55	0-N
	H	$\overline{\text{SHIFT}}$	P1000	20				9-26
	J	GND			P1000	71		0-N
	K	K BIT 7	P1000	23				9-34
	L	K BIT 5	P1000	10				9-3
	M						Empty	
	N	K BIT 4	P1000	53				9-16
	P	K BIT 3	P1000	38				9-15
	R	K BIT 2	P1000	32				9-17
	S	K BIT 1	P1000	45				9-14

WIRE LIST FOR

TC-1
P10, P11 and P17

PLUG or JACK	PIN	SIGNAL NAME	TO		FROM		MISCELLANEOUS	WIRE COLOR CODE
			PLUG and/ or JACK	PIN	PLUG and/ or JACK	PIN		
P10	2	$\overline{\text{ASCII}}$	J10	2	J1000	29		9-36
	1	$\overline{\text{APL}}$	J10	1	J1000	41		9-25
	3						SPARE	
P11	1	$\overline{\text{ASCII}}$					for APL interface option	

WIRE LIST FOR

TC-1
P10, P11 and P17 (cont)

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P17	1	ECH SP	J17	1	P47	1	Ribbon cable to Character Generator	
	2	VIEW	P-47	2				
	3	$\overline{\text{75 Hz}}$	P-47	3				
	4	5 Hz	P-47	4				
	5	ALPHA E	P-47	5				
	6	SUPPRESS	P-47	6				
	7	$\overline{\text{CHAR A}}$	P-47	7				
	8	$\overline{\text{CHAR COMPL}}$	J17	8	P47	8		
	9	$\overline{\text{CHAR B}}$	P-47	9				
	10			10			Empty	
	11			11			Empty	
	12			12			Empty	
	13	GO BABY	P-47	13				
	14	1.22 MHz	P-47	14				
	15	VIEW	P-47	15				
	16	$\overline{\text{75 Hz}}$	P-47	16				
	17	5 Hz	P-47	17				
	18	ALPHA E		18				
	19	SUPPRESS		19				
	20	$\overline{\text{CHAR A}}$		20				
	21	$\overline{\text{CHAR COMPL}}$	J17	21	P47	21		
	22	$\overline{\text{CHAR B}}$		22				
	23	$\overline{\text{ASCII}}$	P-47	23				
	24	$\overline{\text{CHAR CLK}}$	P-47	24				
	25	$\overline{\text{ALPHA}}$	P-47	25				
	26	+5 V	P-47	26				

WIRE LIST FOR

TC-2
(670-3092-05 and 670-3559-05)
P20, P21 and P22

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P20	1	−15 VDC	Inputs and outputs TO/FROM JOYSTICK OPTION					
	2	Y						
	3	Y GND						
	4	GND						
	5	Empty						
	6	Empty						
	7	X						
	8	X GND						
	9	SELECT						
	10	+15 VDC						

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WIRE LIST FOR

TC-2
(670-3092-05 and 670-3559-05)
P20, P21 and P22 (cont)

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/or JACK	TO PIN	FROM PLUG and/or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P21	1							Empty
	2	Y POT			J1000	13		9-02
	3	$\overline{\text{MARG 2}}$			J1000	35		9-37
	4	$\overline{\text{MARG 1}}$			J1000	33		9-06
	5	KBIT 8			J1000	24		9-12
	6	KSTROBE			J1000	40	Twisted Pair 0-N	8-22 Shield
	7	$\overline{\text{KSTROBE}}$			J1000	37	Twisted Pair 2-N	8-22 Shield
	8	GND						
	9	GND						
	10	KBIT 2			J1000	32		9-17
	11	KBIT 7			J1000	23		9-34
	12	KBIT 6			J1000	57		9-35
	13	$\overline{\text{FULL LED}}$	J1000	58				9-03
	14	$\overline{\text{AUTO PRINT}}$			J1000	16		9-2
	15	KBIT 5			J1000	10		9-3
	16	KBIT 4			J1000	53		9-16
	17							Empty
	18	KBIT 1			J1000	45		9-14
	19	KBIT 3			J1000	38		9-15
	20	X POT			J1000	60		9-28
P22	1	X8	J-34	1			Ribbon Cable to TC-3	
	2	Y6	J-34	2				
	3	Y11	J-34	3				
	4	Y7	J-34	4				
	5	Y10	J-34	5				
	6	X9	J-34	6				
	7	X3	J-34	7				
	8	X1	J-34	8				
	9	X2	J-34	9				
	10	X4	J-34	10				
	11	X6	J-34	11				
	12	X7	J-34	12				
	13	X11	J-34	13				
	14	Y4	J-34	14				
	15	Y2	J-34	15				
	16	Y1	J-34	16				
	17	Y3	J-34	17				
	18	Y5	J-34	18				
	19	Y8	J-34	19				
	20		J-34	20				Empty
	21	$\overline{\text{CHSTP}}$	J-34	21				
	22	Y9	J-34	22				
	23	Y12	J-34	23				
	24	X12	J-34	24				
	25	X5	J-34	25				
	26	X10	J-34	26				

WIRE LIST FOR
TC-3
P34, 36 and 37

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P34	1	X8			J22	1	Ribbon Cable from TC-2	
	2	Y6			J22	2		
	3	Y11			J22	3		
	4	Y7			J22	4		
	5	Y10			J22	5		
	6	X9			J22	6		
	7	X3			J22	7		
	8	X1			J22	8		
	9	X2			J22	9		
	10	X4			J22	10		
	11	X6			J22	11		
	12	X7			J22	12		
	13	X11			J22	13		
	14	Y4			J22	14		
	15	Y2			J22	15		
	16	Y1			J22	16		
	17	Y3			J22	17		
	18	Y5			J22	18		
	19	Y8			J22	19		
	20				J22	20	Empty	
	21	$\overline{\text{CHSTP}}$			J22	21		
	22	Y9			J22	22		
	23	Y12			J22	23		
	24	X12			J22	24		
	25	X5			J22	25		
	26	X10			J22	26		
P36	1	Y ANALOG Shield	P1000	**11**			Twisted Pair 8-55	Shield
	2	Y ANALOG	P1000	**3**			Twisted Pair 8-55	2-N
	3	Y ANALOG Gnd	P1000	**7**			Twisted Pair 8-55	0-N
	4	X ANALOG Gnd	P1000	**1**			Twisted Pair 8-N	0-N
	5	X ANALOG	P1000	**5**			Twisted Pair 8-N	2-N
	6	X ANALOG Shield	P1000	**2**			Twisted Pair 8-N	Shield
P37	1	Y ANALOG Shield					For Display Multiplexer Option	
	2	Y ANALOG						
	3	Y ANALOG Gnd						
	4	X ANALOG Gnd						
	5	X ANALOG						
	6	X ANALOG Shield						

WIRE LIST FOR
CHARACTER GENERATOR
P46 and 47

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P46	1	$\overline{\text{FUZZY}}$	J139	1				9-1
	2	$\overline{\text{NEW}}$	J139	2				9-2
	3	NOT USED	J139	3				9-3
	4	GND	J139	4				9-4

WIRE LIST FOR CHARACTER GENERATOR P46 and 47 (cont)

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P47	1	ECHSP	P17	1			Ribbon Cable	
	2	VIEW			P17	2	from TC-1	
	3	$\overline{\text{75 Hz}}$			P17	3		
	4	5 Hz			P17	4		
	5	ALPHA E			P17	5		
	6	SUPPRESS			P17	6		
	7	$\overline{\text{CHAR A}}$			P17	7		
	8	$\overline{\text{CHAR COMPL}}$	P17	8				
	9	$\overline{\text{CHAR B}}$			P17	9		
	10				P17	10	Empty	
	11				P17	11	Empty	
	12				P17	12	Empty	
	13	GO BABY			P17	13		
	14	1.22 MHz			P17	14		
	15	VIEW			P17	15		
	16	$\overline{\text{75 Hz}}$			P17	16		
	17	5 Hz			P17	17		
	18	ALPHA E			P17	18		
	19	SUPPRESS			P17	19		
	20	$\overline{\text{CHAR A}}$			P17	20		
	21	$\overline{\text{CHAR COMPL}}$	P17	21				
	22	$\overline{\text{CHAR B}}$			P17	22		
	23	ASCII			P17	23		
	24	CHAR CLK			P17	24		
	25	ALPHA			P17	25		
	26	+5 V			P17	26		

WIRE LIST FOR Deflection Amplifier Board P50, P51, P52, P53, P54, P55

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS		WIRE COLOR CODE
P50	1	SLOW RAMP Gnd			J1005	4	To	Twisted	0-N
	2	SLOW RAMP			J1005	3	4014-1/4015-1	pair	2-N
	3	FAST RAMP			J1005	1	from	Twisted	2-N
	4	FAST RAMP Gnd			J1005	2	Hard Copy Unit	pair	0-N
P51	1	$\overline{\text{CENTER}}$					Empty		
	2	$\overline{\text{ORIGIN}}$			J114	1			9-1
	3	$\overline{\text{READ}}$			J114	2			9-2
P52	1	Signal Gnd					CAL		
	2	$\overline{\text{CENTER}}$			J52	3	2-pin jumper		
	3	+5 VDC	J52	2			NORMAL		
P53	1	Signal Gnd					CAL		
	2	X COORD			J53	3	2-pin jumper		
	3	X COORD	J53	2			NORMAL		
P54	1	Signal Gnd.					CAL		
	2	Y COORD			J54	3	2-pin jumper		
	3	Y COORD	J54	2			NORMAL		

WIRE LIST FOR

Deflection Amplifier Board (cont)
P56, P57, P58, P59, P60, P61, P62

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P55	1	Signal Gnd					CAL	
	2	X_2+Y_2			J55	3	2-pin jumper	
	3	DYNAMIC FOCUS	J55	2			NORMAL	
P56	1	Y DEF YOKE	CRT		Y DEF YOKE			5-H
	2	Y DEF YOKE	CRT		Y DEF YOKE			9-05
	3	Y DEF YOKE	CRT		Y DEF YOKE			4-H
P57	1		Q1018		Base			9-1
	2		Q1018		Collector			9-2
	3		Q1018		Emitter			9-3
	4		Q1016		Base			9-4
	5		Q1016		Collector			9-5
	6		Q1016		Emitter			9-6
P58	1		Q1017		Base			9-1
	2		Q1017		Collector			9-2
	3		Q1017		Emitter			9-3
	4		Q1019		Base			9-4
	5		Q1019		Collector			9-5
	6		Q1019		Emitter			9-6
P59	1	X DEF YOKE	CRT		X DEF YOKE			6-H
	2	X DEF YOKE	CRT		X DEF YOKE			9-02
	3	X DEF YOKE	CRT		X DEF YOKE			2-H
P60	1		Q1013		Base			9-1
	2		Q1013		Collector			9-2
	3		Q1013		Emitter			9-3
	4		Q1011		Base			9-4
	5		Q1011		Collector			9-5
	6		Q1011		Emitter			9-6
P61	1		Q1012		Base			9-1
	2		Q1012		Collector			9-2
	3		Q1012		Emitter			9-3
	4		Q1014		Base			9-4
	5		Q1014		Collector			9-5
	6		Q1014		Emitter			9-6
P62	1	+7 VDC	P155	10				2-1
	2	+7 VDC			P1000	77	interchangeable	2-1
	3	+7 VDC			P1000	80		2-1
	4	−7 VDC			P1000	63	interchangeable	7-0
	5	−7 VDC			P1000	66		7-0
	6	+20 VDC			P1000	79		2-4
	7	Signal Gnd ±7 V Return	P1000	74				9-0
	8	GND	P1000	73				0-N
	9	−20 VDC			P1000	65		7-2

WIRE LIST FOR

Deflection Amplifier Board (cont)
P63, P64, P65, P66

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/or JACK	TO PIN	FROM PLUG and/or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P63	1	GND	P158					0-N
	2	GND	P71	2			50 Ω coax	9-1 Shield
	3	DYNAMIC FOCUS	P71	1			50 Ω coax	9-1 Center
	4	$\overline{\text{INT OFF}}$	P72	6				9-5
	5	$\overline{\text{SLU}}$	P1000	17				9-0
	6	−15VDC			P162			7-1
	7	GND			P158			0-N
	8	+5 VDC			P161			2-0
	9	+15 VDC			P163			2-3
P64	1	Y ANALOG			P1000	5	Twisted Pair 8-55	2-N
	2	Y ANALOG Gnd			P1000	1		0-N
	3	X ANALOG Gnd			P1000	7	Twisted Pair 8-N	0-N
	4	X ANALOG			P1000	3		2-N
P65	1	$\overline{\text{HCU}}$	P1000	54				9-8
	2	$\overline{\text{COPY}}$ fm Kybrd or $\overline{\text{COPY}}$ fm Pdstl			P153	3,4		9-04
P66	1	$\overline{\text{HCU}}$			J1005	13	(4014-1/4015-1)	9-8
	2	$\overline{\text{COPY}}$ fm Kybrd or $\overline{\text{COPY}}$ fm Pdstl	J1005	11				9-04

WIRE LIST FOR

High Voltage and Z Axis Board
P70, P71

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/or JACK	TO PIN	FROM PLUG and/or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P70	1	+490 VDC			P160			9-4
	2	+290 VDC			P110	1,2		2-6
P71	1	$\overline{\text{H.C. INTER}}$			J1005	5	4014-1 93 Ω coax	9-7 Center
	2	$\overline{\text{H.C. INTER GND}}$			J1005	6	4015-1	9-7 Shield

WIRE LIST FOR

High Voltage and Z Axis Board (cont)
P72, P73, P74, P75, P76

PLUG or JACK	PIN	SIGNAL NAME	TO		FROM		MISCELLANEOUS	WIRE COLOR CODE
			PLUG and/ or JACK	PIN	PLUG and/ or JACK	PIN		
P72	1	DYNAMIC FOCUS			P63	3		9-1 Center
	2	GND			P63	2	50 Ω coax	9-1 Shield
	3	GND			P1000	31		9-N Shield
	4	$\overline{\text{Z DIS}}$			P1000	25	93 Ω coax	9-N Center
	5	$\overline{\text{FOCUS}}$			P1000	34		9-48
	6	$\overline{\text{INT OFF}}$			P63	4		9-5
	7	H.C.S.			P110	3		9-06
	8	$\overline{\text{BRITE}}$			P1000	39		9-13
P73	1	−15 VDC	H.C. INT Adj.					7-1
	2	H.C. INT			H.C. INT Wiper			9-4
	3	GND	H.C. INT Adj.					0-N
P74	1	+350 VDC			P159			2-7
	2	+175 VDC			P164			2-5
	3	+15 VDC (ref)			P1000	59		2-03
	4	+15 VDC			P163			2-3
	5	+5 VDC			P161			2-0
	6	GND			P158			0-N
	7	−15 VDC			P162			7-1
P75	1	+20 VDC			P1000	76		2-N
	2	GND			P1000	70	Twisted Pair 8-N	0-N
P76	1		Q1032		Collector			9-1
	2		Q1032		Emitter			9-2
	3		Q1032		Base			9-3

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WIRE LIST FOR

Low Voltage Power Supply
P80, P81, P82, P83, P84, P85, P86, P87, P88, P89, P90

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P80	1	+5 VDC	P127	6				2-0
	2	+5 VDC	P127	7				2-0
	3	+5 VDC	P127	8				2-0
	4	+5 VDC	P127	9				2-0
	5	+5 VDC	Speaker					2-0
	6	+5 VDC	J1000	30				2-0
	7	+5 VDC	J1000	78				2-0
	8	+5 VDC						Empty
	9	+5 VDC						Empty
	10	+5 V Sense	P127	10				2-01
P81	1		Q1002		Gate			9-3
	2		Q1002		Anode			9-0
	3		Q1004		Base			9-1
P82	1	−20 VDC	J1000	65				7-2
	2	−20 VDC						Empty
P83	1	−15 VDC						Empty
	2	−15 VDC	P127	5				7-1
	3	−15 VDC	J1000	36				7-1
	4	−15 VDC	J1000	56				7-1
P84	1	+15 VDC						Empty
	2	+15 VDC	P127	4				2-3
	3	+15 VDC	J1000	55				2-3
	4	+15 VDC (ref)	J1000	59				2-03
P85	1	+20 VDC						Empty
	2	+20 VDC	J1000	79				2-4
P86	1	FIL-2	J1000	72				1-N
	2	FIL-1	J1000	49				1-3
P87	1		Q1007		Emitter			7-2
	2		Q1007		Base			9-5
	3		Q1007		Collector			9-4
P88	1		Q1001		Collector			2-4
	2		Q1001		Base			9-6
	3		Q1001		Emitter			9-7
P89	1		Q1009		Collector			2-1
	2		Q1009		Base			9-2
	3		Q1009		Emitter			9-3
P90	1	+290 VDC			J1000	43		2-6
	2	+290 VDC						Empty

WIRE LIST FOR

Low Voltage Power Supply (cont)
P91, P92, P93, P94, P95, P96, P97, P98, P99, P100, P101, P102

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P91	1	+490 VDC	J1000	48				9-4
	2	+490 VDC						Empty
P92	1	12 VAC	J1000	18				9-08
	2	12 VAC	J1000	12				9-07
P93	1	+175 VDC	J1000	67				2-5
	2	+175 VDC						Empty
P94	1	+350 VDC						Empty
	2	+350 VDC	J1000	75				2-7
P95	1	−7 VDC	J1000	63				7-0
	2	−7 VDC	J1000	66				7-0
P96	1	+7 VDC	J1000	77				2-1
	2	+7 VDC	J1000	80				2-1
P97	1	+20 VDC	CR1001		Cathode			2-4
	2	+20 VDC						Empty
P98	1	+20 VDC	J1000	76			Twisted Pair	2-N
	2	GND	J1000	70				0-N
	3	Shield Gnd	J1000	62				8-N (Shield)
P99	1	GND			P125	8		0-N
	2	GND			P127	1		0-N
	3	GND			P127	2		0-N
	4	GND			P127	3		0-N
	5	GND			P129	3		0-N
	6	GND			J1000	64		0-N
	7	GND			J1000	71		0-N
	8	GND			J1000	73		0-N
	9	GND						Empty
P100	1	−20 VDC	CR1004		Anode			7-2
	2	−20 VDC						
P101	1	GND	Q1002		Cathode			0-N
	2	GND	Q1004		Collector			0-N
P102	1	±7 V return			J1000	74		0-9
	2	±7 V return						Empty

WIRE LIST FOR

Storage Board
P110, P111, P112, P113, P114, P115

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P110	1	+290 VDC	P70	2			interchangeable	2-6
	2	+290 VDC	P1000	43				2-6
	3	H.C.S.	P72	7				9-06
	4	$\overline{\text{D BUSY}}$	P1000	50				9-45
	5	$\overline{\text{ERASE}}$			P1000	46		9-47
	6	VIEW			P1000	22		9-46
	7	12 VAC			P1000	18		9-08
	8	12 VAC			P1000	12		9-07
	9	FIL-2			P1000	72		1-N
	10	FIL-1			P1000	49		1-3
P111	1	GND			P158			0-N
	2	+5 VDC			P161			2-0
	3	−15 VDC			P162			7-1
	4	+15 VDC			P163			2-3
	5	+175 VDC			P164			2-5
	6	+350 VDC			P159			2-7
	7	+490 VDC			P160			2-8
P112	1		Q1025		Collector			9-1
	2		Q1025		Base			9-2
	3		Q1025		Emitter			9-3
	4		Q1027		Emitter			9-4
	5		Q1027		Base			9-5
	6		Q1027		Collector			9-6
	7		Q1029		Base			9-7
	8		Q1029		Emitter			9-8
	9		Q1029		Collector			9-N
P113	1		Q1021		Collector			9-1
	2		Q1021		Base			9-2
	3		Q1022		Base			9-3
	4		Q1022		Emitter			9-4
	5		Q1024		Base			9-5
	6		Q1024		Emitter			9-6
P114	1	$\overline{\text{ORIGIN}}$	P51	2				9-1
	2	$\overline{\text{READ}}$	P51	3				9-2
P115	1	GND	P131	1			(4014-1/4015-1)	9-1
	2	H.C.S.	P131	2				9-2
	3	+5 VDC	P131	3				9-3
	4	−15 VDC	P131	4				9-4
	5	+15 VDC	P131	5				9-5

WIRE LIST FOR

Storage Board (cont)
P116, P117, P118

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P116	1	TARGET	P132	1				9-1
	2	CE-2	P132	2				9-2
	3	CE-1	P132	3				9-3
	4	FIL-2	P132	4			(4014-1/4015-1)	9-4
	5	FIL-1	P132	5				9-5
	6	F.G. ANODE	P132	6				9-6
	7	F.G. CATHODE	P132	7				9-7
P116	1	TARGET	P3	1				9-1
	2	CE-2	P3	2				9-2
	3	CE-1	P3	3				9-3
	4	FIL-2	P3	4			(4014/4015)	9-4
	5	FIL-1	P3	5				9-5
	6	F.G. ANODE	P3	6				9-6
	7	F.G. CATHODE	P3	7				9-7
P117	1		Q1023		Emitter			9-1
	2		Q1023		Collector			9-2
	3		Q1023		Base			9-3
P118	1	$\overline{\text{WAIT}}$			J1005	14		9-05
	2	$\overline{\text{READ}}$			J1005	9		9-7

WIRE LIST FOR

Mother Board
P120, P125

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P120	1	$\overline{\text{LED 2}}$	J1000	8				9-7
	2	$\overline{\text{SHIFT}}$	Minibus	30	J1000	20		9-26
	3	$\overline{\text{BREAK}}$	Minibus	L	J1000	44		9-18
	4							Empty
	5	$\overline{\text{HCU}}$	Minibus	J	J1000	54		9-8
	6	$\overline{\text{RESET}}$ (HOME)	Minibus	F	J1000	26		9-38
	7	$\overline{\text{PAGE}}$	Minibus	E	J1000	42		9-27
P125	1							Empty
	2	$\overline{\text{LED 1}}$	J1000	28	Minibus	25		9-23
	3	$\overline{\text{COPY}}$			Minibus	$\overline{\text{C}}$		Empty
	4	VIEW	J1000	22	Minibus	22		9-46
	5					19		Empty
	6	$\overline{\text{SPEAK}}$	Speaker		Minibus			9-28
	7	$\overline{\text{SW 1}}$	Minibus	Z	J1000	27		9-5
	8	GND	P99					0-N
	9	$\overline{\text{SW 2}}$	Minibus	X	J1000	14		9-05

WIRE LIST FOR

Mother Board (cont)
P127, P129

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P127	1	GND	P99					0-N
	2	GND	P99					0-N
	3	GND	P99					0-N
	4	+15 VDC			P84			2-3
	5	−15 VDC			P83			7-1
	6	+5 VDC			P80			2-0
	7	+5 VDC			P80			2-0
	8	+5 VDC			P80			2-0
	9	+5 VDC			P80			2-0
	10	+5 V Sense	P80	10				2-01
P129	1	$\overline{\text{LOCAL}}$	Minibus	H	J1000	51		9-01
	2							Empty
	3	GND	P99					0-N
	4							Empty
	5							Empty
	6							Empty

WIRE LIST FOR

Jumper Board (4014/4015)
P132

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P132	1	TARGET			P116	1		9-1
	2	CE-2			P116	2		9-2
	3	CE-1			P116	3		9-3
	4	FIL-2			P116	4		9-4
	5	FIL-1			P116	5		9-5
	6	F.G. ANODE			P116	6		9-6
	7	F.G. CATHODE			P116	7		9-7

WIRE LIST FOR

Jumper Board (4014/4015) (cont)
P133, P134

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P133	1	TARGET	CRT		TARGET		50Ω coax	9-N Center
	2	TARGET Gnd	CRT		TARGET Shield			9-N (Shield)
	3	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	4	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	5	CE-1	CRT		CE-1			9-5
	6	CE-2	CRT		CE-2			9-3
	7	F.G. ANODE	CRT		F.G. ANODE			9-6
	8	F.G. ANODE	CRT		F.G. ANODE			9-6
	9	F.G. ANODE	CRT		F.G. ANODE			9-6
	10	F.G. ANODE	CRT		F.G. ANODE			9-6
P134	1	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	2	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	3	FIL-1	CRT		FIL-1			9-1
	4	FIL-1	CRT		FIL-1			9-1
	5	FIL-1	CRT		FIL-1			9-1
	6	FIL-1	CRT		FIL-1			9-1
	7	FIL-2	CRT		FIL-2			9-2
	8	FIL-2	CRT		FIL-2			9-2
	9	FIL-2	CRT		FIL-2			9-2
	10	FIL-2	CRT		FIL-2			9-2

WIRE LIST FOR

Hard Copy Amplifier (4014-1 and 4015-1)
P130, P131, P132

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P130	1	$\overline{\text{TARSIG}}$	J1005	7			93Ω coax	9-8 Center
	2	$\overline{\text{TARSIG}}$ Gnd	J1005	8				9-8 Shield
P131	1	GND			P115	1		9-1
	2	H.C.S.			P115	2		9-2
	3	+5 VDC			P115	3		9-3
	4	−15VDC			P115	4		9-4
	5	+15 VDC			P115	5		9-5
P132	1	TARGET			P116	1		9-1
	2	CE-2			P116	2		9-2
	3	CE-1			P116	3		9-3
	4	FIL-2			P116	4		9-4
	5	FIL-1			P116	5		9-5
	6	F.G. ANODE			P116	6		9-6
	7	F.G. CATHODE			P116	7		9-7

WIRE LIST FOR

Hard Copy Amplifier (4014-1 and 4015-1) (cont)
P133, P134

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P133	1	TARGET	CRT		TARGET		50Ω coax	9-N Center
	2	TARGET Gnd	CRT		TARGET Shield			9-N Shield
	3	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	4	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	5	CE-1	CRT		CE-1			9-5
	6	CE-2	CRT		CE-2			9-3
	7	F.G. ANODE	CRT		F.G. ANODE			9-6
	8	F.G. ANODE	CRT		F.G. ANODE			9-6
	9	F.G. ANODE	CRT		F.G. ANODE			9-6
	10	F.G. ANODE	CRT		F.G. ANODE			9-6
P134	1	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	2	F.G. CATHODE	CRT		F.G. CATHODE			0-N
	3	FIL-1	CRT		FIL-1			9-1
	4	FIL-1	CRT		FIL-1			9-1
	5	FIL-1	CRT		FIL-1			9-1
	6	FIL-1	CRT		FIL-1			9-1
	7	FIL-2	CRT		FIL-2			9-2
	8	FIL-2	CRT		FIL-2			9-2
	9	FIL-2	CRT		FIL-2			9-2
	10	FIL-2	CRT		FIL-2			9-2

WIRE LIST FOR

DISPLAY CONTROL
P139, P140 and P141

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P139	1	$\overline{\text{FUZZY}}$	J46	1				9-1
	2	GND		2				9-2
	3	NOT USED		3				9-3
	4	$\overline{\text{NEW}}$		4				9-4
P140	1	FOCUS	J1000	34				9-48
	2	BRITE	J1000	39				9-13
	3	ERASE	J1000	46				9-47
	4	MC	J1000	21				9-04
	5	WRITE-THRU INT			J1000	52		9-1
	6	Z DIS	J1000	25			93Ω coax	9-N Center
	7	GND	J1000	31				9-N Shield
	8	D BUSY			J1000	50		9-45
	9	SLU			J1000	17		9-0

WIRE LIST FOR

Display Control Card (cont)

P141

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P141	1	$\overline{\text{Z NORM}}$						
	2	$\overline{\text{FP Ø}}$						
	3	$\overline{\text{DR Ø}}$						
	4	Z GRAPHICS					for optional 4014/4015 Display Multiplexer	
	5	Z WRITE						
	6	SELECT						
	7	$\overline{\text{Z MUX}}$						
	8	GND						

WIRE LIST FOR

Display Interconnect Board

P150, P151, P152

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P150	1	$\overline{\text{APL}}$	P153	2			(ASCII/APL Switch and APL LED pin 1)	9-25
	2	$\overline{\text{COPY}}$	P153	4			(AUTO PRINT/COPY Switch)	9-04
	3						Empty	
	4	$\overline{\text{LOCAL}}$	P153	5			(LOCAL/LINE Switch)	9-01
	5	$\overline{\text{ASCII}}$	P153	6			(ASCII/APL Switch)	9-36
	6	$\overline{\text{SW 1}}$	P153	7			Switch 1 Center	9-5
	7	$\overline{\text{LED 1}}$	LED 1	1				9-23
	8	$\overline{\text{LED 2}}$	LED 2	1				9-7
	9	$\overline{\text{SW 2}}$	P153	10			Switch 2 Center	9-05
P151	1	GND					Control Panel Switches and Indicators	0-N
	2	+5 VDC					Write-Thru Intensity Pot	2-0
	3	−15VDC					X and Y position pots	7-1
	4	+15 VDC					Write-Thru Int. and X & Y position pots	2-3
P152	1	X POT	P155	1			X position wiper	9-28
	2	Y POT	P155	2			Y position wiper	9-02
	3	$\overline{\text{FULL LED}}$	FULL LED	1				9-03
	4	$\overline{\text{AUTO PRINT}}$	P155	4			(AUTO PRINT/COPY Switch)	9-2
	5	WRITE-THRU INT	P155	5			Write-Thru Int. wiper	9-13
	6	MARG 1	P155	6			Margin Control Switch	9-06
	7	MARG 2	P155	7			Margin Control Switch	9-37
	8	$\overline{\text{LED 3}}$	LED 3	1				9-24
	9	$\overline{\text{SW 3}}$	P155	9			Switch 3 Center	9-6
	10	+7 VDC	POWER pilot lamp		P155	10		2-1

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WIRE LIST FOR

Display Interconnect Board (cont)
P153, P155, P156, P158, P159, P160

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P153	1	$\overline{\text{APL}}$	P8	7			interchangeable	9-25
	2	$\overline{\text{APL}}$	P1000	41	P150	1		9-25
	3	$\overline{\text{COPY}}$ fm Pdstl	P65	2			interchangeable	9-04
	4	$\overline{\text{COPY}}$ fm Kybrd	P150	2	P1000	21		9-04
	5	$\overline{\text{LOCAL}}$	P1000	51	P150	4		9-01
	6	$\overline{\text{ASCII}}$	P1000	29	P150	5		9-36
	7	$\overline{\text{SW1}}$	P1000	27	P150	6		9-5
	8	$\overline{\text{LED 1}}$	P150	7	P1000	28		9-23
	9	$\overline{\text{LED 2}}$	P150	8	P1000	8		9-7
	10	$\overline{\text{SW2}}$	P1000	14	P150	9		9-05
P155	1	X POT	P1000	60	P152	1		9-28
	2	Y POT	P1000	13	P152	2		9-02
	3	$\overline{\text{FULL LED}}$			P1000	58		9-03
	4	$\overline{\text{AUTO PRINT}}$	P1000	16	P152	4		9-2
	5	WRITE-THRU INT	P1000	52	P152	5		9-13
	6	$\overline{\text{MARG 1}}$	P1000	33	P152	6		9-06
	7	$\overline{\text{MARG 2}}$	P1000	35	P152	7		9-37
	8	$\overline{\text{LED 3}}$		8	P1000	47		9-24
	9	$\overline{\text{SW3}}$	P1000	15	P152	9		9-67
	10	+7 VDC		10	P62	1,2,3		2-1
P156	1	$\overline{\text{LED 1}}$	220Ω pullup		LED 1	2	anode	9-14
	2	$\overline{\text{APL LED}}$	68Ω pullup		APL LED	2	anode	9-1
	3	$\overline{\text{LED 2}}$	68Ω pullup		LED 2	2	anode	9-67
	4	$\overline{\text{LED 3}}$	68Ω pullup		LED 3	2	anode	9-8
	5	$\overline{\text{FULL LED}}$	68Ω pullup		FULL LED	2	anode	9-01
P158	1	GND			P1000	4		0-N
	2	GND	P63	1				0-N
	3	GND	P63	7			interchangeable	0-N
	4	GND	P74	6				0-N
	5	GND	P111	1				0-N
P159	1	+350 VDC			P1000	75		2-7
	2	+350 VDC	P74	1			interchangeable	2-7
	3	+350VDC	P111	6				2-7
P160	1	+490 VDC			P1000	48		9-4
	2	+490 VDC	P70	2			interchangeable	9-4
	3	+490 VDC	P111	7				9-4

WIRE LIST FOR

Display Interconnect Board (cont)
P161, P162, P163, P164

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
P161	1	+5 VDC			P1000	78	interchangeable	2-0
	2	+5 VDC	P63	8				2-0
	3	+5 VDC	P74	5				2-0
	4	+5 VDC	P111	2				2-0
P162	1	−15 VDC			P1000	36	interchangeable	7-1
	2	−15 VDC	P63	6				7-1
	3	−15 VDC	P74	7				7-1
	4	−15 VDC	P111	3				7-1
P163	1	+15 VDC			P1000	55	interchangeable	2-3
	2	+15 VDC	P63	9				2-3
	3	+15 VDC	P74	4				2-3
	4	+15 VDC	P111	4				2-3
P164	1	+175VDC			P1000	67	interchangeable	2-5
	2	+175 VDC	P74	2				2-5
	3	+175 VDC	P111	5				2-5

WIRE LIST FOR

P1000 Pedestal-Display Connection

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
J1000	1	Y ANALOG GND	P64	2	P36	3		0-N
	2	Y ANALOG Shield	Cut at Deflection Amplifier Board		P36	1	Twisted Pair 8-55	8-55 Shield
	3	X ANALOG	P64	4	P36	5	Twisted Pair 8-N	0-N
	4	GND	Pedestal Gnd Lug		Display Gnd Lug			0-N
	5	Y ANALOG	P64	1	P36	2	Twisted Pair 8-55	2-N
	7	X ANALOG Gnd	P64	3	P36	4	Twisted Pair 8-N	0-N
	8	$\overline{\text{LED 2}}$	P153	9	P120	1		9-7
	10	KBIT 5	P21	15	P8	L		9-3
	11	X ANALOG Shield			P36	6	Twisted Pair 8-N	Shield
	12	12 VAC	P110	8	P92	2	Elevated at 290 V	9-07
	13	Y POT	P21	2	P155	2		9-02
	14	$\overline{\text{SW2}}$	P125	9	P153	10		9-05
	15	$\overline{\text{SW3}}$	Open Plug in Pedestal		P155	9		9-67
	16	$\overline{\text{AUTO PRINT}}$	P21	14	P155	4		9-2
	17	$\overline{\text{SLU}}$	P140	9	P63	5		9-0
	18	12 VAC	P110	7	P92	1	Elevated at 290 V	9-08
	20	$\overline{\text{SHIFT}}$	P120	2	P8	H		9-26
	21	$\overline{\text{COPY}}$	P153	3,4	P140	4	FROM P125 pin 3	9-04

WIRE LIST FOR

P1000 Pedestal-Display Connector (cont)

PLUG or JACK	PIN	SIGNAL NAME	TO		FROM		MISCELLANEOUS	WIRE COLOR CODE
			PLUG and/ or JACK	PIN	PLUG and/ or JACK	PIN		
J1000	22	VIEW	P110	6	P125	4		9-46
	23	KBIT 7	P21	11	P8	K		9-34
	24	KBIT 8	P21	5	P8	9		9-12
	25	$\overline{\text{Z DIS}}$	P72	4	P140	6	93Ω coax	9-N Center
	26	$\overline{\text{RESET}}$	P120	6	P8	B		9-38
	27	$\overline{\text{SW1}}$	P125	7	P153	7		9-5
	28	$\overline{\text{LED 1}}$	P153	8	P125	2		9-23
	29	$\overline{\text{ASCII}}$	P10	2	P153	6		9-36
	30	+5 VDC	P8	5,E	P80			2-0
	31	$\overline{\text{Z DIS}}$ Gnd	P72	3	P140	7	93Ω coax	9-N Shield
	32	KBIT 2	P21	10	P8	R		9-17
	33	MARG 1	P21	4	P155	6		9-06
	34	$\overline{\text{FOCUS}}$	P72	5	P140	1		9-48
	35	MARG 2	P21	3	P155	7		9-37
	36	−15 VDC	P162		P83			7-1
	37	$\overline{\text{K STROBE}}$	P21	7	P8	6	Twisted Pair 8-22	2-N
	38	KBIT 3	P21	12	P8	P		9-15
	39	$\overline{\text{BRITE}}$	P72	8	P140	2		9-13
	40	K STROBE	P21	6	P8	F	Twisted Pair 8-22	0-N
	41	$\overline{\text{APL}}$	P10	1	P153	1,2		9-25
	42	$\overline{\text{PAGE}}$	P120	7	P8	A		9-27
	43	+290 VDC	P90		P110	1,2		2-6
	44	$\overline{\text{BREAK}}$	P120	3	P8	3		9-18
	45	KBIT 1	P21	18	P8	S		9-14
	46	$\overline{\text{ERASE}}$	P110	5	P140	3		9-47
	47	$\overline{\text{LED 3}}$	P155	8	Open Plug in Pedestal			9-24
	48	+490 VDC	P160		P91			9-4
	49	FIL-1	P110	10	P86	2		1-3
	50	$\overline{\text{D BUSY}}$	P140	8	P110	4		9-45
	51	$\overline{\text{LOCAL}}$	P129	1	P153	5		9-01
	52	WRITE-THRU INT.	P140	5	P155	5		9-1
	53	KBIT 4	P21	16	P8	N		9-16
	54	$\overline{\text{HCU}}$	P120	5	P65	1		9-8
	55	+15 VDC	P163		P84			2-3
	56	−15 VDC	P8	4	P83			7-1
	57	KBIT 6	P21	19	P8	11		9-35
	58	$\overline{\text{FULL LED}}$	P155	3	P21	13		9-03
	59	+15 VDC (Ref)	P74	3	P84			2-03
	60	X POT	P21	20	P155	1		9-28
	62	GND	Cut at N.V. Board		P98	3	Twisted Pair 8-N	Shield
	63	−7 VDC	P62	4,5	P95			7-0
	64	GND	P99		P158			0-N
	65	−20 VDC	P62	9	P82			7-2
	66	−7 VDC	P62	4,5	P95			7-0
	67	+175 VDC	P164		P93			2-5
	70	GND	P75	2	P98	2	Twisted Pair 8-N	0-N

WIRE LIST FOR

P1000 Pedestal-Display Connection (cont)

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
	71	GND	P8	8,J	P99			0-N
	72	FIL-2	P110	9	P86	1		1-N
	73	GND	P99		P62	8		0-N
	74	±7 VDC RETURN SIGNAL GND	P102		P62	7		0-9
	75	+350 VDC	P159		P94			2-7
	76	+20 VDC	P75	1	P98	1	Twisted Pair 8-N	2-N
	77	+7 VDC	P62	1,2,3	P96			2-1
	78	+5 VDC	P161		P80			2-0
	79	+20 VDC	P62	6	P85			2-4
	80	+7 VDC	P62	1,2,3	P96			2-1
	82	GND	Pedestal Ground Lug		Display Ground Lug			0-N

*See Wire Lists for TC-2 Card (P20 and P21) for signal destination. Differences in destination are due to board changes.

WIRE LIST FOR

Hard Copy Connector (4014-1/4015-1) J1005

PLUG or JACK	PIN	SIGNAL NAME	TO PLUG and/ or JACK	TO PIN	FROM PLUG and/ or JACK	FROM PIN	MISCELLANEOUS	WIRE COLOR CODE
1005	1	FAST RAMP	P50	3			Twisted Pair 8-22	2-N
	2	FAST RAMP Gnd	P50	4				0-N
	3	SLOW RAMP	P50	2			Twisted pair 8-N	2-N
	4	SLOW RAMP Gnd	P50	1				0-N
	5	$\overline{\text{H.C. INTER}}$	P71	1			93Ω coax	9-7 Center
	6	$\overline{\text{H.C. INTER}}$ Gnd	P71	2				9-7 Shield
	7	$\overline{\text{TARSIG}}$			P130	1	93Ω coax	9-8 Center
	8	$\overline{\text{TARSIG}}$ Gnd			P130	2		9-8 Shield
	9	$\overline{\text{READ}}$	P118	2				9-7
	10	GND	Ground lug					0-N
	11	$\overline{\text{COPY}}$ fm Kybrd $\overline{\text{COPY}}$ fm Pdstl			P66	2		9-04
	12							Empty
	13	$\overline{\text{HCU}}$	P66	1				9-8
	14	$\overline{\text{WAIT}}$	P118	1				9-05
	15	GND	Ground lug					0-N

INTRODUCTORY BLOCK DIAGRAMS

BASIC CONCEPTS OF COMPUTER/TERMINAL COMMUNICATIONS

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.).

Refer to the Computer/Terminal Communications block diagram. 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 computer can speak and act only through the use of binary numbers. The job of the computer then, 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 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.

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 Unit to give a visual representation on the display screen of the data interchange between the operator and the computer.

The Display Unit 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 for 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 that, as a result of the operator's depressing any one of its keys, produces a binary data word that is distinctive for that key. This binary representation of the depressed key 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. This circuitry also 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 Unit, 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 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 because of the low frequency response of the telephone lines; therefore, 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.

PEDESTAL CIRCUITRY BLOCK DIAGRAM DESCRIPTION

General

This information provides an over-view of Terminal logic functions for those cards that plug into the Terminal minibus on the standard Terminal. One exception is that the Discrete Plot Card, included as part of Option 34 (Enhanced Graphics Module), is also discussed.

Standard Terminal logic operation is controlled by the six logic cards listed below.

1. Computer Interface Card
2. TC-1 Card
3. TC-2 Card
4. TC-3 Card
5. Character Generator Card
6. Display Control Card

The Discrete Plot Card would be a seventh card. However, for this card to be installed, the Minibus Extender (which is an option) must also be installed. Each card has 72 interconnecting pins. Corresponding pins on each card are connected to one another by a plug-in connector board. This connector board is called the minibus. It is designed to accommodate transmission between any devices connected to it.

Data is placed on 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 storbe $\overline{\text{TSTROBE}}$ 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 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.

$\overline{\text{CPUNT}}$ (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 $\overline{\text{CPUNT}}$ to inhibit the Terminal and any other device (other than the Interface) from placing data on the minibus.

Transmitting Operation (From Keyboard)

Refer to the Pedestal Circuitry Block Diagram. When data is entered at the keyboard, the key pressed causes equivalent codes to be sent to the Multiplexer on eight parallel lines: $\overline{\text{KBIT 1}}$—$\overline{\text{KBIT 8}}$. The eighth bit is either high or low, depending on the way it is wired at the keyboard. Keyboard strobe signals, termed KSTROBE and $\overline{\text{KSTROBE}}$, accompany the keyboard bits to the Multiplexer. When on line, the strobe signals cause the computer strobe signal ($\overline{\text{CSTROBE}}$) to go active and cause the Multiplexer to place the keyboard bits on the minibus as $\overline{\text{BIT 1}}$—$\overline{\text{BIT 8}}$. Then $\overline{\text{CSTROBE}}$ strobes the bits into the Interface Card, from where they are sent to the computer. If the $\overline{\text{ECHO}}$ signal from the Interface Card is low, $\overline{\text{TSTROBE}}$ goes active along with $\overline{\text{CSTROBE}}$. 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 $\overline{\text{CPUNT}}$ signal from the Interface appears to prepare the Terminal. Then $\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$ are received, accompanied by $\overline{\text{TSTROBE}}$, which enters the Input Decoder and Timing circuitry. If a character is to be written, it is indicated by $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$, which cause the circuit to generate an $\overline{\text{ALPHA}}$ signal. This signal begins the character generation process by latching character code bits $\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$ into the Character Generator. Other signals follow from the Input Decoder and Function Timer to control the character generation process. The Character Generator sends X and Y MATRIX signals to the X and Y Digital to Analog (D/A) converter circuits on TC-3. $\overline{\text{TBUSY}}$ goes active during character generation, preventing reception of more data until the character is drawn. The X and Y DEFLECTION signals to the Display Unit change in accordance with the X and Y MATRIX signals. The decoded $\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$ data bits cause $\overline{\text{Z}}$ to go active at those matrix positions that are necessary to form the character. WRITE is a signal that goes active for the duration of the character generation process. Both WRITE and Z enter the Display Control circuitry which then determines proper active time of the Z DIS signal for each active Z signal. Z DIS enters the Display Unit to turn on the writing beam.

If the data bits contain the code for a Control Character, it is also indicated by the BIT 6—BIT 7 combination, and detected by the Input Decoder. The Input Decoder then outputs SPECIAL FUNCTION signals as commanded by the Control Character. For example, if the data bits contain the Control Character code for a BS (BACKSPACE), the Input Decoder and Timer circuits apply signals to the Output Control circuits that, in turn, output the required number of pulses on the LEFT line. At the same time, TBUSY goes active until the function is completed, to prevent other Terminal activity. The LEFT pulses decrement the digital output of the X Register, causing the output of the X and Y D/A circuits to change accordingly. Thus, the display beam moves left one character space.

When receiving in Alpha Mode, data can be displayed in a focused, defocused, or write-thru configuration. Defocused ALPHA only occurs in the smaller two character sizes. These three are program selectable. The focused mode is also set when the Terminal is initialized as is the large character size. Code selection for a display mode consists of an ESC Display Character sequence. An ESC Control Character causes the LCE (Last Character was Escape) signal to go active from the Input Decoding circuits. LCE "arms" the Display Control circuitry which in turn monitors the next character placed on the minibus. If the bit content of the next character states that the data that follows is to be defocused, then the Character Generator dot moving circuitry is enabled via FUZZY from the display control board. This causes the written character to become slightly defocused. If the bit content of the Display Character selects the Write-Thru display, then the SELW signal goes active. SELW enters the Input Decoder and Timing circuits that set the Character Generator Control and Timing signals to the Character Generator for Write-Thru operation. The Z signal from the Character Generator increases to four times its normal speed. However, because the Display Control circuits are enabled for Write-Thru operation, active Z pulses cause the Z DIS signal to go active only long enough to make the characters visible but not store. Thus, in Write-Thru, the data must be continually "refreshed" by the computer to be useful.

Refer back to keyboard. A signal termed LOCAL inputs to the Multiplexer. If the LOCAL/LINE switch is in LOCAL, LOCAL goes active. No data can be sent to the computer under this condition. Both TSTROBE and CSTROBE go active in response to keyboard inputs; however, LOCAL prevents the interface from responding to CSTROBE. Only TSTROBE is responded to and the results will be effectively the same as explained for Receiving Operation.

Receiving Operation; Graph Mode

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 and WRITE signals may go active to draw the vector. The Graph Mode description is divided into two sections; Standard Circuit Operation, and Optional Circuit Operation.

Refer to the Pedestal Circuitry Data Flow Block Diagram. When the Control Character bits for a GS are received by the Interface card, TSTROBE and CPUNT go active. BIT 1—BIT 7 are placed on the minibus. The Input Decoder and Timer circuits are activated by TSTROBE, and from BIT 6 and BIT 7 detect that a Control Character has been received. It then causes the Decoder to decode the remaining data bits (BIT 1—BIT 5) to initiate the Special Function signals that set Terminal logic for Graph Mode. The next data bits received from the computer contain the first character of the coordinate address. BIT 6 and BIT 7 are decoded and the BYTE LOAD signal goes active, loading BIT 1—BIT 5 into the Graphic Data Latches. 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 bits into X Register and 10 bits 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 address bits of the input data. The X and Y DIGITAL signals input to the X and Y Digital to Analog (D/A) Converter circuits on TC-3, there they provide an address to which the beam is to be deflected. The D/A Converters begin changing the X and Y DEFLECTION voltages at a constant rate, and the beam moves to the addressed point.

The receipt of the last address character also activates Special Function Signals that enable the Z and WRITE signals from the Output Control circuits when a vector is to be drawn. These signals enter the Display Control circuitry to activate the Z DIS signal, causing the beam to be turned on as it is being deflected. When the X and Y DEFLECTION voltages equal their respective X and Y DIGITAL counterparts, ENDCOUNT goes active, entering the Output Control circuit to disable the Z and WRITE signals, and beam movement stops.

Vector display can also be program selected to be defocused, or write-thru vectors. Operation for focused and defocused vectors is similar to that described for Alpha Mode Receiving. For Write-Thru, the Display Control circuits modulate the Z DIS signal at a rate that prevents vectors from storing.

Optional Circuit Operation (Enhanced Graphics Module). The following information pertains to a Terminal that contains the Enhanced Graphics Module—Option 34. Option 34 extends the graphic capabilities of the Terminal by providing additional graphic modes of Point Plot, Special Point Plot, and Incremental Plot modes. In addition, the display resolution is increased from 1024 to 4096 and various vector types (dotted, dot-dashed, short-dashed, and long-dashed) can be drawn.

Vector drawing is similar to that previously discussed for the Standard Terminal. However, increasing the display resolution to 4096 requires 12 bits of address data for each axis. This necessitates the use of a fifth or "Extra" byte in the address sequence (The Extra Byte is the second byte in time sequence of the address). 4096 addressing requires the use of a different TC-2 card that contains an Extra Byte Latch. This latch retains the two least significant bits of both the X and Y address and presents them to the X and Y Registers upon receipt of the last byte of the graphic address. The vector is then drawn as previously explained for the Standard Terminal.

The Enhanced Graphic Module also includes the use of a different Display Control Card to enable the dotted, dot-dashed, etc. vectors to be drawn upon program command. As with defocused and write-thru displays, and ESC Display Character sequence must be received by the Terminal. With LCE active, the bit content of the following character is monitored to determine display status. Then, every displayed vector drawn thereafter, is displayed as a normal (solid), dotted, dot-dashed, short-dashed, or long-dashed vector, as per the bit content of the Display Character. The Display Character that sets the vector type can also set defocused or write-thru operation.

As part of the Enhanced Graphics Module (Option 34) the Discrete Plot Card provides the additional graphic modes of Point Plot, Special Point Plot, and Incremental Point Plot. These modes function as follows:

Point Plot mode uses the same addressing sequence as normal Graph Mode; however, only the end points of the vector are plotted. Point Plot is enabled when the computer, via the Interface Card, sends the Control Character FS. FS is directly decoded by the Discrete Plot Card that controls when the $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ signals go active to write the point. When the BYTE LOAD SIGNALS indicate that the last byte of the point address has been received, the beam begins moving toward the addressed point. However, note that the Discrete Plot Card is also monitoring the Byte Load Signals. When the last byte is received the Discrete Plot Card activates the $\overline{\text{END COUNT}}$ signal that inhibits the normal $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ signals that occur as a result of the last graphic address byte. $\overline{\text{END COUNT}}$ remains active for a pre-determined time. This ensures enough time for the deflection circuitry to reach the address and stablize. When $\overline{\text{END COUNT}}$ goes inactive $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ are enabled from the Discrete Plot Card. These signals enter the Display Control Card where they cause $\overline{\text{Z DIS}}$ to go active to write the point.

Special Point Plot is enabled by the ESC FS sequence. Receipt of the ESC Control Character causes LCE to go active from the Input Decoder circuits on TC-1. This enables the following FS Control Character to set Point Plot operation. Special Point Plot uses the same point addressing as previously described, except for the Intensity Character that must precede each point address. During the reading of the Intensity Character, the Terminal's response to that character is inhibited by $\overline{\text{TSUP}}$. The pulse width of the $\overline{\text{Z}}$ signal (from the Discrete Plot Card; is then determined by the Intensity Character. If switched out of Special Point Plot Mode into Point Plot or Incremental Plot, the beam intensity set by the intensity character is retained.

Incremental Plot provides one register point of beam movement in one of eight directions as per the increment character. Bit content determines not only direction of movement but also whether the beam is turned on or off.

Receipt of the RS Control Character sets the Incremental Plot mode. The Increment Character that follows determines whether the $\overline{\text{LEFT}}$, $\overline{\text{RIGHT}}$, $\overline{\text{UP}}$, or $\overline{\text{DOWN}}$ signal go active. these signals control the beam position registers on TC-2 that, in turn, deflect the beam one register point. (Register Points are synonomous with minipoints. Four minipoints equal one Tekpoint.) After a predetermined time allowed for beam positioning, $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ go active to write the point. Plotter Control Signals comparable to the $\overline{\text{LEFT}}$, $\overline{\text{RIGHT}}$, $\overline{\text{UP}}$, $\overline{\text{DOWN}}$ and $\overline{\text{Z}}$ signals are available as outputs to an outboard mechanical plotter.

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. An optional joystick may also be used to position the crosshair cursor.

Refer to the Pedestal Circuitry Block Diagram. The control character sequence (ESC SUB) that initiates the GIN Mode is received from the computer and causes the Input Decoder to output a $\overline{\text{CURSE}}$ 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 $\overline{\text{CURSE}}$ signal, the Crosshair Generator circuit sends $\overline{\text{DOWN}}$ 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 analog value, outputting it as the Y DEFLECTION voltage to the Display Unit. The Crosshair Generator sets the $\overline{\text{Z}}$ line active at a rep rate that ensures no gaps appear in the displayed crosshair. The $\overline{\text{Z}}$ pulses input to the Display Control card that shortens the $\overline{\text{Z DIS}}$ pulse width to ensure the crosshair does not store. 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 $\overline{\text{RIGHT}}$ 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 $\overline{\text{TSTROBE}}$ signal. $\overline{\text{CBUSY}}$ goes active during the time it takes the Terminal to transmit the data bits. When the Terminal completes the transmitting process. $\overline{\text{CBUSY}}$ goes inactive. This causes the Multiplexer to send an active $\overline{\text{GO DIGITIZE}}$ 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 $\overline{\text{PT FOUND}}$ 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 $\overline{\text{BIT 6}}$ high and $\overline{\text{BIT 7}}$ low and generates the $\overline{\text{CSTROBE}}$ signal. This causes the data to be sent to the computer.

NOTE

Installation and use of the Enhanced Graphic Module (Option 34) does not change the Graphic Input sequence. Graphic Input remains at 20 bits of X and Y data.

The computer can also request the coordinates of the crosshair cursor by sending the control character ESC followed by the control character ENQ. When ENQ is decoded by the Input Decoder, the $\overline{\text{INQUIRE}}$ signal to the Multiplexer goes low. The operation of the Graphic Input circuitry is then the same as if $\overline{\text{CBUSY}}$ 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 Input Decoder sends the $\overline{\text{INQUIRE}}$ signal to the Multiplexer, which places Terminal status bits on the $\overline{\text{BIT 1}}$—$\overline{\text{BIT 5}}$ lines, (along with $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$) and then generates a $\overline{\text{CSTROBE}}$ signal. The Interface Card generates $\overline{\text{CBUSY}}$ while it sends the status bits to the computer. When through, $\overline{\text{CBUSY}}$ ends. Its trailing edge causes the Multiplexer to remove the status bit from the $\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$ lines. Again $\overline{\text{CSTROBE}}$ is generated and the Interface generates $\overline{\text{CBUSY}}$. When $\overline{\text{CBUSY}}$ 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. Provided the CR is not echoed by the computer.

DISPLAY UNIT CIRCUITRY BLOCK DIAGRAM DESCRIPTIONS

General

Refer to the Block Diagram of the Display Unit. The Display Unit displays, on the crt (cathode ray tube), the information prepared in the Pedestal. Upon command, it makes information stored on the crt available for printing by the optional Hard Copy Unit that may be connected to the 4014-1 or 4015-1 Terminals. The Display Unit communicates with the Pedestal and Hard Copy Unit through control lines and analog voltages representing operations and graphic coordinates respectively. The Display Unit contains all the circuitry necessary to manipulate the crt for the writing, storing, reading, and erasing of information patterns. The writing portion of the Display Unit consists of a High Voltage and Z Axis Board, a Deflection Amplifier Board, X and Y Deflection Yoke, and the writing components of the crt — namely the Beam Cathode, Control Grid, and Focus Electrode. The storage section consists of the Storage Board and the storage components of the crt — the Flood Gun Cathode, Flood Gun Anode, Collimation Electrodes (CE-1, CE-2), and the Target. Hard copy description pertains only to the 4014-1 and 4015-1 Terminals. The hard copy circuitry consists of the Deflection Multiplexer (in all terminals), special logic circuitry included on the Storage Board, and the High Voltage and Z Axis Board, and the Hard Copy Target Signal Amplifier board (4014-1/4015-1 only). Assume that future references to hard copy operation are applicable to the 4014-1 and 4015-1 only.

High Voltage and Z Axis Board

The High Voltage and Z Axis Board controls the writing beam acceleration, intensity, and focus. From the Pedestal, $\overline{\text{Z DIS}}$ activates the writing beam. $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ control writing beam focus and writing beam intensity. $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ are asserted in accordance with the selected display mode controlled by the Pedestal. $\overline{\text{INT OFF}}$ indicates a malfunction in the Deflection Amplifiers and, when asserted, turns the writing beam off. Writing beam intensity is determined by the voltage between the Beam Cathode and the Control Grid. The amount of focus is determined by the voltage on the Focus Electrode. When the 4014-1 or 4015-1 is in the hard copy mode and producing a hard copy, the H.C.S. (Hard Copy Switch) signal goes true, enabling the writing beam to be controlled by $\overline{\text{H.C. Inter}}$ (interrogation pulse form the Hard Copy Unit). H.C.S. also selects the writing beam intensity compatible with making a hard copy.

Deflection Amplifier Board

The Deflection Amplifier Board contains three sections. The Deflection Multiplexer provides for selection of the Hard Copy Unit deflection signals. The Geometry Correction and Dynamic Focus section provides signals for writing-beam deflection correction and focus correction. The Deflection Amplifiers establish the magnetic field in the deflection yoke necessary to position the writing beam.

The Deflection Multiplexer uses the READ signal from the Storage Board to determine which unit (the Pedestal or the Hard Copy Unit) is to control the writing beam deflection. READ is normally low causing X ANALOG and Y ANALOG from the Pedestal to supply the deflection coordinate information (X COORD and Y COORD). During hard copy operation, READ is true causing SLOW RAMP and FAST RAMP to provide the deflection coordinate information.

An Origin Shifter is also included in the Deflection Multiplexer circuits. The Origin Shifiter modifies the deflection coordinate information (X ANALOG and Y ANALOG) from the Pedestal. Eight slightly different settings are available to prolong the life of the crt. During an erase cycle, $\overline{\text{ORIGIN}}$ may trigger the Origin Shifter to establish a new reference for the following page of written information, thus ensuring that no point on the face of the crt is repetitively written from page to page. The action of the Origin Shifter may be inhibited by a strap connection on the Deflection Amplifier Board.

The Geometry Correction and Dynamic Focus section uses the deflection coordinates X COORD and Y COORD, which are output from the Deflection Multiplexer, to create the X GEOM, Y GEOM, and DYNAMIC FOCUS signals. X GEOM and Y GEOM provide writing beam displacement correction for the Deflection Amplifiers. DYNAMIC FOCUS provides focus correction for the writing beam, through the High Voltage and Z Axis Board.

The Deflection Amplifiers provide and maintain the deflection currents in the deflection yoke as determined by the analog coordinate inputs. $\overline{\text{SLU}}$ (a temporary wait) is asserted when either Deflection Amplifier is slewing. Slewing is the rapid establishment of a new deflection current different from the present current. $\overline{\text{INT OFF}}$ is asserted when a Deflection Amplifier failure occurs, turning off the writing beam.

Storage Board

The Storage Board controls electrodes in the crt to store, view, and erase information displayed on the Target. $\overline{\text{ERASE}}$ causes the Storage Board to execute an erase cycle during which the electrodes (Target, CE-2, and CE-1) are cycled through a voltage sequence to completely write and erase the display. $\overline{\text{ERASE}}$ is asserted at the Keyboard by pressing the RESET/PAGE key. It is also asserted by an ESC FF control character sequence from the Computer. $\overline{\text{ORIGIN}}$ is asserted during the erase cycle to shift the deflection reference for the next page of stored information. When VIEW is high, the flood gun electrodes are activated to enhance stored information and make it visible. $\overline{\text{READ}}$ and $\overline{\text{WAIT}}$ are inputs from the optional Hard Copy Unit that demand control of the Display Unit. As the result of a hard copy command, the Hard Copy Switch (H.C.S.) and READ signals are generated to enable the optional hard copy circuitry in the Deflection Multiplexer, Hard Copy Target Signal Amplifier, and the High Voltage and Z Axis Board. $\overline{\text{D BUSY}}$ is asserted both during an erase cycle and when the Hard Copy Unit is making a copy of the display.

Hard Copy Target Signal Amplifier

The Hard Copy Target Signal Amplifier is optional and made available on the 4014-1 and 4015-1. Display information, $\overline{\text{TARSIG}}$, is made available to the Hard Copy Unit from this board. The H.C.S. signal enables the Hard Copy Target Signal Amplifier to prepare a $\overline{\text{TARSIG}}$ output when an interrogate pulse ($\overline{\text{H.C. INTER}}$) activates the Z Axis.

Hard Copy Operation (4014-1 & 4015-1)

Hard copy operation pertains only to the 4014-1 and 4015-1. Whenever a $\overline{\text{MAKE COPY}}$ signal is initiated on the keyboard, or is initiated by an ESC ETB sequence from the computer, the MAKE COPY command is applied to the Hard Copy Unit (H.C.U.) where it causes several outputs. A $\overline{\text{READ}}$ signal and a $\overline{\text{WAIT}}$ signal are applied to the Storage Board indicating that a hard copy is either being made or is to be made. READ, and H.C.S. (Hard Copy Switch) signals are produced to enable the operation of hard copy circuitry in the Display Unit. READ is the inverse of $\overline{\text{READ}}$ which is asserted by the H.C.U. while it processes the display to make a hard copy. $\overline{\text{D BUSY}}$ is asserted to disable the keyboard during hard copy operation. $\overline{\text{WAIT}}$ is asserted to hold the Terminal inactive while the H.C.U. processes the display of another terminal; this is a hard copy multiplex option.

The Hard Copy Unit provides a positive-going slow ramp to the X Deflection circuits causing the Terminal to sweep horizontally one time. As it sweeps, a succession of fast ramps is supplied to the Y Deflection circuits. This causes repetitive vertical sweeps during the horizontal sweep. During each fast ramp, the H.C.U. supplies a repetitive interrogate signal ($\overline{\text{H.C. INTER}}$) to the Z Axis to turn the writing beam on. If writing exists on the Target at the position indicated by the deflection circuits, the resultant current in the target surface causes a $\overline{\text{TARSIG}}$ signal to be output from the Hard Copy Target Signal Amplifier Board. The ramp signals are supplied to the Readout circuits in the H.C.U. at the same time they are being provided to the Terminal, permitting both units to be evaluating the same point on the display.

When READ is high, the Deflection Multiplexer selects the SLOW RAMP and FAST RAMP analog signals for the deflection coordinates. On the High Voltage and Z Axis Board, H.C.S. enables the hard copy intensity circuits to be set for hard copy making. H.C.S. also enables the Z Axis to be activated by the $\overline{\text{H.C. INTER}}$ (Hard Copy Interrogate) signal. On the Hard Copy Target Signal Amplifier, H.C.S. enables target display information to be output as $\overline{\text{TARSIG}}$.

4014 and 4014-1

KEYBOARD DESCRIPTION

General Description

Refer to the keyboard schematic. The 4014 and 4014-1 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 KBIT1 through KBIT7; to develop strobe output labeled KSTROBE and $\overline{\text{KSTROBE}}$ (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. It should be noted that only the keys in the main cluster on the keyboard are represented on the keyboard schematic. Other switches and indicators on the keyboard panel are located off the keyboard and are shown on the Display Interconnecting diagram.

Assume that characters are being entered at the keyboard. The oscillator generates a symmetrical output pulse that is applied to Z1 and 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 the Character Decoder holds a low on the Z10 gate, causing the output of Z21 to remain high. This inhibits outputs from the Character Output Gates. KSTROBE is held low and $\overline{\text{KSTROBE}}$ is held high 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 reaches a code that selects the closed key. Since the 4 LSB Counter continues to cycle, a low is eventually placed on the closed key. This low is applied to the Character Detector, causing its W output to go high. This high provides enabling voltage to Z10 in the Strobe Generator. When the Ø1 output of the oscillator goes high, it causes a negative going INHB pulse of about 22 ms duration. An INHA pulse from Z10 is input to the oscillator to prevent additional clock pulses from affecting the 4 LSB Counter.

With the count from the 4LSB and 4 MSB Counters frozen, the B5, B6, and B7 logic circuits place the decoded equivalents of the B5, B6, and 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 KBIT 1—KBIT 7 lines the representative bit combination of the character pressed. $\overline{\text{INHB}}$ going low enables the KSTROBE and $\overline{\text{KSTROBE}}$ signals that accompany the data bits.

$\overline{\text{INHB}}$ also triggers the Character Repeat Oscillator. If the same key is held down for more than about 1/2 second, the Character Repeat Oscillator strobes Z21 in the Strobe Generator at an approximately 10 Hz repetition rate. This enables the Strobe signals 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 its output to return to its high state. This ends the KBIT1—KBIT7 and Strobe outputs.

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 KBIT1—KBIT7 to represent the upper-case alpha character. Pressing the CONTROL (CTRL) key causes the output bit configuration to represent a control character. Pressing TTY permits only upper-case alpha bit configurations to be structured. The $\overline{\text{ALT}}$ signal is reserved for use when an optional character set has been installed in the Terminal. The effect of the TTY key is nullified should an alternate character set be installed and selected. Thus, TTY inputs from the keyboard are inhibited if an optional character set has been installed.

4015 and 4015-1 KEYBOARD DESCRIPTION

General

Refer to the 4015 and 4015-1 Keyboard schematic. The keyboard provides seven encoded bits to indicate which character key has been depressed. In addition, it produces KSTROBE and $\overline{\text{KSTROBE}}$ signals to accompany the bits. $\overline{\text{SHIFT}}$, $\overline{\text{PAGE}}$, $\overline{\text{RESET}}$, and $\overline{\text{BREAK}}$ signals are also originated on the keyboard. It should be noted that only the keys in the main cluster on the keyboard are represented on the keyboard schematic. Other switches and controls on the keyboard panel are located off the keyboard and are shown on the Display Interconnecting Diagram.

Character Encoding

When a character key is pressed, the resulting interconnection at Z2 causes the built-in encoder to stop when that character's binary equivalent is reached. The code present on the KBIT1 through KBIT7 lines then represents that character. If the SHIFT key is held down during key entry, shifted character code is emitted by Z2. If the CTRL key or CTRL and SHIFT keys are held down during letter key entry, control character code is produced.

TTY Operation

If ASCII is selected ($\overline{\text{APL}}$ is high) and the TTY key is pressed, it causes the $\overline{\text{TTY}}$ signal to go low. $\overline{\text{TTY}}$ and its complement TTY input to Z4A to cause KBIT6 to limit ASCII letter key output to upper-case code, regardless of the SHIFT key position. This action continues until the TTY key is pressed once again to release Z4 from its TTY state. If APL is selected ($\overline{\text{APL}}$ is low) and the TTY key is pressed, TTY (from Pin 3 of Z5) goes low and $\overline{\text{TTY}}$ goes high. This allows shifted key outputs when the APL character set is selected.

KSTROBE Repeat Circuit

Feedback from the KSTROBE output is applied to an integrator circuit to prevent Z2 from cycling the KSTROBE signal for about 1/2 second. If a character key is held down for more than about 1/2 second, the $\overline{\text{KSTROBE}}$ output cycles low and high at an approximate 10 Hz rate, effectively causing the character to be transmitted repeatedly.

PAGE/SHIFT/RESET Circuit

When pressed alone, the Page key causes a $\overline{\text{PAGE}}$ output. If either Shift key is pressed, it causes a $\overline{\text{SHIFT}}$ signal to be sent to the Terminal circuits, in addition to being applied to the CR4—Q3 junction. And if PAGE is pressed while $\overline{\text{SHIFT}}$ is active, the pin 8 output of Z5C is disabled and the pin 11 output of Z5D goes active, generating a $\overline{\text{RESET}}$ signal.

TC-1 BLOCK DIAGRAM DESCRIPTION

Introduction

TC-1 is divided into three major groups of operation; Decoding, Timing, and Output Control blocks. Fig. 5-3 shows the relationship of these three groups of circuitry.

The Decoding circuitry decodes the 7-bit ASCII code into one of 22 specific Decode Control signals. These signals input directly to the Timing circuitry, the Output Control circuitry, the minibus, or other control cards. The majority of the Decode Control signals input to the Timing Circuitry. The Timing Circuitry responds to the Decode Control signals by initiating proper Function Control Timing signals for the majority of Terminal Functions. The Function Control Timing and Decode Control signals control the Output Control Circuitry to set the proper Function Control signals that enable the function to be performed.

DECODING CIRCUITRY

Function Decoding

Refer to the TC-1 Block Diagram and the TC-1 Schematic. An illustration of the TC-1 component locations is located on the apron of the schematic. The Function Decoding section of TC-1 contains the following circuits.

Home—When power is turned on, this circuit outputs the $\overline{\text{HOME}}$ signal that sets Terminal logic to initial conditions — Alpha Mode, etc.

TSTROBE Gating—A circuit that recognizes valid data to be decoded by TC-1, and generates proper strobe timing signals.

Page Selector—Decodes minibus data to control outputs from the Function Decoder, depending on which "page" (Alpha, Graf, Bypass, or LCE) is selected.

Function Decoder—Provides one of 22 distinct outputs as controlled by the outputs from the Page Selector.

Decode Timer—Provides proper timing for the decoded function to occur.

Alpha Character Detector—Detects an alpha character on the minibus.

Escape F/F—Signals the Page Selector to interpret the next character to perform an LCE Function.

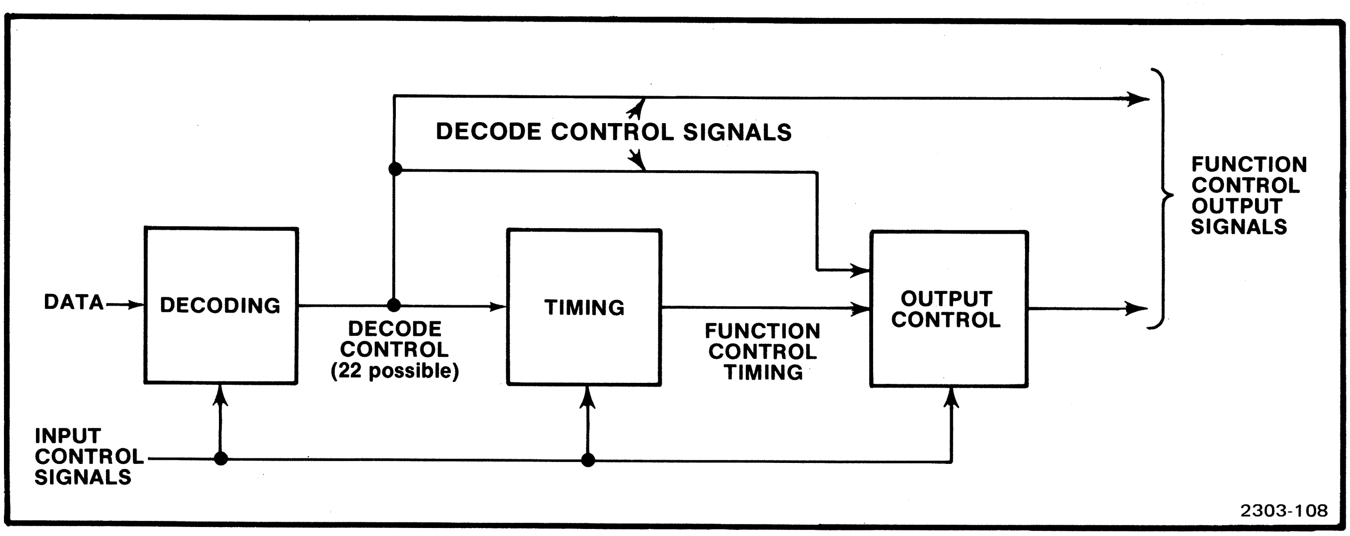

Fig. 5-3. TC-1 Simplified Block Diagram.

Operation of the above circuits is given as a unit and not individual block descriptions. Assume that Power is on and data to be processed by the Terminal is on the minibus.

Power On Effects

When power is turned on the Home circuit pulls down on the HOME line. A low HOME signal sets the logic to Alpha Mode by setting the outputs of the following circuits as shown in Table 5-2.

TABLE 5-2

Circuits Controlled By Home

Circuit	Signal	State
GRAF F/F	$\overline{\text{GRAF}}$	HI
	$\overline{\text{NOLI}}$	LO
Character Size Selector	$\overline{\text{CHAR A}}$	LO
	$\overline{\text{CHAR B}}$	LO
ASCII/APL F/F	$\overline{\text{ASCII}}$	LO
Make Copy	$\overline{\text{MAKE COPY}}$	HI
Escape F/F	LCE	LO

Decoding

Data on the minibus that is to be processed by the Terminal is accompanied by $\overline{\text{TSTROBE}}$. As long as $\overline{\text{BTSUP}}$ and $\overline{\text{TSUP}}$ are inactive, $\overline{\text{TSTROBE}}$ enables the STROBE and TSTROBE signals from the TSTROBE Gating circuit. STROBE triggers complimentary 400 ns PAUSE signals from the Decode Timer Circuit. If the character on the minibus is not a control character (determined by $\overline{\text{BIT 6}}$ or $\overline{\text{BIT 7}}$ being low), the Alpha Character Detector circuit generates an "Early Alpha" ($\overline{\text{ALPHAE}}$) signal. $\overline{\text{ALPHAE}}$ enters the Alpha Cursor Suppress circuit, and is also sent to the Character Generator as a preparatory signal that "prepares" the Character Generator for character generation. ALPHAE remains true approximately 400 ns.

When data is placed on the minibus it is decoded by the Page Selector Read Only Memory (ROM). The ROM is constantly enabled and controls five output lines to the Function Decoder. (Up to 32 distinct 5-bit codes can be set by the Page Selector ROM; however, only 22 are used by the standard Terminal.) When the $\overline{\text{400 ns}}$ signal ends, the 5-bit decoded output is enabled form the Output Latches (part of the Page Selector ROM). This $\overline{\text{400 ns}}$ timing pause ensures that data has had sufficient time to be decoded by the ROM. Fig. 5-4 shows the timing for data coding.

Note that data is present on the minibus 600 ns prior to $\overline{\text{TSTROBE}}$. As previously mentioned, $\overline{\text{TSTROBE}}$ enables the 400 ns pause. Thus, a time of 1 μs (600 ns + 400 ns) ensures that the ROM has had sufficient time to decode the data before output from the ROM is enabled.

When the 400 ns PAUSE signal ends, the $\overline{\text{DECODE ENABLE}}$ signal from the Decode Timer is enabled. This signal enables the Function Decoder to begin decoding the 5-bit code input from the Page Selector ROM. $\overline{\text{DECODE ENABLE}}$ ends on the trailing edge of $\overline{\text{TSTROBE}}$.

The Function Decoder decodes the 5-bit input into one of 22 outputs. For example, if the character on the minibus was an alphanumeric character, the 5-bit code input would all be Ø's, causing the $\overline{\text{ALPHA}}$ signal to be enabled. This signal would then cause the Character Generator to begin generating the character.

Page Selection. As previously stated, all data placed on the minibus is decoded by the Page Selector ROM. "Page" refers to the type of effect (if any) the 128 ASCII characters have on the Terminal. Every character that is to be processed by the Terminal sets a corresponding 5-bit code to the Function Decoder. This 5-bit code depends on the page (or mode) of Terminal operation. For example, most of the character codes of columns 2-7 (of the ASCII or APL Code Chart received during Alpha mode) cause the Page Selector to output a 5-bit code to the Function Decoder that, in turn, enables the $\overline{\text{ALPHA}}$ signal. However, any of these characters received during Graph Mode cause an entirely different decode output from the Page Selector ROM. In this case, the 5-bit code input to the Function Decoder causes either $\overline{\text{HIY}}$, $\overline{\text{LOY}}$, $\overline{\text{HIX}}$, or $\overline{\text{LOXE}}$ outputs to go active as determined by the 7-bit code on the minibus.

The signals that control page selection are NOLI, ECHSP, and ESC. Pages are, ALPHA, GRAPH, BYPASS and LCE (Bypass is set when Gin Mode is selected. It can also be selected by ESC CAN). Table 5-3 shows the page selection for the various states of the Page Select Signals.

TABLE 5-3

Page Selection

Page Selection	Page Control Signals $\overline{\text{NOLI}}$	$\overline{\text{ECHSP}}$	$\overline{\text{ESC}}$
LCE	Lo	Lo	Lo
ALPHA	Lo	Lo	Hi
LCE	Lo	Hi	Lo
BYPASS	Lo	Hi	Hi
LCE	Hi	Lo	Lo
GRAPH	Hi	Lo	Hi
LCE	Hi	Hi	Lo

Table 5-4 shows the decode output from the Function Decoder for distinct combinations of the 5-BIT outputs from the Page Selector ROM.

NOTE

The LCE page supercedes any other previously selected page. For example, the LCE Page can be selected from Graph, and when the character that follows ESC performs its "escape" function, the system will remain in the Graph Page, unless a CR, US, etc. has exited Graph.

Escape Flipflop

This circuit controls the LCE page. When an ESC control character is decoded by the Page Selector ROM and the FUNCITON DECODER, and $\overline{\text{ESC}}$ signal sets LCE active from the ESCAPE Flipflop. The LCE signal remains active only until the trailing edge of the $\overline{\text{TSTROBE}}$ signal that accompanies the character that followed ESC. When the $\overline{\text{TSTROBE}}$ that accompanies the second character ends, LCE goes inactive; that is if the second character is not another ESC.

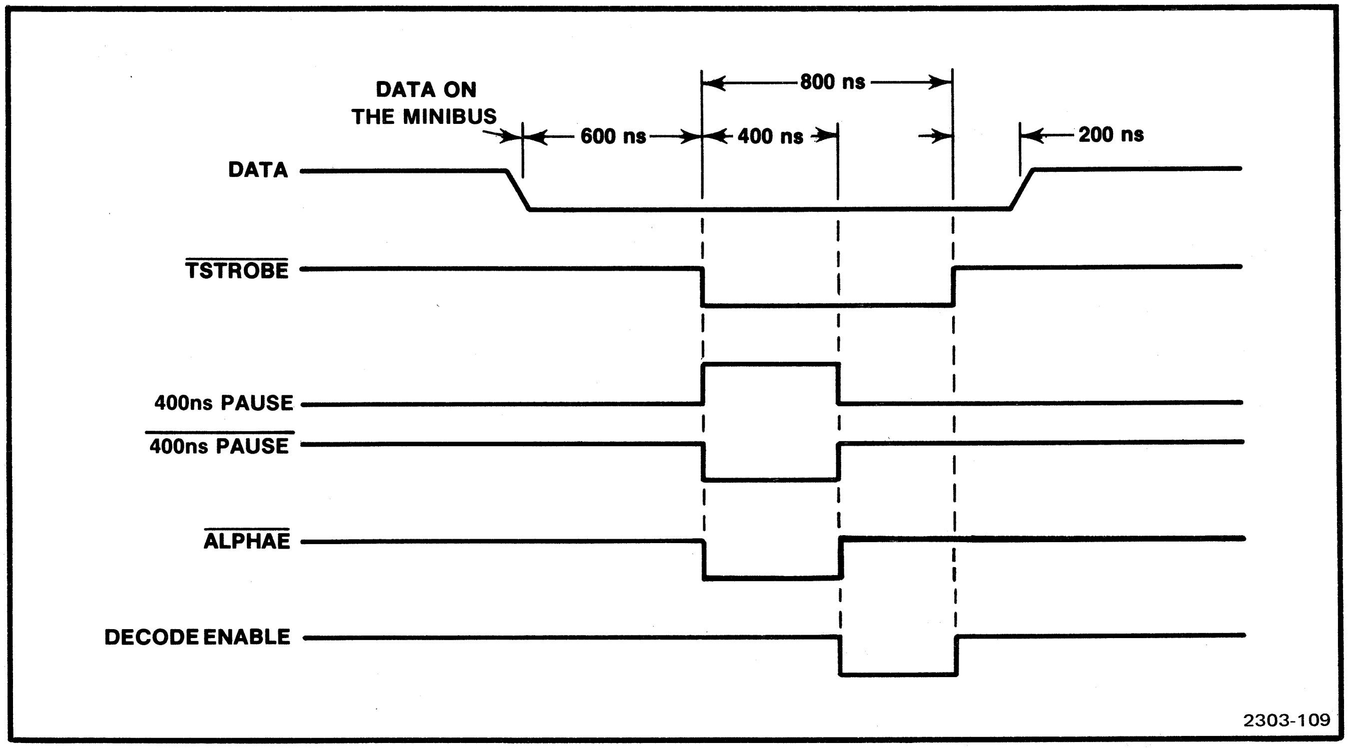

Fig. 5-4. Timing for data coding.

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TABLE 5-4
DECODING

5-BIT ROM OUTPUT 16_2	8_2	4_2	2_2	1_2	FUNCTION DECODER OUTPUT	FUNCTION INITIATED BY DECODER OUTPUT AS PER PAGE SELECTION: ALPHA	GRAPH	GIN or BYPASS	ESCAPE (LCE)
0	0	0	0	0	ALPHA[1]	Enables Character Generator to begin generating the character			
0	0	0	0	1	CR	Carriage Return	Set Alpha and perform Carriage Return	Set Alpha and perform Carriage Return	Set LCE active
0	0	0	1	0	BEL	Ring Bell	Ring bell	Ring Bell	Ring Bell
0	0	0	1	1	US		Set Alpha	Set Alpha	Set Alpha
0	0	1	0	0	HT	Space right one			Space right one
0	0	1	0	1	BS	Space left one			Space left one
0	0	1	1	0	VT	Move one line up			Move one line up
0	0	1	1	1	LF[5]	Move one line down	Move one line down	Move one line down and reset bypass.	Set LCE active.
0	1	0	0	0	Not Used				
0	1	0	0	1	GS	Set Graph page & Dark Vector	Dark Vector	Set Graph page & Dark Vector	Set Graph page & Dark Vector
0	1	0	1	0	ETB[2]				Make Copy
0	1	0	1	1	FF[2]	Erase & Home	Erase & Home	Erase & Home	
0	1	1	0	0	Not Used				
0	1	1	0	1	Not Used				
0	1	1	1	0	Not Used				
0	1	1	1	1	Not Used				
1	0	0	0	0	ESC	Set LCE	Set LCE	Set LCE	Set ESC (LCE active)
1	0	0	0	1	ASCII[2]			SI resets bypass	Select ASCII char set if in Alpha
1	0	0	1	0	APL[2]				Select APL[3] char. Set if in Alpha
1	0	0	1	1	LOY (ESC?)				LOY for GRAPH if RUBOUT can't be used
1	0	1	0	0	CH SIZE STB[4]	Char. Size Strobe			Change Char. Size Strobe
1	0	1	0	1	Not Used				
1	0	1	1	0	Not Used				
1	0	1	1	1	Not Used				
1	1	0	0	0	LOY		LOY for GRAPH if RUBOUT is used		
1	1	0	0	1	HIX or HIY		Set HIX or HIY		
1	1	0	1	0	CAN				Set Bypass
1	1	0	1	1	LOXE		Execute Vector		
1	1	1	0	0	Not Used				
1	1	1	0	1	Not Used				
1	1	1	1	0	ENQ[2]				Set INQUIRE active
1	1	1	1	1	SUB[2]	Set Bypass (GIN) Mode	Set Bypass (GIN) Mode		Set GIN Mode

[1]Active when an alphanumeric character is detected in Alpha Mode.
[2]Must be preceded by ESC.
[3]APL Character Set in 4015 and 4015-1 Terminals only.
[4]Goes active when ESC is followed by either the 8, 9, : or ; characters.
[5]If LF follows GS, the first vector is written. However, LF will cause beam to be positioned accordingly.

TIMING CIRCUITRY

General

This group of circuitry contains the System Clock and function timing logic. It receives input signals from the Decoding Circuitry and the minibus, to control cusor positioning and other functions such as timing pauses when switching out of graphics, when initiating a carriage return.

The Timing Circuitry contains the following circuits:

System Clock—Provides timing signals for TC-1 and other Terminal Circuits.

Load Pulse Generator—Provides a pulse that loads preset count data into the Function Timer.

Count Selector—Provides the majority of Preset count inputs for the Function Timer.

Function Timer—Controls the initiation and the timing of the majority of Terminal functions.

LF/CR Circuit—Controls the Terminal effect upon receipt of LF and CR codes.

Vector Control—Outputs signals that control vector drawing.

Character Size Selector—Outputs signals that control character size and cursor movement.

For the most part, the operation of these blocks will be described as a unit.

System Clock

The System Clock is a 4.9152 crystal controlled oscillator that ouputs 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 Function Timer and LF/CR circuits.

LF/CR Circuit

When the Function Decoder outputs an $\overline{\text{LF}}$ signal, the LF/CR Circuit outputs an $\overline{\text{LF}}$ signal to the Count Selector, Load Pulse Generator and the Page Selector ROM circuits. A strap option can enable the CR output to also be generated upon receipt of an $\overline{\text{LF}}$ signal. The LF generated CR also resets the Graf Flipflop to Alpha Mode. The $\overline{\text{CR}}$ signal also inputs to this circuit. It is inverted and outputs on the CR line. A strap option can also enable an $\overline{\text{LF}}$ signal to be generated upon receipt of $\overline{\text{CR}}$.

The $\overline{\text{EOL}}$ input from TC-2 goes active when spacing past the end of a line, activating the linefeed portion of the wraparound feature. It activates $\overline{\text{LF}}$, which in this case inputs to the Page Selector ROM. Here it presets the outputs from the Output Latches to cause the Count Selector outputs to be such that the Function Timer pulses the $\overline{\text{DOWN}}$ line the required number of times to perform the Linefeed.

Load Pulse Generator

Each of seven inputs to this circuit generates a low $\overline{\text{LOAD}}$ pulse that is input to the Count Selector, the Function Timer, and the Vector Control circuit. The Load Pulse generator serves no other purpose. The $\overline{\text{LOAD}}$ pulse is shorter in time than any of the input signals that cause the pulse. Thus, $\overline{\text{LOAD}}$ comes and goes to ensure that valid inputs are loaded into the Count Selector, Function timer and Vector control circuits.

Count Selector and Function Timer

The Count Selector circuit receives inputs from the Function Decoder, Character Size Selector, LF/CR, and Load Pulse Generator circuits. The $\overline{\text{LOAD}}$ signal loads inputs from the Function Decoder, LF/CR, and Character Size Selector circuits into the Count Selector.

Each of the loaded inputs sets a corresponding 8-bit PRESET COUNT code that inputs to the Function Timer. (The $\overline{\text{LOAD}}$ signal remains low long enough for the Count Selector inputs to be decoded and input as the PRESET COUNT to the Function Timer.)

The Function Timer is a Programmable Counter clocked by a 2.45 MHz signal from the System Clock. The Timer counts continuously except when a low is applied on the $\overline{\text{LOAD}}$ line or when $\overline{\text{FPAUSE}}$ goes low, except when a character is being generated. As the Timer circuitry is counting, it is outputting the following square wave signals for use by other TC-1 and Character Generator circuitry.

5 Hz—Used in Make Copy circuitry on TC-1 and the Cursor Refresher circuit on the Character Generator card.

75 Hz, 150 Hz, 300 Hz—Used in the View/Hold circuit.

1200 Hz—Used in the Bell circuit.

614 kHz, 154 kHz—Used in the Write-Thru circuit.

1.22 MHz—Used by the Cursor circuit and circuits on the Character Generator Card.

$\overline{\mathrm{LOAD}}$ loads the PRESET COUNT into the Function Timer, and also pulls down on the $\overline{\mathrm{MSB}}$ signal. The PRESET COUNT inputs from the Count Selector and Vector/Bell circuits "program" the Function Timer to determine the time between the trailing edge of $\overline{\mathrm{LOAD}}$ (when the Timer starts counting) and the Trailing edge of the $\overline{\mathrm{MSB}}$ output (When the most significant bit of the Timer goes high). The low time of the $\overline{\mathrm{MSB}}$ signal determines how long the Terminal stays busy to perform the function. This time depends on the function being performed.

Basic functions controlled by this circuit are linefeed, carriage return, backspace, space, and vertical tab. A "pause" ($\overline{\mathrm{TBUSY}}$) is also provided by this circuit when coming out of graphics and when a US is decoded.

Timing for linefeed ($\overline{\mathrm{LF}}$), backspace ($\overline{\mathrm{BS}}$), vertical tab ($\overline{\mathrm{VT}}$) and horizontal tab ($\overline{\mathrm{HT}}$) depends on the character size selected. Each different character size requires a different PRESET COUNT input for the above four functions. The Preset Count for these functions is controlled by the $\overline{\mathrm{CHAR\ A}}$ and $\overline{\mathrm{CHAR\ B}}$ signals.

Table 5-5 shows the Preset Count that is selected by a specific input, and how it varies (if any) depending on the character size. Note that the table not only provides the 8-bit preset information, but also shows the active time of the $\overline{\mathrm{MSB}}$ signal for each function. The number of 1.22 MHz signals is the number of times the $\overline{\mathrm{DOWN}}$, $\overline{\mathrm{LEFT}}$, $\overline{\mathrm{UP}}$, or $\overline{\mathrm{RIGHT}}$ line is pulsed to increment or decrement either the X or Y position registers on TC-2.

TABLE 5-5
Preset Count Effects

			PRESET COUNT								ACTIVE TIME OF MSB*	NUMBER OF 1.22 MHz CLOCKS**
$\overline{\mathrm{CHAR\ A}}$	$\overline{\mathrm{CHAR\ B}}$	FUNCTION	P8	P7	P6	P5	P4	P3	P2	P1		
1	1	BS	1	1	1	0	0	0	0	1	39	48
1	1	HT	1	1	1	0	0	0	0	1	39	48
1	1	VT	1	1	0	1	0	0	0	0	25	31
1	1	LF	1	1	0	1	0	0	0	0	25	31
1	1	CR	1	1	1	1	0	1	1	1	6.5	9
1	1	US	1	1	1	1	0	1	1	1	6.5	9
1	0	BS	1	1	0	1	1	1	1	0	43	53
1	0	HT	1	1	0	1	1	1	1	0	43	53
1	0	VT	1	1	0	0	1	0	1	1	28	34
1	0	LF	1	1	0	0	1	0	1	1	28	34
1	0	CR	1	1	1	1	0	1	1	1	6.5	9
1	0	US	1	1	1	1	0	1	1	1	6.5	9
0	1	BS	1	1	0	0	1	1	0	1	67	82
0	1	HT	1	1	0	0	1	1	0	1	67	82
0	1	VT	1	0	1	0	1	1	1	0	42	51
0	1	LF	1	0	1	0	1	1	1	0	42	51
0	1	CR	1	1	1	1	0	1	1	1	6.5	9
0	1	US	1	1	1	1	0	1	1	1	6.5	9
0	0	BS	1	1	0	0	1	0	0	0	72	88
0	0	HT	1	1	0	0	1	0	0	0	72	88
0	0	VT	1	0	1	0	1	0	0	0	46	56
0	0	LF	1	0	1	0	1	0	0	0	46	56
0	0	CR	1	1	1	1	0	1	1	1	6.5	9
0	0	US	1	1	1	1	0	1	1	1	6.5	9

***Time is in microseconds.**

****The number of 1.22 MHz clocks shown in this column is actually one more than that shown under the PRESET COUNT Column.**

Vector Control

Under the normal operation, the Vector Control circuit keeps the $\overline{\text{ENABLE}}$ signal high for the first vector following GS. This enables the writing beam to be deflected to the first addressed point without turning on the writing beam. This is a dark vector and occurs because even though the $\overline{\text{LOXE}}$ signal (that commands the vector to be drawn) enters the Load Pulse Generator, causing a $\overline{\text{LOAD}}$ pulse to pull down on the $\overline{\text{MSB}}$ line, the Graph Z Enable circuit cannot activate the $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ signals. However, the receipt of $\overline{\text{LOXE}}$ from the next vector string, causes the $\overline{\text{ENABLE}}$ signal to go low. With MSN low, the $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ signals are enabled. $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ remain active until the $\overline{\text{END COUNT}}$ signal from TC-3 goes low to signify that the beam has been deflected to the new address. $\overline{\text{NOLT}}$ also goes high to enable the vector circuitry on TC-3. Thus a vector is drawn.

OUTPUT CONTROL CIRCUITRY

General

This group of circuitry processes outputs from the Decoding and Timing circuitry as well as inputs from other Terminal control cards. The output control circuits provide control for the Character Generator, Graph mode, bell ringing, copy making, and cursor movement.

Circuits that provide control for the Character Generator are the Character Set Select Circuit, Alpha Cursor Suppress, View/Hold, and Selective Write circuit.

Circuits that provide Graph Mode Control are the Graph Flipflop, the Graphic Byte Decoder, and the Graph Z Enable circuit.

Miscellaneous Circuits are Move Cursor, Make Copy, Bell, and Terminal Busy.

Alpha Mode Control Circuits

Character Set Select Circuit. This circuit outputs the $\overline{\text{ASCII}}$ signal that is used by the Character Generator circuitry to select the ASCII or alternate (APL in 4015) character sets. It receives inputs from the ASCII/APL Character Set Select switch on the Terminal console, or program select inputs from the Function Decoder. The three-position Character Set Select switch causes the $\overline{\text{ASCII}}$ signal from the switch to go low when ASCII is selected. This in turn sets the $\overline{\text{ASCII}}$ signal low to select the ASCII character set on the Character Generator. If the APL or (ALT) position is selected, the $\overline{\text{ASCII}}$ signal goes high and the $\overline{\text{APL}}$ signal goes low. This selects the APL Character set on the 4015.

NOTE

The Character Set Select switch is only operative with the 4015 and 4015-1 and works as an alternate character set selector on the 4014 and 4014-1 only when these two terminals have an alternate character set installed.

Placing the switch to the center position allows the program to select the character set. Thus, the two character sequence of ESC SO (ESC CTRL N from the keyboard) selects the APL character set on the 4015 and 4015-1 Terminals. ESC SI (ESC CTRL O from keyboard) selects the ASCII character set.

Alpha Cursor Suppress Circuit. The SUPPRESS signal is the only output signal generated by this circuit. Its primary purpose is to cause the X and Y Matrix outputs from the Character Generator card to reflect a beam position of the bottom left corner of the character matrix. SUPPRESS goes active when one of the following signals go true.

$\overline{\text{ALPHAE}}$—goes true whenever an alphanumeric character is detected on the minibus. If in Alpha mode this causes the X and Y Matrix outputs from the Character Generator to be in position to begin drawing the character.

$\overline{\text{GIN}}$—goes true in GIN (BYPASS) Mode.

$\overline{\text{GRAPH}}$—goes true in Graph (vector) Mode.

$\overline{\text{DRBUSY}}$—goes true when an optional hard copy unit is making a copy of the display, or the Terminal display is being erased.

When inactive (low), SUPPRESS, along with $\overline{\mathrm{EOL}}$, causes an $\overline{\mathrm{LF}}$ signal to be activated by the CR/LF circuit. This performs the linefeed function of the wraparound feature, as explained in the prevous discussion on the LF/CR circuit. Also when SUPPRESS is low, it enables the operation of the VIEW/HOLD circuit.

View/Hold Circuit. 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, a one-shot multivibrator times out, permitting the VIEW signal to become modulated by the 75, 150, and 300 Hz signals from the Function Timer. This action provides a 12-1/2% duty cycle for the VIEW signal, thus dimming the display. This is known as "Hold" Status. The input signals to the View/Hold circuit must be in the following states before Hold status can occur.

1. SUPPRESS—Low (must be low long enough to permit the "View Multi" to time out).

2. $\overline{\mathrm{HOME}}$—High.

3. $\overline{\mathrm{SHIFT}}$—High.

The display can be returned to normal viewing level by entering new data (other than control characters) or by pressing the SHIFT key.

This circuit also outputs a signal called $\overline{\mathrm{VIEW}}$ to the Cursor Refresher circuit on the Character Generator. When the 90 second period occurs, this signal goes low to inhibit the Alpha cursor during the time the Terminal is in Hold.

If either the $\overline{\mathrm{GRAPH}}$, $\overline{\mathrm{GIN}}$, $\overline{\mathrm{DRBUSY}}$, or $\overline{\mathrm{ALPHAE}}$ signals go active, the SUPPRESS signal from the Alpha Cursor Suppress circuit goes high, preventing Hold Status from occurring. This keeps the displayed information in view.

Write-Thru Circuit. This circuit provides a GOBABY and $\overline{\mathrm{CHRCLK}}$ inputs for the Character Generator Card. When in VIEW (VIEW signal is high) and not in Write-Thru. $\overline{\mathrm{SELW}}$ is high, GOBABY is low and the $\overline{\mathrm{CHRCLK}}$ rep rate is 154 kHz. This is indicative of normal display in Alpha Mode. When in Alpha Mode and VIEW is high and $\overline{\mathrm{SELW}}$ goes low, GOBABY goes high and the $\overline{\mathrm{CHRCLK}}$ rep rate becomes 614 kHz. A low $\overline{\mathrm{SELW}}$ signal indicates Write-Thru operation is selected. The change in CHRCLK rep rate from 154 kHz to 614 kHz is used by the Character Generator to drive the Z Axis signal ($\overline{\mathrm{Z}}$) at a rate that prints the printable characters; yet not at an intensity where it is useful unless it is continually rewritten (refreshed) by the program.

Graph Mode Control Circuits

Graph Flipflop. The Graph Flipflop controls the $\overline{\mathrm{GRAF}}$ and $\overline{\mathrm{NOLI}}$ signals that switch the Terminal in and out of Graph Mode. Decoding the GS Control Character sets the Graph Flipflop. $\overline{\mathrm{GRAF}}$ goes low to set circuitry on other control cards for Graph Mode Operation. $\overline{\mathrm{GRAF}}$ enters the VIEW/HOLD circuit to keep the Terminal from timing into Hold Status while in Graph. $\overline{\mathrm{GRAF}}$ also enters the Alpha Cursor Suppress circuit to activate the SUPPRESS signal to hold the X and Y Matrix outputs of the Character Generator to the bottom left corner of the character matrix. $\overline{\mathrm{NOLI}}$ goes high to enable the vector circuitry on other control cards and also sets the Page Selector ROM to interpret data in the Graph Page.

The $\overline{\mathrm{PAGE}}$, $\overline{\mathrm{CURSE}}$, and $\overline{\mathrm{HOME}}$ signals reset the Graph Flipflop to Alpha Mode ($\overline{\mathrm{NOLI}}$ goes low, $\overline{\mathrm{GRAF}}$ goes high). Control Characters US and CR also reset to Alpha Mode, as do the two character sequences of ESC SUB and ESC FF.

Graphic Byte Decoder. When the Terminal receives graphic plot data, it arrives in a sequence of 4 seven-bit bytes (5 bytes if the Enhanced Graphic Module—Option 34—is being used) for each coordinate point addressed. Five of the bits contain steering data. The steering data designates the specific byte as being High Order Y (Hi Y or High Order X (Hi X), Low Order Y (Lo Y), and Low Order X (Lo X), received in that order. The Graphic Byte Decoder operates in the following manner.

This circuit is set by $\overline{\mathrm{GS}}$ to generate the graphic byte output signals $\overline{\mathrm{HIY}}$, $\overline{\mathrm{LOY}}$, $\overline{\mathrm{HIX}}$, and $\overline{\mathrm{LOXE}}$. These signals are used to load their respective 5-bit graphic bytes into the Data Latches on TC-2. The bit content of each character is decoded by the Page Selector ROM, which inputs data to the Function Decoder, that in turn, decodes the $\overline{\mathrm{HIY}}$, $\overline{\mathrm{LOY}}$, $\overline{\mathrm{HIX}}$, and $\overline{\mathrm{LOXE}}$ signals. When the Terminal receives a GS control character, it activates the $\overline{\mathrm{GS}}$ signal from the Function Decoder. This signal sets the Graphic Plot Mode as previously explained. With $\overline{\mathrm{NOLI}}$ inactive (high), the Page Selector ROM now interprets $\overline{\mathrm{BIT\ 6}}$ and BIT 7 as Byte Enable information for the Graphic Byte Decoder. The graphic byte code bits are shown in Table 5-6.

TABLE 5-6

Graphic Byte Code Bits

Byte	Bit 7	Bit 6	Contents
HIY	0	1	Most significant 5 bits of Y
LOY	1	1	Least significant 5 bits of Y
HIX	0	1	Most significant 5 bits of X
LOX	1	0	Least significant 5 bits of X

Notice that the Hi Y and Hi X bits have the same bit 7 and bit 6 configuration. The problem of interpreting byte content is accomplished by the GS signal, the Lo Y byte, and the Lo X byte. The GS signal sets the Graphic Byte Decoder to interpret the first high order code as being Hi Y. The Lo Y code, causes the Graphic Byte Decoder to interpret the next high order code as Hi X. Each time a vector is executed by the LOXE signal, the circuit resets to recognize the next high order byte as Hi Y. Circuit operation is the same, even if the Enhanced Graphic Module (Option 34) is being used. The Extra Byte contains the BIT 6, BIT 7 combination for Lo Y; therefore, a second sequential Lo Y byte causes the graphic information contained in that byte to be loaded into the Extra Byte Latch on TC-2.

Lo X is the last Byte of the vector string to be decoded. It outputs directly to the minibus (as LOXE) and is used as an input to TC-2. There, it jams all 20 bits (24 for optional 4096 addressability) into the registers to begin drawing the vector. LOXE also inputs to the Load Pulse Generator and Vector/Bell Control circuits to perform functions as previously described in the description of these circuits.

Notice that the GIN signal inputs to the Graphic Byte Decoder. Its purpose is to inhibit the Decoder during the sending of graphic input data to the computer.

Graph Z Enable. This circuit activates the Z and WRITE signals in Graph Mode. It's operation has been discussed in the description of the Vector Control circuit.

DEL IMPLIES LOY Strap. This strap is available for those systems that cannot use RUBOUT as a Low Order Y code. The DEL→LOY selection is the standard strap setting that permits RUBOUT to be decoded as Lo Y. The DEL position prevents RUBOUT from having effect on the graphic address circuitry; instead, the ESC ? sequence can be substituted for the RUBOUT code. Thus, sending ESC ? allows the Graph circuitry to function just as though RUBOUT were being used. The DEL→LOY setting actually permits either RUBOUT or ESC ? to be used as a particular Lo Y code.

Miscellaneous Circuits

Bell Circuit. When the control character BEL is received, BEL goes low from the Function Decoder. BEL inputs to U101A which is an approximate 50 ns one shot which enables the 1200 Hz tone to the speaker.

Make Copy Circuit. The MAKE COPY signal is activated when an ESC ETB sequence is decoded by the Function Timer and Page Selector ROM. The width of this pulse is controlled by the 5 Hz signal from the Function Timer. HOME sets the MAKE COPY signal inactive.

Terminal Busy. This circuit sets the TBUSY signal active for the duration of the MSB, MAKE COPY, BEL and DRBUSY signals. TBUSY inhibits the reception of data from the computer, or auxiliary devices, when using flagged interfaces.

Move Cursor Circuit. This circuit provides increment or decrement commands for the X and Y Registers on TC-2 whenever a BS, LF, or VT control character is decoded. The HT output from the Function Decoder goes active upon receipt of either a SPACE character or an HT control character. Note also that a CHAR COMP signal (from the Character Generator) also enables an HT signal from U251D. These signals establish preset inputs, dependent on character size selected, for the Function Timer. The Function Timer, in turn, sets the MSB signal low for the time determined by the PRESET COUNT input. MSB enables the 1.22 MHz signal to clock the LEFT, RIGHT, UP, or DOWN line the required number of times. The Move Cursor Circuit is not enabled until the 5-BIT ROM OUTPUT signals indicate either the BS, HT, VT, or LF code respectively. Table 5-7 shows the Tekpoint movement for character spacing and line movement as determined by the character size selected. Refer back to Table 5-5 for the Preset Count effects on he LEFT, (BS), RIGHT (HT), UP (VT), and DOWN (LF) signals.

TABLE 5-7

Cursor Movement For (in Tekpoints) Different Character Sizes

Char Size	Char Per Line	Lines Per Display	Spacing (BS and HT) In Tekpoints	Line Movement (VT and LF) In Tekpoints
A	74	35	14	22
B	81	38	12.75	20.5
C	121	58	8.5	13.25
D	133	64	7.75	12.25

CHARACTER GENERATOR
BLOCK DIAGRAM DESCRIPTION

INTRODUCTION

Overview of Character Generation

Refer to the Character Generator Block Diagram and the schematic, as necessary. The schematic apron shows component locations for the Character Generator.

The Character Generator Card performs those operations pertinent to the generation of ASCII and APL writing characters and the alpha cursor. Future references to APL can be assumed to be true for the 4015 and 4015-1 Terminals only.

The principal operations of character generation are:

1. Sequentially place the writing beam to each of 16 vertical positions (rows) in each of 8 horizontal positions (columns) to form a 9Y by 7X matrix for character writing. See Fig. 5-5.

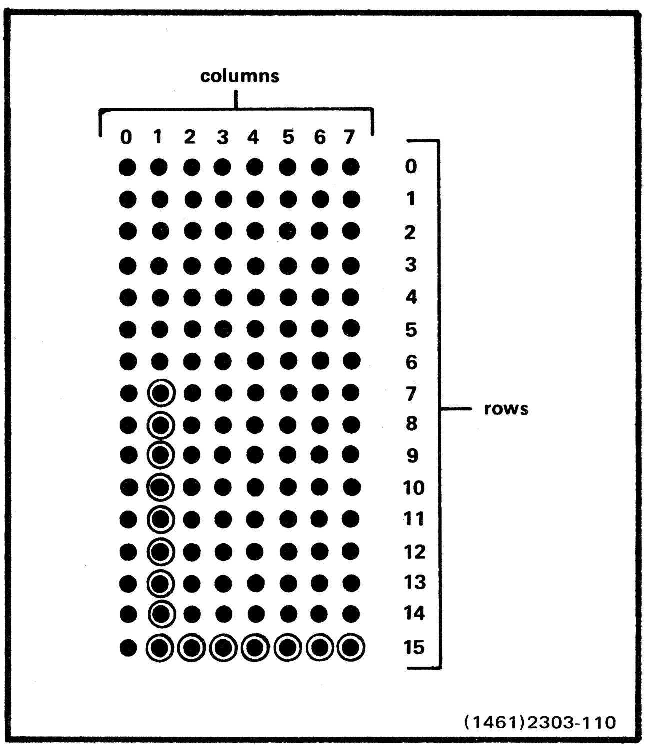

Fig. 5-5. Dots indicate the matrix generated by the Row Counter and Column Counter. No dots can be written when column Ø or row Ø through row 6 are selected.

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. 5-6.

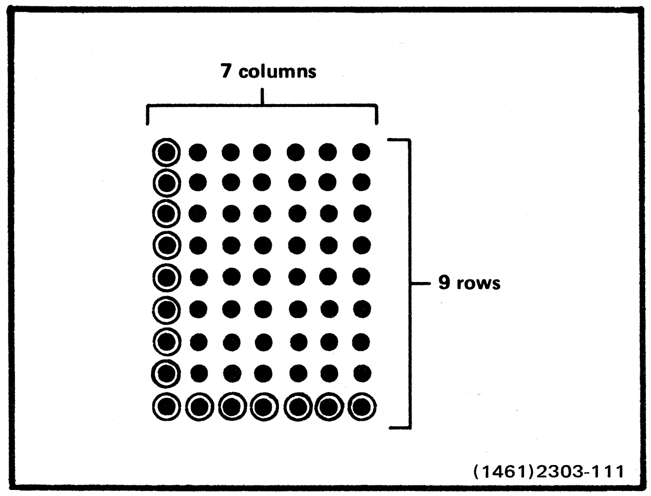

Fig. 5-6. Dots indicate matrix positions for character writing. Circles indicate which dots are written to form the letter L.

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 written. Generally the operation is performed in the following manner (refer to Figs. 5-5 and 5-6 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.

(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 Refresh circuit then becomes enabled. The Column and Row Counters continue to cycle, and each dot in row 7 through 15 of column Ø through 7 is written (as previously described) until another writing character is received, or Hold Status occurs, or another operating mode is selected.

Principal Circuits

ROM A, ROM B, ROM C—The standard 4014 and 4014-1 contains two Read Only Memory (ROM) devices — ROM A and ROM B. The standard 4015 and 4015-1 contains three ROMS ROM A, ROM B, and ROM C. The selectable ROMs provide character writing information for all writing characters in the ASCII or APL code (APL for 4015 and 4015-1 only). The selected ROM is programmed by the character being processed ($\overline{\text{BIT 1}}$—$\overline{\text{BIT 7}}$).

ROM Selector—Selects either ROM A, ROM B, or ROM C.

Character Status—Activates the generation of a character. Sets $\overline{\text{TBUSY}}$ active; completes the character generation process by sending a character completed signal to TC-1 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 Ø 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 Matrix Digital-to-Analog and Y Matrix Digital-to-Analog circuits to establish normal italics, subscript, or superscript writing.

Z Axis Control—Provides write dot information pulses to control the Z Axis circuit for character writing in normal character storage and write-thru. Also provides write dot information for generation of the Alpha Cursor.

Dot Multiplexer—Sequentially examines the dot information from the ROM as the Row Counter steps through the rows. The output state is dependent upon the ROM outputs and controls the Z Axis writing via the Z Axis Control circuit.

Character Generator Latch—Latches character bits into the Character Generator.

Y Matrix Digital-to-Analog (Y MAT D/A)—Converts the digital output of the Row Counter into its analog equivalent for display beam positioning.

X Matrix Digital-to-Analog (X MAT D/A)—Converts the digital output of the Column Counter into its equivalent analog voltage for display beam positioning.

Beam Wiggler—Allows the Larger two character sizes to appear bold by moving the beam in four different positions during each written dot.

Column Reset F/F—Resets the Column Counter to column Ø of the character matrix.

Cursor Control Circuit—Provides control signals to the Z Axis Control circuit that permits an 8 x 9 dot matrix to be displayed but not stored.

Bypass Control—Inhibits character generation.

DETAILED BLOCK DESCRIPTION

The following describes in more detail the operation of the Character Generator. Some of the circuits are described separately, but for the most part they are described as they affect or control a character generator function.

Character Latch

Whenever a $\overline{\text{TSTROBE}}$ signal is concurrent with data on the minibus, the data gets latched into the Character Generator. If in Alpha Mode the character will be processed into video and displayed. If in the Graph or GIN mode of operation, displaying of the character is suppressed by the Bypass Control circuit. See description of this circuit for more information. If $\overline{\text{TSUP}}$ or $\overline{\text{BTSUP}}$ is asserted the character will not be latched.

Selecting the ROM

The Character Generator is capable of producing the full ASCII and APL writing character sets by using three selectable Read Only Memory (ROM) devices. ROM A and ROM B provide ASCII character information and are the only character generator ROMs in the standard 4014 or 4014-1. However, the 4015 and 4015-1 Terminals provide not only the ASCII character set from ROMs A and B, but also the APL character set by using ROMs B and C. ROM selection occurs as follows.

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 $\overline{\text{ASCII}}$. These signals control ROM selection as shown in Table 5-8. A "1" indicates the selected ROM.

TABLE 5-8

ROM Selector Truth Table

Inputs				ROM Selected		
$\overline{\text{CIP}}$	$\overline{\text{ASCII}}$	BIT7	BIT6	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

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 in Alpha Mode and data bits for a character are received by the Terminal, $\overline{\text{TSTROBE}}$ actives the $\overline{\text{ALPHA E}}$ signal from TC-1. $\overline{\text{ALPHA E}}$ is an "early warning" signal to the Character Generator that prepares it for character generation. It causes the Column Reset circuit to output a $\overline{\text{COL RES}}$ (column Reset) signal that sets the Column Counter outputs to zero. $\overline{\text{TSTROBE}}$ also loads $\overline{\text{BIT 1}}$ through $\overline{\text{BIT 7}}$ into the Character Latch, making the character bits available to the Read Only Memory (ROM) devices and the ROM Selector circuits. The SUPPRESS signal (also an output of TC-1) goes active for the same length of time as the $\overline{\text{ALPHA E}}$ signal. SUPPRESS enters an inverter circuit where it is output as the low active $\overline{\text{SUPPRESS}}$ signal. The $\overline{\text{SUPPRESS}}$ signal loads preset inputs into the Column and Row Counters, causing their respective BCD outputs to set the X MAT and Y MAT signals to a beam position indicative of the bottom left corner of the character matrix.

When $\overline{\text{ALPHA}}$ E ends, so does SUPPRESS. This action causes the $\overline{\text{COL RES}}$ signal to go inactive on the trailing edge of the next 614 kHz signal. The next signal, in time sequence, to come from TC-1 is the $\overline{\text{ALPHA}}$ signal. $\overline{\text{ALPHA}}$ is an output of the Function Decoder circuit on TC-1 that goes true whenever an alphanumeric character is received by the Terminal in Alpha Mode. $\overline{\text{ALPHA}}$ causes the Character Status circuit to set the $\overline{\text{CIP}}$ signal active. $\overline{\text{CIP}}$ enters the Character Modifier circuit and also enables the ROM Selector to select the appropriate ROM device as per the $\overline{\text{ASCII}}$, BIT 6, and BIT 7 inputs. The complement of $\overline{\text{CIP}}$ (CIP) goes high to enable the Character Modifier, and Z Axis Control circuits (see individual block descriptions for more information on these circuits). Concurrent with the $\overline{\text{CIP}}$ and CIP signals are $\overline{\text{TBUSY}}$ and $\overline{\text{WRITE}}$. These four signals remain active for the time it takes to generate the character.

Notice that the $\overline{\text{ALPHA}}$ signal inputs to the Row Counter. There it provides a clear function, setting the R1, R2, R4, and R8 outputs low. These four low outputs enter the Y Matrix Circuit to cause the Y MAT signal to deflect the writing beam to the top of the matrix. (See Fig. 5-5.) These low-going outputs also enable the Address Read (AR) signal that in turn, causes the C1, C2, and C3 outputs of the Column Counter to be loaded into the ROMs. Because C1, C2, and C3 indicate the left-most column (column Ø), the selected ROM outputs Column Dot information. The selected ROM outputs Column Dot information to the Dot Multiplexer on eight Dot Information lines. The ROM also supplies SHIFT information to the Character Modifier.

Scanning the Character Matrix

After the Row Counter outputs are cleared to zero and $\overline{\text{ALPHA}}$ goes inactive, the Row Counter begins counting on the trailing edge of the $\overline{\text{CHRCLK}}$ signals. This signal is either 154 kHz or 614 kHz depending on whether character display is normal store operation or write-thru operation. (Refer once again to Fig. 5-5.) Even though no write-dot information is contained in Column Ø, the Row Counter must be counted through the Column in order to obtain Column Ø shift information. After counting Column Ø, the Row Counter outputs (R1, R2, R4, and R8) all shift low on the next occurring $\overline{\text{CHRCLK}}$ signal. This causes the Y MAT signal to deflect the beam to the Row Ø position. The low-going edge of the R8 output clocks the Column Counter, causing its output to select Column 1 of the addressed character. The X Matrix D/A circuit changes the analog value of X MAT signal to reflect the new horizontal position.

When the outputs of the 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 selection causes 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. 5-6.) The CIP signal enables the Write Dot circuit during character writing.

When there is dot information to be written, Z dot receives a signal from the dot multipler and turns on the Z axis output for approximately 16 μs. During this time the Beam Wiggler is positioning the beam in four different positions on the screen. This is only in the larger two character sizes in order to fill in the areas between dots to make the characters appear bold.

The preceding operation is disabled in WRITE-THRU, GIN and the smaller two character sizes.

If there is no dot to display the control circuitry bypasses that dot position without processing the Z axis information.

Refer once again to Fig. 5-6 and notice that the letter "L" is shown in the matrix. Nine clock pulses provide nine successive WRITE DOT pulses to the $\overline{\text{Z}}$ 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 dot position. (For more information on how the $\overline{\text{Z}}$ signal is controlled for character writing, see the Z Axis Control circuit description). When the row count once again switches from 15 to Ø the R8 line once again clocks the Column Counter, causing its outputs to indicate column 2. The new column code, in combination with active AR 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 1 dot of Column 7, the low-going R8 line clocks the Column Counter once more. This time, the column outputs (C1, C2, C4) go low, and a signal called CARRY goes high. CARRY actually signifies a binary count of 9 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 Load Pulse Generator circuitry on TC-1, where it causes the Function Timer to advance the display beam one character space.

The CARRY signal also enters the Column Reset circuit. Here it causes the $\overline{\text{COL RES}}$ signal to go active on the next trailing edge of the 614 kHz clock. $\overline{\text{COL RES}}$ 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) as well as the $\overline{\text{CHAR COMP}}$, $\overline{\text{TBUSY}}$, and $\overline{\text{WRITE}}$ signals also end, completing the resetting of the Character Generator.

Bypass Control Circuit

When either the GIN or the BYPASS Mode is selected, the outputs of the Bypass Control circuit prevent the Character Generator from responding to data on the Minibus. Bypass mode is automatically set when $\overline{\text{GIN}}$ goes true. Bypass can also be program selected via ESC CAN. In GIN Mode, data is used to indicate either writing beam position, or Terminal status information that is to be transmitted to the computer. The Character Generator must not respond to that data placed on the minibus. Therefore, when $\overline{\text{GIN}}$ goes active a low $\overline{\text{ECHSP}}$ signal prevents the Character Status circuit from responding to $\overline{\text{ALPHA}}$ signals. This action prevents the Character Generator from responding to the data that generated the $\overline{\text{ALPHA}}$ signal. The $\overline{\text{ECHSP}}$ signal also inputs to the Character Modifier circuit, where it inhibits the operation of this circuit. The $\overline{\text{BYPASS}}$ signal goes low (active) when the ESC CAN sequence is received by the Terminal. As with GIN Mode, the Terminal's response to the majority of codes (particularly the printable characters) is suppressed. During GIN mode, the high active ECHSP signal inputs to TC-1 to hold the $\overline{\text{BYPASS}}$ signal low.

The Bypass Control circuit is reset by the $\overline{\text{LOCAL}}$, $\overline{\text{GRAF}}$, or $\overline{\text{TBUSY}}$ signals. $\overline{\text{LOCAL}}$ goes active when the LOCAL/LINE switch is placed in the LOCAL position; $\overline{\text{GRAF}}$ goes active when a GS control character is reached by the Terminal; $\overline{\text{TBUSY}}$ allows the Character Generator to switch back to alphanumeric character generation when switching out of Graph or GIN Mode. $\overline{\text{TBUSY}}$ occurs automatically when switching from Graph to Alpha Mode. However, $\overline{\text{TBUSY}}$ does not automatically occur when GIN Mode ends, and must be made to occur as explained in the Operation section of this manual.

Character Generator Suppress in Graph Mode

During Graph Mode, or when making a copy of the display, the SUPPRESS signal is active. It is inverted by the Inverters circuit and loads preset inputs into the Row and Column Counters. The Preset inputs for the Row Counter are +5 Vdc; for the Column Counter it is +5 Vdc and ground. These inputs cause the outputs of the two counters to indicate the bottom left corner of the character matrix. Thus, in Graphic Plot Mode, or when making a hard copy of the diplay, the X MAT and Y MAT signals are such that the writing beam is positioned to the lower-left corner of the 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.

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 $\overline{\text{COL RES}}$ signal, the Character Modifier senses the low state of the C1, C2, C4 output lines of the Column Counter. When Row 8 is reached by the Row Counter, the positive going R8 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 R8 output from the Row Counter 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 combination of shift information signals required to activate the various shift conditions are as shown in Table 5-9.

TABLE 5-9

Writing Selection

Column Ø Shift Info.	Columns 1-7 Shift Info.	Signal Activated	Writing Selected
LOW	LOW	$\overline{\text{SUP}}$	Superscript
LOW	HIGH	$\overline{\text{ITAL}}$	Italics
HIGH	LOW	SUB	Subscript
HIGH	HIGH	none	Normal

$\overline{\text{SUP}}$ goes true when the APL overline or dieresis character is decoded by the ROM; this shifts the Y Matrix output up. $\overline{\text{ITAL}}$ goes true when printing APL alpha characters. The $\overline{\text{ITAL}}$ signal combines with a sampling of the Y MAT output to "twist" the X MAT output; thus providing an italic appearance to alpha characters. SUB goes true whenever ASCII lower-case characters g, j, p, q, and y are detected or when APL underline is to be written. The signal SUB causes the Y MAT signal to shift the writing matrix down slightly, writing the tails of the character below the alphanumeric baseline.

Cursor Control

The Alpha Cursor is generated in Alpha Mode and is a pulsating display of the 8 x 9 ROM dot matrix. If not in Hold Status, it is continuously displayed in Alpha Mode (when not generating characters) and is generated as follows:

When not generating a character in Alpha Mode, the Row and Column Counters cycle continuously, outputting X MAT and Y MAT signals. At each dot position of the 8 x 9 matrix, the ROM and Dot Multiplexer circuits output an active WRITE DOT signal that turns on the $\overline{\text{Z}}$ signal to write the dot. This, with the X MAT and Y MAT signals that deflect the beam, combine to generate a display of the 8 x 9 character matrix. To cycle through the character matrix once, takes 850 microseconds, or about 1200 times a second. (These times decrease by a factor of four when Write-Thru operation is selected.) However, Cursor Refresh Control limits the number of times a second that the matrix is displayed, and to also cause it to blink.

The CARRY signal, which outputs from the Column Counter, is a positive-going pulse that occurs once at the end of each character matrix cycle. It enters the Cursor Control circuitry where it combines with the 75 Hz signal to generate a positive-going CURS EN signal. The CURS EN signal is an .85 millisecond pulse that occurs 75 times each second. This signal permits the WRITE DOT line to control the Z Axis Circuit for one character time every 13.5 ms (or 75 times a second). The 5 Hz signal inputs to the Cursor Refresher circuit to allow the CURS EN signal to be active only during the positive portion of the 5 Hz signal. This divides by two the number of times the matrix is displayed each second (75 ÷ 2 = 37.5 times each second) and provides the cursor blinking effect. The on time of the Z axis for each dot is controlled by the Display Control Card. The Display Control Card recognizes when a character is not being written by the fact that the $\overline{\text{WRITE}}$ signal from the Character Status circuit is high. Thus, it limits the effect of the $\overline{Z}$ signal from the Z Axis Control circuit, keeping the $\overline{Z}$ Axis signal to the display unit short enough so that the matrix does not store.

Z Axis Control Circuit

This circuit controls the $\overline{Z}$ signal for character and Alpha Cursor Generation. The $\overline{\text{CGSUP}}$ (Character Generator Suppress) signal must be inactive in order to obtain an active $\overline{Z}$ signal from this circuit. $\overline{\text{CGSUP}}$ is reserved for use by optional circuits, devices, etc. and is therefore normally high. This allows Character Generator circuitry to control the $\overline{Z}$ signal.

Alpha Cursor Z Axis Control. As long as the SUPPRESS signal remains low, the Character Generator continuously cycles through the count sequences of the Row and Column Counters. Each dot count causes an active WRITE DOT signal that (when synched with the $\overline{\text{CHAR CLK}}$ and CURS EN signals;) causes an active $\overline{Z}$ pulse. The CURS EN signal (from the Cursor Control circuit) goes active ≈0.85 milliseconds, 37.5 times each second. During this time, the WRITE DOT signal pulses the $\overline{Z}$ line once for each dot position in the 8 by 9 matrix. This becomes the Alpha cursor. Because no character is being drawn, the $\overline{\text{WRITE}}$ signal is high, enabling the Display Control Card to shorten the $\overline{Z}$ pulse width. This ensures that the matrix does not store on the display. CURS EN is of such a repetition rate that the Alpha Cursor is made to "blink."

Character Z Axis Control. When generating characters in Alpha Mode, the Z pulse width is determined by the Alpha Intensity Adjustment and the BRITE Intensity Adjustment on the High Voltage board. This adjustment is enabled by a high CIP (Character In Progress) signal and a low GOBABY signal. (GOBABY goes high during Write-Thru operation, which is discussed later.) CIP remains high for the time required to write the character. Any high-going WRITE DOT pulse during CIP time triggers a $\overline{Z}$ signal with a pulse width determined by the Alpha Intensity Adjustment. The $\overline{\text{WRITE}}$ signal, that is output from the Character Status circuit, is concurrent with the CIP signal. $\overline{\text{WRITE}}$ inputs to the Display Control Card to enable the $\overline{Z}$ signal to be transferred directly to the Display Unit.

During Write-Thru operation, the GOBABY signal goes high and the $\overline{\text{CHAR CLK}}$ frequency increases to 614 kHz. This enables the Character Generator to generate characters at four times the normal rate. As in normal character writing, $\overline{Z}$ pulses are determined by the concurrence of CIP, WRITE DOT, and $\overline{\text{CHAR CLK}}$ signals. However, in Write-Thru, the selected character size determines whether the $\overline{Z}$ line is pulsed once or twice for each written dot. For example, when generating characters in either of the two larger character sizes, the $\overline{\text{CHAR A}}$ signal from TC-1 is low. This signal is inverted by the Inverters circuit and becomes the BIG CHAR (Big Characters) signal. Both $\overline{\text{CHAR A}}$ and BIG CHAR input to the Z Axis Control circuit and cause the 1.22 MHz signal to pulse the $\overline{Z}$ line twice for each active WRITE DOT signal. If either of the two smaller character writing sizes is selected, $\overline{\text{CHAR A}}$ is high; consequently BIG CHAR goes low. This causes the $\overline{Z}$ line to be pulsed once with each high-going WRITE DOT pulse. Keep in mind that in Write-Thru operation, the Z Axis Control Circuit does not control $\overline{Z}$ pulse width; circuitry on the Display Control Card performs this function. See the Block Diagram description of that card for more information.

TC-2 BLOCK DIAGRAM DESCRIPTION

INTRODUCTION

The Block Diagram Description of TC-2 includes two different TC-2 cards; the standard TC-2 card (670-3092-XX) and the optional TC-2 card (670-3559-XX) used with the Enhanced Graphics Module—Option 34. The TC-2 Block Diagram covers both the standard and optional TC-2 cards. Use the 670-XXXX-XX board numbers on the pullouts for different versions of the standard TC-2 card. The standard TC-2 card does not have enhanced graphics capability. Partial TC-2 schematics for different versions of the TC-2 card used with the Enhanced Graphics Module, show the Extra Byte circuits necessary to increase the address resolution to 4096. (4096 addressability is provided as part of the Enhanced Graphics Module.) Only partial TC-2 schematics are shown as the rest of the TC-2 circuitry is the same as the standard TC-2 schematic. Component locations for the different TC-2 cards is located on the apron of the schematics.

GENERAL DESCRIPTION

Refer to the TC-2 Block Diagram and the applicable TC-2 schematic(s). Below is a list of circuits that contain the greater part of TC-2 circuitry. A short description of each is given.

X Latch, Y Latch—Vector data latches used when operating in the Graphic Plot Mode; (and when using the Point Plot modes provided by the Enhanced Graphic Module Option), provide storage for three 5-bit bytes of the 20-bit coordinate address.

Extra Byte Latch—Provides storage for Extra Byte when using 24-bit addressing used only with the Enhanced Graphic Module — Option 34.

X and Y Registers—Each register contains an up-down counter, whose 12 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 and Page Full Control—Controls when the MARG signal is placed onto the minibus and when a page full condition occurs.

Automatic Make Copy—With Auto Print selected this circuit controls the making of a copy when the page is full, and the erasing of the page after the copy is made.

Data Multiplexer—Depending upon the output of the Multiplexer Control circuits, the Data Multiplexer will place one of eight data bytes onto the minibus.

Strobe Logic—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 and 7 Logic—Places the complement of keyboard bits 6 and 7 onto their respective minibus data lines; also codes BIT6 and BIT7 with each 5-bit byte of data from the Data Multiplexer when operating in the GIN Mode.

Digitization Control—A group of circuits that control 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 Potentiometer.

Crosshair Generator Circuitry—A group of circuits that generate the crosshair cursor by sending a sequence of pulses that increment the X and Y Registers. Rapidly counting through the Registers, while turning on the Z Axis signal for the right amount of time, provides a crosshair-type cursor, bright enough to be visible, yet with a Z Axis intensity that keeps it from storing.

DETAILED BLOCK DIAGRAM DESCRIPTION

When possible each of the afore-mentioned blocks will be described as an entity. However, in some cases it is difficult to obtain an overview of circuit operation by discussing individual circuits. In such cases, groups of circuitry are described in a sequence of operations—such as those needed to generate the crosshair cursor.

X and Y Data Latches

Standard TC-2 Circuits. The X and Y Data Latches are used to store 15 bits of the vector address in Graph Mode. Storage is provided for ten bits of the Y address and five bits of the X address. These latches are necessary to hold these 15 bits until the arrival of the last five bits of the X address (the Low Order X bits). The 20 bits of the coordinate address are received in four seven-bit bytes. The two most significant bits of each seven bit byte are decoded by TC-1 to generate in sequence the $\overline{\text{HIY}}$, $\overline{\text{LOY}}$, $\overline{\text{HIX}}$, and $\overline{\text{LOXE}}$ signals. The five least significant bits of the first three bytes of the "vector string" are latched through the Latches to their respective Latch output lines by their respective $\overline{\text{HIY}}$, $\overline{\text{LOY}}$, and $\overline{\text{HIX}}$ signals. This makes 15 bits of vector information available at respective bit inputs of the X and Y Registers. (This coordinate data remains as outputs of the latches until replaced by new coordinate data or the Terminal power is turned off.) The arrival of the Low Order X Byte causes the $\overline{\text{LOXE}}$ signal to go active, which in turn causes the 5 Low Order X bits, as well as the other 15 bits of the coordinate address information, to be parallel loaded (jammed) into their respective bit positions in the X and Y Registers. The output of the registers change to reflect the new beam position. Notice that the Low Order X bits are not loaded into a latch, but instead, input directly to the X Register as soon as $\overline{\text{LOXE}}$ goes active.

Extra Byte Latch—Optional TC-2 Circuitry

This circuit provides for 12-bit addressing (4096 addressable points in each axis), by detecting when two Low Order Y bytes are sent in sequence. The first Low Order Y byte is called the "Extra" Byte and provides two extra bits for both the X and Y Registers. This increases the addressability of each axis to 4096. The Extra Byte follows the High Order Y Byte and contains a Bit 7 and Bit 6 code that sets the $\overline{\text{LOY}}$ signal active. The $\overline{\text{LOY}}$ signal subsequently places all five bits of the Extra Byte on the five LOY output lines of the Y Data Latch, where they are felt, not only at the inputs to the Y Register, but also at the inputs of the Extra Byte Latch.

The $\overline{\text{LOY}}$ signal generated by the Extra Byte, arms the Extra Byte Latch. If the third byte of the vector string has a Bit 7 and Bit 6 code that again sets $\overline{\text{LOY}}$ active, this second $\overline{\text{LOY}}$ signal latches the preceding Low Order Y bits into the Extra Byte Latch. The first Low Order Y bits, placed on the outputs of the Y latch, are now replaced by the second Low Order Y bits.

Bits 1 and 2 of the Extra Byte contain the two least significant bit information for the 12 bit Y address. Bits 3 and 4 of the Extra Byte contain the two least significant bit information for the 12 bit X address. Bit 5 of the Extra Byte is a Margin Control bit that also inputs to the Y Register and can be used to provide program select for Margin 2. These five bits of the Extra Byte, as well as of the second Low Order Byte, are made available at their respective X or Y Register inputs as soon as the second $\overline{\text{LOY}}$ signal ends. As with 10-bit addressing, the last two bytes of a new vector address are the High Order X and Low Order X Bytes. As in the 10-bit addressing the receipt of the $\overline{\text{LOXE}}$ signal simultaneously loads the 24 vector address bits into the X and Y Registers. The output of the Registers change to reflect the new beam position.

Register Operation

Both the X and Y Registers are up-down counters whose 12-bit digital output can be either serial or parallel controlled, depending on the mode of operation. In Alpha and GIN Modes, the registers are serially controlled by the $\overline{\text{LEFT}}$, $\overline{\text{RIGHT}}$, $\overline{\text{UP}}$, and $\overline{\text{DOWN}}$ signals (GIN Mode uses only RIGHT and DOWN). Table 5-10 shows the number of low-going transitions that must occur on the serial input lines to establish proper character and line spacing for the four selectable character sizes.

TABLE 5-10

Character and Line Spacing

Char Size	Character Spacing $\overline{\text{LEFT}}$ (BS) & $\overline{\text{RIGHT}}$ (SP and HT)	Line Spacing $\overline{\text{DOWN}}$ (LF) & $\overline{\text{UP}}$ (VT)
A	56	88
B	51	82
C	34	53
D	31	49

In Graph Mode, the register outputs are parallel controlled by either 10 or 12-bit parallel inputs as previously explained. Twelve-bit addressing provides an address resolution of 4096X by 4096Y and is used only when the Enhanced Graphic Module option is installed and an Extra Byte has been received as part of the Graphic Address; otherwise, the Register output is restricted to 10-bit (1024) resolution. See descriptions of the X and Y Vector Data Latches for more information.

X Register. The X Register is a 12-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 $\overline{\text{LEFT}}$ signal decrements the count; each low-going $\overline{\text{RIGHT}}$ signal increments the count. One count pulse is equivalent to one minipoint of beam deflection. It requires four serial clocks to move the writing beam one tekpoint. The X Register can be parallel loaded by either ten or twelve parallel inputs form the X Vector Data Latch. These inputs contain the X coordinate address in Graph Mode operation. 10-bit addressing enables the writing beam to be addressed to any of 1024 points in the X axis. This is standard. Use of the Enhanced Graphic Option increases addressability to 4096 and uses 12-bit addressing.

The CR (Carriage Return), $\overline{\text{HOME}}$, or $\overline{\text{PAGE}}$ signal provide a CLRX signal that resets the X Register to zero. $\overline{\text{HOME}}$ goes active when Terminal power is initialized or when the Reset key is pressed. $\overline{\text{PAGE}}$ goes active when the Page key is pressed, or control character sequence ESC FF is received by the Terminal.

The X Register automatically wraps-around to the opposite end of the register when either incremented or decremented past a count of 4095 or zero, respectively. See description of $\overline{\text{EOL}}$ signal in Margin Control circuit for more information on what occurs when incrementing past 4095.

Y Register and Top-of-Page Detect. Like the X Register, the Y Register is serially operated (by $\overline{\text{UP}}$ or $\overline{\text{DOWN}}$) or is parallel loaded (by receiving 10 or 12 bits of data from the Y Vector Data Latch). This register is also capable of outputting a count of 0 to 4095 on 12 output lines. In the X Register, all 4096 of the separate minipoints are viewable. In the Y Axis, only 3120 are viewable. When a $\overline{\text{PAGE}}$ or $\overline{\text{HOME}}$ signal clears the Y Register to zero, the Y Register inverters cause the register zeroing to be accepted as a 4095 count and the beam is positioned off the top of the screen. Since $\overline{\text{PAGE}}$ or $\overline{\text{HOME}}$ reset Alpha Mode, a Top-of-Page Detect circuit becomes active as soon as the $\overline{\text{HOME}}$ or $\overline{\text{PAGE}}$ signal ends to reset the beam to the home position. The Top-of-Page Detect circuit functions as follows:

When the Y Register is zeroed by $\overline{\text{PAGE}}$ or $\overline{\text{HOME}}$, the outputs from the inverters go high, positioning the display beam off-screen at a count of 4095. The two most significant bits (Y12 and Y11) from the inverters are sensed by the Top-of-Page Detect circuit. When both go high, and the mode is not GIN or Graph, the Top-of-Page Detect circuit places the 614 kHz square wave on the $\overline{\text{DOWN}}$ line. Immediately the Y Register begins to count up, causing the digital output to begin moving the display beam in the down direction. When the count from the Y Register has incremented 1024 counts, the 2nd MSB (Y11) goes low, inhibiting the Top-of-Page Detect circuit and removing the 614 kHz signal from the $\overline{\text{DOWN}}$ line. Thus, the count is stopped at 3071 (4095 minus 1024 = 3071), the Home position. Notice that incrementing the Y Register results in decrementing the position count. This is true because of the inverters on the output lines. $\overline{\text{TBUSY}}$ goes true when the Top-of-Page Detect circuit is incrementing the Y Register to the Home position.

The MARG signal output is actually a thirteenth bit of the Y Register. When the Register increments one point past the Ø minipoint position, (bottom of screen), MARG goes high while the inverter outputs return the beam to the 4095Y minipoint position. When the Y Register again decrements through the Ø minipoint position (or when reset by $\overline{\text{HOME}}$ or $\overline{\text{PAGE}}$), MARG returns low. The MARG signal inputs to the Multiplexer, Margin Shifter, and Margin and Page Full Control. Its effect can be found in the descriptions of each of those blocks.

NOTE

MARG can be controlled by the Fifth bit of the Extra Byte (if so desired) when using 4096 addressibility in Graph mode. MARG control is only provided if the Enhanced Graphics Module is used.

Margin Control and Page Full Circuit

This circuit determines the following:

1. At what time the MARG signal is placed on the minibus.

2. At what time a Page Full Break occurs.

3. When $\overline{\text{EOL}}$ occurs.

The MARG signal that outputs from the Y Register goes high in Alpha Mode when $\overline{\text{DOWN}}$ signals increment the Register past 4095. (MARG is actually a 13th bit from the Y Register that has a binary weight of 4096.) When MARG goes high it causes the Margin Control circuit to hold high the MSB (X12) output of the X Register. This occurs when the ALPHA signal from U321C is high (A high ALPHA signal indicates Alpha Mode). Holding the X12 bit high causes the X Digital to Analog circuit on TC-3 to output a voltage level that corresponds to the center of the display screen. This is Margin 2. Carriage Returns (CR) return the cursor to Margin 2 and will not set the X12 bit low as long as the ALPHA and MARG signals are High. $\overline{\text{PAGE}}$ or $\overline{\text{HOME}}$ inhibit Margin 2 by clearing the X and Y Registers to zero.

Wrap-around in either direction occurs regardless of whether Margin 1 or Margin 2 is selected.

The MARG signal is placed onto the minibus dependent on the position of the Margin Selector Switch and the Mode of operation. If in Alpha Mode (the ALPHA signal from U321C is high) and Margin 1 selected, the MARG 1 signal enables the MARG signal to be placed onto the minibus when the Y Register is counted past zero. MARG also enables the $\overline{\text{TBUSY}}$ and the $\overline{\text{FULL LED}}$ signals. $\overline{\text{TBUSY}}$ acts as a flag for flagged interfaces to prevent the Terminal from receiving further computer data until the page is cleared; thus, functioning as a "page full break." The $\overline{\text{FULL LED}}$ signal lights the FULL indicator on the Consile. The Page Full condition can be over-ridden by the Terminal operator entering any coded character from the keyboard. This causes the $\overline{\text{DATA ENABLE}}$ signal to go low and deactivate the MARG, $\overline{\text{TBUSY}}$, and $\overline{\text{FULL LED}}$ signals. CR, $\overline{\text{PAGE}}$, or $\overline{\text{HOME}}$ signal also clears the Page Full condition.

Selecting Margin 2 at the keyboard in Alpha Mode allows the margin at the center of the screen to be used. This provides an additional column on which data can be displayed. However, the MARG signal is not placed onto the minibus until the Y Register decrements past a count of zero in the second column. This holds the $\overline{\text{TBUSY}}$ and $\overline{\text{FULL LED}}$ signals inactive, inhibiting the Page Full condition until after the second column is full. If the Margin Selector switch is placed at OFF, MARG is not placed onto the minibus; consequently, no Page Full condition exists.

When incrementing past a count of 4095 (the right margin) in Alpha Mode, the $\overline{\text{EOL}}$ signal is activated. $\overline{\text{EOL}}$ inputs to TC-1 to enable an automatic carriage return and linefeed. TC-1, in turn, generates the CR signal which ensures that the X Register clears to zero when incrementing past a count of 4095. $\overline{\text{EOL}}$ also enters the Fold Pause circuit in the Crosshair Generator circuitry to trigger the $\overline{\text{FPAUSE}}$ signal that is used during crosshair generation.

Auto Make Copy Circuit (4014-1 and 4015-1 Only)

This circuit is used to automatically generate a $\overline{\text{MAKE COPY}}$ signal on a Page Full as selected by the Margin Selection switch. This circuit is enabled by setting the Hard Copy switch on the keyboard console to AUTO PRINT. This activates the $\overline{\text{AUTO PRINT}}$ signal. Then, when a Page Full condition occurs, the MARG signal from the Margin Control circuit triggers the $\overline{\text{MAKE COPY}}$ signal, if the $\overline{\text{HCU BUSY}}$ signal is high (as would be the case when the Hard Copy Unit is not making a copy). As the copy is being made, $\overline{\text{HCU BUSY}}$ and $\overline{\text{DRBUSY}}$ go low. As soon as the copy is made, $\overline{\text{DRBUSY}}$ goes high. This triggers the $\overline{\text{PAGE}}$ signal that erases the page and clears the Page Full condition. The Terminal is now automatically re-enabled to receive more information from the computer.

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 by placed onto the minibus lines until the DATA ENABLE signal from the Strobe Logic circuit goes high. This happens when KSTROBE and $\overline{\text{KSTROBE}}$ go active. (More will be explained about the KSTROBE signals 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.

Bit6—Bit8 are placed on the minibus through a special gating network labeled BITS 6, 7, and 8 Gating. See the description of that circuit for more information.

Strobe Logic

This circuit controls the various strobe signals associated with Terminal and/or computer operation. KSTROBE and $\overline{\text{KSTROBE}}$ go active when data is entered from the keyboard. In response to $\overline{\text{KSTROBE}}$, $\overline{\text{CSTROBE}}$ is generated (as long as $\overline{\text{CPUNT}}$ or $\overline{\text{KLOCK}}$ are 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 LOCAL is high and $\overline{\text{ECHO}}$ is low. $\overline{\text{ECHO}}$ can be pulled low by a strap or switch control 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 (when the Local/Line switch is at Line); $\overline{\text{TSTROBE}}$ causes data to be executed by the Terminal. Each time $\overline{\text{TSTROBE}}$ or $\overline{\text{CSTROBE}}$ is generated, the DATA ENABLE signal goes high to allow the Data Multiplexer and $\overline{\text{BIT 6}}$, $\overline{\text{BIT 7}}$, and BIT 8 Logic outputs to be placed on the minibus. This circuitry also outputs a $\overline{\text{DATA ENABLE}}$ signal (in response to keyboard inputs) to the Margin and Page Full circuit. This enables a keyboard entry to clear a "Terminal Busy or Page Full" condition.

$\overline{\text{KLOCK}}$ 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 or a $\overline{\text{KSTROBE}}$ 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 by the Hard Copy Unit during copy making or by the Terminal during erase cycles, inhibiting the Strobe Logic circuitry until the operation is complete.

BITS 6, 7, and 8 Gating

When sending data from the keyboard, this circuit places the complements of keyboard KBIT6, KBIT7, and KBIT8 onto their respective minibus lines. When operating in the Graphic Input Mode, coding signals from the State Decoder control the configuration of $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$; $\overline{\text{BIT 8}}$ is arbitrary, being dependent upon the wiring connection of the Terminal keyboard.

Crosshair Generator

The crosshair cursor provides a visible screen indication of the voltages set by the X and Y Position Potentiometers. These potentiometers output a voltage that feeds the Crosshair Generator circuitry to move the respective line of the cursor the full width, or height, of the screen. The "intersect" point of the horizontal and vertical lines is indicative of the voltages supplied by the Position Potentiometers. This voltage is digitized and transmitted when commanded, either by the program or by the operator at the keyboard. How the crosshair is generated, how a point is digitized, and how the digitized point is transmitted is explained in the following material.

Generating the Crosshair Cursor

The crosshair is generated in GIN (Graphic Input) Mode. GIN Mode is established when the two-character sequence of ESC SUB is received by the Terminal. This character sequence is decoded by TC-1 that subsequently sets the $\overline{\text{CURSE}}$ signal active.

$\overline{\text{CURSE}}$ inputs to the Found and the Axis Switching circuits. The FOUND signal goes low and the $\overline{\text{FOUND}}$ signal goes high. Both the FOUND and $\overline{\text{FOUND}}$ signals input to the Crosshair Clock circuit to enable the Z and REG CLK signals. The $\overline{\text{Z}}$ signal is cycled on for 6.0 μs and off for 2.5 μs, except when FPAUSE goes active (more about $\overline{\text{FPAUSE}}$ later). The REG CLK, and its complement $\overline{\text{REG CLK}}$, are 307 kHz (614 kHz $\div$ 2) spikes that provide timing inputs to the Switch Control and Axis Switching circuits. Note that the low FOUND signal enters the Register circuitry via U321A, where it prevents the MARG signal from going active.

In the Axis Switching circuit, $\overline{\text{CURSE}}$ selects the $\overline{\text{DOWN}}$ line, enabling it to be pulsed by the 307 kHz REG CLK signal. Each pulse decrements the digital output from the Y Register one register count. The digital output from the Y Register is converted into its analog equivalent by the Y Digital to Analog circuit on TC-3. The change in the Y ANALOG voltage from TC-3 moves the display beam down one minipoint each time the $\overline{\text{DOWN}}$ line is pulsed. The Y ANALOG voltage is monitored by the X and Y Comparators circuit that also has voltages picked off by the wipers of the X and Y Position Potentiometers (or optional Joystick inputs). When the Y Register has been clocked by the $\overline{\text{DOWN}}$ signal to a point that its digital output causes the Y ANALOG voltage to equal, or pass slightly, the reference voltage set by the Y Position Potentiometer, a COIN (Coincidence) pulse occurs from the Comparators circuit. The COIN signal gets clocked into the Axis Switching circuit on the trailing edge of the $\overline{\text{REG CLK}}$ signal and causes a 100 ns PT FND (Point Found) pulse to be generated. The PT FND signal causes the SELECT X signal to go active and the clocking switches from the Y to the X Register. Now the $\overline{\text{RIGHT}}$ line is being clocked by the REG CLK signals and the beam begins moving to the right. The SELECT X signal causes the Comparators circuit to look at the X POT and X ANALOG inputs. When Coincidence occurs once again, the Switch Control circuit pulls down on the $\overline{\text{Z DIS}}$ signal for about 2.5 μs. This disables the $\overline{\text{Z}}$ signal from the Crosshair Clock circuit for that period of time.

The COIN signal occurs once every 13 ms when generating the Crosshair. This is the time it takes to complete 4096 counts. Shortly after Coincidence occurs, the trailing (positive-going) edge of the $\overline{\text{REG CLK}}$ signal clocks the high COIN signal into the Switch Control circuit. The next leading edge of the positive going REG CLK signal enables the Point Found signals, PT FND and $\overline{\text{PT FND}}$. The Point Found signals stay true only for the duration of one REG CLK signal, which is about 100 ns. The leading edge of the PT FND signal affects the digitizing circuitry as explained later. However, the trailing edge of the $\overline{\text{PT FND}}$ signal is used to switch the register count from one register to the other. The trailing edge of the PT FND signal triggers a 65 μs PAUSE signal from the Switch Pause Multi. This PAUSE signal holds the $\overline{\text{PT FND}}$ signal low to prevent the circuitry from inadvertantly switching back to the preceding axis. This provides switching stability around the intersect point.

When the X Register is incremented past 4095, it "wraps-around" to a count of Ø. This causes the $\overline{\text{EOL}}$ signal to go active. $\overline{\text{EOL}}$ inputs to the Fold Pause circuit to trigger a one-shot multi with an on time of about 5 μs. Its output, $\overline{\text{FPAUSE}}$, interrupts the Crosshair Clock circuit outputs ($\overline{\text{Z}}$, REG CLK, and $\overline{\text{REG CLK}}$) for this period of time. This allows time for the X deflection circuitry to stabilize before the count continues.

After $\overline{\text{FPAUSE}}$ times out, the $\overline{\text{RIGHT}}$ line is again pulsed by the REG CLK pulses and the $\overline{\text{Z}}$ signal is turned on to once again display the counting process. When the X ANALOG voltage equals (or slightly passes) the preset voltage set by the X Position Potentiometer, the COIN signal once again goes active, causing the register counting to once again switch to the Y Register. The SELECT X signal goes inactive to enable the Comparators circuit to monitor the Y POT and Y ANALOG inputs.

When the Y Register digital outputs are decremented past the low end of the Register, the count also wraps-around to the other end of the register. No pause is needed in the Y Register counting sequence because when the Y Register wraps around the beam is positioned out of the display area at the top of the screen. By the time the count has incremented to a point where the beam is brought back onto the screen, the vertical deflection circuitry has had ample time to stabilize.

When Y coincidence occurs again, the afore described process repeats until the mode is changed or until the Ø to 7 State Counter is incremented.

Multiplexer Control and Digitization

The Crosshair Generator causes the digital equivalent of the X and Y Position Potentiometers to be reflected at the outputs of the X and Y Registers. The process of obtaining the digital equivalent of the Position Potentiometer 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 circuits. These circuits are the Found, State Counter, State Decoder, and Strobe Logic.

Assume that the crosshair cursor is running as explained in the Crosshair Generator description. The $\overline{\text{CURSE}}$ signal, which started the crosshair causes the FOUND signal to go low. This enables the Ø to 7 State Counter circuit to advance on the trailing edge of $\overline{\text{CBUSY}}$ signals. To begin with, the Ø to 7 State Counter output is at State Ø. 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 5-11). 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, sending a $\overline{\text{PREP}}$ pulse to the Strobe Logic circuit. The State Decoder circuit then outputs a low on the STATE Ø line, feeding it back to hold the State Counter enabled.

TABLE 5-11

Data Multiplexer Output Control (Pertains to each multiplexer device U249, U259, U141, U271, and U265)

0—7 State Counter Status	Byte Being Transmitted	Multiplexer Input Control Line Status C (Pin 11)	B (Pin 10)	A (Pin 9)	Multiplexer Y Output (Pin 5) Controlled by
0	Keyboard Character	0	0	0	D0 (Pin 1)
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 $\overline{\text{PREP}}$ 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 PT FND pulse from the Switch Control circuit causes FOUND to go high and $\overline{\text{FOUND}}$ to go low. This inhibits the output of the Clock circuitry and stops the count at the Coincidence Point. The outputs of the X and Y Register then reflect the digital equivalent of the voltage selected by the Position Potentiometers. The low-going PT FND signal also causes STATE 2 ADVANCE to go high, advancing the State Counter to State 2. The high-going FOUND signal also causes the Strobe Logic circuit to become enabled.

With the PREP signal and the FOUND signals high, $\overline{\text{CSTROBE}}$ 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 $\overline{\text{CSTROBE}}$ 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. In GIN mode only the 10 MSB's of the X and Y Registers are input to the computer, regardless of whether the Enhanced Graphics Module is installed. At this point, if CR or EOT have not been selected for transmission (by option straps), the $\overline{\text{COUNTER RESET}}$ signal goes low and is sent to the Ø to 7 State Counter to return it to Ø 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, $\overline{\text{COUNTER RESET}}$ ends the action by setting the Counter to Ø; otherwise, EOT is sent just as CR was, and the Counter advances to Ø 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 15 millisecond delay must occur between ESC SUB and ESC ENQ in order for valid X Coordinate data to be generated.

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 Ø and the crosshair cursor is not running, the State Counter advances 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 principle 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 the Graph beam.

TC-3 BLOCK DIAGRAM DESCRIPTION

TC-3 is used to convert digital inputs from TC-2 into X and Y Analog voltages that drive the deflection circuitry.

The X and Y channels each contain the following circuits: Magnitude Comparator, Absolute Difference, Normalizing Shift Register, Rate Multiplier, Step Control, Counter, Digital to Analog converter, and Deglitcher/Output Driver. Circuits that provide inputs to both the X and Y channels are Loxe Delay, End Detector, Clock Control, and Speed Compensation Counter. Because of similarity between the X and Y circuitry, most references will be to the X channel. For clarity, the Y channel will be mentioned as needed. Those circuits used by both X and Y channels will also be explained.

The majority of circuitry on this card is used only when drawing visible vectors, to control vector speed in Graph Mode. When drawing a vector in Graph Mode, TC-3 holds the speed at which the beam is deflected to the addressed point fairly constant, regardless of vector length. At all other times, such as character generation, crosshair display, and dark vectors, this card provides a straightforward analog conversion for the X and Y DIGITAL inputs.

Refer to the TC-3 Block Diagram and schematic. Component locations for TC-3 are shown on the apron of the schematics. The Block Diagram description is divided into two parts; Vector Display Operation (that includes descriptions of those circuits common to both channels — X and Y), and Non-Vector Display Operation. Vector Display Operation is discussed first.

VECTOR DISPLAY OPERATION

In Graph Mode, the $\overline{\text{NOLI}}$ signal to U261A is high. This activates the $\overline{\text{LOAD}}$ signal to the X Counter. When a vector is to be drawn, twelve bits of X DIGITAL position information is supplied on parallel lines from TC-2. Whether X1 or X2 contain address information is dependent on whether the Enhanced Graphics Module Option is being used. The X DIGITAL inputs are representative of the position to which the beam is to be deflected in the X axis. These inputs are made available to the X Counter, Magnitude Comparator, and Absolute Difference circuits. With $\overline{\text{LOAD}}$ from U261A inactive, the X DIGITAL bits are not loaded into the X Counter, but provide a number at the Counter inputs to which the Counter is to be counted. The Counter receives either UP COUNT or DOWN COUNT pulses from the Step Control circuit that counts the register up or down to the X digital number at the X Counter inputs. The X' DIGITAL output from the Counter is also a 12 bit digital number. It differs from the X DIGITAL in that the X DIGITAL represents the new position to which the beam is to be moved; whereas X' DIGITAL represents the current beam position in Graph Mode. Keep the above points in mind, and then read the following to find how a visible vector is drawn.

Determining Vector Length

Shortly after $\overline{\text{LOXE}}$ goes active the X DIGITAL bits are made available to the Magnitude Comparators circuit. This circuit compares the current X position (X' DIGITAL) with the new X position (X DIGITAL). It then activates an output that indicates whether the new position is greater than ($X > X'$), less than ($X < X'$), or equal to ($X = X'$) the current beam position. If there is a difference in beam positions, the Absolute Difference circuit calculates that difference and arrives at a 12-bit DELTA X number. This number is always the absolute difference between the current X position and the new X position. Whether X DIGITAL is subtracted from X' DIGITAL or vice versa is determined by the $X > X'$ signal. If X DIGITAL is larger than X' DIGITAL then the $X > X'$ signal will be high, causing X' DIGITAL to be subtracted from the X DIGITAL digits. If X DIGITAL is less than X' DIGITAL, the operation is reversed. The DELTA X number is the actual distance in minipoints that the beam is to move in the X axis, thus it represents vector length, and it is an addition to or subtraction from the DELTA X number set by the preceding vector.

Setting the Deflection Speed

The Normalizing Shift Register is enabled to receive the new DELTA X number because of an active DLOXE (delayed $\overline{\text{LOXE}}$) signal from the Loxe Delay circuit. DLOXE goes active when $\overline{\text{LOXE}}$ occurs, signifying that a vector is to be drawn, and remains active long enough to ensure that the DELTA X number gets latched into the Normalizing Shift Register. Once in the Register it gets clocked through to its outputs by the CLK 2 signal from the Shift Selector circuit. DELTA X now becomes an X STEP SET number. (Remember that the DELTA X number is the difference in minipoints between the old and new vector address, and is equivalent to the distance the beam must move.) As soon as DLOXE goes low the Normalizing Shift Register switches from CLK 2 to CLK 1. CLK 1 begins shifting the Normalizing Shift Register toward the Most Significant Bit (MSB) of the X STEP SET number. As soon as a one (high) appears in the MSB (X12) output

@

position of either the X or Y channel, the MSBX signal or MSBY goes high. Either of these signals prevent the 4.9 MHz square wave from pulsing the CLK 1 line. The Normalizing Shift Register now has a 12-bit STEP SET number that is a DELTA X number modified by the number of times the Shift Register was shifted by the CLK 1 signal.

For example, assume that the DELTA X number shown in Table 5-12 was loaded into the Normalizing Shift Register and shifted towards the MSB until a one (high) appears in that position. Note that for the number shown, two shifts must occur. Note also, that with each shift, zero's (lows) are placed in the least (LSB) position.

TABLE 5-12

Setting the Step Select Number

	(MSB) 12	11	10	9	8	7	6	5	4	3	2	(LSB) 1
Before Shifting	0	0	1	1	0	0	0	1	0	0	1	1
After Shifting	1	1	0	0	0	1	0	0	1	1	0	0

← Shifted toward MSB

The number at the outputs (after shifting is stopped) is the number that now becomes the STEP SELECT NUMBER. Referring back to the Block Diagram, note that the output of the Clock Control circuit feeds both the X and Y Normalizing Shift Registers. Thus, whether the MSBX or MSBY goes active first, the relationship of XSTEP SET to Y STEP SET remains the same, because both Registers were shifted the same number of times.

X Rate Multiplier (or Selecting the Step Frequency)

The Rate Multiplier is a 12-bit rate multiplier that selects the frequency at which the X Counter is clocked.

The signal used to clock the Multipliers is called FCOMP. The Multiplier output is called XSTP. XSTP is a recurring signal, at whose frequency the X Counter is clocked. The frequency of XSTP is determined by multiplying the FCOMP frequency by X STEP SELECT, then dividing by 4096:

$$\text{XSTP} = \frac{(\text{FCOMP})\ (\text{X STEP SELECT})}{4096}$$

X STEP SELECT is the 12-bit binary number from the Normalizing Shift Registers. From the preceding formula it can be seen that XSTP is proportional to the X STEP SELECT inputs, and X STEP SELECT is proportional to DELTA X. Therefore, XSTP is proportional to DELTA X and in turn YSTP is proportional to DELTA Y. XSTP then determines how fast the X counter is clocked, which determines how fast the beam is deflected to the new position.

Stepping the X Counter

The XSTP frequency enters the X Step Control circuit where it begins pulsing the UP COUNT or DOWN COUNT line as determined by the X > X' or X < X' inputs. As the X Counter is counted toward the number set by the X DIGITAL inputs, the X' DIGITAL outputs change accordingly. A change in the X' digits causes a resultant change in the output (X ANA) of the X Digital to Analog Converter circuit. X ANA inputs to X Deglitcher and Output Driver circuit that causes the X ANALOG voltage to change, resulting in beam deflection in the X axis. Combined with the concurrent change (if any) occurring to the Y ANALOG voltage, the beam moves toward the addressed point. When UP or DOWN COUNT pulses have clocked the X Counter to the point where X' DIGITAL equals X DIGITAL, the X Magnitude comparator sets the X = X' line high. X = X' inhibits the XSTP pulses from the Rate Multiplier, stopping the counting of the X Counter. The beam has now been moved to the new address.

If a vector address has been given an address, within a point or two of either end of the Register, the Register may "wrap around" to the opposite end of the counter before XSTP pulses can be inhibited by X = X'. To prevent the X and Y Counters from clocking past the high or low end of the Registers (wrapping around) an $\overline{\text{XHU}}$ or $\overline{\text{XHD}}$ signal goes active (depending on which end of the Register is reached) generating an OVERFLOW signal. OVERFLOW generates a $\overline{\text{LOAD}}$ pulse. $\overline{\text{LOAD}}$ holds output of the Counter at the address set by the DIGITAL inputs from TC-2; thus preventing an unwanted vector from being drawn across the display.

In summary, the Counters operate much like an integrator. The rate at which the Counter output changes is determined by the rate at which the Counter is being clocked, which is determined by the frequency XSTP. The rate at which XSTP changes is directly proportional to DELTA X. The rate at which YSTP changes is proportional to DELTA Y. Because both axes are being clocked by constant STP signals, the result on the screen is a straight line through the addressed point.

Digital to Analog Conversion

Digital to Analog (D/A) Converter Circuits. These circuits convert the 12-bit digital outputs of the Counters into their respective analog values. The X and Y Matrix analog signals (X MAT, Y MAT) from the Character Generator are summed with the Counter outputs in their respective D/A circuits.

Deglitcher/Output Driver. These circuits ensure that "clean" X and Y ANALOG signals are placed on their respective minibus pins. The Digital to Analog Converters have a tendency to "glitch" every 16th count (up or down) from the Counters. Thus, every 16 counts, the $\overline{\text{X16}}$ line from the counter goes low. This opens up an electronic switch within the Deglitcher circuit that isolates the ANALOG output from the output of the D/A converter circuit. The current beam position is stored in a capacitor (C381 for X and C383 for Y). After a determined amount of time (set by a one-shot multi within the Deglitcher circuit), that allows sufficient time for the D/A output to stabilize, the switch closes and the ANALOG voltage continues to change.

Common Circuits

End Detector. This circuit outputs an $\overline{\text{END COUNT}}$ signal that inputs to TC-1 to end the $\overline{\text{Z}}$ signal that turns on the Z axis to draw the vector. In retrospect, looking back to a function of TC-1, when the Low Order X byte is received by the Terminal, TC-1 activates $\overline{\text{LOXE}}$. This signal also activates the $\overline{\text{Z}}$ signal from TC-1 that can remain active for a time up to 3.26 milliseconds. 3.26 milliseconds is the time required to draw the longest vector. Thus, $\overline{\text{END COUNT}}$ is generated when the display beam has reached the addressed point to ensure that the $\overline{\text{Z}}$ signal is on only for the time required to draw the vector. $\overline{\text{END COUNT}}$ goes active when X = X', when Y = Y', when $\overline{\text{FPAUSE}}$ is high, when $\overline{\text{GRAF}}$ is low, and when $\overline{\text{ZON}}$ is high. The ZON signal is an output of the Loxe Delay circuit. It prevents $\overline{\text{END COUNT}}$ from occurring for approximately 8 microseconds after vector drawing begins. This ensures the $\overline{\text{Z}}$ signal from TC-1 is on long enough to draw at least one point for any one point vectors. The DONE signal is reserved for auxiliary device use.

In normal graphics operation, $\overline{\text{END COUNT}}$ occurs after a one shot delay that ensures the beam is at its destination before the Z axis is turned off.

In write through mode, this delay is shortened in order to keep the end of a write through vector from storing.

Loxe Delay. When $\overline{\text{LOXE}}$ goes active, DLOXE goes high. $\overline{\text{DLOXE}}$ goes low, $\overline{\text{CGZSUP}}$ goes low, and $\overline{\text{ZON}}$ goes low. DLOXE, and its complement $\overline{\text{DLOXE}}$, remain true for two 614 kHz clock times. DLOXE latches the DELTA X number into the Normalizing Shift Registers and also clears the XSTP setting in the Rate Multipliers. $\overline{\text{ZON}}$ and $\overline{\text{CGZSUP}}$ remain true for five 614 kHz clock times. $\overline{\text{ZON}}$ performs a function as described in the description of the End Detector block. $\overline{\text{CGZSUP}}$ inputs to the Character Generator and TC-1 to inhibit the $\overline{\text{Z}}$ outputs of these circuits. This provides a stable $\overline{\text{Z}}$ line prior to turning on the Z axis signal to draw the vector.

Speed Compensation Counter. XSTP and YSTP input to this circuit, which remembers what has occurred to these inputs for the preceding two steps (whether X was stepped, Y was stepped, or both were stepped). A boolean function is performed on these inputs to arrive at a number between 12 and 15. This number is loaded into a counter that counts from that number to 15, reloads the number again and counts to 15 again. This repeats as the vector is being drawn. Each time the boolean derived number is loaded into the counter, a low pulse occurs on the $\overline{\text{FCOMP}}$ line. If the number loaded is 15, then $\overline{\text{FCOMP}}$ has the same frequency as the 4.9 MHz clock that is clocking the counter. If the number is lower than 15, then the FCOMP frequency is the 4.9 MHz clock divided by 15 — N + 1; where N = the number between 12 and 15. Example: If N = 13, then:

$$
\begin{aligned}
\overline{\text{FCOMP}} &= \frac{4.9 \text{ X } 10^{-6}}{15 - \text{N} + 1} \\
&= \frac{4.9 \text{ X } 10^{-6}}{15 - 13 + 1} \\
&= \frac{4.9 \text{ X } 10^{-6}}{3} \\
&= 1.633 \text{ MHz}
\end{aligned}
$$

$\overline{\text{FCOMP}}$ is an input to the Rate Multipliers that is multiplied by the STEP SET number to arrive at a Frequency for the X and YSTP signals. Because both the X and YSTP signals are also used as inputs to the Speed Compensation Counter, a closed feed-back loop is realized. The Speed Compensation Counter ensures that the drawing time between short and long vectors is fairly constant.

NON-VECTOR DISPLAY OPERATION

When a visible vector is not being drawn, the $\overline{\text{NOLI}}$ signal is high. $\overline{\text{NOLI}}$ is high in Alpha Mode, GIN Mode, and when drawing dark vectors. $\overline{\text{NOLI}}$ provides a straightforward path through the counters for the DIGITAL inputs from TC-2. Changes in X and Y DIGITAL are felt immediately on the X' and Y' DIGITAL outputs, where they are converted into their analog counterpart by the D/A circuits. The changes in X and YANA voltages are routed through their respective Deglitcher/Output Driver circuit and onto their respective minibus line.

The $\overline{\text{CHSTP}}$ signal is an output of the X and Y Registers on TC-2. It is a signal much like $\overline{\text{X16}}$ and $\overline{\text{Y16}}$ that occurs when the Crosshair Generator circuitry is clocking the X and Y Registers on TC-2 when drawing the crosshair. Like $\overline{\text{X16}}$ and $\overline{\text{Y16}}$, $\overline{\text{CHSTP}}$ isolates the ANALOG outputs from the outputs of the D/A converters.

DISPLAY CONTROL CARD BLOCK DIAGRAM DESCRIPTION

INTRODUCTION

This description covers both the standard Display Control Card (670-3294-XX) and the Enhanced Graphics Module Display Control Card (670-3519-XX) used with Option 34. The Block Diagram is the same for both cards, except in those areas to be mentioned. However, separate schematics are required to show the circuit differences between the two cards. Component locations for the different cards, are shown on the apron of the schematics. The main difference is the Vector Type Generator circuit that generates the various vector types (dotted, dashed, etc.) provided as part of the Enhanced Graphics Module. The circuits common to both cards are described first, with the Vector Type Generator described last.

The primary purpose of this card is to provide control over the Z Axis pulse width to the High Voltage and Z Axis circuitry. This card also provides Z Axis inputs for the Optional Display Multiplexer card. In addition, control is provided over the $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ signals that input to the High Voltage circuits.

Principal Circuits

Circuits contained in the Standard Display Control Card are listed below.

Display Character Decoder—Decodes the Display Character sequence — which is ESC followed by any character code between 96_{10} and 126_{10}.

Display Character Latch—Holds the information bits of the Display Character on the output lines until a new Display Character is received or a $\overline{\text{PAGE}}$, $\overline{\text{HOME}}$, or CR signal goes active.

Display Mode Decoder—Controls the state of the $\overline{\text{SELW}}$ and $\overline{\text{FUZZ}}$ signals as per Bit 4 and Bit 5 of the Display Character.

Z Axis Control—Provides pulse width control of the Z Axis signals to the Terminal Display and the Optional Display Multiplexer card.

Focus and Intensity Control—Controls the $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ signals that input to the Z Axis circuits in the Display Unit.

MUX Gating—Provides interfacing to and from the Optional Display Multiplexer card for display control.

Display Modes

When ESC is followed by a Display Character, information can be displayed in any of three "display modes". A short description of each is given below.

Normal Display Mode—Selected upon power-up; or upon activation of CR, $\overline{\text{HOME}}$ or $\overline{\text{PAGE}}$, or upon receipt of ESC followed by a Normal Z Axis character. Written information; both alphanumeric and graphic is stored. Display drops into Hold if Terminal remains inactive after approximately 90 seconds in Alpha Mode. Hold operation allows the stored information to dim out, yet remain stored. Receipt of more information returns display to normal View Status.

Defocused Display Mode—If the Terminal receives an ESC 104_{10}—111_{10} code sequence, displayed information becomes slightly defocused; otherwise, operation is the same as Normal Display Mode.

Write Through Mode—Terminal receipt of an ESC followed by a 112_{10}—119_{10} code sequence prevents data from storing as it is being written. Data previously stored remains stored, as write-through logic does not affect the View Status. This mode allows simultaneous display of stored and write-through data. However, the write-through data has to be continually refreshed to be useful.

Return to normal operation from either of the last two modes is established when the CR, $\overline{\text{PAGE}}$, or $\overline{\text{HOME}}$ signal goes active. Display modes can be switched from mode-to-mode upon receipt of appropriate display codes.

DETAILED BLOCK DESCRIPTION

Display Character Decoder

When it is desired to set the display status to some status other than normal, a display code sequence must be received by the Terminal. ESC followed by a character from 96_{10} to 126_{10} "conditions" the display as determined by the bit content of the character. For example, when ESC is decoded on TC-1, LCE goes high and "arms" the Decoder. When the next character is received the $\overline{\text{BIT 6}}$ and $\overline{\text{BIT 7}}$ content are sampled to ensure that the character is indeed a character from the LOY columns of the ASCII or APL code charts. Then, when the $\overline{\text{TSTROBE}}$ occurs, a LOAD signal goes high to latch the remaining five bits of the display character into the Display Character Latch. A low active $\overline{\text{BTSUP}}$ or $\overline{\text{TSUP}}$ signal inhibits the afore-stated operation.

Display Character Latch

This circuit is used to retain BIT 1 — BIT 5 of the Display Character on its output lines. These bits are latched through the circuit when the LOAD signal from the Display Character Decoder goes high. These bits remain on the output lines until a new ESC Display Character sequence is received or a $\overline{\text{PAGE}}$, $\overline{\text{HOME}}$, or CR signal goes active to clear the output. The Display Control Card used in the standard Terminal uses only BIT 4 and BIT 5 outputs from the Latch. The BIT 1 — BIT 3 outputs are reserved for use with the Optional Enhanced Graphics Module.

Display Mode Decoder

This circuit decodes the BIT 4 and BIT 5 content of the Display Character and sets $\overline{\text{FUZZ}}$ and $\overline{\text{SELW}}$ signals accordingly. BIT 4 and BIT 5 from the Display Character Latch effect the outputs as shown in Table 5-13.

TABLE 5-13

Display Character Effects on Display Mode Decoder Circuit

Display Mode	Display Character BITS		Corresponding Outputs	
	BIT 5	BIT 4	$\overline{\text{FUZZ}}$	$\overline{\text{SELW}}$
Normal	0	0	High	High
Defocus	0	1	Low	High
Write-thru	1	0	High	Low
Not Allowed	1	1		

Focus Control Circuit

This circuit uses the $\overline{\text{GRAF}}$, $\overline{\text{WRITE}}$, $\overline{\text{SLEW}}$ and $\overline{\text{FUZZ}}$ signals to control the $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ signals that input to the High Voltage circuits. $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ are low true signals. With $\overline{\text{FOCUS}}$ low, information written on the screen is in focus; pulling $\overline{\text{FOCUS}}$ high causes display information to become slightly defocused. With $\overline{\text{BRITE}}$ low, information is stored at increased intensity. Table 5-14 shows valid combinations of $\overline{\text{FUZZ}}$, $\overline{\text{SELW}}$, $\overline{\text{GRAF}}$, and $\overline{\text{WRITE}}$ signals, and their effect on $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$. All other input signal combinations hold $\overline{\text{FOCUS}}$ and $\overline{\text{BRITE}}$ high.

TABLE 5-14

Mode Effects on Focus Control Circuit

Display Mode	INPUT SIGNALS				OUTPUT SIGNALS	
	$\overline{\text{FUZZ}}$	$\overline{\text{SELW}}$	$\overline{\text{GRAF}}$	$\overline{\text{WRITE}}$	$\overline{\text{FOCUS}}$	$\overline{\text{BRITE}}$
Defocus Vector	0	1	0	0	1	0
Larger Alpha Characters	0	1	1	0	0	0
Normal (focused) Vector	1	1	0	0	1	1
Normal (focused) Alpha Character	1	1	1	0	0	1
Write-through Vector	1	0	0	0	1	0
Write-through Alpha Character	1	0	1	0	1	0

Z Axis Control

This circuit provides Z Axis signals for the Terminal Display and for the Optional Display Multiplexer Card. No Z Axis output signals are activated until the $\overline{\text{Z}}$ input signal goes active. The effect $\overline{\text{Z}}$ has on the Z Axis outputs depends on the mode of operation. Table 5-15 lists the effects on the Z Axis outputs as controlled by the $\overline{\text{Z}}$, $\overline{\text{WRITE}}$, $\overline{\text{GRAF}}$, and $\overline{\text{SELW}}$ signals. Study of this table will show the following:

TABLE 5-15

Z Axis Control

	INPUTS				Z AXIS OUTPUTS TO TERM. DISPLAY	Z AXIS OUTPUTS (TO DISPLAY MUX.)		
	$\overline{\text{SELW}}$	$\overline{\text{GRAF}}$	$\overline{\text{WRITE}}$	$\overline{\text{Z}}$	$\overline{\text{Z DIS}}$	[1]Z CURSOR	[1]$\overline{\text{Z NORM}}$	[1]Z WRITE THRU
Alpha and Crosshair Cursor Display (1)	HIGH	HIGH	HIGH	Low-going output from C.G. for Alpha Cursor; from TC-2 for Crosshair Cursor.	Active, low-going pulse at $\overline{\text{Z}}$ rate; P/W from 120 ns to 1 μs as set by Cursor Brightness Pot.	Same as $\overline{\text{ZDIS}}$ except pulse is high-going.	Disabled (held high)	Disabled (held low)
Alphanumeric Character Display (2)	HIGH	HIGH	LOW- Active (stays active for time it takes to generate character)	Low-going output from C.G.	Active low-going pulse at $\overline{\text{Z}}$ rate; P/W same as $\overline{\text{Z}}$	Disabled (held Low)	Same as $\overline{\text{ZDIS}}$	Active high-going pulse at $\overline{\text{Z}}$ rate. P/W adjustable from 50 ns to 300 ns by Write-Thru Int. Pot.
Vector Display (3)	HIGH	Active low from TC-1 in Graph Mode.	Goes Active low concurrent with $\overline{\text{Z}}$.	Active for time needed to draw vector.	Active low for time of $\overline{\text{Z}}$	Disabled (held low)	Same as $\overline{\text{ZDIS}}$	Pulses high for time of 50 ns to 300 ns as determined by Vector Brightness Pot. Occurs only once for each vector when $\overline{\text{WRITE}}$ and $\overline{\text{Z}}$ go active.
Alpha and Crosshair Cursor Display with WRITE-THRU (4)	Active low when ESC is followed by Write-Thru Command.	HIGH	HIGH	Same as $\overline{\text{Z}}$ for Line 1	See $\overline{\text{ZDIS}}$ for LINE 1	See Z Cursor FOR LINE 1	See $\overline{\text{Z NORM}}$, LINE 1	See Z WRITE-THRU LINE 1.
Alphanumeric Character Display with WRITE-THRU (5)	Same as Line 4	HIGH	Same as $\overline{\text{Z}}$ for Line 2	Same as $\overline{\text{Z}}$ for Line 2	Goes active low once each $\overline{\text{Z}}$ time. P/W determined by WRITE-THRU Int. Pot.	Disabled (held low)	Disabled (held high)	Same as $\overline{\text{ZDIS}}$ except pulse is high-going.
Vector Display with WRITE-THRU (6)	Same as Line 4	Same as Line 3	Same as Line 3	Same as Line 3	Goes active low once every 4 μs. P/W determined by Write-Thru Int. Pot.	Disabled (held low)	Disabled (held high)	Same as $\overline{\text{ZDIS}}$ except pulse is high-going.

[1]**Reserved for use by optional accessories.**

Cursor Display. When generating the Alpha or Crosshair Cursor, the $\overline{Z}$ pulses come from the Character Generator or TC-2, respectively. The Z Axis Control circuit shortens the $\overline{Z}$ pulses, giving them a pulse width from 120 ns to 1 μs, as determined by Cursor Brightness Pot. R21. This provides $\overline{ZDIS}$ pulses of sufficient length to display the written point but not store it. Activation of Write-Thru ($\overline{SELW}$ goes active) produces no noticeable effect on the Z Axis outputs when developing the cursors.

Alphanumeric Character Display. When writing a character, the Character Generator activates the $\overline{WRITE}$ signal. It also activates the $\overline{Z}$ signal on those dots that form the character. The $\overline{WRITE}$ signal causes the Z Axis Control circuit to route the $\overline{Z}$ pulses directly through to the $\overline{ZDIS}$ and ZNORM outputs of the circuit. Write-Thru Operation disables the ZNORM output and causes the pulse width of the $\overline{ZDIS}$ and ZWRITE-THRU signals to be between 50 and 400 ns as adjusted by the Write-Thru Intensity Pot at the right of the keyboard. This enables the character to be displayed but not stored, thus providing a "write through" capability.

Vector Display. Occurs when Graph Mode is selected. The $\overline{WRITE}$ and $\overline{Z}$ signals go low for the time needed to draw the vector. These signals cause the $\overline{ZDIS}$ and ZNORM signals to go true for the duration of the $\overline{Z}$ signal. Thus, as the beam is deflected, it displays the vector. Write-thru operation causes the $\overline{ZDIS}$ and Z WRITE-THRU signals to go active only once every 4 microseconds as the beam is being deflected. Pulse width is from 50 to 300 ns as determined by the Write-Thru Intensity Pot. This allows the vector to be displayed as it is being written, but the pulse width does not allow the vector to store. Continually redrawing the same vector enables it to be visible, thus providing vector "write through".

MUX Gating

This circuit is used when an optional Display Multiplexer Card is installed in the Terminal and connected to a display monitor(s). It also provides buffering for the $\overline{SLU}$, $\overline{DBUSY}$, $\overline{MAKE\ COPY}$ and $\overline{PAGE}$ signals. With the SELECT signal high, this circuit is enabled. Select is a control line used by the Display MUX. $\overline{PAGE}$ from the Terminal causes an $\overline{ERASE}$ signal to go active. $\overline{ERASE}$ is used by the Terminal Display Unit to erase the display. $\overline{MAKE\ COPY}$ from the Terminal activates the MC signal. (The MC signal goes to the display to make a copy if a HCU is connected.) $\overline{DBUSY}$ is an input from the Terminal Display Unit that goes true when the Display is being erased, or a hard copy is being made. $\overline{DBUSY}$ activates the $\overline{DRBUSY}$ output that controls transmission of Terminal data to the monitor. $\overline{DRBUSY}$ also disables the $\overline{ZDIS}$ output from the Z Axis Control circuit. $\overline{SLU}$ is an output form the Deflection Amplifiers circuit that goes active in extreme cases of deflection circuit instability; such as occur during linefeed, carriage return, and during point plot Operation (Point-Plot is a mode of Graphic operation provided by the Enhanced Graphics Module Option). SLU activates $\overline{FPAUSE}$ to inhibit Terminal activity.

Vector Type Generator (used with Enhanced Graphics Module only)

This circuit is enabled by $\overline{NOLI}$ going high when the Terminal is switched to Graph Mode. The receipt of a Display Character code sequence (ESC followed by some ASCII or APL character between 96_{10} and 126_{10}) causes LOAD to go active. LOAD clears the Vector-type Generator circuit, via U371D preparing it for receipt of BIT 1 — BIT 3 of the Display Character. LOAD loads BITS 1—5 of Display character into the Display Character Latch where they are then applied to the outputs. There they remain until the latch is cleared or a new display character is received by the Terminal. BIT 1 — BIT 3 of the Display Character input to the Vector Type Generator to determine the vector type; normal, dotted, dot-dashed, short dashed or long dashed. As the vector is being drawn, Z is active, enabling low-going edges of the 614 kHz signal to clock the Vector Type Generator. The Vector Type Generator begins outputting pulses as selected by the BIT 1 — BIT 3 content of the Display Character. The $\overline{ZOFF}$ signal inputs to the Z Axis Control circuit to control when the ZDIS signal is turned on. $\overline{ZOFF}$ also outputs from the Vector Type Generator and is reserved for use by the Optional Display Multiplexer.

DISCRETE PLOT CARD

(Available with Optional Enhanced Graphics Module Only)

INTRODUCTION

General

The Discrete Plot Card communicates with the Terminal and with a mechanical plotter. The Card provides the Terminal with the additional graphics modes of Incremental Plot, Point Plot, and Special Point Plot with the following functions:

Incremental Plot

This mode is entered by placing the control character RS on the Terminal minibus. Data words are then interpreted as XY plotter commands of pen up, pen down, carriage up, carriage down, chart right, and chart left. If the plotter (connected to the J5 pins on the Card) is deactivated, the Terminal is able to provide a rapid preview of the plot. With the plotter activated, the Terminal causes data transmission to be slowed and provided to the mechanical plotter at a rate commensurate with plotter response time.

Point Plot

This mode is entered by placing the control character FS on the minibus. The Terminal responds to subsequent data words as though in Graph Mode, and reads each four word sequence as a display address. At each address, a point is written on the display, at an intensity set during Special Point Plot mode operation.

Special Point Plot

This mode is entered by placing the control character sequence ESC FS on the Terminal minibus. The Terminal responds to subsequent data as though in Point Plot mode in that an individual point is plotted for each four-word address. Different from POINT PLOT operation, this mode allows each point to be plotted at a distinct and controlled intensity level. This intensity level is set by transmission of a separate word (the Intensity Character) prior to each point address. This Intensity Character is read by the Discrete Plot Card, during which time the Terminal is suppressed. Refer to Table 2-25 for a listing of relative writing time (related to intensity) corresponding to a given Intensity Character.

The intensity level set during this mode is referred to by the Terminal for plots in both Incremental Plot and Point Plot modes; during these modes, plot intensity is held constant until Special Point Plot mode is re-entered, and a new Intensity Character is input to the data bus, or the RESET key is pressed on the keyboard.

Mode Change

Arbitrary changes from one Terminal operating mode to another are not allowed for reasons explained later. As shown in Fig. 2-5, a transition from Point Plot to Special Point Plot mode requires only that the control character sequence ESC FS be asserted. A transition in the reverse direction requires two steps: Alpha Mode must be entered (by control character US or CR, control character sequence ESC FF or keyboard PAGE or RESET) and then Special Point Plot mode is entered (ESC FS).

BLOCK DIAGRAM DESCRIPTION

General

Refer to the Discrete Plot Card Block Diagram. The circuitry can be divided into three functions: Writing Time Control, Mode Command Decoder, and Incremental Plot Control. During Incremental Plot mode operation, all blocks are activated. In Point Plot and Special Point Plot mode operation, the Incremental Plot Control block is inhibited.

Mode Control

This block serves to decode control commands on the minibus and to interact with the Terminal control lines in enabling Writing Time Control functions in each mode. Mode Control activates Incremental Plot Control only in response to control character RS.

Writing Time Control

This block controls beam intensity by determining the duration of the $\overline{Z}$ pulse. Point size is proportional to the duration of the $\overline{Z}$ pulse. Regardless of whether Incremental Plot, Point Plot, or Special Point Plot mode is active, this intensity level (stored in the Discrete Plot Card) is referred to by the Terminal display prior to writing a point.

Writing time, and therefore point intensity, may be altered when the Mode Control accepts a command to activate Special Point Plot mode. The Mode Control then allows a subsequent Intensity Character on the minibus to set a new writing time. The latter is stored in the Writing Time Control circuitry, and is referenced by the display during all modes of the Card. The Terminal is suppressed while the Intensity Character is being read.

Incremental Plot Control

This circuitry is activated only in response to control character RS, as decoded by the Mode Control block. When operating, the Incremental Plot Control circuitry activates TSUP to suppress the Terminal's reading of noncontrol characters, and reads information on the BIT 1—BIT 7 lines as incremental plot commands of Pen Down, Pen Up, Carriage Up, Carriage Down, Chart Right, and Chart Left. These commands, either singularly or in combination, cause the Incremental Plot Control block to pulse the LEFT, RIGHT, UP, and DOWN lines that control the beam position registers on TC-2. These directional controls are made available to a mechanical plotter as the CHART LEFT (−X), CHART RIGHT (+X), CARRIAGE UP (+Y), and CARRIAGE DOWN (−Y) signals.

Whether or not the signals are made available to the plotter is controlled by the spare Terminal switches (SW1, SW2 or SW3), by the plotter (REMOTE SELECT), or both, as determined by strap options (refer to the Servicing section).

The Incremental Plot Control circuitry allows incremental data to be accepted rapidly (with the mechanical plotter suppressed) or slowly (with the plotter activated). The plotter receive rate may be adjusted for individual plotter characteristics (refer to the Servicing section).

DETAILED CIRCUIT DESCRIPTION

General

The following detailed description makes reference to the schematic diagram of the Discrete Plot Chart. Component locations are shown on the apron of the schematics. Explanation of the various Terminal bus lines will only be discussed in the context of the Discrete Plot Card. Each mode, Incremental Plot, Point Plot, and Special Point Plot, will be considered separately.

Incremental Plot

Refer to those gates of the Mode Control circuitry that read the BIT1 — BIT7 lines. The assertion of control character RS and accompanying TSTROBE, in the absence of a Terminal suppressed (TSUP) or Terminal blanked (BTSUP) condition, causes activation of GRAF (from U385F), GIN (from U385E), and a high RS (from U271D) to the Incremental Plot flip-flop (U271A and B). Activation of GRAF sets the Terminal's Graph Flip-Flop on TC-1, which holds GRAF active. The Discrete Plot Card asserts GIN with GRAF to comply with Terminal requirements. GRAF can only be deactivated by a transition to Alpha or GIN mode, as described in the Terminal Users Manual. With GRAF active, the set condition to the Incremental plot Flip-Flop no longer relies upon RS, and is maintained until GRAF is deactivated.

The resulting high signal from U271B (INCRP) causes activation of NOLI, which suppresses the linear interpolation used by the Terminal Graph Mode circuitry even though the GRAF signal is active. The activation of NOLI still allows individual points to be displayed on the Terminal. INCRPLT also causes AUX SENSE to be asserted at U41F. AUX SENSE is a bit of the Terminal Status Character that can be monitored by the computer should the computer send the ESC ENQ sequence. See the description of GIN Mode in the Operations section of this manual.

INCRPLT Signal. INCRPLT is the master enable for many Incremental Plot Control functions. In general it allows the circuitry to translate Terminal BIT1 — BIT7 information into XY plotter incremental commands. The output of Q47 (PLOTTER ON) controls whether the incremental commands drive the Terminal beam positioning and blanking control, and whether parallel data is provided to both the Terminal and a mechanical plotter.

PLOTTER ON (a high-active signal) results when a low signal is applied to the base of Q47. With the REMOTE SELECT strap in the IN position, the plotter may select itself for operation by applying a −15 volt signal to J5 pin 2. PLOTTER ON may also be activated by spare Terminal Switches by appropriate positioning of the PLOTTER SELECT strap. Placing this strap in the SW1 position allows Terminal keyboard Switch 1 to activate PLOTTER ON when depressed right. Similarly, placing the strap in the SW2 position gives control to Terminal Switch 2. The SW3 position enables an optional signal to activate PLOTTER ON through J6 pin 1. Control of PLOTTER ON may be given to both the plotter (REMOTE SELECT strap IN) and the Terminal (PLOTTER SELECT strap in the SW1, SW2 or SW3 position), in which case a low signal from either is sufficient to activate PLOTTER ON.

Operation Example — Without Incremental Plotter. Assume then that the control character RS has, in the absence of inhibiting commands from the Terminal, set GRAF and INCRPLT active. Assume also that a mechanical plotter is not energized (PLOTTER ON low). The arrival of the first incremental command on the BIT1 — BIT7 lines is accompanied by a TSTROBE. BIT1 — BIT6 appear at the input to latch U141, but await an enable provided by U281C before progressing further. This enable (STROBE) is provided by TSTROBE in the absence of an active BTSUP and CONTROL CHARACTER (CTRL) signals. (The CTRL signal is asserted only when the minibus carries a control character (detected by U265A) or an invalid character (126_{10}) or Rubout (127_{10}), detected by U245A and U251A.

STROBE latches the incremental data character through U141. STROBE, in conjunction with INCRPLT, causes a .1 μs low pulse from one-shot multivibrator U365 to activate U161C. The output from the latter is COMMAND LOAD (CMLD).

CMLD simultaneously asserts TBUSY from U185 (inhibiting receipt of further data for the .1 μs period) and gates the incremental command through NOR gates U135B, U131C, U135D, U131D and U135A as selected by the increment character. The selected step commands Carriage Up (BIT3 active), Chart Left (BIT1 active), Carriage Down (BIT4 active), and Chart Right (BIT2 active) are then directly fed to the Terminal X and Y address registers as UP, RIGHT, DOWN and LEFT commands.

The display beam is thus incremented to a new position, and awaits a command to write the point. This write command (Z) comes from the Pen Up/Down flip-flop (U261B and U281B) which is enabled by INCRPLT. This flip-flop stores the last Pen up or Pen down command received. A Pen Down command (selected by bit 6) strobed through U135B by CMLD, sets the Flip-Flop in the Pen Down State. This activates the UNBLANK signal from U261B. A Pen Up Command (selected by bit 6) strobed through U135A, causes the Flip-Flop to reset, deactivating UNBLANK.

The coincidence of INCRPLT, STROBE, UNBLANK, and the absence of PLOTTER ON activates ENDCOUNT. ENDCOUNT inputs to TC-1 to ensure that it does not apply a Z signal. In other words, in Incremental Plot, the Z signal comes strictly under control of the Z output from the writing Time Control circuit. At the same time ENDCOUNT goes active, the Writing Time Control circuit is energized to pulse Z for a .05 μsc to 25 μs period, depending upon conditions discussed in the following text.

NOTE

In the previous description of Terminal Incremental Plot functions, only step and blanking information are made available to the Terminal beam control circuitry, not absolute addresses. As a result, the incremental plot begins at that point on the screen where the lower left corner of the alpha cursor appears during Alpha Mode, or at the position of the crosshair intersection during GIN Mode.

Should the plotter be activated during Incremental Plot mode, (PLOTTER ON), a different sequence of events occurs as is described in the following.

Operation Example — with Incremental Plotter. Assuming that the control command RS has activated INCRPLT, and PLOTTER ON is active. The Ø.1μs pulse from U365 activates one-shot multivibrator U165 to produce a much longer (250 μs) low pulse, which asserts COMMAND LOAD (CMLD) for that duration. TBUSY is thus activated for the longer period at U165. Latching of incremental commands continues as before (on active STROBE, signals), and the presence of PLOTTER ON at gates U351, U31D, U35C, U31C and U35B causes these commands to be relayed directly to the plotter as 0 or +15 volt, 250 μs signals. Information is provided to the Terminal as before, and control of the Pen Up/Down flip-flop occurs as described previously. A PEN DOWN command thus enables the Terminal Z axis and also pulses the plotter's PEN DOWN input through U35A. A PEN UP command blanks the Terminal Z axis and pulses the plotter's PEN UP input through U35B.

With PLOTTER ON active, the assertion of TBUSY is extended to allow for delay times of the plotter in response to Pen Down, Step and Pen Up commands. A Pen Down command thus activates one-shot multivibrator U65, which asserts TBUSY for an adjustable length of time necessary for the plotter to respond to the command. Similarly, a Step command causes one-shot multivibrator U75 to assert TBUSY for an adjustable period; a Pen Up command causes U191 to assert TBUSY for an adjustable period.

Point Plot

The assertion of control character FS and accompanying TSTROBE in the absence of a Terminal Suppressed (TSUP) or Terminal Blanked (BTSUP) condition causes activation of GRAF, GIN, and a high condition to the Point Plot flip-flop (U131A and U381A). The Point Plot Flip-Flop is enabled by the absence of INCRPLT, which explains why a direct transition from Incremental Plot to Point Plot mode is not allowed.

The set condition of the Point Plot Flip-Flop results in an active POINT PLOT (PTPLT) signal from U381A. PTPLT causes activation of NOLI through U385D, and as discussed in the context of Incremental Plot mode operation, NOLI causes suppression of the Terminal vector interpolation circuitry. With the setting of the Point Plot Flip-Flop, Point Plot mode operation is established.

Recall that in Incremental Plot mode, the Discrete Plot Card intercepts minibus data by suppressing Terminal response to that data with TSUP. The Incremental Plot Control function then interprets the data as incremental X-Y plotter commands, and provides these commands to a mechanical plotter directly, or to the Terminal as UP, DOWN, RIGHT, LEFT pulses to the beam position registers.

Differing from Incremental Plot mode operation, Point Plot mode does not cause suppress Terminal response to data that follows FS. As a result, the Terminal interprets a character sequence (up to five characters maximum) on the minibus as the XY coordinate. The addressing sequence is identical to that of Graph Mode.

Operation Example. Assume that a graphic address has been received by the Terminal. The arrival of the last character (the Low Order X byte) activates $\overline{\mathrm{LOXE}}$. The coincidence of PTPLT, $\overline{\mathrm{LOXE}}$ and a high-going edge of the 4.9 MHz Terminal clock causes one-shot multivibrator U361 to pulse the Writing Time Control circuitry. As in the case of Incremental Plot, a low going pulse to U281A asserts $\overline{\mathrm{ENDCOUNT}}$ (inhibiting $\overline{Z}$ outputs from TC-1) and begins the Writing Time Control process to pulse $\overline{Z}$ for a predetermined interval. This interval is related to the intensity of the written point; it can only be altered by entering Special Point Plot mode and setting a new level (by a process described in the following text).

Special Point Plot

The arrival of control character ESC on the minibus activates the Escape Flip-Flop (on Terminal Circuit Card TC-1), resulting in a high LCE signal. Following ESC with control character FS establishes Special Point Plot mode, as will be described.

Operation Example. Assume that LCE is high. The arrival of FS asserts $\overline{\mathrm{GRAF}}$ and $\overline{\mathrm{GIN}}$, thus setting the Point Plot Flip-Flop (U131A and U381A) that consequently asserts $\overline{\mathrm{NOLI}}$. Additionally, the conjunction of LCE and FS (at U275B) causes the clearing of Intensity Character flip-flop U375, and sets the Special Point Plot Flip-Flop (U275A, U275C). The cleared state of U375 allows the Writing Time Control circuitry to read the forthcoming Intensity Character on the minibus. It asserts $\overline{\mathrm{AUXSENSE}}$, with the effect previously described, and suppresses the Terminal with $\overline{\mathrm{TSUP}}$ so as not to interpret the Intensity Character as address information. The Intensity Character is followed by beam address which uses the same addressing scheme as Graph Mode.

Assume that an ASCII (or APL) numeral 9 is received as an Intensity Character and is present on the $\overline{\mathrm{BIT1}}$ — $\overline{\mathrm{BIT7}}$ lines. The accompanying STROBE signal, in conjunction with the cleared state of the Intensity Character flip-flop, activates an $\overline{\mathrm{ENABLE}}$ signal from U261C. $\overline{\mathrm{ENABLE}}$ allows U205 to read the Intensity Character.

The falling edge of STROBE clocks the Intensity Character flip-flop back to its set state. This action releases $\overline{\mathrm{AUXSENSE}}$ and $\overline{\mathrm{TSUP}}$. The release of $\overline{\mathrm{TSUP}}$ allows the Terminal to respond to the beam address data. Following the storage of the Intensity Character, the first character of the point address (the Hi order Y byte) and accompanying STROBE (from U285D) arrive.

Write command ($\overline{Z}$) begins with the final address word, the Low Order X byte. This byte is accompanied by $\overline{\mathrm{LOXE}}$, from the Terminal Graphic Byte Decoder on TC-1. The conjunction of PTPLT (recall that the FS part of ESC FS set the Point Plot flip-flop), $\overline{\mathrm{LOXE}}$ and the high-going edge of the 4.9 MHz clock causes U361 to pulse for 250 μs, exactly as occurs in Point Plot mode. Whether originating from U361 during Point Plot or Special Point Plot mode, or from U175 during Incremental Plot mode, the low-going pulse to U281A has one effect only: it causes the display beam to be pulsed on for a duration controlled by the Intensity Character (now stored in latch U205).

$\overline{\mathrm{LOXE}}$ has an additional effect unique to Special Point Plot mode: the conjunction of $\overline{\mathrm{LOXE}}$, and high signals from both the Point Plot and Special Point Plot flip-flops, enable the K input of the Intensity Character Flip-Flop. This allows the STROBE signal that accompanies $\overline{\mathrm{LOXE}}$ to clock the Intensity Character flip-flop active, preparing data latch U205 to receive a new Intensity Character. The process then repeats as described previously (see Fig. 5-7).

Writing Time Control

The Writing Time Control circuitry consists of oscillator U145A, counters U125, U331A, U231B, and U201, data latch U205 (already mentioned), D-type flip-flop U331B, Multiplexer U105, and various gates.

Setting the Intensity. Assume that an Intensity Character has been loaded into data latch U205 and that a low occurs at either input of U281A, simultaneously with STROBE. $\overline{\mathrm{END\ COUNT}}$ is asserted. The low pulse that activates $\overline{\mathrm{END\ COUNT}}$ also applies a $\overline{\mathrm{LOAD}}$ command to the counters U125 and U210. It also applies a clear to Oscillator U145A and D-type flip-flop U331B. The Q output of U331B asserts $\overline{\mathrm{TBUSY}}$ through U185. As the $\overline{\mathrm{LOAD}}$ pulse ends, the oscillator begins to function; highs are applied to both inputs of U335B, and $\overline{Z}$ goes active.

Oscillator U145A provides a 15 MHz pulse string adjustable by C45. Counter U125 is clocked at this frequency, and acts as a frequency divider. Further division is provided by U331A and U231B, and six signals with frequencies of the form $f/2^n$ ($n = 0, 1, 2 \ldots 6$) are input to Data Selector U105. The frequency of the resulting CLOCK signal at the output of U105 is a function of the data selection inputs A (pin 22), B (pin 10) and C (pin 9). These inputs are provided directly from the Intensity Character Latch (U205). As a result, $\overline{\mathrm{BIT6}}$, $\overline{\mathrm{BIT5}}$ and $\overline{\mathrm{BIT4}}$ of the Intensity Character control the frequency of the CLOCK signal applied to U201. U201 is preset by $\overline{\mathrm{BIT3}}$, $\overline{\mathrm{BIT2}}$ and $\overline{\mathrm{BIT1}}$ of the Intensity Character. Consider the Intensity Character ASCII 9. Data Select inputs to U105 are C = 1, B = 0, A = 0. These select input D_4 (f/64) that is relayed to Clock Counter U201. Because $\overline{\mathrm{BIT3}}$—$\overline{\mathrm{BIT1}}$ of the Intensity Character preset U201 at 1, fifteen clock pulses are required before counter output Q_D goes high, and sixteen before it drops low again. Assume that (12) X (64/f) seconds following the end of the initiating pulse, Q_D

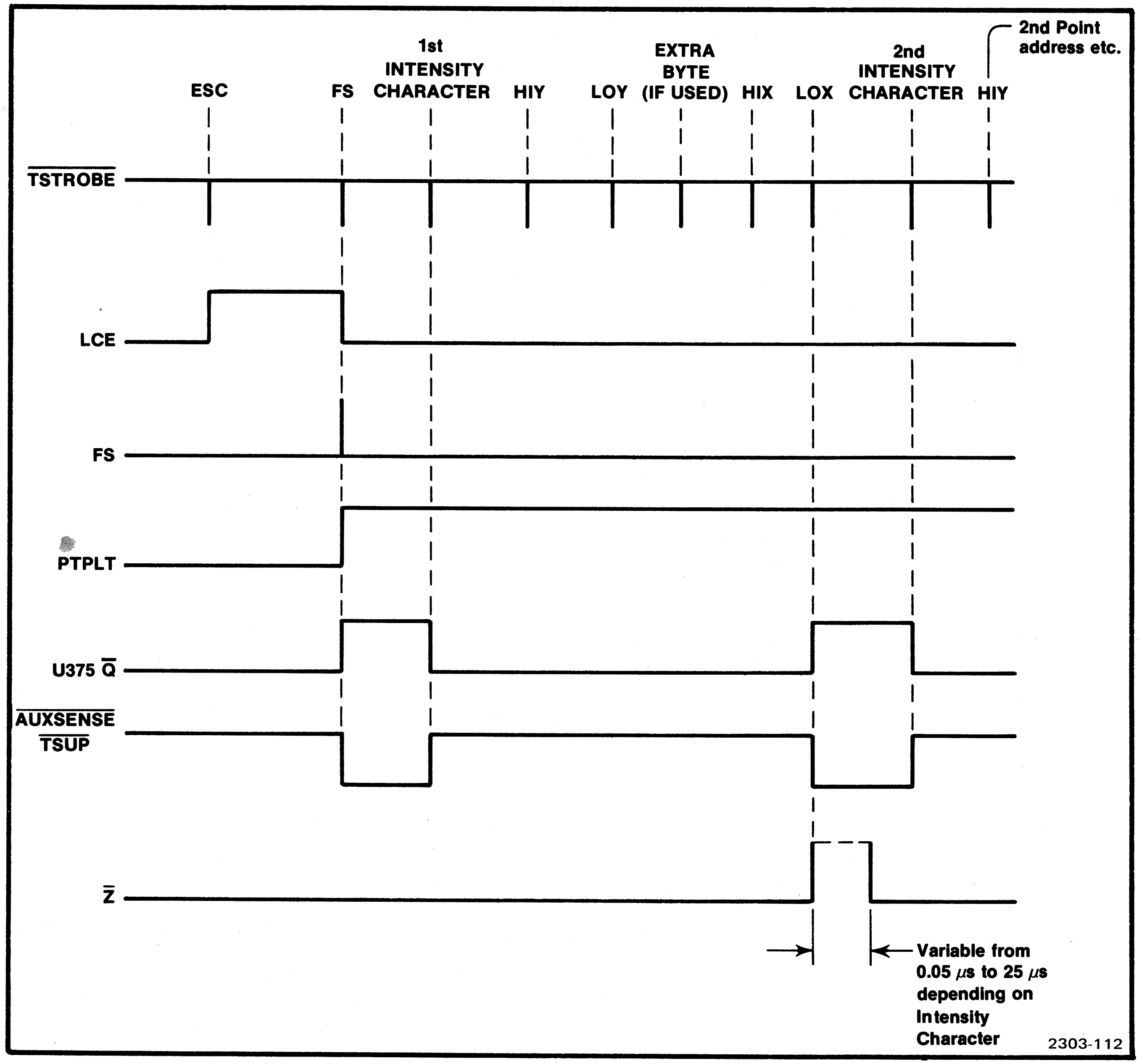

Fig. 5-7. Special Point Plot Mode minibus signals. A sequence of ESC FS, Intensity character, Point Address, and next intensity Character are followed. In Point Plot Mode, the Intensity Character segments are absent, and U375Q is never high.

has previously risen and now falls. This falling edge becomes a rising edge to U331B, which immediately sets This action removes the enable to U335B, and the $\overline{\text{Z}}$ and $\overline{\text{WRITE}}$ pulses stop; additionally, $\overline{\text{TBUSY}}$ is released, U201 is cleared, and the Writing Time Control circuitry has completed its function.

$\overline{\text{BIT7}}$ of the Intensity Character is decoded separately, and when active causes assertion of Terminal $\overline{\text{FUZZ}}$ (provided that PTPLT is active and $\overline{\text{DRBUSY}}$ is inactive) through U265D. $\overline{\text{FUZZ}}$ causes a slight enlargement of the display beam diameter. Note that $\overline{\text{FUZZ}}$ operation is not allowed in Incremental Plot mode.

Default Intensity. If a $\overline{\text{HOME}}$ pulse is applied to the Master Reset inputs of U206, a default intensity condition is established. The A, B, and C data select inputs to U105 are all low, causing U201 to be clocked at frequency f/8. The preset inputs to U201 are also all low, require that 16 of these clock pulses be applied before output Q_D falls and the Z pulse is terminated. The default intensity is therefore equivalent to that established by the Intensity Character _ (ASCII underscore character), resulting in a point written for 13% of the maximum time.

HIGH VOLTAGE AND Z AXIS BOARD

BLOCK DIAGRAM DESCRIPTION

Refer to the block diagram and schematic of the High Voltage and Z Axis Board. The schematic apron shows component locations. The High Voltage and Z Axis Board controls and regulates the writing beam focus and intensity. Principal circuits are the High Voltage Oscillator, High Voltage Supply, Control Grid Supply, Z Axis Amplifier, Intensity Control, Intensity Amplifier, Focus Supply and Focus Controller.

High Voltage Oscillator

The High Voltage Oscillator is a regulated blocking oscillator which provides an alternating drive voltage to the primary winding (1-2) on high voltage transformer T111. Winding (3-4) provides positive feedback to drive the oscillator. Winding (5-6) provides ac phase feedback used to block a portion of the oscillation. Feedback from the High Voltage Supply regulates the duty cycle to compensate for both the high voltage load and power line fluctuations. Thus the −6,000 V dc output from the High Voltage Supply is maintained.

High Voltage Supply

The High Voltage Supply delivers −6,000 volts dc to the Beam Cathode and provides feedback to the High Voltage Oscillator. The High Voltage Supply also provides a −6,000 volt reference to both the Heater Supply and the Control Grid Supply. The H.V. adjustment determines the High Voltage level by regulating the feedback to the High Voltage Oscillator.

Intensity Control

The Intensity Control sets the limits of writing beam intensity selected by the logic values of H.C.S. $\overline{\text{BRITE}}$, $\overline{\text{FOCUS}}$ and $\overline{\text{INT OFF}}$ (Intensity Off). Refer to Table 5-16 for the Intensity Adjustment used by the Intensity Amplifier in setting the writing beam intensity. The ALPHA and VECTOR INTENSITY adjustment determines the basic writing beam intensity for the display unit. The BRITE Mode is asserted with $\overline{\text{BRITE}}$ going low, selecting the high writing beam intensity, adjustable with the BRITE adjustment. Hard Copy writing beam intensity is determined by the H.C. INTENSITY adjustment. When $\overline{\text{INT OFF}}$ is asserted, none of the Intensity Adjustments is selected, thus preventing the writing beam from turning on.

TABLE 5-16
Intensity Control B050000 & Up

$\overline{\text{INT OFF}}$	H.C.S.	$\overline{\text{BRITE}}$	$\overline{\text{FOCUS}}$	SELECTION INTENSITY	SELECTION FOCUS
1	0	0	0	BRITE	BRITE FOCUS
1	0	0	1	BRITE	DEFOCUS
1	0	1	0	ALPHA	FOCUS
1	0	1	1	VECTOR	FOCUS
1	1	d	d	H.C.	FOCUS
0	d	d	d	NONE	d

0 = low
1 = high
d = don't care

Control Grid Supply

The Control Grid Supply provides the Control Grid voltage that controls the writing beam. The Grid Bias adjustment provides a reference voltage to set the writing beam cutoff bias. The Control Grid voltage is changed by the output of the Z Axis Amplifier to turn the writing beam on at a given intensity.

Z Axis Amplifier

The Z Axis Amplifier is a logic controlled, high voltage switch that provides a writing beam voltage to the Control Grid Supply. The writing beam voltage is switched between zero volts and the intensity voltage from the Intensity Amplifier. The Z Axis Amplifier turns the writing beam on and off as controlled by $\overline{\text{Z DIS}}$ from the Pedestal and $\overline{\text{H.C. INTER}}$ (Hard Copy Interrogate) from the Hard Copy Unit. The Hard Copy Switch (H.C.S.) enables $\overline{\text{H.C. INTER}}$ to activate the Z Axis Amplifier.

Intensity Amplifier

The Intensity Amplifier is a regulated voltage amplifier clamping the upper limit of the writing beam voltage from the Z Axis Amplifier. The voltage at the output of the Intensity Amplifier is set by voltage dividers in the Intensity Control circuits.

Focus Supply

The Focus Supply provides a floating, controllable, negative voltage to the Focus Electrode. The Focus Electrode voltage is set by the CENTER FOCUS adjustment and dynamically modified by the Focus Controller.

Focus Controller

The Focus Controller establishes control to maintain a consistent writing beam focus. It also provides an alternative writing beam width. These functions are provided by programmed modification of a reference voltage used by the Focus supply. The DYNAMIC FOCUS signal compensates for additional writing beam focus requirements at the edge of the screen, by providing to the Focus Controller a voltage that increases with writing beam deflection. The CORNER FOCUS adjustment determines the DYNAMIC FOCUS signal magnitude necessary to maintain a focused writing beam. The BRITE FOCUS for large characters and DEFOCUS for wide Vectors are adjustments used to set the alternative writing beam width when the Terminal is operating in the BRITE Mode. In BRITE operation, $\overline{\text{FOCUS}}$ determines which of the two writing beam widths is selected. During hard copy operation on the 4014-1/4015-1, H.C.S. goes high to provide for optimum writing beam focus when making a hard copy.

DETAILED DESCRIPTION

High Voltage Oscillator

The High Voltage Oscillator is a regulated blocking oscillator supplying power to the primary winding (1-2) of High Voltage Transformer T111. Q1032 is the switching transistor. L311 and C211 keep the ac signal out of the +20 V Supply.

The High Voltage Oscillator uses two types of feedback, positive feedback and regulating feedback. Positive feedback is provided by the L-C network from winding (3-4) to enable the oscillation. Regulating feedback is a composite signal appearing at the gate of Q236. Typical High Voltage Oscillator waveforms are in Fig. 5-8. The oscillator duty cycle is determined by the high voltage load, H.V. Adjustment R341, and the amplitude of the +20 V Supply.

Operation of the oscillator is started initially by R323 to put Q1032 into conduction. Q1032 remains in conduction to establish magnetic flux in the transformer until the current through Q1032 reaches β times the available base drive. The collector voltage of Q1032 then increases, causing a resultant decrease in voltage at the base of Q1032 through the positive feedback network. Positive feedback keeps Q1032 off until the magnetic flux in the transformer collapses. Current is again supplied to the base of Q1032. The oscillations continue to increase in magnitued and duty cycle until −6,000 V dc is almost established on the Beam Cathode. At this time the regulation amplifier consisting of Q236, Q223, and Q321 becomes active to limit the magnitude and duty cycle of the oscillations.

The regulated cycle starts when the voltage at the gate of Q236 (the regulating feedback) goes negative, increasing the source-to-drain resistance for Q236. Q223 then turns off and Q321 turns on thereby grounding the base of Q1032 and taking the remaining current from the positive feedback network. The regulating feedback voltage goes positive when the transformer lead voltages reach their peak. The positive feedback network again takes over to keep Q1032 turned off until the magnetic flux in the transformer has collapsed. The positive feedback network reverses to forward bias Q1032 until the regulating amplifier again grounds the base of Q1032.

High Voltage Supply

The High Voltage Supply provides the Beam Cathode with −6,000 V dc. The high voltage ac signal appears across transformer winding (8-26). Lead 26 has a peak-to-peak voltage on it of ±3,000 volts with respect to lead 8. Diodes CR11 and CR31 with capacitors C14 and C145 are in a voltage doubler configuration. When lead 26 goes positive, diode CR11 causes 3,000 volts to be across C14. When lead 26 goes negative, the 3,000 volts across C14 is added to the −3,000 volts on lead 26. CR31 causes −6,000 volts to appear across the parallel capacitance network of C145, C151, and C155. This voltage is the Beam Cathode voltage and is regulated by feedback to the High Voltage Oscillator through the voltage divider network R147A and R147B. An ac component of the Beam Cathode voltage is fed through C141 and R241. The Beam Cathode voltage (−6,000 V dc) is set by H.V. Adjustment R341.

Intensity Control

The Intensity Control is a set of four voltage dividers selected by the logic inputs $\overline{\text{BRITE}}$, H.C.S., $\overline{\text{FOCUS}}$ and $\overline{\text{INT OFF}}$. Table 5-16 indicates the voltage divider and intensity adjustment selected. (The Hard Copy Adjustment is located to the right of the keyboard.) The output of the selected logic gate goes low to control the writing beam intensity by reverse biasing the diode at its output. The other outputs are high. Q447 has an operating point of +1 volt set by the bias on the base of Q448. The selected adjustment increases the writing beam intensity as the wiper of that adjustment is moved toward the negative voltage source. In the case where $\overline{\text{INT OFF}}$ is low, all four logic gates have a high output which prevents the writing beam from turning on.

Control Grid Supply

The Control Grid Supply utilizes an ac voltage source, three dc voltage sources, and a dc restoring circuit. The ac source is from transformer lead 25. The Grid Bias dc voltage source consists of U355 and Q255 with negative feedback, set by the GRID BIAS adjustment. The Z Axis dc

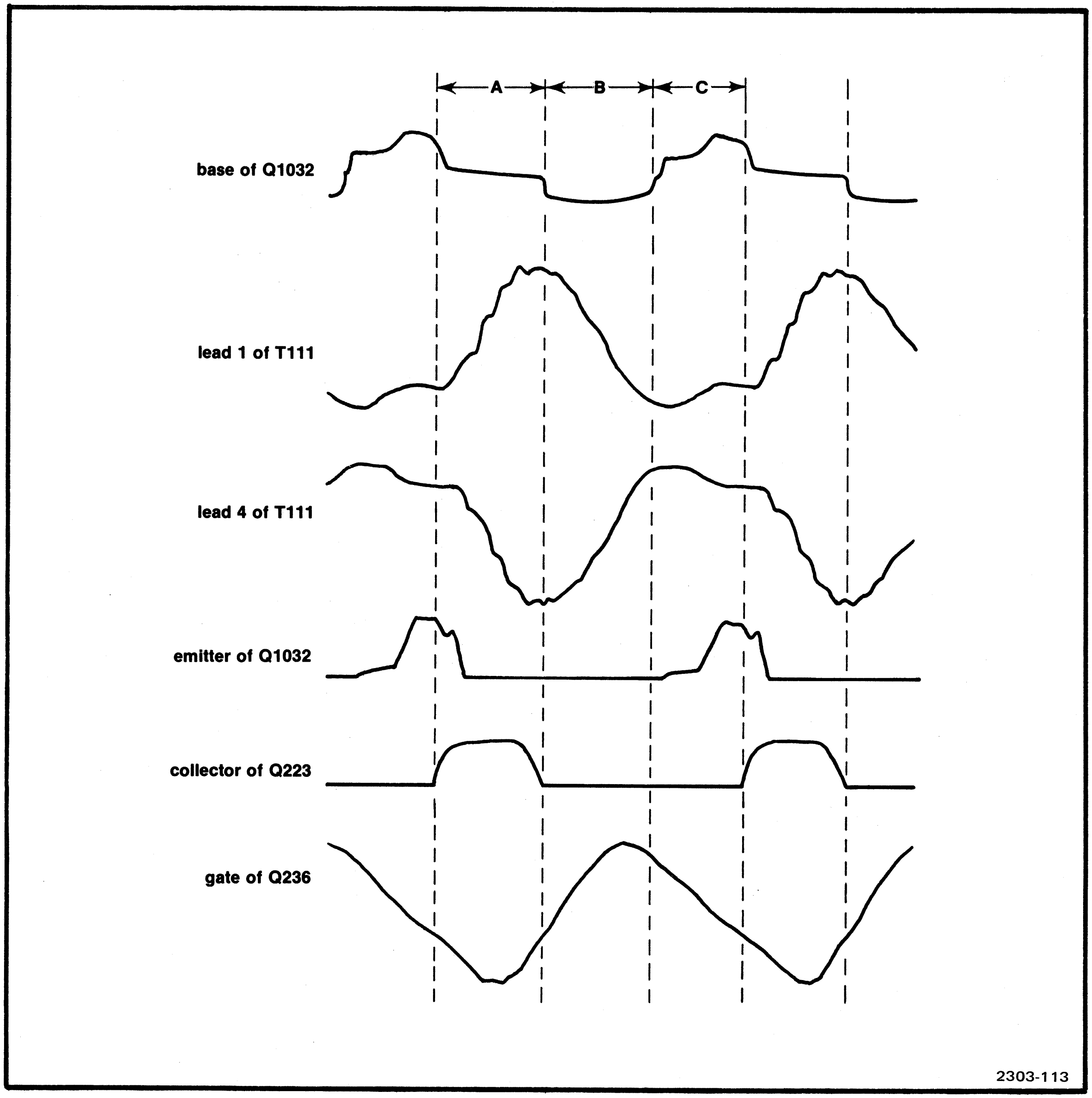

Fig. 5-8. High Voltage Oscillator Waveform. A = Regulation; B = Positive feedback (Q1032 cutoff); C = Positive feedback (Q1032 forward biased).

voltage source is from the emitter of Q275 in the Intensity Amplifier. The Beam Cathode voltage of −6,000 volts is the third dc source. The ac disconnect diodes are CR64 and CR65 on the Beam Cathode voltage, CR262 and CR263 on the Z Axis voltage source, and CR256 and CR261 on the Grid Bias voltage source. C171 and C162 have about 6 kV across them.

The dc restoring circuit establishes the writing beam cut-off voltage on the Control Grid. As the ac voltage from transformer lead 25 goes high, it is clamped by CR256 and CR261 at the Grid Bias voltage appearing at the junction of CR256 and C255. The voltage across C162 becomes 6,000 V plus the Grid Bias voltage. As the ac voltage goes low, it is clamped by CR262 and CR263 at zero volts appearing at Q275. This reverse biases diodes CR64 and CR65, and forward biases diodes CR76 and CR77. By charging C170, a negative Grid Bias voltage is placed on the Control Grid with respect to the Beam Cathode. Grid Bias adjustment R342 is adjusted so the voltage on the Control Grid becomes the writing beam cut-off voltage.

The Z Axis voltage (or writing beam voltage) from Q275, with its fast risetime and falltime, is felt immediately through C170 for the control of writing beam intensity and blanking.

Z Axis Amplifier

The Z Axis Amplifier is a high voltage, logic controlled switch that turns the writing beam on and off. When $\overline{\text{Z DIS}}$ goes low, Q374 turns off, turning on the writing beam. During hard copy operation, H.C.S. is high. This enables a monostable multivibrator (U664) to output a 100 ns pulse each time $\overline{\text{H.C. INTER}}$ goes low, turning on the writing beam.

The Z Axis voltage (or writing beam voltage) is made available to the Control Grid Supply circuits through the emitter follower Q275. Q676 provides a zener regulated voltage at its emitter to obtain a predictable risetime for the Z Axis voltage. L371 provides inductive peaking. CR476 clamps the high Z Axis voltage to the output of the Intensity Amplifier. The Z Axis voltage is usually at zero volts or at a given intensity determined by the output of the Intensity Amplifier (the collector of Q456).

Shut-down protection is provided by Q557 and U656D. The +5 volt power supply is known to fall before the +15 volt supply when the instrument is turned off. For this reason Q557 provides an input to U656D to keep Q374 in conduction and the writing beam turned off when the instrument is turned off.

Intensity Amplifier

The Intensity Amplifier is a regulated voltage source that determines writing beam intensity when Q374 is off. This regulated voltage appears at the collector of Q456. The Intensity Amplifier consists of 3 transistors, Q447, Q448, and Q456. The 82 volt zener diode VR336 sets the maximum intensity voltage limit which is applied due to amplifier malfunction. The operating point of the regulated amplifier (at the base of Q447) is set near +1 volt by the bias resistors R547 and R546 on the base of Q448.

The negative feedback through R445, in conjunction with the 36.5 k bias resistors in the Intensity Control circuits, provides an overall intensity voltage gain of 5.1 for the voltage on the wiper of the selected intensity adjustment, referenced to +1 volt.

For a brief dynamic analysis of the Intensity Amplifier, have the base of Q447 go slightly more positive. This causes Q447 to conduct less and Q448 to conduct more, maintaining a constant current through R441. The emitter follower arrangement of Q448 determines the voltage across R441. With Q448 conducting more, the voltage at R454 increases causing Q456 to conduct a larger current. The collector voltage of Q456 decreases and is felt at the base of Q447 (through R445) returning the Q447 base to its original value.

Focus Supply

The Focus Supply is a floating supply referenced at transformer pin 10 and dynamically controlled by the Focus Controller. The dc voltage across C176 is caused by diodes and capacitors in a voltage doubling arrangement as discussed in the High Voltage Supply section. CENTER FOCUS adjustment R191 supplies the Focus Electrode voltage.

Focus Controller

The Focus Controller has inputs $\overline{\text{FOCUS}}$, $\overline{\text{BRITE}}$, H.C.S. and DYNAMIC FOCUS. For optimum writing beam focus, either $\overline{\text{FOCUS}}$ is low or the Display Unit is in hard copy operation as commanded by H.C.S. being low. In this mode Q786 is off, which holds Q791 off.

The Dynamic Focus Amplifier consists of U592, Q385, and Q285. The DYNAMIC FOCUS signal is attenuated by R585 and R485 on the inverting input of U592. The gain of the Dynamic Focus Amplifier from pin 2 of U592 to the emitter of Q285 is determined by R595, R586, and CORNER FOCUS adjustment (R484). The output voltage at the emitter of Q285 provides the reference voltage for the Focus Supply.

In the Defocus Mode of operation FOCUS is high, and, through a series of logic gates, turns Q688 on, feeding the Dynamic Focus Amplifier feedback loop. The amount of current is set by DEFOCUS adjustment R692 to control the width of the writing beam. This additional current increases the Q285 emitter voltage, causing a fixed amount of writing beam defocus.

DEFLECTION AMPLIFIER BOARD

BLOCK DIAGRAM DESCRIPTION

Refer to the block diagram of the Deflection Amplifier Board. The Deflection Amplifier Board is divided into three distinct operational areas, Deflection Multiplexer, Geometry Correction and Dynamic Focus, and Deflection Amplifiers. This board provides the CRT with writing beam deflection and dynamic focus necessary for information display and hard copy production.

Deflection Multiplexer

The Deflection Multiplexer gives the Hard Copy Unit a means to control the Deflection Amplifier circuits. It also modifies position information from the Pedestal to enhance the life of the crt. The Deflection Multiplexer consists of four circuit blocks, Switch Driver, Switch X, Switch Y, and Origin Shifter.

Signal Switching. The Switch Driver provides a current to Switch X and Switch Y. The polarity of the current is determined by READ. READ is normally low, forcing current from Switch X and Switch Y to provide X ANALOG and Y ANALOG signals at outputs X COORD and Y COORD. During hard copy operation on the 4014-1/4015-1, READ goes high, forcing current into Switch X and Switch Y to provide SLOW RAMP and FAST RAMP signals at outputs X COORD and Y COORD.

Origin Shifter. The Origin Shifter modifies position information from the Pedestal to enhance the life of the crt. The Origin Shifter is an eight position binary counter clocked by $\overline{\text{ORIGIN}}$. $\overline{\text{ORIGIN}}$ is a logic pulse concurrent with the erase cycle on the Storage Board. The output of the counter is fed through current dividers then added to the X ANALOG and Y ANALOG signals to modify the reference position for each new page. (A page is the information stored on the crt.) The eight position references provided by the Origin Shifter ensures that no point on the crt is repetitively written from page to page. The action of the Origin Shifter can be cancelled by a Deflection Amplifier Board strap on J52 set to the CAL position.

Geometry Correction and Dynamic Focus

The Geometry Correction and Dynamic Focus section uses as inputs X COORD and Y COORD. The section provides writing beam focus correction and displacement correction necessary to compensate for display "pin cushion" effects common with magnetic deflection (see Fig. 5-9). X COORD is the linear displacement of the horizontal X axis. Y COORD is the linear displacement on the vertical Y axis. The Multipliers provide at their output a product of their inputs. The coordinate values, X COORD and Y COORD, and their geometry displacement correction factors, X GEOM and Y GEOM, are made available to the Deflection Amplifiers. DYNAMIC FOCUS, the focus correction signal, is made available to the Focus circuitry on the High Voltage and Z Axis Board.

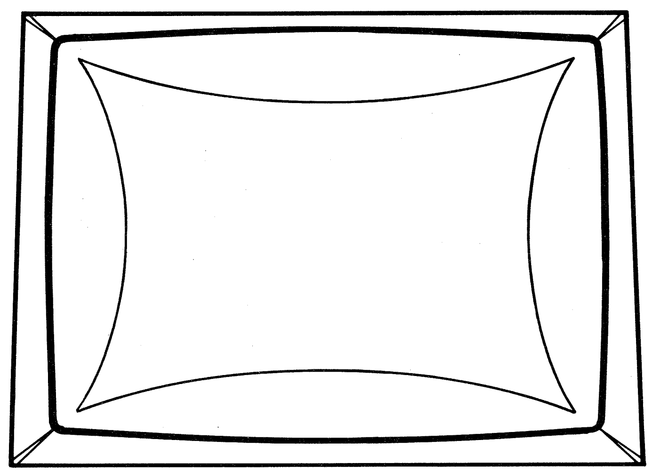

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Fig. 5-9. Pin Cushion Effects.

Deflection Amplifiers

The Deflection Amplifiers section provides the necessary deflection currents in the Deflection Yoke. The Deflection Amplifiers section consists of four circuit blocks: X Deflection Amplifier, Y Deflection Amplifier, Zero Sensing Comparators, and Emergency Shut-down and Slew Logic. The four major adjustments on the Deflection Amplifier Board control the display size and position. XPOS and YPOS control the display center reference position. X GAIN and Y GAIN control the display width and height.

The X Deflection and Y Deflection Amplifiers are high gain current amplifiers supplying drive currents to the Deflection Yoke. The drive currents establish a magnetic field in the Deflection Yoke for writing beam deflection. The amplifiers are in continuous operation to provide proper deflection control at all times. Because of similarity between the X and Y amplifiers, only the X amplifier operation is discussed.

Input to the X Deflection Amplifier is a summation of X COORD, X GEOM, X POS, and X Feedback signals to control the X Axis deflection. A change in the inputs to the X Deflection Summing point causes the output of the Deflection Amplifier to change, altering the writing beam deflection. The current gain of the X Deflection Amplifier is controlled by the X GAIN adjustment, which regulates the X Feedback.

Zero Sensing Comparators. The Zero Sensing Comparators compare the outputs of the Deflection Summing amplifiers against a threshold near zero volts. The comparators go active when either of the Deflection Summing amplifiers have an output other than zero. The voltage out of the Deflection Summing amplifiers is zero when the proper deflection current is established in the Deflection Yoke. A Deflection Amplifier is slewing when the rapid establishment of a new deflection current is necessary. As a result, the output of the Deflection Summing amplifier is other than zero. In the event of Deflection Amplifier failure, the Deflection Summing output never returns to zero. For this reason the output of the Zero Sensing Comparators is continuously monitored by the Emergency Shut-down and Slew Logic.

Emergency Shut-down and Slew Logic. The Emergency Shut-down and Slew Logic initiates $\overline{\text{SLU}}$, a temporary wait signal indicating an unstable amplifier condition, which shuts down the function timer on TC-1 and the Crosshair Generator on TC-2 in the Pedestal. $\overline{\text{INT OFF}}$ is asserted if the deflection amplifiers do not come within the zero threshold after a preset time. $\overline{\text{INT OFF}}$ causes the High Voltage and Z Axis Board to turn off the writing beam as a result of Deflection Amplifier failure, thus protecting the crt from phosphor burns due to loss of writing beam position control.

DETAILED CIRCUIT DESCRIPTION

Deflection Multiplexer

Refer to the Deflection Multiplexer schematic. Refer to the diagram apron for component locations. The Deflection Multiplexer provides a means for the Hard Copy Unit to control the Deflection Amplifier circuits. In normal operation, X ANALOG and Y ANALOG provide the writing beam deflection values. Deflection origin shifting circuits and Hard Copy position adjustments are also included in this section.

Switch Driver. In normal operation READ is low, holding Q515 off. Q517, an emitter follower, pulls current from Switch X and Switch Y. This causes X COORD and Y COORD to take on the values of X ANALOG and Y ANALOG. During hard copy operation, READ is high, causing Q515 to force current through CR519 into Switch X and Switch Y. This causes X COORD and Y COORD to take on the values of SLOW RAMP and FAST RAMP.

Switch X. The two operational amplifiers are biased near unity voltage gain for the analog deflection signals (X ANALOG and SLOW RAMP). The junction of R622 and R623 is normally negative (when READ is low), reverse biasing CR624 and forward biasing CR612. The non-inverting input of U615 goes negative, reverse biasing disconnect diode CR620. U635 passes the X ANALOG signal to the X COORD output. The X ANALOG and Y ANALOG signals are limited in magnitude by Q635 and Q735 to approximately ± 5 volts. During hard copy operation CR612 becomes reverse biased and CR624 becomes forward biased. The inverting input of U635 becomes positive and its output reverse biases disconnect diode CR644. SLOW RAMP then becomes the X COORD output.

Switch Y. Operation is similar to Switch X.

Hard Copy Adjustments (used for 4014-1 and 4015-1 only). The Hard Copy adjustments are X H.C. Position (R502), Y H.C. Position (R501), X H.C. Gain (R614), and Y H.C. Gain (R601). X H.C. Position and Y H.C. Position center the SLOW RAMP and FAST RAMP signals on the display. X H.C. Gain and Y H.C. Gain determine the length of the SLOW RAMP and FAST RAMP signals on the display.

Origin Shifter. The Original Shifter is composed of binary counter U305 clocked by the $\overline{\text{ORIGIN}}$ signal, which comes from the Storage Board. The inverters on the outputs of U305 are switches on graduated networks of divider resistors. Each divider, when selected, adds its increment of current to the X ANALOG and Y ANALOG signals. For calibration, the counter is reset with $\overline{\text{CENTER}}$ going low, either externally or with J52 in the Calibrate position.

Geometry Correction and Dynamic Focus

Refer to the Geometry Correction and Dynamic Focus schematic. Refer to the diagram apron for component locations. The four major integrated circuits in this section are analog multipliers U5, U105, U115, and U215. The output (0+, 0−) of an analog multiplier is a differential current proportional to the product of the two differential voltages on the four inputs (A+, A−, B+, B−). The output current is converted back to a voltage by an operational amplifier.

The output signals from this section have the following analog voltage representations:

DYNAMIC FOCUS	$(X^2 + Y^2)$ times a constant
X GEOM	$X (X^2 + Y^2)$ times a constant
Y GEOM	$Y (X^2 + Y^2)$ times a constant

where X and Y represent a distance from the center of the CRT. The geometry correction signals (X GEOM and Y GEOM) are subtracted from the X COORD and Y COORD signals to compensate for the "pin cushion" effect of displayed information, common to magnetic deflection systems (see Fig. 5-9). The DYNAMIC FOCUS signal is zero at the center of the CRT and increases to maximum at the corner, compensating for additional focus requirements as the writing beam has farther to move.

Output adjustments R242 and R243 provide the Y GEOM and X GEOM signal attenuation necessary for making the X Axis and Y Axis deflection linear on the display. All the other adjustments in the Geometry Correction and Dynamic Focus section provide discrepancy correction for each analog multiplier and operational amplifier.

Deflection Amplifiers

Refer to the Deflection Amplifiers schematic, the diagram apron shows component locations. The Deflection Amplifiers circuits consist of two high gain current amplifiers and their deflection coils. Emergency Shutdown and Slew circuits with the Zero Sensing Comparators monitor the operation of the Deflection Amplifiers. Display adjustments in the Deflection Amplifiers circuits are X POS for horizontal position, X GAIN for horizontal width, Y POS for vertical position, and Y GAIN for vertical height.

X Deflection Amplifier. The X Deflection Amplifier is a high gain current amplifier driving the X Deflection Yoke. U432 is a summing amplifier providing a sum of X COORD, X GEOM, X POS, and X Feedback to the X Deflection Amplifier. X POS (R270) is a center position reference adjustment. X Feedback is determined by X GAIN (R273). A change in any input to U432 causes current in the X Deflection Yoke to change.

During normal deflection amplifier operation, both the Darlington Amplifiers (Q1011 and Q1012) are turned off. Their affect can be ignored unless the voltage required to drive the deflection coil is greater than that available from the 7 V power supplies. The Darlington Amplifiers are temporarily activated during events requesting instantaneous deflection across the screen, such as carriage return signals and operation in the fast point plot mode.

The X Deflection Amplifier is composed of the following elements: U432 is a summing operational amplifier, providing at its output a signal representing the sum of X COORD, X GEOM, X POS, and feedback from X GAIN. This output signal may be called an error signal, driving the X Deflection Amplifier. Q465 and Q466 are level shift voltage amplifiers that provide bias to the inverting amplifiers Q481 and Q482. Q481 and Q482 provide base current to the current amplifiers Q491 and Q492. These in turn provide base current to the output transistors Q1013 and Q1014 powering the X Deflection Yoke. The Darlington Amplifiers (Q1011 and Q1012) are demand amplifiers driven into conduction of Q352 and Q561 when the 7 V power supplies are insufficient to change the deflection current as rapidly as requested.

As pin 6 of U432 starts to go negative, Q465 forward biases, creating a larger voltage across R474, and causing Q481 to become more forward biased. Likewise, the complementing transistors (Q466 and Q482) both become more reverse biased. With Q481 conducting more current than Q482, the current difference tries to turn Q491 on and Q492 off, thus increasing the current into the bases of Q1013 and Q1014. These output transistors, Q1013 and Q1014, provide additional current amplification to increase the deflection current in the X Deflection Yoke. An increase in deflection current increases the feedback voltage through R273 to regulate the amount of current through the X Deflection Yoke.

If the 7 volt power supplies are inadequate to change the deflection current as rapidly as needed, the feedback voltage through R273 and R340 becomes insufficient to regulate the deflection current. The X Deflection Amplifier saturates into the 7 V Supply. As a result, the output of U432 swings rapidly positive or negative, biasing the transistors Q352 and Q561 to turn on one of the Darlington Amplifiers (Q1011 or Q1012). The particular Darlington Amplifier selected reverse biases a disconnect diode on one of the 7 V supplies, and effectively applies 20 V across the deflection coil to quickly re-establish the writing beam deflection.

Y Deflection Amplifier. The Y Deflection Amplifier has the same operational characteristics as the X Deflection Amplifier already discussed.

Zero Sensing Comparators. The Zero Sensing Comparators (U143 and U433) sense when a Deflection Amplifier is slewing. A Deflection Amplifier is slewing if the output of its summing amplifier (U132 or U432) is other than zero volts. This happens when a new deflection current is rapidly being established, or when there is a malfunction in one of the deflection amplifier components. An operating threshold near signal ground (zero volts) is established on the inputs of comparators U143 and U433. The outputs of the comparators (open collector) are normally high. If either the X or Y Deflection Amplifier is slewing, a voltage outside the input operating threshold of a comparator causes the comparator output to go low. The output is continuously monitored by the Emergency Shut-down and Slew logic.

Emergency Shut-down and Slew. The Emergency Shut-down and Slew Logic circuits consist of a pulse stretcher (Q533, C318, U325D, and U405C) and a monostable multivibrator (U425B) with control and delay gates. Output signals are $\overline{\text{SLU}}$ which activates a temporary wait in the Pedestal circuits, and $\overline{\text{INT OFF}}$ which is asserted after a preset delay on U425B to indicate amplifier failure.

Normal quiescent voltage levels are as follows. Voltage from the Zero Sensing Comparators is +5 volts. Voltage from the inverter outputs U325D and U405B is zero. $\overline{\text{INT OFF}}$ and $\overline{\text{SLU}}$ are +5 volts.

When the Zero Sensing Comparators output goes low, the monostable multivibrator (U425B) is triggered with +5 volts on pin 10 causing pin 12 to go low. C401 maintains a low on U325A until after U425B has activated. $\overline{\text{INT OFF}}$ goes low only after U425B times out and pin 12 becomes high. If the amplifiers are slewing, $\overline{\text{INT OFF}}$ never goes low, for there is always a low on an input of U325A. $\overline{\text{SLU}}$ is activated everytime the Zero Sensing Comparators output goes low.

Q533, U325D, U405C, and C318 along with resistors are a pulse stretching and signal conditioning network. The output of the Zero Sensing Comparators is normally +5 volts, Q533 is on, and C318 has no voltage across it. When the comparator outputs go low, U325D has +5 volts on its output, U405C has a low on its output, and Q533 turns off. C318 still has no voltage across it. When the comparator outputs again go high (being open collector) Q533 is off, and C318 charges through R241. Noise is kept from the TTL logic circuitry as the voltage on C318 approaches the switching threshold of U325D. When U325D attempts to change state, Q533 becomes forward biased and shunts the capacitor's charge. U405C also provides additional signal pull-up. This positive feedback keeps noise off of the logic output lines $\overline{\text{INT OFF}}$ and $\overline{\text{SLU}}$.

STORAGE BOARD

BLOCK DIAGRAM DESCRIPTION

Refer to the block diagram of the Storage Board. The Storage Board controls electrodes in the crt to store, view and erase displayed information. It also interfaces with the optional Hard Copy Unit through the signal lines $\overline{\text{READ}}$ and $\overline{\text{WAIT}}$. $\overline{\text{DBUSY}}$, H.C.S., and READ are asserted by the Storage Board to control Terminal operations while making a hard copy. The five basic circuits are the Erase Multivibrators, Target Control, Collimation (CE-2) Control, Collimation (CE-1) Control, and the Flood Gun Amplifier. Electrodes controlled by the Storage Board are Target, CE-2, CE-1, and Flood Gun Anode.

Erase Multivibrators

The Erase Multivibrators are responsible for timing the erase cycle. The erase cycle is initiated by the $\overline{\text{ERASE}}$ signal from the Pedestal going low. $\overline{\text{ORIGIN}}$ is asserted for about 60 ms and is made available to the Deflection Amplifier Board. A 60 ms pulse is also made available to the Target Control, the Collimation (CE-2) Control, and the Collimation (CE-1) Control to cause the screen to write completely. Upon completion of this 60 ms pulse, the CE-1 voltage returns to normal while the electrode voltages on the Target and CE-2 go to zero to erase the screen and then return slowly to normal operation levels enabling the storage of new information. $\overline{\text{DBUSY}}$ is asserted to inhibit any terminal activity during the entire erase cycle of about one second. VIEW is high during the erase cycle to activate the Flood Guns. VIEW, however, is controlled by circuitry in the Pedestal. Typical electrode voltage waveforms are shown in Fig. 5-10.

Target Control

The Target Control circuits provide the operating voltage for the crt Target. The Target voltage is between +100 V and +285 V during normal operation. During the erase cycle, it increases by 150 V for the first 60 ms to write the entire screen by providing additional electron acceleration potential between the Target and the Flood Guns. At the end of this 60 ms the voltage drops to zero, erasing the phosphors. Then the Target voltage slowly returns to the operating level preventing the storage phosphors from becoming written, thus leaving the storage phosphors in a ready-to-write state.

Collimation Control

The Collimation Electrodes (CE-1, CE-2) are electron lenses necessary to cause a consistent flood gun beam over the Target. Their voltages are determined by the state of their control circuits, Collimation (CE-1) Control and Collimation (CE-2) Control. CE-1 and CE-2 experience a positive voltage during the first 60 ms of the erase cycle. This provides a consistent, high intensity flood beam over the Target. After the 60 ms pulse from the Erase Multivibrators the CE-1 voltage immediately returns to normal, and CE-2 goes low, then slowly returns to normal. The normal operating voltages on CE-1 and CE-2 provide the necessary flood beam characteristics for viewing, storing, and writing information. During hard copy operation on the 4014-1/4015-1, +250 volts is placed on CE-1 to prevent current oscillations within the crt that could destroy hard copy accuracy.

Flood Gun Amplifier

The Flood Gun Amplifier activates the Flood Guns with a positive voltage on the Flood Gun Anode when VIEW is high. This positive voltage causes a flood of electrons to be slowly accelerated toward the Target. Their energy, except during the first 60 ms of the erase cycle, is insufficient to cause writing. The Flood Gun electrons cause the written phosphor on the Target to glow thus making the stored display information visible. The VIEW signal is asserted by the Pedestal for the following: during the erase cycle, while making a hard copy, during the GIN Mode of operation, while writing on the screen with the writing beam, and for about 90 seconds after the last information was written on the screen.

DETAILED CIRCUIT DESCRIPTION

Refer to the schematic of the Storage Board. The diagram apron shows component locations. The Storage Board consists of Erase Multivibrators, Target Control, Collimation CE-1 Control, Collimation CE-2 Control, Flood Gun Amplifier, and a +290 volt regulated dc power supply.

The Target, CE-2 and CE-1 operating voltages are different for each manufactured crt. The respective circuit adjustments are set for optimum display quality while viewing the display in subdued light.

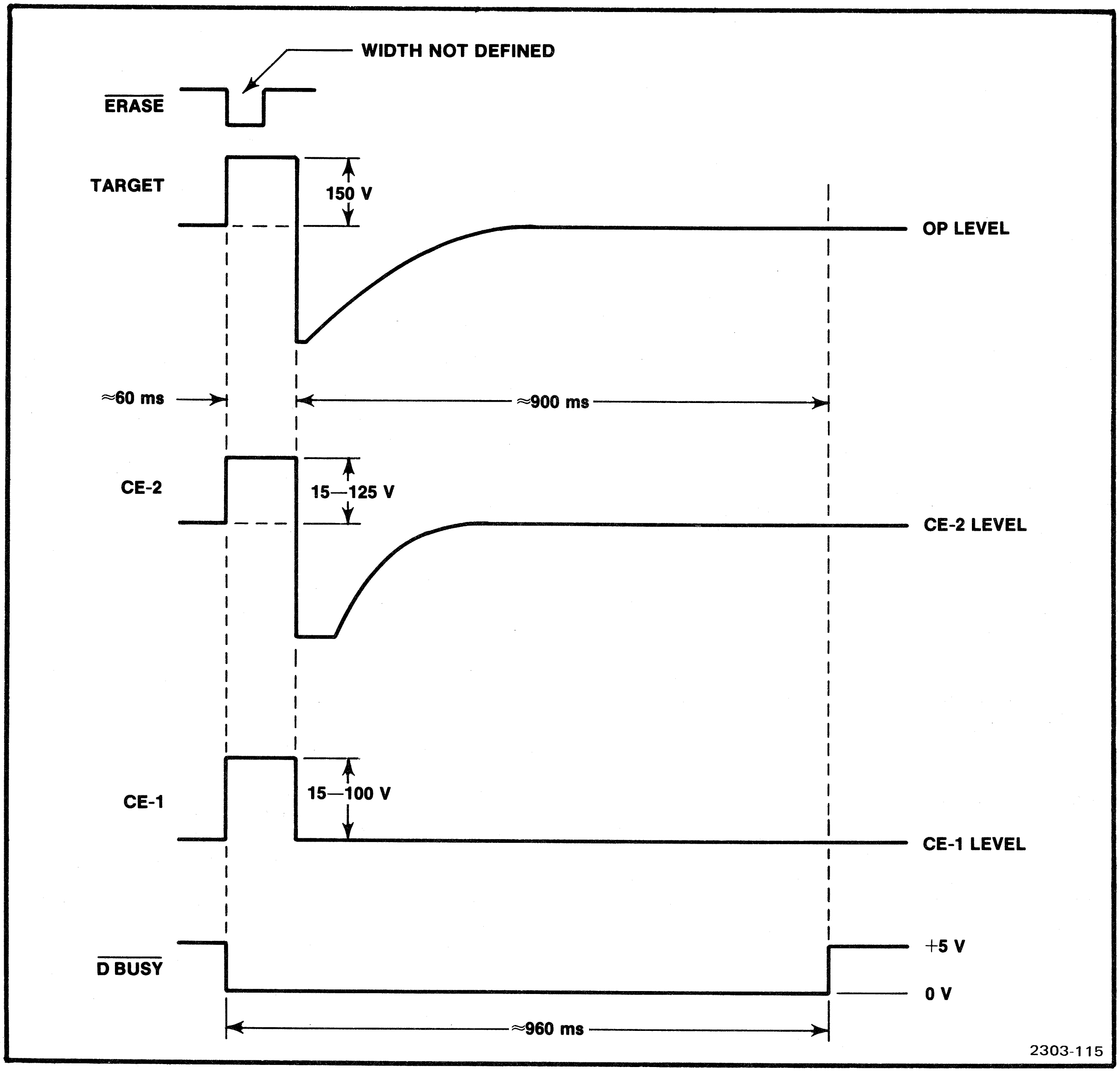

Fig. 5-10. Typical storage electrode voltage waveforms.

Erase Multivibrators

The Erase Multivibrators provide timing for the erase cycle. During an erase cycle, initiated by $\overline{\text{ERASE}}$ going low, multivibrators U51 and U35 trigger in sequential order. U51 provides a positive 60 ms pulse to U211F to form ORIGIN. This 60 ms pulse also triggers the Target, CE-2 and CE-1 Control circuits. U51 and U35 hold $\overline{\text{DBUSY}}$ low for about one second during the erase cycle. $\overline{\text{DBUSY}}$ also goes low when $\overline{\text{READ}}$ or $\overline{\text{WAIT}}$ go low for hard copy operation. U211C, R113, C115, and U111B provide a delay on the completion of $\overline{\text{DBUSY}}$. $\overline{\text{DBUSY}}$ going high indicates the completion of either cycle or hard copy operation.

Target Control

The quiescent voltage on the Target is set by the OP LEVEL adjustment (R140) which provides feedback control to the base of Q143. The emitter of Q143 drives voltage amplifiers Q1023 and Q154. The other transistors are emitter follower amplifiers providing the current necessary on the Target to maintain a fixed voltage. Voltage feedback to Q143 is through R163.

During the erase cycle, a 60 ms positive pulse from the Erase Multivibrators causes the outputs of U211D and U311C to go low. The output of U211D provides a negative input on the base of Q143, thus increasing the Target voltage about 150 volts. U311C causes C124, a timing capacitor, to discharge. When the 60 ms pulse completes, U211D and U311C have an open collector going positive. C124 causes the bias voltage on Q143 to go positive and decay to normal. The Target voltage goes to zero and then returns slowly to the normal operating level.

Collimation CE-2 Control

Q255 provides input to voltage amplifier Q257. Q285 and Q1024 are emitter follower amplifiers providing current to maintain the CE-2 voltage. Voltage feedback to Q255 is through R252. The CE-2 quiescent operating voltage is set by the CE-2 adjustment, R221.

The collector outputs of U211B and U211E are normally high and go low during the 60 ms pulse from the Erase Multivibrators. The CE-2 Pulse adjustment, R223, sets the CE-2 voltage during the 60 ms pulse. C235, a timing capacitor, discharges through R229 and U211E during the 60 ms pulse. After the 60 ms pulse, the output collector voltages of U211B and U211C go high. CR242 and CR245 become forward biased and cause the CE-2 voltage to drop to zero. The charging time of C235 creates the slow recovery of the CE-2 voltage. The forward turn-on voltages of CR241, CR242, and CR245 provide a reference voltage for C235, and the operating bias limits on the base of Q255.

Collimation CE-1 Control

Q355 provides input to voltage amplifier Q357. Q385 and Q1025 are emitter follower amplifiers providing current to maintain the CE-1 voltage. Voltage feedback to Q355 is through R352. The CE-1 quiescent operating voltage is set by the CE-1 adjustment, R341.

The collector output of U311E is normally high and goes low during the 60 ms pulse from the Erase Multivibrators. The CE-1 Pulse adjustment, R343, sets the CE-1 voltage during the 60 ms pulse. The collector output of U311F is normally high and goes low when $\overline{\text{READ}}$ or $\overline{\text{WAIT}}$ go low. A low output on U311F causes a CE-1 voltage of 250 volts. This prevents current oscillations in the CRT from interfering with Hard Copy operation.

Flood Gun Amplifier

When VIEW is high, Q444 and Q469 are off. R478 and R481 provide a 152 volt bias to Q485. Q485 and Q1027 supply the Flood Gun Anode at J116-6 with about 150 volts. Q444, being off, causes a high output on U311D activating M325 which measures in hours the amount of time VIEW is on during the life of the instrument. M329 measures the time the instrument is turned on.

When VIEW is low, Q444 is on and Q469 is on providing the Flood Gun Anode at J116-6 with −15 volts. Q444, being on, causes a low output on U331D turning of M325.

290 Volt Power Supply

The voltage regulator, U525, receives its power from a floating 12 volt ac supply through J110-7,8. The coarse voltage level is determined by R514 and R517. The 290 volts is set by R411. Q1029 has its base on the U525 regulated output and provides the current necessary to maintain the output supply voltage. R538, R531, and R539 set the current limit at 250 mA.

HARD COPY TARGET SIGNAL AMPLIFIER

Refer to the Hard Copy Target Signal Amplifier Board Schematic. The diagram apron shows component locations. In the 4014 and 4015 Terminals without hard copy compatiblity, J116 is connected directly through a Jumper Board to the crt electrodes. In the 4014-1 and 4015-1 Terminals, the Hard Copy Amplifier Board is installed.

TARGET signals are an increase in Target current when the interrogation writing beam lands on stored information on the crt screen. The Target signals are coupled through T53 and applied to a differential amplifier U43 which has a gain of approximately 400. Its output is amplified by approximately 10 in U21 and applied to a comparator, U3. U3 provides a negative output pulse in response to Target signals of an amplitude determined by Hard Copy Threshold adjustment R26. R26 permits the voltage at the positive input of U3 to be set between Ø and +2.3 volts. The negative output pulses from U3 are applied to one-shot multivibrator U101, which responds by generating 400 ns (approximate) positive-going pulses when enabled by the H.C.S. signal going high as a copy is being made. These pulses are inverted by Q115 to create $\overline{\text{TARSIG}}$ signals at J130-1.

LOW VOLTAGE POWER SUPPLY

Refer to the Low Voltage Power Supply schematic. The diagram apron shows component locations. The power supply circuits have regulated outputs of +15 volts, +5 volts, and −15 volts. They also have unregulated outputs of −20 volts, −7 volts, +7 volts, +20 volts, +175 volts, +350 volts, and +490 volts. The 12 V ac and the +350 Volt Supply provide power for the regulated +290 Volt Supply on the Storage Board.

Seven fuses provide protection for the power supply circuits. F191 and F302 fuse the +20 Volt Supply. F137 fuses the +5 Volt Supply and F161 fuses the −20 Volt Supply. F386 fuses the 490 Volt Supply, F491 fuses the 350 Volt Supply and F371 fuses the 175 Volt Supply.

Unregulated Supplies

All of these, except for the +175 Volt Supply, obtain their power from conventional full-wave bridge rectifier circuits. The +175 Volt Supply uses a full-wave center-tapped transformer configuration. The +490 Volt Supply uses the +290 Volt Supply on the Storage Board as a voltage reference to which +200 volts is added.

Regulated Supplies

The +15 Volt Supply uses an integrated voltage regulator and two output transistors. U285 takes power from the +20 Volt Supply to regulate the +15 Volt Supply. A voltage reference of approximately 7.15 volts at pin 6 of U285 drives two voltage dividers. +5 volts is picked from R191 as a reference voltage for both the +15 Volt Supply and the +5 Volt Supply. A regulating voltage is output from pin 10 of U285 and made available to Q195 which biases the output power transistor Q1001. The feedback voltage is provided across R293 and R295 establishing 5 V on the inverting input (pin 4 of U285) of an operational amplifier within the integrated regulator to maintain +15 V output from the +15 Volt Supply. Pin 5 of U285 is the non-inverting input. The voltage across R195 provides current limiting.

The +5 Volt Supply compares, at U251, the +5 volt sense line with a +5 volt reference from R196. U251 uses the voltage difference to generate a regulating output voltage to Q151 which controls the drive current generated by Q1004 and Q1005. The voltage developed across R105, in the collector circuit of Q1005, provides current limiting. In large current demands, Q246 turns off, Q245 turns on, and Q243 turns on to reduce and limit the drive current. Over-voltage protection is provided by Q146 and Q1002. Q146 is normally insufficient to cause the device to conduct, since its base is held at approximately 4.67 volts by R191. If the +5 volt sense line would go as high as 5.3 volts, Q146 conducts. When the voltage at the gate of Q1002 reaches 1.2 volts, Q1002 conducts and immediately lowers the +5 volt output line to less than 2 volts, removing power from the circuit.

The −15 volt regulator uses ground for a reference at an input of U261. The negative input receives its signal from a comparison between the +15 Volt Supply and the −15 Volt Supply applied through the voltage divider R273 and R274. Any deviations on the −15 volt line cause drive to U261 which in turn provides a signal to the error amplifier Q176. Q176 controls the current through Q1007, regulating the −15 Volt Supply. The voltage across R183 is amplified by Q177 to limit the −15 Volt Supply current.

The Flood Gun Heaters see a regulated 26.8 volts across J86-1,2. 30 volts is applied across R190 and R189 by VR189. R190 is adjusted to determine the voltage out of Q1009.

SECTION 6
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
ASSY	ASSEMBLY
CAP	CAPACITOR
CER	CERAMIC
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
ELCTLT	ELECTROLYTIC
ELEC	ELECTRICAL
INCAND	INCANDESCENT
LED	LIGHT EMITTING DIODE
NONWIR	NON WIREWOUND
PLSTC	PLASTIC
QTZ	QUARTZ
RECP	RECEPTACLE
RES	RESISTOR
RF	RADIO FREQUENCY
SEL	SELECTED
SEMICOND	SEMICONDUCTOR
SENS	SENSITIVE
VAR	VARIABLE
WW	WIREWOUND
XFMR	TRANSFORMER
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 COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
01963	CHERRY ELECTRICAL PRODUCTS CORPORATION	3600 SUNSET AVENUE	WAUKEGAN, IL 60085
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05397	UNION CARBIDE CORPORATION, MATERIALS SYSTEMS DIVISION	11901 MADISON AVENUE	CLEVELAND, OH 44101
07109	OAKTRON INDUSTRIES, INC.	704 30TH STREET	MONROE, WI 53566
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
11237	CTS KEENE, INC.	3230 RIVERSIDE AVE.	PASO ROBLES, CA 93446
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
18583	CURTIS INSTRUMENTS, INC.	200 KISCO AVE.	MOUNT KISCO, NY 10549
18788	GENERAL ILLUMINATION INC.	2958 N CLEVELAND	ST. PAUL, MN 55113
18796	ERIE TECHNOLOGICAL PRODUCTS, INC. STATE COLLEGE DIVISION	1900 W. COLLEGE AVE.	STATE COLLEGE, PA 16801
22753	U. I. D. ELECTRONICS CORP.	4105 PEMBROKE RD.	HOLLYWOOD, FL 33021
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
27193	CUTLER-HAMMER, INC. SPECIALTY PRODUCTS DIVISION	4201 N. 27TH ST.	MILWAUKEE, WI 53216
32159	WEST-CAP ARIZONA	2201 E. ELVIRA ROAD	TUCSON, AZ 85706
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
33096	COLORADO CRYSTAL CORPORATION	2303 W 8TH STREET	LOVELAND, CO 80537
33297	ELECTRONIC ARRAYS, INC.	550 E MIDDLEFIELD ROAD	MOUNTAIN VIEW, CA 94043
50522	MONSANTO CO., ELECTRONIC SPECIAL PRODUCTS	3400 HILLVIEW AVENUE	PALO ALTO, CA 94304
51284	MOS TECHNOLOGY, INC., VALLEY FORGE CORPORATE CENTER	950 RITTENHOUSE ROAD	NORRISTOWN, PA 19401
52833	KEYTRONIC CORPORATION	BLDG. 14 SPOKANE INDUSTRIAL PK.	SPOKANE, WA 99216
53944	ELT INC., GLOW LITE DIVISION	BOX 698	PAULS VALLEY, OK 73075
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
71482	CLARE, C. P., AND CO.	3101 PRATT BLVD.	CHICAGO, IL 60645
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., P O BOX 5825	COMPTON, CA 90224
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83003	VARO, INC.	P O BOX 411, 2203 WALNUT STREET	GARLAND, TX 75040
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E WASHINGTON STREET P O BOX 372	INDIANAPOLIS, IN 46206
91418	RADIO MATERIALS COMPANY, DIV. OF P.R. MALLORY AND COMPANY, INC.	4242 W BRYN MAWR	CHICAGO, IL 60646
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
99409	SYNTRONIC INSTRUMENTS, INC.	100 INDUSTRIAL	ADDISON, IL 60101

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				CIRCUIT BOARD ASSEMBLIES		
A1	670-3090-01			CKT BOARD ASSY:MOTHER	80009	670-3090-01
A2	670-3293-02			CKT BOARD ASSY:INTERCONNECT	80009	670-3293-02
A3	119-0483-02			KEYBOARD,CMPTR:	80009	119-0483-02
	----- -----			(4014/4014-1 ONLY)		
A3	119-0488-00			KEYBOARD,CMPTR:	80009	119-0488-00
	----- -----			(4015/4015-1 ONLY)		
A4	670-3091-07			CKT BOARD ASSY:TC-1	80009	670-3091-07
A5	670-3147-02			CKT BOARD ASSY:CHAR GEN	80009	670-3147-02
	----- -----			(4014/4014-1 ONLY)		
A5	670-3336-02			CKT BOARD ASSY:CHAR GEN	80009	670-3336-02
	----- -----			(4015/4015-1 ONLY)		
A6	670-3092-05			CKT BOARD ASSY:TC-2	80009	670-3092-05
A6	670-3559-05			CKT BOARD ASSY:TC-2	80009	670-3359-05
	----- -----			(OPTION 34 ONLY)		
A7	670-3093-03	B050000	B053951	CKT BOARD ASSY:TC-3	80009	670-3093-03
	----- -----			(4014/4014-1 ONLY)		
A7	670-3093-04	B053952		CKT BOARD ASSY:TC-3	80009	670-3093-04
	----- -----			(4014/4014-1 ONLY)		
A7	670-3093-03	B050000	B050759	CKT BOARD ASSY:TC-3	80009	670-3093-03
	----- -----			(4015/4015-1 ONLY)		
A7	670-3093-04	B050760		CKT BOARD ASSY:TC-3	80009	670-3093-04
	----- -----			(4015/4015-1 ONLY)		
A8	670-3294-04			CKT BOARD ASSY:DISPLAY CONTROL	80009	670-3294-04
A8	670-3519-04			CKT BOARD ASSY:DISPLAY CONTROL	80009	670-3519-04
	----- -----			(OPTION 34 ONLY)		
A9	670-3372-01			CKT BOARD ASSY:DISCRETE PLOT	80009	670-3372-01
	----- -----			(OPTION 34 ONLY)		
A10	670-3094-06	B050000	B054607	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS	80009	670-3094-06
	----- -----			(4014/4014-1 ONLY)		
A10	670-3094-07	B054608	B055689	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS	80009	670-3094-07
	----- -----			(4014/4014-1 ONLY)		
A10	670-3094-08	B055690		CKT BOARD ASSY:HIGH-VOLTAGE AND Z AXIS	80009	670-3094-08
	----- -----			(4014/4014-1 ONLY)		
A10	670-3094-06	B050000	B050874	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS	80009	670-3094-06
	----- -----			(4015/4015-1 ONLY)		
A10	670-3094-07	B050875	B051089	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS	80009	670-3094-07
	----- -----			(4015/4015-1 ONLY)		
A10	670-3094-08	B051090		CKT BOARD ASSY:HIGH-VOLTAGE AND Z AXIS	80009	670-3094-08
				(4015/4015-1 ONLY)		
A11	670-3095-04			CKT BOARD ASSY:DEFLECTION AMPL	80009	670-3095-04
A12	670-3096-01	B050000	B054471	CKT BOARD ASSY:STORAGE	80009	670-3096-01
	----- -----			(4014/4014-1 ONLY)		
A12	670-3096-02	B054472		CKT BOARD ASSY:STORAGE	80009	670-3096-02
	----- -----			(4014/4014-1 ONLY)		
A12	670-3096-01	B050000	B050946	CKT BOARD ASSY:STORAGE	80009	670-3096-01
	----- -----			(4015/4015-1 ONLY)		
A12	670-3096-02	B050947		CKT BOARD ASSY:STORAGE	80009	670-3096-02
	----- -----			(4015/4015-1 ONLY)		
A13	670-3097-01			CKT BOARD ASSY:HARD COPY AMPL	80009	670-3097-01
A14	670-3089-04	B050000	B059999	CKT BOARD ASSY:POWER SUPPLY	80009	670-3089-04
A14	670-3089-05	B060000		CKT BOARD ASSY:POWER SUPPLY	80009	670-3089-05
A15	670-3603-01			CKT BOARD ASSY:JUMPER	80009	670-3603-01

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A1 MOTHER ASSY		
A1	670-3090-01			CKT BOARD ASSY:MOTHER	80009	670-3090-01
C102	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C195	290-0201-00			CAP.,FXD,ELCTLT:100UF,+75-10%,15V	56289	30D107G015DC9
CR104	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR105	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
R101	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R103	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R107	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R108	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R109	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R207	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R208	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R301	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R303	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R307	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R308	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
U9	307-0455-00			RES,NTWK,FXD,FI:1.8K OHM,20%	91637	LDP1402182G
U205	307-0455-00			RES,NTWK,FXD,FI:1.8K OHM,20%	91637	LDP1402182G
U305	307-0455-00			RES,NTWK,FXD,FI:1.8K OHM,20%	91637	LDP1402182G
				A2 INTERCONNECT ASSY		
A2	670-3293-02			CKT BOARD ASSY:INTERCONNECT	80009	670-3293-02
R56	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	91637	MFF1816G18701F
R57	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R118	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R120	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R122	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R124	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R126	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A3 KEYBOARD CMPTR (4014-4014-1 ONLY)		
A3	119-0483-02			KEYBOARD,CMPTR:	80009	119-0483-02
C2	118-0046-00			CAP.,FXD,CER DI:0.022UF	52833	28-0223-01
C3	118-0047-00			CAP.,FXD,CER DI:0.68UF	52833	28-684-01
C4	118-0046-00			CAP.,FXD,CER DI:0.022UF	52833	28-0223-01
C5	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C6	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C7	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C8	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C9	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C10	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C11	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
Q1	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q2	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q3	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
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
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,(NOM 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-S60	260-1507-00			SWITCH,REED:SPST	56289	162D225X9020
Z1	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z2	156-0075-00			MICROCIRCUIT,DI:SGL 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:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
Z5	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	80009	156-0032-00
Z6	156-0111-00			MICROCIRCUIT,DI:SGL BCD-TO-DEC DEC/DRIVER	80009	156-0111-00
Z7	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00

KEYBOARD CMPTR (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Z8	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
Z9	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
Z10	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00
Z11	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	80009	156-0035-00
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	80009	156-0034-00
Z14	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
Z15	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
Z16	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z17	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
Z19	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
Z20	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
Z21	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00
Z22	156-0092-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0092-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A3 KEYBOARD,CMPTR (4015/4015-1 ONLY)		
A3	119-0488-00			KEYBOARD,CMPTR:	80009	119-0488-00
C1	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C2	285-0686-00			CAP.,FXD,PLSTC:0.068UF,10%,100V	56289	410P68391
C3	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C5	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C6	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C7	----- -----					
C8	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C9	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C10	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C12	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C13	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C14	283-0249-00			CAP.,FXD,CER DI:0.068UF,10%,50V	72982	8131N075 C 683K
CR1	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR2	152-0186-00			SEMICOND DEVICE:SILICON,80V,4MA	18796	1N198
CR4	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR5	152-0186-00			SEMICOND DEVICE:SILICON,80V,4MA	18796	1N198
CR6	152-0233-00			SEMICOND DEVICE:SILICON,85V,100MA	80009	152-0233-00
CR7	152-0233-00			SEMICOND DEVICE:SILICON,85V,100MA	80009	152-0233-00
CR8	152-0233-00			SEMICOND DEVICE:SILICON,85V,100MA	80009	152-0233-00
Q1	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q2	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q3	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q5	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q6	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q7	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q8	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
R1	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R2	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R4	SELECTED					
R5	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R6	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R7	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R8	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R9	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R10	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R11	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R12	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R13	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R14	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R16	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R17	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R18	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R19	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R20	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025

KEYBOARD CMPTR (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R21	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R22	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R23	----- -----			RES.,FXD,CMPSN:68K OHM,NOMINAL,SELECTED		
R24	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R25	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R26	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R27	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R28	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R29	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R30	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R31	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R32	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R33	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R34	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R35	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R36	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R37	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R38	315-0180-00			RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R39	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
S1-S60	260-1507-00			SWITCH,REED:SPST	56289	162D225X9020
VR3	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	07910	1N4372A
Z1	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
Z2	156-0394-00			MICROCIRCUIT,DI:ENCODER	51284	MCS1020-001
Z3	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
Z4	156-0037-00			MICROCIRCUIT,DI:2-INPUT +AND/OR/INVERT GATE	80009	156-0037-00
Z5	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
Z6	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
Z7	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A4 TC-1 ASSY		
A4	670-3091-07			CKT BOARD ASSY:TC-1	80009	670-3091-07
C6	290-0530-00			CAP.,FXD,ELCTLT:68UF,20%,6V	90201	TDC686M006NLF
C27	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C45	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C91	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C93	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C95	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C113	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	04222	7001-1374
C121	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	72982	301-000U2J0680K
C131	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	72982	301-000U2J0680K
C132	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C140	290-0530-00			CAP.,FXD,ELCTLT:68UF,20%,6V	90201	TDC686M006NLF
C155	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C177	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C203	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C206	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C215	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C266	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C307	283-0076-00			CAP.,FXD,CER DI:27PF,10%,500V	56289	40C287A2
C313	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C326	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C327	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C393	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C407	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C433	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	04222	7001-1380
C443	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C445	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C456	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C467	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C476	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
CR106	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR204	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR405	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
L123	108-0317-00			COIL,RF:FIXED,15UH	32159	71501M
L130	108-0317-00			COIL,RF:FIXED,15UH	32159	71501M
Q7	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q461	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q475	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
R4	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R5	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R6	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R134	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R205	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R227	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R256	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R304	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R305	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R307	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335

TC-1 (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R313	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R333	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R347	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R360	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R366	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R404	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R451	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R455	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
U5	156-0143-00			MICROCIRCUIT,DI:RETRIGGERABLE MONOST/MV	80009	156-0143-00
U15	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	80009	156-0032-00
U21	156-0150-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	01295	SN7437N
U25	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U35	307-0349-00			RES.,FXD,FILM:13 RES. NTWK,1K OHM,2%,0.125W	73138	899-1-R1K
U41	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U51	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U101	156-0172-01			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE,(SEL)	80009	156-0172-01
U105	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U115	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U135	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	01295	SN7417N
U141	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U151	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	80009	156-0035-00
U161	156-0078-00			MICROCIRCUIT,DI:4 TO 16 LINE DECODER	80009	156-0078-00
U171	156-0078-00			MICROCIRCUIT,DI:4 TO 16 LINE DECODER	80009	156-0078-00
U181	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U191	156-0423-00			MICROCIRCUIT,DI:ROM	80009	156-0423-00
U205	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U215	156-0174-00			MICROCIRCUIT,DI:DUAL J-K MS,FLIP-FLOP	01295	SN74111N
U221	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U225	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U235	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U241	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	01295	SN7417N
U251	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U255	156-0165-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NOR GATE	01295	SN7425N
U261	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U271	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	80009	156-0035-00
U275	156-0219-00			MICROCIRCUIT,DI:8-INPUT PRIORITY DCDR	07263	9318DC
U281	156-0425-00			MICROCIRCUIT,DI:32-X PROM,CUSTOM MASK	80009	156-0425-00
U291	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U305	156-0405-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
U315	156-0040-00			MICROCIRCUIT,DI:QUAD LATCH,TTL	80009	156-0040-00
U321	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U325	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U335	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00
U341	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U351	156-0141-00			MICROCIRCUIT,DI:DUAL 2 TO 4 LINE DCDR/DMUX	80009	156-0141-00
U355	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	80009	156-0144-00
U361	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U371	156-0536-00			MICROCIRCUIT,DI:PRESETTABLE DECADE/BIN CNTR	80009	156-0536-00
U375	156-0536-00			MICROCIRCUIT,DI:PRESETTABLE DECADE/BIN CNTR	80009	156-0536-00
U381	156-0536-00			MICROCIRCUIT,DI:PRESETTABLE DECADE/BIN CNTR	80009	156-0536-00
U391	156-0536-00			MICROCIRCUIT,DI:PRESETTABLE DECADE/BIN CNTR	80009	156-0536-00
VR85	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	07910	1N4372A

TC-1 (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
VR86	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	07910	1N4372A
VR87	152-0395-00			SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	04713	1N749A
Y126	158-0072-00			XTAL UNIT,QTZ:4.9152 MHZ,0.05%	33096	OBD

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A5 CHAR GEN ASSY		
A5	670-3147-02			CKT BOARD ASSY:CHAR GEN	80009	670-3147-02
A5	----- -----			(4014/4014-1 ONLY)		
A5	670-3336-02			CKT BOARD ASSY:CHAR GEN	80009	670-3336-02
A5	----- -----			(4015/4015-1 ONLY)		
C14	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C29	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C44	281-0630-00			CAP.,FXD,CER DI:390PF,5%,500V	72982	630000Y5D391J
C151	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C182	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C209	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C231	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C233	281-0524-00			CAP.,FXD,CER DI:150PF,+/-30PF,500V	04222	7001-1381
C259	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C309	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T368C476M020AZ
C429	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C439	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T368C476M020AZ
C441	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T368C476M020AZ
C446	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C472	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C484	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C485	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
Q305	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q378	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
R6	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R21	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R46	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R49	311-1285-00			RES.,VAR,NONWIR:25K OHM,+/-10%,0.5W	32997	3329W-L58-253
R121	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R129	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R205	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R207	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	91637	MFF1816G10701F
R232	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R266	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R276	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R278	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R279	321-0309-00			RES.,FXD,FILM:16.2K OHM,1%,0.125W	91637	MFF1816G16201F
R280	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
R281	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R282	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R284	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R285	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R287	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R288	321-0376-00			RES.,FXD,FILM:80.6K OHM,1%,0.125W	91637	MFF1816G80601F
R289	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
R291	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R292	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
R294	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R376	315-0224-00			RES.,FXD,CMPSN:220K OHM,5%,0.25W	01121	CB2245

CHAR GEN (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R378	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R379	321-0259-00			RES.,FXD,FILM:4.87K OHM,1%,0.125W	91637	MFF1816G48700F
R380	321-0259-00			RES.,FXD,FILM:4.87K OHM,1%,0.125W	91637	MFF1816G48700F
R381	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R382	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R389	321-0313-00			RES.,FXD,FILM:17.8K OHM,1%,0.125W	91637	MFF1816G17801F
R391	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R392	321-0326-00			RES.,FXD,FILM:24.3K OHM,1%,0.125W	91637	MFF1816G24301F
R394	321-0282-00			RES.,FXD,FILM:8.45K OHM,1%,0.125W	91637	MFF1816G84500F
R478	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R479	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R480	321-0270-00			RES.,FXD,FILM:6.34K OHM,1%,0.125W	91637	MFF1816G63400F
R481	321-0355-00			RES.,FXD,FILM:48.7K OHM,1%,0.125W	91637	MFF1816G48701F
R482	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R484	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R485	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R489	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R491	321-0342-00			RES.,FXD,FILM:35.7K OHM,1%,0.125W	91637	MFF1816G35701F
R492	321-0296-00			RES.,FXD,FILM:11.8K OHM,1%,0.125W	91637	MFF1816G11801F
R494	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R495	321-0237-00			RES.,FXD,FILM:2.87K OHM,1%,0.125W	91637	MFF1816G28700F
U11	156-0112-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U15	156-0061-00			MICROCIRCUIT,DI:SGL,BCD TO DEC DECODER	01295	SN7442N
U25	156-0142-00			MICROCIRCUIT,DI:50 MHZ PRESETTABLE BIN CNTR	80009	156-0142-00
U31	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U41	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U55	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U111	307-0387-00			RES.,FXD,FILM:13 RES.NETWORK	73138	898-1-R8 2K
U115	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	01295	SN7417N
U125	156-0165-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NOR GATE	01295	SN7425N
U131	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U141	156-0093-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN7416N
U145	156-0142-00			MICROCIRCUIT,DI:50 MHZ PRESETTABLE BIN CNTR	80009	156-0142-00
U155	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U161	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U171	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U175	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U185	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U191	156-0117-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	80009	156-0117-00
U215	156-0299-00			MICROCIRCUIT,DI:16-BIT DATA SEL	80009	156-0299-00
U225	156-0220-00			MICROCIRCUIT,DI:DUAL 4-BIT LATCH W/CLEAR	80009	156-0220-00
U241	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U245	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U255	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U261	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U271	156-0112-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U305	156-0296-00			MICROCIRCUIT,DI:CARICATURE GENERATOR	33297	EA4001
U315	156-0294-03			MICROCIRCUIT,DI:ROM,CHK & PRGM	80009	156-0294-03
	----- -----			(U315, 4015/4015-1 ONLY)		
U325	156-0293-03			MICROCIRCUIT,DI:READ ONLY MEM	80009	156-0293-03
U331	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U341	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00

CHAR GEN (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U345	156-0042-00			MICROCIRCUIT,DI:J-K M/S FLIP-FLOP	80009	156-0042-00
U355	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U361	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U371	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	01295	SN7417N
U385	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U485	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A6 TC-2 ASSY		
A6	670-3092-05			CKT BOARD ASSY:TC-2	80009	670-3092-05
C51	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C75	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C109	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C111	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C115	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C116	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C169	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C191	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C217	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C218	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C225	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C231	281-0510-00			CAP.,FXD,CER DI:22PF,+/-4.4PF,500V	72982	301-000C0G0220M
C239	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C259	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C275	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C282	283-0047-00			CAP.,FXD,CER DI:270PF,5%,500V	72982	0831522Z5D00271J
C305	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C331	283-0001-00			CAP.,FXD,CER DI:0.005UF,+100-0%,500V	72982	831-559E502P
C351	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C360	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C375	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C391	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C411	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C439	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C446	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C469	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C475	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C476	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-509B152J
C491	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C495	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
Q495	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
R2	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R3	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R4	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R5	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R14	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R15	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R16	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R17	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R101	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R102	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R103	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R104	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R111	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R112	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R113	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R114	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F

TC-2 (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R115	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R116	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R125	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R131	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R209	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R231	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R281	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R318	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R335	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R336	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R345	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R359	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R382	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R399	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R419	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R439	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R473	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R474	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R489	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R491	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R497	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R499	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
U35	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U41	156-0061-00			MICROCIRCUIT,DI:SGL,BCD TO DEC DECODER	01295	SN7442N
U49	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U59	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U65	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U71	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U79	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U89	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U95	156-0152-00			MICROCIRCUIT,DI:DUAL 5-BIT BUFFER-REG	18324	N8201N
U109	156-0411-00			MICROCIRCUIT,LI:QUAD-COMP,SGL SUPPLY	80009	156-0411-00
U121	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U129	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U135	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	80009	156-0032-00
U141	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U149	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U159	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U165	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U171	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U179	156-0222-00			MICROCIRCUIT,DI:HEX.LATCH	80009	156-0222-00
U189	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U209	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U215	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U221	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00
U229	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U235	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U241	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U249	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U259	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U265	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U271	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U279	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U289	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U295	156-0040-00			MICROCIRCUIT,DI:QUAD LATCH,TTL	80009	156-0040-00
U309	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U315	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U321	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U329	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U335	156-0042-00			MICROCIRCUIT,DI:J-K M/S FLIP-FLOP	80009	156-0042-00
U341	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U349	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U359	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U365	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U371	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U379	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U389	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	80009	156-0144-00
U395	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U409	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U415	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U421	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U429	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U435	156-0143-00			MICROCIRCUIT,DI:RETRIGGERABLE MONOST/MV	80009	156-0143-00
U441	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00
U449	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U459	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U465	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U471	156-0402-00			MICROCIRCUIT,LI:TIMER	18324	NE555V
U479	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U489	156-0405-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
VR495	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	07910	1N4372A

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A6 TC-2 ASSY (OPTION 34 ONLY)		
A6	670-3559-05			CKT BOARD ASSY:TC-2	80009	670-3559-05
C51	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C75	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C109	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C111	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C115	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C116	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C169	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C191	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C217	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C218	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C225	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C231	281-0510-00			CAP.,FXD,CER DI:22PF,+/-4.4PF,500V	72982	301-000C0G0220M
C239	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C259	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C275	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C282	283-0047-00			CAP.,FXD,CER DI:270PF,5%,500V	72982	0831522Z5D00271J
C305	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C331	283-0001-00			CAP.,FXD,CER DI:0.005UF,+100-0%,500V	72982	831-559E502P
C351	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C360	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C375	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C391	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C411	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C439	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C446	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C469	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C475	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C476	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-509B152J
C491	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C495	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
Q495	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
R2	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R3	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R4	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R5	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R14	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R15	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R16	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R17	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R101	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R102	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R103	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R104	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R111	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R112	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R113	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R114	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R115	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R116	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R125	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R131	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R209	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R231	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R281	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R318	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R335	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R336	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R345	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R359	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R382	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R399	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R419	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R439	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R473	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R474	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R489	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R491	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R497	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R499	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
U35	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U41	156-0061-00			MICROCIRCUIT,DI:SGL,BCD TO DEC DECODER	01295	SN7442N
U49	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U59	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U65	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U71	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U79	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U89	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U95	156-0152-00			MICROCIRCUIT,DI:DUAL 5-BIT BUFFER-REG	18324	N8201N
U109	156-0411-00			MICROCIRCUIT,LI:QUAD-COMP,SGL SUPPLY	80009	156-0411-00
U121	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U129	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U135	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	80009	156-0032-00
U141	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U149	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U159	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U165	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U171	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U179	156-0222-00			MICROCIRCUIT,DI:HEX.LATCH	80009	156-0222-00
U189	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U209	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U215	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U221	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00
U229	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U235	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U241	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U249	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U259	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U265	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U271	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00

TC-2 (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U279	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U289	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U295	156-0040-00			MICROCIRCUIT,DI:QUAD LATCH,TTL	80009	156-0040-00
U309	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U315	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U321	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U329	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U335	156-0042-00			MICROCIRCUIT,DI:J-K M/S FLIP-FLOP	80009	156-0042-00
U341	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U349	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U359	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U365	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U371	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U379	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U389	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	80009	156-0144-00
U395	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U409	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U415	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U421	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U429	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U435	156-0143-00			MICROCIRCUIT,DI:RETRIGGERABLE MONOST/MV	80009	156-0143-00
U441	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00
U449	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U459	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U465	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U471	156-0402-00			MICROCIRCUIT,LI:TIMER	18324	NE555V
U479	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U489	156-0405-00			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
VR495	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	07910	1N4372A

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A7 TC-3 ASSEMBLY		
A7	670-3093-03 ----- -----	B050000	B053951	CKT BOARD ASSY:TC-3 (4014/4014-1 ONLY)	80009	670-3093-03
A7	670-3093-04 ----- -----	B053952		CKT BOARD ASSY:TC-3 (4014/4014-1 ONLY)	80009	670-3093-04
A7	670-3093-03 ----- -----	B050000	B050759	CKT BOARD ASSY:TC-3 (4015/4015-1 ONLY)	80009	670-3093-03
A7	670-3093-04 ----- -----	B050760		CKT BOARD ASSY:TC-3 (4015/4015-1 ONLY)	80009	670-3093-04
C2	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C31	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C53	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C75	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C99	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C102	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C131	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C155	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C181	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C199	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C202	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C253	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C275	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C299	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C326	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C354	283-0625-00			CAP.,FXD,MICA D:220PF,1%,500V	00853	D105F221F0
C361	283-0625-00			CAP.,FXD,MICA D:220PF,1%,500V	00853	D105F221F0
C377	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C381	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C382	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C383	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C384	283-0672-00			CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F201F0
C385	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C431	290-0309-00			CAP.,FXD,ELCTLT:100UF,20%,25V	56289	109D107X0025F2
C434	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C436	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C438	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C445	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C465	290-0309-00			CAP.,FXD,ELCTLT:100UF,20%,25V	56289	109D107X0025F2
C475	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C476	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C477	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
CR4	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR5	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR96	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR99	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
L443	108-0395-00			COIL,RF:64UH	80009	108-0395-00
L451	108-0395-00			COIL,RF:64UH	80009	108-0395-00
Q329	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q366	151-0221-00			TRANSISTOR:SILICON,PNP	80009	151-0221-00

TC-3 (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q373	151-0221-00			TRANSISTOR:SILICON,PNP	80009	151-0221-00
R1	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R153	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R225	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R280	321-0131-00			RES.,FXD,FILM:226 OHM,1%,0.125W	91637	MFF1816G226R0F
R325	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R326	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R327	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R328	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R353	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R362	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R364	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R365	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R370	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R372	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R373	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R374	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R375	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R376	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R426	321-0739-01			RES.,FXD,FILM:1.68K OHM,0.5%,0.125W	91637	MFF1816G16800D
R429	321-0361-00			RES.,FXD,FILM:56.2K OHM,1%,0.125W	91637	MFF1816G56201F
R431	321-0398-00			RES.,FXD,FILM:137K OHM,1%,0.125W	91637	MFF1816G13702F
R471	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R481	321-0408-00			RES.,FXD,FILM:174K OHM,1%,0.125W	91637	MFF1816G17402F
U5	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U11	156-0087-00			MICROCIRCUIT,DI:4-BIT BINARY FULL ADDER	80009	156-0087-00
U15	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U25	156-0087-00			MICROCIRCUIT,DI:4-BIT BINARY FULL ADDER	80009	156-0087-00
U31	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U35	156-0087-00			MICROCIRCUIT,DI:4-BIT BINARY FULL ADDER	80009	156-0087-00
U41	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U51	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U61	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U65	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U71	156-0087-00			MICROCIRCUIT,DI:4-BIT BINARY FULL ADDER	80009	156-0087-00
U75	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U81	156-0087-00			MICROCIRCUIT,DI:4-BIT BINARY FULL ADDER	80009	156-0087-00
U85	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U91	156-0087-00			MICROCIRCUIT,DI:4-BIT BINARY FULL ADDER	80009	156-0087-00
U95	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U105	156-0123-00			MICROCIRCUIT,LI:4-BIT MAGNITUDE COMPARATOR	80009	156-0123-00
U111	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U115	156-0123-00			MICROCIRCUIT,LI:4-BIT MAGNITUDE COMPARATOR	80009	156-0123-00
U125	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U131	156-0123-00			MICROCIRCUIT,LI:4-BIT MAGNITUDE COMPARATOR	80009	156-0123-00
U135	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U141	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U151	156-0311-00			MICROCIRCUIT,DI:6-BIT BINARY RATE MULT	01295	SN7497N
U161	156-0311-00			MICROCIRCUIT,DI:6-BIT BINARY RATE MULT	01295	SN7497N
U165	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U171	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U175	156-0123-00			MICROCIRCUIT,LI:4-BIT MAGNITUDE COMPARATOR	80009	156-0123-00

TC-3 (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U181	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U185	156-0123-00			MICROCIRCUIT,LI:4-BIT MAGNITUDE COMPARATOR	80009	156-0123-00
U191	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U195	156-0123-00			MICROCIRCUIT,LI:4-BIT MAGNITUDE COMPARATOR	80009	156-0123-00
U205	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U211	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U215	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U225	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U231	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U235	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U241	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U251	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U261	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U265	156-0311-00			MICROCIRCUIT,DI:6-BIT BINARY RATE MULT	01295	SN7497N
U271	156-0311-00			MICROCIRCUIT,DI:6-BIT BINARY RATE MULT	01295	SN7497N
U275	156-0117-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	80009	156-0117-00
U278	156-0371-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND ST	01295	SN74132N
U281	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U285	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U291	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U295	156-0089-00			MICROCIRCUIT,DI:4-BIT UP/DOWN COUNTER	80009	156-0089-00
U305	156-0415-00			MICROCIRCUIT,DI:DIG-TO-ANALOGCONN	80009	156-0415-00
U325	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U331	156-0131-00			MICROCIRCUIT,DI:8-BIT SER TO PARALLEL SHF	80009	156-0131-00
U335	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U341	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U351	156-0120-00			MICROCIRCUIT,DI:SINGLE 4-BIT R/L SHIFT REG	80009	156-0120-00
U361	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00
U365	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U375	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U381	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U385	156-0415-00			MICROCIRCUIT,DI:DIG-TO-ANALOGCONN	80009	156-0415-00
U425	156-0317-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFLIER	80009	156-0317-00
U481	156-0317-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFLIER	80009	156-0317-00
VR379	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A8 DISPLAY CONTROL ASSY		
A8	670-3294-04			CKT BOARD ASSY:DISPLAY CONTROL	80009	670-3294-04
C41	285-0627-00			CAP.,FXD,PLSTC:0.0033UF,5%,100V	56289	410P33251
C45	285-0627-00			CAP.,FXD,PLSTC:0.0033UF,5%,100V	56289	410P33251
C141	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C165	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C211	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C229	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C275	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C306	281-0638-00			CAP.,FXD,CER DI:240PF,5%,500V	72982	301000Z5D241J
C309	281-0630-00			CAP.,FXD,CER DI:390PF,5%,500V	72982	630000Y5D391J
C331	281-0622-00			CAP.,FXD,CER DI:47PF,1%,500V	72982	308-000C0G0470F
C336	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	72982	301-055C0G0100F
C341	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C351	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C375	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C380	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T368C476M020AZ
C382	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D153F471F0
CR305	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR308	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR375	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
Q337	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
R31	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503
R65	321-0162-00			RES.,FXD,FILM:475 OHM,1%,0.125W	91637	MFF1816G475R0F
R307	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R311	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R315	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R321	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R337	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R375	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R381	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503
R383	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
U11	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U21	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U35	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U45	307-0383-00			RES.,FXD,FILM:4.7K OHM,2%,1.5W	73138	899-1-R4.7K
U61	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00
U71	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U111	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U121	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U135	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U145	156-0222-00			MICROCIRCUIT,DI:HEX.LATCH	80009	156-0222-00
U181	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00
U221	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U235	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U245	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U261	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U311	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N

DISPLAY CONTROL (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U321	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	80009	156-0144-00
U335	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00
U345	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U361	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U381	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00

DISPLAY CONTROL (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A8 DISPLAY CONTROL ASSY (OPTION 34 ONLY)		
A8	670-3519-04			CKT BOARD ASSY:DISPLAY CONTROL	80009	670-3519-04
C41	285-0627-00			CAP.,FXD,PLSTC:0.0033UF,5%,100V	56289	410P33251
C45	285-0627-00			CAP.,FXD,PLSTC:0.0033UF,5%,100V	56289	410P33251
C141	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C165	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C211	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C229	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C275	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C306	281-0638-00			CAP.,FXD,CER DI:240PF,5%,500V	72982	301000Z5D241J
C309	281-0630-00			CAP.,FXD,CER DI:390PF,5%,500V	72982	630000Y5D391J
C331	281-0622-00			CAP.,FXD,CER DI:47PF,1%,500V	72982	308-000C0G0470F
C336	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	72982	301-055C0G0100F
C341	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C351	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C375	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C380	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T368C476M020AZ
C382	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D153F471F0
CR305	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR308	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR375	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
Q337	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
R31	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503
R65	321-0162-00			RES.,FXD,FILM:475 OHM,1%,0.125W	91637	MFF1816G475R0F
R307	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R311	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R315	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R321	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R337	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R375	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R381	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503
R383	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
U11	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U21	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U35	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U45	307-0383-00			RES.,FXD,FILM:4.7K OHM,2%,1.5W	73138	899-1-R4.7K
U61	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00
U71	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U111	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U121	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U135	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U145	156-0222-00			MICROCIRCUIT,DI:HEX.LATCH	80009	156-0222-00
U161	156-0110-00			MICROCIRCUIT,DI:DUAL 2 - 4 LINE DCDR DEMUX	80009	156-0110-00
U171	156-0146-00			MICROCIRCUIT,DI:8-BIT SHIFT REGISTER	01295	SN74165N
U181	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00
U221	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U235	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N

DISPLAY CONTROL (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U245	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U261	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U271	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U311	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U321	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	80009	156-0144-00
U335	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00
U345	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U361	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U371	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U381	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				DISCRETE PLOT ASSY (OPTION 34 ONLY)		
A9				CKT BOARD ASSY:DISCRETE PLOT	80009	670-3372-01
C28	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C41	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C45	281-0097-00			CAP.,VAR,CER DI:9-35PF,200V	72982	538-006-D9-35
C66	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2
C68	290-0136-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	162D225X0020CD2
C79	285-0905-00			CAP.,FXD,PLSTC:0.33UF,5%,50V	56289	LP66A1A334J002
C81	285-0905-00			CAP.,FXD,PLSTC:0.33UF,5%,50V	56289	LP66A1A334J002
C93	290-0136-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	162D225X0020CD2
C95	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2
C132	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C166	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C167	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C176	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C186	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C202	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C228	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C252	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C266	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C276	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C283	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	04222	7001-1364
C289	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C328	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C332	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C351	285-0686-00			CAP.,FXD,PLSTC:0.068UF,10%,100V	56289	410P68391
C355	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	04222	7001-1380
C366	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C367	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C376	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C389	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
CR56	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
Q47	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
R7	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R9	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R13	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R15	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R17	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R19	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R46	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R50	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R52	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R54	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R71	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R73	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503
R83	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R85	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503
R90	311-1286-00			RES.,VAR,NONWIR:50K OHM,10%,0.5W	32997	3329W-L58-503

DISCRETE PLOT (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R91	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R169	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R181	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R261	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R339	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R344	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R369	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R373	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
U31	156-0112-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U35	156-0112-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U41	156-0092-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0092-00
U65	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U75	156-0081-00			MICROCIRCUIT,LI:SGL RETRIGGERABLE MV	07263	9601PC
U105	156-0075-00			MICROCIRCUIT,DI:SGL 8-BIT DATA SEL MUX	80009	156-0075-00
U125	156-0142-00			MICROCIRCUIT,DI:50 MHZ PRESETTABLE BIN CNTR	80009	156-0142-00
U131	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U135	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U141	156-0222-00			MICROCIRCUIT,DI:HEX.LATCH	80009	156-0222-00
U145	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00
U161	156-0129-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	80009	156-0129-00
U165	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U175	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	80009	156-0035-00
U185	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	80009	156-0035-00
U191	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U201	156-0142-00			MICROCIRCUIT,DI:50 MHZ PRESETTABLE BIN CNTR	80009	156-0142-00
U205	156-0220-00			MICROCIRCUIT,DI:DUAL 4-BIT LATCH W/CLEAR	80009	156-0220-00
U231	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U235	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U245	156-0165-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NOR GATE	01295	SN7425N
U251	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	80009	156-0144-00
U261	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U265	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00
U271	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U275	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U281	156-0047-00			MICROCIRCUIT,DI:TPL 3-INPUT POS NAND GATE	80009	156-0047-00
U285	156-0058-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0058-00
U331	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U335	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U361	156-0081-00			MICROCIRCUIT,LI:SGL RETRIGGERABLE MV	07263	9601PC
U365	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U375	156-0038-00			MICROCIRCUIT,DI:J-K MASTER SLAVE FLIP-FLOP	80009	156-0038-00
U381	156-0165-00			MICROCIRCUIT,DI:DUAL 4-INPUT POS NOR GATE	01295	SN7425N
U385	156-0092-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0092-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A10 H.V. & Z-AXIS ASSEMBLY		
A10	670-3094-06 ----- -----	B050000	B054607	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS (4014/4014-1 ONLY)	80009	670-3094-06
A10	670-3094-07 ----- -----	B054608	B055689	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS (4014/4014-1 ONLY)	80009	670-3094-07
A10	670-3094-08 ----- -----	B055690		CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS (4014/4014-1 ONLY)	80009	670-3094-08
A10	670-3094-06 ----- -----	B050000	B050874	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS (4015/4015-1 ONLY)	80009	670-3094-06
A10	670-3094-07 ----- -----	B050875	B051089	CKT BOARD ASSY:HIGH-VOLTAGE & Z AXIS (4015/4015-1 ONLY)	80009	670-3094-07
A10	670-3094-08 ----- -----	B051090		CKT BOARD ASSY: HIGH-VOLTAGE & Z AXIS (4015/4015-1 ONLY)	80009	670-3094-08
C13	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C14	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C141	283-0291-00			CAP.,FXD,CER DI:25PF,10%,6000V	56289	41C426
C145	285-1141-00			CAP.,FXD,PLSTC:0.0047UF,20%,10KV	56289	430P4720100
C151	285-1140-00			CAP.,FXD,PLSTC:0.01UF,20%,10KV	56289	430P1030100
C162	285-1141-00			CAP.,FXD,PLSTC:0.0047UF,20%,10KV	56289	430P4720100
C170	285-1141-00			CAP.,FXD,PLSTC:0.0047UF,20%,10KV	56289	430P4720100
C176	285-1141-00			CAP.,FXD,PLSTC:0.0047UF,20%,10KV	56289	430P4720100
C183	285-1137-00			CAP.,FXD,PLSTC:0.0047UF,10%,8000V	56289	430P472980
C211	290-0316-00			CAP.,FXD,ELCTLT:47UF,20%,35V	56289	150D476X0035S2
C214	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C226	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C241	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C247	283-0001-00			CAP.,FXD,CER DI:0.005UF,+100-0%,500V	72982	831-559E502P
C255	283-0189-00			CAP.,FXD,CER DI:0.1UF,20%,400V	72982	8151N401X5R0104M
C352	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	04222	7001-1364
C394	283-0189-00			CAP.,FXD,CER DI:0.1UF,20%,400V	72982	8151N401X5R0104M
C395	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C442	281-0564-00			CAP.,FXD,CER DI:24PF,5%,500V	72982	301-000C0G0240J
C444	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	72982	301-000C0J0339C
C464	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C492	281-0510-00			CAP.,FXD,CER DI:22PF,+/-4.4PF,500V	72982	301-000C0G0220M
C548	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C594	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	72982	301-000C0J0339C
C611	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C614	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C622	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C623	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C627	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C632	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C669	283-0107-00			CAP.,FXD,CER DI:51PF,5%,200V	72982	8121B232C0G0510J
C772	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C777	283-0189-00			CAP.,FXD,CER DI:0.1UF,20%,400V	72982	8151N401X5R0104M
CR11	152-0408-00			SEMICOND DEVICE:SILICON,10KV,5MA	83003	H345
CR12	152-0408-00			SEMICOND DEVICE:SILICON,10KV,5MA	83003	H345
CR31	152-0408-00			SEMICOND DEVICE:SILICON,10KV,5MA	83003	H345
CR32	152-0408-00			SEMICOND DEVICE:SILICON,10KV,5MA	83003	H345

H.V. & Z-AXIS (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR64	152-0170-00			SEMICOND DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR77	152-0170-00			SEMICOND DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR227	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR233	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR236	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR252	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR261	152-0170-00			SEMICOND DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR263	152-0170-00			SEMICOND DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR276	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR283	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR293	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR301	152-0412-00			SEMICOND DEVICE:SILICON,50V,3A	80009	152-0412-00
CR315	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR369	152-0574-00			SEMICOND DEVICE:SILICON,120V,0.15A	80009	152-0574-00
CR456	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR474	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR476	152-0574-00			SEMICOND DEVICE:SILICON,120V,0.15A	80009	152-0574-00
CR493	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR548	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR563	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR634	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR635	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR636	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR637	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR642	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR643	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR644	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR645	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
DS52	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
DS291	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
DS292	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
DS293	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
DS294	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
DS295	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
E45	119-0758-00			ARSR,ELEC SURGE:350V,GAS FILLED	80009	119-0758-00
E76	119-0758-00			ARSR,ELEC SURGE:350V,GAS FILLED	80009	119-0758-00
E77	119-0758-00			ARSR,ELEC SURGE:350V,GAS FILLED	80009	119-0758-00
E133	119-0284-00			ARSR,ELEC SURGE:1.5KV,+/-500VD	91418	SCOR75Y52-IRO
E256	119-0758-00			ARSR,ELEC SURGE:350V,GAS FILLED	80009	119-0758-00
E273	119-0759-00			ARSR,ELEC SURGE:145V,GAS FILLED	71482	CG145L
E392	119-0284-00			ARSR,ELEC SURGE:1.5KV,+/-500VD	91418	SCOR75Y52-IRO
L311	108-0422-00			COIL,RF:80UH	80009	108-0422-00
L314	108-0234-00			COIL,RF:130UH	80009	108-0234-00
L371	108-0213-00			COIL,RF:2.5MH	76493	8862-2.5
Q223	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q224	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q236	151-1005-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1005-00
Q255	151-0311-01			TRANSISTOR:SILICON,NPN	80009	151-0311-01
Q275	151-0279-00			TRANSISTOR:SILICON,NPN	80009	151-0279-00
Q285	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q321	151-0334-00			TRANSISTOR:SILICON,NPN	80009	151-0334-00

H.V. & Z-AXIS (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q374	151-0124-00			TRANSISTOR:SILICON,NPN,SEL FROM 2N3501	80009	151-0124-00
Q385	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q447	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q448	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q456	151-0124-00			TRANSISTOR:SILICON,NPN,SEL FROM 2N3501	80009	151-0124-00
Q557	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q676	151-0150-00			TRANSISTOR:SILICON,NPN	80009	151-0150-00
Q686	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
Q687	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q688	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
R51	301-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.50W	01121	EB1015
R53	301-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.50W	01121	EB1015
R62	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R65	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
R66	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
R76	301-0395-00			RES.,FXD,CMPSN:3.9M OHM,5%,0.50W	01121	EB3955
R123	301-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.50W	01121	EB4715
R147A,B	307-0314-00	B050000	B054607	RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0314-00
	----- -----			(4014/4014-1 ONLY)		
R147A,B	307-0314-01	B054608		RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0314-01
	----- -----			(4014/4014-1 ONLY)		
R147A,B	307-0314-00	B050000	B050874	RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0314-00
	----- -----			(4015/4015-1 ONLY)		
R147A,B	307-0314-01	B050875		RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0314-01
	----- -----			(4015/4015-1 ONLY)		
R148	301-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.50W	01121	EB2735
R181A,B	307-0316-00			RES.,FXD,FILM:VOLTAGE DIVIDER	80009	307-0316-00
R191	311-1459-00			RES.,VAR,NONWIR:5M OHM,2W	01121	73M4G048L505U
R215	304-0152-00			RES.,FXD,CMPSN:1.5K OHM,10%,1W	01121	GB1521
R221	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R231	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R232	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R237	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R241	315-0224-00			RES.,FXD,CMPSN:220K OHM,5%,0.25W	01121	CB2245
R242	315-0824-00			RES.,FXD,CMPSN:820K OHM,5%,0.25W	01121	CB8245
R244	321-0423-00			RES.,FXD,FILM:249K OHM,1%,0.125W	91637	MFF1816G24902F
R251	303-0123-00			RES.,FXD,CMPSN:12K OHM,5%,1W	01121	GB1235
R262	305-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,2W	01121	HB1255
R269	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R271	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R281	301-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.50W	01121	EB3935
R283	315-0333-00	B050000	B055689	RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
	----- -----			(4014/4014-1 ONLY)		
R283	303-0333-00	B055690		RES.,FXD,CMPSN:33K OHM,5%,1W	01121	GB3335
	----- -----			(4014/4014-1 ONLY)		
R283	315-0333-00	B050000	B051089	RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
	----- -----			(4015/4015-1 ONLY)		
R283	303-0333-00	B051090		RES.,FXD,CMPSN:33K OHM,5%,1W	01121	GB3335
	----- -----			(4015/4015-1 ONLY)		
R286	323-0540-00			RES.,FXD,FILM:4.12M OHM,1%,0.50W	91637	HMF129G41203F
R291	316-0222-00			RES.,FXD,CMPSN:2.2K OHM,10%,0.25W	01121	CB2221
R305	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R323	301-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.50W	01121	EB2725

H.V. & Z-AXIS (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R325	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R326	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R332	305-0243-00			RES.,FXD,CMPSN:24K OHM,5%,2W	01121	HB2435
R337	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R341	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R342	311-1231-00			RES.,VAR,NONWIR:25K OHM,20%,0.50W	32997	3386F-T04-253
R343	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	91637	MFF1816G10701F
R346	323-0441-00			RES.,FXD,FILM:383K OHM,1%,0.50W	75042	CECTO-3833F
R347	321-0323-00			RES.,FXD,FILM:22.6K OHM,1%,0.125W	91637	MFF1816G22601F
R351	321-0317-00			RES.,FXD,FILM:19.6K OHM,1%,0.125W	91637	MFF1816G19601F
R354	316-0335-00			RES.,FXD,CMPSN:3.3M OHM,10%,0.25W	01121	CB3351
R361	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R362	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R364	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R365	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R376	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R383	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R392	304-0564-00			RES.,FXD,CMPSN:560K OHM,10%,1W	01121	GB5641
R393	303-0470-00			RES.,FXD,CMPSN:47 OHM,5%,1W	01121	GB4705
R423	315-0220-01			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R433	305-0243-00			RES.,FXD,CMPSN:24K OHM,5%,2W	01121	HB2435
R436	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R441	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R445	323-0411-00			RES.,FXD,FILM:187K OHM,1%,0.50W	75042	CECTO-1873F
R454	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R463	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R465	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R466	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R472	308-0334-00			RES.,FXD,WW:7K OHM,1%,3W	91637	RS2B-B70000H
R474	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R483	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R484	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R485	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R491	316-0335-00			RES.,FXD,CMPSN:3.3M OHM,10%,0.25W	01121	CB3351
R492	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R495	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R536	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R542	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R544	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R545	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R546	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	91637	MFF1816G14001F
R547	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R552	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R553	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R555	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R557	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R561	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R564	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R566	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R571	305-0363-00			RES.,FXD,CMPSN:36K OHM,5%,2W	01121	HB3635
R575	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R583	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R584	321-0354-00			RES.,FXD,FILM:47.5K OHM,1%,0.125W	91637	MFF1816G47501F

H.V. & Z-AXIS (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R585	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R586	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R595	322-0610-00			RES.,FXD,FILM:500K OHM,1%,0.5%,0.25W	91637	MFF1421G50002F
R610	308-0244-00			RES.,FXD,WW:0.3 OHM,10%,2W	91637	RS2B162ER3000K
R613	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R619	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R621	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R626	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R633	321-0343-00			RES.,FXD,FILM:36.5K OHM,1%,0.125W	91637	MFF1816G36501F
R636	321-0411-00			RES.,FXD,FILM:187K OHM,1%,0.125W	91637	MFF1816G18702F
R641	321-0343-00			RES.,FXD,FILM:36.5K OHM,1%,0.125W	91637	MFF1816G36501F
R644	321-0343-00			RES.,FXD,FILM:36.5K OHM,1%,0.125W	91637	MFF1816G36501F
R645	321-0343-00			RES.,FXD,FILM:36.5K OHM,1%,0.125W	91637	MFF1816G36501F
R671	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R684	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R685	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R692	311-1253-00			RES.,VAR,NONWIR:500K OHM,20%,0.50W	32997	3386F-T05-504
R734	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R736	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R745	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R746	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R747	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R771	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R772	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R773	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R774	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R775	321-0279-00			RES.,FXD,FILM:7.87K OHM,1%,0.125W	91637	MFF1816G78700F
R776	321-0279-00			RES.,FXD,FILM:7.87K OHM,1%,0.125W	91637	MFF1816G78700F
R777	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R788	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	91637	MFF1816G31601F
R789	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	91637	MFF1816G31601F
R792	311-1253-00			RES.,VAR,NONWIR:500K OHM,20%,0.50W	32997	3386F-T05-504
T111	120-0826-00			XFMR,PWR,SDN & SU:	80009	120-0826-00
U355	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U592	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U645	156-0141-00			MICROCIRCUIT,DI:DUAL 2 TO 4 LINE DCDR/DMUX	80009	156-0141-00
U654	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
U656	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	80009	156-0140-00
U664	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL,14 DIP	80009	156-0072-00
VR325	152-0508-00			SEMICOND DEVICE:ZENER,0.4W,12.6V,5%	80009	152-0508-00
VR336	152-0295-00			SEMICOND DEVICE:ZENER,1W,82V,5%	80009	152-0295-00
VR583	152-0287-00			SEMICOND DEVICE:ZENER,0.4W,110V,5%	04713	1N986B

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A11 DEFLECTION AMPLIFIER ASSY		
A11	670-3095-04			CKT BOARD ASSY:DEFLECTION AMPLIFIER	80009	670-3095-04
C15	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C16	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C41	281-0521-00			CAP.,FXD,CER DI:56PF,+/-5.6PF,500V	72982	302000C0G560K
C51	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C53	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C75	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C151	281-0526-00			CAP.,FXD,CER DI:1.5PF,+/-0.5PF,500V	72982	301-000S2K0159D
C154	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C171	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C172	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C284	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C293	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C318	283-0187-00			CAP.,FXD,CER DI:0.047UF,10%,400V	72982	8131N401X5R0473K
C335	281-0528-00			CAP.,FXD,CER DI:82PF,+/-8.2PF,500V	72982	301-000U2M0820K
C341	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C343	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C373	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C401	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C435	281-0500-00			CAP.,FXD,CER DI:2.2PF,+/-0.5PF,500V	72982	301-000C0J0229D
C444	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C461	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C462	283-0065-00			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	805-518-Z5D0102J
C523	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C585	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C593	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C617	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C643	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C660	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C661	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C666	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C673	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C682	290-0201-00			CAP.,FXD,ELCTLT:100UF,+75-10%,15V	56289	30D107G015DC9
C692	290-0201-00			CAP.,FXD,ELCTLT:100UF,+75-10%,15V	56289	30D107G015DC9
C697	290-0307-00			CAP.,FXD,ELCTLT:100UF,+75-10%,40V	56289	600D107G040DG4
C699	290-0307-00			CAP.,FXD,ELCTLT:100UF,+75-10%,40V	56289	600D107G040DG4
C717	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C743	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	72982	301-000U2J0470M
C760	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C761	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C766	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C773	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
CR74	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR99	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	80009	152-0398-00
CR152	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR195	152-0399-00			SEMICOND DEVICE:SILICON,50V,3A	04713	SR1878
CR196	152-0399-00			SEMICOND DEVICE:SILICON,50V,3A	04713	SR1878
CR255	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02

DEFLECTION AMPLIFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR260	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR261	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR283	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR284	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR285	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR286	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR299	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	80009	152-0398-00
CR371	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR399	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	80009	152-0398-00
CR495	152-0399-00			SEMICOND DEVICE:SILICON,50V,3A	04713	SR1878
CR496	152-0399-00			SEMICOND DEVICE:SILICON,50V,3A	04713	SR1878
CR519	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR536	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR552	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR554	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR555	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR581	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR582	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR584	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR585	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR598	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	80009	152-0398-00
CR612	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR620	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR624	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR632	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR633	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR644	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR698	152-0399-00			SEMICOND DEVICE:SILICON,50V,3A	04713	SR1878
CR712	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR719	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR724	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR732	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR733	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR744	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
F681	159-0014-00			FUSE,CARTRIDGE:3AG,5A,250V,FAST-BLOW	71400	MTH5
F685	159-0014-00			FUSE,CARTRIDGE:3AG,5A,250V,FAST-BLOW	71400	MTH5
Q60	151-0466-00			TRANSISTOR:SILICON,NPN	04713	MJE224
Q173	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
Q174	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q184	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
Q185	151-0103-00			TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q192	151-0466-00			TRANSISTOR:SILICON,NPN	04713	MJE224
Q193	151-0465-00			TRANSISTOR:SILICON,PNP	04713	MJE234
Q265	151-0465-00			TRANSISTOR:SILICON,PNP	04713	MJE234
Q352	151-0466-00			TRANSISTOR:SILICON,NPN	04713	MJE224
Q465	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
Q466	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q481	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
Q482	151-0103-00			TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q491	151-0466-00			TRANSISTOR:SILICON,NPN	04713	MJE224
Q492	151-0465-00			TRANSISTOR:SILICON,PNP	04713	MJE234
Q515	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00

DEFLECTION AMPLIFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q517	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q533	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q561	151-0465-00			TRANSISTOR:SILICON,PNP	04713	MJE234
Q635	151-0216-00			TRANSISTOR:SILICON,PNP	80009	151-0216-00
Q735	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
R1	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R2	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R3	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R4	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R11	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R12	321-0290-00			RES.,FXD,FILM:10.2K OHM,1%,0.125W	91637	MFF1816G10201F
R13	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	91637	MFF1816G31601F
R14	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R21	321-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
R23	321-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
R24	311-1226-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	32997	3386F-T04-252
R25	321-0295-00			RES.,FXD,FILM:11.5K OHM,1%,0.125W	91637	MFF1816G11501F
R27	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R29	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R31	321-0299-00			RES.,FXD,FILM:12.7K OHM,1%,0.125W	91637	MFF1816G12701F
R36	308-0242-00			RES.,FXD,WW:0.25 OHM,5%,5W	91637	RS2A-ER2500K
R41	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R43	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R44	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R45	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
R51	315-0184-00			RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R53	321-0282-00			RES.,FXD,FILM:8.45K OHM,1%,0.125W	91637	MFF1816G84500F
R55	321-0187-00			RES.,FXD,FILM:866 OHM,1%,0.125W	91637	MFF1816G866R0F
R56	311-1136-00			RES.,VAR,NONWIR:100K OHM,30%,0.25W	71450	201-YA5536
R61	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R63	321-0053-00			RES.,FXD,FILM:34.8 OHM,1%,0.125W	91637	MFF1816G34R80F
R65	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R71	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R73	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R74	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R75	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R81	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R83	303-0102-00			RES.,FXD,CMPSN:1K OHM,5%,1W	01121	GB1025
R85	321-0148-00			RES.,FXD,FILM:340 OHM,1%,0.125W	91637	MFF1816G340R0F
R92	311-1328-00			RES.,VAR,NONWIR:100 OHM,30%,0.25W	71450	201-YA5553
R95	307-0460-00			RES.,FXD,FILM:0.3 OHM,5%,1.5W	80009	307-0460-00
R97	304-0151-00			RES.,FXD,CMPSN:150 OHM,10%,1W	01121	GB1511
R99	304-0151-00			RES.,FXD,CMPSN:150 OHM,10%,1W	01121	GB1511
R101	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R102	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R103	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R110	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R111	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R112	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R113	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R121	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R122	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R123	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103

DEFLECTION AMPLFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R127	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R129	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
R130	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R131	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R135	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R141	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R153	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R154	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R160	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R161	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R163	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R164	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R165	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R171	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R174	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R175	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R181	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R183	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R187	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R191	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R198	301-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.50W	01121	EB2705
R199	308-0242-00			RES.,FXD,WW:0.25 OHM,5%,5W	91637	RS2A-ER2500K
R203	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R204	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	91637	MFF1816G174R0F
R205	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	91637	MFF1816G174R0F
R206	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R209	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R210	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R211	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R212	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R213	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R221	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R222	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R223	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R227	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R229	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
R230	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R231	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R235	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R241	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R242	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R243	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R251	315-0244-00			RES.,FXD,CMPSN:240K OHM,5%,0.25W	01121	CB2445
R252	315-0244-00			RES.,FXD,CMPSN:240K OHM,5%,0.25W	01121	CB2445
R253	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R254	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R263	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R264	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R270	311-1136-00			RES.,VAR,NONWIR:100K OHM,30%,0.25W	71450	201-YA5536
R271	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R272	321-0053-00			RES.,FXD,FILM:34.8 OHM,1%,0.125W	91637	MFF1816G34R80F
R273	311-1328-00			RES.,VAR,NONWIR:100 OHM,30%,0.25W	71450	201-YA5553
R274	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F

DEFLECTION AMPLIFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R275	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R281	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R283	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R287	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R291	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R295	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R296	303-0102-00			RES.,FXD,CMPSN:1K OHM,5%,1W	01121	GB1025
R297	308-0242-00			RES.,FXD,WW:0.25 OHM,5%,5W	91637	RS2A-ER2500K
R301	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R310	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R315	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R319	321-0389-00			RES.,FXD,FILM:110K OHM,1%,0.125W	91637	MFF1816G11002F
R321	321-0298-00			RES.,FXD,FILM:12.4K OHM,1%,0.125W	91637	MFF1816G12401F
R322	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R330	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R332	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R335	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R336	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R340	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
R341	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R343	321-0282-00			RES.,FXD,FILM:8.45K OHM,1%,0.125W	91637	MFF1816G84500F
R344	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R351	321-0187-00			RES.,FXD,FILM:866 OHM,1%,0.125W	91637	MFF1816G866R0F
R354	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R355	321-0053-00			RES.,FXD,FILM:34.8 OHM,1%,0.125W	91637	MFF1816G34R80F
R360	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R361	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R363	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R365	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R373	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R374	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R381	303-0102-00			RES.,FXD,CMPSN:1K OHM,5%,1W	01121	GB1025
R383	321-0148-00			RES.,FXD,FILM:340 OHM,1%,0.125W	91637	MFF1816G340R0F
R395	307-0460-00			RES.,FXD,FILM:0.3 OHM,5%,1.5W	80009	307-0460-00
R396	304-0151-00			RES.,FXD,CMPSN:150 OHM,10%,1W	01121	GB1511
R397	304-0151-00			RES.,FXD,CMPSN:150 OHM,10%,1W	01121	GB1511
R401	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R410	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	91637	MFF1816G64901F
R411	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F
R412	321-0420-00			RES.,FXD,FILM:232K OHM,1%,0.125W	91637	MFF1816G23202F
R413	321-0389-00			RES.,FXD,FILM:110K OHM,1%,0.125W	91637	MFF1816G11002F
R414	321-0320-00			RES.,FXD,FILM:21K OHM,1%,0.125W	91637	MFF1816G21001F
R415	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	91637	MFF1816G15002F
R419	321-0436-00			RES.,FXD,FILM:340K OHM,1%,0.125W	91637	MFF1816G34002F
R420	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R421	321-0415-00			RES.,FXD,FILM:205K OHM,1%,0.125W	91637	MFF1816G20502F
R443	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R444	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R451	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R452	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R454	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R455	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R460	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

DEFLECTION AMPLIFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R461	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R472	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R473	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R474	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R475	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R484	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R485	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R497	301-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.50W	01121	EB2705
R499	308-0242-00			RES.,FXD,WW:0.25 OHM,5%,5W	91637	RS2A-ER2500K
R501	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	32997	3386F-T04-104
R502	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	32997	3386F-T04-104
R503	321-0705-00			RES.,FXD,FILM:41.7K OHM,1%,0.125W	91637	MFF1816G41701F
R504	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R505	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R506	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R509	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R512	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R514	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R520	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R522	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
R523	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R524	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
R525	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R526	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R543	315-0244-00			RES.,FXD,CMPSN:240K OHM,5%,0.25W	01121	CB2445
R544	315-0244-00			RES.,FXD,CMPSN:240K OHM,5%,0.25W	01121	CB2445
R545	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R551	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R560	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R561	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R565	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R566	321-0053-00			RES.,FXD,FILM:34.8 OHM,1%,0.125W	91637	MFF1816G34R80F
R572	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R573	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R575	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R581	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R591	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R593	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R595	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R596	308-0242-00			RES.,FXD,WW:0.25 OHM,5%,5W	91637	RS2A-ER2500K
R601	311-1214-00			RES.,VAR,NONWIR:200K OHM,20%,0.50W	01121	E2B204
R602	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R603	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R604	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R605	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R606	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R609	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R614	311-1214-00			RES.,VAR,NONWIR:200K OHM,20%,0.50W	01121	E2B204
R619	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R622	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R623	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R624	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R625	321-0294-00			RES.,FXD,FILM:11.3K OHM,1%,0.125W	91637	MFF1816G11301F

DEFLECTION AMPLIFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R626	321-0295-00			RES.,FXD,FILM:11.5K OHM,1%,0.125W	91637	MFF1816G11501F
R629	321-0295-00			RES.,FXD,FILM:11.5K OHM,1%,0.125W	91637	MFF1816G11501F
R630	321-0392-00			RES.,FXD,FILM:118K OHM,1%,0.125W	91637	MFF1816G11802F
R631	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R644	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R645	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R646	321-0160-00			RES.,FXD,FILM:453 OHM,1%,0.125W	91637	MFF1816G453R0F
R651	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	91637	MFF1816G16500F
R654	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R660	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R661	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R666	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R673	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R695	303-0102-00			RES.,FXD,CMPSN:1K OHM,5%,1W	01121	GB1025
R701	321-0705-00			RES.,FXD,FILM:41.7K OHM,1%,0.125W	91637	MFF1816G41701F
R702	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R703	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R704	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R705	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R706	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R709	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R718	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R722	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R723	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R724	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R725	321-0291-00			RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816G10501F
R726	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	91637	MFF1816G10701F
R729	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	91637	MFF1816G10701F
R730	321-0290-00			RES.,FXD,FILM:10.2K OHM,1%,0.125W	91637	MFF1816G10201F
R731	321-0363-00			RES.,FXD,FILM:59K OHM,1%,0.125W	91637	MFF1816G59001F
R744	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R745	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R746	321-0160-00			RES.,FXD,FILM:453 OHM,1%,0.125W	91637	MFF1816G453R0F
R751	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	91637	MFF1816G16500F
R754	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R760	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R761	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R766	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R773	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R781	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R792	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
U5	156-0407-00			MICROCIRCUIT,LI:4-QUAD,ANALOG MULT	04713	MC1495L
U35	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U105	156-0407-00			MICROCIRCUIT,LI:4-QUAD,ANALOG MULT	04713	MC1495L
U115	156-0407-00			MICROCIRCUIT,LI:4-QUAD,ANALOG MULT	04713	MC1495L
U135	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U142	156-0317-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFLIER	80009	156-0317-00
U143	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U215	156-0407-00			MICROCIRCUIT,LI:4-QUAD,ANALOG MULT	04713	MC1495L
U235	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U305	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	80009	156-0032-00
U306	156-0093-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN7416N

DEFLECTION AMPLIFIER (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U325	156-0145-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND BFR	80009	156-0145-00
U405	156-0093-00			MICROCIRCUIT,DI:HEX. INVERTER	01295	SN7416N
U425	156-0172-00			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT W/CLR	80009	156-0172-00
U432	156-0317-00			MICROCIRCUIT,LI:OPERATIONAL AMPLFLIER	80009	156-0317-00
U433	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U615	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
U635	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
U715	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
U735	156-0122-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	18324	NE531T
VR151	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR262	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR535	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR556	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR782	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00
VR792	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A12 STORAGE ASSY		
A12	670-3096-01	B050000	B054471	CKT BOARD ASSY:STORAGE	80009	670-3096-01
	----- -----			(4014/4014-1 ONLY)		
A12	670-3096-02	B054472		CKT BOARD ASSY:STORAGE	80009	670-3096-02
	----- -----			(4014/4014-1 ONLY)		
A12	670-3096-01	B050000	B050946	CKT BOARD ASSY:STORAGE	80009	670-3096-01
	----- -----			(4015/4015-1 ONLY)		
A12	670-3096-02	B050947		CKT BOARD ASSY:STORAGE	80009	670-3096-02
	----- -----			(4015/4015-1 ONLY)		
C13	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C41	290-0297-00			CAP.,FXD,ELCTLT:39UF,10%,10V	56289	150D396X9010B2
C54	290-0263-00			CAP.,FXD,ELCTLT:2.7UF,15V	56289	162D275X9015CD2
C115	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C123	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C124	290-0136-00	B050000	B054471	CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	162D225X0020CD2
	----- -----			(4014/4014-1 ONLY)		
C124	290-0301-00	B054472		CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
	----- -----			(4014/4014-1 ONLY)		
C124	290-0136-00	B050000	B050946	CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	162D225X0020CD2
	----- -----			(4015/4015-1 ONLY)		
C124	290-0301-00	B050947		CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
	----- -----			(4015/4015-1 ONLY)		
C129	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C153	281-0603-00			CAP.,FXD,CER DI:39PF,5%,500V	72982	308-000C0G0390J
C235	290-0276-00			CAP.,FXD,ELCTLT:0.68UF,10%,35V	56289	162D684X9035CD2
C262	281-0603-00			CAP.,FXD,CER DI:39PF,5%,500V	72982	308-000C0G0390J
C362	281-0603-00			CAP.,FXD,CER DI:39PF,5%,500V	72982	308-000C0G0390J
C445	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C505	290-0397-00			CAP.,FXD,ELCTLT:1UF,+50-10%,450V	56289	34D105F450EE4
C507	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C520	283-0001-00			CAP.,FXD,CER DI:0.005UF,+100-0%,500V	72982	831-559E502P
C545	290-0215-00			CAP.,FXD,ELCTLT:100UF,+75-10%,25V	56289	30D107G025DD9
C567	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C572	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C579	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C583	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C587	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
CR125	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR156	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR183	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR241	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR242	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR245	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR263	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR366	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR439	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR484	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR488	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR519	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR521	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02

STORAGE (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR523	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR524	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR551	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR559	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR561	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR563	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR565	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
M325	149-0030-00			METER,T TOTAL:CIRCUIT BOARD MOUNT,DC	18583	120-LC
M329	149-0030-00			METER,T TOTAL:CIRCUIT BOARD MOUNT,DC	18583	120-LC
Q85	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q143	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q154	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q183	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q255	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q257	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q285	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q355	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q357	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q385	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q444	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q469	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q485	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
R17	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R40	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R43	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R45	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R63	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R71	305-0203-00			RES.,FXD,CMPSN:20K OHM,5%,2W	01121	HB2035
R81	305-0203-00			RES.,FXD,CMPSN:20K OHM,5%,2W	01121	HB2035
R109	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R113	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R118	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R120	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R121	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R122	315-0220-01			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R125	315-0684-00 ----- -----	XB054472		RES.,FXD,CMPSN:680K OHM,5%,0.25W (4014/4014-1 ONLY)	01121	CB6845
R125	315-0684-00 ----- -----	XB050947		RES.,FXD,CMPSN:680K OHM,5%,0.25W (4015/4015-1 ONLY)	01121	CB6845
R126	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	91637	MFF1816G18701F
R127	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
R131	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R132	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R133	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R140	311-1226-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	32997	3386F-T04-252
R141	323-0452-00			RES.,FXD,FILM:499K OHM,1%,0.50W	75042	CECT0-4993F
R142	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	MFF1816G34801F
R152	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R163	304-0184-00			RES.,FXD,CMPSN:180K OHM,10%,1W	01121	GB1841
R171	305-0203-00			RES.,FXD,CMPSN:20K OHM,5%,2W	01121	HB2035
R181	305-0203-00			RES.,FXD,CMPSN:20K OHM,5%,2W	01121	HB2035
R185	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

STORAGE (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R187	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R188	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R189	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R209	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R221	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R223	311-1234-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T06-503
R224	321-0328-00			RES.,FXD,FILM:25.5K OHM,1%,0.125W	91637	MFF1816G25501F
R225	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R227	321-0299-00			RES.,FXD,FILM:12.7K OHM,1%,0.125W	91637	MFF1816G12701F
R229	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R247	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R251	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R252	323-0426-00			RES.,FXD,FILM:267K OHM,1%,0.50W	75042	CECTO-2673F
R266	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R269	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R271	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R278	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R281	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R288	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R341	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R343	311-1234-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T06-503
R344	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R345	321-0328-00			RES.,FXD,FILM:25.5K OHM,1%,0.125W	91637	MFF1816G25501F
R346	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R347	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R351	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R352	323-0426-00			RES.,FXD,FILM:267K OHM,1%,0.50W	75042	CECTO-2673F
R363	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R371	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R378	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R381	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R388	315-0101-03			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R411	311-1223-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3386F-T04-251
R431	316-0126-00			RES.,FXD,CMPSN:12M OHM,10%,0.25W	01121	CB1261
R433	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R435	316-0126-00			RES.,FXD,CMPSN:12M OHM,10%,0.25W	01121	CB1261
R437	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R455	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R461	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R463	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R465	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R478	305-0823-00			RES.,FXD,CMPSN:82K OHM,5%,2W	01121	HB8235
R481	323-0381-00			RES.,FXD,FILM:90.9K OHM,1%,0.50W	75042	CECTO-9092F
R509	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R511	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R514	321-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.125W	91637	MFF1816G37400F
R517	323-0726-00			RES.,FXD,FILM:306K OHM,1%,0.50W	91637	MFF1226G30602F
R531	323-0457-00			RES.,FXD,FILM:562K OHM,1%,0.50W	75042	CECTO-5623F
R533	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	91637	MFF1816G76800F
R535	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R539	308-0344-00			RES.,FXD,WW:18.2 OHM,1%,3W	91637	RS2B-K18R20F
R568	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R571	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5

STORAGE (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R578	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R582	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R585	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R589	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
U11	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U35	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U51	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00
U111	156-0149-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND SCHMITT	80009	156-0149-00
U211	156-0093-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN7416N
U311	156-0093-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN7416N
U525	156-0071-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	80009	156-0071-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A13 HARD COPY AMPL ASSY		
A13	670-3097-01			CKT BOARD ASSY:HARD COPY AMPL	80009	670-3097-01
C1	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C6	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C12	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C13	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C17	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C31	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C34	281-0512-00			CAP.,FXD,CER DI:27PF,+/-2.7PF,500V	72982	308-000C0G0270K
C35	281-0623-00			CAP.,FXD,CER DI:650PF,5%,500V	04222	7001-1362
C105	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C122	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C123	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C124	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C131	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C141	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C142	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C145	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C157	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C158	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
L44	108-0146-00			COIL,RF:5UH	80009	108-0146-00
L140	108-0214-00			COIL,RF:400UH	80009	108-0214-00
L144	108-0214-00			COIL,RF:400UH	80009	108-0214-00
Q115	151-0223-00			TRANSISTOR:SILICON,NPN	80009	151-0223-00
Q134	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
R2	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R5	315-0100-02			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R7	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R11	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R14	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R15	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R16	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R26	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R32	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R33	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R36	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R37	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R45	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R54	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R106	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R112	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R113	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R114	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R121	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R125	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R126	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R132	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	91637	MFF1816G16500F
R135	301-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.50W	01121	EB1515
R136	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F

HARD COPY AMPL (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R145	301-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.50W	01121	EB1515
R146	301-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
T53	120-0827-00			XFMR,TOROID:THREE 12 TURN WINDINGS	80009	120-0827-00
U3	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U21	156-0162-00			MICROCIRCUIT,LI:DIFFERENTIAL VIDEO AMPL	80009	156-0162-00
U43	156-0162-00			MICROCIRCUIT,LI:DIFFERENTIAL VIDEO AMPL	80009	156-0162-00
U101	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	80009	156-0072-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				A14 POWER SUPPLY ASSY		
A14	670-3089-04	B050000	B059999	CKT BOARD ASSY:POWER SUPPLY	80009	670-3089-04
A14	670-3089-05	B060000		CKT BOARD ASSY:POWER SUPPLY	80009	670-3089-05
C131	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
C141	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	04222	7001-1380
C155	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C221	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
C225	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
C231	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	274C10
C241	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C249	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C250	283-0104-00			CAP.,FXD,CER DI:2000PF,5%,500V	72982	811-565B202J
C257	290-0528-00			CAP.,FXD,ELCTLT:15UF,20%,50V	90201	TDC156M050WLC
C271	283-0104-00			CAP.,FXD,CER DI:2000PF,5%,500V	72982	811-565B202J
C275	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C278	290-0511-00			CAP.,FXD,ELCTLT:250UF,+75-10%,250V	90201	20-35958
C291	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	04222	7001-1364
C298	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2
C371	290-0511-00			CAP.,FXD,ELCTLT:250UF,+75-10%,250V	90201	20-35958
CR171	152-0066-01			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0066-01
CR181	152-0066-01			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0066-01
CR185	152-0066-01			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0066-01
CR187	152-0066-01			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0066-01
CR391	152-0200-00			SEMICOND DEVICE:SILICON,400V,1500MA	80009	152-0200-00
CR491	152-0200-00			SEMICOND DEVICE:SILICON,400V,1500MA	80009	152-0200-00
F137	159-0038-00			FUSE,CARTRIDGE:3AG,15A,32V,FAST-BLOW	71400	MDL 15A
F161	159-0014-00			FUSE,CARTRIDGE:3AG,5A,250V,FAST-BLOW	71400	MTH5
F191	159-0014-00			FUSE,CARTRIDGE:3AG,5A,250V,FAST-BLOW	71400	MTH5
F302	159-0022-00			FUSE,CARTRIDGE:3AG,1A,250V,FAST-BLOW	71400	AGC 1
F371	159-0029-00			FUSE,CARTRIDGE:3AG,0.3A,250V,SLOW-BLOW	71400	MDL3/10
F386	159-0029-00			FUSE,CARTRIDGE:3AG,0.3A,250V,SLOW-BLOW	71400	MDL3/10
F490	159-0029-00			FUSE,CARTRIDGE:3AG,0.3A,250V,SLOW-BLOW	71400	MDL3/10
Q146	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q151	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
Q176	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
Q177	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q185	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
Q195	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
Q243	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q245	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
Q246	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
R43	301-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.50W	01121	EB4715
R45	301-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.50W	01121	EB4705
R55	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R105	308-0575-00			RES.,FXD,WW:0.06 OHM,10%,6W	80009	308-0575-00
R106	308-0548-00	XB060000		RES.,FXD,WW:0.1 OHM,3%,5W	91637	RS5-ER1000UH
R143	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R144	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

POWER SUPPLY (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R145	315-0162-00	B050000	B059999	RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R145	315-0132-00	B060000		RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R148	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R149	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R156	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R157	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R158	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R159	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R175	301-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.50W	01121	EB4715
R179	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R183	308-0244-00			RES.,FXD,WW:0.3 OHM,10%,2W	91637	RS2B162ER3000K
R184	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R189	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R190	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R191	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
R192	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
R193	321-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
R194	315-0272-03			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R195	308-0244-00			RES.,FXD,WW:0.3 OHM,10%,2W	91637	RS2B162ER3000K
R196	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R197	311-1224-00			RES.,VAR,NONWIR:500 OHM,20%,0.50W	32997	3386F-T04-501
R198	301-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.50W	01121	EB4705
R199	301-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.50W	01121	EB4705
R200	301-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.50W	01121	EB4715
R201	301-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.50W	01121	EB4705
R232	321-0603-00			RES.,FXD,FILM:15K OHM,0.25%,0.125W	91637	MFF1816D15001C
R233	321-0350-00			RES.,FXD,FILM:43.2K OHM,1%,0.125W	91637	MFF1816G43201F
R234	315-0470-03			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R235	315-0471-03			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R237	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R238	321-0270-00			RES.,FXD,FILM:6.34K OHM,1%,0.125W	91637	MFF1816G63400F
R239	321-0138-00	B050000	B059999	RES.,FXD,FILM:267 OHM,1%,0.125W	91637	MFF1816G267R0F
R239	321-0128-00	B060000		RES.,FXD,FILM:210 OHM,1%,0.125W	91637	MFF1816G210R0F
R245	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R247	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R256	321-0816-03			RES.,FXD,FILM:5K OHM,0.25%,0.125W	91637	MFF1816D50000C
R258	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R259	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R273	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R274	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R287	315-0472-03			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R293	321-0604-00			RES.,FXD,FILM:30K OHM,0.25%,0.125W	91637	MFF1816D30001C
R295	321-0603-00			RES.,FXD,FILM:15K OHM,0.25%,0.125W	91637	MFF1816D15001C
R296	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R297	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
R298	321-0226-00			RES.,FXD,FILM:2.21K OHM,1%,0.125W	91637	MFF1816G22100F
R372	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R385	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R397	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R483	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R485	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045
R487	305-0104-00			RES.,FXD,CMPSN:100K OHM,5%,2W	01121	HB1045

POWER SUPPLY (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U251	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U261	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U285	156-0071-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	80009	156-0071-00
VR189	152-0241-00			SEMICOND DEVICE:ZENER,0.4W,33V,5%	80009	152-0241-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
C110	290-0545-00	B050000	B059999	CAP.,FXD,ELCTLT:86,000UF,+75-10%,15V	56289	36D863G015DC2A
C110	290-0713-00	B060000		CAP.,FXD,ELCTLT:120,000UF,+75-10%,15V	56289	36D7879
C305	290-0682-00			CAP.,FXD,ELCTLT:25,000UF,+75-10%,30V	80009	290-0682-00
C331	290-0682-00			CAP.,FXD,ELCTLT:25,000UF,+75-10%,30V	80009	290-0682-00
C405	290-0485-00			CAP.,FXD,ELCTLT:21,000UF,+75-10%,15V	56289	36D213G015BB2A
C431	290-0485-00			CAP.,FXD,ELCTLT:21,000UF,+75-10%,15V	56289	36D213G015BB2A
C471	290-0681-00			CAP.,FXD,ELCTLT:400UF,+50-10%,400V	56289	36D8157
C1000	283-0022-00			CAP.,FXD,CER DI:0.02UF,1400VDCAC	80009	283-0022-00
C1001	283-0022-00			CAP.,FXD,CER DI:0.02UF,1400VDCAC	80009	283-0022-00
CR1001	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR1002	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR1003	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR1004	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR1006	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR1007	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR1009	152-0475-00			SEMICOND DEVICE:RECT,SILICON,50V,12A	80009	152-0475-00
CR1041	150-1001-00			LT EMITTING DIO:RED,660NM,100MA MAX	50522	MV5024
CR1042	150-1001-00			LT EMITTING DIO:RED,660NM,100MA MAX	50522	MV5024
CR1043	150-1001-00			LT EMITTING DIO:RED,660NM,100MA MAX	50522	MV5024
CR1045	150-1001-00			LT EMITTING DIO:RED,660NM,100MA MAX	50522	MV5024
CR1047	150-1001-00			LT EMITTING DIO:RED,660NM,100MA MAX	50522	MV5024
DS1050	150-0170-00			LAMP,CARTRIDGE:10V,0.07A,GREEN	18788	T600-9-H533
F1000	159-0011-00			FUSE,CARTRIDGE:3AG,6.25V,125V,5SEC	75915	3136.25
J1001	161-0033-07			CABLE ASSY,PWR,:3 WIRE,92 INCH LONG	80009	161-0033-07
L1012	108-0786-00			COIL,TUBE DEFLE:X DEFLE AMPL	99409	C8295-2
L1017	108-0786-00			COIL,TUBE DEFLE:Y DEFLE AMPL	99409	C8295-2
LS1001	119-0305-00			LOUDSPEAKER,PM:PERMANENT MAGNET,45 OHM,2W	07109	35A45C
Q1001	151-0337-00			TRANSISTOR:SILICON,NPN	80009	151-0337-00
Q1002	151-0515-01			SCR:SILICON	04713	2N4441
Q1004	151-0323-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE521	80009	151-0323-00
Q1005	151-0470-00			TRANSISTOR:SILICON,NPN	80009	151-0470-00
Q1007	151-0337-00			TRANSISTOR:SILICON,NPN	80009	151-0337-00
Q1009	151-0337-00			TRANSISTOR:SILICON,NPN	80009	151-0337-00
Q1011	151-0414-00			TRANSISTOR:SILICON,PNP	04713	MJE1092
Q1012	151-0415-00			TRANSISTOR:SILICON,NPN	04713	MJE1102
Q1013	151-0349-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE2801	80009	151-0349-00
Q1014	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q1016	151-0414-00			TRANSISTOR:SILICON,PNP	04713	MJE1092
Q1017	151-0415-00			TRANSISTOR:SILICON,NPN	04713	MJE1102
Q1018	151-0349-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE2801	80009	151-0349-00
Q1019	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q1021	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00
Q1022	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00
Q1023	151-0423-00			TRANSISTOR:SILICON,NPN	80009	151-0423-00
Q1024	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00
Q1025	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q1027	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00
Q1029	151-0468-00			TRANSISTOR:SILICON,NPN	80009	151-0468-00
Q1032	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00
R1000	304-0335-00			RES.,FXD,CMPSN:3.3M OHM,10%,1W	01121	GB3351
R1001	304-0335-00			RES.,FXD,CMPSN:3.3M OHM,10%,1W	01121	GB3351
R1047	311-0310-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	W-7350A
R1048	311-1460-00			RES.,VAR NONWIR:10K OHM,20%,1W	01121	73J1G040L103M
R1049	311-1460-00			RES.,VAR NONWIR:10K OHM,20%,1W	01121	73J1G040L103M
R1050	311-0580-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	11237	300SF-41695
S1001	260-1805-00			SWITCH,TOGGLE:DPST,15A,125VAC	27193	7561K6
S1002	260-1497-00			SWITCH,PUSH:DPDT,10A,250VAC	01963	E79-30A
S1040	260-1619-00			SWITCH,LEVER:SPDT,0.5A,125VAC	22753	RSW412-ND-B-STD
S1041	260-1640-00			SWITCH,SLIDE:DPTT,0.5A,125VAC	22753	RSW-023-GP
S1042	260-1619-00			SWITCH,LEVER:SPDT,0.5A,125VAC	22753	RSW412-ND-B-STD
S1043	260-1619-00			SWITCH,LEVER:SPDT,0.5A,125VAC	22753	RSW412-ND-B-STD
S1044	260-1619-00			SWITCH,LEVER:SPDT,0.5A,125VAC	22753	RSW412-ND-B-STD
S1045	260-1640-00			SWITCH,SLIDE:DPTT,0.5A,125VAC	22753	RSW-023-GP
S1046	260-1620-00			SWITCH,PUSH:DPDT,0.5A,0.125VAC	22753	RSW-422-SR-B-STD
S1047	260-1642-00			SWITCH,SLIDE:DPTT,0.5A,125VAC	22753	RSW-023-SRD-GP
T1000	120-0927-00			XFMR,PWR,SDN & SU:	80009	120-0927-00
V1	154-0761-50			ELECTRON TUBE:CRT,TESTED,T4014-400	80009	154-0761-50
V1	154-0762-00			ELECTRON TUBE:CRT,P401	80009	154-0762-00
	020-0308-00 ----- -----			COMPONENT KIT: (OPTION 26 ONLY)		
U61	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U65	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U71	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U75	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U81	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U85	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U91	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U95	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
	020-0308-00 ----- -----			COMPONENT KIT: (OPTION 27 ONLY)		
U161	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U165	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U171	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U175	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U181	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U185	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U191	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00
U195	156-0968-00			MICROCIRCUIT,DI:16348 X 1 DYNAMIC RAM	80009	156-0968-00

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

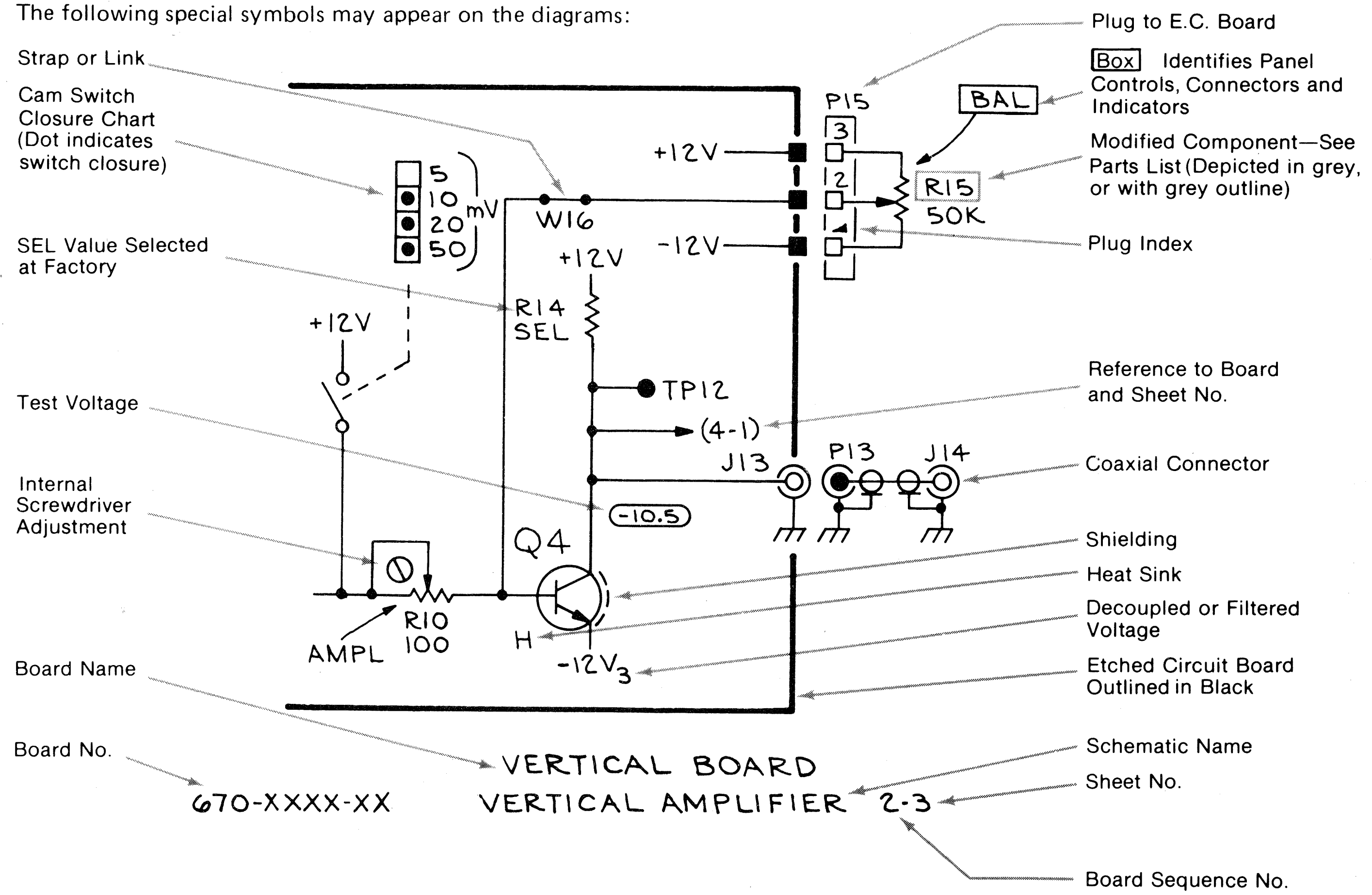
Abbreviations are based on ANSI Y1.1-1972.
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:



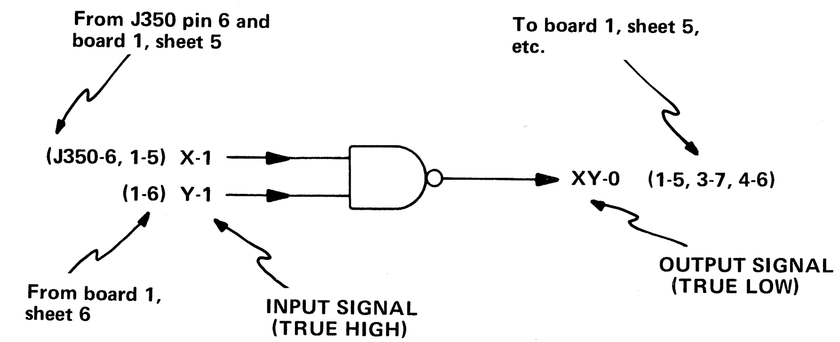
1. TRUE HIGH and TRUE LOW Signals

Signal names on the schematics are followed by −1 or −0. A TRUE HIGH signal is indicated by −1, and a TRUE LOW signal is indicated by −0.

SIGNAL−1 = TRUE HIGH
SIGNAL−0 = TRUE LOW

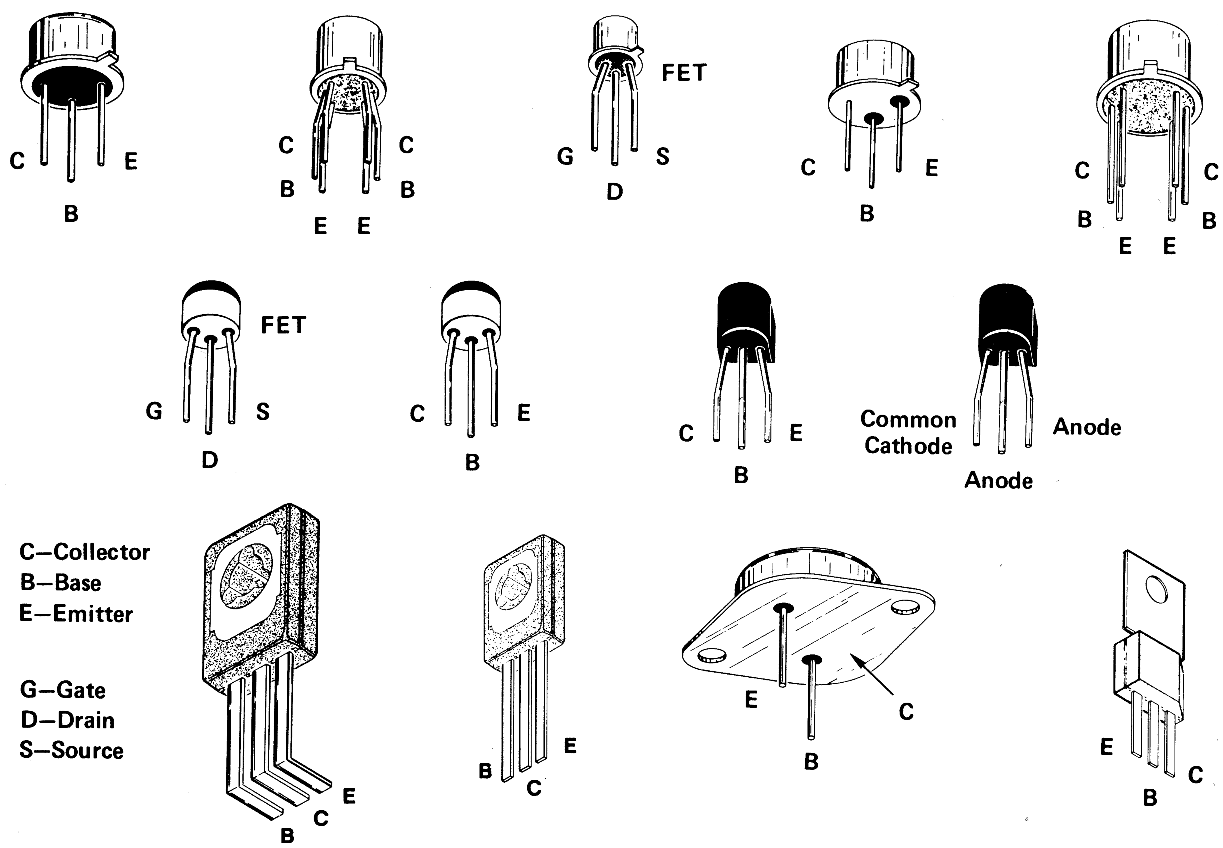
2. Cross-References

Schematic cross-references (from/to information) are included on the schematics. The "from" reference only indicates the signal "source," and the "to" reference lists all loads where the signal is used. All from/to information will be enclosed in parenthesis.

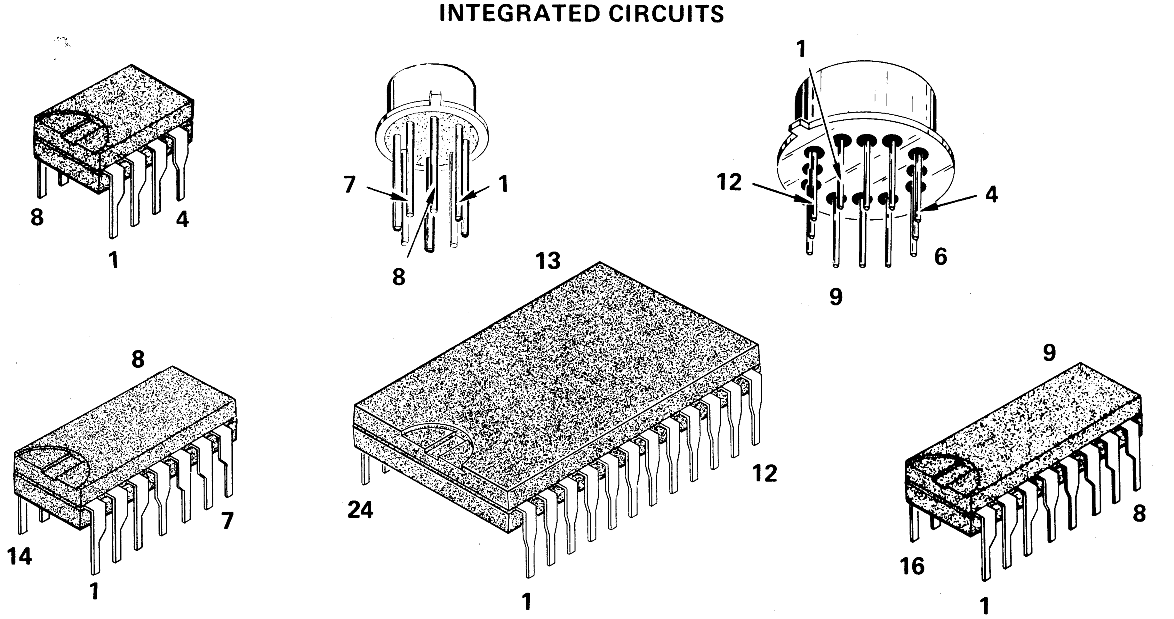


@

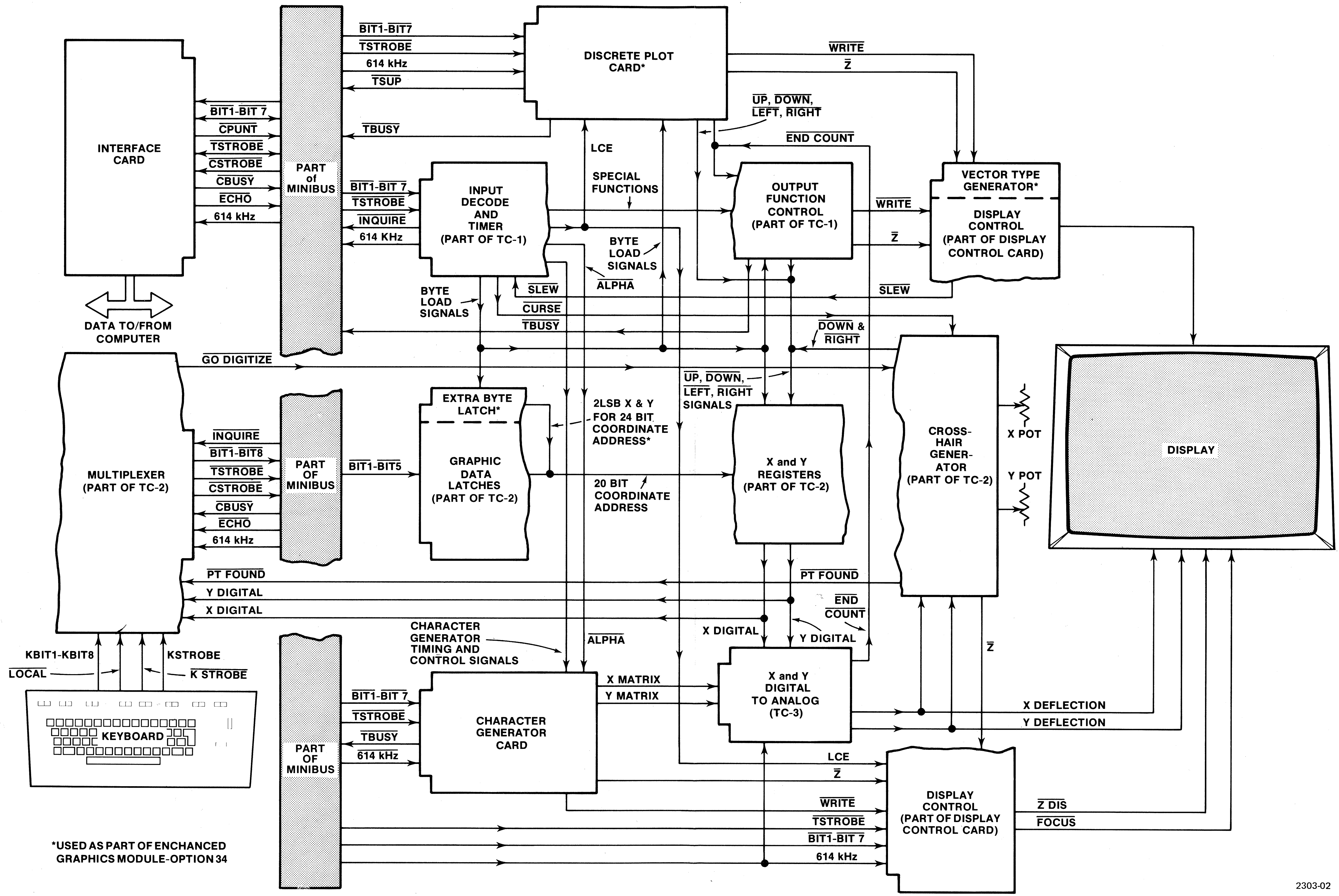
SEMICONDUCTOR DEVICES



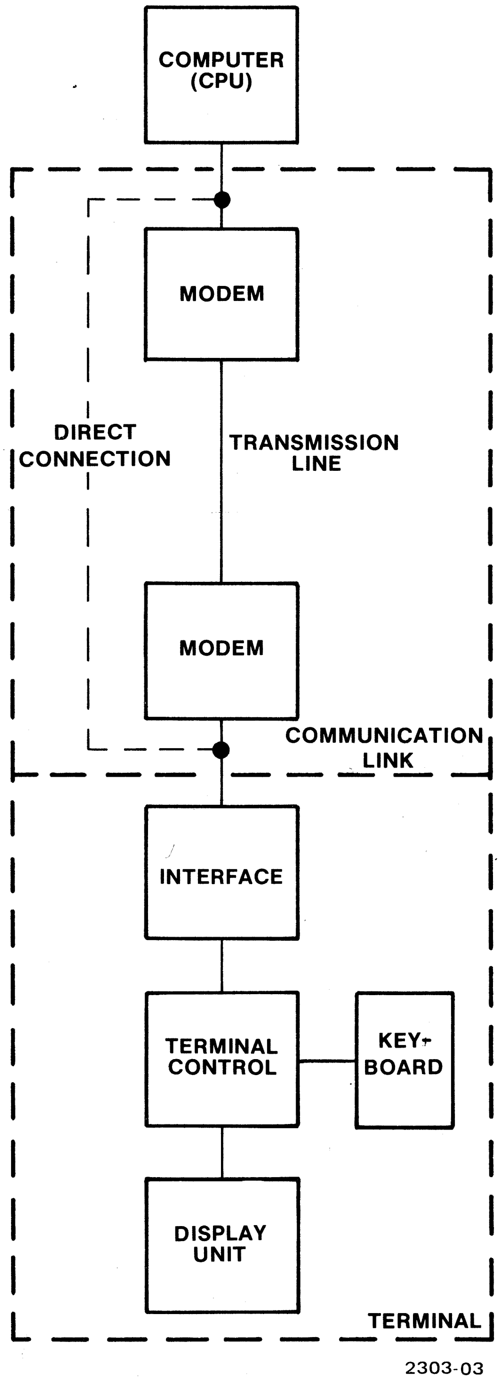
INTEGRATED CIRCUITS



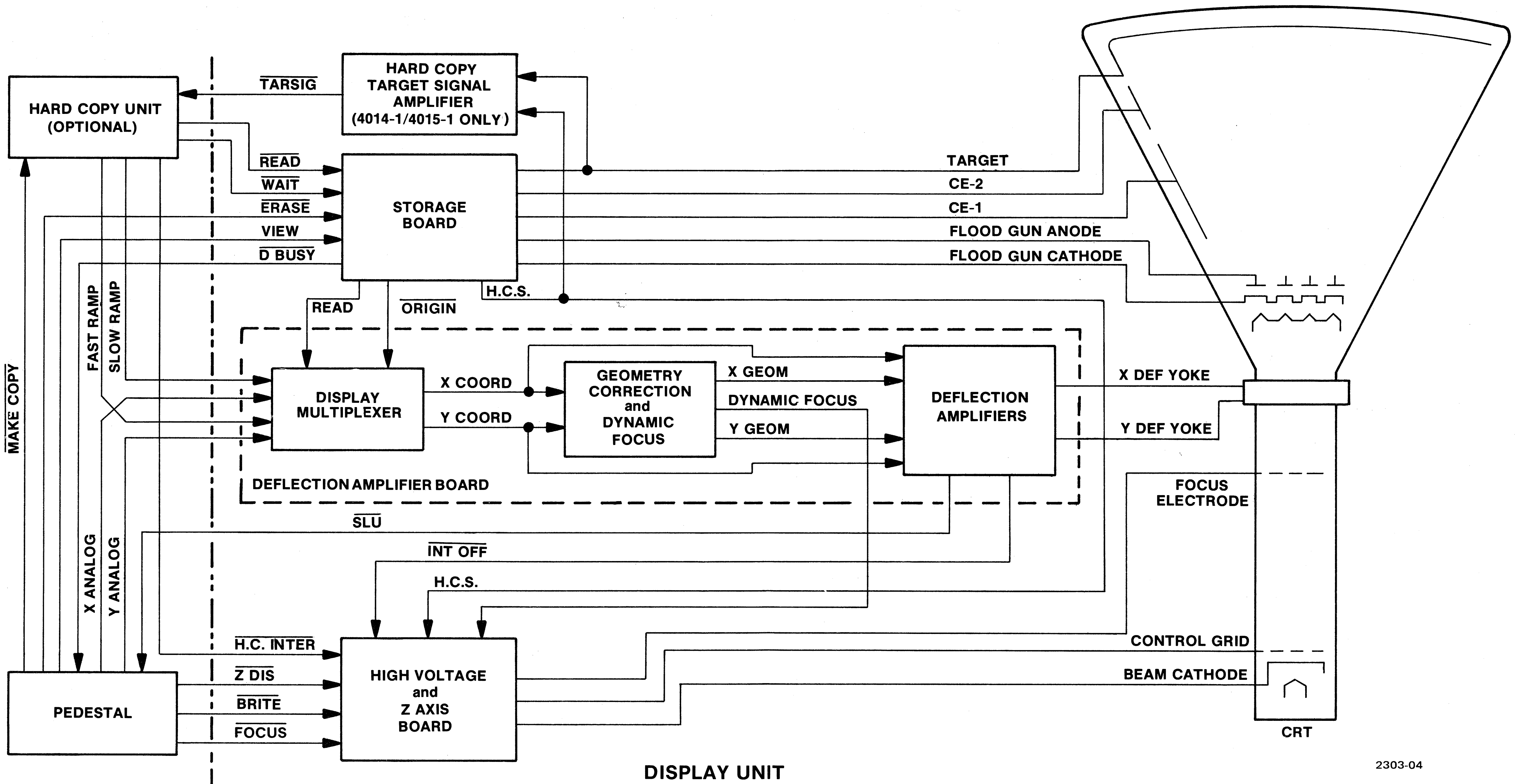
(1183)2303-01



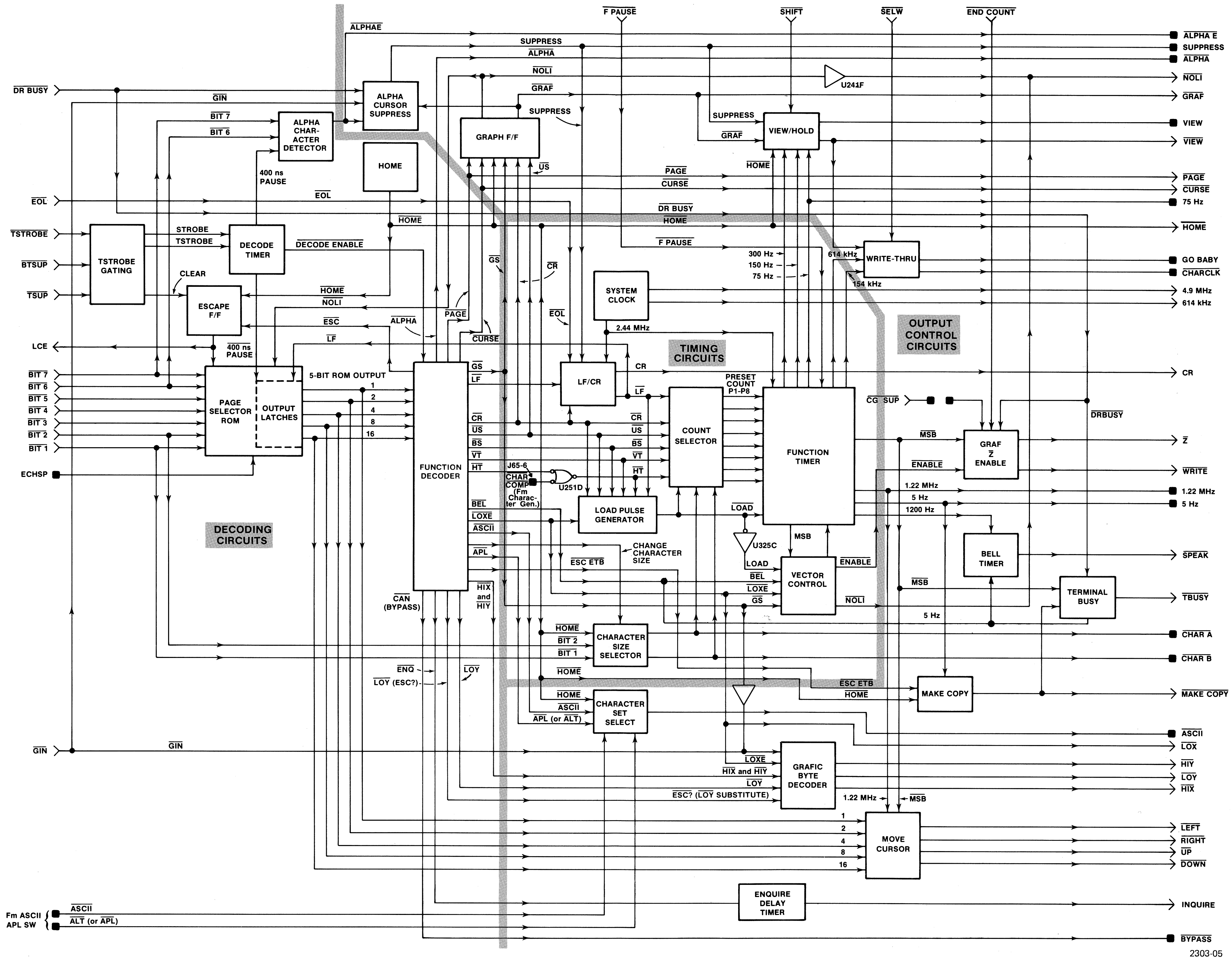
Pedestal Circuitry Data Flow Block Diagram.



Computer/Terminal Communication Block Diagram.



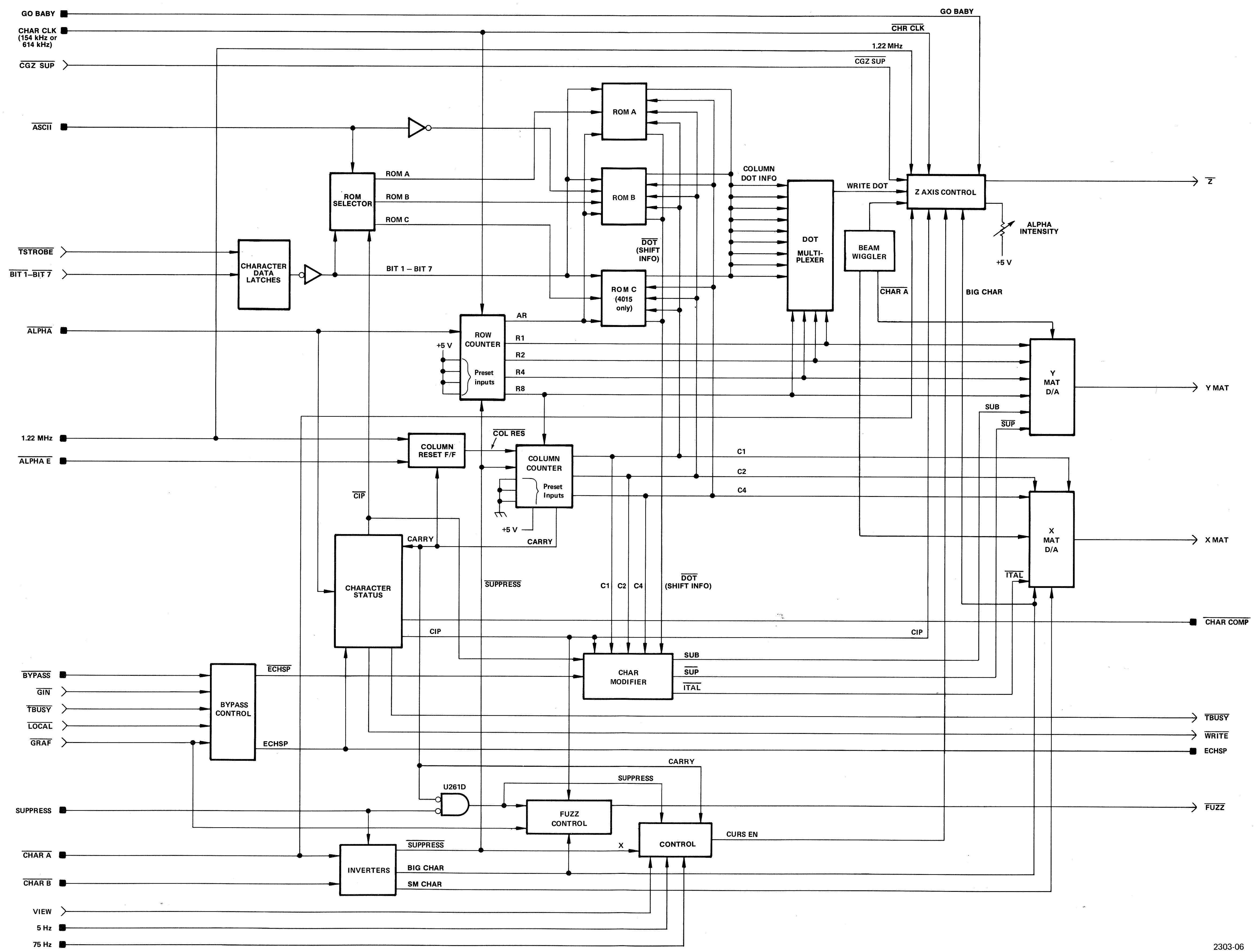
Display Unit Block Diagram.



TC-1 Block Diagram

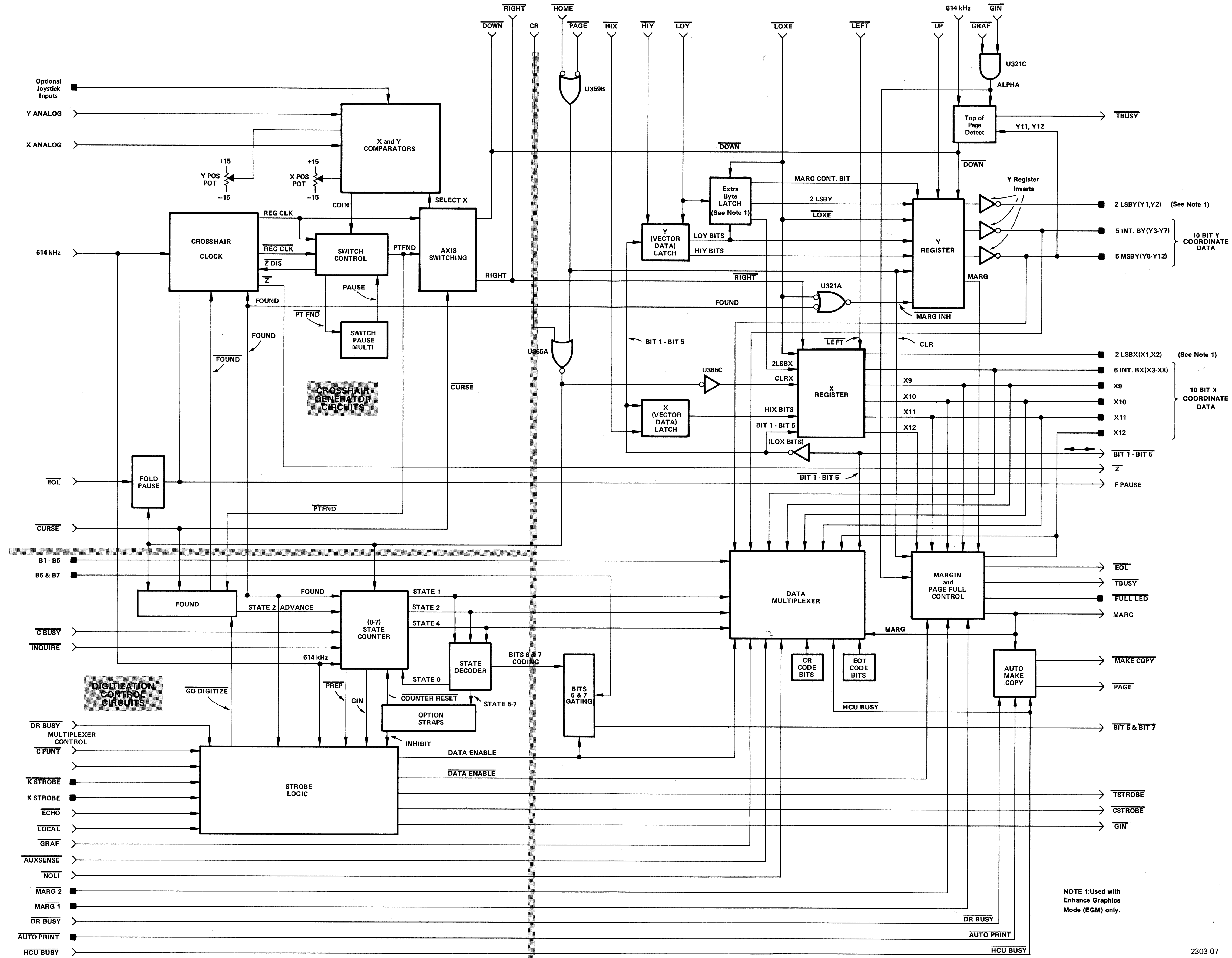
TC-1 BLOCK DIAGRAM

@

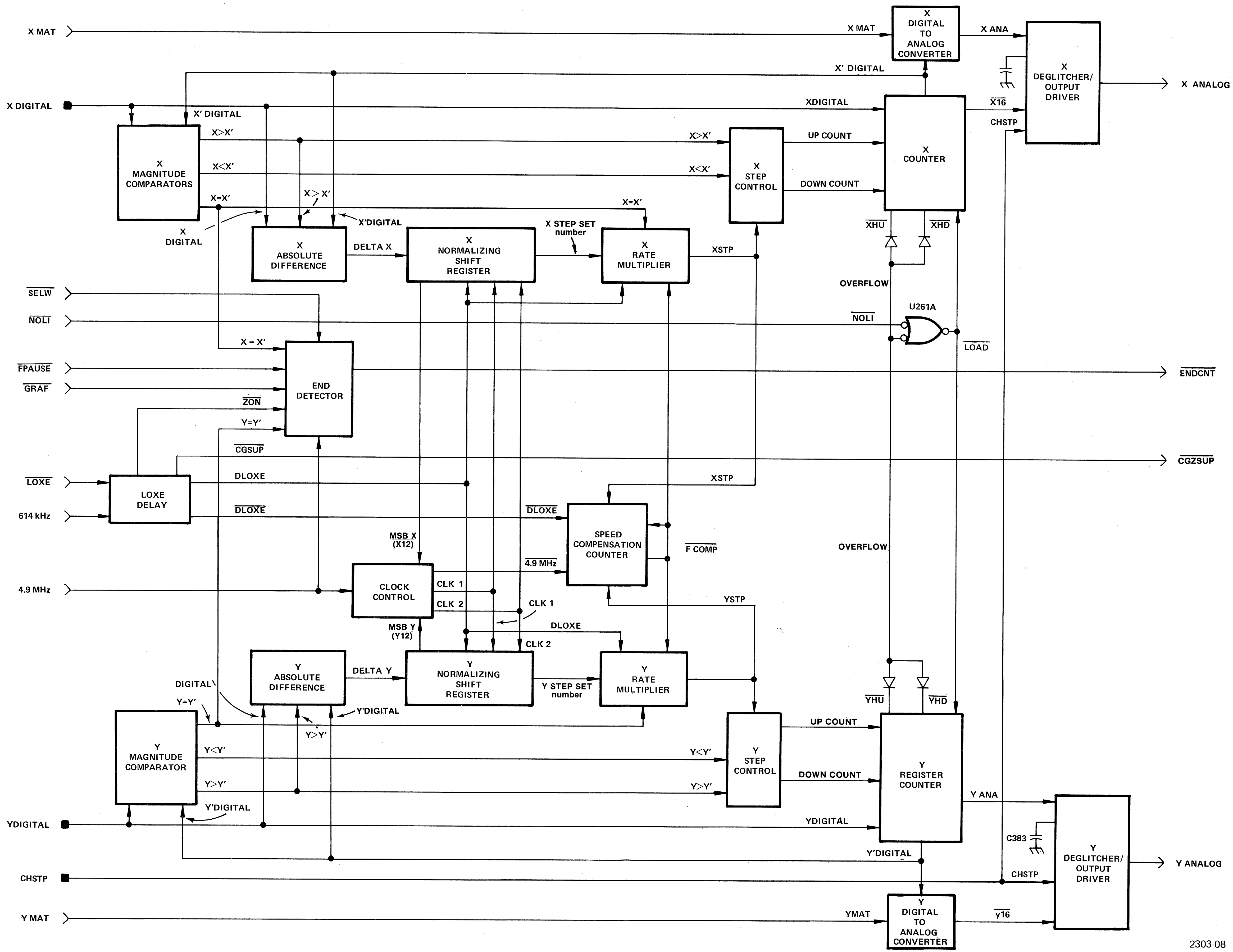


Character Generator Block Diagram

@



4014/4015 (SN B050000 & up) **TC-2 Block Diagram**

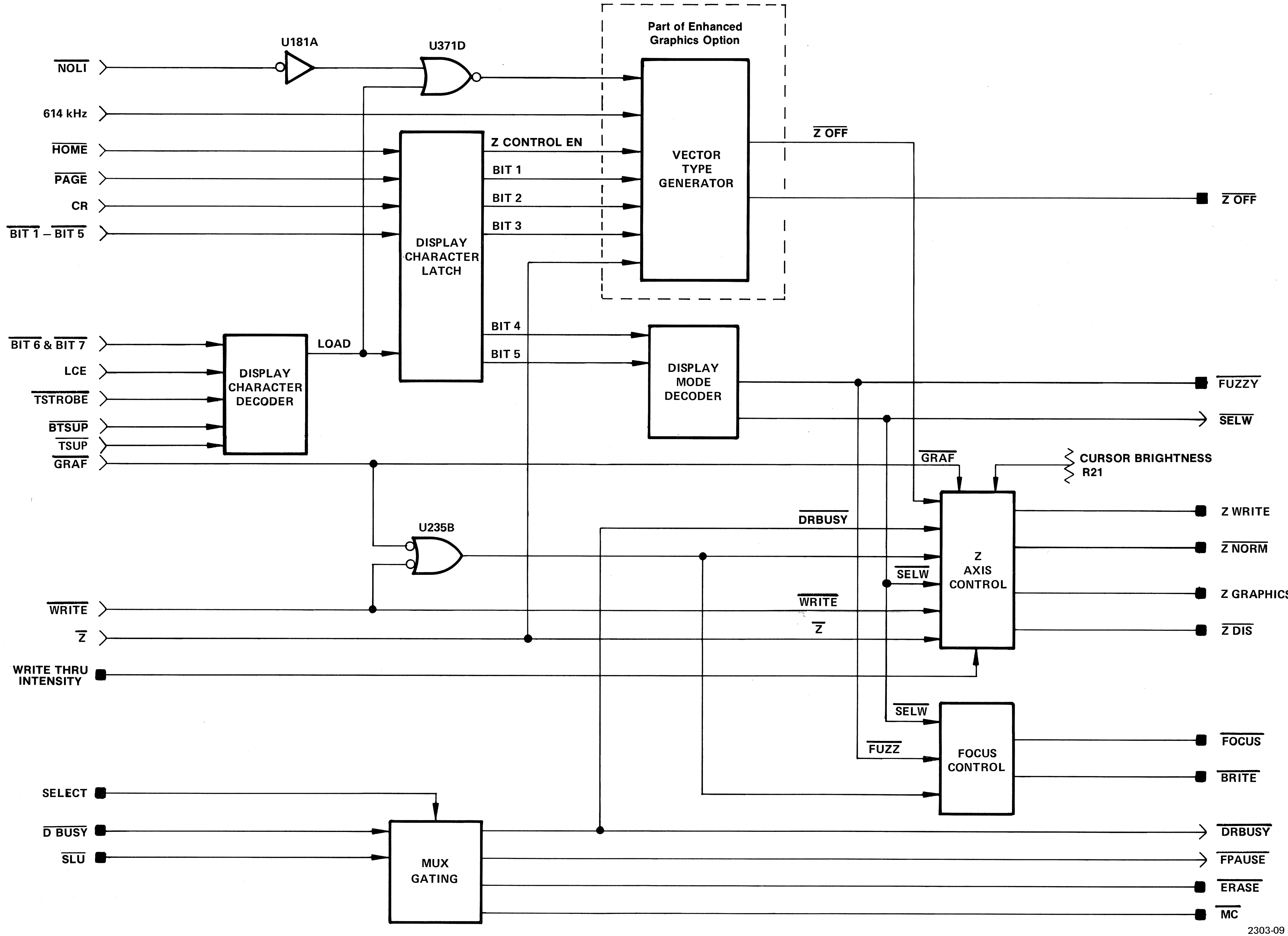


4014/4015 (SN B050000 & up)

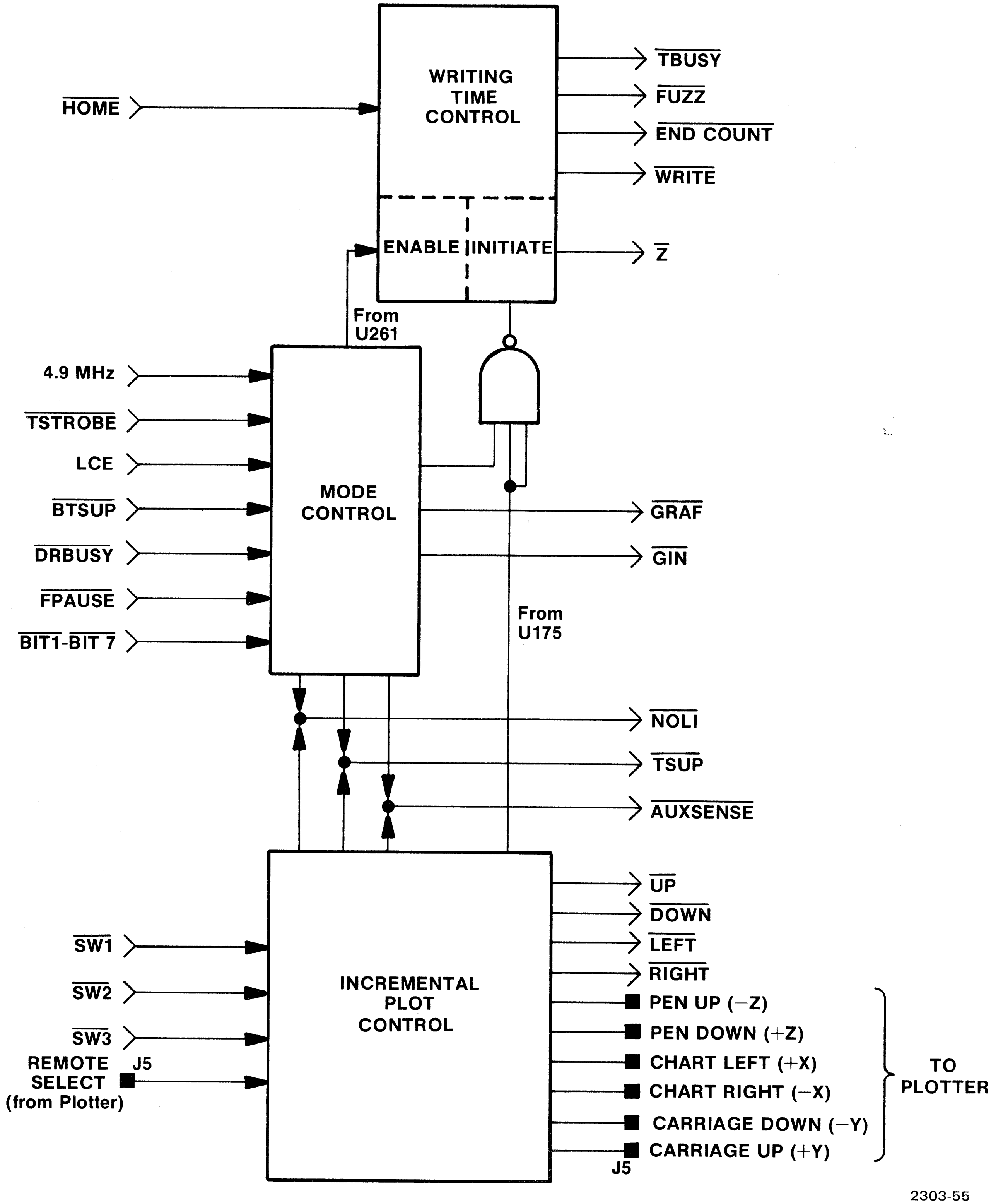
TC-3 Block Diagram

TC-3 BLOCK DIAGRAM

@

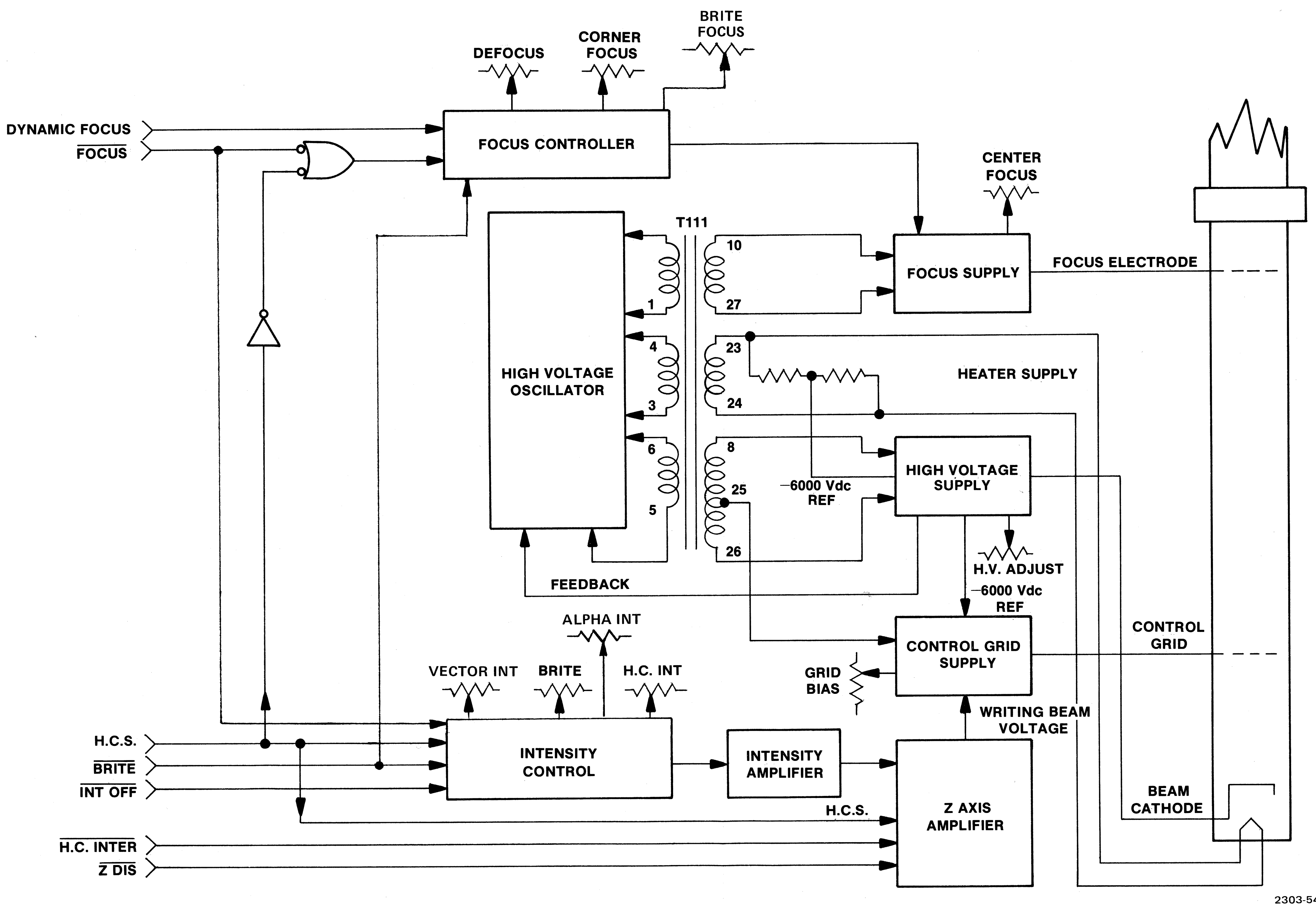


Display Control Card Block Diagram

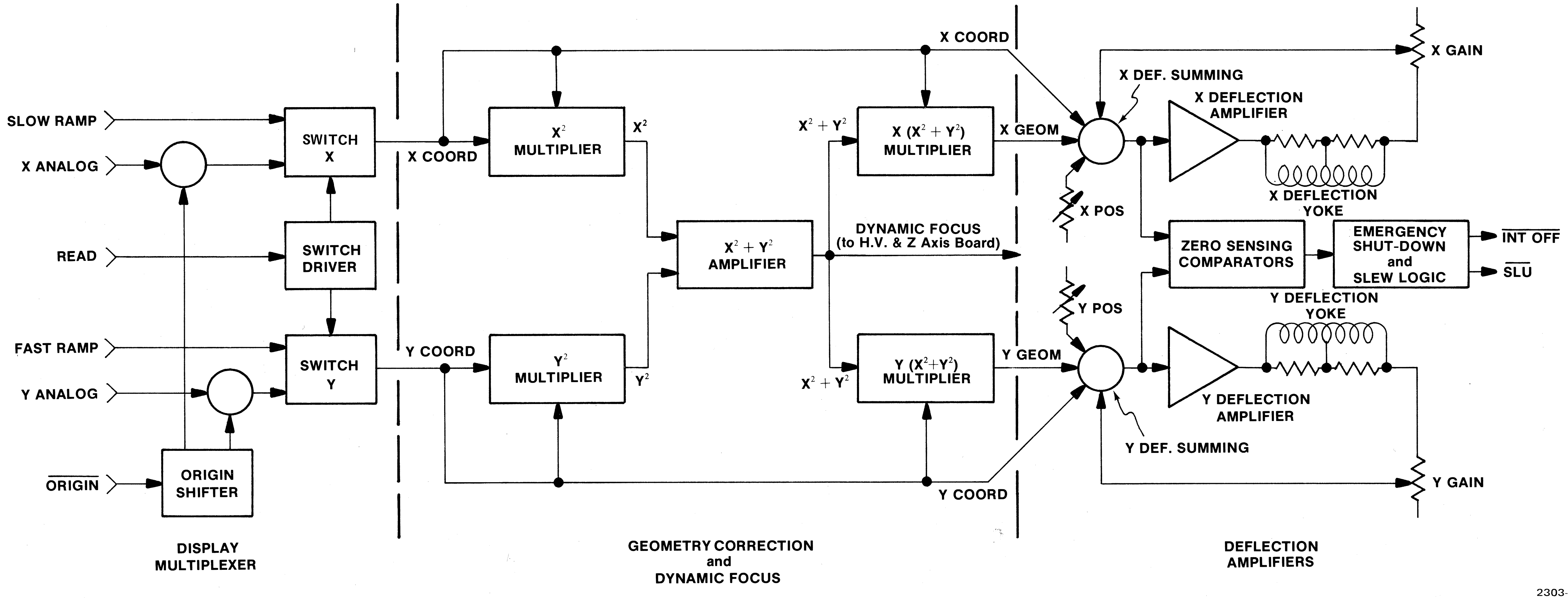


Discrete Plot Card Block Diagram.

@



High Voltage and Z Axis Board Block Diagram.

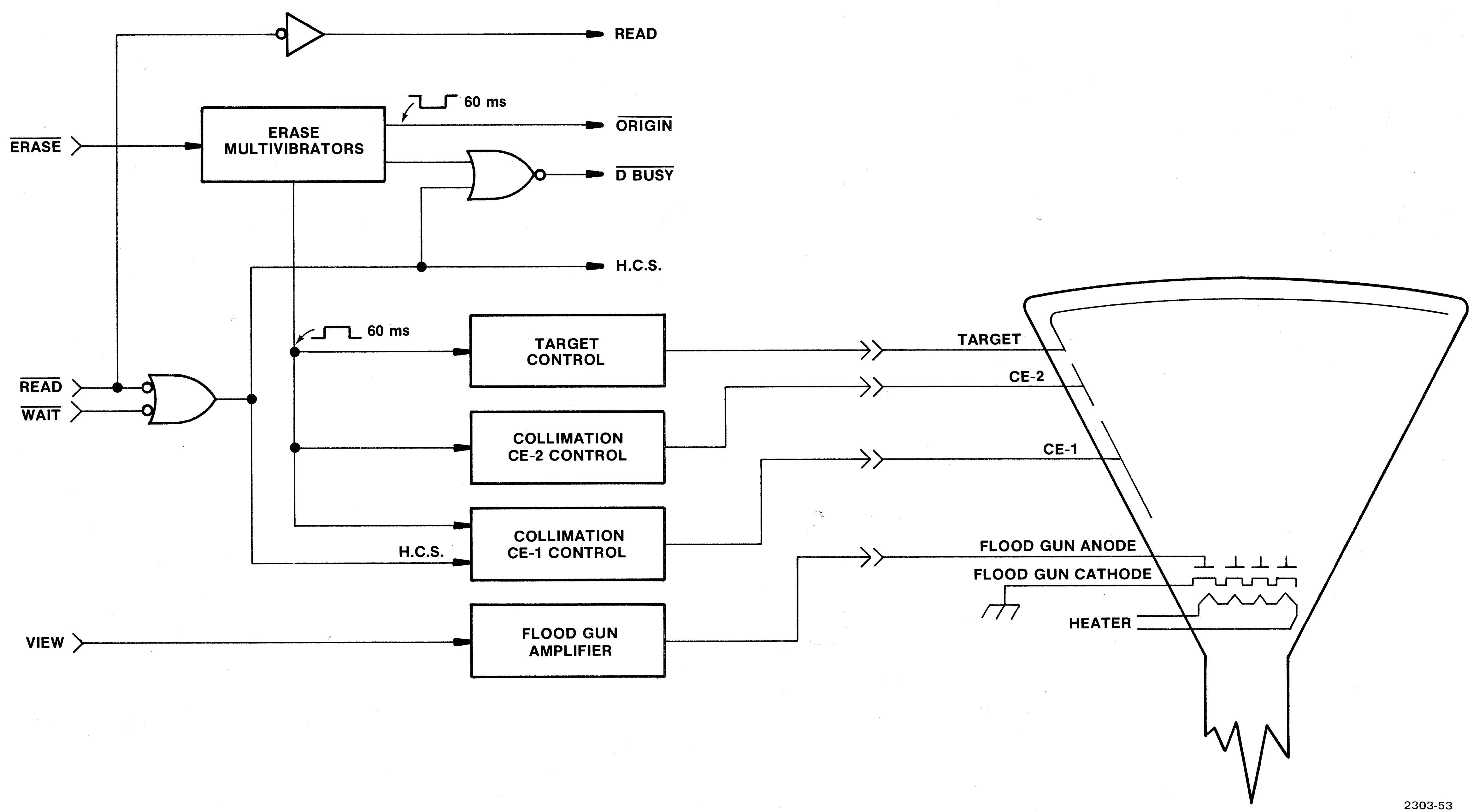


Deflection Amplifier Board Block Diagram.

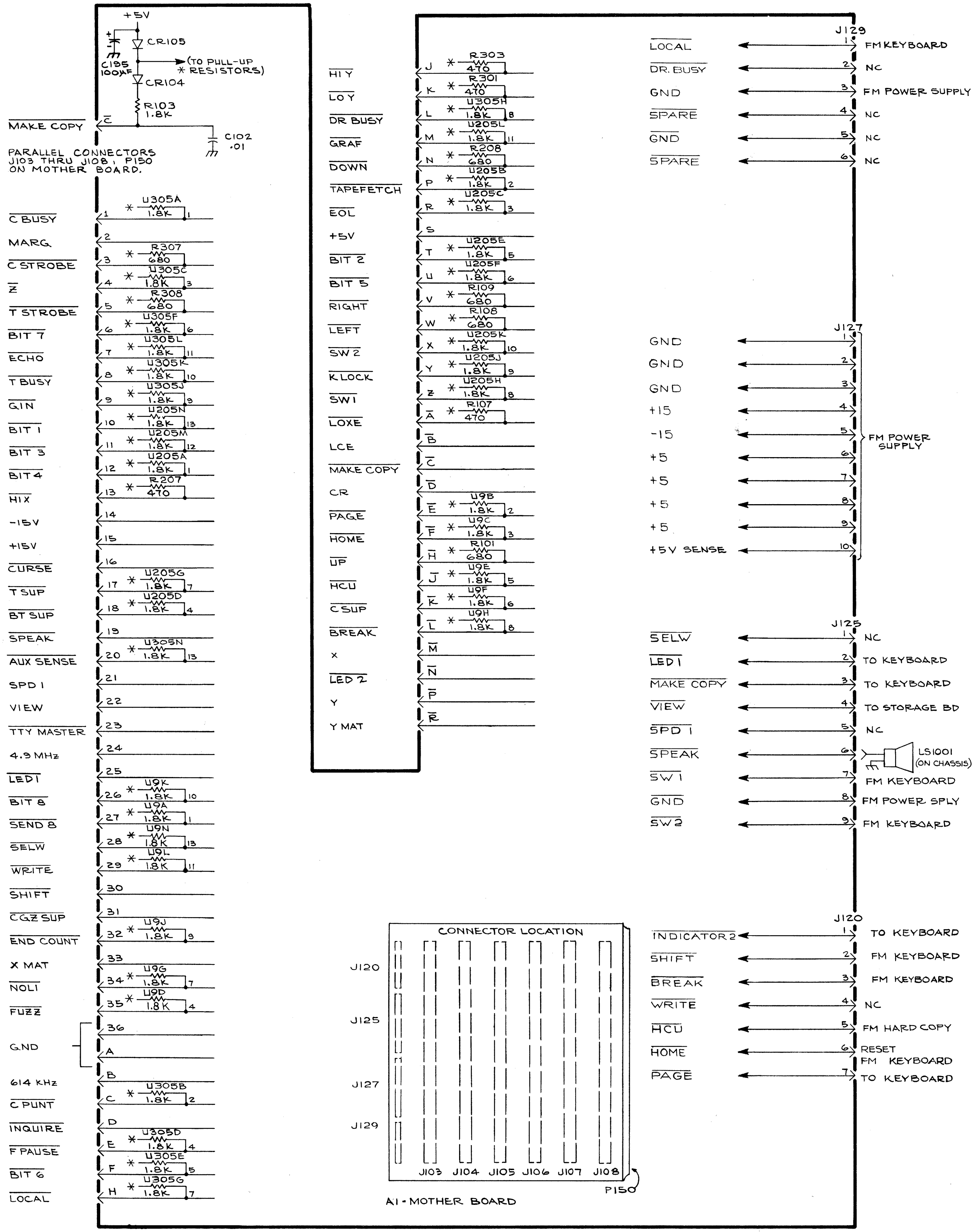
DEFLECTION AMPLIFIER BOARD BLOCK DIAGRAM

@

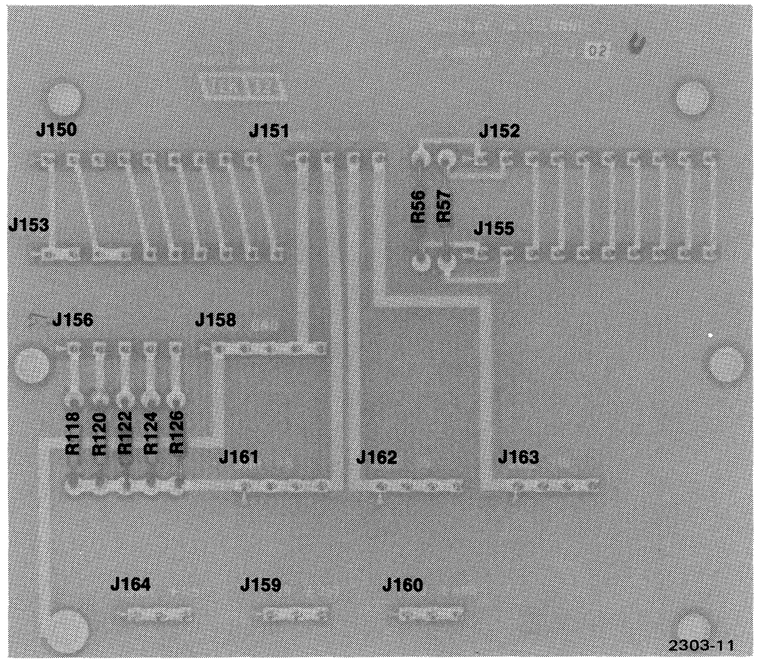
STORAGE BOARD
BLOCK DIAGRAM



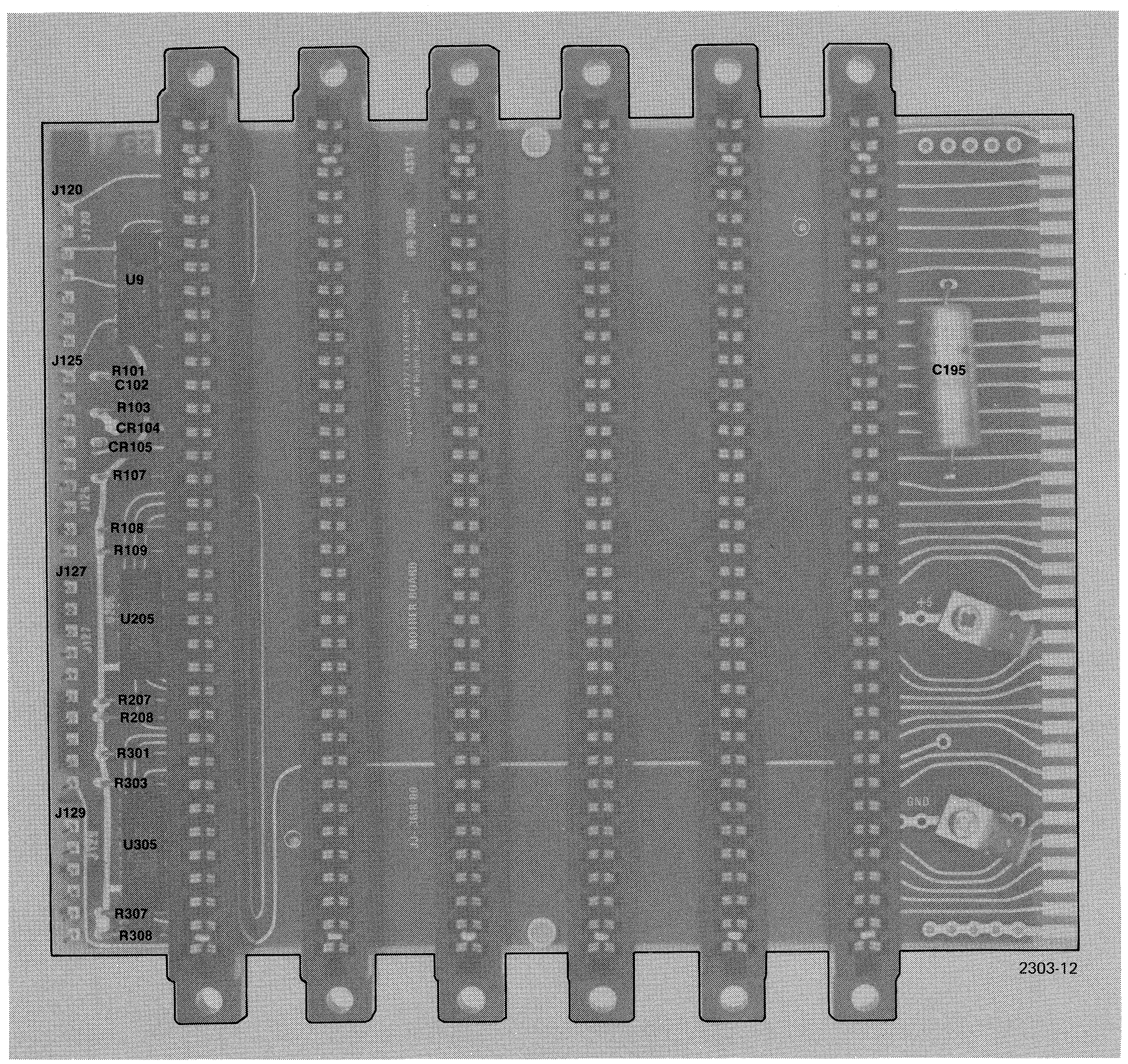
Storage Board Block Diagram.



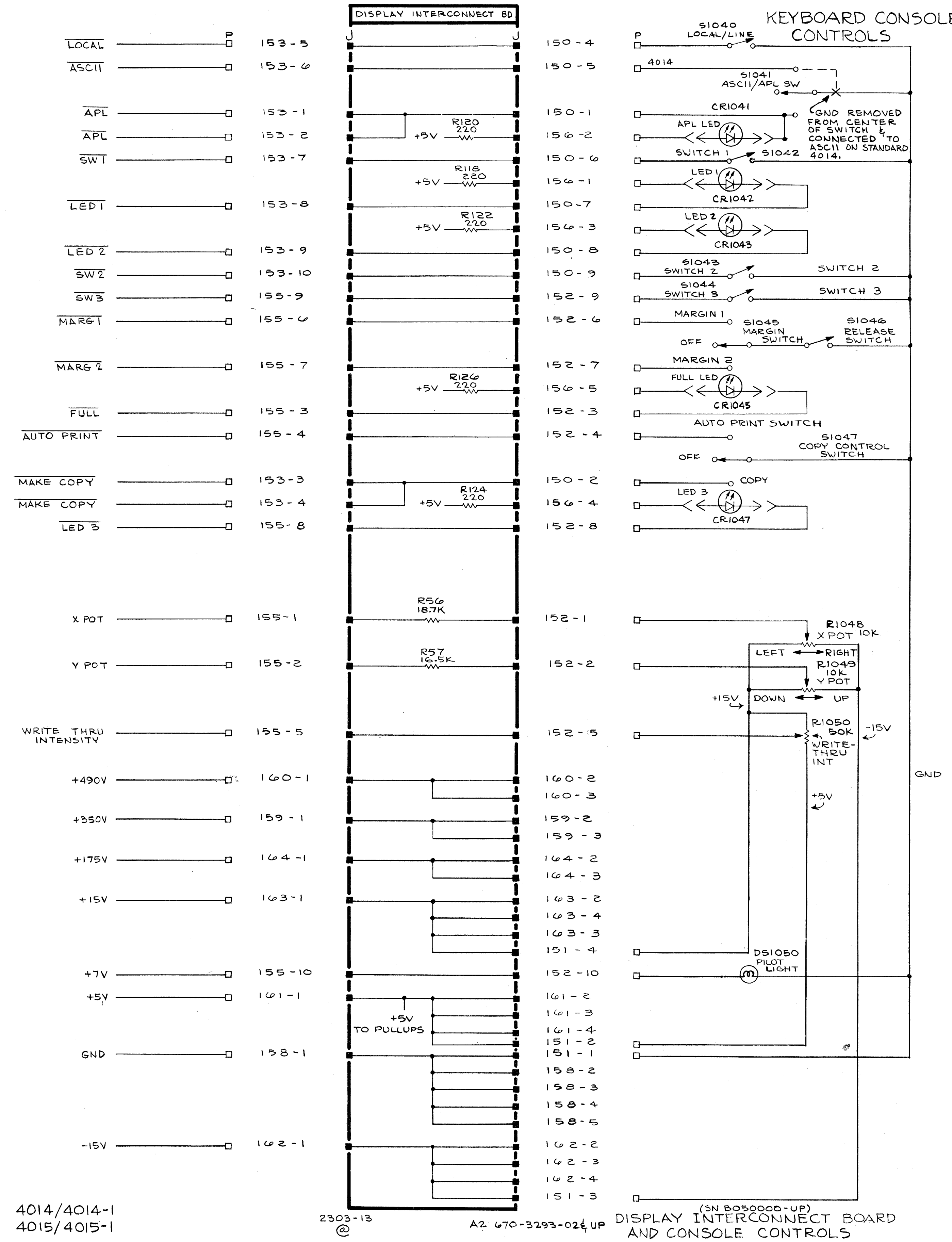
+5V
CR105
C195 100µF
(TO PULL-UP * RESISTORS)
CR104
R103 1.8K
MAKE COPY
C102 .01
PARALLEL CONNECTORS J103 THRU J108, P150 ON MOTHER BOARD.
C BUSY
MARG
C STROBE
Z
T STROBE
BIT 7
ECHO
T BUSY
GIN
BIT 1
BIT 3
BIT 4
HIX
-15V
+15V
CURSE
T SUP
BT SUP
SPEAK
AUX SENSE
SPD 1
VIEW
TTY MASTER
4.9 MHz
LED1
BIT 8
SEND 8
SELW
WRITE
SHIFT
CGZ SUP
END COUNT
X MAT
NOLI
FUZZ
GND
614 KHz
C PUNT
INQUIRE
F PAUSE
BIT 6
LOCAL
HI Y
LO Y
DR BUSY
GRAF
DOWN
TAPEFETCH
EOL
+5V
BIT 2
BIT 5
RIGHT
LEFT
SW 2
K LOCK
SW 1
LOXE
LCE
MAKE COPY
CR
PAGE
HOME
UP
HCU
C SUP
BREAK
X
LED 2
Y
Y MAT
J129
LOCAL
DR. BUSY
GND
SPARE
GND
SPARE
FM KEYBOARD
NC
FM POWER SUPPLY
NC
NC
NC
J127
GND
GND
GND
+15
-15
+5
+5
+5
+5
+5V SENSE
FM POWER SUPPLY
J125
SELW
LED 1
MAKE COPY
VIEW
SPD 1
SPEAK
SW 1
GND
SW 2
NC
TO KEYBOARD
TO KEYBOARD
TO STORAGE BD
NC
LS1001 (ON CHASSIS)
FM KEYBOARD
FM POWER SPLY
FM KEYBOARD
J120
INDICATOR 2
SHIFT
BREAK
WRITE
HCU
HOME
PAGE
TO KEYBOARD
FM KEYBOARD
FM KEYBOARD
NC
FM HARD COPY
RESET FM KEYBOARD
TO KEYBOARD
CONNECTOR LOCATION
J120
J125
J127
J129
J103 J104 J105 J106 J107 J108
P150
A1-MOTHER BOARD



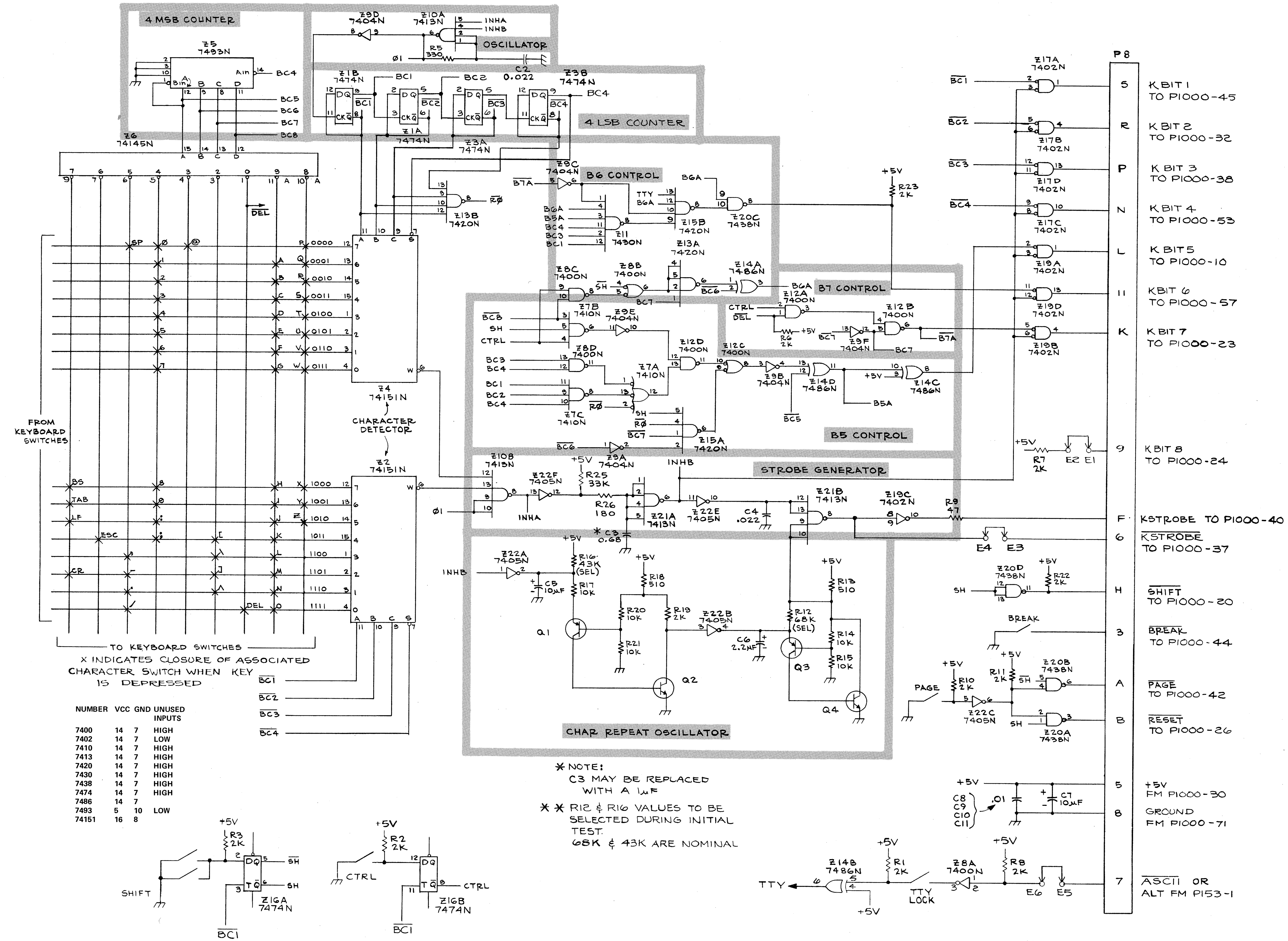
Display Interconnect Board Component Locations (670-3293-02 & up).



Mother Board Component Locations (670-3090-01).



MOTHERBOARD & DISPLAY INTERCONNECT
A1 670-3090-01 & A2 670-3293-02



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	

* NOTE:
C3 MAY BE REPLACED WITH A 1µF

** R12 & R16 VALUES TO BE SELECTED DURING INITIAL TEST.
68K & 43K ARE NOMINAL

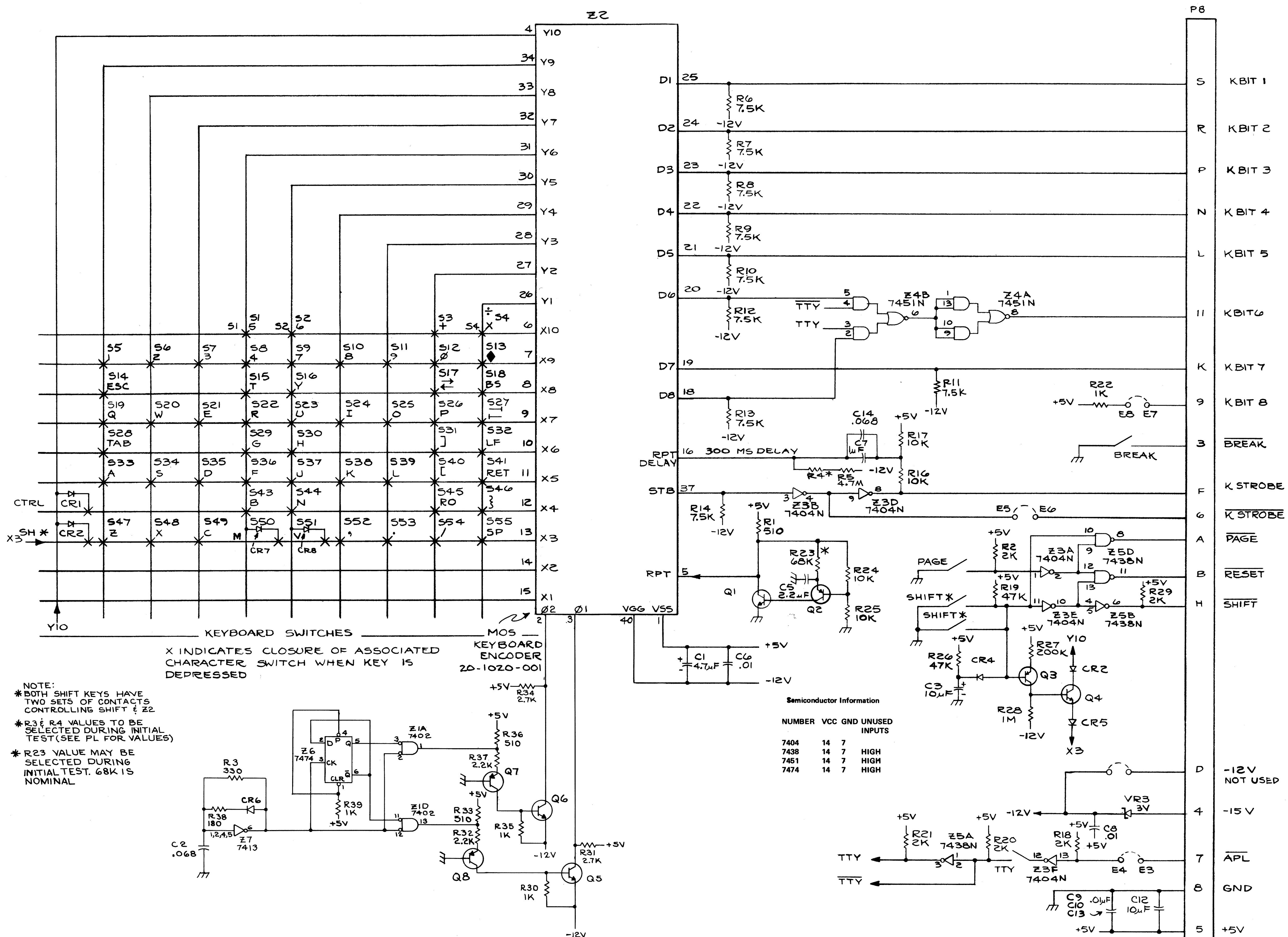
KEY TRONIC CORP.

(SN B050000-UP)

A3 119-0483-02 4014 AND 4014-1 KEYBOARD

2303-14

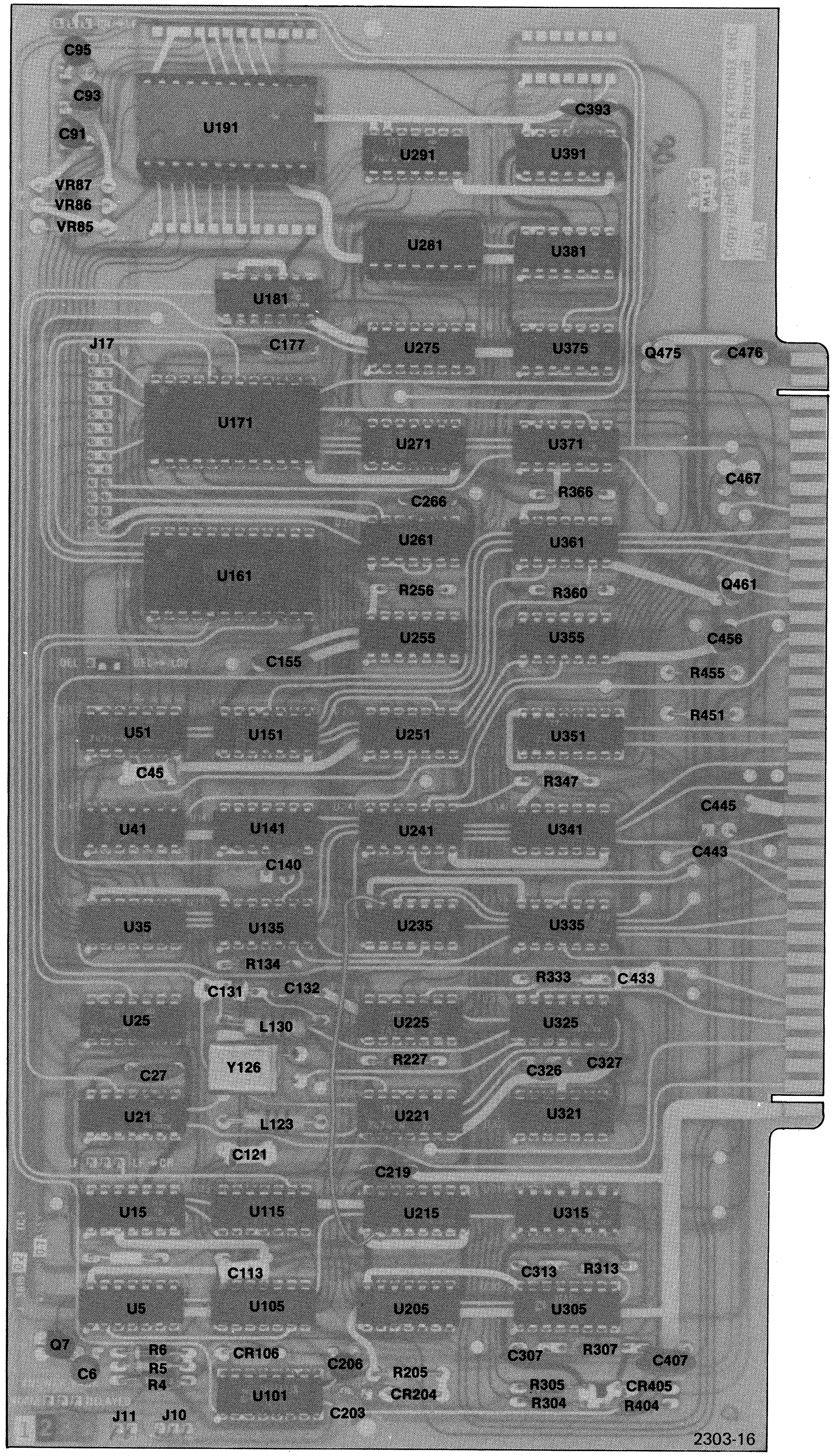
4014/4014-1
4015/4015-1



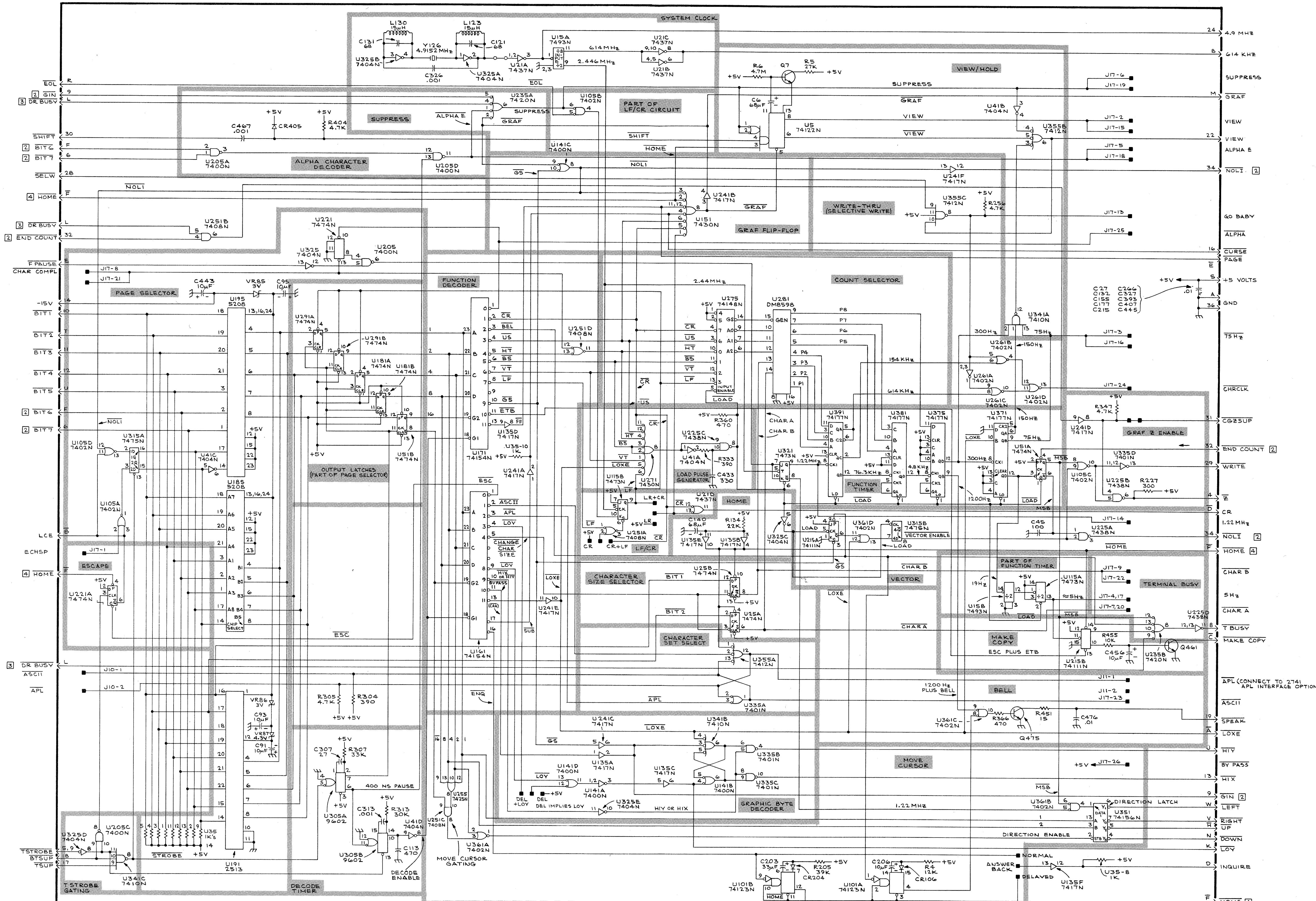
4014/4014-1
4015/4015-1

2303-15
@

(SN B050000-UP)
A3 119-0488-02 4015 AND 4015-1 KEYBOARD



TC-1 (670-3091-07) Component Locations.



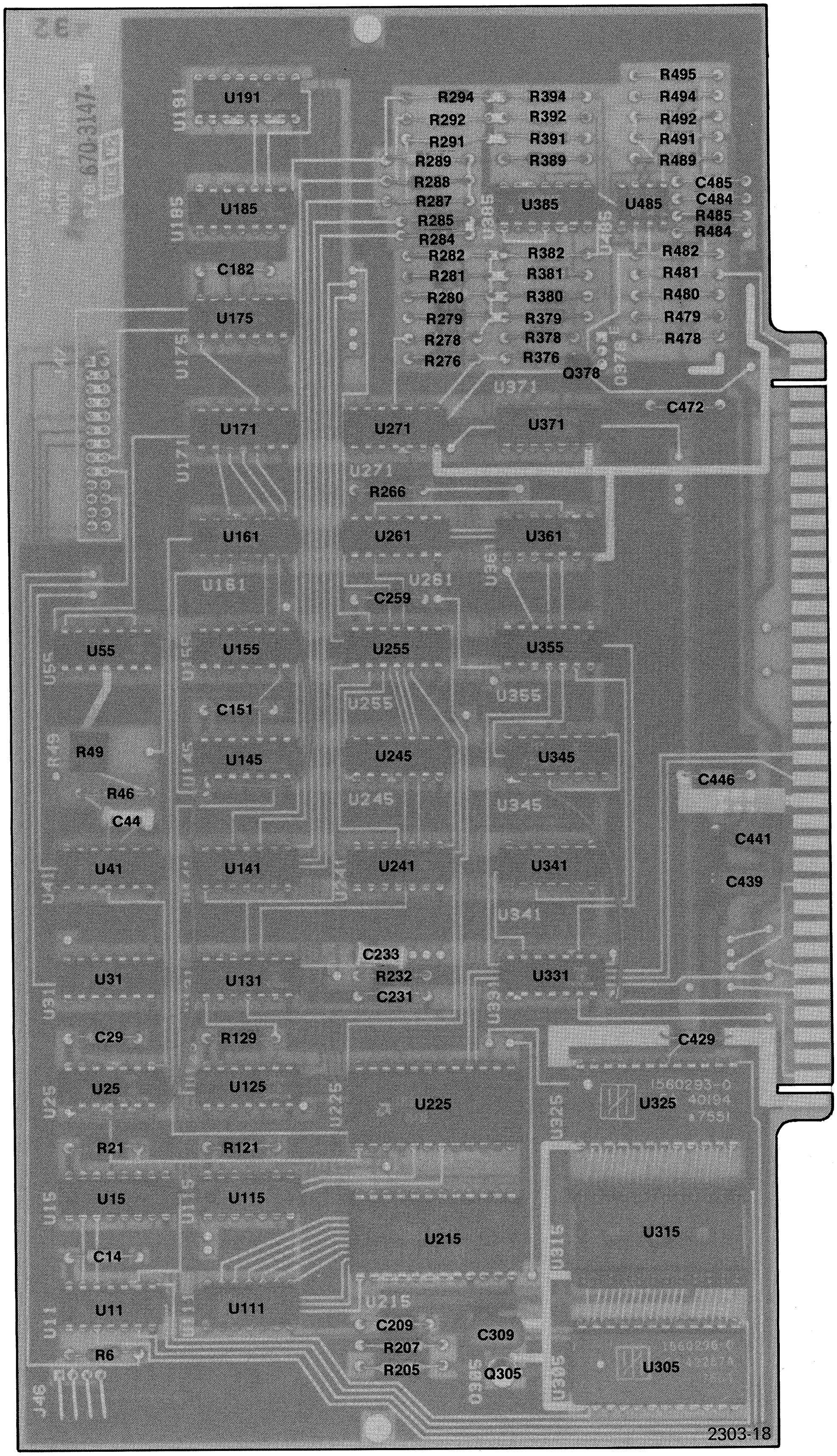
4014/4014-1
4015/4015-1

□ APPEARS MORE THAN ONCE

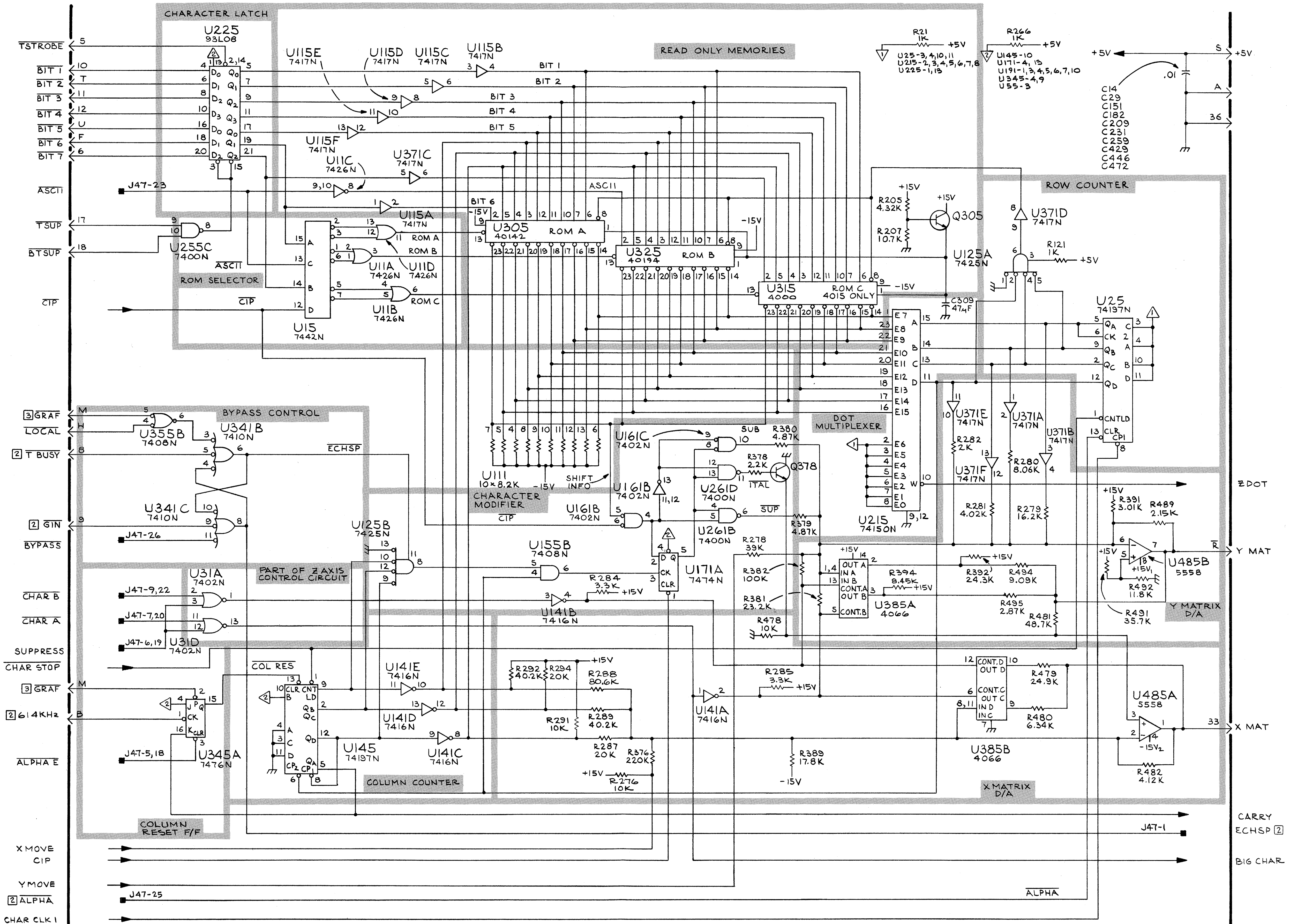
2303-17

(SN B050000-UP)
A4 670-3091-07 TC-1

1075
RHL



Character Generator Component Locations—
670-3147-02 (4014/4014-1) and 670-3336-02 (4015/4015-1).



☐ APPEARS MORE THAN ONCE.

4014/4014-1
4015/4015-1

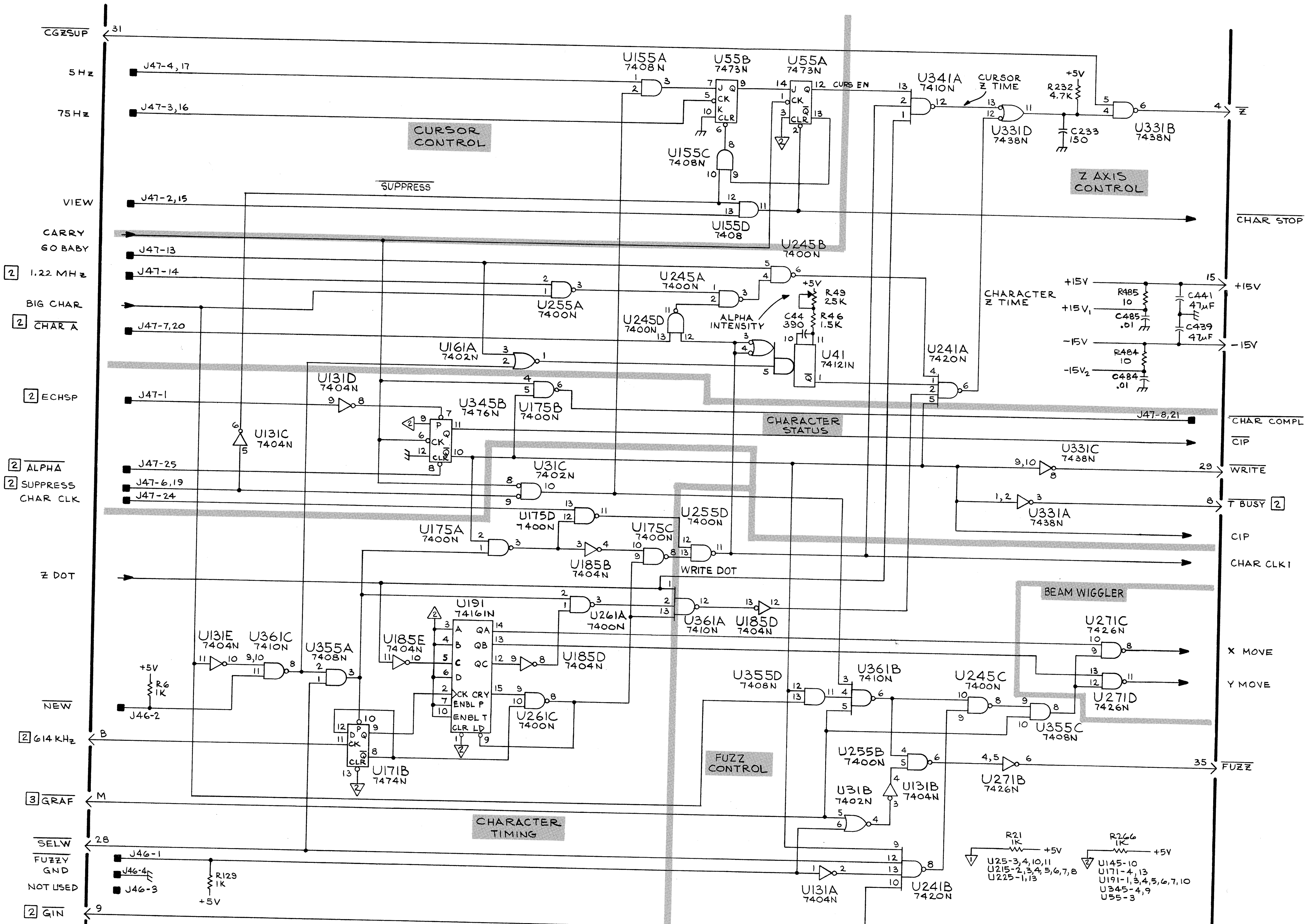
2303-19
REV A, MAR 1979

(4014/4014-1 ONLY) A5 670-3147-02 (SN B050000-UP)
(4015/4015-1 ONLY) A5 670-3336-02

CHARACTER GENERATOR

R.W.
SHEET 1 OF 2

CHARACTER GENERATOR
SHEET 1 OF 2



☐ APPEARS MORE THAN ONCE.

4014/4014-1
4015/4015-1

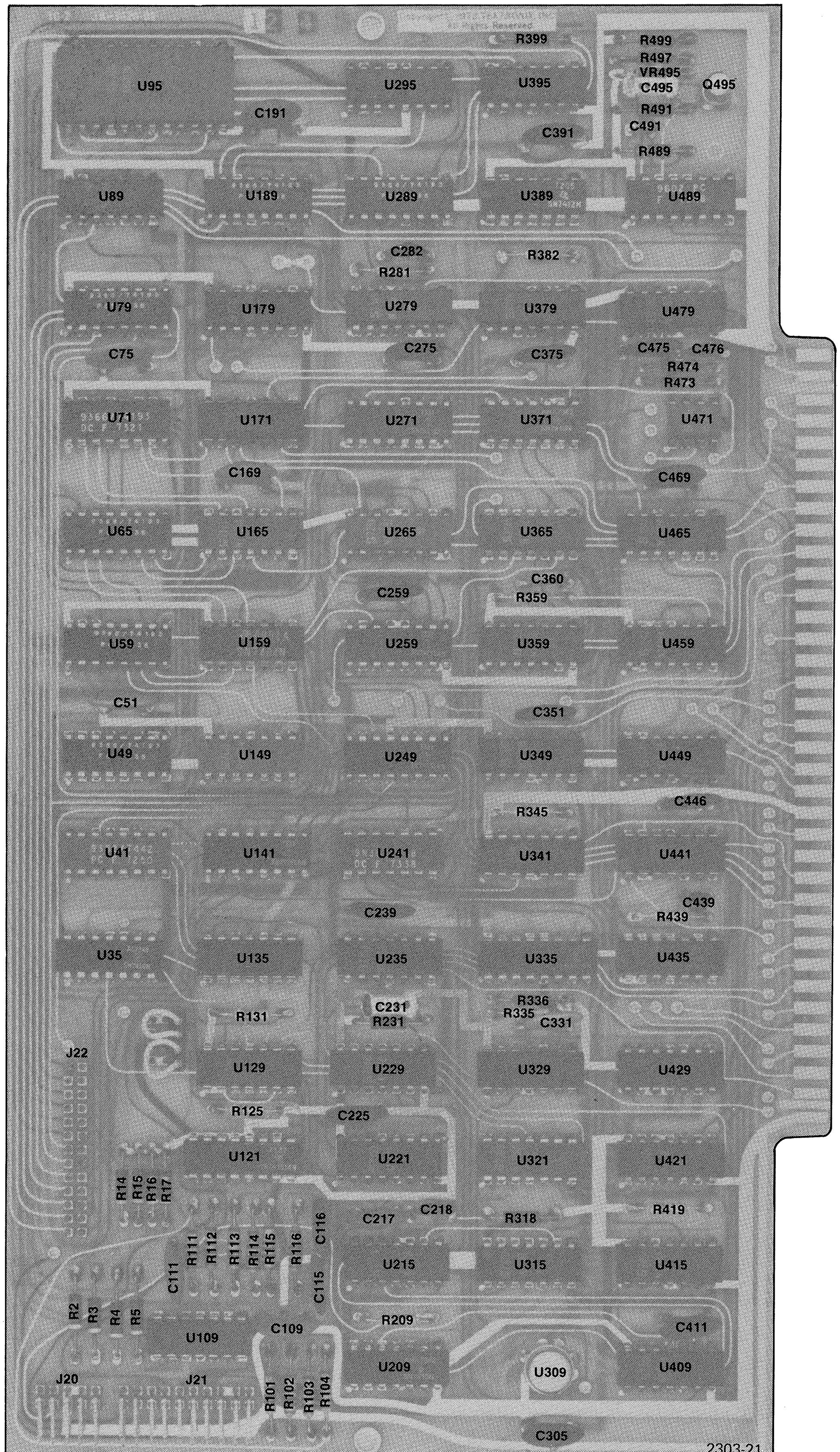
2303-20
REV A, MAR 1979

(4014/4014-1 ONLY) A5 670-3147-02
(4015/4015-1 ONLY) A5 670-3336-02

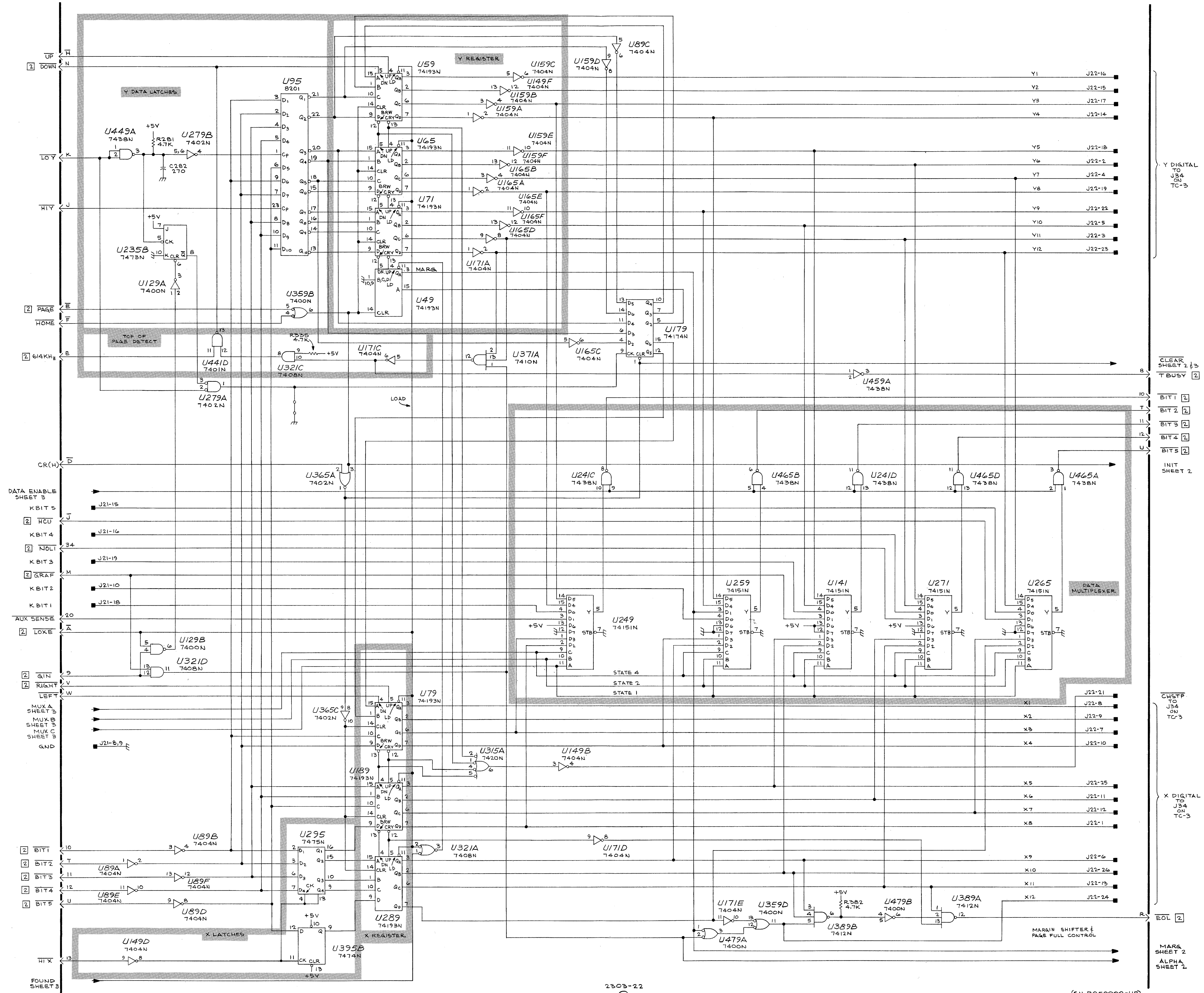
(SN B050000-UP)
CHARACTER GENERATOR

R.W.

SHEET 2 OF 2



TC-2 (670-3092-05) Component Locations.

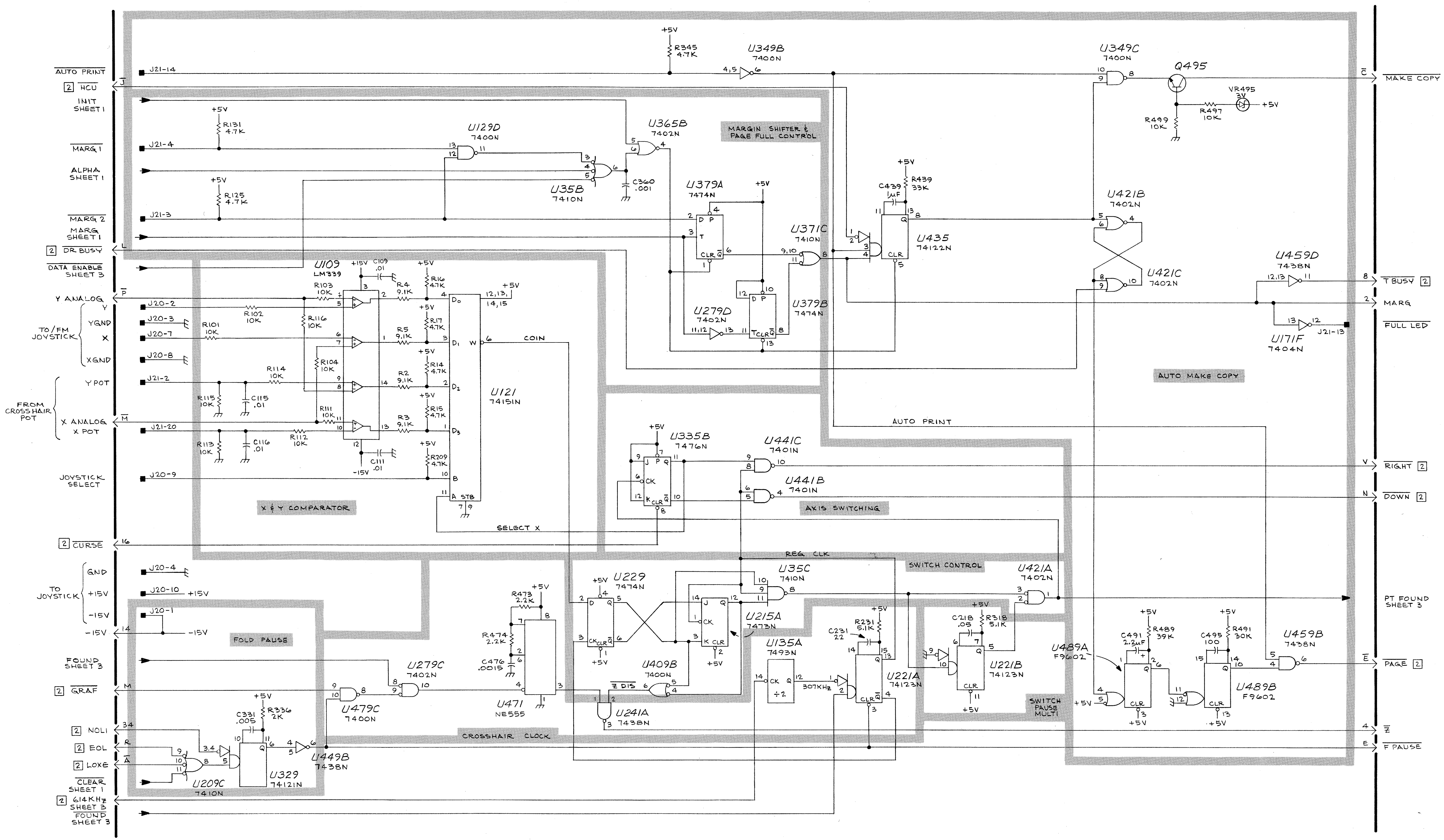


TC-2 SCHEMATIC SHEET 1 OF 3

4014/4014-1
4015/4015-1

2303-22

(SN B050000-UP)
A6 670-3092-05 TC-2 SHEET 1 OF 3

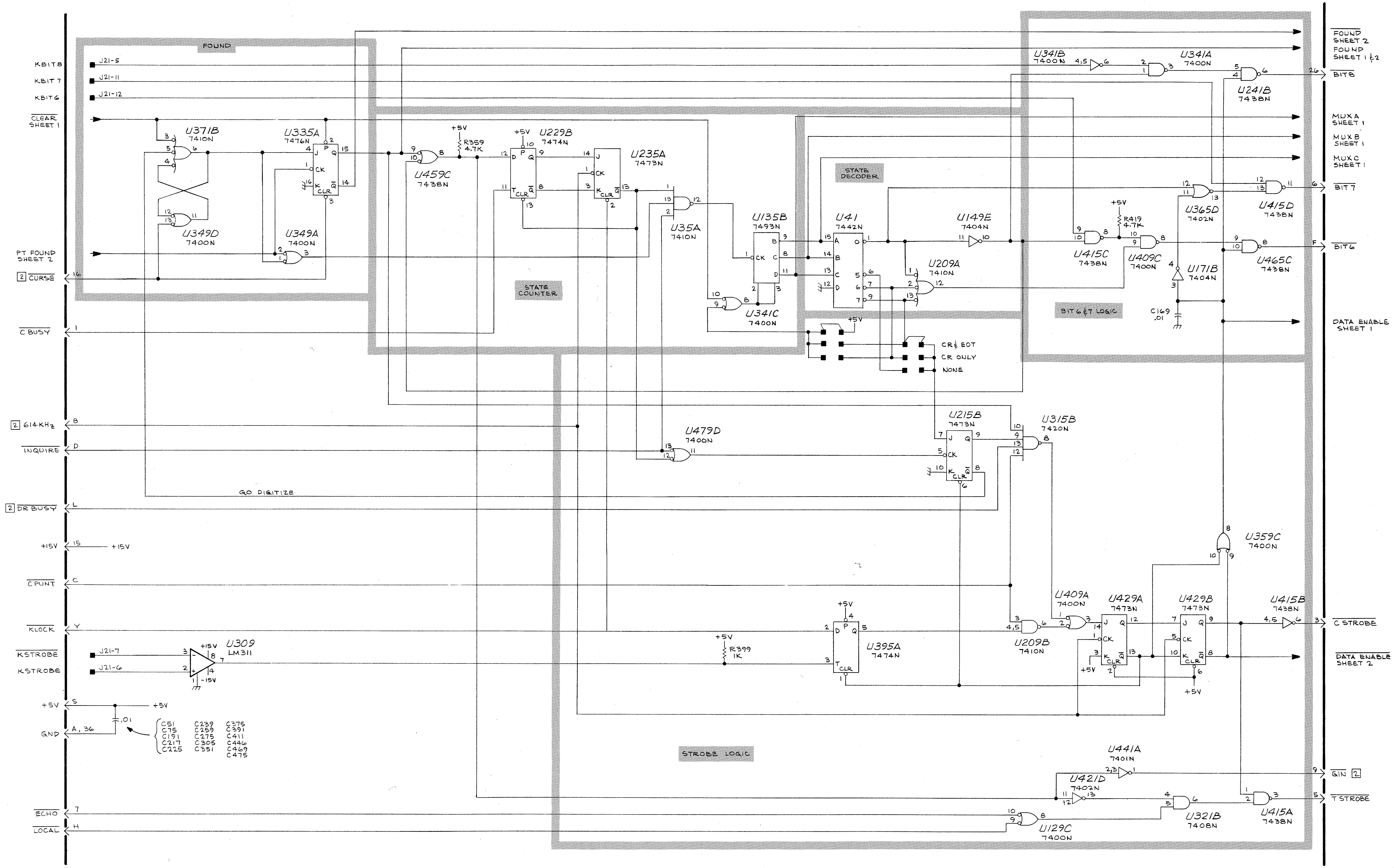


4014/4014-1
4015/4015-1

2303-23
REV A, MAR 1979

(SN B050000-UP)
A6 670-3092-05 TC-2 SHEET 2 OF 3

TC-2 SCHEMATIC
SHEET 2 OF 3

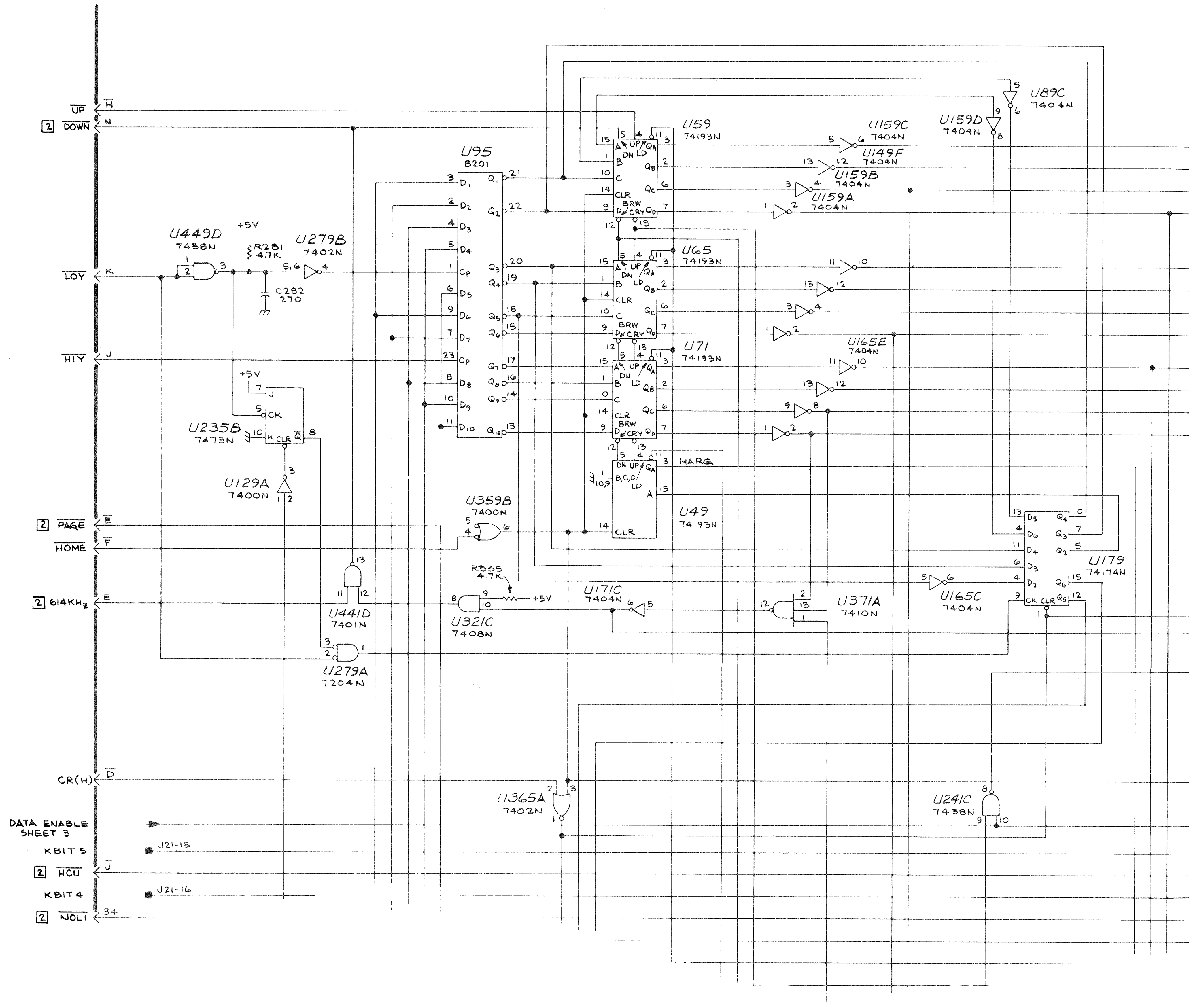


4014/4014-1
4015/4015-1

2303-24

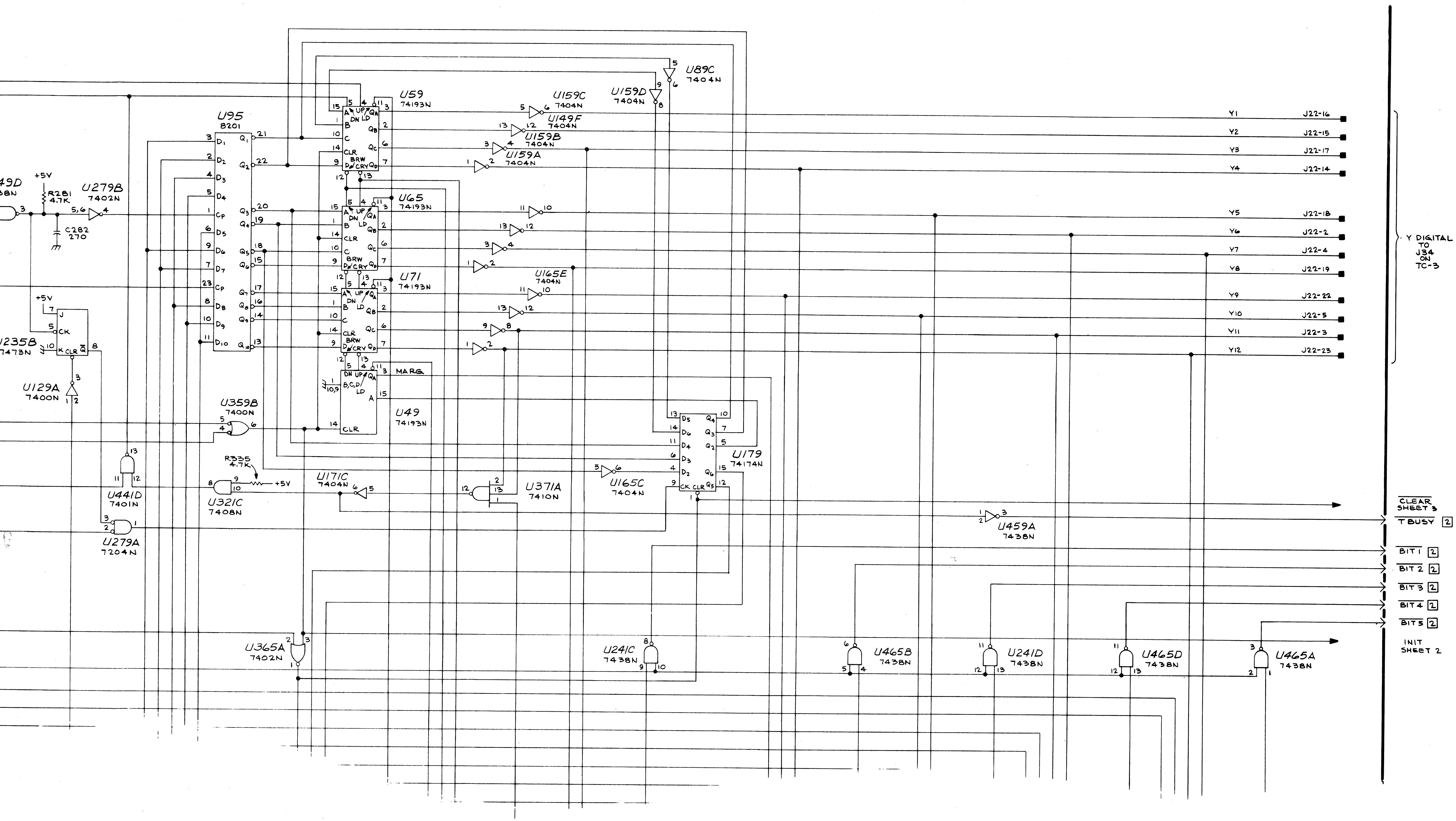
(SN B050000-UP)
A6 670-3092-05 TC-2 SHEET 3 OF 3

TC-2 SCHEMATIC
SHEET 3 OF 3



4014/4014-1
4015/4015-1

(2303)2303-25
@



NOTE: PARTIAL TC-2 (670-3559-05) SHOWING THE EXTRA BYTE LATCH USED WITH THE ENHANCED GRAPHICS MODULE - OPTION 34. OTHER CIRCUITS ARE THE SAME AS TC-2 (670-3092-05).

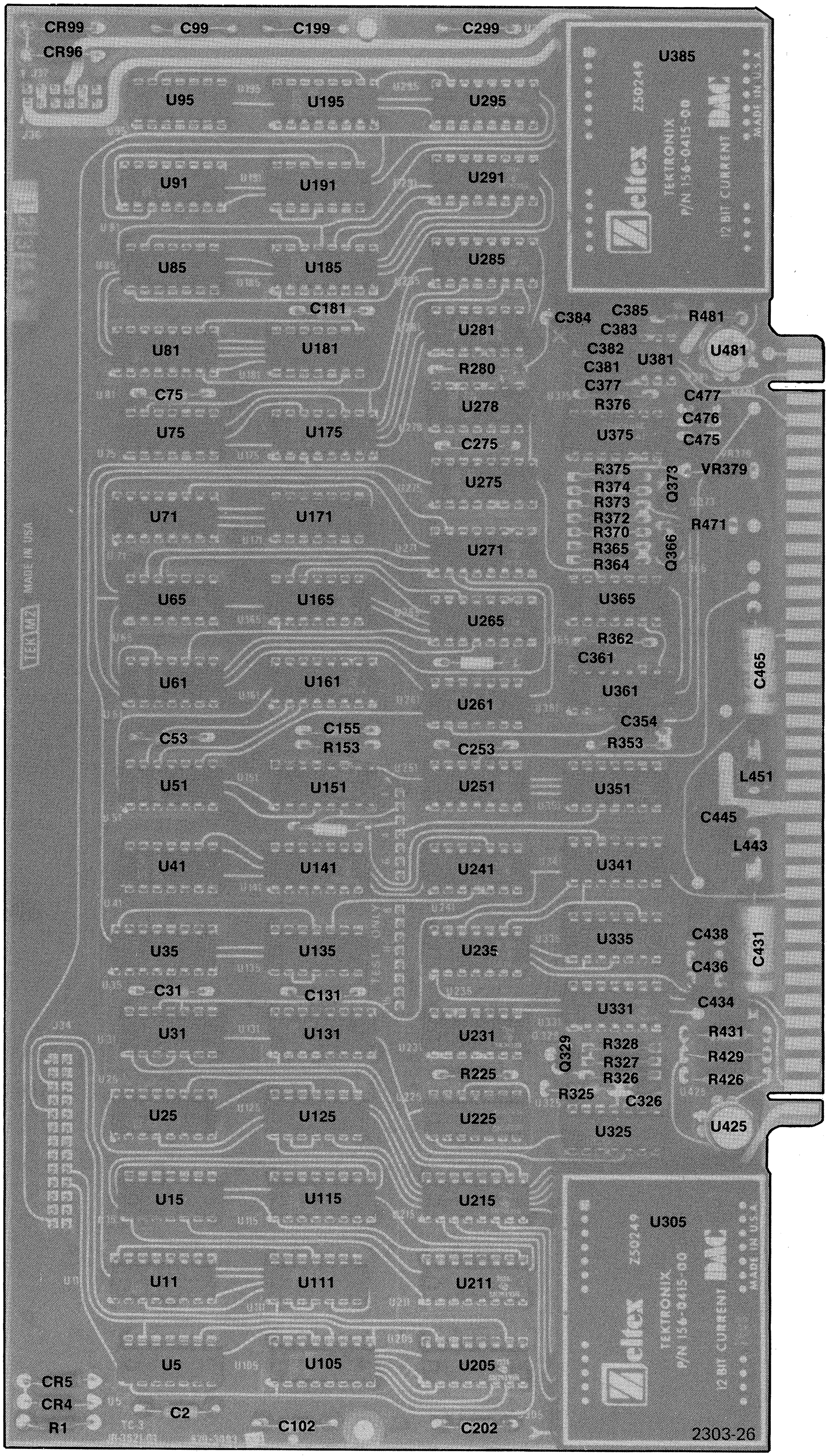
(2303) 2303-25

@

(SN B050000-UP)

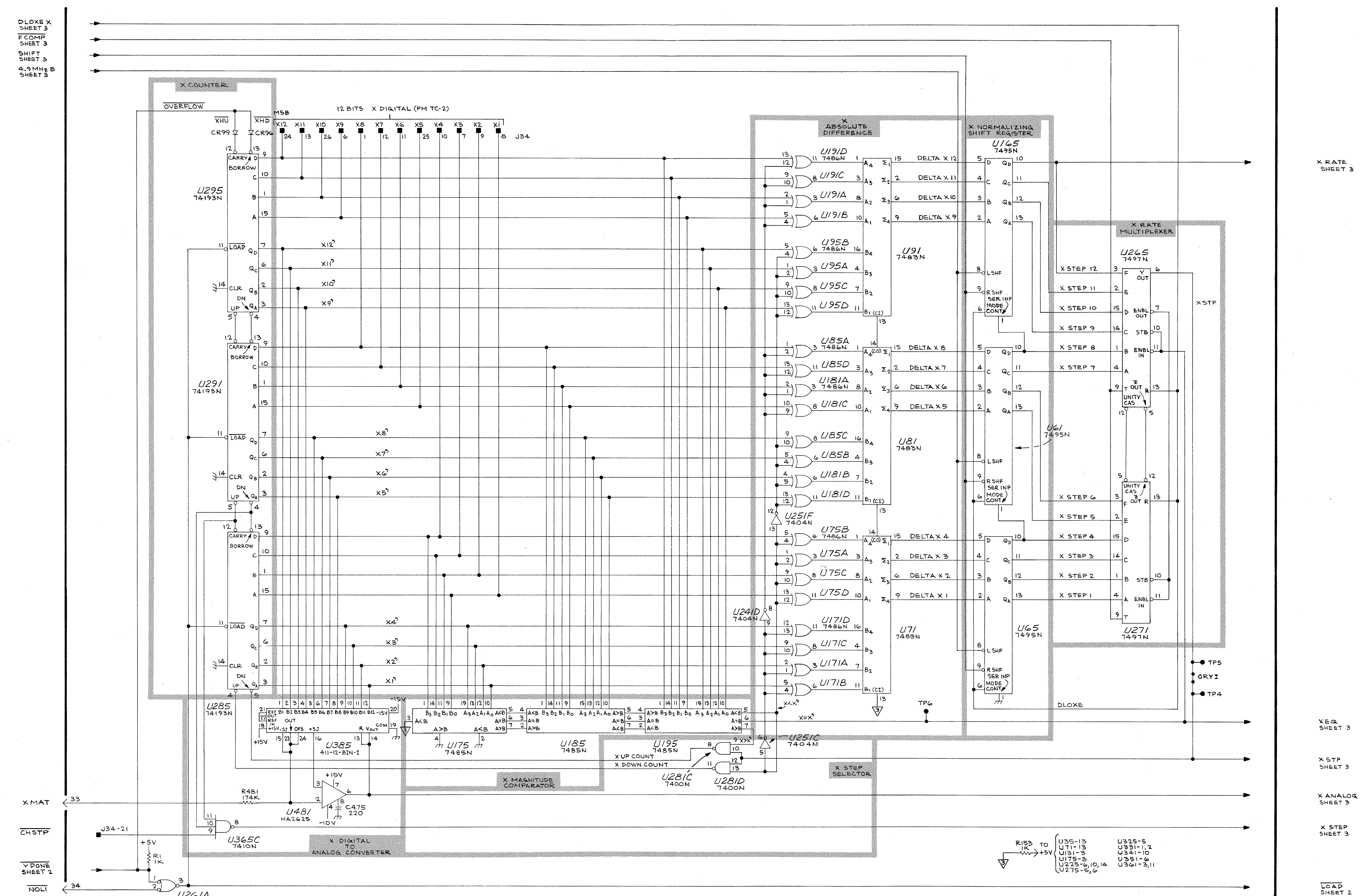
A6 670-3559-05 PARTIAL TC-2 OPTION 34 ONLY

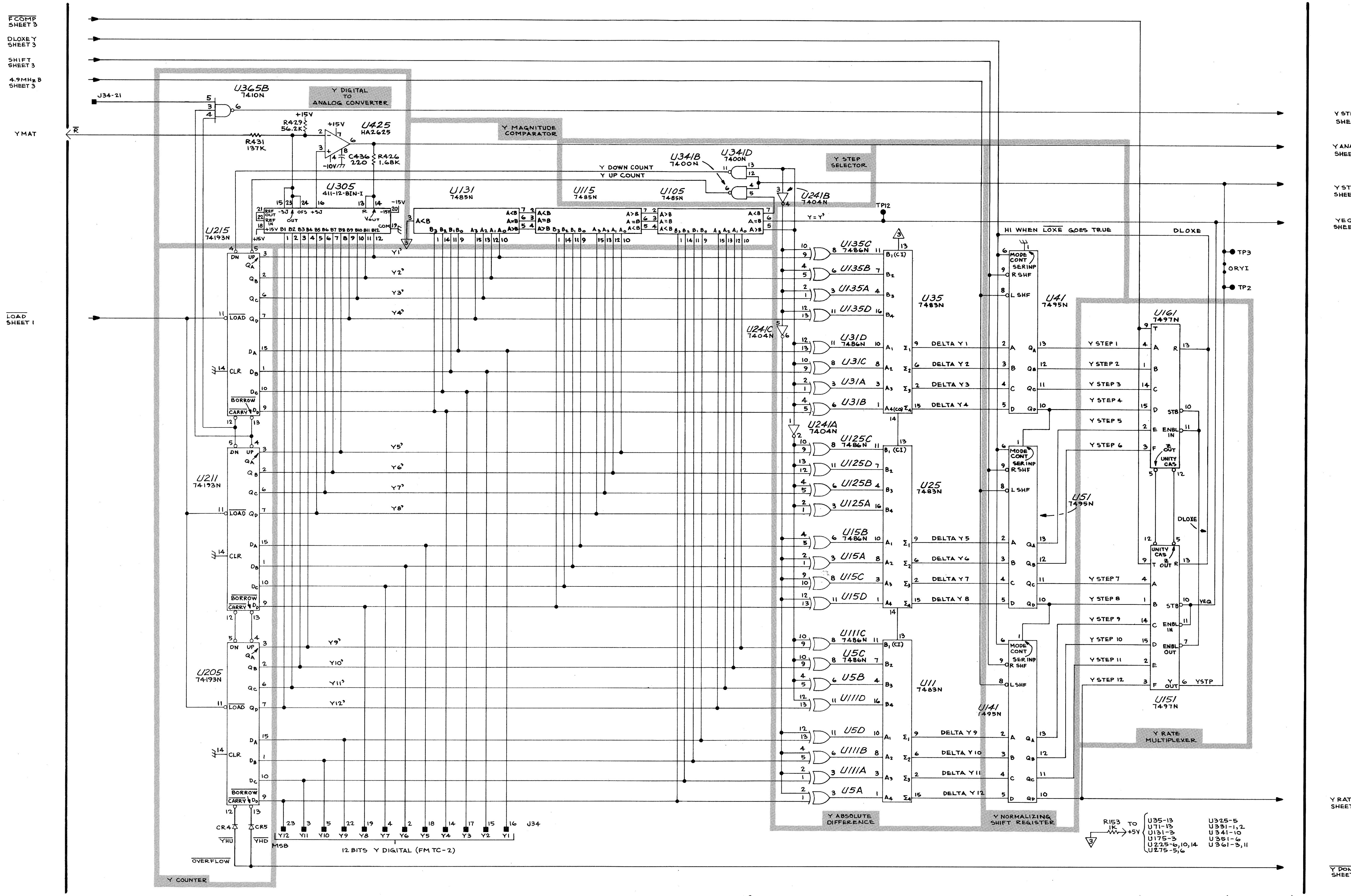
PARTIAL TC-2 (OPTION 34 ONLY)
670-3559-05



TC-3 (670-3093-03 & up) Component Locations.

TC-3 SCHEMATIC
SHEET 1 OF 3





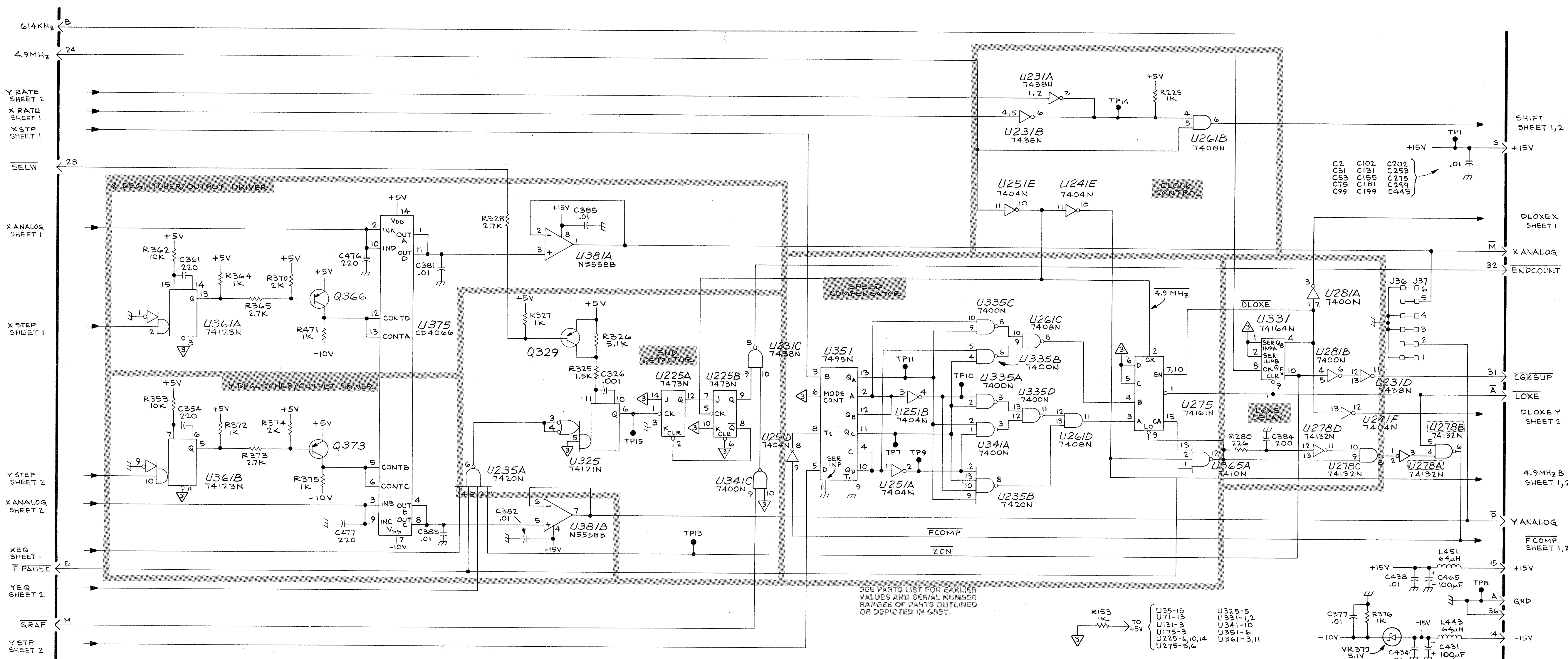
TC-3 SCHEMATIC
SHEET 2 OF 3

4014/4014-1
4015/4015-1

2303-28

(SN B050000-UP)

A7 670-3093-03 & UP TC-3 SHEET 2 OF 3

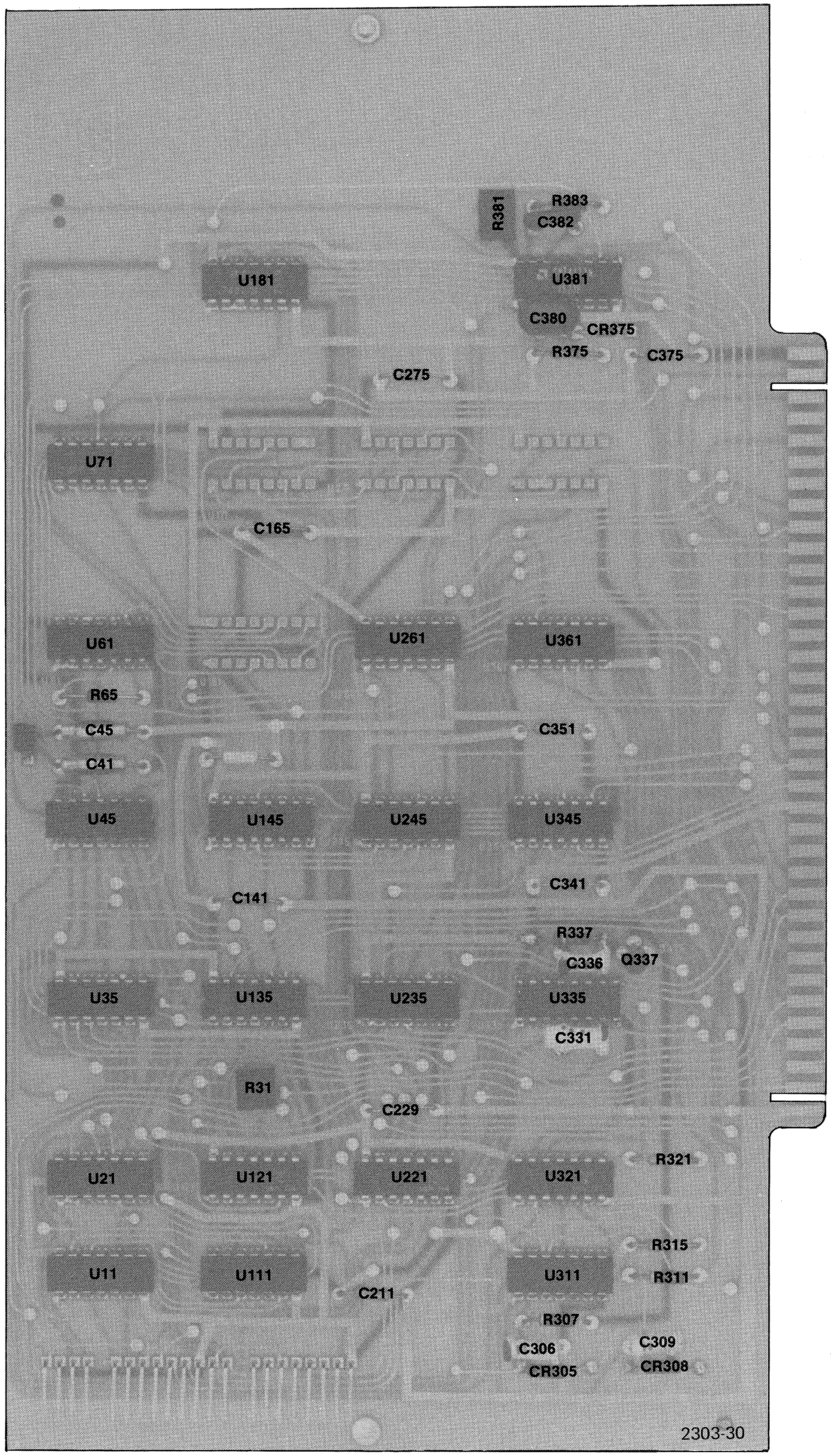


TC-3 SCHEMATIC
SHEET 3 OF 3

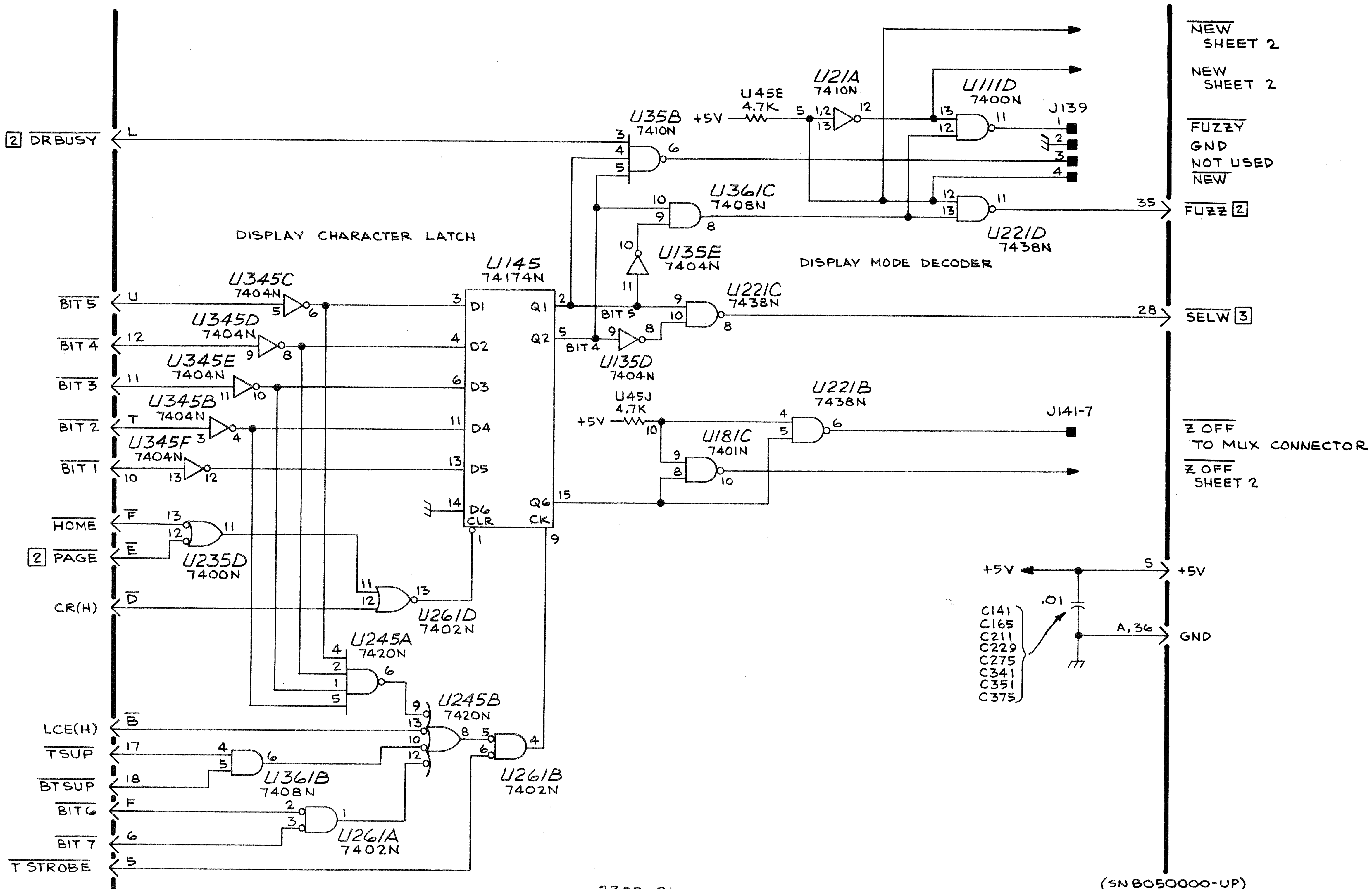
4014/4014-1
4015/4015-1

2303-29

(SN B050000-UP)
A7 670-3033-03 & UP TC-3 SHEET 3 OF 3



Display Control Card (670-3294-04) Component Locations



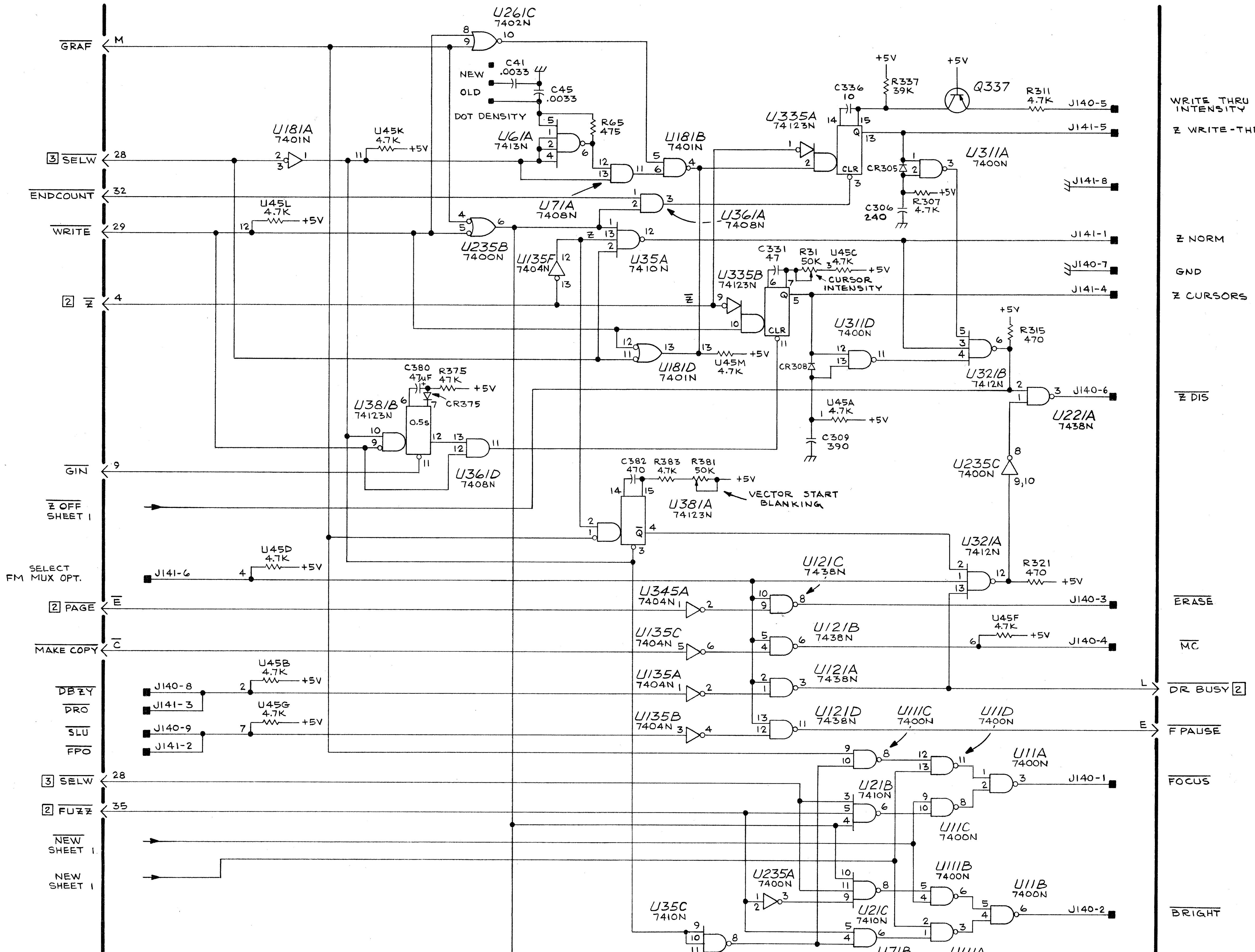
4014/4014-1
4015/4015-1

2303-31

(SN B050000-UP)
A8 670-3294-04 STANDARD DISPLAY CONTROL CARD
(WITHOUT ENHANCED GRAPHIC CAPABILITY)

SHEET 1 OF 2

DISPLAY CONTROL CARD SHEET 1 OF 2



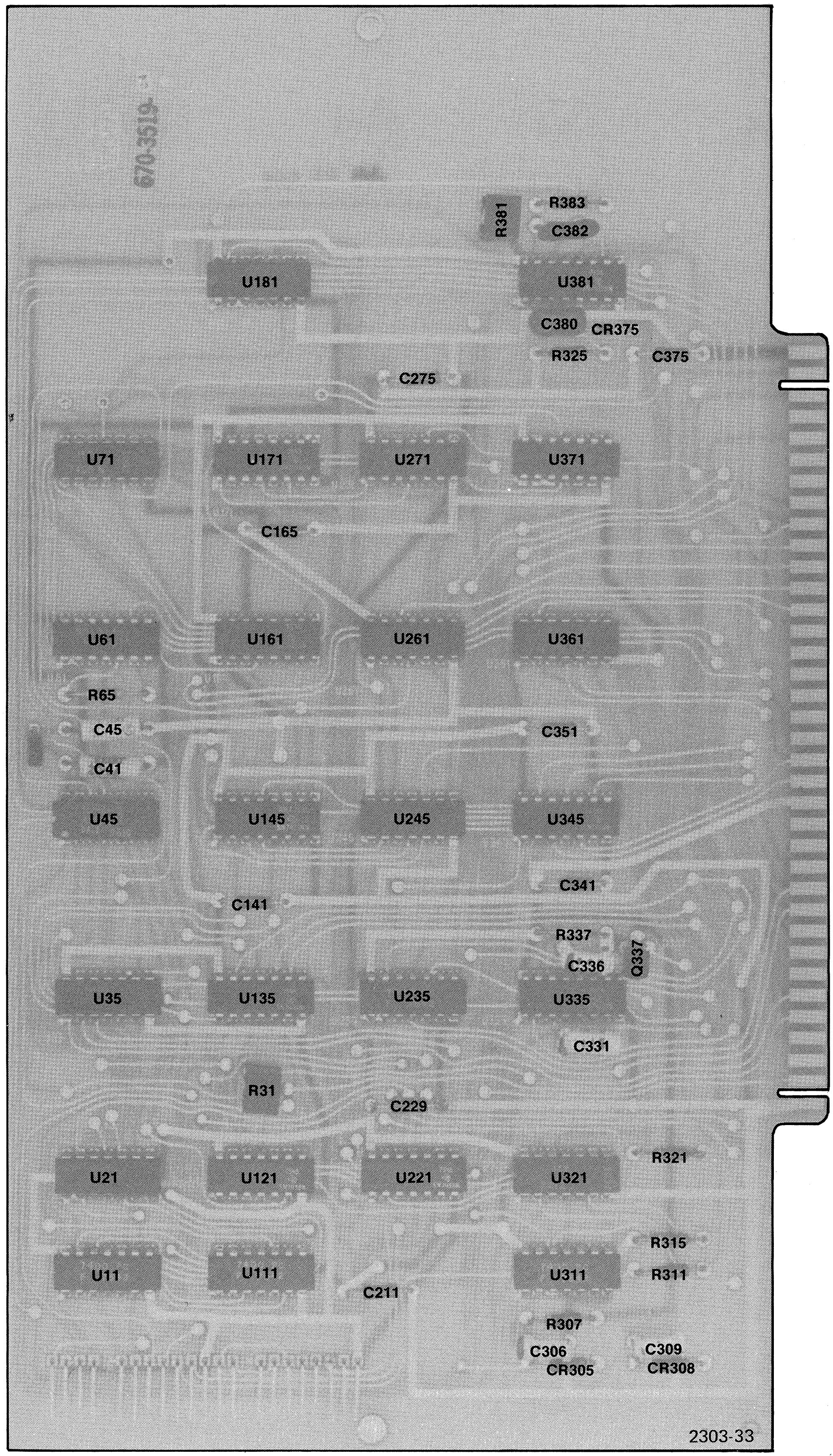
4014/4014-1
4015/4015-1

2303-32

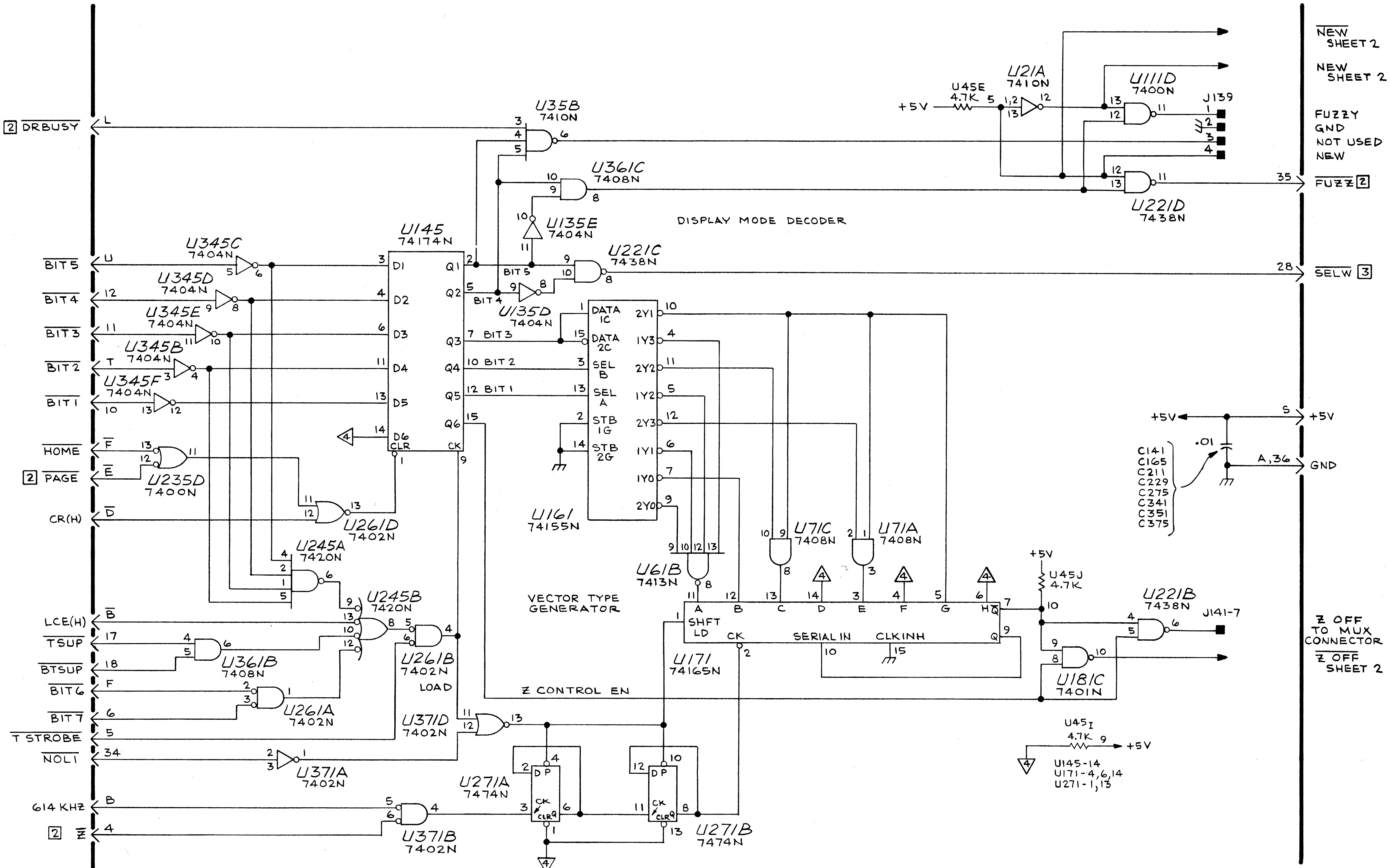
(SN B050000-UP)
A8 670-3294-04 STANDARD DISPLAY CONTROL CARD
(WITHOUT ENHANCED GRAPHIC CAPABILITY)

376
RH

SHEET 2 OF 2



Display Control Card (Option 34) (670-3294-04) Component Locations.



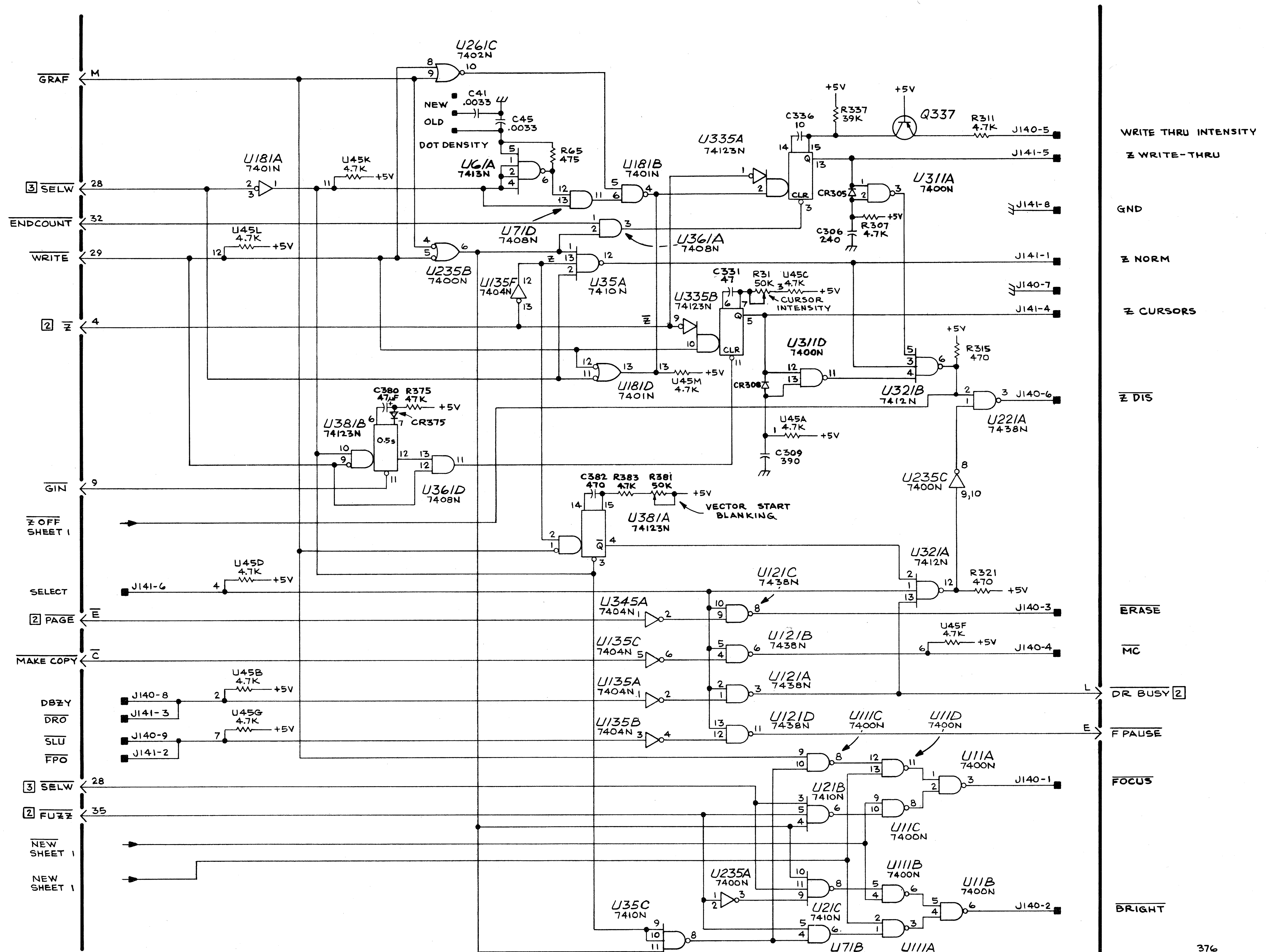
4014/4014-1
4015/4015-1

2303-34
@

(SN B050000-UP)
A8 670-3519-04 DISPLAY CONTROL CARD SHEET 1 OF 2
(USED WITH ENHANCED GRAPHICS MODULE - OPTION 34)

376
RH

DISPLAY CONTROL CARD
(OPTION 34) SHEET 1 OF 2



4014/4014-1
4015/4015-1

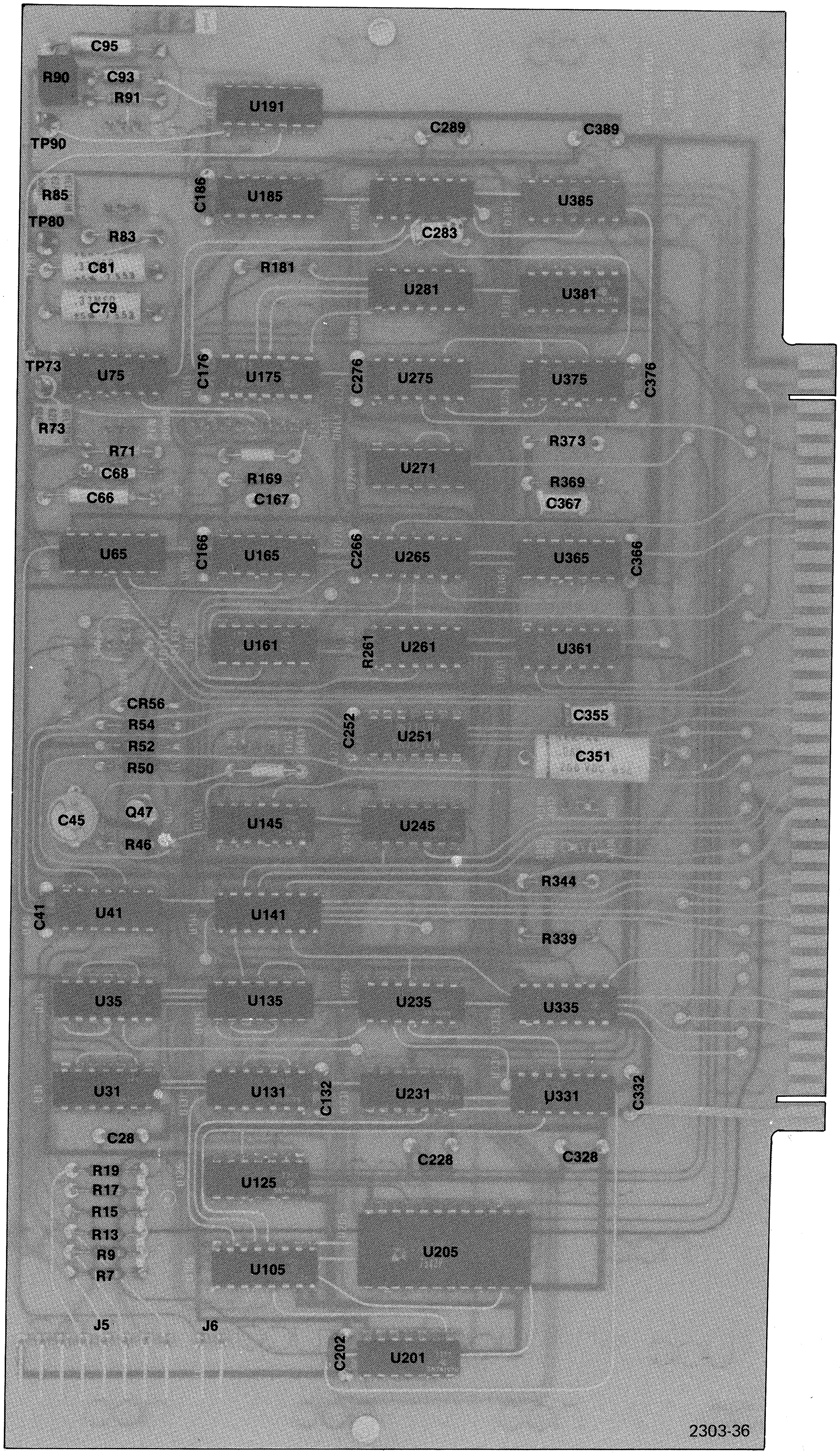
2303-35

A8 670-3519-04 (SN B050000-UP) DISPLAY CONTROL CARD (USED WITH ENHANCED GRAPHICS MODULE - OPTION 34)

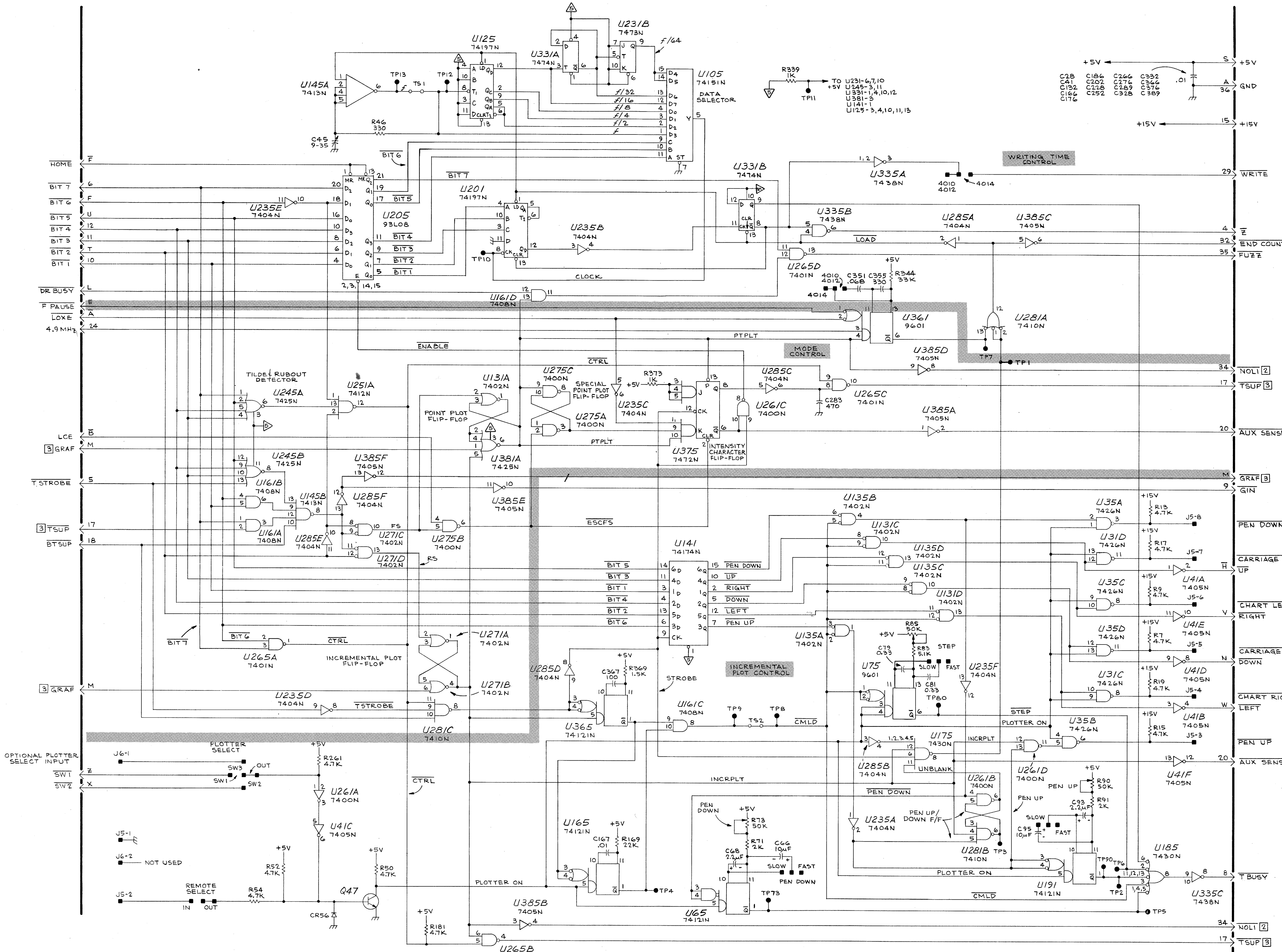
SHEET 2 OF 2

376

DISPLAY CONTROL CARD (OPTION 34) SHEET 2 OF 2



Discrete Plot Card (670-3372-01) Component Locations.



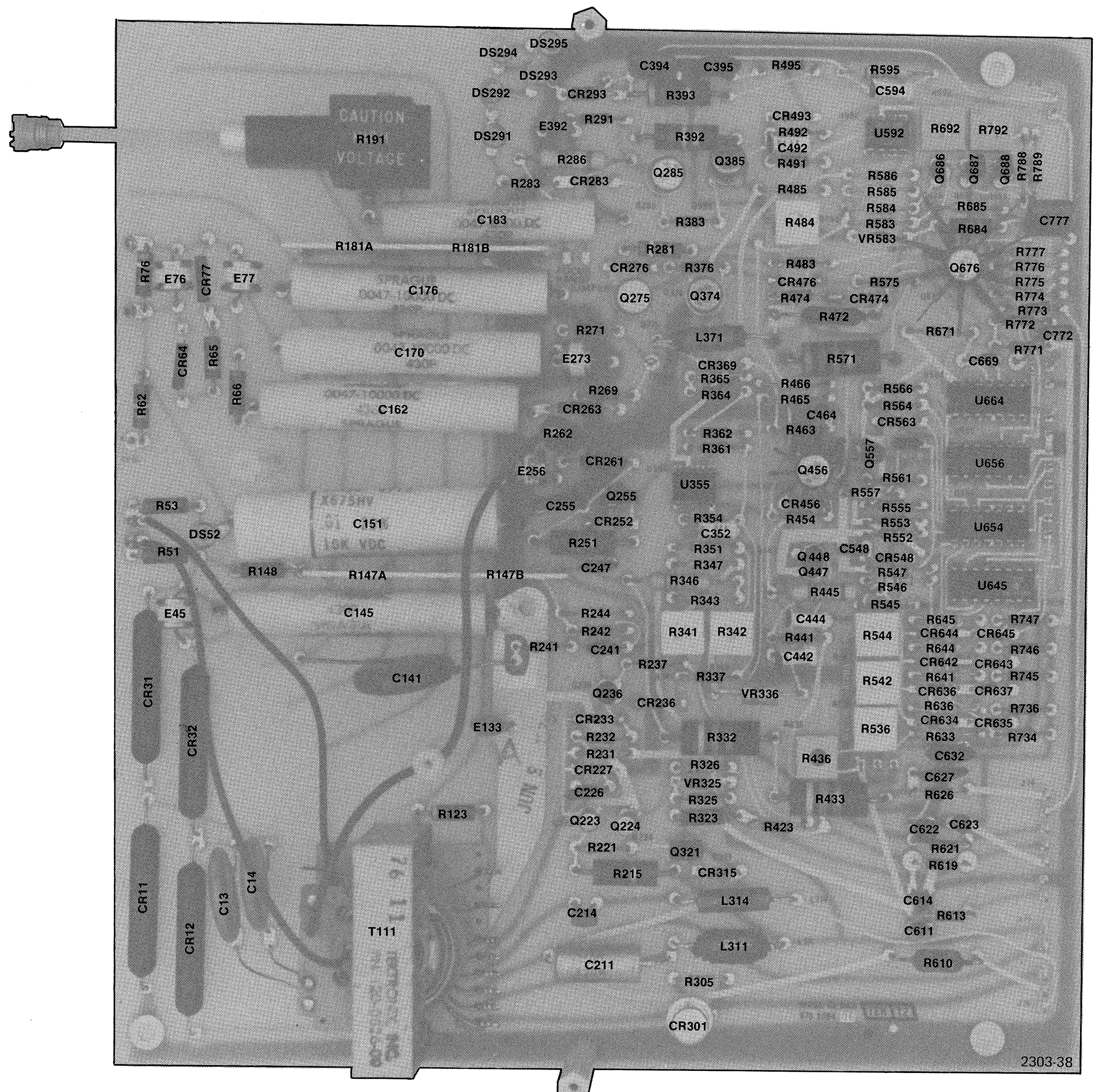
☐ APPEARS MORE THAN ONCE.

4014/4014-1
4015/4015-1

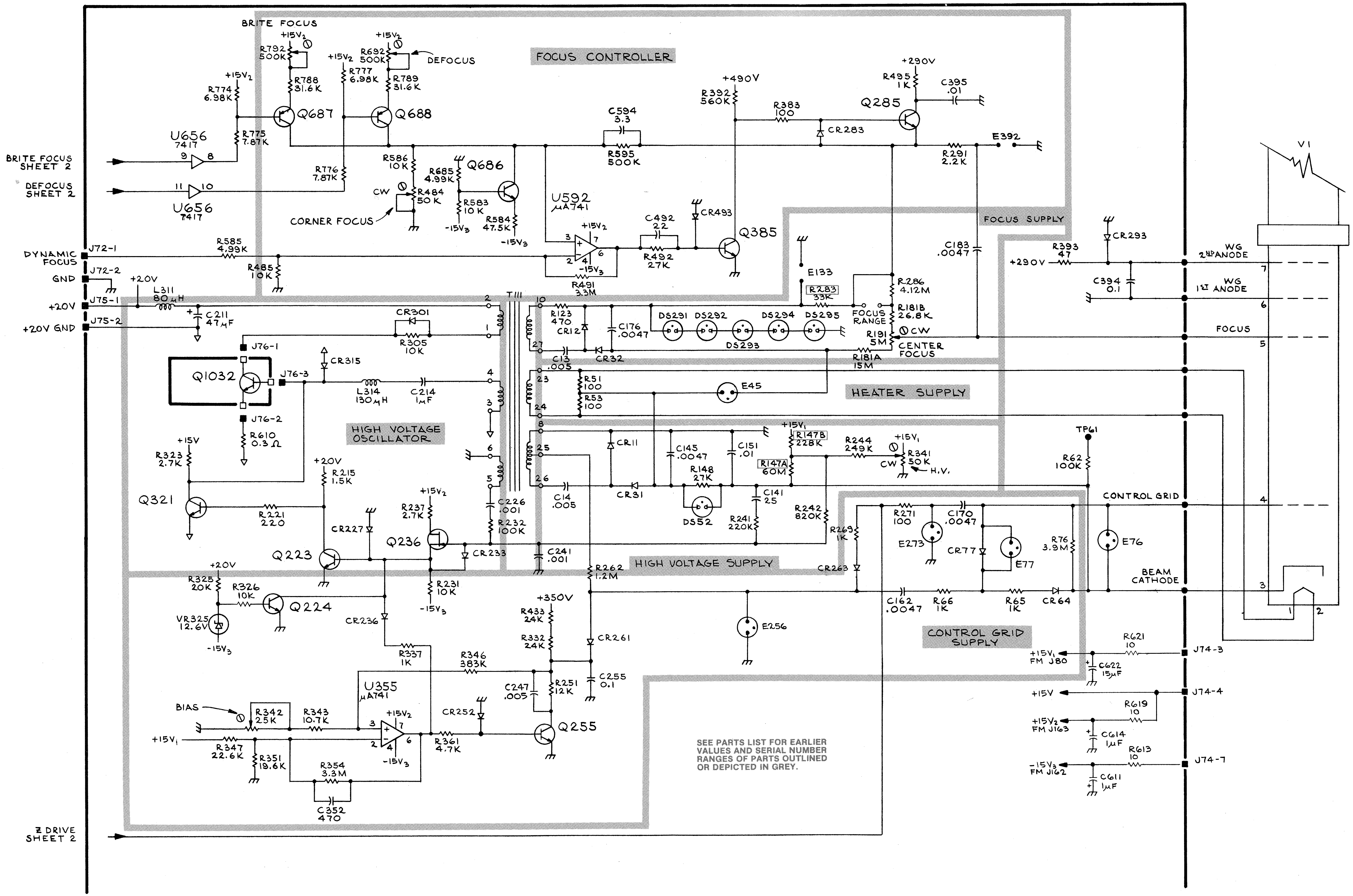
2303-37

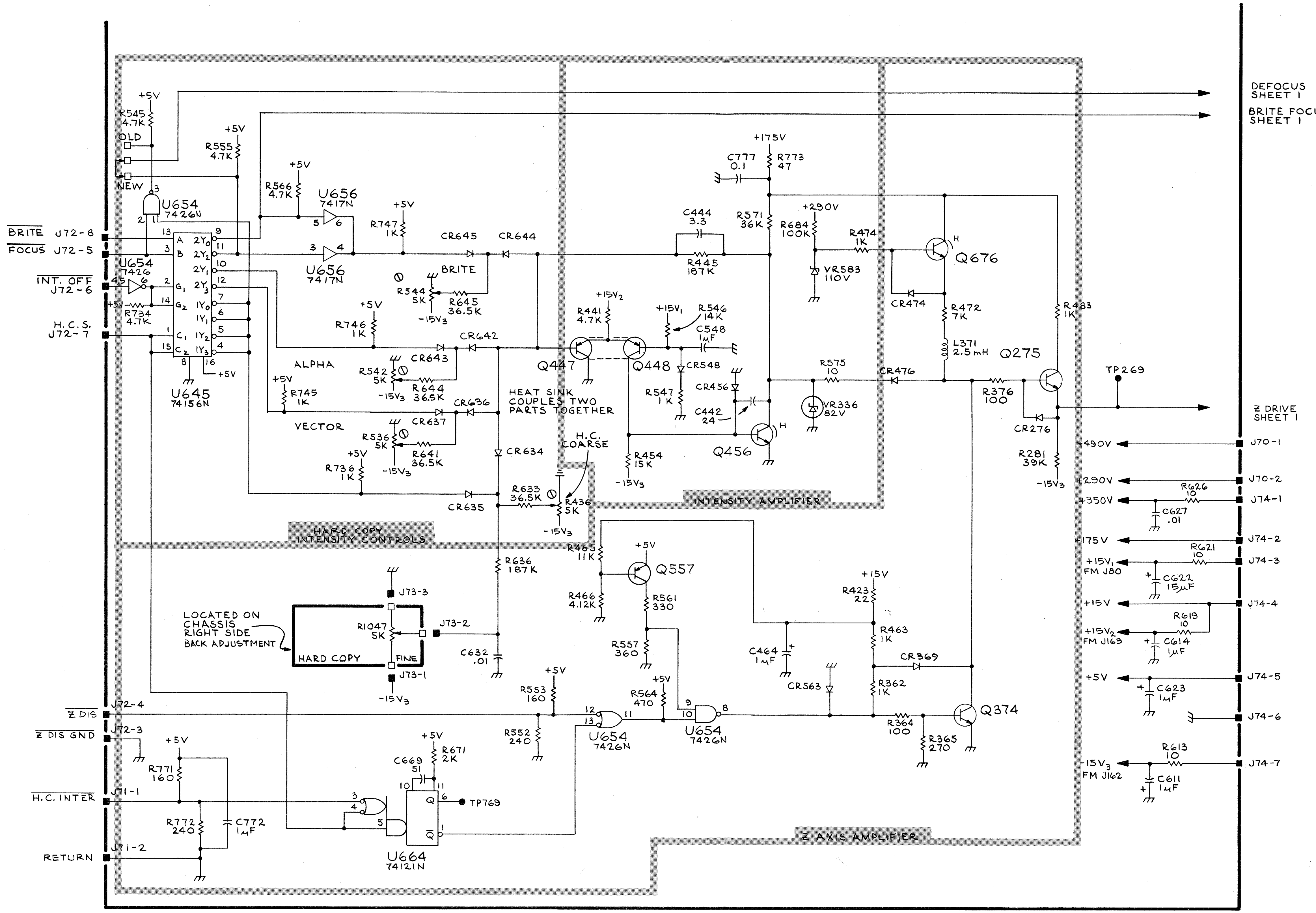
(SN B050000-UP)
A9 670-3372-01 DISCRETE PLOT CARD
(PART OF ENHANCED GRAPHICS MODULE - OPTION 34)

DISCRETE PLOT CARD
SCHEMATIC



High Voltage & Z Axis (670-3094-07 & up) Component Locations.


FOCUS CONTROLLER
FOCUS SUPPLY
HEATER SUPPLY
HIGH VOLTAGE OSCILLATOR
HIGH VOLTAGE SUPPLY
CONTROL GRID SUPPLY
BRITE FOCUS
BRITE FOCUS SHEET 2
DEFOCUS SHEET 2
DEFOCUS
CORNER FOCUS
DYNAMIC FOCUS
GND
+20V
+20V GND
Z DRIVE SHEET 2
BIAS
FOCUS RANGE
CENTER FOCUS
H.V.
WG 2ND ANODE
WG 1ST ANODE
FOCUS
CONTROL GRID
BEAM CATHODE
+15V1 FM J80
+15V
+15V2 FM J163
-15V3 FM J162
U656 7417
U592 μA741
U355 μA741
Q687
Q688
Q686
Q385
Q285
Q1032
Q321
Q223
Q236
Q224
Q255
T111
V1
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.



HIGH VOLTAGE & Z AXIS SHEET 2 OF 2

4014/4014-1
4015/4015-1

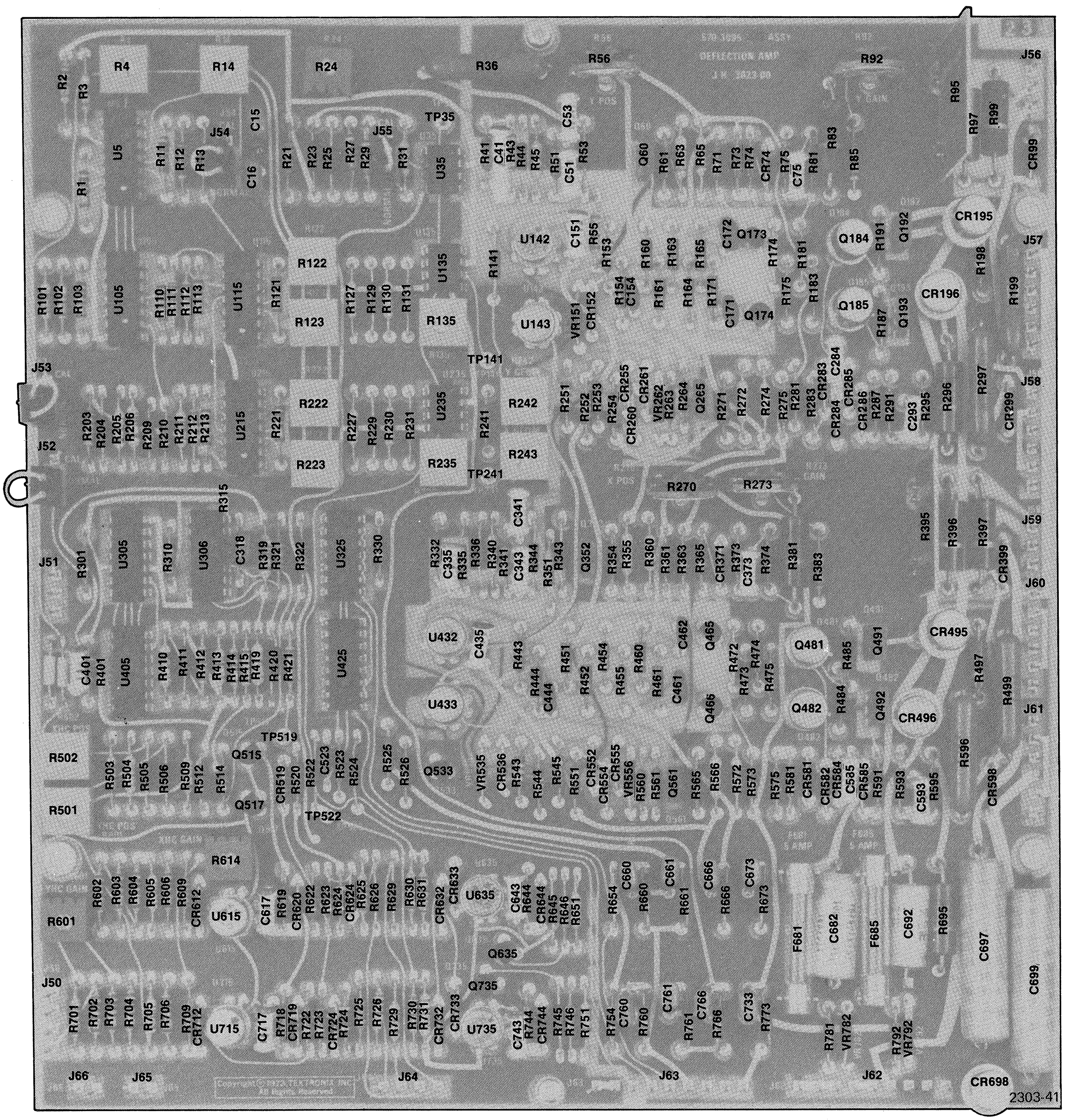
2303-40

@

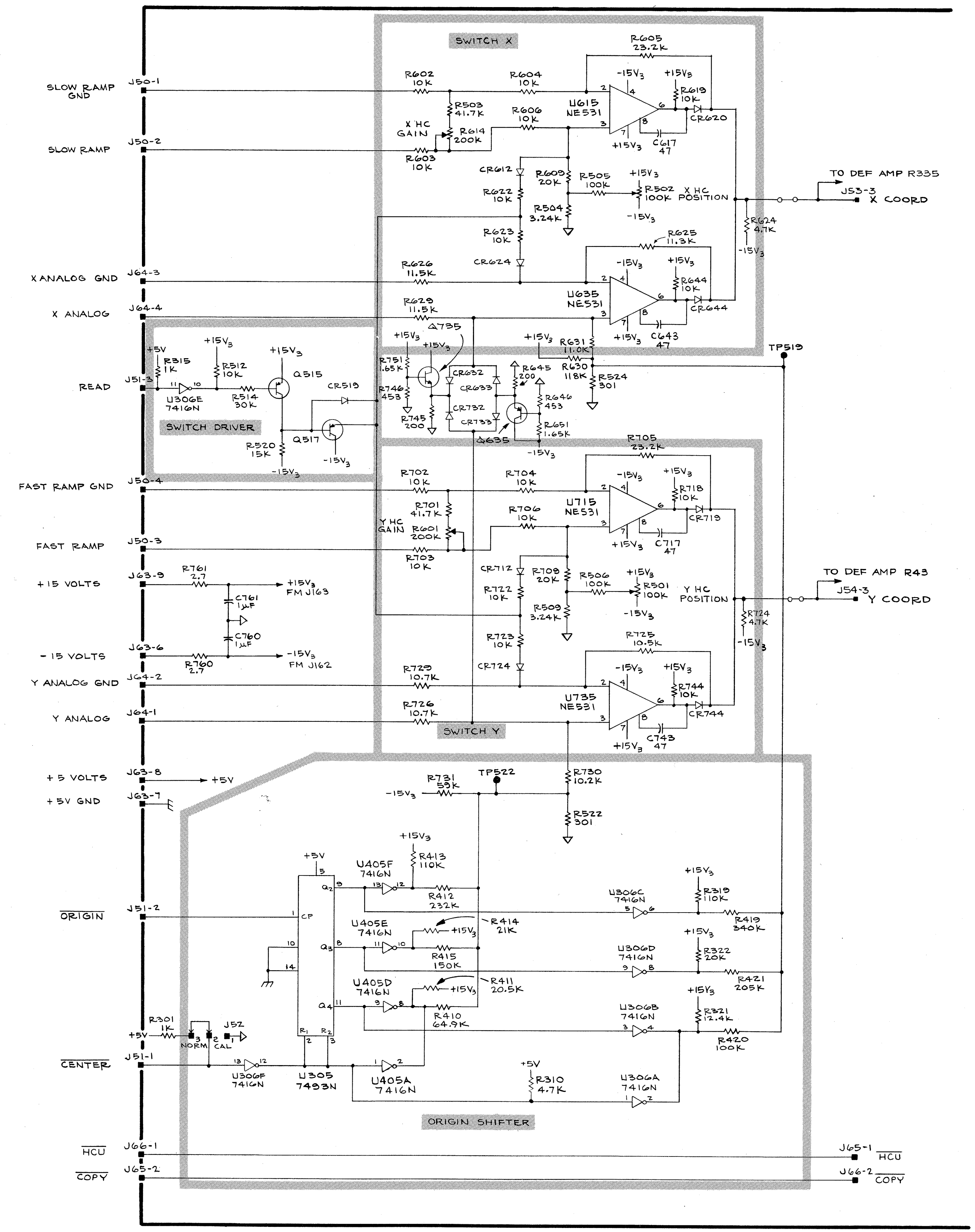
(SN B050000-UP)

A10 670-3094-07 HIGH VOLTAGE & Z AXIS

SHEET 2 OF 2



Deflection Amplifier (670-3095-04) Component Locations.

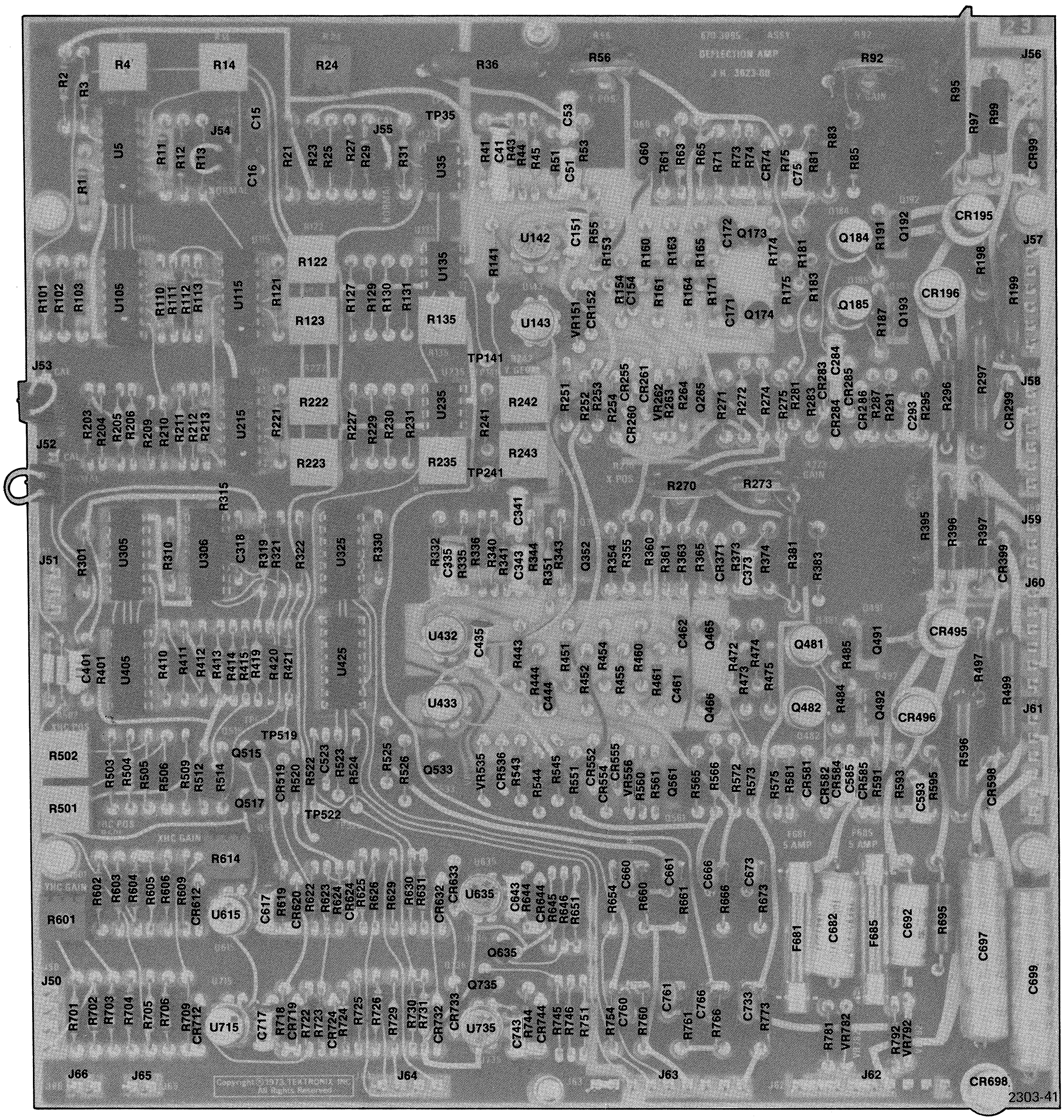


4014/4014-1
4015/4015-1

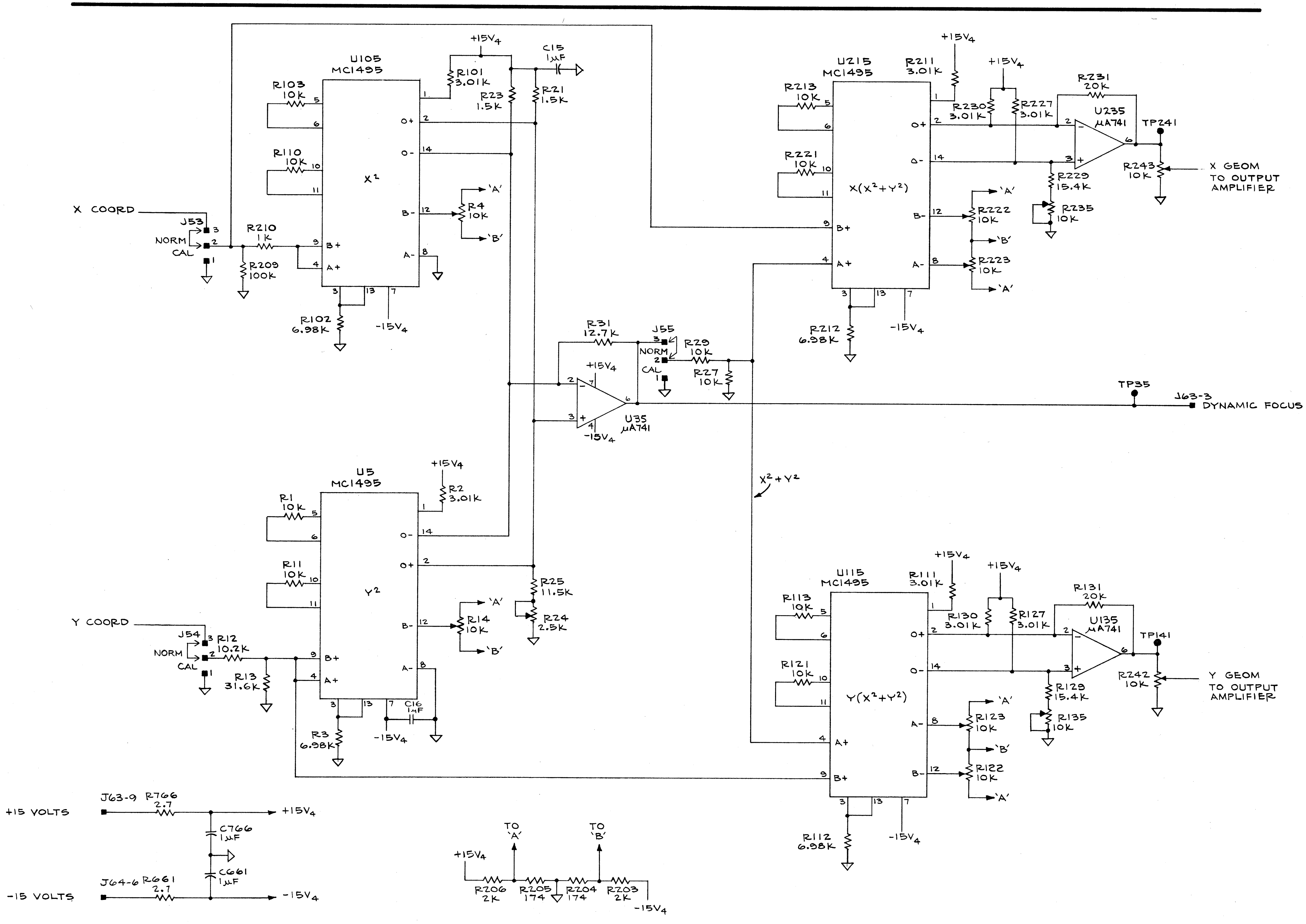
2303-42
@

(SN B050000-UP)
DEFLECTION MULTIPLEXER
(PART OF DEFLECTION AMPLIFIER BOARD A11 670-3095-04)

DEFLECTION MULTIPLEXER
SCHEMATIC



Deflection Amplifier (670-3095-04) Component Locations.

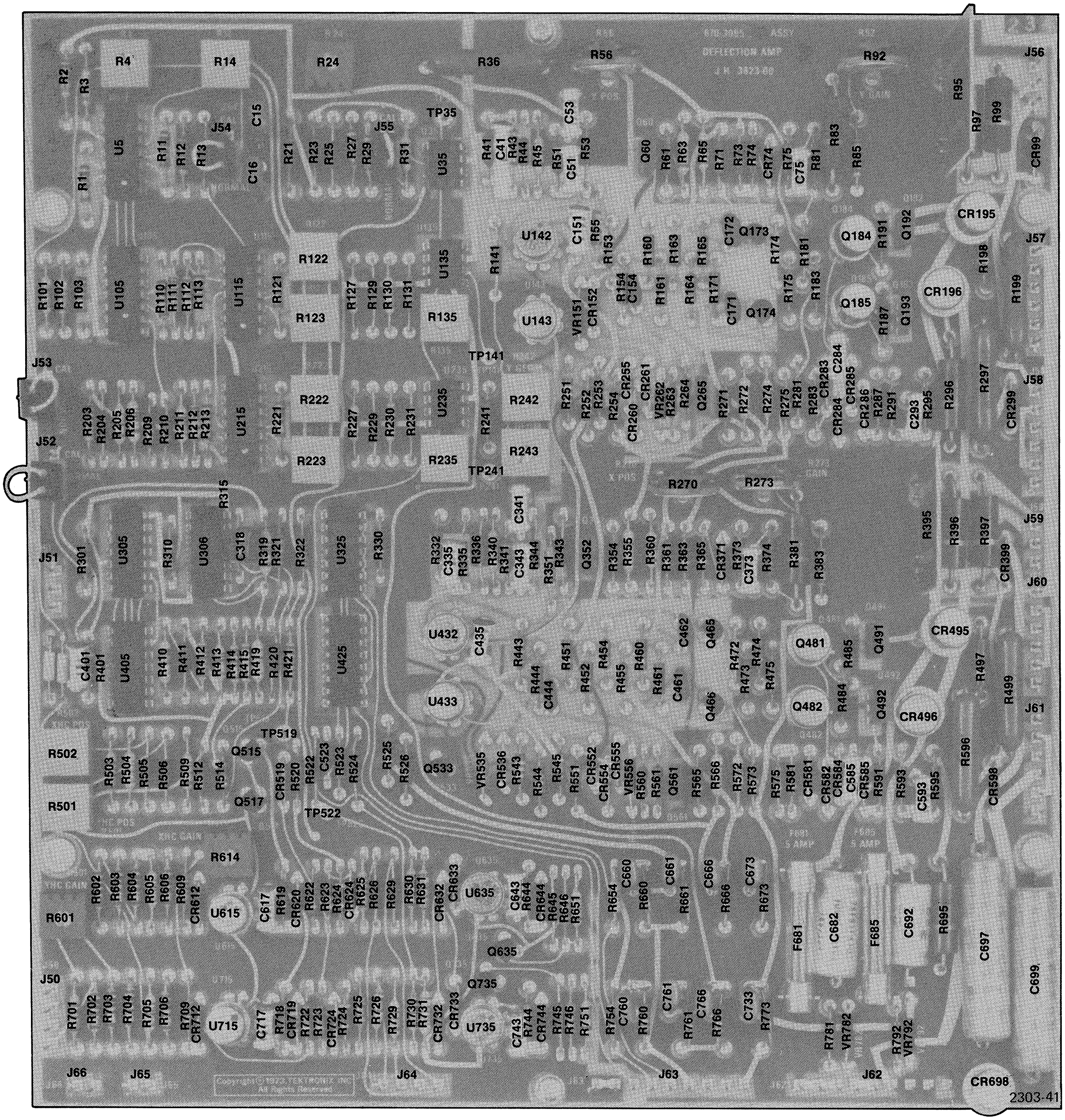


4014/4014-1
4015/4015-1

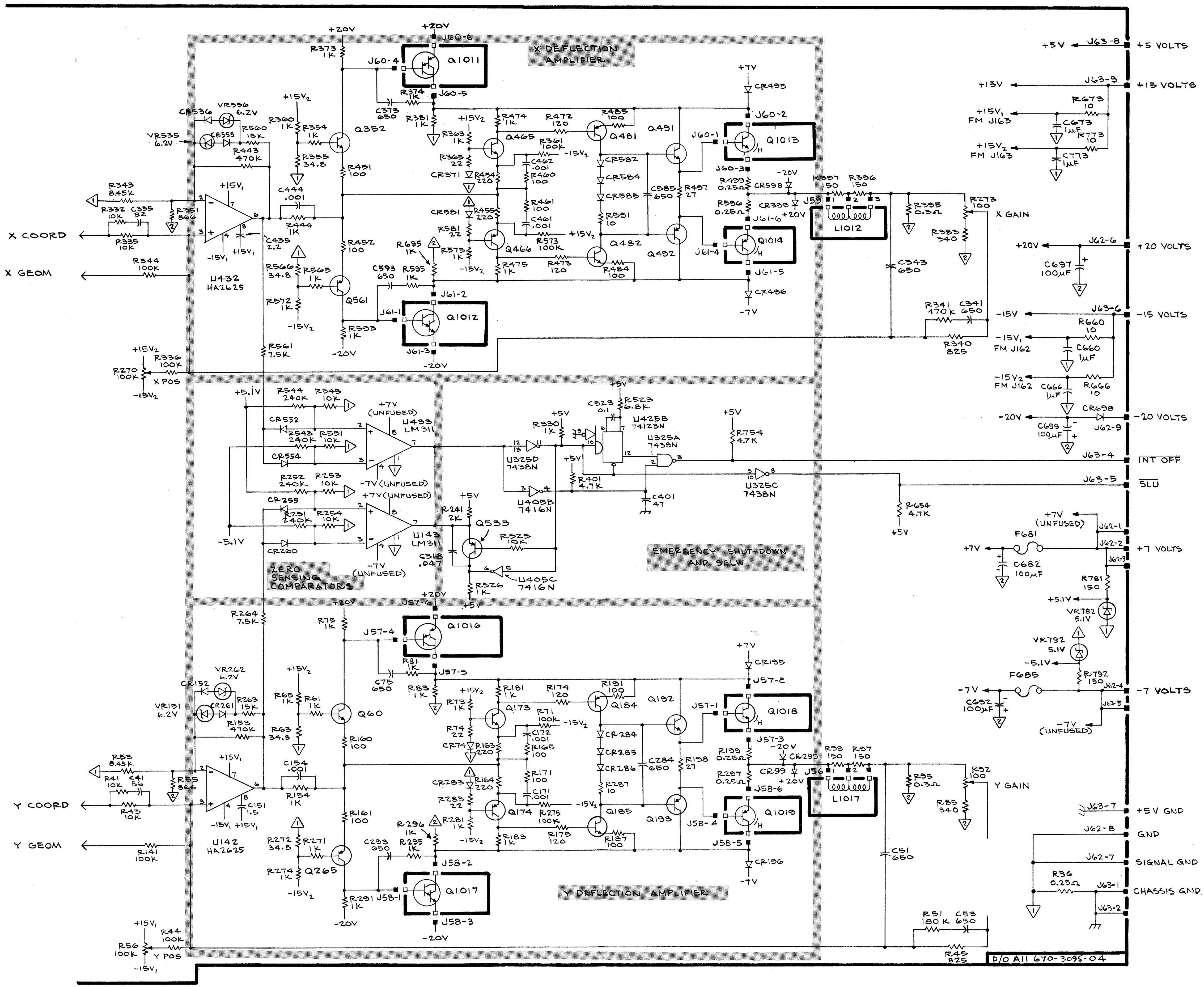
2303-43
@

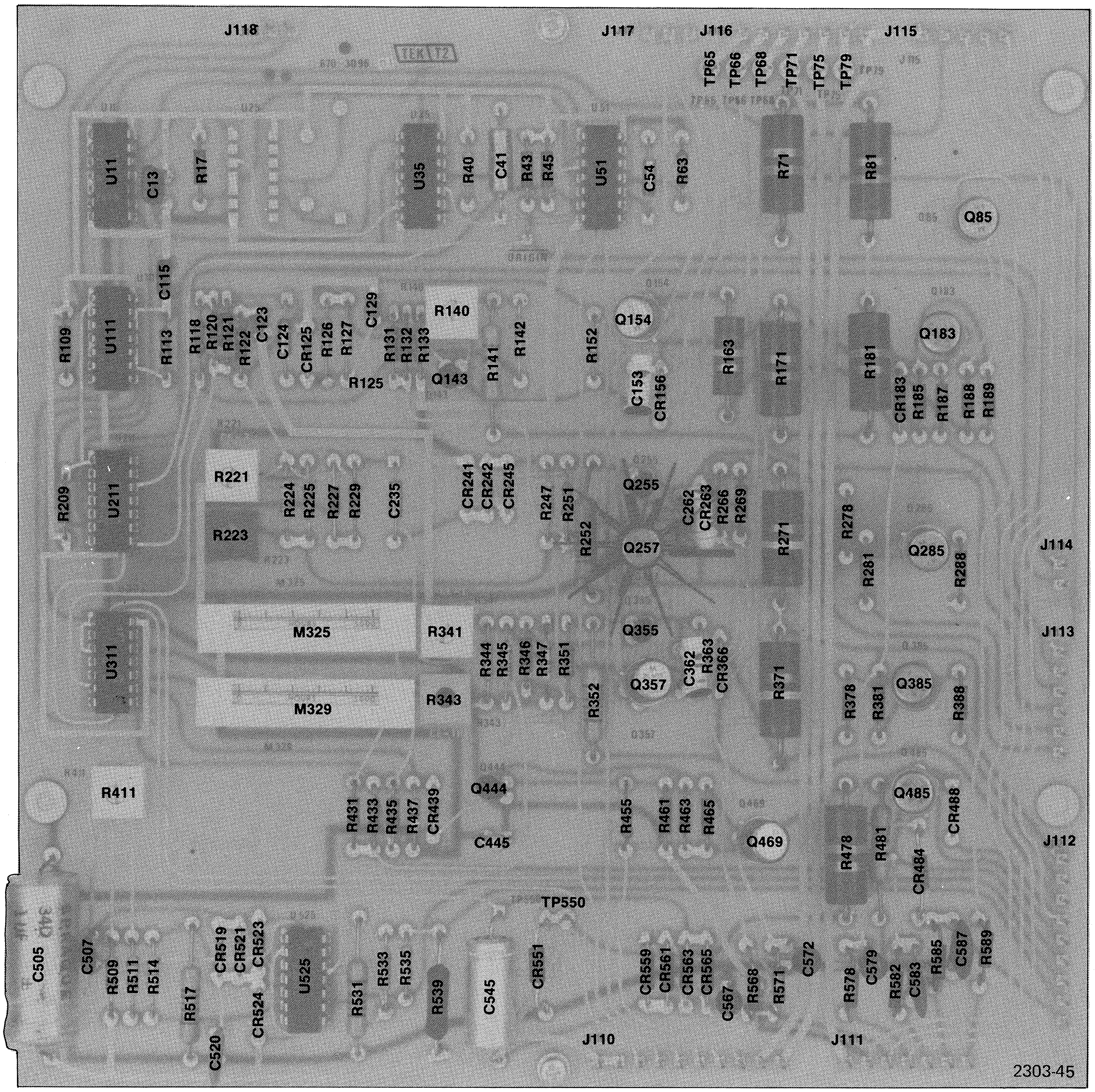
(SN B050000-UP)
GEOMETRY CORRECTION & DYNAMIC FOCUS
(PART OF DEFLECTION AMPLIFIER BOARD A11 670-3095-04)

GEOM. CORR. & DYN. FOCUS SCHEMATIC

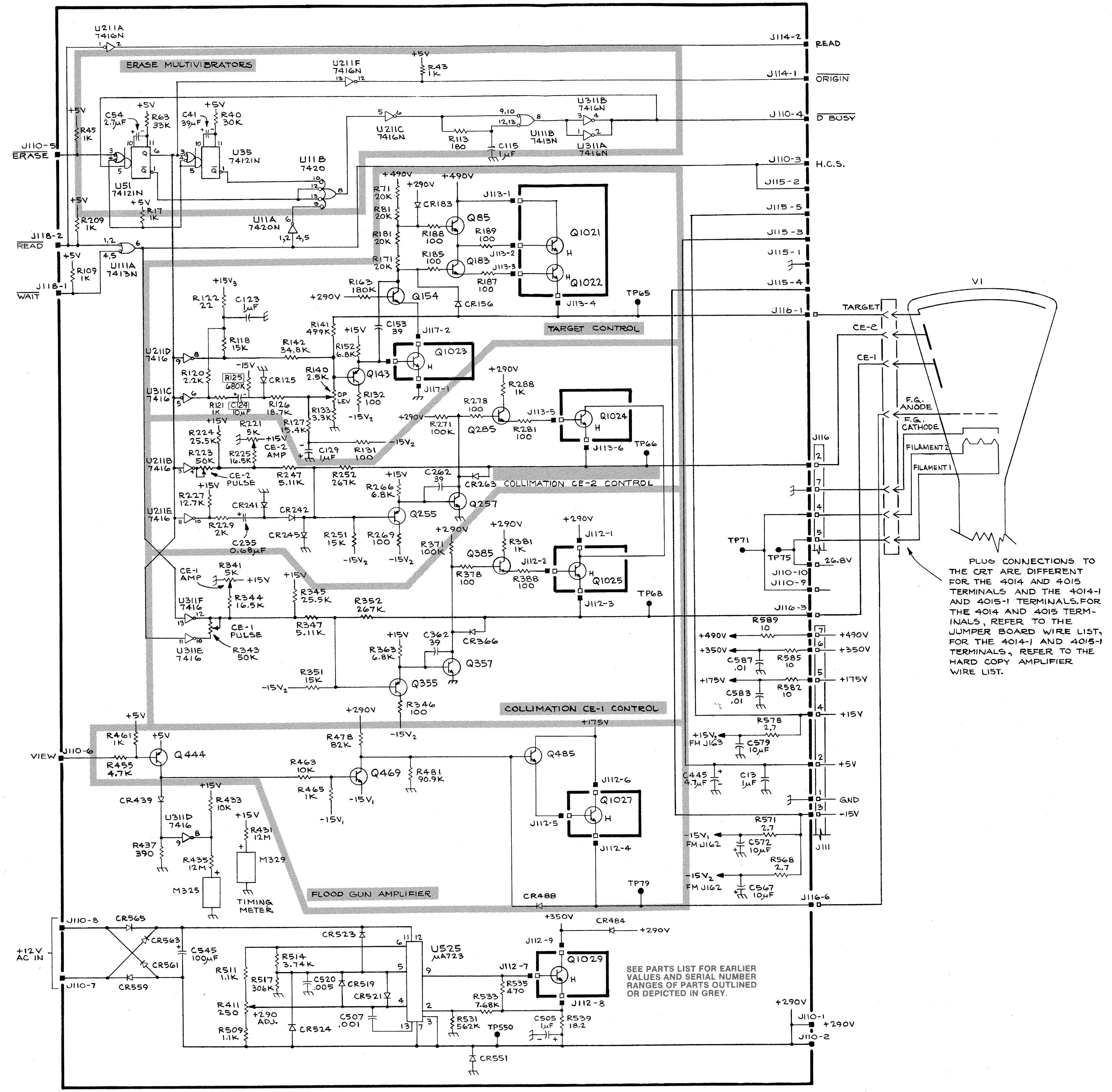


Deflection Amplifier (670-3095-04) Component Locations.


X DEFLECTION AMPLIFIER
ZERO SENSING COMPARATORS
EMERGENCY SHUT-DOWN AND SELW
Y DEFLECTION AMPLIFIER
X COORD
X GEOM
Y COORD
Y GEOM
X POS
Y POS
X GAIN
Y GAIN
U432 HA2625
U142 HA2625
U433 LM311
U143 LM311
+5 VOLTS
+15 VOLTS
+20 VOLTS
-15 VOLTS
-20 VOLTS
INT OFF
SLU
+7 VOLTS
-7 VOLTS
+5V GND
GND
SIGNAL GND
CHASSIS GND
P/O A11 670-3095-04



Storage Board (670-3096-01 & up) Component Locations.

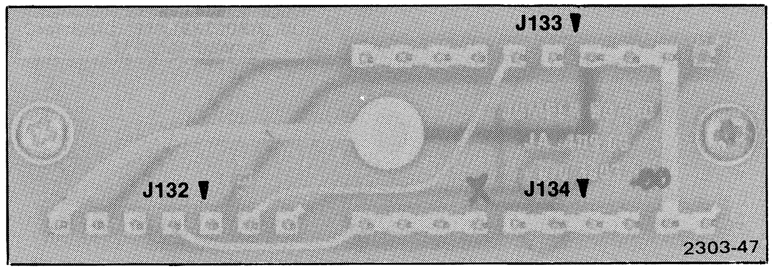


STORAGE BOARD SCHEMATIC

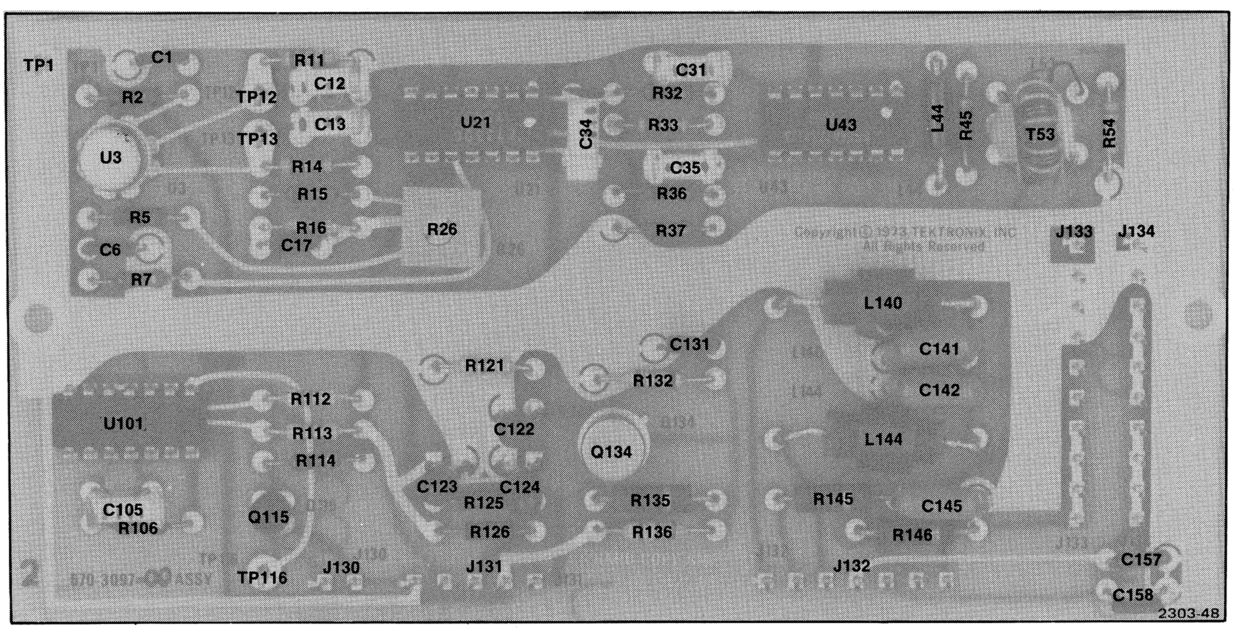
4014/4014-1
4015/4015-1

2303-46
REV. A, AUG 1978

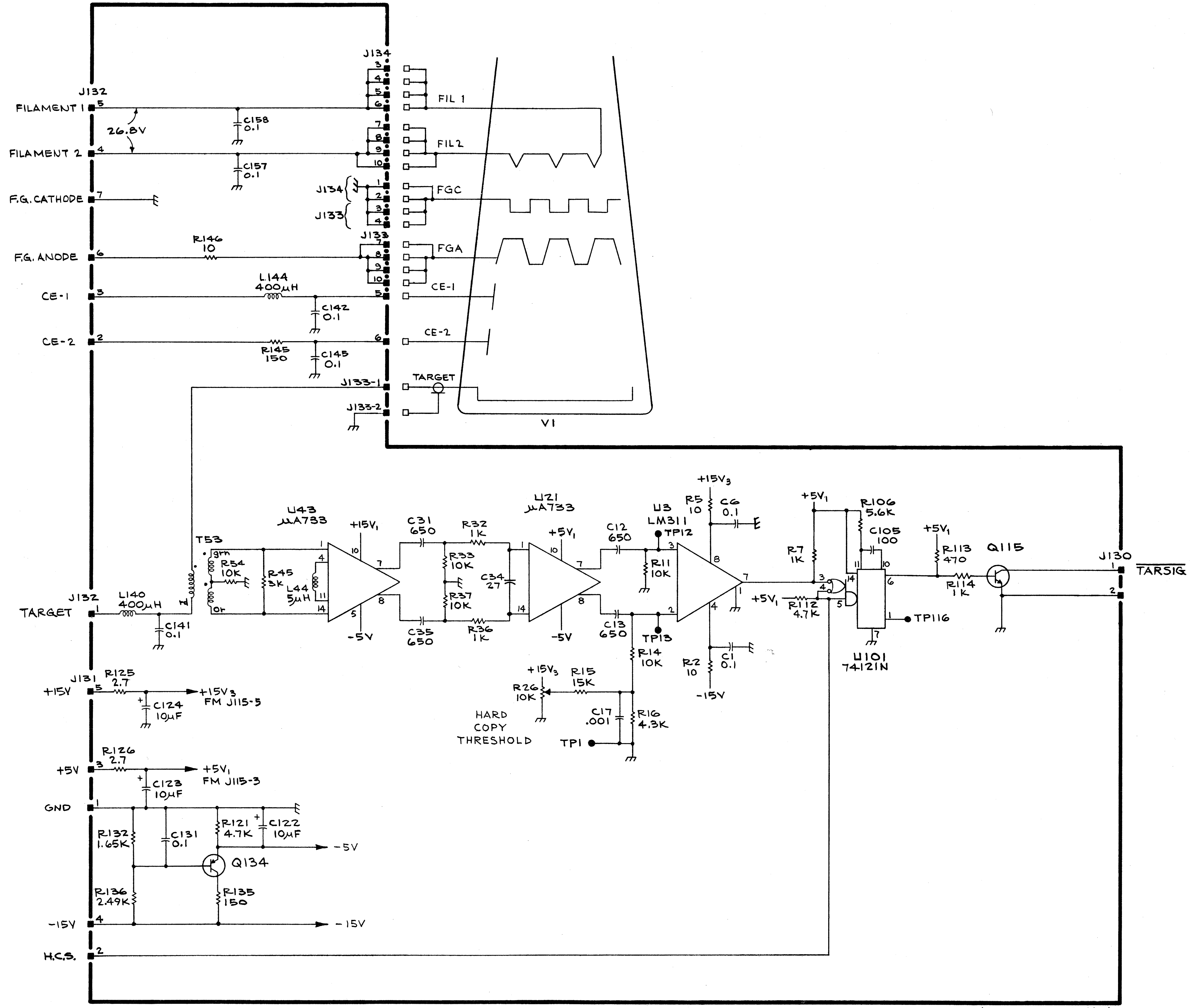
(SN B050000-UP)
A12 670-3096-01 & UP STORAGE BOARD



Jumper Board (670-3603-01) Component Locations used in 4014/4015.



Hard Copy Target Signal Amplifier Board (670-3097-01) Component Locations.

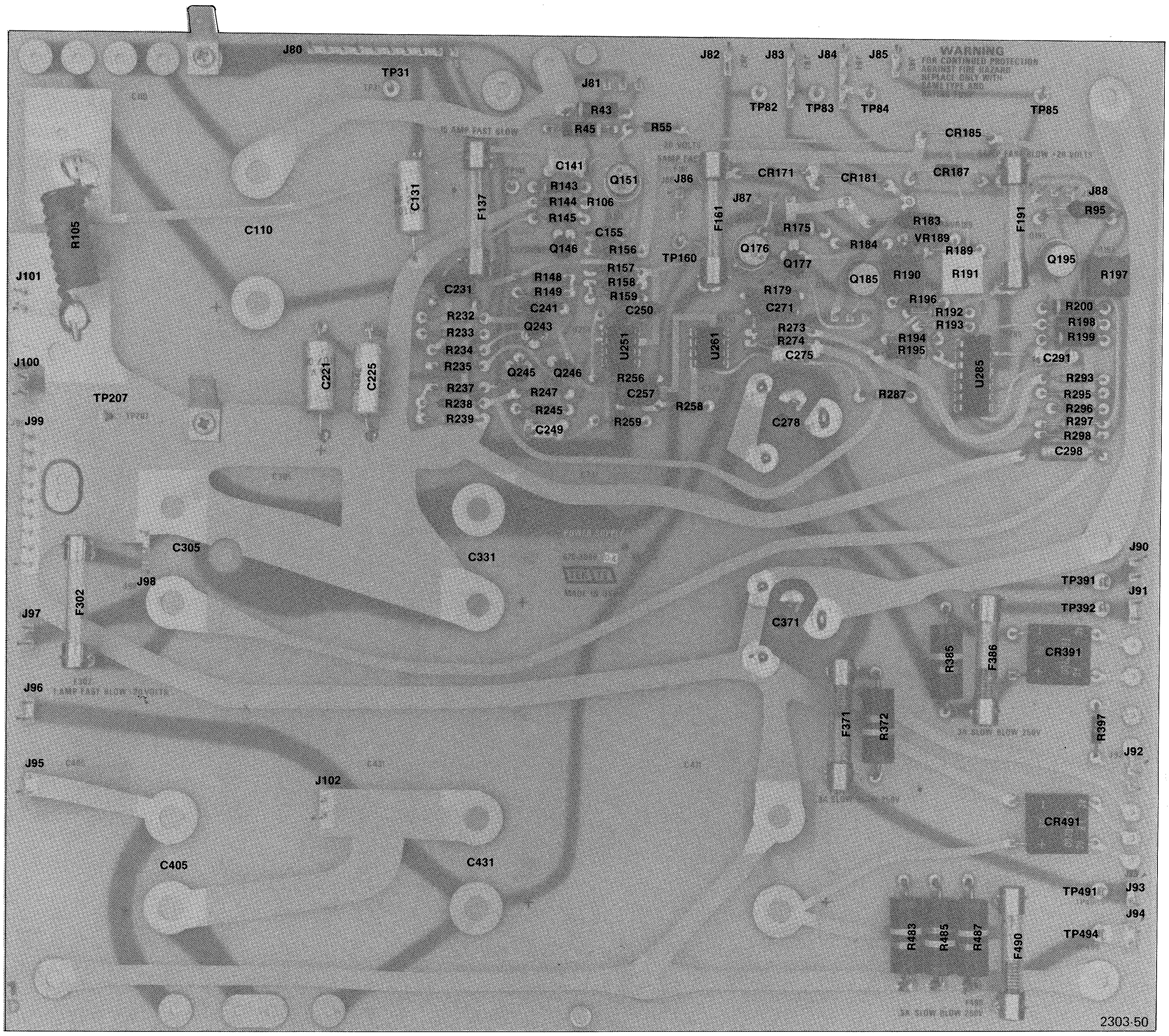


HARD COPY TARSIG AMP.
SCHEMATIC

4014/4014-1
4015/4015-1

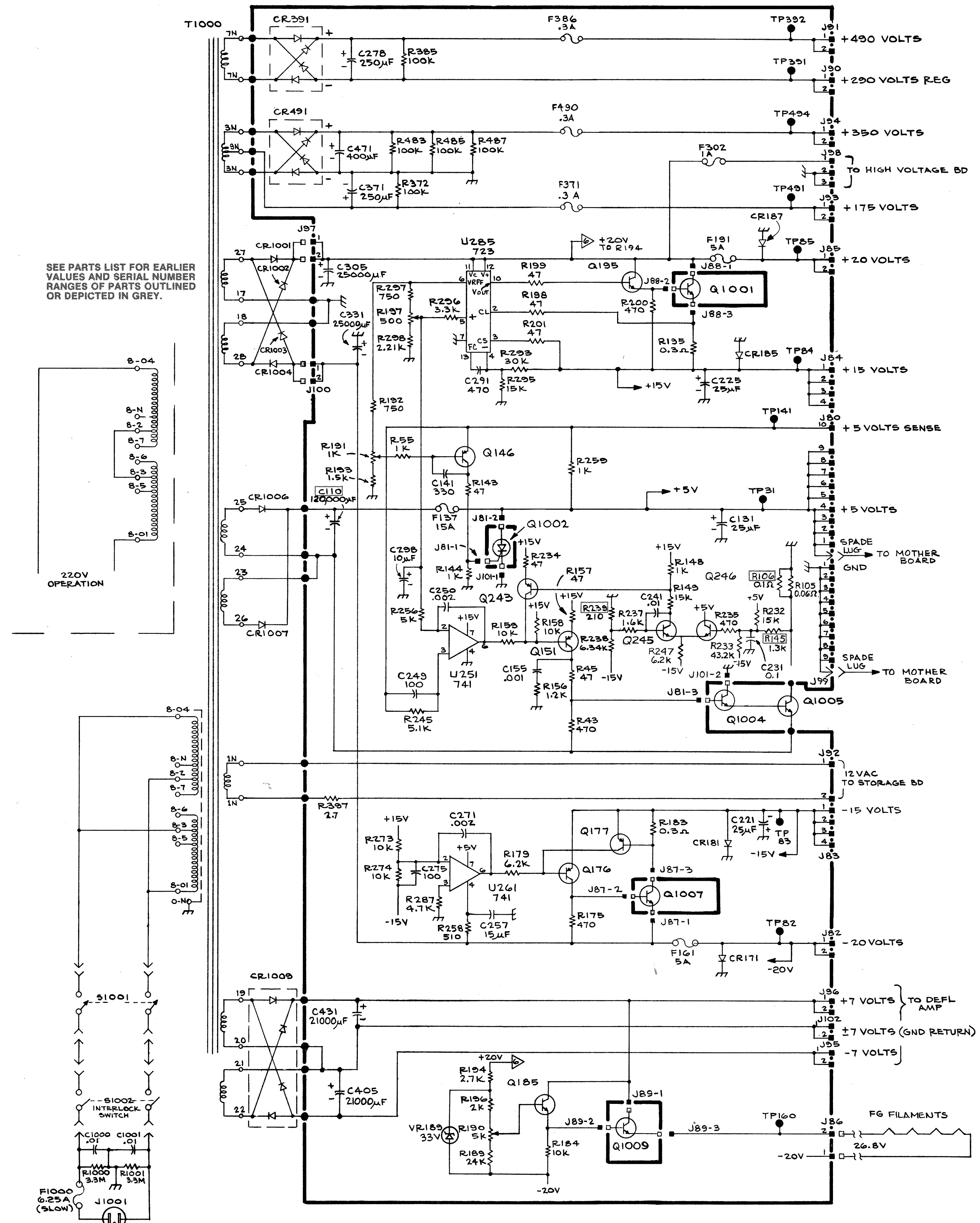
2303-49
REV. A, DEC. 1978

(SN B050000-UP)
A13 670-3097-01 HARD COPY BOARD
(USED WITH 4014-1 AND 4015-1 ONLY)



Low Voltage Power Supply Board (670-3089-04 & up) Component Locations.

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.



4014/4014-1
4015/4015-1

2303-51
REV. B, DEC 1978

(SN B050000-UP)
A14 670-3089-04 & UP LOW VOLTAGE POWER SUPPLY

LOW VOLTAGE POWER SUPPLY
SCHEMATIC

SECTION 8
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
000AH	STANDARD PRESSED STEEL CO., UNBRAKO DIV.	8535 DICE ROAD	SANTA FE SPRINGS, CA 90670
000EO	ZEPHER ELECTRONIC SALES CORP.	647 INDUSTRY DRIVE	SEATTLE, WA 98188
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
02107	SPARTA MANUFACTURING COMPANY	ROUTE NO. 2, BOX 128	DOVER, OH 44622
03614	BUSSMAN MFG., DIV. OF MCGRAW EDISON CO.	502 EARTH CITY PLAZA	EARTH CITY, MO 63045
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
04963	MINNESOTA MINING AND MFG. CO., ADHESIVES COATINGS AND SEALERS DIVISION	3M CENTER	ST. PAUL, MN 55101
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
05820	WAKEFIELD ENGINEERING, INC.	AUDUBON ROAD	WAKEFIELD, MA 01880
07109	OAKTRON INDUSTRIES, INC.	704 30TH STREET	MONROE, WI 53566
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
11897	PLASTIGLIDE MFG. CORPORATION	P O BOX 867, 1757 STANFORD ST.	SANTA MONICA, CA 90406
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
13150	VERNITRON ELECTRICAL COMPONENTS, BEAU PRODUCTS DIVISION	P O BOX 10	LACONIA, NH 03246
18722	RCA CORP., SOLID STATE DIVISION	CRESTWOOD ROAD	MOUNTAINTOP, PA 18707
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
31223	MICRO PLASTICS, INC.	20821 DEARBORN STREET	CHATSWORTH, CA 91311
31781	EDAC	360 MOBILE DRIVE	TORONTO, ONT, 4A1HP
52833	KEYTRONIC CORP., OCR DIV.	SPOKANE INDUSTRIAL PK., P. O. BOX 14687	SPOKANE, WA 99214
53387	MINNESOTA MINING AND MFG. CO., ELECTRO PRODUCTS DIVISION	3M CENTER	ST. PAUL, MN 55101
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
56878	STANDARD PRESSED STEEL COMPANY	BENSON EAST	JENKINTOWN, PA 19046
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
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, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
71838	STANDARD PRESSED STEEL COMPANY, CLEVE-LAND CAP SCREW DIVISION	4444 LEE ROAD	CLEVELAND, OH 44128
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
77339	NATIONAL LOCK WASHER COMPANY	P O BOX 5115,INDUSTRIAL PARKWAY	NORTH BRANCH, NJ 08856
77342	AMF INC., POTTER AND BRUMFIELD DIV.	200 RICHLAND CREEK DRIVE	PRINCETON, IN 47671
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80710	ALLEGHENY LUDLUM STEEL CORP., A DIVISION OF ALLEGHENY LUDLUM INDUSTRIES, INC.	BRACKENRIDGE WORKS, RIVER AVE.	BRACKENRIDGE, PA 15014
81044	MILLER, ROBERT E., AND COMPANY, INC.	50 BROADWAY, RM 1103	NEW YORK, NY 10004
82647	TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.	34 FOREST ST.	ATTLEBORO, MA 02703
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86445	PENN FIBRE AND SPECIALTY CO., INC.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 19134
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
88245	LITTON SYSTEMS, INC., USECO DIV.	13536 SATICOY ST.	VAN NUYS, CA 91409
90484	ITT, SURPRENANT DIV.	172 STERLING STREET	CLINTON, MA 01510
91260	CONNOR SPRING AND MFG. CO.	1729 JUNCTION AVE.	SAN JOSE, CA 95112
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
97913	INDUSTRIAL ELECTRONIC HARDWARE CORP.	109 PRINCE STREET	NEW YORK, NY 10012

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-1	390-0420-01			1	CAB.TOP,DSPL UN:	80009	390-0420-01
					(ATTACHING PARTS)		
-2	210-0457-00			6	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-3	334-1555-00			4	PLATE,IDENT:TRADEMARK	80009	334-1555-00
-4	426-0928-02			4	FRAME,TRIM:GRAY PLASTIC	80009	426-0928-02
					(ATTACHING PARTS)		
-5	213-0088-00			1	SCR,TPG,THD CTG:4-24 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-6	426-1124-02			1	FRAME SECT,CAB.:UPPER RIGHT,GRAY	80009	426-1124-02
	426-1123-02			1	FRAME SECT,CAB.:UPPER LEFT,GRAY	80009	426-1123-02
					(ATTACHING PARTS)		
-7	212-0111-00			3	SCREW,MACHINE:8-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-8	426-1125-02			2	FRAME SECT,CAB.:LOWER,GOLD	80009	426-1125-02
					(ATTACHING PARTS)		
-9	210-0457-00			3	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-10	334-2324-00			1	PLATE,IDENT:	80009	334-2324-00
	----- -----			-	(4014 ONLY)		
	334-2325-00			1	PLATE,IDENT:	80009	334-2325-00
	----- -----			-	(4015 ONLY)		
	334-2330-00			1	PLATE,IDENT:	80009	334-2330-00
	----- -----			-	(4014-1 ONLY)		
	334-2331-00			1	PLATE,IDENT:	80009	334-2331-00
	----- -----			-	(4015-1 ONLY)		
	610-1025-02			1	CHASSIS ASSY:KEYBOARD	80009	610-1025-02
	610-1026-00			1	CHASSIS ASSY:KEYBOARD	80009	610-1026-00
					(ATTACHING PARTS)		
-11	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-12	211-0034-00			2	SCREW,MACHINE:2-56 X 0.50 INCH,PNH	83385	OBD
					- - - * - - -		
	----- -----			-	. KEYBOARD ASSY INCLUDES:		
-13	366-0261-02			2	. KNOB:GRAY,0.129 ID X 0.372 OD	80009	366-0261-02
	----- -----			-	. . EACH KNOB INCLUDES:		
	214-0949-00			1	. . SPR,HLCL,TRSN:0.282" OD X 0.125" LONG	80009	214-0949-00
-14	----- -----			1	. RES.,VAR:HARD COPY INTENSITY(SEE R1047 EPL)		
					(ATTACHING PARTS)		
-15	210-0583-00			2	. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-16	210-0046-00			1	. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-17	----- -----			1	. RES.,VAR:WRITE-THRU INTENSITY(SEE R1050 EPL)		
					(ATTACHING PARTS)		
-18	210-0583-00			1	. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
					- - - * - - -		
-19	407-1512-00			1	. BRACKET,ANGLE:VAR RESISTOR,ALUMINUM	80009	407-1512-00
					(ATTACHING PARTS)		
-20	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-21	210-0586-00			2	. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-22	131-0775-00			1	. CONTACT,ELEC:HEX,0.25 INCH W/6-32 1 END	88245	1601-A
-23	386-3009-01			2	. SUPPORT,PANEL:KEYBOARD	80009	386-3009-01
					(ATTACHING PARTS)		
-24	210-0457-00			2	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-25	366-0128-01			2	. KNOB:THUMBWHEEL	80009	366-0128-01
	----- -----			-	. . EACH KNOB INCLUDES:		
	213-0076-00			1	. . SETSCREW:2-56 X 0.125 INCH,HEX.SOC STL	74445	OBD
-26	----- -----			1	. RES.,VAR:LEFT/RIGHT(SEE R1048 EPL)		
					(ATTACHING PARTS)		
-27	210-0583-00			1	. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-28	210-0046-00			1	. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-29	----- -----			1	. RES.,VAR:UP/DOWN(SEE R1049 EPL)		
					(ATTACHING PARTS)		
-30	210-0583-00			1	. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-31	210-0046-00			1	. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-32	407-1463-01			1	. BRACKET,ANGLE:HIGH VOLTAGE XFMR,ALUMINUM	80009	407-1463-01
					(ATTACHING PARTS)		
-33	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			1	. KEYBOARD,CMPTR:4014/4014-1(SEE A3 EPL)		
					(ATTACHING PARTS)		
-34	211-0628-00			6	. SCREW,MACHINE:6-32 X 1.125 INCH,PNH,STL	83385	OBD
					- - - * - - -		
	----- -----			-	. . KEYBOARD ASSY INCLUDES:		
-35	366-1553-00			1	. . PUSH BUTTON SET:60 BUTTON	52833	66-0929-01
	366-1555-01			1	. . . PUSH BUTTON SET:A THRU Z	52833	GLWW010199000101
	366-1555-02			1	. PUSH BUTTON:MARKED "A"	52833	GLWW01010000A001
	366-1555-03			1	. PUSH BUTTON:MARKED "B"	52833	GLWW01010000B001
	366-1555-04			1	. PUSH BUTTON:MARKED "C"	52833	GLWW01010000C001
	366-1555-05			1	. PUSH BUTTON:MARKED "D"	52833	GLWW01010000D001
	366-1555-06			1	. PUSH BUTTON:MARKED "E"	52833	GLWW01010000E001
	366-1555-07			1	. PUSH BUTTON:MARKED "F"	52833	GLWW01010000F001
	366-1555-08			1	. PUSH BUTTON:MARKED "G"	52833	GLWW01010000G001
	366-1555-09			1	. PUSH BUTTON:MARKED "H"	52833	GLWW01010000H001
	366-1555-10			1	. PUSH BUTTON:MARKED "I"	52833	GLWW01010000I001
	366-1555-11			1	. PUSH BUTTON:MARKED "J"	52833	GLWW01010000J001
	366-1555-12			1	. PUSH BUTTON:MARKED "K"	52833	GLWW01010000K001
	366-1555-13			1	. PUSH BUTTON:MARKED "L"	52833	GLWW01010000L001
	366-1555-14			1	. PUSH BUTTON:MARKED "M"	52833	GLWW01010000M001
	366-1555-15			1	. PUSH BUTTON:MARKED "N"	52833	GLWW01010000N001
	366-1555-16			1	. PUSH BUTTON:MARKED "O"	52833	GLWW01010000O001
	366-1555-17			1	. PUSH BUTTON:MARKED "P"	52833	GLWW01010000P001
	366-1555-18			1	. PUSH BUTTON:MARKED "Q"	52833	GLWW01010000Q001
	366-1555-19			1	. PUSH BUTTON:MARKED "R"	52833	GLWW01010000R001
	366-1555-20			1	. PUSH BUTTON:MARKED "S"	52833	GLWW01010000S001
	366-1555-21			1	. PUSH BUTTON:MARKED "T"	52833	GLWW01010000T001
	366-1555-22			1	. PUSH BUTTON:MARKED "T"	52833	GLWW01010000U001
	366-1555-23			1	. PUSH BUTTON:MARKED "V"	52833	GLWW01010000V001
	366-1555-24			1	. PUSH BUTTON:MARKED "W"	52833	GLWW01010000W001
	366-1555-25			1	. PUSH BUTTON:MARKED "X"	52833	GLWW01010000X001
	366-1555-26			1	. PUSH BUTTON:MARKED "Y"	52833	GLWW01010000Y001
	366-1555-27			1	. PUSH BUTTON:MARKED "Z"	52833	GLWW01010000Z001
	366-1555-28			1	. . . PUSH BUTTON SET:1 THRU 9	52833	GLWW010199020801
	366-1555-29			1	. . . PUSH BUTTON:MARKED ZERO	52833	GLWW010110100101
	366-1553-01			1	. . . PUSH BUTTON:ASTERISK/COLON	52833	GLWW010100001011
	366-1555-31			1	. . . PUSH BUTTON:MARKED EQUAL OVER MINUS	52833	GLWW010110380802
	366-1555-32			1	. . . PUSH BUTTON:MARKED + OVERSEMI-COLON	52833	GLWW010110370802
	366-1555-33			1	. . . PUSH BUTTON:MARKED LESS THAN OVER COMMA	52833	GLWW010110340802
	366-1555-34			1	. . . PUSH BUTTON:MKD GREATER THAN OVER PERIOD	52833	GLWW010110350802
	366-1555-35			1	. . . PUSH BUTTON:MKD ? OVER /	52833	GLWW010110140802
	366-1553-02			1	. . . PUSH BUTTON:RESET PAGE	52833	GGWW01010000R444
	366-1555-37			1	. . . PUSH BUTTON:MKD L BRACE OVER L BRACKET	52833	GGWW010110850802
	366-1555-38			1	. . . PUSH BUTTON:MARKED ESC	52833	GGWW0101E3890701
	366-1555-39			1	. . . PUSH BUTTON:MARKED TILDE OVER CARET	52833	GGWW010110640802
	366-1555-40			1	. . . PUSH BUTTON:MARKED TAB	52833	GGWW0101T5990701
	366-1555-41			1	. . . PUSH BUTTON:MARKED CTRL	52833	GGWW0101C3560701
	366-1555-42			1	. . . PUSH BUTTON:MARKED TTY LOCK	52833	GGWW0101T4931101
	366-1553-03			1	. . . PUSH BUTTON:SHIFT	52833	GGWW02030000S577
	366-1555-44			1	. . . PUSH BUTTON:MKD R BRACE OVER R BRACKET	52833	GGWW010110860802
	366-1555-45			1	. . . PUSH BUTTON:MARKED BACK SPACE	52833	GGWW0101B3211101
	366-1555-46			1	. . . PUSH BUTTON:MARKED GRAVE ACCENT OVER AT	52833	GGWW010110790802
	366-1555-47			1	. . . PUSH BUTTON:MARKED LF	52833	GGWW0101L4780701
	366-1555-48			1	. . . PUSH BUTTON:MKD VERT DSH OV BACK SLASH	52833	GGWW010110870802
	366-1555-49			1	. . . PUSH BUTTON:MARKED RUB OUT	52833	GGWW2502R4431101
	366-1555-50			1	. . . PUSH BUTTON:MARKED BREAK	52833	GGWW0101B3310701

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-	366-1553-04			1	. . . PUSH BUTTON:RETURN	52833	GGWW09060000R445
	366-1555-52			1	. . . PUSH BUTTON:MARKED SHIFT	52833	BBWW020255770701
	366-1553-05			1	. . . PUSH BUTTON:SPACE BAR	52833	GGGG120100001090
-36	118-0031-00			1	. . ACTUATOR ASSY:9OZ SGL UNIT,W/MECH ALT ACT	52833	61-0261-09
-37	118-0041-00			5	. . ACTUATOR ASSY:4 UNIT	52833	61-0036-15
-38	118-0040-00			1	. . ACTUATOR ASSY:6 UNIT,W/6 OZIN POS #1	52833	61-0036-30
-39	118-0045-00			4	. . ACTUATOR ASSY:6 UNIT	52833	61-0034-15
-40	118-0043-00			2	. . ACTUATOR ASSY:SINGLE UNIT	52833	61-0021-03
-41	118-0044-00			1	. . ACTUATOR ASSY:5 UNIT W/POS #5 VACANT	52833	61-0045-33
-42	118-0042-00			1	. . ACTUATOR ASSY:9OZ SINGLE UNIT	52833	61-0021-08
-43	----- -----			36	. . NUT,PLAIN,HEX:	52833	47-0001-01
-44	----- -----			2	. . RAIL,STIFFENING:	52833	49-0062
					(ATTACHING PARTS)		
-45	----- -----			2	. . SCREW,MACHINE:	52833	47-0009-02
					- - - * - - -		
-46	118-0038-00			2	. . BRKT,SPACE BAR:	52833	044-00003
					(ATTACHING PARTS)		
-47	----- -----			1	. . SCREW,MACHINE:	52833	47-0005-02
-48	----- -----			1	. . NUT,PLAIN,HEX:	52833	47-0001-01
					- - - * - - -		
-49	118-0039-00			2	. . SPRT,SPACER BAR:	52833	44-0001
-50	118-0037-00			1	. . PIVOT,BAR:	52833	49-0002
-51	118-0036-00			1	. . CKT CARD ASSY:KEYBOARD	52833	PCB065-0929-02B
	----- -----			1	. KEYBOARD,CMPTR:4015/4015-1(SEE A3 EPL)		
	366-1554-00			1	. . PUSH BUTTON SET:60 BUTTON	52833	66-0928-010
	366-1553-02			1	. . . PUSH BUTTON:RESET PAGE	52833	GGWW01010000R444
	366-1554-01			1	. . . PUSH BUTTON:DIERERSIS/1/EXCLAMATION POINT	52833	GGWW01010000R444
	366-1554-02			1	. . . PUSH BUTTON:NEGATIVE/2/ATSIGN	52833	GLWW010100003402
	366-1554-03			1	. . . PUSH BUTTON:LESS THAN/3/POUND OR NUMBER	52833	GLWW010100003403
	366-1554-04			1	. . . PUSH BUTTON:LESS THAN OR EQUAL/4/DOLLAR	52833	GLWW010100003404
	366-1554-05			1	. . . PUSH BUTTON:EQUAL/5/PERCENT	52833	GLWW010100003405
	366-1554-06			1	. . . PUSH BUTTON:GREATER THAN OR EQUAL/6/CAROT	52833	GLWW010100003406
	366-1554-07			1	. . . PUSH BUTTON:GREATER THAN/7/APERSAND	52833	GLWW010100003397
	366-1554-08			1	. . . PUSH BUTTON:NOT EQUAL/8/ASTERISK	52833	GLWW010100001773
	366-1554-09			1	. . . PUSH BUTTON:OR/9/LEFT PARENTHESIS	52833	GLWW010100003409
	366-1554-10			1	. . . PUSH BUTTON:AND/ZERO/RIGHT PARENTHESIS	52833	GLWW010100003380
	366-1554-11			1	. . . PUSH BUTTON:MINUS-PLUS/UNDERSCORE/MINUS	52833	GLWW010100001700
	366-1554-12			1	. . . PUSH BUTTON:DIVIDE/MULTIPLY/PLUS/EQUAL	52833	GLWW010100001698
	366-1554-13			1	. . . PUSH BUTTON:DOLLAR/DIAMOND/TILDE/GRAVE	52833	GLWW010100001697
	366-1554-14			1	. . . PUSH BUTTON:BACK SPACE	52833	GGWW05010000B269
	366-1555-38			1	. . . PUSH BUTTON:MARKED ESC	52833	GGWW0101E3890701
	366-1554-15			1	. . . PUSH BUTTON:QUESTION MARK/Q	52833	GLWW01010000563Q
	366-1554-16			1	. . . PUSH BUTTON:OMEGA/W	52833	GLWW01010000563W
	366-1554-17			1	. . . PUSH BUTTON:EPSILON/E	52833	GLWW01010000563E
	366-1554-18			1	. . . PUSH BUTTON:RHO/R	52833	GLWW01010000562R
	366-1554-19			1	. . . PUSH BUTTON:TILDE/T	52833	GLWW01010000562T
	366-1554-20			1	. . . PUSH BUTTON:TAKE/Y	52833	GLWW01010000563Y
	366-1554-21			1	. . . PUSH BUTTON:DROP/U	52833	GLWW01010000563W
	366-1554-22			1	. . . PUSH BUTTON:IOTA/I	52833	GLWW01010000563I
	366-1554-23			1	. . . PUSH BUTTON:CIRCULAR/O	52833	GLWW01010000563C
	366-1554-24			1	. . . PUSH BUTTON:ASTERISK/P	52833	GLWW01010000562P
	366-1554-25			1	. . . PUSH BUTTON:BRANCH ASSIGNMENT/BRACKETS	52833	GLWW010100001703
	366-1554-26			1	. . . PUSH BUTTON:RIGHT & LEFT TACK/VERTICAL DA	52833	GLWW010100001604
	366-1555-47			1	. . . PUSH BUTTON:MARKED LF	52833	GGWW0101L4780701
	366-1553-04			1	. . . PUSH BUTTON:RETURN	52833	GGWW09060000R445
	366-1555-40			1	. . . PUSH BUTTON:MARKED TAB	52833	GGWW0101T5990701
	366-1555-41			1	. . . PUSH BUTTON:MARKED CTRL	52833	GGWW0101C3560701
	366-1554-27			1	. . . PUSH BUTTON:ALPHA/A	52833	GLWW01010000563A
	366-1554-28			1	. . . PUSH BUTTON:CEILING/S	52833	GLWW01010000563S
	366-1554-29			1	. . . PUSH BUTTON:FLOOR/D	52833	GLWW01010000563D
	366-1554-30			1	. . . PUSH BUTTON:UNDERSCORE/F	52833	GLWW01010000563F
	366-1554-31			1	. . . PUSH BUTTON:DEC/G	52833	GLWW01010000563G
	366-1554-32			1	. . . PUSH BUTTON:DELTA/H	52833	GLWW01010000563H
	366-1554-33			1	. . . PUSH BUTTON:NULL/J	52833	GLWW01010000563J
	366-1554-34			1	. . . PUSH BUTTON:APOSTROPHE/K	52833	GLWW01010000563K

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-	366-1554-35			1	. . . PUSH BUTTON:QUAD/L	52833	GLWW01010000563L
	366-1554-36			1	. . . PUSH BUTTON:L PARENTHESIS/LEFT BRACKET	52833	GLWW010100001705
	366-1554-37			1	. . . PUSH BUTTON:R PARENTHESIS/RIGHT BRACKET	52833	GLWW010100001710
	366-1554-38			1	. . . PUSH BUTTON:LEFT BRACE/RIGHT BRACE	52833	GLWW010100001624
	366-1554-39			1	. . . PUSH BUTTON:RUB OUT	52833	GGWW25020000R557
	366-1555-42			1	. . . PUSH BUTTON:MARKED TTY LOCK	52833	GGWW0101T4931101
	366-1555-43			1	. . . PUSH BUTTON:MARKED SHIFT	52833	GGWW0203S5770701
	366-1554-40			1	. . . PUSH BUTTON:IMBED/Z	52833	GLWW01010000563Z
	366-1554-41			1	. . . PUSH BUTTON:INCLUSION/X	52833	GLWW01010000563X
	366-1554-42			1	. . . PUSH BUTTON:INTERSECTION/C	52833	GLWW01010000563C
	366-1554-43			1	. . . PUSH BUTTON:UNION/V	52833	GLWW01010000563V
	366-1554-44			1	. . . PUSH BUTTON:DECODE/B	52833	GLWW01010000563B
	366-1554-45			1	. . . PUSH BUTTON:ENCODE/N	52833	GLWW01010000563N
	366-1554-46			1	. . . PUSH BUTTON:RESIDUE/M	52833	GLWW01010000563M
	366-1554-47			1	. . . PUSH BUTTON:SEMI-COLON/COMMA/LESS THAN	52833	GLWW010100001707
	366-1554-48			1	. . . PUSH BUTTON:COLON/PERIOD/GREATER THAN	52833	GLWW010100001708
	366-1554-49			1	. . . PUSH BUTTON:BACK SLASH/SLASH/QUESTION MARK	52833	GLWW010100001709
	366-1555-52			1	. . . PUSH BUTTON:MARKED SHIFT	52833	BBWW020255770701
	366-1555-50			1	. . . PUSH BUTTON:MARKED BREAK	52833	GGWW0101B3310701
	366-1553-05			1	. . . PUSH BUTTON:SPACE BAR	52833	GGGG120100001090
-52	118-0031-00			1	. . ACTUATOR ASSY:9OZ SGL UNIT,W/MECH ALT ACT	52833	61-0261-09
-53	----- -----			1	. . ACTUATOR ASSY:6 UNIT,W/6 OZ IN POS #1	52833	61-0036-41
-54	----- -----			5	. . ACTUATOR ASSY:6 UNIT	52833	61-0036-17
-55	----- -----			4	. . ACTUATOR ASSY:4 UNIT	52833	61-0034-16
-56	----- -----			3	. . ACTUATOR ASSY:SINGLE UNIT	52833	61-0031-04
-57	----- -----			1	. . ACTUATOR ASSY:4 UNIT W/POS #4 VACANT	52833	61-0044-37
-58	118-0042-00			1	. . ACTUATOR ASSY:9OZ SINGLE UNIT	52833	61-0021-08
-59	----- -----			42	. . NUT,PLAIN,HEX:	52833	47-0001-01
-60	----- -----			2	. . RAIL STIFFENING:	52833	49-0062
					(ATTACHING PARTS)		
-61	----- -----			2	. . SCREW,MACHINE:	52833	47-0009-02
					- - - * - - -		
-62	----- -----			2	. . BRKT,SPACE BAR:	52833	44-0003
					(ATTACHING PARTS)		
-63	----- -----			2	. . SCREW,MACHINE:	52833	47-0004-01
-64	----- -----			2	. . NUT,PLAIN HEX:	52833	47-0001-01
					- - - * - - -		
-65	118-0039-00			2	. . SPRT,SPACER BAR:	52833	44-0001
-66	118-0037-00			1	. . PIVOT,BAR:	52833	49-0002
-67	----- -----			1	. . CKT BOARD ASSY:KEYBOARD	52833	PCB65-0928-02B
-68	386-2836-01			1	. SPRT,KEYBOARD:	80009	386-2836-01
					(ATTACHING PARTS)		
-69	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-70	----- -----			2	. SWITCH,LEVER:LOCAL/LINE,S1(SEE S1040,1042 EPL)		
	----- -----			2	. SWITCH,LEVER:S2,S3(SEE S1043,S1044 EPL)		
					(ATTACHING PARTS)		
-71	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-72	----- -----			2	. SW,LEVER:ASC11/APL,MARGIN(SEE S1041,1045 EPL)		
					(ATTACHING PARTS)		
-73	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-74	----- -----			1	. SWITCH,LEVER:MARGIN RELEASE(S1046 EPL)		
					(ATTACHING PARTS)		
-75	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-76	----- -----			1	. SWITCH,LEVER:COPY CONTROL(SEE S1047 EPL)		
					(ATTACHING PARTS)		
-77	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-78	----- -----			5	. LAMP,LED:(SEE CR1041,1042,1043,1045,1047 EPL)		
-79	----- -----			1	. LIGHT,INDICATOR:POWER(SEE DS1050 EPL)		
-80	331-0375-02			1	. MASK,KEYBOARD:	80009	331-0375-02

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-81	386-3010-01			1	. PANEL,KEYBOARD:	80009	386-3010-01
	----- -----			-	. (4014/4014-1 ONLY)		
	386-3014-01			1	. PANEL,KEYBOARD:	80009	386-3014-01
	----- -----			-	. (4015/4015-1 ONLY)		
-82	179-2250-00	B050000	B054519X	1	. WIRING HARNESS,:KEYBOARD	80009	179-2250-00
	----- -----			-	(4014/4014-1 ONLY)		
	179-2250-00	B050000	B050859X	1	WIRING HARNESS,:KEYBOARD	80009	179-2250-00
	----- -----			-	(4015/4015-1 ONLY)		
	179-2250-01	XB054520		1	WIRING HARNESS,:KEYBOARD	80009	179-2250-01
	----- -----			-	(4014/4014-1 ONLY)		
	179-2250-01	XB050860		1	WIRING HARNESS,:KEYBOARD	80009	179-2250-01
	----- -----			-	(4015/4015-1 ONLY)		
-83	131-0707-00			10	. . CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	131-0621-00			30	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-84	352-0169-00			5	. . HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
-85	352-0199-01			1	. . HLDR,TERM CONN:3 WIRE BROWN	80009	352-0199-01
-86	352-0200-01			1	. . CONN BODY,PL,EL:4 WIRE BROWN	80009	352-0200-01
-87	352-0201-06			1	. . CONN BODY,PL,EL:5 WIRE BLUE	80009	352-0201-06
-88	352-0205-00			1	. . CONN BODY,PL,EL:9 WIRE BLACK	80009	352-0205-00
-89	352-0206-02			1	. . CONN BODY,PL,EL:10 WIRE RED	80009	352-0206-02
-90	348-0128-00			4	BUMPER,PLASTIC:CABINET MTG,2.022 INCH LONG	80009	348-0128-00
					(ATTACHING PARTS)		
-91	211-0513-00			2	SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
					- - - * - - -		
-92	390-0421-01			1	CAB. DSPL UNIT:BOTTOM	80009	390-0421-01
					(ATTACHING PARTS)		
-93	212-0507-00			4	SCREW,MACHINE:10-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		

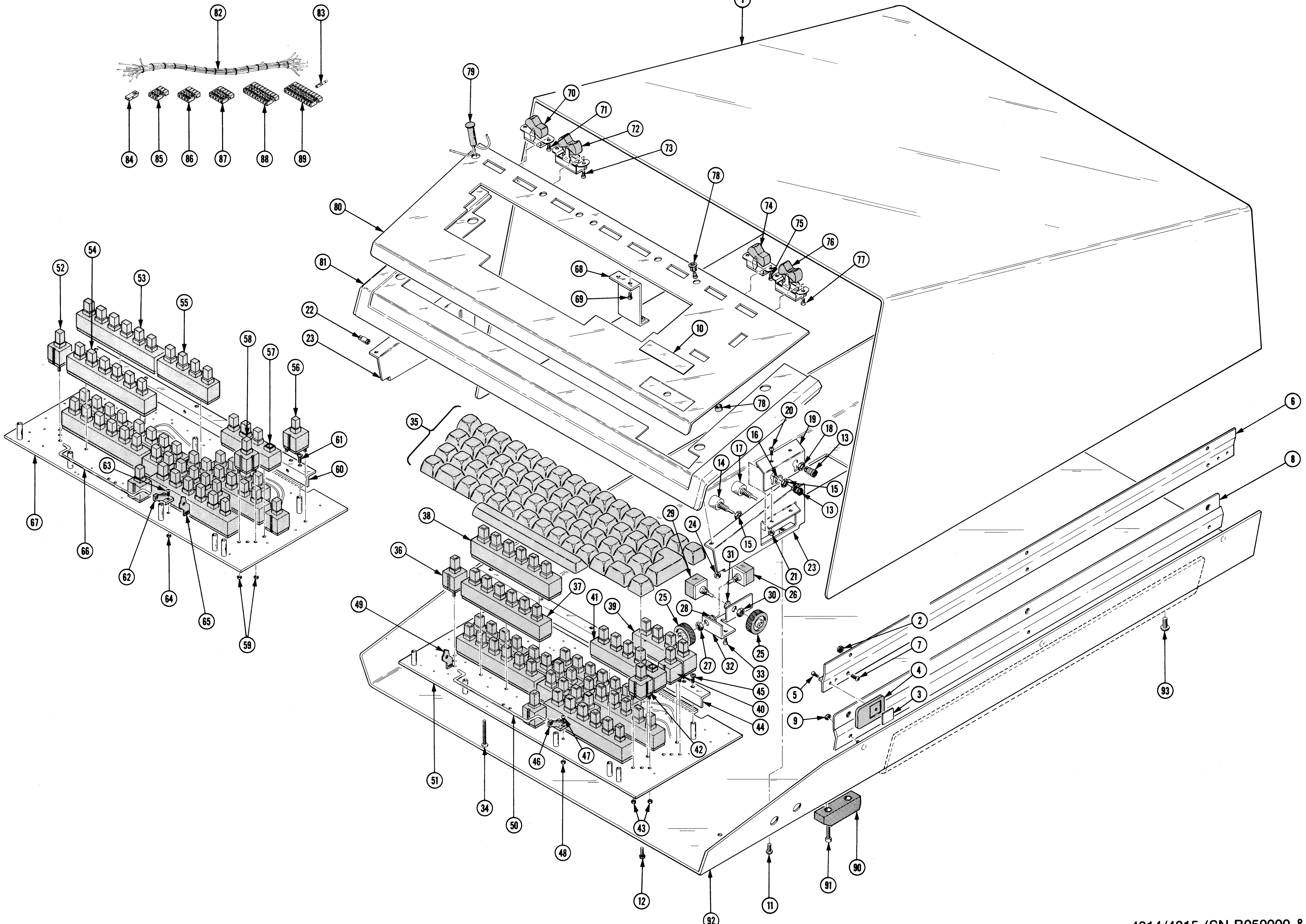


FIG. 2 CRT ASSEMBLY

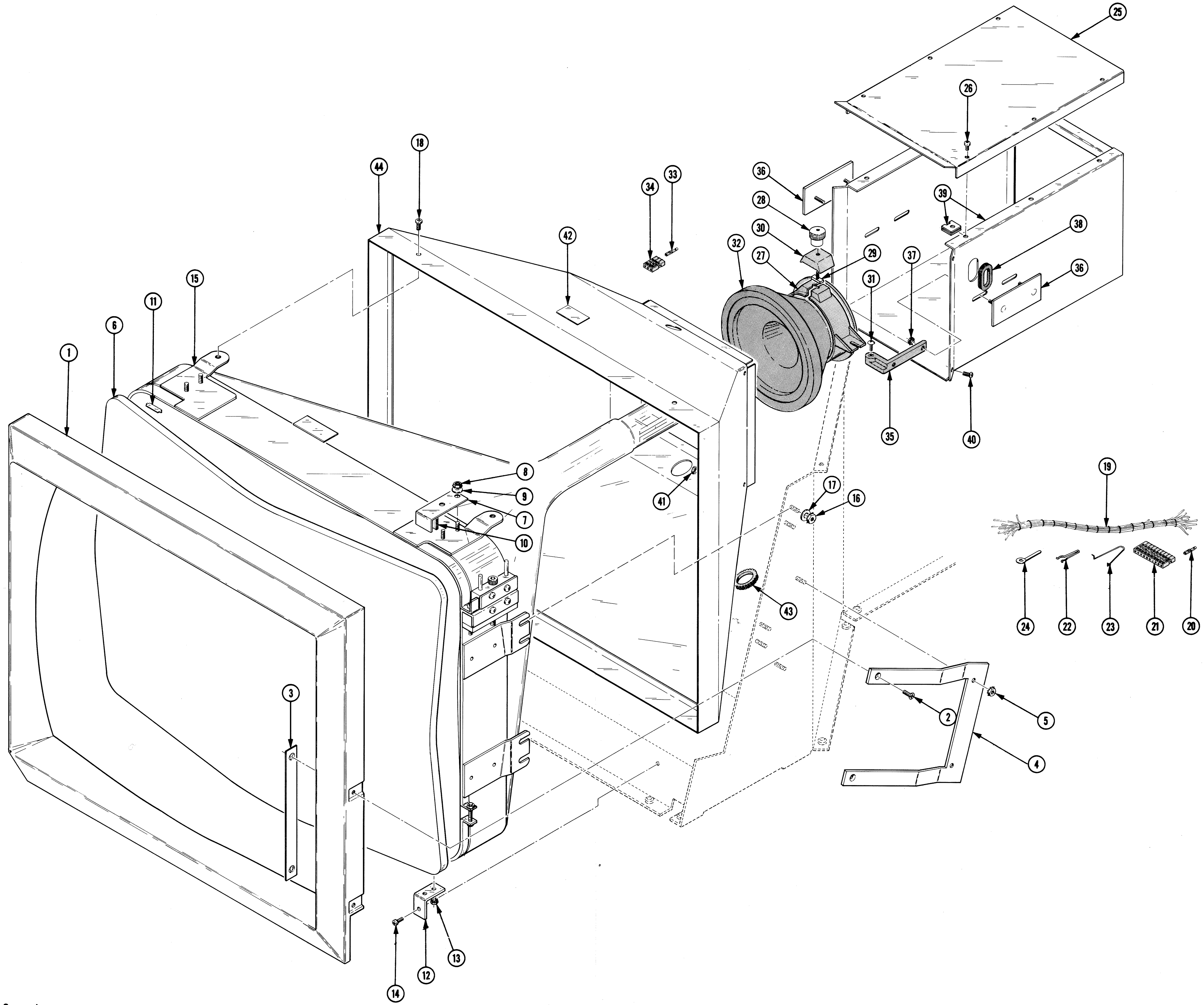


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-1	331-0374-07			1	MASK,CRT:TAN	80009	331-0374-07
					(ATTACHING PARTS)		
-2	211-0538-00			4	SCREW,MACHINE:6-32 X 0.312"100 DEG,FLH STL	83385	OBD
-3	386-3272-00			2	PLATE,NUT RTNG:	80009	386-3272-00
					- - - * - - -		
-4	407-1764-00			1	BRACKET,MASK:LEFT,ALUMINUM	80009	407-1764-00
	407-1765-00			1	BRACKET,MASK:RIGHT	80009	407-1765-00
					(ATTACHING PARTS)		
-5	210-0457-00			2	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-6	337-1981-01			1	SHLD,IMPLOSION:GREEN	80009	337-1981-01
					(ATTACHING PARTS)		
-7	407-1508-00			4	BRACKET,ANGLE:FILTER,ALUMINUM	80009	407-1508-00
-8	210-0457-00			8	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-9	210-0805-00			8	WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
					- - - * - - -		
-10	253-0056-00			FT	CUSHION:POLYURETHANE FOAM,PRESSURE SENS	04963	4116
-11	131-1520-00			4	CONTACT,ELEC:GROUNDING	80009	131-1520-00
-12	407-1763-00			1	BRACKET,ANGLE:CRT,ALUMINUM	80009	407-1763-00
					(ATTACHING PARTS)		
-13	210-0457-00			2	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-14	211-0510-00			1	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
-15	----- -----			1	ELECTRON TUBE:CRT(SEE V1 EPL)		
					(ATTACHING PARTS)		
-16	220-0410-00			8	NUT,EXTENDED WA:10-32 X 0.375 INCH,STL	83385	OBD
-17	210-0805-00			8	WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
-18	211-0510-00			4	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CRT ASSY INCLUDES:		
-19	179-2424-00	B050000	B056109	1	WIRING HARNESS,:CRT	80009	179-2424-00
	----- -----			-	(4014/4014-1 ONLY)		
	179-2424-01	B056110		1	WIRING HARNESS,:CRT	80009	179-2424-01
	----- -----			-	(4014/4014-1 ONLY)		
	179-2424-00	B050000	B051179	1	WIRING HARNESS,:CRT	80009	179-2424-00
	----- -----			-	(4015/4015-1 ONLY)		
	179-2424-01	B051180		1	WIRING HARNESS,:CRT	80009	179-2424-01
	----- -----			-	(4015/4015-1 ONLY)		
-20	131-0621-00			8	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-0622-00			1	. . CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
	131-0792-00			1	. . CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
-21	352-0206-03			1	. . HLDR,TERM CONN:10 WIRE ORANGE	80009	352-0206-03
	352-0206-04			1	. . HLDR,TERM CONN:10 WIRE YELLOW	80009	352-0206-04
-22	344-0035-00			1	. . CLIP,ELECTRICAL:SNAP-ON	80009	344-0035-00
-23	131-1594-00			1	. . CONTACT,ELEC:ANODE,0.042 DIA SPR STL,U-SHP	91260	OBD
	136-0660-00			2	. . SKT,PL-IN ELEK:FLOOD GUN	80009	136-0660-00
-24	210-0224-00			1	. . TERMINAL,LUG:0.20 ID X 0.344 OD,SE,BRS	86928	A373-148-1
-25	337-2012-00			1	SHIELD,SECT,CRT:UPPER REAR	80009	337-2012-00
					(ATTACHING PARTS)		
-26	211-0507-00			6	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
	119-0502-00			1	COIL,TUBE DEFLE:YOKE ASSY,X/Y AXIS	80009	119-0502-00
					(ATTACHING PARTS)		
-27	343-0532-00			1	CLAMP,DEFL COIL:W/RO11 PIN	80009	343-0532-00
-28	220-0733-00			1	NUT,PLAIN,KNURL:6-32 X 0.625 OD X 0.60"	80009	220-0733-00
-29	214-2219-00			1	BOLT,TEE HEAD:6-32 X 1.00 INCH LONG	80009	214-2219-00
-30	214-2218-00			1	ACTUATOR,CLAMP:DEFLECTION COIL	80009	214-2218-00
-31	211-0540-00			2	SCREW,MACHINE:6-32 X 0.50 INCH,TRH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. YOKE ASSY INCLUDES:		
-32	----- -----			2	. COIL,TUBE DEFL:X & Y AXIS(SEE L1012,L1017 EPL)		
-33	131-0621-00			6	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-34	352-0199-06			1	. CONN BODY,PL,EL:3 WIRE BLUE	80009	352-0199-06
	352-0199-09			1	. HLDR,TERM CONN: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
2-35	407-1602-00			2	BRACKET,ANGLE:COIL MOUNT,POLYAMIDE	80009	407-1602-00
					(ATTACHING PARTS)		
-36	386-2819-01			1	PLATE,RETAINING:BRACKET	80009	386-2819-01
-37	210-0457-00			2	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-38	348-0233-00			1	GROMMET,PLASTIC:GRAY,OVAL SHAPE,0.927 ID	80009	348-0233-00
-39	337-2013-00			1	SHIELD SECT,CRT:LOWER REAR	80009	337-2013-00
					(ATTACHING PARTS)		
-40	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-41	210-0457-00			4	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-42	334-1379-00			1	LABEL:CRT,ADHESIVE BACK	80009	334-1379-00
-43	255-0334-00			1	PLASTIC CHANNEL:12.75 X 0.175X 0.155,NYL	11897	122-37-2500
-44	337-1982-00			1	SHIELD SECT,CRT:FRONT	80710	337-1982-00-A

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	CKT BOARD ASSY:HARD COPY(SEE A13 EPL)		
					(ATTACHING PARTS)		
-2	211-0207-00			2	SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-3	131-0589-00			34	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-4	214-0579-00			4	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-5	210-1014-00			1	. WASHER,NONMETAL:0.094 ID X 0.312" OD,TEFLON	80009	210-1014-00
-6	352-0125-00			1	. HOLDER,TOROID:MOLD ACETAL	80009	352-0125-00
-7	214-0506-00			1	. CONTACT,ELEC:0.045 SQ X 0.375 INCH L	80009	214-0506-00
	----- -----			1	CKT BOARD ASSY:JUMPER(SEE A15 EPL)		
					(ATTACHING PARTS)		
	211-0207-00			2	SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
	131-0589-00			27	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
	385-0149-00			2	. SPACER,POST:0.625 L W/4-40 THD EA END,NYL	80009	385-0149-00
					(ATTACHING PARTS)		
	211-0207-00			1	. SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
-8	----- -----			1	CKT BOARD ASSY:STORAGE(SEE A12 EPL)		
					(ATTACHING PARTS)		
-9	211-0207-00			4	SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-10	131-0589-00			52	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-11	214-0579-00			7	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-12	385-0149-00			2	. SPACER,POST:0.625 L W/4-40 THD EA END,NYL	80009	385-0149-00
					(ATTACHING PARTS)		
-13	211-0207-00			1	. SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
-14	214-1254-00			1	. HEAT SINK,ELEC:0.422 H X 1.240 INCH OD	05820	209-AB
	136-0183-00	XB054970		1	. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
	----- -----			-	(4014/4014-1 ONLY)		
	136-0183-00	XB050960		1	. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
	----- -----			-	(4015/4015-1 ONLY)		
-15	337-2064-01			1	SHIELD,ELEC:STORAGE AND DEFLCTN CARD	80009	337-2064-01
					(ATTACHING PARTS)		
-16	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-17	----- -----			1	CKT BOARD ASSY:DEFLECTION AMPL(SEE A11 EPL)		
					(ATTACHING PARTS)		
-18	211-0207-00			4	SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-19	131-0589-00			75	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-20	131-0566-00			2	. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-21	214-0579-00			5	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-22	344-0154-00			4	. CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
	131-1334-00			4	. BUS CONDUCTOR:	80009	131-1334-00
	----- -----			-	. . EACH JUMPER INCLUDES:		
-23	131-0621-00			2	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-24	352-0198-00			1	. . HLDR,TERM CONN:2 WIRE BLACK	80009	352-.198-00
-25	385-0149-00			2	. SPACER,POST:0.625 L W/4-40 THD EA END,NYL	80009	385-0149-00
					(ATTACHING PARTS)		
-26	211-0207-00			1	. SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
-27	----- -----			1	TRANSISTOR:(SEE Q1023 EPL)		
					(ATTACHING PARTS)		
-28	211-0008-00			1	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-29	210-1181-00			1	WASHER,SHLDR:1.22 ID X 0.2OD	31223	OBD
-30	210-0586-00			1	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-31	342-0203-00			1	INSULATOR,PLATE:XSTR,0.675 X 0.625 X 0.001	18722	DF103C
-32	343-0401-00			3	RETAINER,CLIP:W/ADHESIVE BACK,GRAY	80009	343-0401-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-33	343-0400-00			3	CLAMP,CABLE:1.250 INCH LONG,PLASTIC	80009	343-0400-00
					(ATTACHING PARTS)		
-34	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-35	255-0334-00			1	PLASTIC CHANNEL:12.75 X 0.175X 0.155,NYL	11897	122-37-2500
	198-3407-00			1	WIRE SET,ELEC:	80009	198-3407-00
	----- -----			1	. CABLE ASSY:J131/J115		
-36	175-0828-00			FT	. . WIRE,ELECTRICAL:5 WIRE RIBBON	08261	OBD
-37	131-0621-00			10	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-38	352-0201-01			1	. . CONN BODY,PL,EL:5 WIRE BROWN	80009	352-0201-01
	352-0201-05			1	. . CONN BODY,PL,EL:5 WIRE GREEN	80009	352-0201-05
	----- -----			1	. CABLE ASSY:J132/J116		
-39	175-0830-00			FT	. . WIRE,ELECTRICAL:7 WIRE RIBBON	08261	SS-0726-710610C
	131-0621-00			14	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-40	352-0203-02			1	. . CONN BODY,PL,EL:7 WIRE ORANGE	80009	352-0203-02
	352-0203-06			1	. . CONN BODY,PL,EL:7 WIRE BLUE	80009	352-0203-06
	----- -----			-	. CABLE ASSY:J117/Q1023		
-41	175-0826-00			FT	. . WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
	131-0621-00			3	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-42	352-0199-07			1	. . HLDR,TERM CONN:3 WIRE VIOLET	80009	352-0199-07
-43	131-1815-00			3	. . CONTACT,ELEC:22-30 AWG,FEMALE,BRASS	27264	08-56-0110
-44	204-0678-00			1	. . CONN BODY,PL,EL:FOR 3 FEMALE CONTACTS	27264	10-17-2032
	----- -----			1	. CABLE ASSY:J114/J51		
	131-0621-00			4	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-45	352-0198-04			1	. . HLDR,TERM CONN:2 WIRE YELLOW	80009	352-0198-04
	352-0199-01			1	. . HLDR,TERM CONN:3 WIRE BROWN	80009	352-0199-01
	----- -----			1	. CABLE ASSY:J76/Q1032		
	175-0826-00			FT	. . WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
	131-0621-00			3	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	352-0199-06			1	. . CONN BODY,PL,EL:3 WIRE BLUE	80009	352-0199-06
-46	334-2255-00			3	MARKER,IDENT:DANGER 500V	80009	334-2255-00
	334-2258-00			2	MARKER,IDENT:DANGER HI VOLT	80009	334-2258-00
	334-2192-01	XB068552		1	MARKER,IDENT:MKD INT SET FOR 110V	80009	334-2192-01
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2192-01	XB061488		1	MARKER,IDENT:MKD INT SET FOR 110V	80009	334-2192-01
	----- -----			-	(4015, 4015-1 ONLY)		
	334-2193-01	XB068552		1	MARKER,IDENT:MKD INT SET FOR 120V	80009	334-2193-01
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2193-01	XB061488		1	MARKER,IDENT:MKD INT SET FOR 120V	80009	334-2193-01
	----- -----			-	(4015, 4015-1 ONLY)		
	334-2194-01	XB068552		1	MARKER,IDENT:MKD INT SET FOR 200V	80009	334-2194-01
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2194-01	XB061488		1	MARKER,IDENT:MKD INT SET FOR 200V	80009	334-2194-01
	----- -----			-	(4015, 4015-1 ONLY)		
	334-2195-01	XB068552		1	MARKER,IDENT:MKD INT SET FOR 220V	80009	334-2195-01
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2195-01	XB061488		1	MARKER,IDENT:MKD INT SET FOR 220V	80009	334-2195-01
	----- -----			-	(4015, 4015-1 ONLY)		
	334-2196-01	XB068552		1	MARKER,IDENT:MKD INT SET FOR 240V	80009	334-2196-01
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2196-01	XB061488		1	MARKER,IDENT:MKD INT SET FOR 240V	80009	334-2196-01
	----- -----			-	(4015, 4015-1 ONLY)		
	334-2558-00	XB068552		1	MARKER,IDENT:MARKED 115V	80009	334-2558-00
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2558-00	XB061488		1	MARKER,IDENT:MARKED 115V	80009	334-2558-00
	----- -----			-	(4015, 4015-1 ONLY)		
	334-2560-00	XB068552		1	MARKER,IDENT:MARKED 230V	80009	334-2560-00
	----- -----			-	(4014, 4014-1 ONLY)		
	334-2560-00	XB061488		1	MARKER,IDENT:MARKED 230V	80009	334-2560-00
	----- -----			-	(4015, 4015-1 ONLY)		
-47	200-1678-01			1	COVER,XSTR:	80009	200-1678-01
					(ATTACHING PARTS)		
-48	211-0071-00			2	SCREW,MACHINE:4-40 X 0.375 INCH,TRH,STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-49	200-1679-01			1	COVER,XSTR:	80009	200-1679-01
					(ATTACHING PARTS)		
-50	211-0071-00			2	SCREW,MACHINE:4-40 X 0.375 INCH,TRH,STL	83385	OBD
					- - - * - - -		
	610-0347-00			1	CHASSIS ASSY:	80009	610-0347-00
					(ATTACHING PARTS)		
-51	212-0045-00			4	SCREW,MACHINE:8-32 X 0.500 INCH,TRH,STL	83385	OBD
					- - - * - - -		
	----- -----			-	. HEATSINK ASSY INCLUDES:		
-52	129-0463-00			4	. SPACER,POST:0.188 HEX X 0.937"L,W/4-40 THD	80009	129-0463-00
					(ATTACHING PARTS)		
-53	211-0014-00			1	. SCREW,MACHINE:4-40 X 0.50 INCH,PNH STL	83385	OBD
-54	210-0004-00			1	. WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
					- - - * - - -		
-55	----- -----			5	. XSTR:(SEE Q1021,Q1022,Q1024,Q1025,Q1027 EPL)		
	----- -----			1	. XSTR:(SEE Q1029 EPL)		
					(ATTACHING PARTS)		
-56	213-0185-00			2	. SCR,TPG,THD FOR:6-20 X 6.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-57	386-0978-00			6	. INSULATOR,PLATE:TRANSISTOR,MICA	80009	386-0978-00
	166-0228-00			1	. INS SLV,ELEC:0.187 ID X 2.75 INCH LONG	80009	166-0228-00
-58	136-0280-00			6	. SOCKET,PLUG-IN:FOR TO-3 FOR TO-3	97913	LST 2202-2
					(ATTACHING PARTS)		
-59	213-0088-00			2	. SCR,TPG,THD CTG:4-24 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-60	----- -----			2	. XSTR:(SEE Q1011,Q1016 EPL)		
	----- -----			2	. XSTR:(SEE Q1013,Q1018 EPL)		
	----- -----			2	. XSTR:(SEE Q1014,Q1019 EPL)		
	----- -----			2	. XSTR:(SEE Q1012,Q1017 EPL)		
					(ATTACHING PARTS)		
-61	211-0513-00	B050000	B054799	1	. SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
	----- -----			-	(4014/4014-1 ONLY)		
	211-0514-00	B054800		1	. SCREW,MACHINE:6-32 X 0.750 INCH,PNH STL	83385	OBD
	----- -----			-	(4014/4014-1 ONLY)		
	211-0513-00	B050000	B050919	1	. SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
	----- -----			-	(4015/4015-1 ONLY)		
	211-0514-00	B050920		1	. SCREW,MACHINE:6-32 X 0.750 INCH,PNH STL	83385	OBD
	----- -----			-	(4015/4015-1 ONLY)		
	210-0802-00	XB054860		1	. WASHER,FLAT:0.15 ID X 0.312 INCH OD	12327	OBD
	----- -----			-	(4014/4014-1 ONLY)		
	210-0802-00	XB050920		1	. WASHER,FLAT:0.15 ID X 0.312 INCH OD	12327	OBD
	----- -----			-	(4015/4015-1 ONLY)		
-62	210-0811-00			1	. WSHR,SHOULDERED:0.125 ID X 0.50 INCH OD	86928	5604-47
-63	210-0071-00			1	. WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
-64	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
-65	342-0136-00			8	. INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
-66	214-2049-01			1	. HEAT SINK,XSTR:	80009	214-2049-01
	198-3405-00			1	. WIRE SET,ELEC:	80009	198-3405-00
	----- -----			1	. . CABLE ASSY:Q1016/Q1018/J57		
-67	175-0829-00			FT	. . . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
-68	131-1918-00			6	. . . CONTACT,ELEC:22-26 AWG WIRE,CRIMP ON,BRS	27264	08-56-0107
-69	204-0671-00			2	. . . BODY,CONN,PLUG,:3 FEMALE POSN. NYLON	27264	09-50-4031
-70	131-0621-00			6	. . . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-71	352-0202-07			1	. . . CONN BODY,PL,EL:6 WIRE VIOLET	80009	352-0202-07
	----- -----			1	. . CABLE ASSY:Q1019/Q1017/J58		
	175-0829-00			FT	. . . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
	131-1918-00			6	. . . CONTACT,ELEC:22-26 AWG WIRE,CRIMP ON,BRS	27264	08-56-0107
	204-0671-00			2	. . . BODY,CONN,PLUG,:3 FEMALE POSN. NYLON	27264	09-50-4031
	131-0621-00			6	. . . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	352-0202-08			1	. . . CONN BODY,PL,EL:6 WIRE GRAY	80009	352-0202-08
	----- -----			1	. . CABLE ASSY:Q1011/Q1013/J60		
	175-0829-00			FT	. . . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
	131-1918-00			6	. . . CONTACT,ELEC:22-26 AWG WIRE,CRIMP ON,BRS	27264	08-56-0107
	204-0671-00			2	. . . BODY,CONN,PLUG,:3 FEMALE POSN. NYLON	27264	09-50-4031

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-	131-0621-00			6	. . . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	352-0202-00			1	. . . HLDR,TERM CONN:6 WIRE BLACK	80009	352-0202-00
	----- -----			1	. . CABLE ASSY:Q1014/Q1012/J61		
	175-0829-00			1	. . . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
	131-1918-00			6	. . . CONTACT,ELEC:22-26 AWG WIRE,CRIMP ON,BRS	27264	08-56-0107
	204-0671-00			2	. . . BODY,CONN,PLUG,:3 FEMALE POSN. NYLON	27264	09-50-4031
	131-0621-00			6	. . . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	352-0202-01			1	. . . CONN BODY,PL,EL:6 WIRE BROWN	80009	352-0202-01
	----- -----			1	. . CABLE ASSY:Q1021/Q1022/Q1024/J113		
	175-0829-00			FT	. . . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
	131-0621-00			6	. . . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	352-0202-03			1	. . . CONN BODY,PL,EL:6 WIRE ORANGE	80009	352-0202-03
	----- -----			-	. . CABLE ASSY:Q1025/Q1027/Q1029/J112		
-72	175-0832-00			FT	. . . WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0926(1061)0C
	131-0621-00			9	. . . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-73	352-0205-02			1	. . . CONN BODY,PL,EL:9 WIRE RED	80009	352-0205-02
-74	179-2119-01			1	WIRING HARNESS,:HARD COPY	80009	179-2119-01
					(ATTACHING PARTS)		
-75	129-0260-00			2	POST,ELEC-MECH:0.255 HEX X 0.500 INCH L	80009	129-0260-00
-76	210-0201-00			1	TERMINAL,LUG:SE #4	86928	A373-157-2
	210-0003-00			1	WASHER,LOCK:EXT,0.123 ID X 0.245" OD,STL	78189	1104-00-00-0541C
-77	210-0406-00			2	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
					- - - * - - -		
	----- -----			-	. CABLE ASSY INCLUDES:		
-78	131-0458-00			1	. CONNECTOR,RCPT,:15 PIN,FEMALE	71468	DA15S
-79	131-0621-00			8	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-0622-00			2	. CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
	131-0792-00			2	. CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
-80	352-0198-00			1	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00
	352-0198-01			1	. HLDR,TERM CONN:2 WIRE BROWN	80009	352-0198-01
	352-0198-06			1	. HLDR,TERM CONN:2 WIRE BLUE	80009	352-0198-06
	352-0198-08			1	. CONN BODY,PL,EL:2 WIRE GRAY	80009	352-0198-08
-81	352-0200-00			1	. HLDR,TERM CONN:4 WIRE BLACK	80009	352-0200-00
-82	200-1751-00			1	COVER,CONN HOLE:0.53 W X 1.625 INCH LONG	80009	200-1751-00
					(ATTACHING PARTS)		
-83	211-0014-00			2	SCREW,MACHINE:4-40 X 0.50 INCH,PNH STL	83385	OBD
-84	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-85	337-2014-01			1	SHIELD,ELEC:HV CKT CARD	80009	337-2014-01
					(ATTACHING PARTS)		
-86	211-0033-00			3	SCR,ASSEM WSHR:4-40 X 0.312 PNH,STL,CD PL	83385	OBD
					- - - * - - -		
-87	----- -----			1	CKT BOARD ASSY:H.V. & Z-AXIS(SEE A10 EPL)		
					(ATTACHING PARTS)		
-88	211-0207-00			4	SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
-89	211-0040-00			1	SCREW,MACHINE:4-40 X 0.25",BDGH PLSTC	26365	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-90	200-1327-00			1	. SHIELD,RESISTOR:	80009	200-1327-00
-91	366-0261-00			1	. KNOB:0.312 OD X 0.406 INCH LONG	80009	366-0261-00
	214-0949-00			1	. . SPR,HLCL,TRSN:0.282" OD X 0.125" LONG	80009	214-0949-00
-92	384-1181-00			1	. EXTENSION SHAFT:1.840 INCH LONG	80009	384-1181-00
-93	376-0029-00			1	. CPLG,SHAFT,RGD:0.128 ID X 0.312 OD X 0.5"L	80009	376-0029-00
-94	----- -----			1	. RES.,VAR:FOCUS(SEE R191 EPL)		
-95	384-0616-00			2	. POST,ELEC-MECH:HEX,0.25 X 1.370 INCH LONG	80009	384-0616-00
					(ATTACHING PARTS)		
-96	211-0033-00			1	. SCR,ASSEM WSHR:4-40 X 0.312 PNH,STL,CD PL	83385	OBD
					- - - * - - -		
-97	129-0369-00			2	. INSULATOR,STDF:1.370 INCH,W/4-40 THREAD	80009	129-0369-00
					(ATTACHING PARTS)		
-98	211-0040-00			1	. SCREW,MACHINE:4-40 X 0.25",BDGH PLSTC	26365	OBD
					- - - * - - -		
-99	214-0973-00			1	. HEAT SINK,ELEC:0.28 X 0.18 OVAL X 0.187"H	80009	214-0973-00
-100	214-1254-00			1	. HEAT SINK,ELEC:0.422 H X 1.240 INCH OD	05820	209-AB
-101	214-1291-00			1	. HEAT SINK,ELEC:XSTR,0.72 OD X 0.375"H	05820	207-AB

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-102	214-0579-00			3	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-103	131-0589-00			30	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-104	131-0993-09			1	. LINK,TERM.CONNE:2 WIRE WHITE	00779	530153-1
	136-0667-00			1	. SOCKET ASSY,CRT:W/CABLE	80009	136-0667-00
-105	136-0278-00			1	. . SOCKET,PLUG-IN:WITH PINS	80009	136-0278-00
	131-1819-00			7	. . CONTACT,ELEC:26-18 AWG,MALE,GOLD PL	00779	350018-3
-106	200-0801-00			1	. . COVER,SOCKET,PL:ELECTRON TUBE,PLASTIC	80009	200-0801-00
107	129-0129-00			4	SPACER,POST:0.25 HEX X 1.125"L,W/4-40 THD	80009	129-0129-00
					(ATTACHING PARTS)		
-108	211-0033-00			1	SCR,ASSEM WSHR:4-40 X 0.312 PNH,STL,CD PL	83385	OBD
					- - - * - - -		
-109	129-0251-00			1	INSULATOR,STDF:0.250 OD X 1.125" L,PLSTC	80009	129-0251-00
					(ATTACHING PARTS)		
-110	211-0033-00			1	SCR,ASSEM WSHR:4-40 X 0.312 PNH,STL,CD PL	83385	OBD
					- - - * - - -		
111	----- -----			1	CKT BOARD ASSY:CABLE INTERCONNECT(SEE A2 EPL)		
					(ATTACHING PARTS)		
-112	211-0207-00			2	SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-113	131-0589-00			74	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-114	210-0202-00			1	TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
					(ATTACHING PARTS)		
-115	211-0507-00			1	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-116	210-0457-00			1	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-117	----- -----			1	TRANSISTOR:(SEE Q1032 EPL)		
					(ATTACHING PARTS)		
-118	213-0183-00	B050000	B054799	2	SCR,TPG,THD FOR:6-20 X 0.5 TYPE B,PNH,STL	83385	OBD
	----- -----			-	(4014/4014-1 ONLY)		
	213-0185-00	B054800		2	SCR,TPG,THD FOR:6-20 X 6.25 INCH,PNH STL	83385	OBD
	----- -----			-	(4014/4014-1 ONLY)		
	213-0183-00	B050000	B050919	2	SCR,TPG,THD FOR:6-20 X 0.5 TYPE B,PNH,STL	83385	OBD
	----- -----			-	(4015/4015-1 ONLY)		
	213-0185-00	B050920		2	SCR,TPG,THD FOR:6-20 X 6.25 INCH,PNH STL	83385	OBD
	----- -----			-	(4015/4015-1 ONLY)		
					- - - * - - -		
-119	166-0228-00			1	INS SLV,ELEC:0.187 ID X 2.75 INCH LONG	80009	166-0228-00
-120	214-1610-00			1	HEAT SINK,ELEC:TRANSISTOR	80009	214-1610-00
-121	136-0280-00			1	SOCKET,PLUG-IN:FOR TO-3 FOR TO-3	97913	LST 2202-2
					(ATTACHING PARTS)		
-122	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-123	348-0056-00			1	GROMMET,PLASTIC:0.375 INCH DIA	80009	348-0056-00
-124	407-1513-00			1	BRACKET,ANGLE:TRANSISTOR	80009	407-1513-00
					(ATTACHING PARTS)		
-125	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-126	386-3089-01			1	SUPPORT,CHASSIS:HV/DEFLECTION,UPPER	80009	386-3089-01
					(ATTACHING PARTS)		
-127	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-128	441-1310-01			1	CHASSIS ASSY:DISPLAY UNIT	80009	441-1310-01
					(ATTACHING PARTS)		
-129	211-0559-00			8	SCREW,MACHINE:6-32 X 0.375"100 DEG,FLH STL	83385	OBD
-130	211-0507-00			10	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-131	179-2248-03			1	WIRING HARNESS,:DISPLAY	80009	179-2248-03
					(ATTACHING PARTS)		
-132	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CABLE ASSY INCLUDES:		
-133	131-0327-00			1	. CONN,RCPT,ELEC:CKT BD,15/30 CONTACT	05574	2VH15/1AN5

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-134	131-0621-00			78	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-0622-00			2	. CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
	131-0792-00			19	. CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
-135	352-0198-00			1	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00
	352-0198-05			2	. HLDR,TERM CONN:2 WIRE GREEN	80009	352-0198-05
-136	352-0199-00			1	. CONN BODY,PL,EL:3 WIRE BLACK	80009	352-0199-00
	352-0199-04			1	. CONN BODY,PL,EL:3 WIRE YELLOW	80009	352-0199-04
	352-0199-09			1	. HLDR,TERM CONN:3 WIRE WHITE	80009	352-0199-09
-137	352-0200-01			1	. CONN BODY,PL,EL:4 WIRE BROWN	80009	352-0200-01
	352-0200-02			1	. CONN BODY,PL EL:4 WIRE RED	80009	352-0200-02
	352-0200-03			1	. HLDR,TERM CONN:4 WIRE ORANGE	80009	352-0200-03
	352-0200-04			1	. HLDR,TERM CONN:4 WIRE YELLOW	80009	352-0200-04
-138	352-0201-08			1	. CONN BODY,PL,EL:5 WIRE GRAY	80009	352-0201-08
-139	352-0203-01			1	. CONN BODY,PL,EL:7 WIRE BROWN	80009	352-0203-01
	352-0203-04			1	. CONN BODY,PL,EL:7 WIRE YELLOW	80009	352-0203-04
-140	352-0204-02			1	. HLDR,TERM CONN:8 WIRE RED	80009	352-0204-02
-141	352-0205-02			1	. CONN BODY,PL,EL:9 WIRE RED	80009	352-0205-02
	352-0205-03			1	. CONN BODY,PL,EL:9 WIRE ORANGE	80009	352-0205-03
-142	352-0206-00			1	. HLDR,TERM CONN:10 WIRE BLACK	80009	352-0206-00
	352-0206-03			1	. HLDR,TERM CONN:10 WIRE ORANGE	80009	352-0206-03
	352-0206-05			1	. HLDR,TERM CONN:10 WIRE GREEN	80009	352-0206-05
-143	131-0958-00			54	. CONTACT,ELEC:MALE,20-22 AWG	00779	66103-1
	131-1625-00			10	. CONTACT,ELEC:MALE,16-18 AWG,1 INCH LONG	00779	66099-1
	131-1574-00			2	. CONTACT,ELEC:MALE	00779	204219-1
-144	213-0438-00			2	. JACKSCREW:MALE,FXD	00779	200875-2
-145	131-0968-00			2	. GUIDE,SKT,CONN:	00779	201047-4
-146	131-0967-00			2	. GUIDE PIN,CONN:	00779	201046-4
-147	204-0620-00			1	. BODY,CONNECTOR:75 CONTACTS,MALE	00779	201622-1
-148	386-3008-01			1	. PLATE,CONN MTG:ALUMINUM	80009	386-3008-01
-149	200-1676-00			1	COVER,MTG HOLE:	80009	200-1676-00
					(ATTACHING PARTS)		
-150	211-0537-00			4	SCREW,MACHINE:6-32 X 0.375 INCH,TRH STL	83385	OBD
-151	210-0006-00			4	WASHER,LOCK:#6 INTL,0.018THK,STL CD PL	78189	1206-00-00-0541C
-152	385-0122-00			4	SPACER,POST:0.937 L W/6-32 THD EA END,AL	80009	385-0122-00
					- - - * - - -		

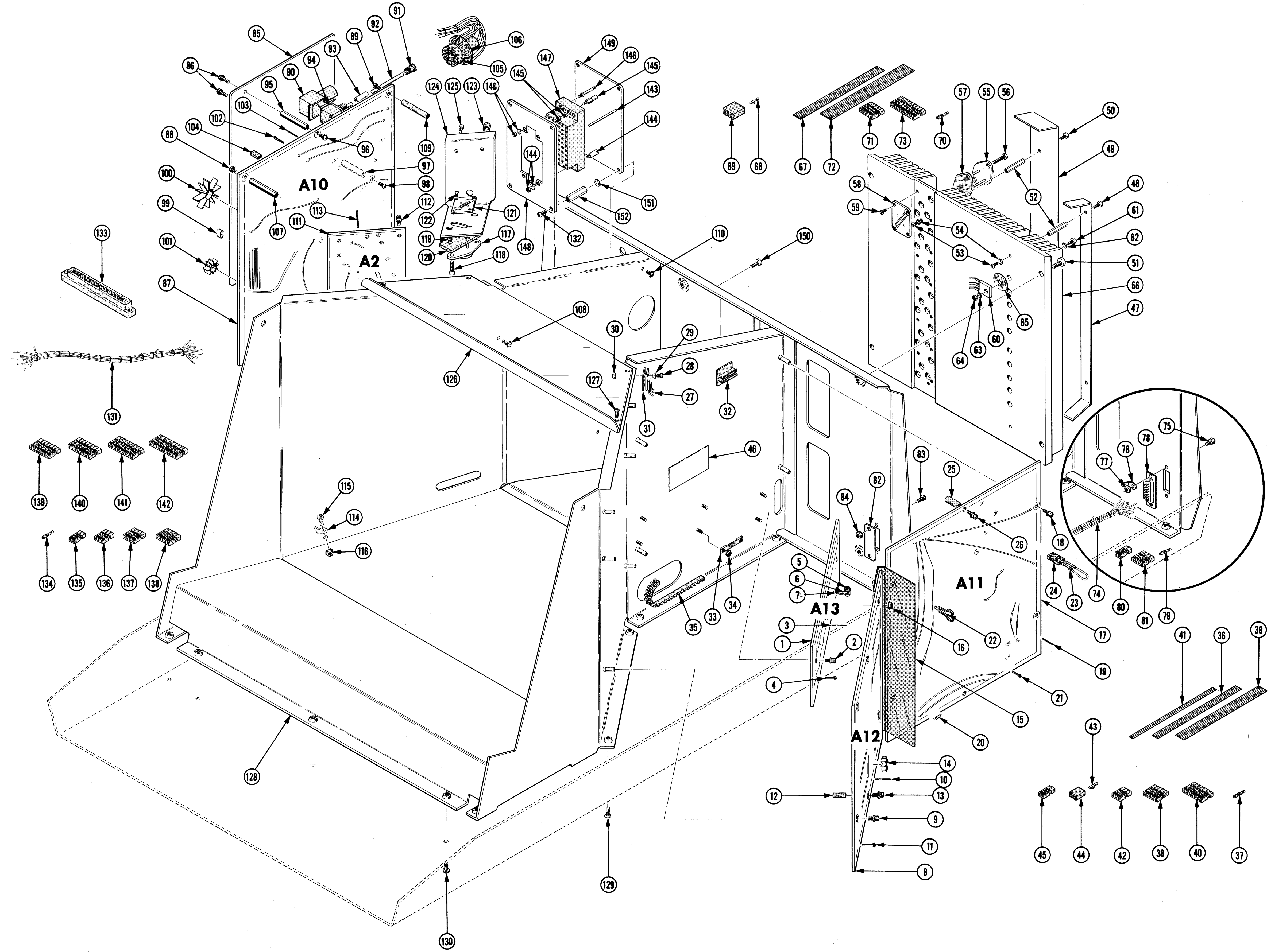


FIG. 3 CHASSIS & CIRCUIT BOARD ASSEMBLIES

FIG. 4 PEDESTAL UNIT

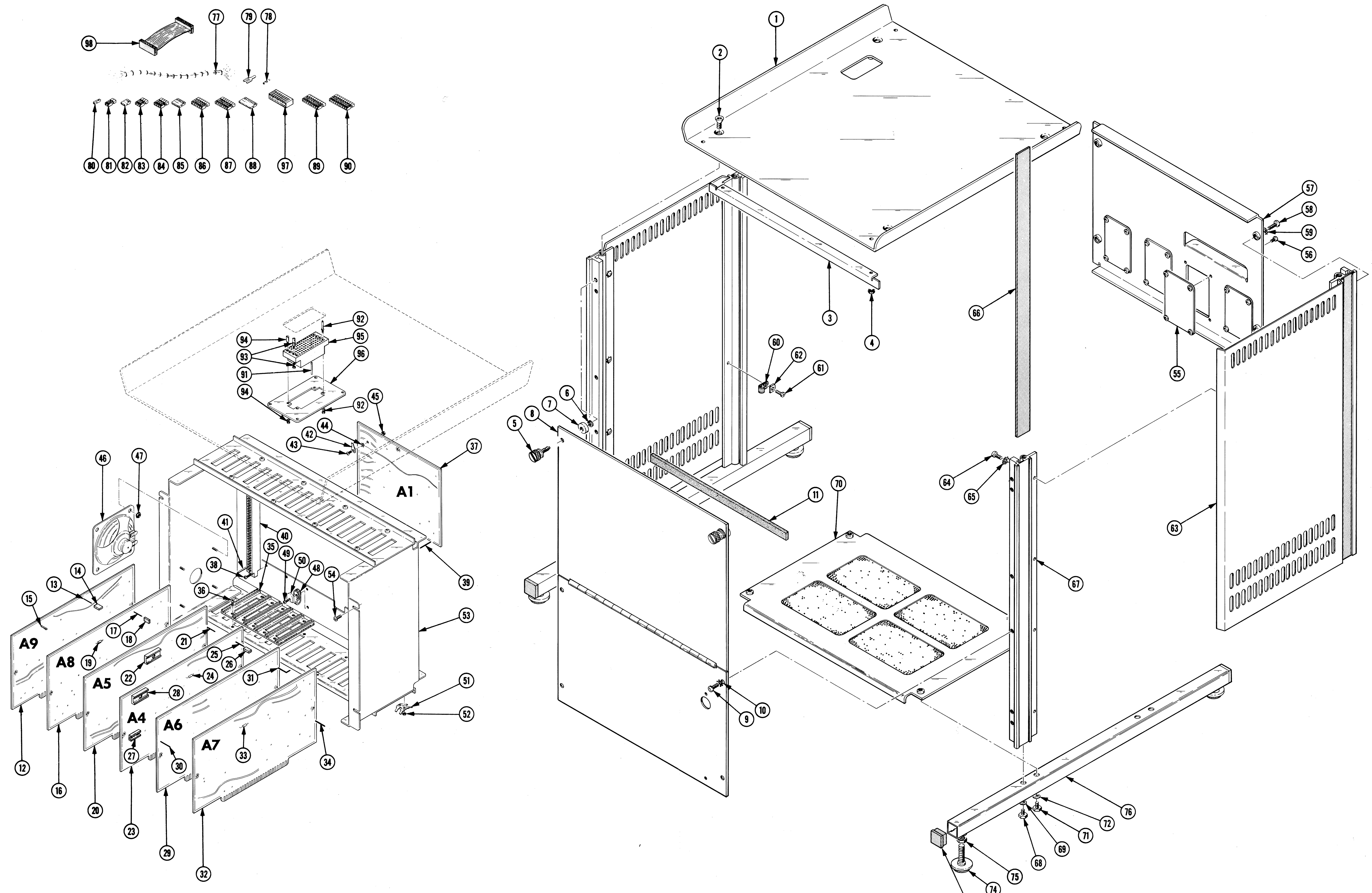


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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-1	386-2852-01			1	PLATE,MOUNTING:DISPLAY UNIT	80009	386-2852-01
					(ATTACHING PARTS)		
-2	213-0344-00			4	SCREW,MACHINE:0.25-20 X 0.50,HEX SOC,FHS	71838	OBD
					- - - * - - -		
-3	407-1455-01			1	BRACKET,ANGLE:TRIM,ALUMINUM	80009	407-1455-01
					(ATTACHING PARTS)		
-4	210-0457-00			2	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-5	213-0167-00			2	THUMBSCREW:10-32 X 1.344 INCH LONG	80009	213-0167-00
					(ATTACHING PARTS)		
-6	354-0025-00			1	RING,RETAINING:0.181 INCH FREE ID	79136	5555-18
					- - - * - - -		
-7	361-0336-00			2	SPACER,RING:0.203 ID X 0.625 OD	80009	361-0336-00
-8	386-3006-01			1	PANEL,ACCESS:FRONT	80009	386-3006-01
					(ATTACHING PARTS)		
-9	212-0577-00			4	SCREW,MACHINE:10-32 X 0.625",TRH,STL	83385	OBD
-10	210-0009-00			4	WASHER,LOCK:EXT,0.193ID X0.40" OD,STL	78189	1110-00
	211-0537-00			2	SCREW,MACHINE:6-32 X 0.375 INCH,TRH STL	83385	OBD
					- - - * - - -		
-11	348-0102-00			1	PAD,CUSHIONING:13.76 INCH LONG(CUT TO FIT)	80009	348-0102-00
-12	----- -----			1	CKT BOARD ASSY:INTERFACE(SEE STD ACCESS)		
	----- -----			1	CKT BOARD ASSY:DISCRETE PLOT(SEE A9 EPL)		
-13	131-0608-00			27	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0787-00			10	. CONTACT,ELEC:0.64 INCH LONG	22526	47359
-14	131-0993-00			7	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
	131-0993-09			2	. LINK,TERM.CONNE:2 WIRE WHITE	00779	530153-1
-15	214-0579-00			3	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-16	----- -----			1	CKT BOARD ASSY:DISPLAY CONTROL(SEE A8 EPL)		
	----- -----			1	CKT BOARD ASSY:DISPLAY CONTROL(SEE OPT. 34 ONLY)		
-17	131-0787-00			21	. CONTACT,ELEC:0.64 INCH LONG	22526	47359
	131-0608-00			3	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-18	131-0993-09			1	. LINK,TERM.CONNE:2 WIRE WHITE	00779	530153-1
-19	131-0566-00			1	. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-20	----- -----			1	CKT BOARD ASSY:CHARACTER GEN(SEE A5 EPL)		
	----- -----			-	(4014,4014-1 ONLY)		
	----- -----			1	CKT BOARD ASSY:CHARACTER GEN(SEE A5 EPL)		
	----- -----			-	(4015,4015-1 ONLY)		
-21	131-0608-00			24	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0589-00			4	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-22	136-0432-00			1	. SOCKET,PLUG-IN:24 CONTACT	71785	133-59-02-011
-23	----- -----			1	CKT BOARD ASSY:TC-1(SEE A4 EPL)		
-24	131-0566-00			1	. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-25	131-0608-00			43	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-26	131-0993-00			4	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-27	136-0260-02			1	. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
-28	136-0432-00			1	. SOCKET,PLUG-IN:24 CONTACT	71785	133-59-02-011
-29	----- -----			1	CKT BOARD ASSY:TC-2(SEE A6 EPL)		
	----- -----			1	CKT BOARD ASSY:TC-2(OPT. 34 ONLY,SEE A6 EPL)		
-30	131-0608-00			38	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-31	131-1425-00			1	. CONTACT SET,ELE:R ANGLE,0.150" L,STR OF 36	22526	65521-136
	131-1426-00			1	. CONTACT SET,ELE:R ANGLE,0.250L,STRIP OF 36	22526	65524-136
	131-1207-00			1	. LINK,TERM.CONNE:4 WIRE BLACK	80009	131-1207-00
-32	----- -----			1	CKT BOARD ASSY:TC-3(SEE A7 EPL)		
-33	131-0566-00			2	. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-34	131-0608-00			41	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0589-00			6	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-35	351-0250-00			4	GUIDE,CKT CARD:	80009	351-0250-00
					(ATTACHING PARTS)		
-36	211-0510-00			4	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
-37	----- -----			1	CKT BOARD ASSY:MOTHER(SEE A1 EPL)		
					(ATTACHING PARTS)		
-38	211-0511-00			6	SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-39	131-0589-00			32	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-40	131-1147-00			6	. CONNECTOR,RCPT,:72 PIN	31781	336-072-520-309
-41	131-1148-00			12	. KEY,CONN PLZN:PLASTIC	00779	67611-6
-42	131-1191-00			2	. TERM,QIK DISC:0.25 X 0.032 X 0.315 BLADE	00779	42822-2
					(ATTACHING PARTS)		
-43	211-0008-00			1	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-44	210-0003-00			1	. WASHER,LOCK:EXT,0.123 ID X 0.245" OD,STL	78189	1104-00-00-0541C
-45	210-0586-00			1	. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-46	119-0305-00			1	LOUDSPEAKER,PM:PERMANENT MAGNET,45 OHM,2W	07109	35A45C
					(ATTACHING PARTS)		
-47	210-0457-00			4	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-48	343-0001-00			1	CLAMP,LOOP:0.15 INCH DIA,PLASTIC	95987	1-8-6B
	343-0005-00			1	CLAMP,LOOP:0.438 INCH	95987	7-16-6B
					(ATTACHING PARTS)		
-49	211-0510-00			1	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-50	210-0863-00			1	WSHR,LOOP CLAMP:FOR 0.50" WIDE CLAMP,STL	95987	C191
					- - - * - - -		
-51	131-1249-00			3	CONTACT,ELEC:QUICK DISCONNECT	00779	41478
					(ATTACHING PARTS)		
-52	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-53	441-1221-03			1	CHASSIS,CKT CD:W/GUIDE SUPPORT	80009	441-1221-03
					(ATTACHING PARTS)		
-54	212-0507-00			4	SCREW,MACHINE:10-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
-55	200-1532-02			4	COVER,INTFC CAV:	80009	200-1532-02
					(ATTACHING PARTS)		
-56	212-0507-00			4	SCREW,MACHINE:10-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
-57	386-2813-01			1	PANEL,REAR:4014/4015	80009	386-2813-01
					(ATTACHING PARTS)		
-58	212-0577-00			4	SCREW,MACHINE:10-32 X 0.625",TRH,STL	83385	OBD
-59	210-0009-00			4	WASHER,LOCK:EXT,0.193ID X0.40" OD,STL	78189	1110-00
					- - - * - - -		
-60	343-0002-00			1	CLAMP,LOOP:0.188 INCH DIA	95987	3-16-6B
					(ATTACHING PARTS)		
-61	211-0510-00			1	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-62	210-0863-00			1	WSHR,LOOP CLAMP:FOR 0.50" WIDE CLAMP,STL	95987	C191
					- - - * - - -		
-63	390-0400-01			2	PANEL,PEDESTAL:	80009	390-0400-01
					(ATTACHING PARTS)		
-64	211-0510-00			8	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-65	210-0005-00			8	WASHER,LOCK:EXT #6	78189	1106-00
					- - - * - - -		
-66	124-0276-00			4	TRIM,STRIP:1.08 W X 24.62 " L,GRAY	80009	124-0276-00
-67	426-1106-01			4	FR SECT,PED UNI:	80009	426-1106-01
					(ATTACHING PARTS)		
-68	213-0001-00			1	SCREW,CAP,SCH:0.25-20 X 0.50 INCH LONG STL	000AH	OBD
-69	210-0016-00			1	WASHER,LOCK:SPLIT,0.259 ID X 0.489 OD,STL	77339	6507
					- - - * - - -		
-70	390-0401-02			1	PANEL,PEDESTAL:W/VENTILATING SCREEN	80009	390-0401-02
					(ATTACHING PARTS)		
-71	213-0001-00			4	SCREW,CAP,SCH:0.25-20 X 0.50 INCH LONG STL	000AH	OBD
-72	210-0016-00			4	WASHER,LOCK:SPLIT,0.259 ID X 0.489 OD,STL	77339	6507
					- - - * - - -		
-73	200-1378-00			4	CAP.,TRIM:BLACK PLASTIC	11897	132-0B-1189
-74	214-2003-00			4	FOOT,CABINET:0.375-16 X 1.0 THD STEM	81044	RH-3-1
					(ATTACHING PARTS)		
-75	220-0734-00			1	NUT,SLFLKG,HEX:0.375-16 CAD PLATED STEEL	56878	OBD
					- - - * - - -		
-76	432-0091-00			2	BASE SECT,PED:RIGHT AND LEFT	80009	432-0091-00
-77	179-2247-01			1	WIRING HARNESS,:PEDESTAL	80009	179-2247-01

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-78	131-0621-00			29	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-0707-00			50	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	131-0708-00			2	. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
	131-0792-00			30	. CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
-79	131-0861-00			1	. TERM,QIK DISC:16-20 AWG,0.22 W X 0.02 THK	00779	42617-2
	131-1159-00			2	. TERM,QIK DISC.:14-18 AWG,U/W0.25 X 0.032	00779	60041-2
-80	352-0171-00			2	. HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00
-81	352-0198-00			1	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00
	352-0198-01			1	. HLDR,TERM CONN:2 WIRE BROWN	80009	352-0198-01
	352-0198-02			3	. HLDR,TERM CONN:2 WIRE RED	80009	352-0198-02
	352-0198-03			1	. HLDR,TERM CONN:2 WIRE ORANGE	80009	352-0198-03
	352-0198-04			1	. HLDR,TERM CONN:2 WIRE YELLOW	80009	352-0198-04
	352-0198-05			2	. HLDR,TERM CONN:2 WIRE GREEN	80009	352-0198-05
	351-0198-06			2	. CONN BODY,PL,EL:2 WIRE BLUE	80009	351-0198-06
-82	352-0161-00			1	. HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
-83	352-0199-08			1	. HLDR,TERM CONN:3 WIRE GRAY	80009	352-0199-08
-84	352-0200-03			1	. HLDR,TERM CONN:4 WIRE ORANGE	80009	352-0200-03
	352-0200-04			1	. HLDR,TERM CONN:4 WIRE YELLOW	80009	352-0200-04
-85	352-0164-07			1	. HLDR,TERM CONN:6 WIRE VIOLET	80009	352-0164-07
-86	352-0202-04			1	. CONN BODY,PL,EL:6 WIRE YELLOW	80009	352-0202-04
-87	352-0203-00			1	. HLDR,TERM CONN:7 WIRE BLACK	80009	352-0203-00
-88	352-0167-00			1	. HLDR,TERM CONN:9 WIRE BLACK	80009	352-0167-00
-89	352-0205-05			1	. HLDR,TERM CONN:9 WIRE GREEN	80009	352-0205-05
	352-0205-09			1	. HLDR,TERM CONN:9 WIRE WHITE	80009	352-0205-09
-90	352-0206-00			1	. HLDR,TERM CONN:10 WIRE BLACK	80009	352-0206-00
	352-0206-07			1	. HLDR,TERM CONN:10 WIRE VIOLET	80009	352-0206-07
-91	131-1039-00			56	. CONNECTOR,TERM:20-22 AWG,CU BE GOLD PL	00779	66104-6
	131-1622-00			12	. CONTACT,ELEC:FEM,M SERIES TYPE 111	00779	66101-1
-92	131-0967-00			2	. GUIDE PIN,CONN:	00779	201046-4
-93	131-0968-00			2	. GUIDE,SKT,CONN:	00779	201047-4
-94	213-0438-00			1	. JACKSCREW:MALE,FXD	00779	200875-2
-95	204-0619-00			1	. BODY,CONNECTOR:75 PIN,FEMALE	00779	201311-1
-96	386-3008-01			1	. PLATE,CONN MTG:ALUMINUM	80009	386-3008-01
-97	352-0330-02			1	. HLDR,TERM. CONN:DBL ROW,10 FEMALE PINS	80009	352-0330-02
-98	175-1470-00			2	CA ASSY,SP,ELEC:3 M CABLE	000EO	OBD
	175-1525-00			FT	. CABLE,SP,ELEC:6.6 INCHES	53387	3365-26
	131-1677-00			2	. CONN,PLUG,ELEC:FEM,26 CNDCT RBN	00779	86905-0

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
5-1	337-1991-01			1	SHIELD,ELEC:HV POWER SUPPLY	80009	337-1991-01
					(ATTACHING PARTS)		
-2	211-0510-00			4	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
-3	337-2009-01			1	SHIELD,ELEC:LINE SELECTOR	80009	337-2009-01
					(ATTACHING PARTS)		
-4	211-0510-00			3	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		
	620-0466-00	B050000	B059999	1	POWER SUPPLY:	80009	620-0466-00
	620-0466-02	B060000		1	POWER SUPPLY:	80009	620-0466-02
					(ATTACHING PARTS)		
-5	212-0577-00			4	SCREW,MACHINE:10-32 X 0.625",TRH,STL	83385	OBD
-6	210-0009-00			4	WASHER,LOCK:EXT,0.193ID X0.40" OD,STL	78189	1110-00
					- - - * - - -		
	----- -----			-	. POWER SUPPLY ASSY INCLUDES:		
-7	----- -----			1	. SWITCH,TOGGLE:POWER(SEE S1001 EPL)		
					(ATTACHING PARTS)		
-8	210-0473-00			1	. NUT,PLAIN,DODEC:0.469-32 X 0.638 INCH,BRS	80009	210-0473-00
-9	210-0902-00			1	. WASHER,FLAT:0.470 ID X 0.656 INCH OD,STL	12327	OBD
-10	210-0021-00			1	. WASHER,LOCK:INTL,0.476 ID X 0.60"OD STL	78189	1222-01-00-0541C
-11	210-0414-00			1	. NUT,PLAIN,HEX.:0.468-32 X 0.562 INCH,BRS	73743	3167-402
					- - - * - - -		
-12	----- -----			1	. SWITCH,PUSH-PUL:SAFETY(SEE S1002 EPL)		
	131-1480-00			2	. LEAD,ELECTRICAL:STRD,22 AWG,3.75 L	80009	131-1480-00
	----- -----			-	. . EACH LINK INCLUDES:		
-13	175-0578-01			1	. . WIRE,ELECTRICAL:0.375 INCHES LONG	90484	OBD
-14	131-0861-00			2	. . TERM,QIK DISC:16-20 AWG,0.22 W X 0.02 THK	00779	42617-2
-15	124-0282-00			1	. TERMINAL STRIP,:GROUND	13150	7605-0803-000B
					(ATTACHING PARTS)		
-16	211-0511-00			2	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
					- - - * - - -		
-17	----- -----			1	. CKT BOARD ASSY:POWER SUPPLY(SEE A14 EPL)		
					(ATTACHING PARTS)		
-18	211-0601-00			7	. SCR,ASSEM WSHR:6-32 X 0.312 INCH,PNH BRS	80009	211-0601-00
-19	210-0202-00			1	. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
-20	212-0507-00			12	. SCREW,MACHINE:10-32 X 0.375 INCH,PNH STL	83385	OBD
-21	210-0081-00			10	. WASHER,LOCK:#10 SPLIT,0.048 THK,STEEL	86928	OBD
	210-0805-00			10	. WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
					- - - * - - -		
	----- -----			-	. . CKT BOARD ASSY INCLUDES:		
-22	131-0589-00			70	. . TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-23	131-1191-00			2	. . TERM,QIK DISC:0.25 X 0.032 X 0.315 BLADE	00779	42822-2
					(ATTACHING PARTS)		
-24	211-0008-00			1	. . SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-25	210-0586-00			1	. . NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-26	214-0579-00			12	. . TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-27	200-0257-00			2	. . SHLD,CAPACITOR:1.0 INCH DIA,2.531 INCH LONG	80009	200-0257-00
-28	344-0154-00	B050000	B059999	12	. . CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
	352-0031-00	B060000		1	. . FUSEHOLDER:3AG FUSE	75915	357001
					(ATTACHING PARTS)		
	211-0510-00			1	. . SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
	210-0006-00			1	. . WASHER,LOCK:#6 INTL,0.018THK,STL CD PL	78189	1206-00-00-0541C
					- - - * - - -		
-29	131-1249-00			1	. CONTACT,ELEC:QUICK DISCONNECT	00779	41478
					(ATTACHING PARTS)		
-30	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-31	343-0002-00			1	. CLAMP,LOOP:0.188 INCH DIA	95987	3-16-6B
					(ATTACHING PARTS)		
-32	211-0510-00			1	. SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-33	210-0863-00			1	. WSHR,LOOP CLAMP:FOR 0.50" WIDE CLAMP,STL	95987	C191
-34	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-35	129-0128-00			4	. POST,ELEC-MECH:0.25 H X 2.312 L,W/4-40 THD	80009	129-0128-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
5-36	----- -----			1	. THYRISTOR:50V,8A,2N444A(SEE Q1002 EPL)		
					(ATTACHING PARTS)		
-37	211-0511-00			1	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
-38	210-0071-00			1	. WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
					- - - * - - -		
-39	342-0136-00			1	. INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
-40	----- -----			1	. SEMICOND DEVICE:RECT,50V,12A(SEE CR1009 EPL)		
					(ATTACHING PARTS)		
-41	211-0511-00			1	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
					- - - * - - -		
-42	255-0334-00			1	. PLASTIC CHANNEL:12.75 X 0.175X 0.155,NYL	11897	122-37-2500
-43	----- -----			5	. CAPACITORS:(SEE C305,331,405,431,471 EPL)		
-44	432-0088-01			5	. BASE,CAP. MTG:	80009	432-0088-01
					(ATTACHING PARTS)		
-45	212-0008-00			2	. SCREW,MACHINE:8-32 X 0.500 INCH,PNH STL	83385	OBD
					- - - * - - -		
-46	----- -----			1	. CAPACITOR:(SEE C110 EPL)		
					(ATTACHING PARTS)		
-47	211-0511-00			1	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
-48	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-49	343-0067-01			1	. CLAMP,LOOP:CAPACITOR MTG	80009	343-0067-01
					(ATTACHING PARTS)		
-50	211-0008-00			3	. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-51	210-0994-00			3	. WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
					- - - * - - -		
-52	441-1232-01			1	. CHASSIS,TERM.:	80009	441-1232-01
					(ATTACHING PARTS)		
-53	212-0004-00			7	. SCREW,MACHINE:8-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-54	337-2040-01	B050000	B069421	1	. SHIELD,ELEC:POWER CORD	80009	337-2040-01
	----- -----			-	. (4014, 4014-1 ONLY)		
	337-2040-01	B069422		2	. SHIELD,ELEC:POWER CORD	80009	337-2040-01
	----- -----			-	. (4014, 4014-1 ONLY)		
	211-0511-00	XB069422		2	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
	----- -----			-	. (4014, 4014-1 ONLY)		
	337-2040-01	B050000	B061547	1	. SHIELD,ELEC:POWER CORD	80009	337-2040-01
	----- -----			-	. (4015, 4015-1 ONLY)		
	337-2040-01	B061548		2	. SHIELD,ELEC:POWER CORD	80009	337-2040-01
	----- -----			-	. (4015, 4015-1 ONLY)		
	211-0511-00	XB061548		2	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
	----- -----			-	. (4015, 4015-1 ONLY)		
					(ATTACHING PARTS)		
-55	211-0507-00			2	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-56	----- -----			1	. TRANSFORMER:POWER(SEE T1000 EPL)		
					(ATTACHING PARTS)		
-57	212-0582-00			4	. SCREW,MACHINE:10-32 X 3.5 INCH,HEX HD STL	83385	OBD
-58	210-0812-00			4	. WASHER,NONMETAL:#10,FIBER	86445	OBD
-59	220-0410-00			4	. NUT,EXTENDED WA:10-32 X 0.375 INCH,STL	83385	OBD
-60	166-0228-00			4	. INS SLV,ELEC:0.187 ID X 2.75 INCH LONG	80009	166-0228-00
					- - - * - - -		
-61	210-0202-00			2	. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
					(ATTACHING PARTS)		
-62	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
-63	131-0775-00			1	. CONTACT,ELEC:HEX,0.25 INCH W/6-32 1 END	88245	1601-A
-64	210-0202-00			1	. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
					(ATTACHING PARTS)		
-65	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
-66	161-0017-03			1	. CABLE ASSY,PWR,:3,18 AWG,96.0L	80009	161-0017-03
					(ATTACHING PARTS)		
-67	358-0529-00			1	. BSHG,STRAIN RLF:FOR 0.3-0.36 OD CABLE,STR	28520	SR-63P-4
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
5-68	200-0237-03			1	. COVER,FUHLR:	80009	200-0237-03
	352-0002-00			1	. FUSEHOLDER:ASSEMBLY	80009	352-0002-00
-69	352-0010-00			1	. . FUSEHOLDER:WITH HARDWARE	03614	HKP-L
-70	200-0582-00			1	. . CAP,ELECTRICAL:FUSE HOLDER	71400	9435 1/2
-71	210-0873-00			1	. . WASHER,NONMETAL:0.5 ID X 0.688 INCH OD,NPRN	70485	OBD
-72	200-1662-00			2	. COVER,XSTR:1.10 X 11.18 INCH LONG	80009	200-1662-00
					(ATTACHING PARTS)		
-73	212-0535-00			2	. SCREW,MACHINE:10-32 X 0.312 INCH,TRH STL	83385	OBD
					- - - * - - -		
-74	----- -----			3	. SEMICOND DEVICE:(SEE CR1001,1002,1003 EPL)		
	----- -----			3	. SEMICOND DEVICE:(SEE CR1004,1006,107 EPL)		
					(ATTACHING PARTS)		
-75	220-0410-00			1	. NUT,EXTENDED WA:10-32 X 0.375 INCH,STL	83385	OBD
-76	210-0805-00			1	. WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
-77	210-0910-00			1	. WASHER,NONMETAL:0.188 ID X 0.313" OD,TEFLON	02107	OBD
-78	210-0224-00			1	. TERMINAL,LUG:0.20 ID X 0.344 OD,SE,BRS	86928	A373-148-1
					- - - * - - -		
-79	210-0909-00			12	. WASHER,NONMETAL:0.196 ID X 0.625" OD,MICA	71400	OBD
-80	----- -----			1	. TRANSISTOR:(SEE Q1004 EPL)		
					(ATTACHING PARTS)		
-81	211-0014-00			1	. SCREW,MACHINE:4-40 X 0.50 INCH,PNH STL	83385	OBD
-82	210-1122-00			1	. WASHER,LOCK:0.228 ID X 0.375 INCH OD,STL	04713	B52200F006
-83	210-0811-00			1	. WSHR,SHOULDERED:0.125 ID X 0.50 INCH OD	86928	5604-47
-84	210-0994-00			1	. WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
-85	210-0406-00			1	. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
					- - - * - - -		
-86	342-0163-00			1	. INSULATOR,PLATE:XSTR,0.675 X 0.625 X 0.001"	80009	342-0163-00
-87	----- -----			1	. TRANSISTOR:(SEE Q1005 EPL)		
					(ATTACHING PARTS)		
-88	211-0513-00			2	. SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
-89	166-0228-00			2	. INS SLV,ELEC:0.187 ID X 2.75 INCH LONG	80009	166-0228-00
-90	210-0967-00			2	. WSHR,SHOULDERED:0.157 ID X 0.375 INCH OD	80009	210-0967-00
-91	210-0803-00			2	. WASHER,FLAT:0.15 ID X 0.032 THK,STL CD PL	12327	OBD
-92	210-0202-00			1	. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
-93	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-94	210-0457-00			1	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-95	386-0978-00			1	. INSULATOR,PLATE:TRANSISTOR,MICA	80009	386-0978-00
-96	----- -----			3	. TRANSISTORS:(SEE Q1001,1007,1009 EPL)		
					(ATTACHING PARTS)		
-97	213-0185-00			2	. SCR,TPG,THD FOR:6-20 X 6.25 INCH,PNH STL	83385	OBD
	166-0228-00			2	. INS SLV,ELEC:0.187 ID X 2.75 INCH LONG	80009	166-0228-00
					- - - * - - -		
-98	386-0978-00			3	. INSULATOR,PLATE:TRANSISTOR,MICA	80009	386-0978-00
-99	136-0280-00			3	. SKT,PL-IN ELEK:TRANSISTOR,3 CONTACT	97913	LST 2202-2
					(ATTACHING PARTS)		
-100	213-0088-00			2	. SCR,TPG,THD CTG:4-24 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-101	210-0201-00			1	. TERMINAL,LUG:SE #4	86928	A373-157-2
-102	214-1956-00			1	. HEAT SINK,XSTR:	80009	214-1956-00
					(ATTACHING PARTS)		
-103	129-0459-00			4	. POST,ELEC-MECH:0.60 INCH LONG HEX	80009	129-0459-00
					- - - * - - -		
-104	361-0561-00			4	. SPACER,SLEEVE:0.281 X 0.95 INCH LONG	80009	361-0561-00
-105	441-1231-03			1	. CHASSIS,TERM.:POWER SUPPLY W/REAR PANEL	80009	441-1231-03
-106	179-2249-01			1	. WIRING HARNESS,:AC	80009	179-2249-01
-107	131-0861-00			4	. . TERM,QIK DISC:16-20 AWG,0.22 W X 0.02 THK	00779	42617-2
	131-1215-00			4	. . CONTACT,ELEC:CRIMP MT W/RED INS	77342	42628-3
	179-2251-00	B050000	B059999	1	. WIRING HARNESS,:HEAT SINK,# 1	80009	179-2251-00
	179-2251-01	B060000		1	. WIRING HARNESS,:HEAT SINK,# 1	80009	179-2251-01
-108	131-0707-00			3	. . CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	131-0621-00	B050000	B059999	7	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-1678-00	B060000		1	. . CONTACT,ELEC:0.250 X 0.032 INCH TAB FIT	00779	61944-2
	131-0792-00			2	. . CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
	131-1159-00			4	. . TERM,QIK DISC.:14-18 AWG,U/W0.25 X 0.032	00779	60041-2

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
5-109	352-0198-00			1	. . HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00
	352-0198-01			1	. . HLDR,TERM CONN:2 WIRE BROWN	80009	352-0198-01
	352-0198-07			1	. . CONN BODY,PL,EL:2 WIRE PURPLE	80009	352-0198-07
-110	352-0161-00			1	. . HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
-111	352-0199-01			7	. . HLDR,TERM CONN:3 WIRE BROWN	80009	352-0199-01
	179-2252-01			1	. WIRING HARNESS,:HEAT SINK, # 2	80009	179-2252-01
	131-0621-00			5	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	352-0199-07			1	. . HLDR,TERM CONN:3 WIRE VIOLET	80009	352-0199-07
	352-0199-08			1	. . HLDR,TERM CONN:3 WIRE GRAY	80009	352-0199-08
	352-0199-09			1	. . HLDR,TERM CONN:3 WIRE WHITE	80009	352-0199-09
	198-3406-00			1	. WIRE SET,ELEC:	80009	198-3406-00
	131-0621-00			2	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-0792-00			1	. . CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
	352-0199-08			1	. . HLDR,TERM CONN:3 WIRE GRAY	80009	352-0199-08

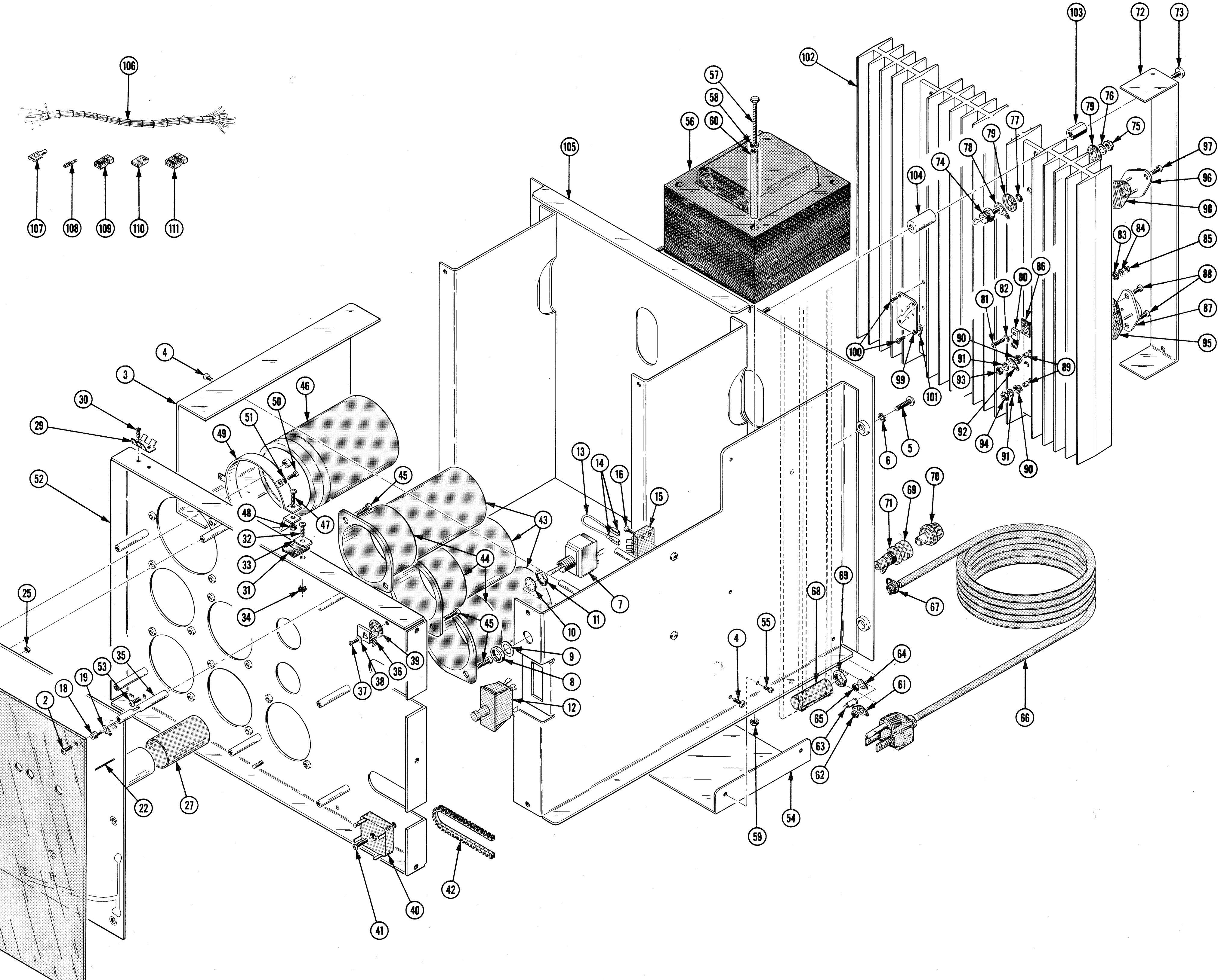

FIG. 5 POWER SUPPLY

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
-5					STANDARD ACCESSORIES		
	021-0065-00			1	INTERFACE ASSY:DATA COMMUNICATION	80009	021-0065-00
	070-1458-00			1	MANUAL,TECH:INSTRUCTION,021-0065-00	80009	070-1458-00
	070-1647-00			1	MANUAL,TECH:OPERATORS,4014	80009	070-1647-00
	070-1649-00			1	MANUAL,TECH:OPERATORS,4015	80009	070-1649-00
					OPTIONAL ACCESSORIES		
	021-0074-01			1	INTERFACE:DATA COMMUNICATIONS	80009	021-0074-01
	018-0122-00			1	CKT BOARD ASSY:EHM,OPT. 34	80009	018-0122-00
	070-2303-00			1	MANUAL,TECH:SERVICE 4014/4015 TERMINAL,B050000	80009	070-2303-00

Tektronix
COMMITTED TO EXCELLENCE

MANUAL CHANGE INFORMATION

PRODUCT 4014,4014-1,4015,4015-1 (SN B05000 & up)

CHANGE REFERENCE M35101

MANUAL PART NO. 070-2303-00

DATE 9-24-79

EFF SN: B069072 for 4014, 4014-1
B061528 for 4015, 4015-1

REPLACEABLE ELECTRICAL PARTS CHANGES

REMOVE:	A7	670-3093-04	CKT BOARD ASSY:TC-3
ADD:	A7	670-3093-05	CKT BOARD ASSY:TC-3
	C325	283-0620-00	CAP,FXD,MICA DI:470PF,1%,300V

SCHEMATIC CHANGES

TC-3 SCHEMATIC, SHEET 3 OF 3