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TEKTRONIX®

466
STORAGE
OSCILLOSCOPE
WITH OPTIONS
SERVICE

INSTRUCTION MANUAL

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

Serial Number _____

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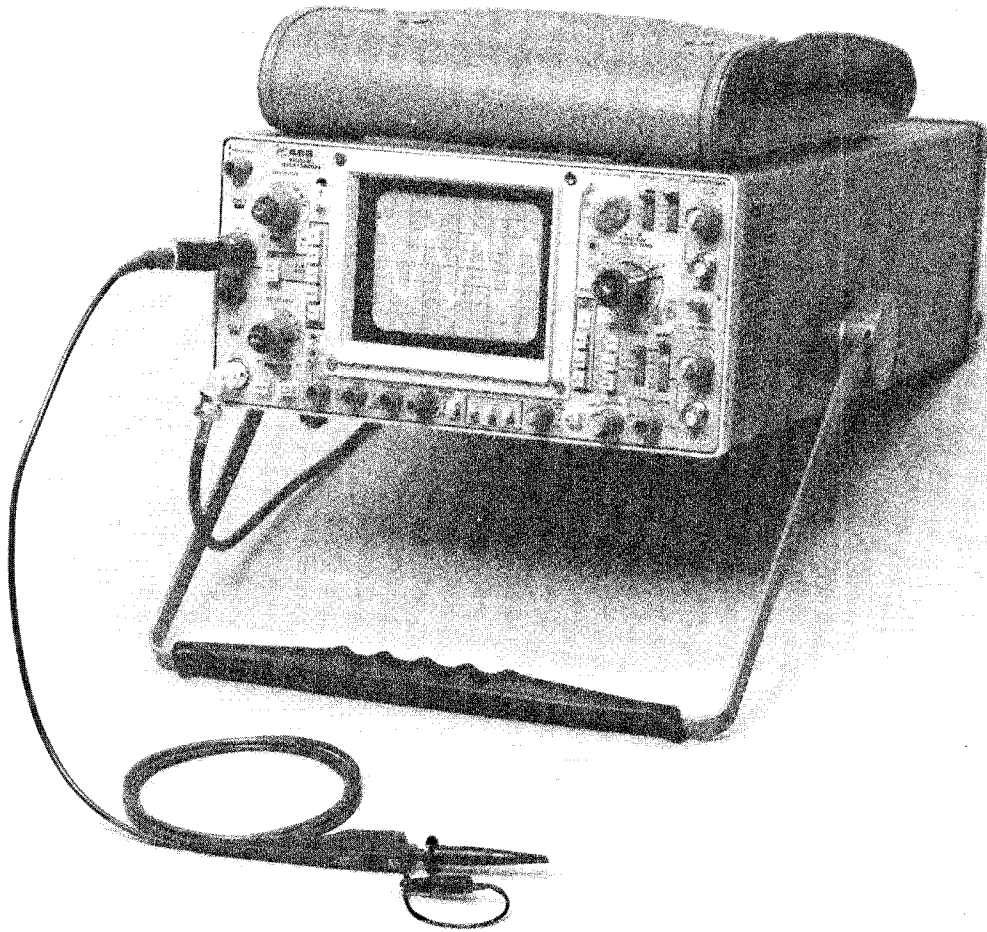
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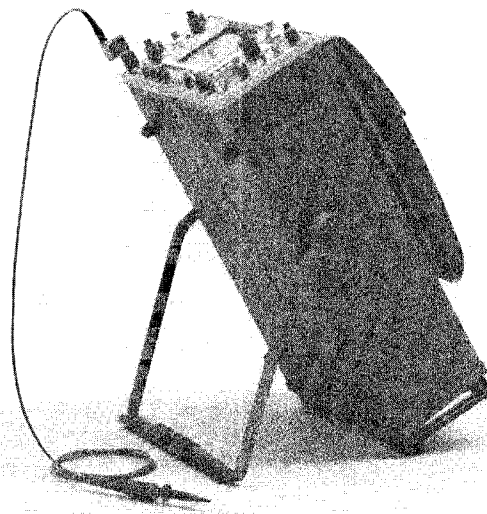


1753-01

THE ACCESSORY POUCH ILLUSTRATED SHOULD REMAIN ATTACHED TO THE OSCILLOSCOPE. IT IS DESIGNED TO KEEP ACCESSORIES READILY AVAILABLE AND TO AFFORD THE OSCILLOSCOPE SOME PROTECTION IN TRANSIT.

THE ADJUSTABLE CARRYING HANDLE IS DESIGNED TO OFFER CONVENIENT STABLE, OPERATING POSITIONS, SUCH AS THOSE ILLUSTRATED.

STORAGE OR OPERATION OF THE OSCILLOSCOPE ON ITS FOUR REAR FEET IS NOT DESIRABLE. THE NEXT-TO-LAST LOCKING POSITION OF THE HANDLE PROVIDES THE MOST STABLE, NEAR-UPRIGHT, OPERATING POSITION. THE MOST STABLE OPERATING POSITIONS ARE ILLUSTRATED.



1753-02

Fig. 1-1. 466 Portable Storage Oscilloscope.

SPECIFICATION

Introduction

The Tektronix 466 is a dual-channel portable oscilloscope. The 466 storage system provides storage for displays with a writing speed up to 3000 divisions/microsecond (in the Fast-Reduced Scan mode). Storage viewing time is greater than 15 seconds at full stored display intensity—extending to more than 6 minutes using reduced intensity in the Save mode.

The dual-channel dc-to-100 megahertz vertical system provides calibrated deflection factors from 5 millivolts to 5 volts/division. The sweep trigger circuits are capable of stable triggering over the full bandwidth capabilities of the vertical deflection system. The horizontal deflection system provides calibrated sweep rates from 0.5 seconds

to 0.05 microsecond/division along with delayed sweep features for accurate relative-time measurements. A X10 magnifier extends the calibrated sweep rate to 5 nanoseconds/division. The instrument operates over a wide variation of line voltages and frequencies. Maximum power consumption is about 100 watts.

This instrument will meet the electrical characteristics listed in the Performance Requirement column of Table 1-1 following complete calibration as given in Section 5. The performance check procedure which is given in Section 2 provides a convenient method of checking instrument performance without making internal checks or adjustments. The following electrical characteristics apply over an ambient temperature range of -15°C to $+55^{\circ}\text{C}$, except as otherwise indicated. Warmup time for given accuracy is 20 minutes.

TABLE 1-1

Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
VERTICAL DEFLECTION SYSTEM (CH 1 and CH 2)		
Deflection Factor Calibrated Range	5 mV to 5 V/DIV in 10 steps; 1-2-5 sequence.	
Cascaded Operation (CH 1 VERT SIGNAL OUT Connected to CH 2)	Deflection Sensitivity at least 1 mV/Div. Bandwidth: Dc to at least 50 MHz.	CH 1 OUT connected to CH 2 input, ac coupled using a 50 Ω 42 inch cable terminated in 50 Ω at CH 2 input.
Uncalibrated (VAR VOLTS/DIV) Range	Provides continuously variable deflection factors between the calibrated steps. Extends maximum uncalibrated deflection factor to at least 12.5 volts per division in the 5 V/DIV position.	At least 2.5:1.
Low Frequency Linearity		0.1 division or less compression or expansion of 2 division signal at center screen positioned to the upper and lower extremes of the graticule area.
Deflection Factor Accuracy	Within 3% of indicated deflection.	With GAIN set at 5 mV/DIV.
Bandwidth	Dc to 100 MHz or greater (-15°C to $+40^{\circ}\text{C}$). DC to 85 MHz ($+40^{\circ}\text{C}$ to $+55^{\circ}\text{C}$).	With a 5 division, vertically centered, reference signal from a 25 Ω source and VAR VOLTS/DIV in calibrated position.

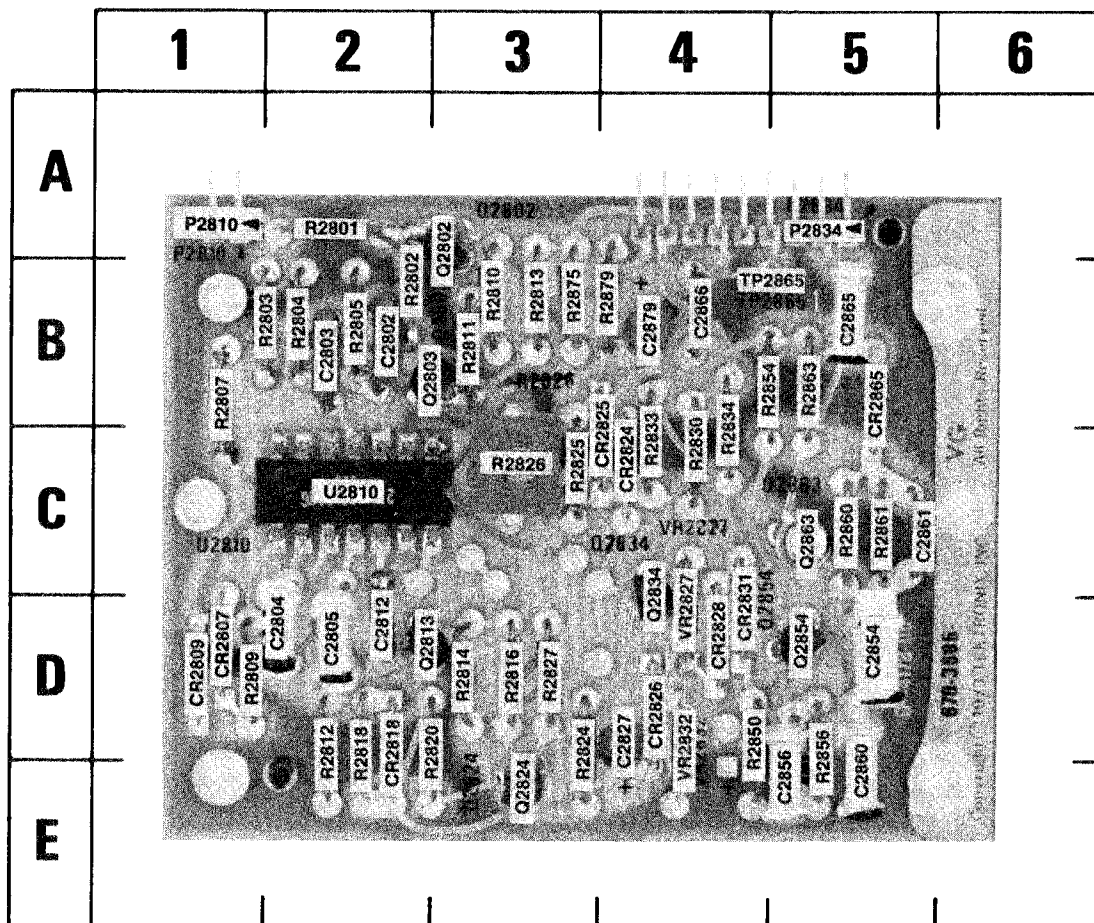


Fig. Option 5-3. A12 TV Sync Separator & Inverter Ampl board component locations.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2802	2B	C2861	5C	CR2825	4C	Q2824	3E	R2801	2A	R2812	2E	R2827	3D
C2803	2B	C2865	5B	CR2826	4D	Q2834	4D	R2802	2B	R2813	3B	R2830	4C
C2804	2D	C2866	4B	CR2828	4D	Q2854	5D	R2803	2B	R2814	3D	R2833	4C
C2805	2D	C2879	4B	CR2831	4D	Q2863	5C	R2804	2B	R2816	3D	R2834	4C
C2812	2D			CR2865	5B			R2805	2B	R2818	2E	R2850	4D
C2827	4D	CR2807	1D			P2810	1A	R2807	1B	R2820	3E	R2854	5B
C2854	5D	CR2809	1D	Q2802	3A	P2834	4A	R2809	1D	R2824	3E	R2856	5E
C2856	5E	CR2818	2E	Q2803	3B	P2833	4C	R2810	3B	R2825	3C	R2860	5C
C2860	5E	CR2824	4C	Q2813	3D	P2863	1A	R2811	3B	R2826	3C	R2861	5C
												R2863	5B
												R2875	3B
												R2879	4B
												TP2865	5B
												U2810	2C
												VR2827	4D
												VR2832	4D

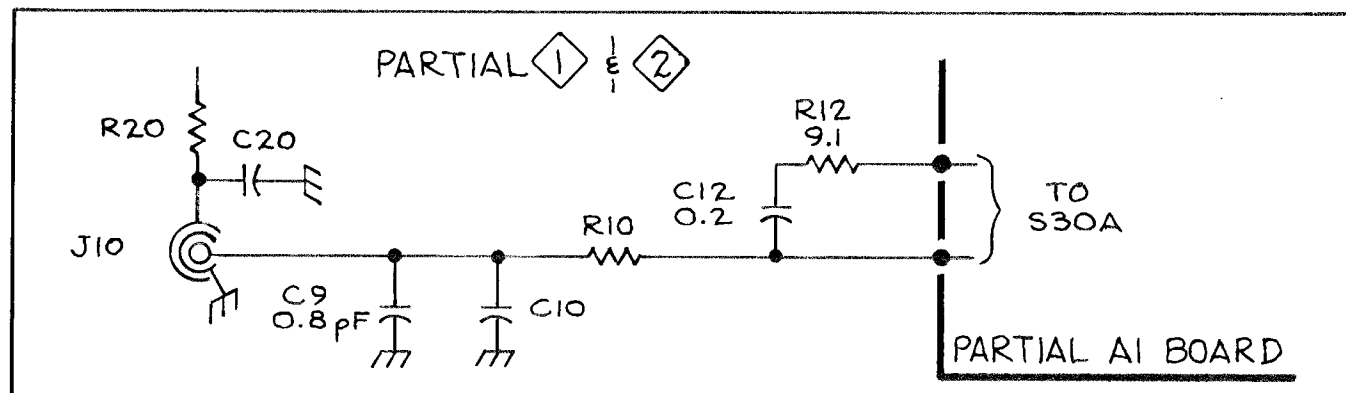


Fig. Option 5-4. Option 5 Vertical Input changes.

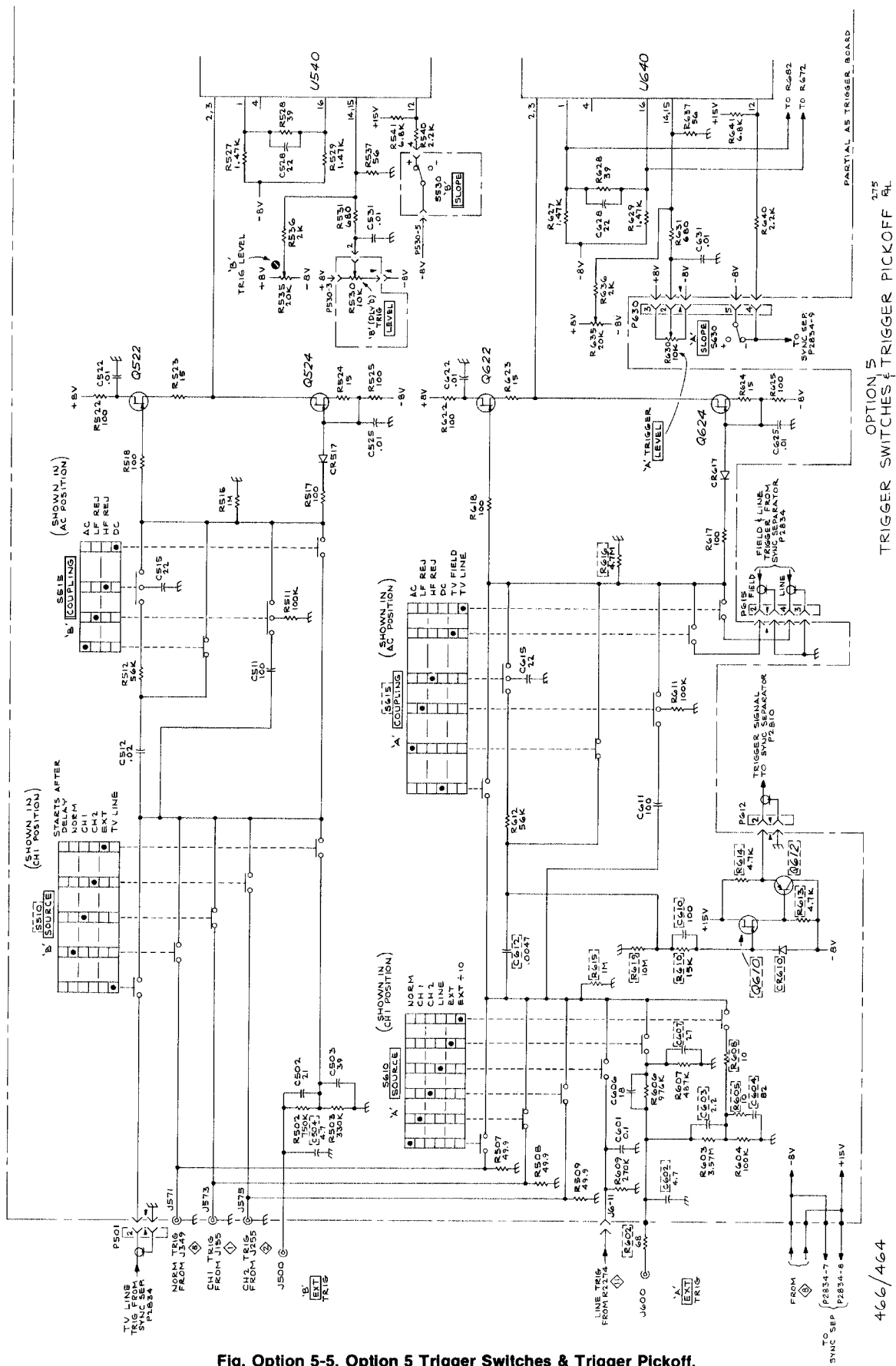


Fig. Option 5-5. Option 5 Trigger Switches & Trigger Pickoff.

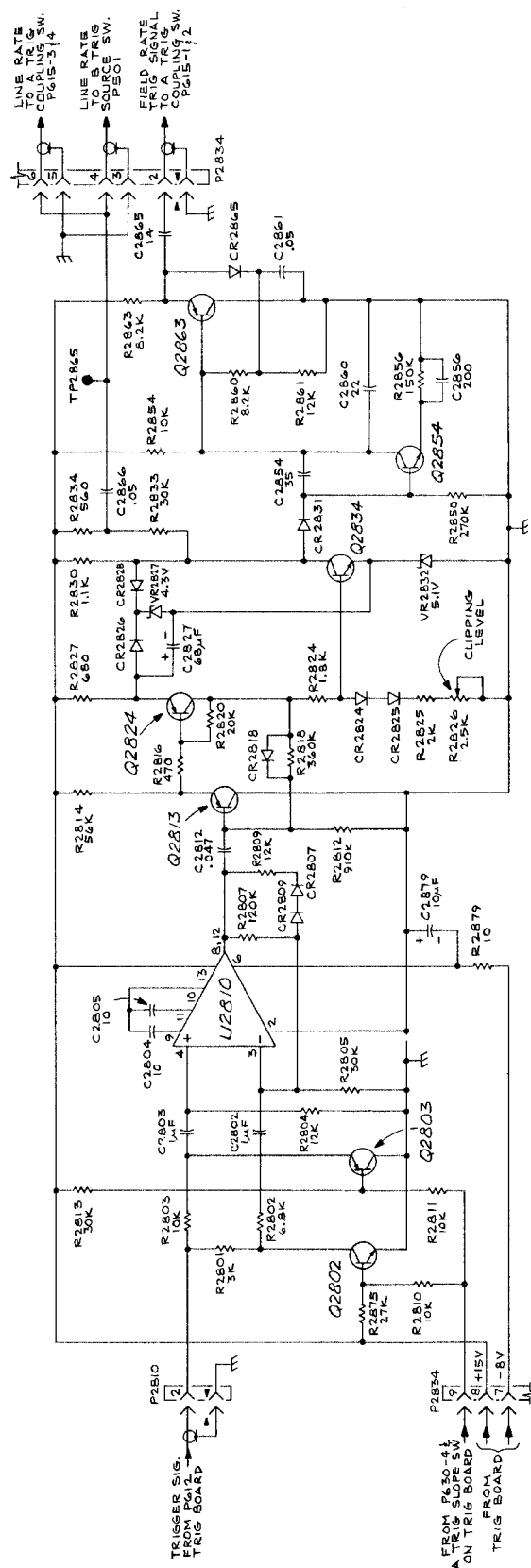
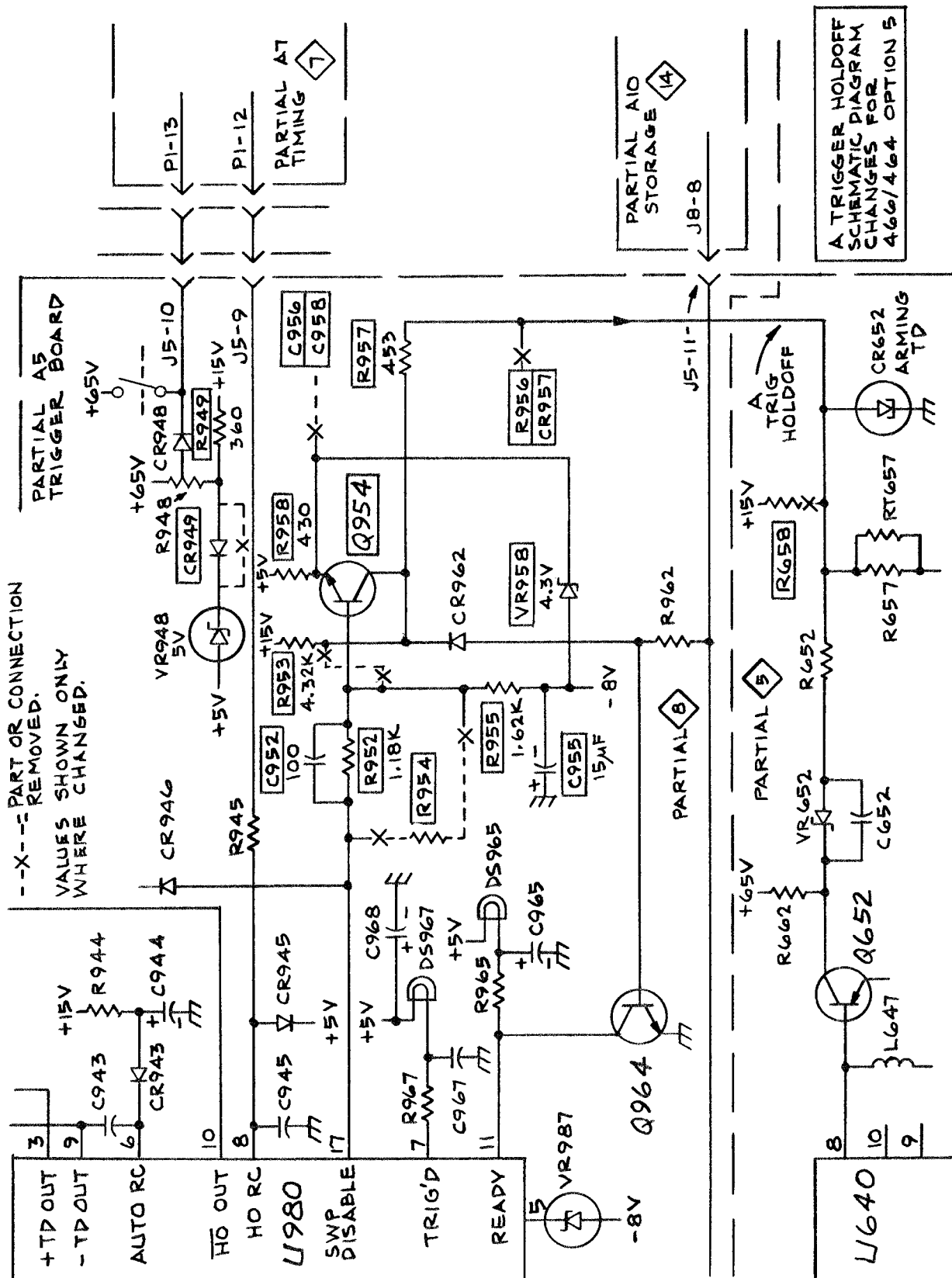


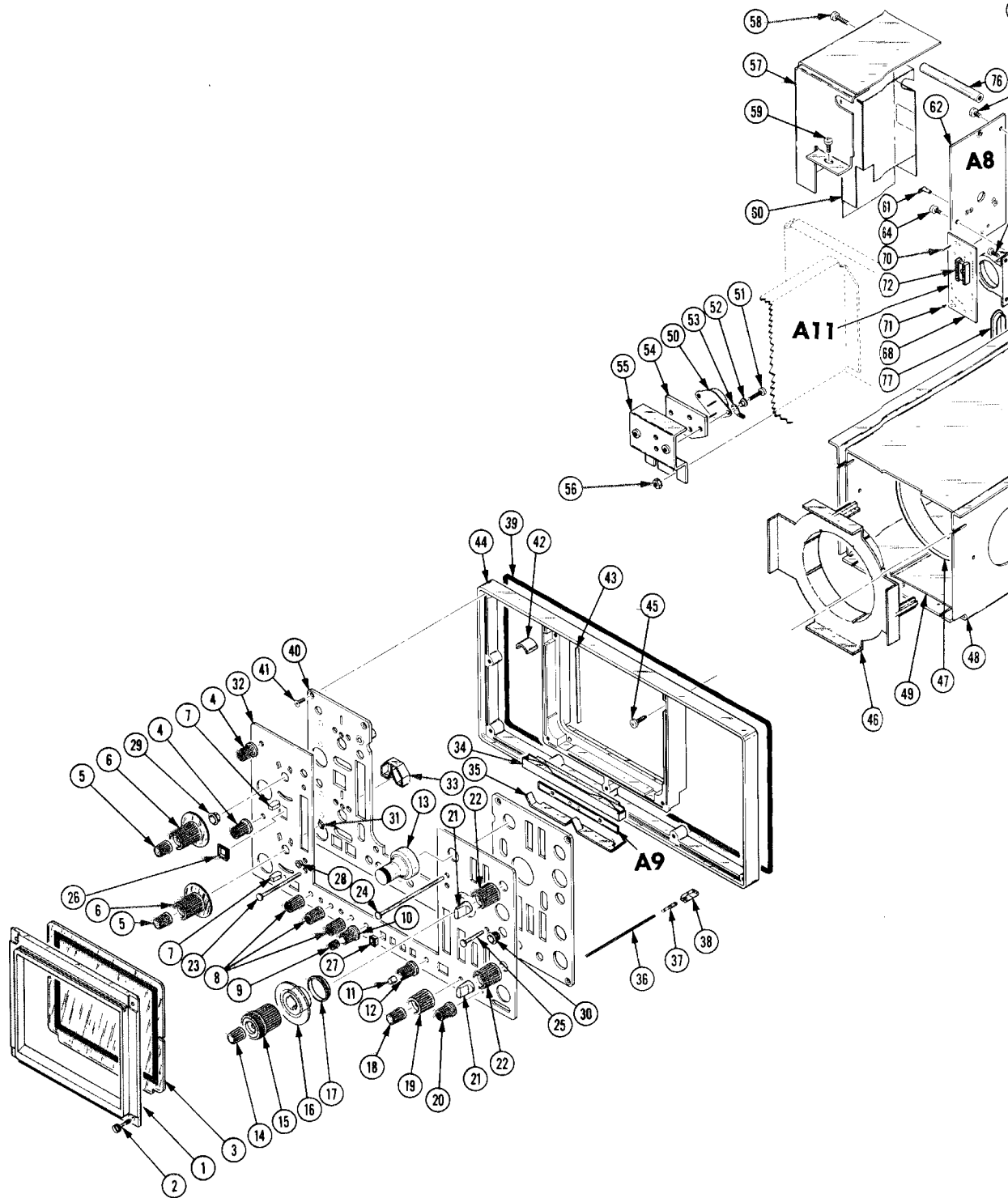
Fig. Option 5-6. Option 5 TV Sync Separator & Inverter Ampl.

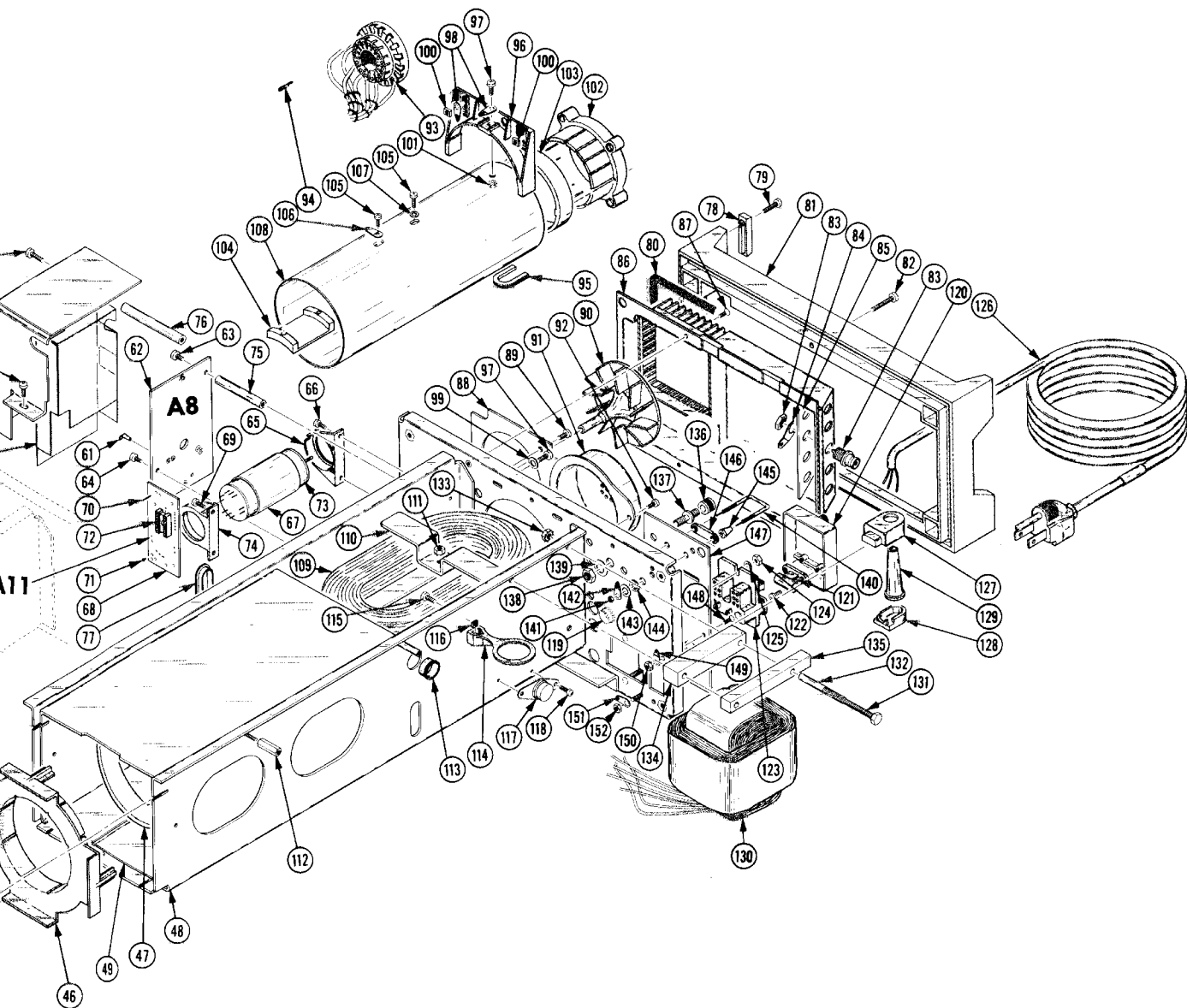
OPTION 5 INVERTOR AMP
TV SYNC SEPARATOR &
275 RL

$$466/464$$



Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
CHANGE TO:					
A1	672-0554-01		CIRCUIT BOARD ASSY:ATTENUATOR,464 OPTION 5	80009	672-0554-01
A1	672-0553-01		CIRCUIT BOARD ASSY:ATTENUATOR,466 OPTION 5	80009	672-0553-01
C12	285-1055-00		CAP.,FXD,PLASTIC:0.2UF,10%,400V	80009	285-1055-00
ADD:					
C9	281-0661-00		CAP.,FXD,CER DI:0.8PF,+/-0.1PF,500V	72982	301-000COK0808B
R12	307-0116-00		RES.,FXD,CMPSN:9.1 OHM,5%,0.25W	01121	CB91G5
CHANGE TO:					
A5	670-3324-01		CKT BOARD ASSY:TRIGGER GEN AND SWEEP LOGIC	80009	670-3324-01
C603	281-0610-00		CAP.,FXD,CER DI:2.2PF,+/-0.1PF,500V	72982	374-001C0J0229B
C604	281-0528-00		CAP.,FXD,CER DI:82PF,+/-8.2PF,500V	72982	301-000U2M0820K
C607	281-0513-00		CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C612	283-0083-00		CAP.,FXD,CER DI:0.0047UF,20%,500V	72982	811-565C472J
C952	281-0523-00		CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
Q954	151-0190-00		TRANSISTOR:SILICON,NPN	80009	151-0190-00
R602	315-0680-00		RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R616	315-0475-00		RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R952	321-0200-00		RES.,FXD,FILM:1.18K OHM,1%,0.125W	91637	MFF1816G11800F
R953	321-0254-00		RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R955	321-0213-00		RES.,FXD,FILM:1.62K OHM,1%,0.125W	91637	MFF1816G16200F
R957	321-0160-00		RES.,FXD,FILM:453 OHM,1%,0.125W	91637	MFF1816G453R0F
R958	315-0431-00		RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
S510	105-0571-01		ACTUATOR,SL SW:6 OF 6 POSITION	80009	105-0571-01
S615	105-0571-01		ACTUATOR,SL SW:6 OF 6 POSITION	80009	105-0571-01
ADD:					
C504	281-0592-00		CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	72982	301-023C0H0479D
C602	281-0592-00		CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	72982	301-023C0H0479D
C610	281-0584-00		CAP.,FXD,CER DI:100PF,5%,500V	72982	301-000Y5D101J
C955	290-0527-00		CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
CR610	152-0246-00		SEMICOND DEVICE:SILICON,400PIV,200MA	07910	CD12676
CR949	152-0141-02		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
Q610	151-1005-00		TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1005-00
Q612	151-0220-03		TRANSISTOR:SILICON,PNP	80009	151-0220-03
R605	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R608	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R610	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R613	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R614	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R615	321-0481-00		RES.,FXD,FILM:1M OHM,1%,0.125W	91637	MFF1816G10003F
R619	315-0106-00		RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065





466

STORAGE OSCILLOSCOPE

WITH OPTIONS

Serial Number B200000 and up

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.

*Please Check for
CHANGE INFORMATION
at the Rear of This Manual*

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ADD—When pressed in, displays the algebraic sum of the Channel 1 and Channel 2 input signals. To end the ADD mode display, release the ADD button by pressing it.

CHOP/ALT—When pressed in, the oscilloscope circuitry switches between two or more of the displayed sweeps at a 500 kHz rate.

When released, the oscilloscope circuitry switches between two or more of the displayed sweeps at the end of each sweep (i.e., it Alternates).

CH 2—When pressed in, displays Channel 2 input signal. To end the signal display, release the Ch 2 button by pressing it.

- 9 **20 MHz BW LIMIT Switch**—When pressed in, limits the bandwidth of the vertical deflection system to 20 MHz. When released the bandwidth is 100 MHz.

- 10 **INVERT**—Channel 2 display is inverted in the INVERT (button in) position.

DISPLAY AND STORAGE

Refer to Fig. 2-3 for location of items 11 through 25.

- 11 **INTERNAL GRATICULE**—Eliminates parallax. Risetime amplitude and measurement points are indicated at the left-hand graticule edge.

- 12 **BEAM FINDER**—Compresses the display to within the graticule area independently of display position or applied signals; provides a visible viewing level to indicate position of display relative to crt center.

- 13A **INTEN**—Controls brightness of the crt display.

- 13B **REDUCED SCAN (PULL-INTEN knob)**—Reduces display to "inner" graticule with an increase in writing rate.

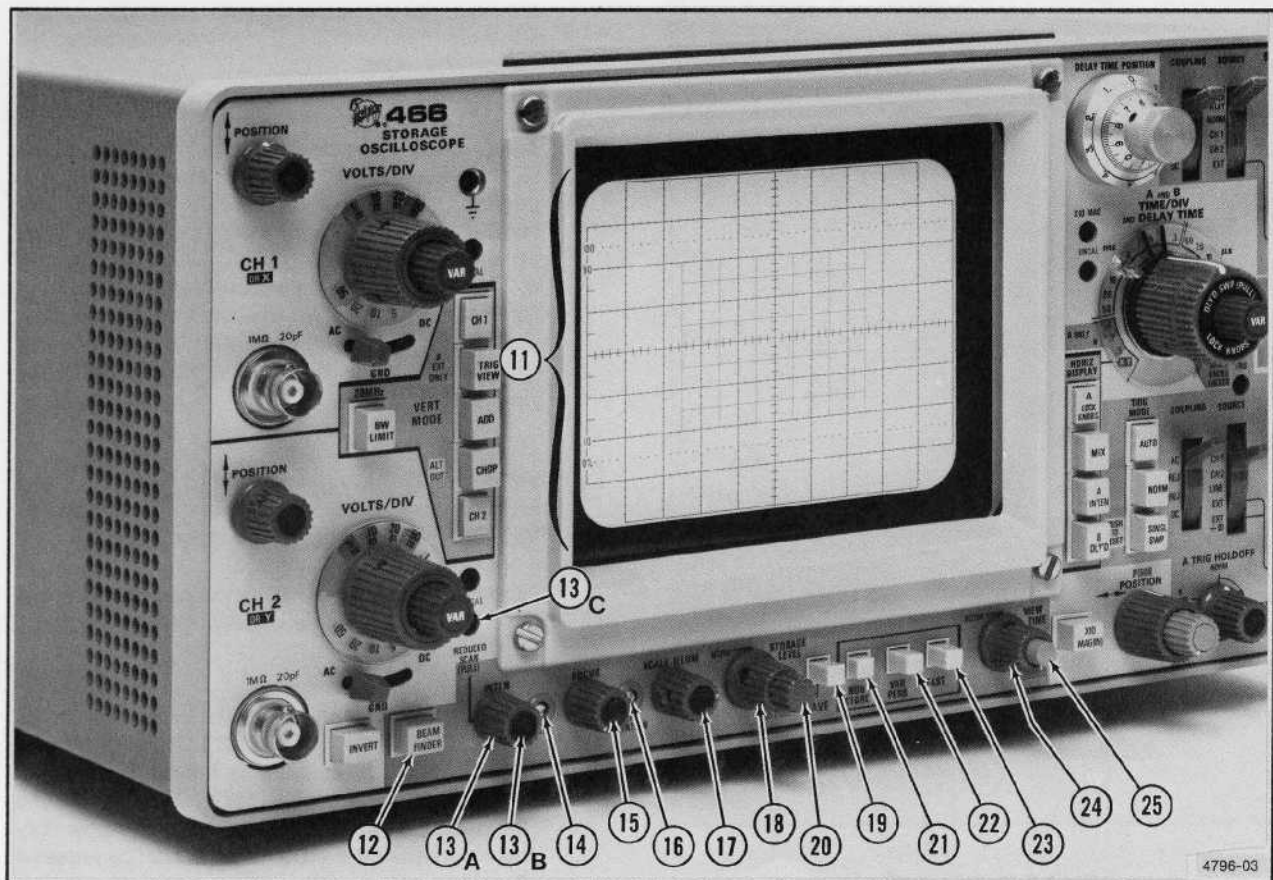


Fig. 2-3. Display and Storage sections.

The output logic levels of ROM U3605 are 0011 on the O_4 - O_1 outputs, respectively. The low-logic level on O_4 disables the Chop Clock generator. The 011 levels on O_3 , O_2 , and O_1 cause FF U3705 to turn on gate-drive transistor Q3617 and turn off Q3619 and Q3719. The same bias levels as for "Channel 1 Only" reverse-bias the Trigger View channel's shunt diodes (CR3432 and CR3434), permitting the Trigger View signal to reach the Delay-Line Driver via series diodes CR3436 and CR3438.

The Trigger View channel is also subject to the control of the TRIG VIEW ENABLE line. When the A TRIGGER SOURCE switch is in EXT or EXT $\div$ 10 and the TRIG VIEW button is pressed in, the TRIG VIEW ENABLE line is at a low-logic level, permitting the diode gate and common-base transistors Q3225 and Q3235 to function normally. When the A TRIGGER SOURCE switch is not in EXT or EXT $\div$ 10 or when the TRIG VIEW button is not pressed in, the TRIG VIEW ENABLE line is at a high-logic level. A high-logic level on the TRIG VIEW ENABLE line reverse-biases Q3225 and Q3235.

Chop Clock and Alternate Logic. The Chop Clock generator produces pulses for switching between vertical displays at a rate independent of sweep speed. The operating frequency of the generator is about 1 MHz.

When the ALT/CHOP button is pressed in and the VERT MODE control is set to more than one display, the Chop Clock generator operates. To present multiple displays, the Chop Clock and Alternate Logic circuit generates pulses to clock FF U3705. Components U3905B, U3805A, R3903, R3904, and C3804 form the Chop Clock generator.

When more than one channel is selected and the ALT/CHOP button is pressed in (Chop mode), a high-logic level from U3605's O_4 output will enable U3805B and U3905D. A low-logic level on the ALT/CHOP SELECT line disables U3905D, whose output, a high-logic level, activates U3805B. (Before U3805B was activated, its output was a low-logic level which kept U3905B disabled.) When activated, U3805B activates U3905B by asserting a high-logic level on the pin 5 input of U3905B. Now that U3905B is active, the low-logic level at its output causes C3804 to discharge toward a low-logic level. When the voltage on C3804 reaches the low threshold voltage of U3805A, that gate switches to a low-logic level output. The low-logic level from U3805A disables U3905B, causing U3905B to switch to a high-logic level. Now C3804 starts charging toward a high-logic level. When the voltage on C3804 reaches the high threshold voltage of U3805A, U3805A switches to a high-logic level output and the cycle repeats. The operating frequency of the chop generator is about 1 MHz. This is determined by the RC time constant of R3903 and C3804 and the threshold levels of U3805A. Figure 3-5 shows details of the waveform at the junction of R3903 and C3804.

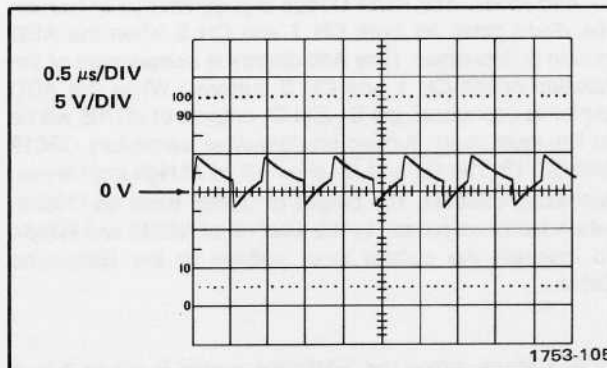


Fig. 3-5. Waveform at the junction of R3903 and C3804.

When the ALT/CHOP control is set to CHOP, a low-logic level on the ALT/CHOP SELECT line disables U3905A. The output of U3905A will be a high-logic level that enables U3805C, which will pass the output of the chop generator on the gate-control circuit and the crt-blanking circuitry.

Because FF U3705 responds only to positive-going transitions, the chop frequency is half the frequency of the chop generator, or about 500 kHz.

When the setting of the VERT MODE control calls for a multiple-trace chopped display, FF U3605 responds to pulses from the chop generator by sequentially activating gate-drive transistors Q3619, Q3719, and Q3617. The sequence of switching is CH 1, CH 2, ADD, and TRIG VIEW. The outputs of U3705, which control the gate-drive transistors, are connected to ROM U3605. Refer to "Gate Control" discussion for details of that circuitry. When the ALT/CHOP control is set to ALT, the ALT/CHOP SELECT line will be at a high-logic level. The high-logic level on ALT/CHOP SELECT has two effects, as follows.

1. The high-logic level on the ALT/CHOP SELECT line enables U3905D. Whenever an operator selects a multiple display while U3905D is enabled, U3905D will be activated and will stop the chop generator.
2. The high-logic level on the ALT/CHOP SELECT line enables U3905A, which will then be activated by the VERT ALT SYNC PULSE. When activated, U3905A disables U3805C. At the end of the sweep, U3905A, now disabled, produces a high-logic level that again activates U3805C. The positive-going edge of U3805C's output clocks FF U3705. Flip-flop U3705 will now switch among the selected inputs at a rate set by the VERT ALT SYNC PULSES.

If the VERT MODE control is set for a single display the O_4 output of U3605 will be at a low-logic level, disabling the chop generator via U3805B. When just one display is selected, FF U3705 receives clock pulses but does not change state.

Calibration—466 Service

h. Set:

VIEW TIME	MAX (in detent)
A TRIG LEVEL	Fully clockwise

i. Push ERASE button several times to ensure meshes are stable, then wait 3 minutes.

j. Trigger sweep by turning A TRIG LEVEL control counterclockwise.

CHECK—Trace is stored and distinguishable from background, everywhere within center 8 x 6 div, for 15 seconds or more.

k. Set:

A TIME/DIV	10 μ s
Storage Mode	NON STORE

l. Adjust leveled sine-wave generator for 3.2 div, 50 kHz display (adjust A TRIG LEVEL control as needed for stable display).

m. Adjust A TIME/DIV VAR control for about 1 cycle/div.

n. Position bottom of display 3 div below center horizontal line.

o. Set:

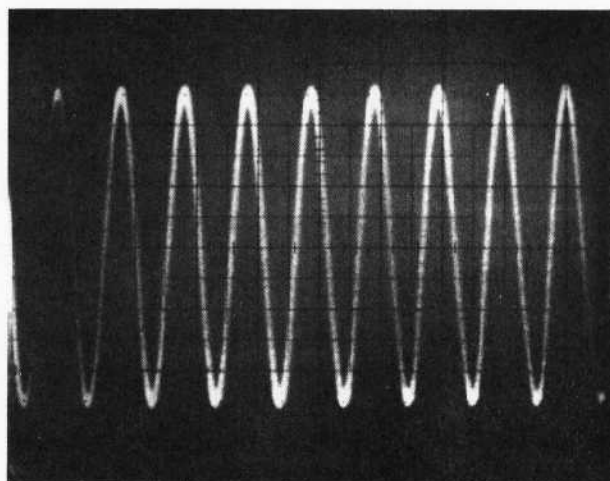
A TRIG LEVEL	Fully clockwise
A TRIG MODE	SINGL SWP
Storage Mode	VAR PERS (push in)
VIEW TIME	MAX (in detent)
STORAGE LEVEL	NORM

p. Push ERASE button.

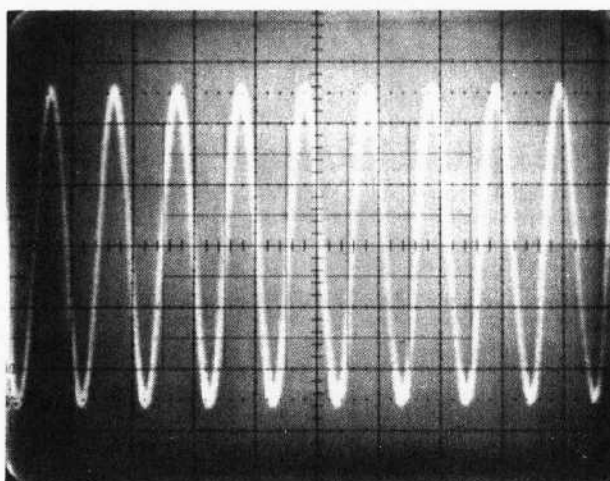
q. Rotate STORAGE LEVEL control clockwise until screen starts to brighten.

r. Trigger sweep by turning A TRIG LEVEL control counterclockwise.

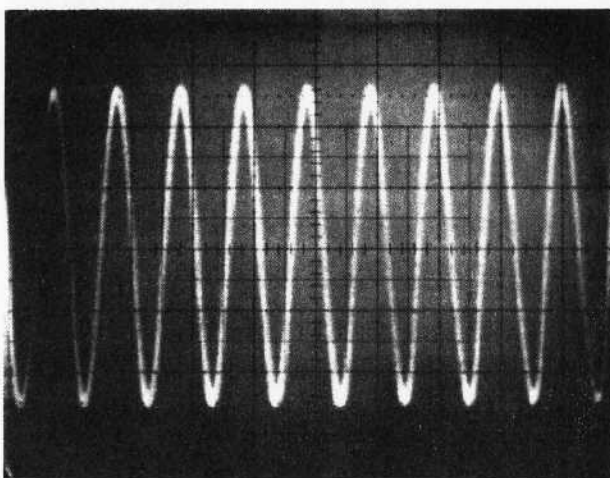
CHECK—Trace is stored and distinguishable from background, within center 8 horizontal div, for 15 seconds or more.



A. Incorrect Adjustment (fading negative).



B. Incorrect adjustment (fading positive).



C. Correct adjustment.

1753-79

Fig. 5-13. Display when R1982, R1989, and STORAGE LEVEL are adjusted for FAST storage.

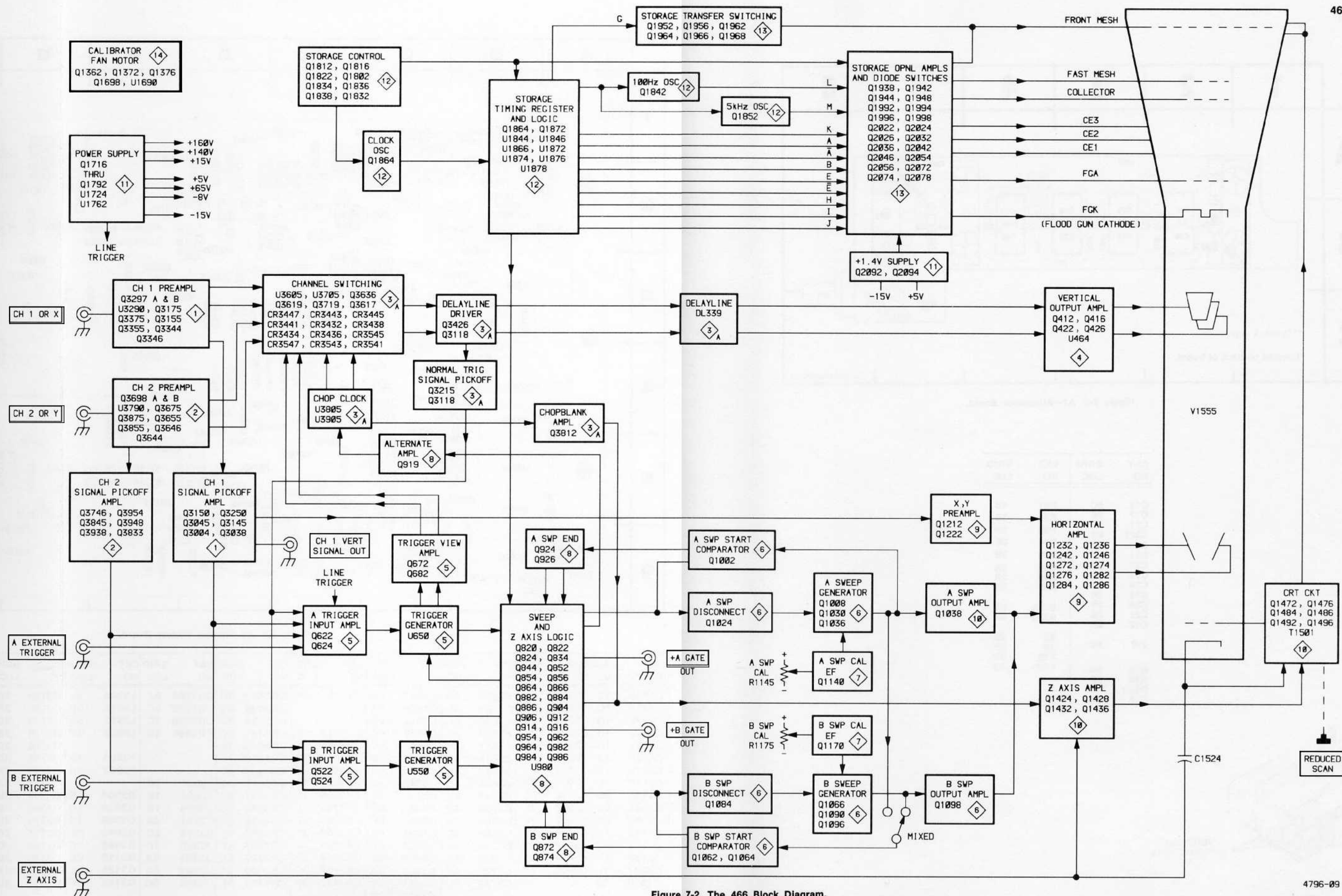
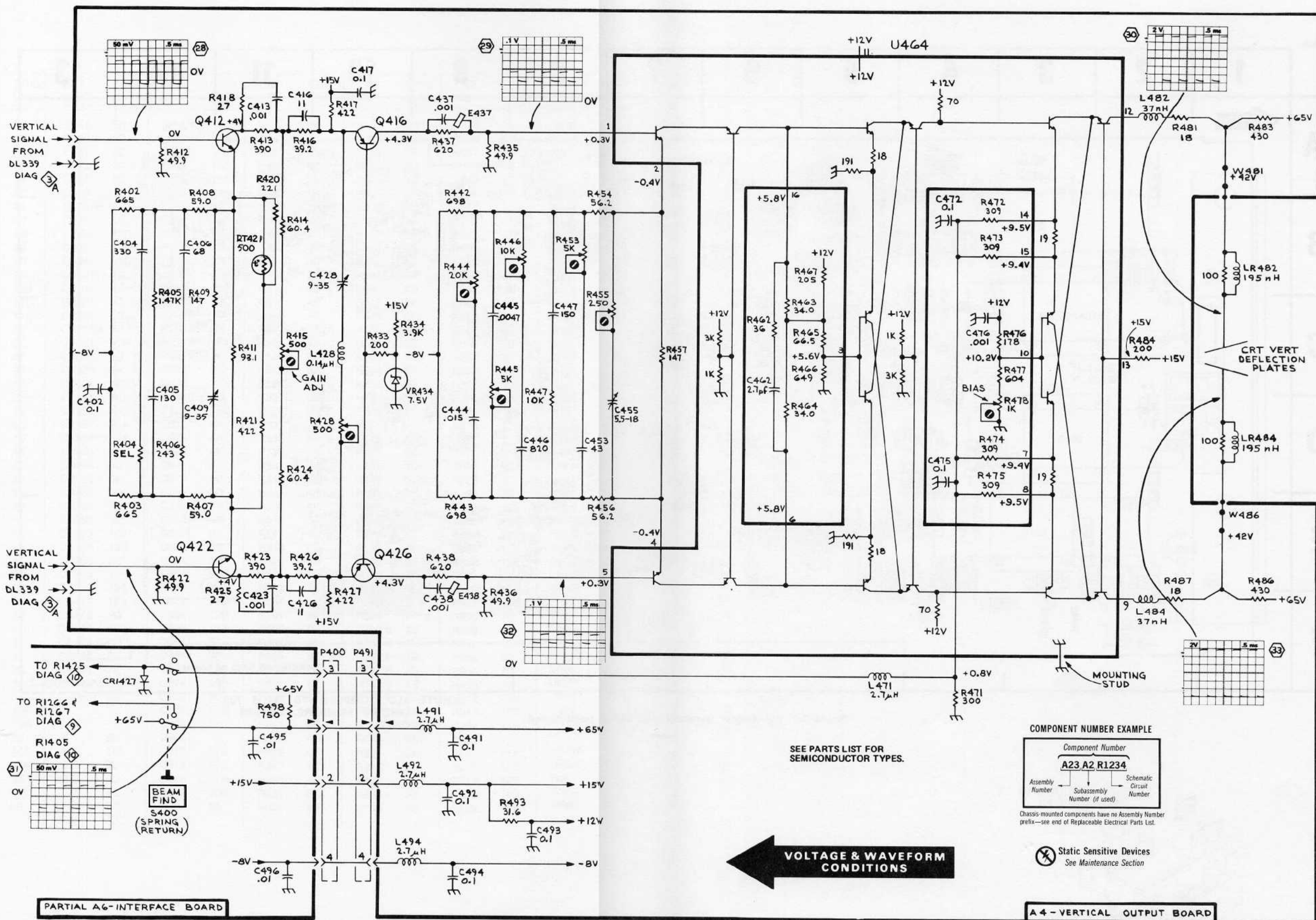


Figure 7-2. The 466 Block Diagram.



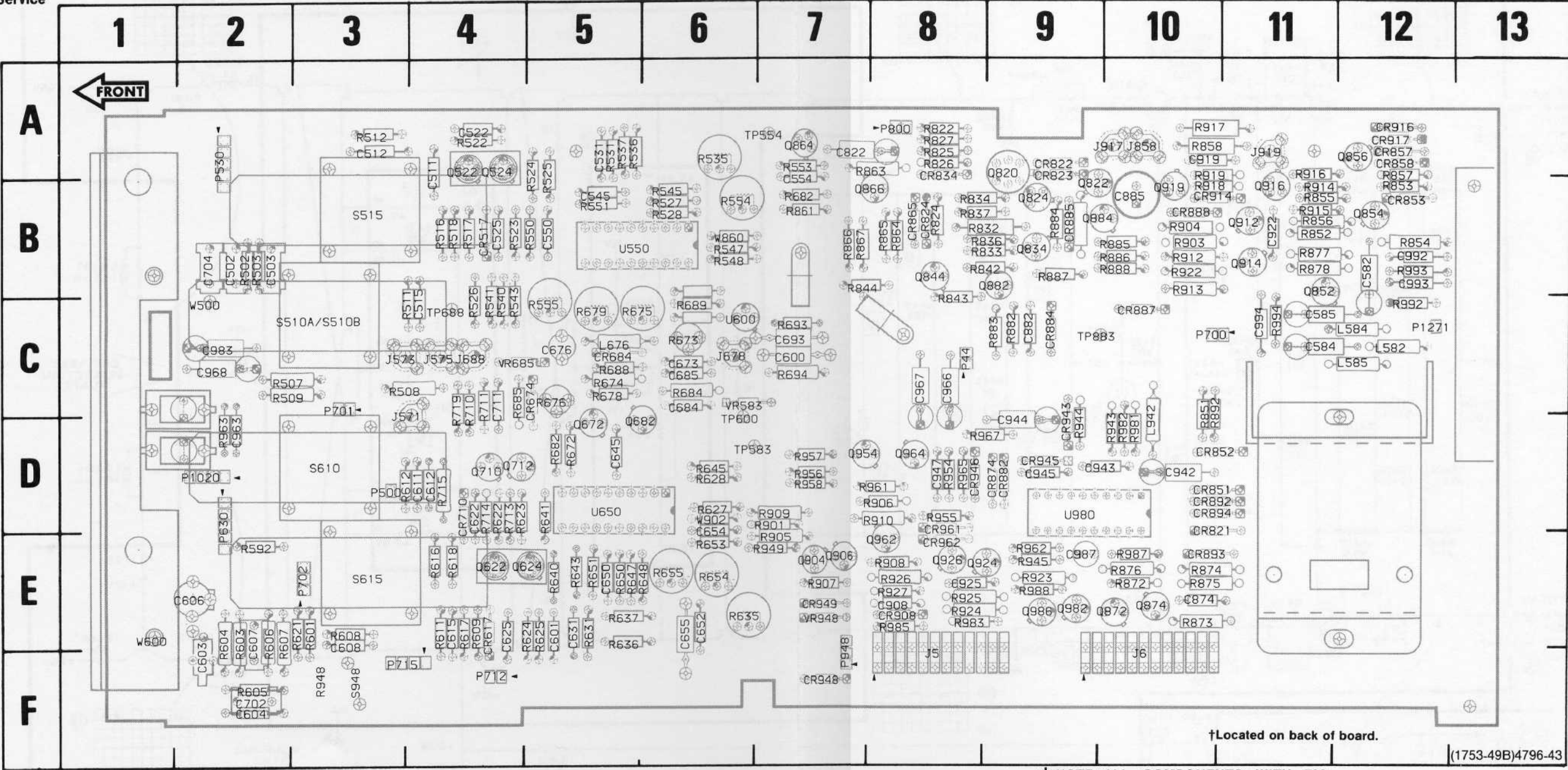
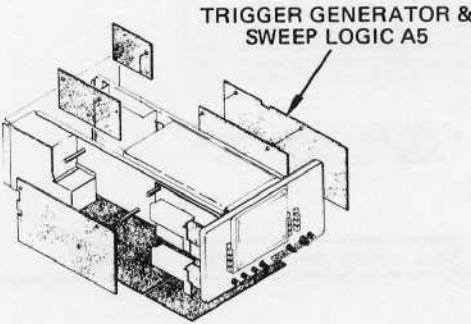


Figure 7-7. A5—Trigger Generator and Sweep Logic Board.



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C502	2B	C944	9D	J858†	10A	Q926	8E	R623	4D	R834	8B	R923	9E
C503	2B	C945	9D	J917†	10A	Q954	7D	R624	5E	R836	9B	R924	8E
C511	4A	C947	8D	J919†	11A	Q962	8E	R625	5E	R837	8B	R925	8E
C511	4B	C963	2D	L582	12C	Q964	8D	R627	6D	R842	9B	R926	8E
C512	3A	C967	8C	L584	12C	Q982	9E	R628	6D	R843	8C	R927	8E
C515	4C	C968	2C	L585	12C	Q986	9E	R631	5E	R844	7B	R943	10D
C522	4A	C983	2C	L676	5C	R502	2B	R635	6E	R851	10D	R944	9D
C525	4B	C987	9E	L942	10D	R507	2C	R636	5E	R852	11B	R945	9E
C531	5A	C992	12B	P44	8C	R508	3C	R637	5E	R853	12B	R948†	3F
C545	5B	C993	12B	P500	3D	R509	2C	R640	5E	R855	11B	R949	7E
C550	5B	C994	11C	P530	2A	R511	3C	R641	5D	R856	11B	R954	8D
C554	7B	CR517	4B	P630	2D	R512	3A	R643	5E	R857	12B	R955	8D
C582	12B	CR617	4E	P630	2E	R516	4B	R645	6D	R858	10A	R956	7D
C584	11C	CR674	5C	P700*	10C	R517	4B	R647	5E	R863	8A	R957	7D
C585	11C	CR684	5C	P701*	3C	R518	4B	R648	6E	R864	8B	R958	7D
C600	7C	CR710*	4D	P702*	3E	R522	4A	R650	5E	R865	8B	R961	8D
C601	5E	CR821	10E	P712*	4F	R523	4B	R651	5E	R866	7B	R962	9E
C603	2F	CR824	8B	P715*	3F	R524	5A	R653	6E	R867	7B	R963	2D
C604	2F	CR834	8A	P800	8A	R525	5A	R654	6E	R872	10E	R965	8D
C606	2E	CR851	10D	P948	7F	R526	4C	R655	6E	R873	10E	R967	8D
C607	2E	CR852	10D	P1020	2D	R527	6B	R672	5D	R874	10E	R981	10D
C608	3E	CR853	12B	P1271	12C	R528	6B	R673	6C	R875	10E	R982	10D
C611	4D	CR857	12A	Q522	4A	R531	5A	R674	5C	R876	10E	R983	8E
C612	4D	CR858	12A	Q524	4A	R535	6A	R675	5C	R877	11B	R985	8E
C615	4E	CR865	8B	Q622	4E	R536	5A	R676	5C	R878	11B	R987	10E
C622	4D	CR884	9C	Q624	4E	R537	5A	R678	5C	R882	9C	R988	9E
C625	4E	CR885	9B	Q672	5D	R540	4C	R679	5C	R883	9C	R992	12C
C631	5E	CR887	10C	Q682	6D	R541	4C	R681	7B	R884	9B	R993	12B
C650	5E	CR888	10B	Q710*	4D	R543	4C	R682	5D	R885	10B	R994	11C
C652	6E	CR892	10D	Q712*	4D	R545	6B	R682	7B	R886	10B	S510A†	3C
C654	6E	CR893	10E	Q820	9A	R547	6B	R684	6C	R887	9B	S510B†	3C
C655	6E	CR894	10D	Q822	9B	R548	6B	R685	4C	R888	10B	S515†	3B
C673	6C	CR908	8E	Q824	9B	R550	5B	R685	4C	R892	10D	S610†	3D
C676	5C	CR914	10B	Q834	9B	R551	5B	R688	5C	R901	7D	S615†	3E
C684	6C	CR916	12A	Q844	8B	R553	7A	R689	6C	R903	10B	S948†	3F
C685	6C	CR917	12A	Q852	11B	R554	6B	R693	7C	R904	10B	TP554	7A
C693	7C	CR943	9D	Q854	12B	R601	3E	R694	7C	R905	7E	TP583	6D
C696	8C	CR945	9D	Q856	12A	R603	2E	R710*	4C	R906	8D	TP600	6D
C697	8C	CR946	8D	Q864	7A	R604	2E	R711*	4C	R907	7E	TP688	4C
C702*	2F	CR948	7F	Q866	8B	R605	2F	R712*	4D	R908	8E	TP883	9C
C704*	2B	CR949	7E	Q872	10E	R606	2E	R713*	4D	R909	7D	U550	5B
C711*	4C	CR961	8E	Q874	10E	R607	2E	R715*	4D	R910	8D	U600	6C
C822	7A	CR962	8E	Q882	9B	R608	3E	R719*	4C	R912	10B	U650	5D
C874	10E			Q884	10B	R609	4E	R822	8A	R913	10B	U980	9D
C885	10B			Q904	7E	R611	4E	R822	9A	R914	11B	VR583	6C
C908	8E	J5	8F	Q906	7E	R612	4D	R823	9A	R915	11B	VR685	4C
C919	10A	J6	10F	Q912	11B	R616	4E	R825	8A	R916	11A	VR948	7E
C922	11B	J571	3D	Q914	11B	R617	4E	R826	8A	R917	10A	W500	2C
C925	8E	J573	3C	Q916	11B	R618	4E	R827	8A	R918	10B	W600	1E
C942	10D	J575	4C	Q919	10B	R621	3E	R832	8B	R919	10B	W860	6B
C943	9D	J678	6C	Q924	8E	R622	4D	R833	9B	R922	10B	W902	6D
		J688	4C										

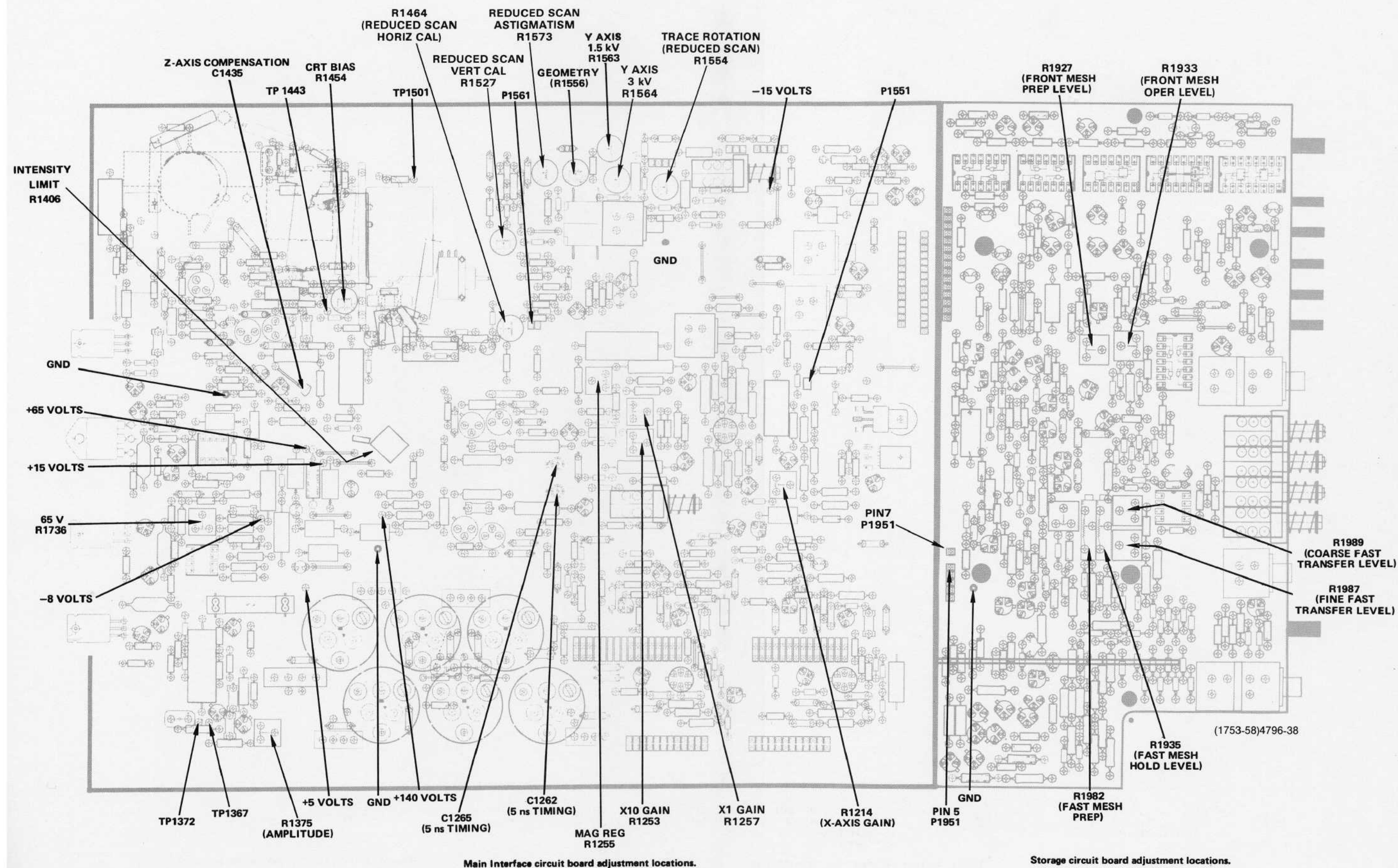
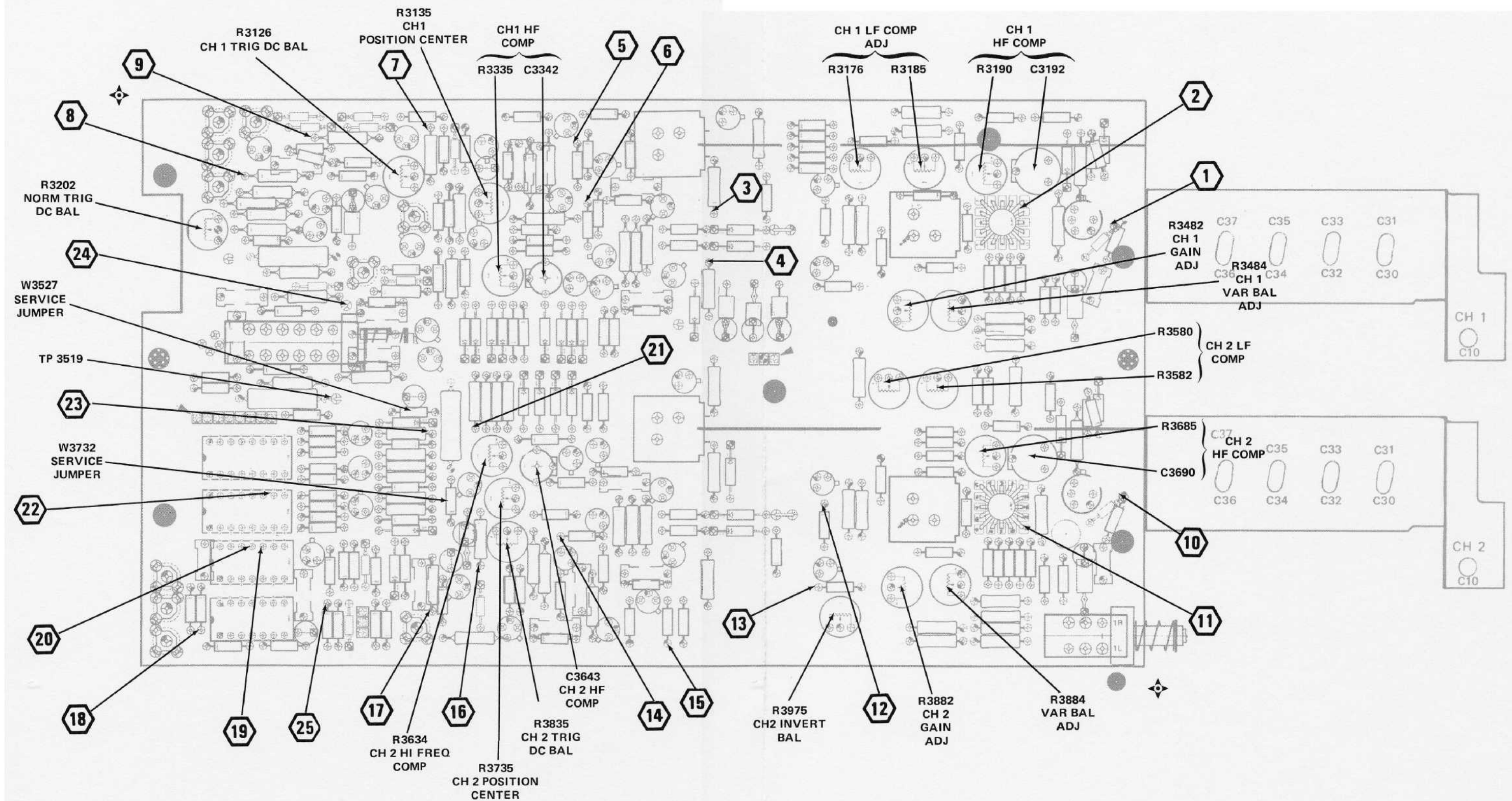


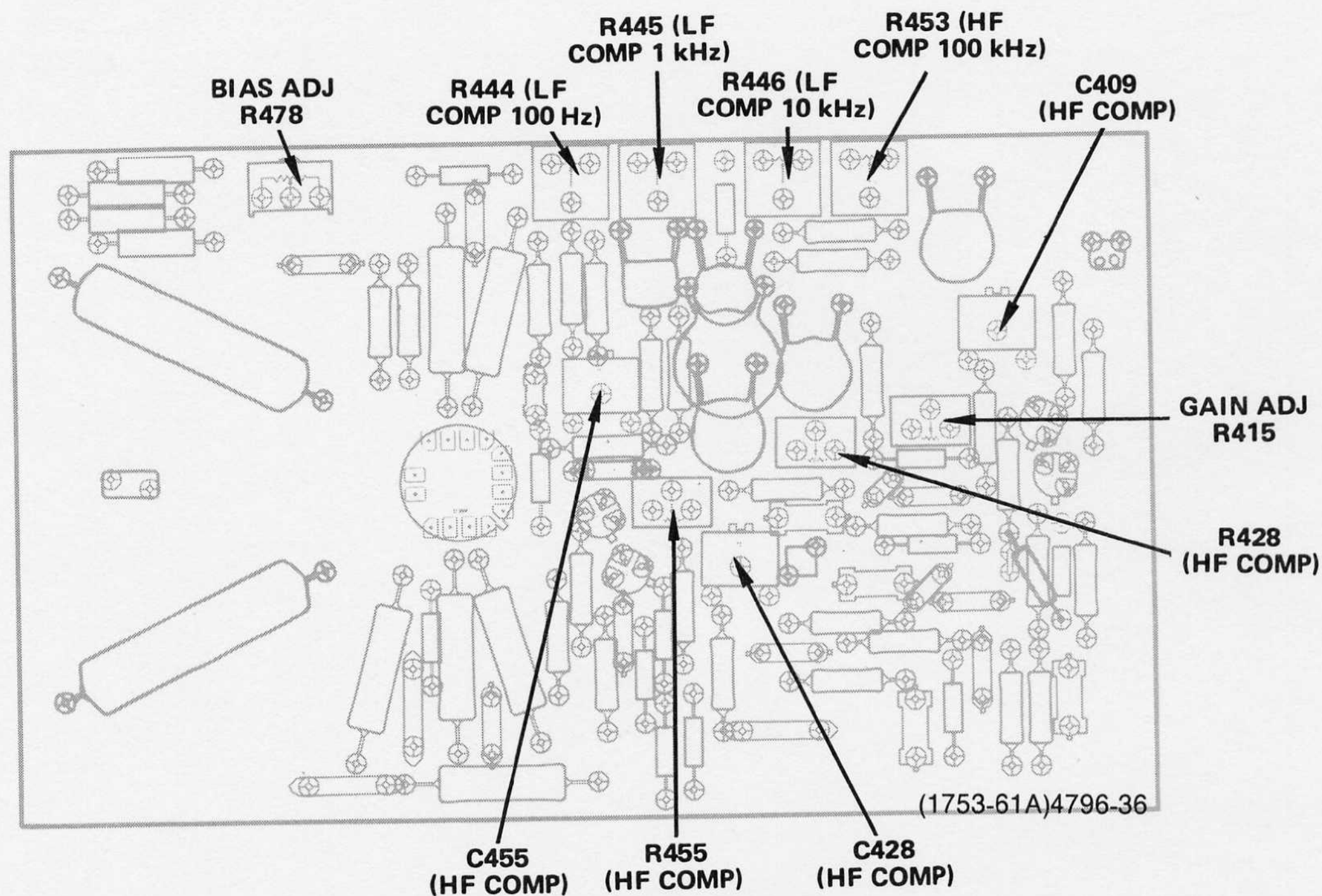
Figure 7-13. A6—Interface, A10—Storage Logic Adjustment Locations 1.

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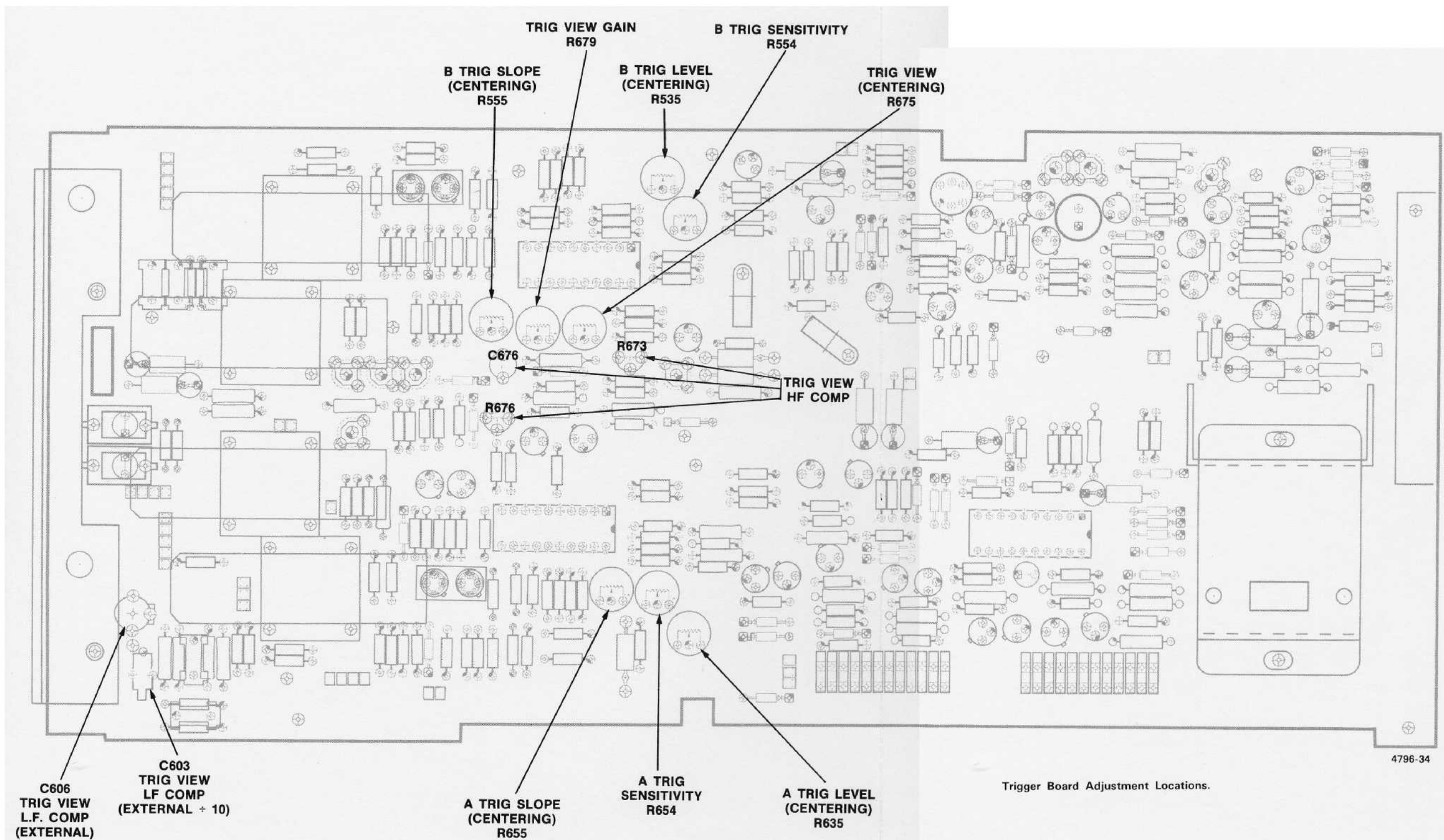


A2 Vertical Preamplifier board.

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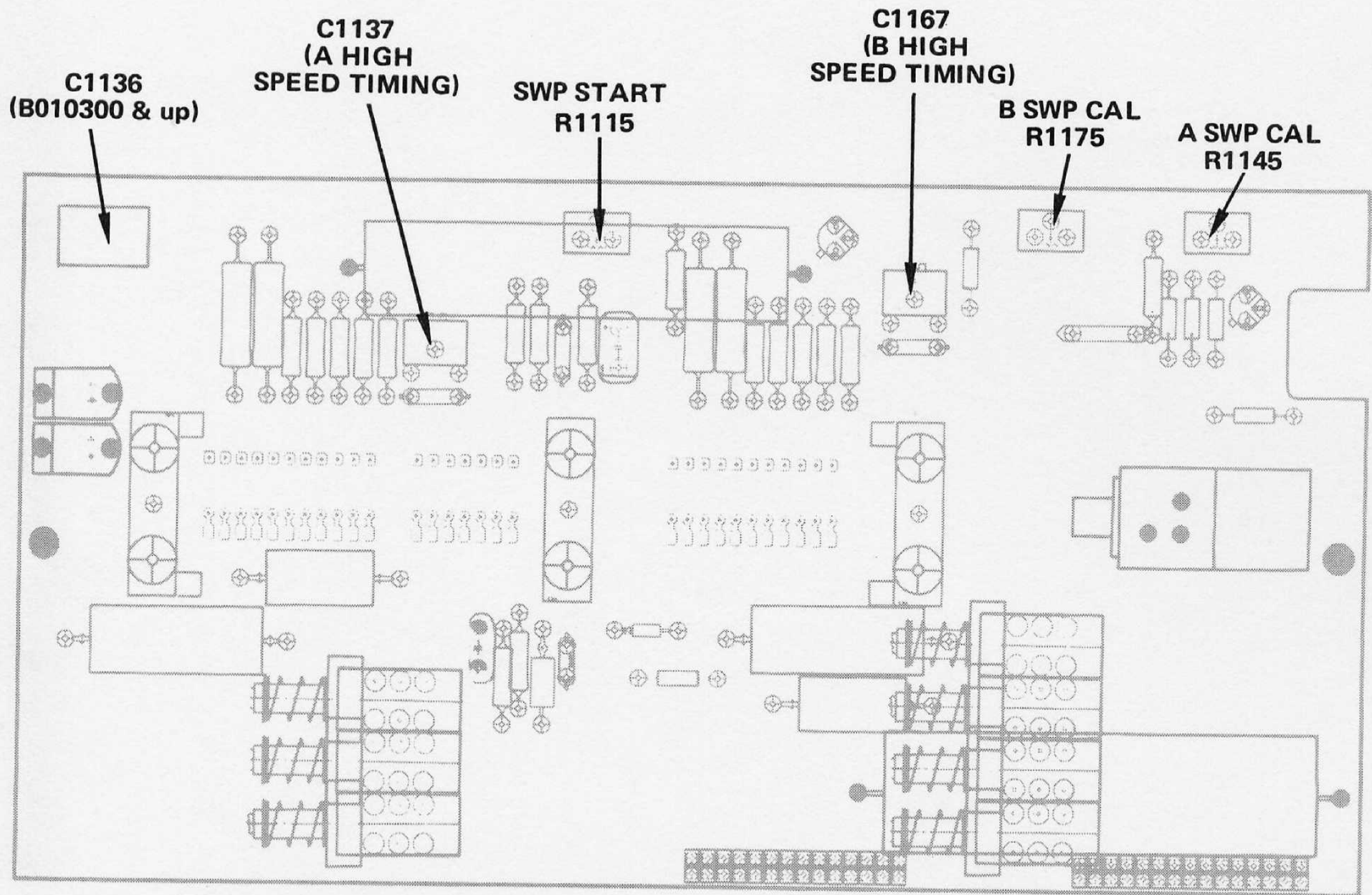


Vertical Output circuit board adjustment locations.



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Figure 7-15. A5—Trigger Generator, A7—Timing Adjustment Locations 3.



(1753-68)4796-49

Timing circuit board adjustment locations.

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.

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.

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

....END ATTACHING PARTS....

Detail Part of Assembly and/or Component

Attaching parts for Detail Part

....END ATTACHING PARTS....

Parts of Detail Part

Attaching parts for Parts of Detail Part

....END ATTACHING PARTS....

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.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

..	INCH	ELECTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICON	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	ORD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
01536	TEXTRON INC CAMCAR DIV SEMS PRODUCTS UNIT	1818 CHRISTINA ST	ROCKFORD IL 61108
01963 04811	CHERRY ELECTRICAL PRODUCTS CORP PRECISION COIL SPRING CO	3600 SUNSET AVE 10107 ROSE ST P O BOX 5450 3628 CRENSHAW BLVD PO BOX 30231	WAUKEGAN IL 60087-3214 EL MONTE CA 91734
05006	20TH CENTURY PLASTICS INC	2118 D ST 17301 RIDGELAND	LOS ANGELES CA 90030
05129 06383 06950	KILO ENGINEERING CO PANDUIT CORP SCREWCORP VSI AEROSPACE PRODUCTS DIV SUB OF FAIRCHILD INDUSTRIES INC	13001 E TEMPLE AVE PO BOX 730	LA VERNE CA 91750-5422 TINLEY PARK IL 07094-2917 CITY OF INDUSTRY CA 91746-1417
07416 07700	NELSON NAME PLATE CO TECHNICAL WIRE PRODUCTS INC DBA TECKNIT INC	3191 CASITAS 129 DERMODY ST	LOS ANGELES CA 90039-2410 CRANFORD NJ 07016-3217
08530 09353 09772	RELANCE MICA CORP C AND K COMPONENTS INC WEST COAST LOCKWASHER CO INC	341-39TH ST 15 RIVERDALE AVE 16730 E JOHNSON DRIVE P O BOX 3588	BROOKLYN NY 11212-2903 NEWTON MA 02158-1057 CITY OF INDUSTRY CA 91744
09922 10392 12327 12360	BURNDY CORP GENERAL STAPLE CO INC FREEWAY CORP ALBANY FASTENERS	RICHARDS AVE 59-12 37TH ST 9301 ALLEN DR 327 PINE ST PO BOX 879	NORWALK CT 06852 WOODSIDE NY 11377-2523 CLEVELAND OH 44125-4632 PAWTUCKET RI 02862
13511 16428	AMPHENOL CADRE DIV BUNKER RAMO CORP COOPER BELDEN ELECTRONIC WIRE AND CA SUB OF COOPER INDUSTRIES INC	NW N ST	LOS GATOS CA RICHMOND IN 47374
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
22670 24546 24931	G M NAMEPLATE INC CORNING GLASS WORKS SPECIALTY CONNECTOR CO INC	2040 15TH AVE WEST 550 HIGH ST 2100 EARLYWOOD DR PO BOX 547	SEATTLE WA 98119-2728 BRADFORD PA 16701-3737 FRANKLIN IN 46131
26233	NYLOK FASTENER CORP	1161 E SANDHILL AVE SUITE D PO BOX 5228	CARSON CA 90749
28520	HEYCO MOLDED PRODUCTS	750 BOULEVARD P O BOX 160 HIGHLAND AVE	KENILWORTH NJ 07033-1721
56878 70278	SPS TECHNOLOGIES INC AEROSPACE & INDUSTRIAL PRODUCTS INC ALLIED STEEL AND CONVEYORS, DIV. OF SPARTON CORP.	17333 HEALY	JENKINTOWN PA 19046 DETROIT, MI 48212
70318 70903	ALLMETAL SCREW PRODUCTS CO INC COOPER BELDEN ELECTRONICS WIRE AND C SUB OF COOPER INDUSTRIES INC	821 STEWART AVE 2000 S BATAVIA AVE	GARDEN CITY NY 11530-4810 GENEVA IL 60134-3325
71159 71279	BRISTOL SOCKET SCREW CO MIDLAND-ROSS CORP	ONE ALEWIFE PLACE	WATERBURY CT CAMBRIDGE MA 02138-2310
71400 71590	CAMBION DIV BUSSMANN DIV OF COOPER INDUSTRIES INC MEPCO/CENTRALAB INC	114 OLD STATE RD PO BOX 14460 HWY 20 W P O BOX 858 459 MT PLEASANT	ST LOUIS MO 63178 FORT DODGE IA 50501
72228	A NORTH AMERICAN PHILIPS CO AMCA INTERNATIONAL CORP CONTINENTAL SCREW CO DIV		NEW BEDFORD MA 02742
73743 74445 75915	FISCHER SPECIAL MFG CO HOLO-KROME CO LITTELFUSE TRACTOR INC SUB TRACTOR INC	111 INDUSTRIAL RD 31 BROOK ST 800 E NORTHWEST HWY	COLD SPRING KY 41076-9749 ELMWOOD CT 06110-2350 DES PLAINES IL 60016-3049
77900	SHAKEPROOF DIV OF ILLINOIS TOOL WORKS	SAINT CHARLES RD	ELGIN IL 60120
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIV	ST CHARLES ROAD	ELGIN IL 60120
79136	WALDES KOHINOR IN	47-16 AUSTEL PLACE	LONG ISLAND CITY NY 11101-4402

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	14150 SW KARL BRAUM DR PO BOX 500 MS 53-111 3221 W BIG BEAVER RD	BEAVERTON OR 97077 TROY MI 48098
83385	MICRODOT MFG INC GREER-CENTRAL DIV		
83486	ELCO INDUSTRIES INC	1101 SAMUELSON RD	ROCKFORD IL 61101
86445	PENN FIBRE AND SPECIALTY CO INC SUB OF PACIFIC TUBE CO	4343 G ST PO BOX 4890A	PHILADELPHIA PA 19124-4325
86928	SEASTROM MFG CO INC	701 SONORA AVE	GLENDALE CA 91201-2431
89663	REESE J RAMSEY INC	555 WHITE PLAINS RD	TARRYTOWN NY 10591-5109
91260	CONNOR SPRING AND MFG CO	1729 JUNCTION AVE	SAN JOSE CA 95112
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
97464	INDUSTRIAL RETAINING RING CO	57 CORDIER ST	IRVINGTON NJ 07111-4035
S3109	FELLER ASA ADOLF AG C/O PANEL COMPONENTS CORP	355 TESCONI CIRCLE	SANTA ROSA CA 95401
TK0392	NORTHWEST FASTENER SALES INC	7923 SW CIRRUS DRIVE	BEAVERTON OR 97005-6448
TK0433	PORTLAND SCREW CO	6520 N BASIN	PORTLAND OR 97217-3920
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609-3320
TK0507	O HARA METAL PRODUCTS CO	542 BRANNAN ST	SAN FRANCISCO CA 94107
TK0508	NORTHWEST SPRING AND MFG CO	5858 WILLOW LANE	LAKE OSWEGO OR 97034-5343
TK0588	UNIVERSAL PRECISION PRODUCTS	1775 NW 216TH	HILLSBORO OR 97123
TK0858	STAUFFER SUPPLY CO	105 SE TAYLOR	PORTLAND OR 97214
TK1319	MORELLIS Q & D PLASTICS	1812 16-TH AVE	FOREST GROVE OR 97116
TK1373	PATELEC-CEM (ITALY)	10156 TORINO	VAICENTALLO 62/45S ITALY
TK1684	TECHNICAL IMAGES INC	2206 MOUNTAIN VIEW DR	NEWBURG OR 97132-9265
TK2038	MULTICOMP INC	3005 SW 154TH TERRACE #3	BEAVERTON OR 97006
TK2042	ZMAN & ASSOCIATES	7633 SO. 180TH	KENT, WA 98032
TK2165	TRI-QUEST CORP	3000 LEWIS AND CLARK HWY	VANCCUVER WA 98661-2999

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	200-1411-00		1	RTNR,IMPLOSION:5.422 X 4.743 X 0.441	TK2165	ORDER BY DESCR
-2	213-0313-00		4	.THUMSCREW:4-40 X 0.45,0.25 OD HD,SST	80009	213-0313-00
-3	337-1674-07		1	SHLD,IMPLOSION:SMOKE GRAY	80009	337-1674-07
	337-1674-08		1	SHLD,IMPLOSION:FILTER,MKD FOR NTSC (OPTION 05 ONLY)	80009	337-1674-08
	337-1674-09		1	SHLD,IMPLOSION:FILTER,MKD FOR CCIR (OPTION 05 ONLY)	80009	337-1674-09
-4	366-0494-00		2	KNOB:GRAY WITH SETSCREW	80009	366-0494-00
	213-0246-00		2	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-5	366-1031-02		2	KNOB:RED,VAR,0.127 ID X 0.392 OD X 0.466 H	TK2165	ORDER BY DESCR
	213-0246-00		2	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-6	366-1426-00		2	KNOB:GY,VOLT/DIV,0.191 X 1.125 X 0.79	80009	366-1426-00
	213-0153-00		2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-7	366-0215-02		2	KNOB:LEVER SWITCH	80009	366-0215-02
-8	366-1023-01		3	KNOB:GY,0.127 ID X 0.392 OD X 0.531 H	80009	366-1023-01
	213-0246-00		3	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-9	366-1319-02		1	KNOB:GY,0.079 ID X 0.28 OD X 0.32 H	80009	366-1319-02
	213-0075-00		1	.SETSCREW:4-40 X 0.094,STL	74445	ORDER BY DESCR
-10	366-1215-03		1	KNOB:GY,0.127 ID X 0.5 OD X 0.531 H	TK2165	ORDER BY DESCR
	213-0153-00		1	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-11	366-1059-00		1	PUSH BUTTON:GRAY,0.227 OD X 0.3	80009	366-1059-00
-12	366-1215-03		1	KNOB:GY,0.127 ID X 0.5 OD X 0.531 H	TK2165	ORDER BY DESCR
	213-0153-00		1	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-13	331-0328-00		1	DIAL,CONTROL:10 TURN,0.0 TO 9.99	05129	461-S-70
	213-0048-00		1	.SETSCREW:4-40 X 0.125,STL	TK0392	ORDER BY DESCR
-14	366-1346-02		1	KNOB:RED,VAR,0.08 ID X 0.392 OD X 0.466 H	80009	366-1346-02
	213-0153-00		1	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-15	366-1219-01		1	KNOB:GY,DLYD SWP,0.203 X 0.97 X 0.89	TK2165	ORDER BY DESCR
	213-0890-00		2	.SETSCREW:6-32 X 0.25 L,STL	56878	ORDER BY DESCR
-16	354-0442-01		1	RING,KNOB SKIRT:CLEAR,1.45 OD	TK2165	ORDER BY DESCR
	213-0005-00		2	.SETSCREW:8-32 X 0.125,STL	TK0392	ORDER BY DESCR
-17	401-0080-00		1	BRG,KNOB SKIRT:0.789 ID X 0.866"OD PLASTIC	80009	401-0080-00
-18	366-1327-00		1	KNOB:GY,0.8 ID X 0.392 OD X 0.466 H	80009	366-1327-00
	213-0153-00		1	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-19	366-1280-00		1	KNOB:GY,0.127 ID X 0.588 OD X 0.6 H	TK2165	ORDER BY DESCR
	213-0153-00		1	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-20	366-0494-00		1	KNOB:GRAY WITH SETSCREW	80009	366-0494-00
	213-0246-00		1	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-21	366-1278-00		2	KNOB:GY,0.08 ID X 0.392 OD X 0.466 H	TK2165	ORDER BY DESCR
	213-0153-00		2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-22	366-1280-00		2	KNOB:GY,0.127 ID X 0.588 OD X 0.6 H	TK2165	ORDER BY DESCR
	213-0153-00		2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-23	426-0681-00		16	FRAME,PUSH BTN:	80009	426-0681-00
-24	426-1072-00		4	FRAME,PUSH BTN:SILVER GRAY PLSTC	80009	426-1072-00
-25	358-0378-01		2	BUSHING,SLEEVE:0.131 ID X 0.18 OD X 0.125 L	80009	358-0378-01
-26	358-0599-00		5	BUSHING,SLEEVE:0.125 ID X 0.25 OD X 0.234	28520	B-187-125
-27	358-0540-00		2	BSHG,MACH THD:0.25-32 X 0.128 X 0.24,AL	80009	358-0540-00
				ATTACHING PARTS		
-28	210-0583-00		2	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-29	210-0940-00		2	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
				END ATTACHING PARTS		
-30	358-0539-00		1	BSHG,MACH THD:0.25-32 X 0.144 X 0.315,AL	80009	358-0539-00
				ATTACHING PARTS		
-31	210-0583-00		1	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-32	210-0940-00		2	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
				END ATTACHING PARTS		
-33	358-0539-00		1	BSHG,MACH THD:0.25-32 X 0.144 X 0.315,AL	80009	358-0539-00
				ATTACHING PARTS		
-34	129-0213-00		1	SPACER,POST:1.156 L,0.25-32 EA END,AL	80009	129-0213-00
-35	210-0940-00		1	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
				END ATTACHING PARTS		
-36	358-0216-01		2	GROMMET,PLASTIC:WHITE,ROUND,0.252 ID	TK2165	ORDER BY DESCR
-37	358-0216-00		1	GROMMET,PLASTIC:GRAY,ROUND,0.257 ID	80009	358-0216-00
-38	378-0635-00		4	LENS,LIGHT:WHITE	80009	378-0635-00
-39	333-2580-01		1	PANEL,FRONT:	80009	333-2580-01
	333-1810-04		1	PANEL,FRONT: (OPTION 05 ONLY)	TK1684	ORDER BY DESCR
-40	352-0477-00		6	HOLDER,LED:GRAY POLYCARBONATE	TK2165	ORDER BY DESCR



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.

**PLEASE CHECK FOR CHANGE INFORMATION
AT THE REAR OF THIS MANUAL.**

000811 **DM44**
DIGITAL
MULTIMETER
WITH OPTIONS
SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077
070-2036-01
Product Group 40

Serial Number _____

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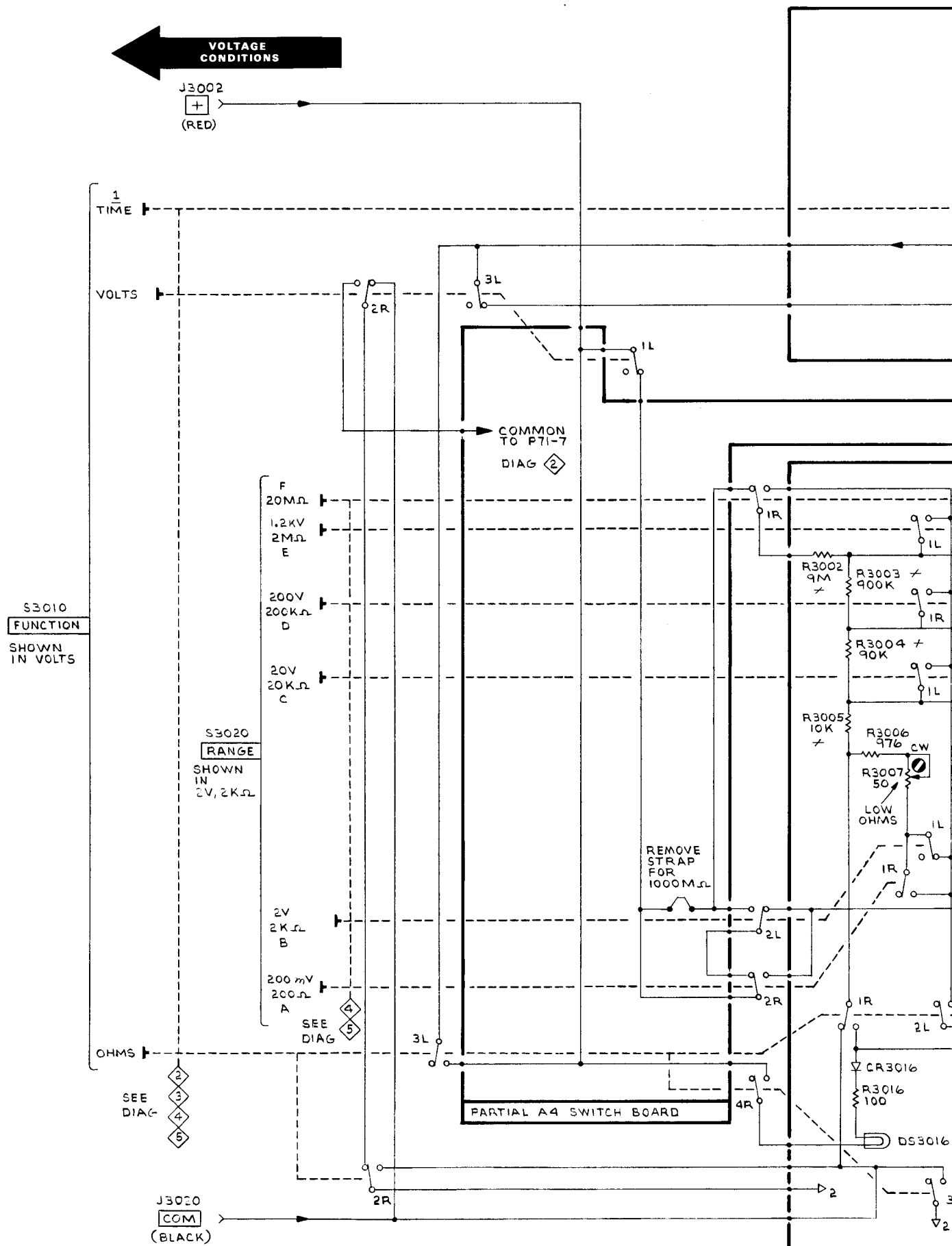
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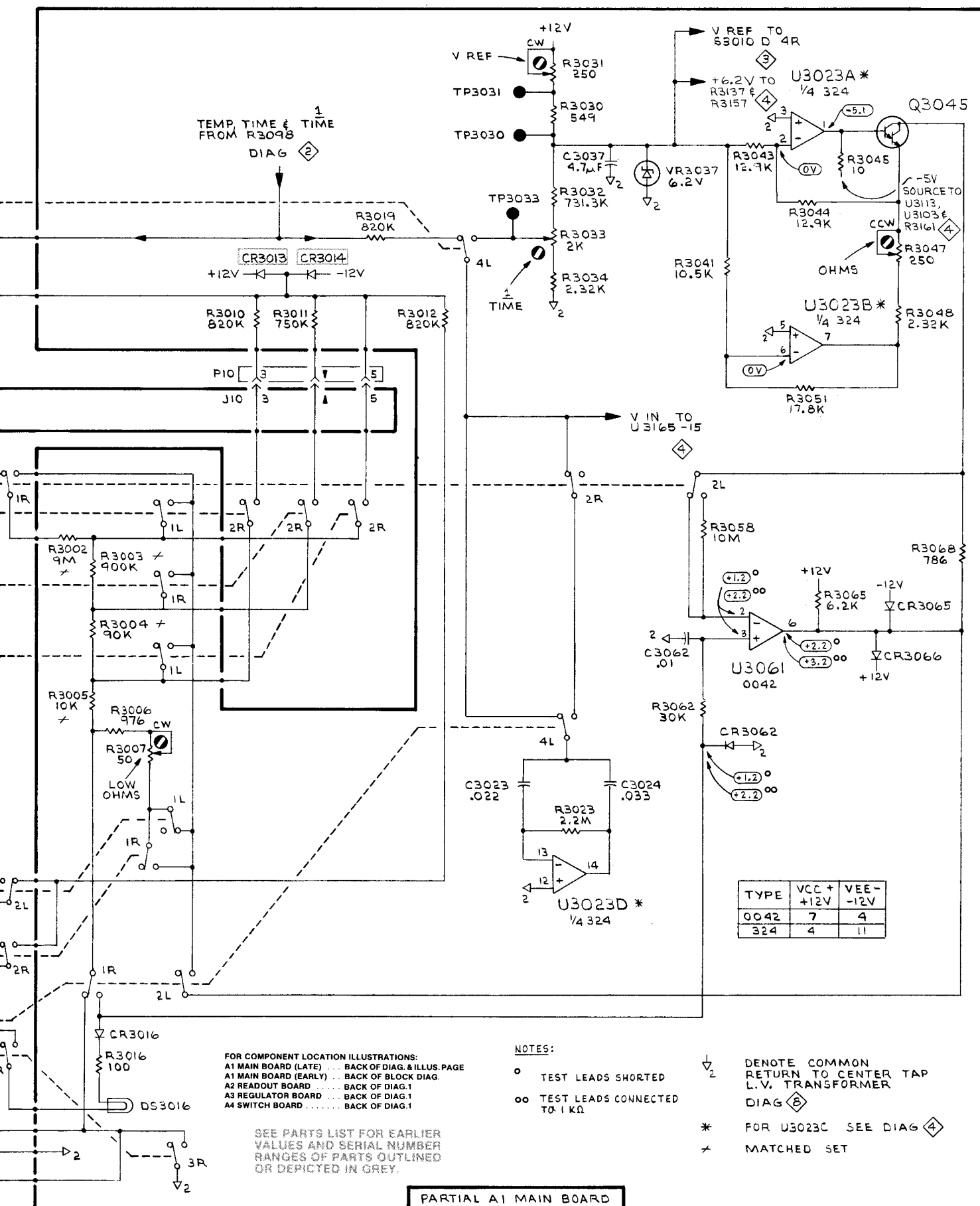
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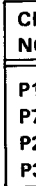


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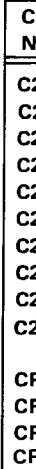
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INPUT ATTENUATOR & OHMS CONVERTER ①

09-013



MORE



***See Parts List**
serial number range

09-014

CKT NO	GRID LOC
P10	2B
P71	1E
P287	1F
P308	2F

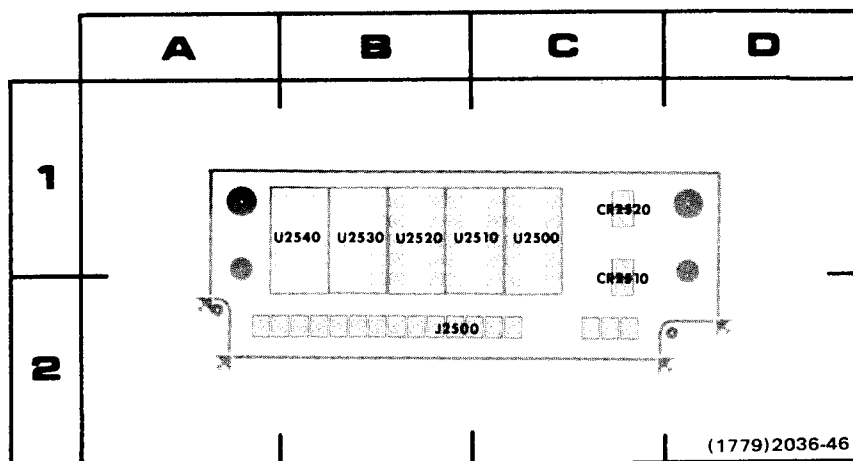


Fig. 9-5. A2 Readout board component locations.

CKT NO	GRID LOC	CKT NO	GRID LOC
C2612	3C	P2651	2D
C2613	2B		
C2615	3A	Q2632	3A
C2622	2C	Q2634	4B
C2623	2C	Q2636	4A
C2624	2B	Q2638	4B
C2626	2A		
C2632	3C	R2633	3B
C2634	4D	R2634	4D
C2636*	4B	R2635	4C
		R2636	4C
CR2610	1B		
CR2622	2E	U2614	3A
CR2623	1E	U2624	2A
CR2636	3D		

CKT NO
CR25
CR25
J250
U250
U251
U252
U253
U254

09-015

*See Parts List for
serial number ranges.

CKT NO	GRID LOC
CR2510	2C
CR2520	1C
J2500	2B
U2500	1C
U2510	1B
U2520	1B
U2530	1B
U2540	1B

09-016

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	200-1723-00		1		COVER,SCOPE:FRONT	80009	200-1723-00
-2	200-1722-00		1		COVER,SCOPE:FRONT	80009	200-1722-00
					(ATTACHING PARTS)		
-3	212-0130-00		2		SCREW,MACHINE:W/RTNR,8-32 X0.5 L,PNH,STL	29372	CA 13036-8-3-8
					- - - * - - -		
-4	-----		1		DM44:		
					(ATTACHING PARTS)		
-5	213-0146-00		2		SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
-6	210-0803-00		2		WASHER,FLAT:0.15 ID X 0.032 THK,STL CD PL	12327	OBD
-7	211-0008-00		3		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-8	210-0938-00		3		WASHER,FLAT:0.109 ID X 0.25 INCH OD,STL	75497	AN960-3
					- - - * - - -		
-9	437-0174-00		1		CABINET,SCOPE:W/DM40/DM43/DM44	80009	437-0174-00
	-----		-		(465 B010100-B305749 ONLY)		
	437-0174-02		1		CABINET,SCOPE:	80009	437-0174-02
	-----		-		(465 B305750 & UP ONLY)		
	437-0174-00		1		CABINET,SCOPE:W/DM40/DM43/DM44	80009	437-0174-00
	-----		-		(475 B010100-B269249 ONLY)		
	437-0174-02		1		CABINET,SCOPE:	80009	437-0174-02
	-----		-		(475 B269250 & UP ONLY)		
	437-0174-02		1		CABINET,SCOPE:	80009	437-0174-02
	-----		-		(465B AND 475A ONLY)		
	437-0176-00		1		CABINET,SCOPE:	80009	437-0176-00
	-----		-		(464 AND 466 ONLY)		
	437-0176-01		1		CABINET,SCOPE:	80009	437-0176-01
	-----		-		(OPTION 1Y ONLY)		
-10	348-0063-00		1		GROMMET,PLASTIC:0.50 INCH DIA	80009	348-0063-00
-11	-----		1		RESISTOR,VAR:(SEE R1110,R930,R816 REPL)		
	-----		-		(R1110 ON 465,R930 ON 475,475A, R816 ON 464,466)		
					(ATTACHING PARTS)		
-12	210-0590-00		1		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-13	210-0978-00		1		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
-14	210-0012-00		1		WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
					- - - * - - -		
-15	366-1563-00		1		KNOB:GY,0.252 ID X0.825 OD X 0.67 H	80009	366-1563-00
	213-0153-00		2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
	198-3160-00	XB022570	1		WIRE SET,ELEC:	80009	198-3160-00
	-----		-		(475 AND 475A ONLY)		
	131-0707-00		36		. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	47439
	131-0708-00		1		. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
	175-0825-00		FT		. WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
	175-0830-00		FT		. WIRE,ELECTRICAL:7 WIRE RIBBON	08261	SS-0726-710610C
	175-0831-00		FT		. WIRE,ELECTRICAL:8 WIRE RIBBON	08261	SS-0826-710610C
	352-0166-00		4		. CONN BODY,PL,EL:8 WIRE BLACK	80009	352-0166-00
	352-0169-00		2		. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	352-0171-00		2		. HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00

DIFFERENCES FOR MAIN PORTION OF STANDARD
INSTRUMENT WHEN EQUIPPED WITH DM44

CHANGE TO:

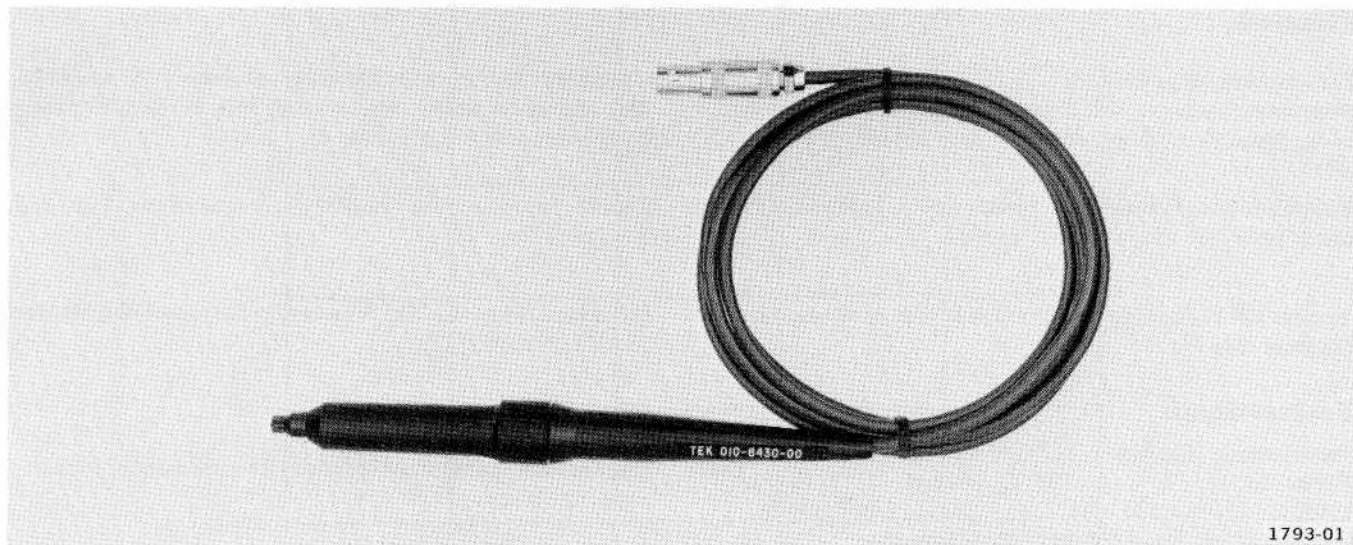
464	FIG.1-13	366-1563-00	KNOB:GY,0.252 ID X 0.825 OD X 0.67 H	80009	366-1563-00
465	FIG.1-26	366-1563-00	KNOB:GY,0.252 ID X 0.825 OD X 0.67 H	80009	366-1563-00
465B	FIG.1-11	366-1563-00	KNOB:GY,0.252 ID X 0.825 OD X 0.67 H	80009	366-1563-00
466	FIG.1-13	366-1563-00	KNOB:GY,0.252 ID X 0.825 OD X 0.67 H	80009	366-1563-00
475	FIG.1-39	366-1563-00	KNOB:GY,0.252 ID X 0.825 OD X 0.67 H	80009	366-1563-00
475A	FIG.1-39	366-1563-00	KNOB:GY,0.252 ID X 0.825 OD X 0.67 H	80009	366-1563-00
475	FIG.2-99	337-2079-00	SHIELD,ELEC:V O AMP	80009	337-2079-00



P6430
TEMPERATURE
PROBE
INSTRUCTION MANUAL

DM 502 6032298 is used with the P6430 probe.
For use with other DM 502s see pages 1-8 in DM 502
manual for performance specifications.

P6430 TEMPERATURE PROBE



The P6430 probe provides temperature measurement when used with Tektronix Digital Multimeters. Temperature is measured by touching the sensor tip to the device being measured. The plug-in feature of the nose tip sensor transistor allows easy replacement. The small diameter probe body design lends itself to use in compact circuitry. Power

is supplied to the transistor and signal is connected to the associated digital multimeter through a two-conductor cable and special two-pin plug. Ground for the base of the sensor transistor is applied through the shell of the probe plug.

SPECIFICATIONS

Electrical

Temperature (Equilibrium)¹: -55°C to +150°C. Accuracy determined by Digital Multimeter and conditions described under Measuring Temperature.

Maximum Safe Voltage on Measurement Surface: 100 V (dc + peak ac) above chassis ground.

Typical RF Frequency and Voltage Limits on Measurement Surface: See Fig. 1.

Environmental

Temperature: Storage—-55°C to +105°C. Operating—(Probe Body) -55°C to +105°C. (Cable) -15°C to +105°C. (Sensor tip) -55°C to +150°C. See Replaceable Parts List, Fig. 6 for part identification.

Altitude: Storage—To 50,000 feet. Operating—To 15,000 feet.

¹ Temperature measurement specifications apply to standard measurement sensor tip supplied with the probe.

Humidity: Storage and Operating—5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (para. 4.5.9 through 4.5.9.5.1, class 4).

Shock: Nonoperating—To 400 g's, ½ sine, ½ ms, 1 ms, and 2 ms duration.

Maximum Allowable Tip Pressure on Surface Being Measured: 20 pounds.

Physical

Dimensions: Length—64 inches (164 centimeters) including probe body.

Net Weight: Probe only—Approximately 3 ounces (84 grams).

Shipping Weight: Probe and Manual—Approximately 10 ounces (280 grams).

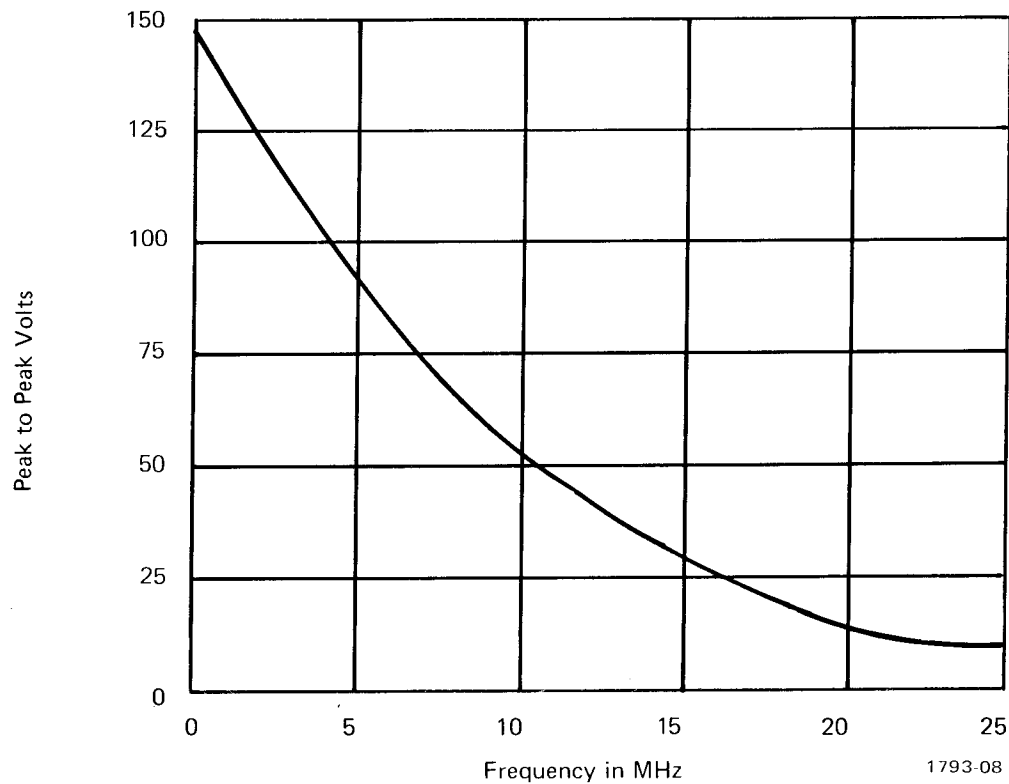


Fig. 1. Typical allowable rf signal limits at the probe tip.

OPERATION

Theory of Operation

Temperature measurement is accomplished through the use of a NPN silicon transistor located at the tip of the voltage probe. Associated circuitry is located in the digital multimeter.

The emitter-base voltage of the transistor is the parameter which is measured to indicate temperature. With zero collector-base voltage and sufficient emitter-base voltage, the collector current of a transistor can be expressed as an exponential function of the base-emitter voltage²:

$$I_c = I_o \exp(qV_{be}/kT)$$

When the associated digital multimeter circuitry switches the collector current between two levels, the difference between the two levels of emitter-base voltage will be a linear function of temperature:

$$\Delta V_{be} = \frac{kT}{q} \ln(I_{c2}/I_{c1})$$

Where I_{c2} and I_{c1} are the two levels of collector current, k is Boltzmann's constant, q is the charge on the electron, and T is absolute temperature. The factors limiting the linear range of operation are the decrease in beta at low temperatures and leakage currents at high temperature. The sensor transistor is connected in the feedback loop of the operational amplifier with the collector at the input, emitter con-

nected to the output, and the base grounded. For a given current input, the output of the operational amplifier forward biases the emitter-base junction of the transistor to the level necessary to maintain the input collector current. (Input current to the operational amplifier is negligible and, thus, the input current essentially is the collector current of the transistor.)

Connecting the Probe to the Digital Multimeter

CAUTION

If the Probe connector and the Digital Multimeter jack are not correctly aligned, the terminals can be damaged by forcing the connector and jack together.

Measuring Temperature

CAUTION

The P6430 is not intended to be used for liquid temperature measurements except as a part of the calibration procedure. The probe body should not be immersed in any liquid past the sealed portion of the probe tip. (See Fig.2). Avoid contact with acids and strong salt solutions.

The surface of the device to be measured should be coated with silicone grease, and the probe sensor tip applied to mate the flat surfaces of the tip and the device, (see Fig. 2) to assure optimum temperature transfer. Surface temperature reading is affected by the angle of contact between probe tip and the surface being measured. When taking a reading, this angle should be varied slightly until the maximum reading is obtained on the associated digital multimeter.

Applying the tip of the probe to a device for temperature measurement may cause a slight change in the temperature of the device. This is similar to the voltage change in an electrical circuit caused by probe loading, and in the case of temperature measurement, is due to a combination of heat sinking and a steady-state gradient error associated with heat transfer between bodies. Heat sinking depends on the thermal mass of the device being measured. The amount of heat sinking, in degrees C, versus the initial device temperature above ambient, is illustrated in Fig. 3 for TO-3, TO-5, and TO-18 transistor cases.

In addition to heat sinking effect, there is a "steady state" error when measuring surface temperature which is caused by the "steady state" gradient associated with flow of heat from the device being measured to the main probe body. Thus the temperature of the sensing transistor will differ from the final surface temperature. This steady state error is dependent upon the final surface temperature above ambient and is illustrated in Fig. 4.

In order to approximate the actual surface temperature of the device, that existed before the probe was applied, both the heat sinking and the thermal gradient effects must be considered. Fig. 5 provides a convenient method for approximating the combined heat sinking and the thermal gradient errors for three common transistor cases, the TO-3, TO-5, and TO-18. The initial temperature of the case can also be found to within 8% using the following equations.

$$\text{TO-3: } T_1 = 1.13 T_m - 0.13 T_o$$

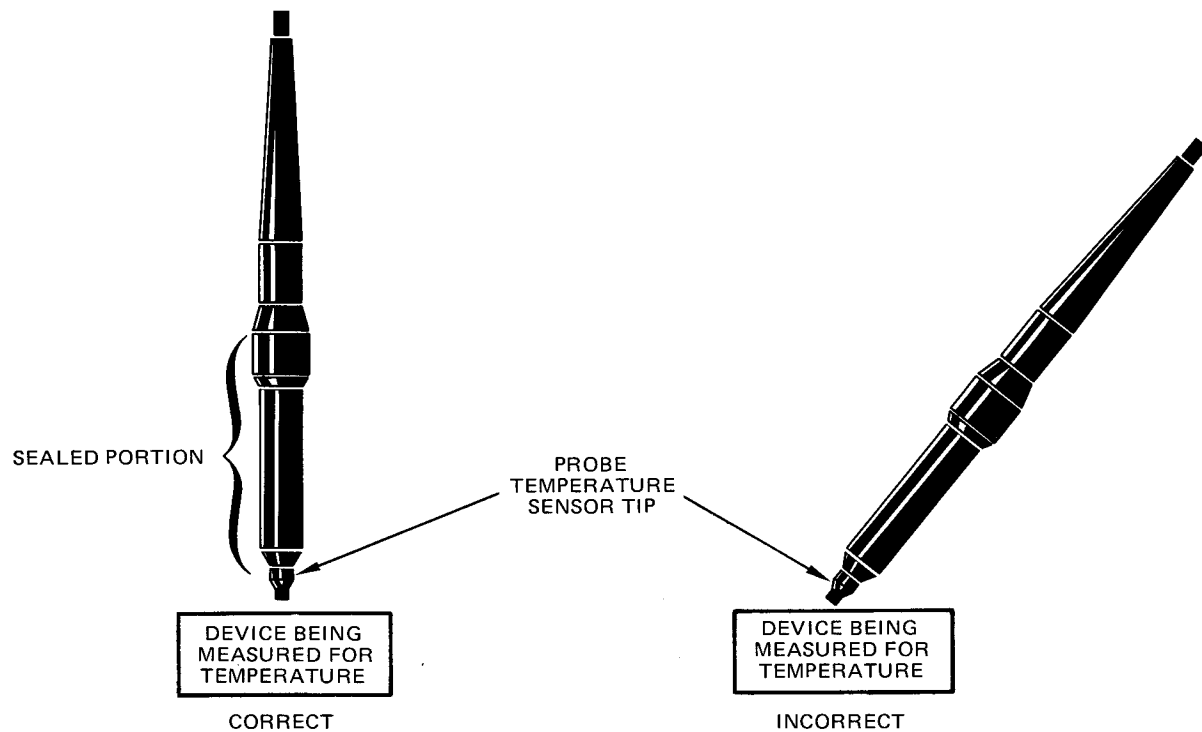
$$\text{TO-5: } T_1 = 1.20 T_m - 0.20 T_o$$

$$\text{TO-18: } T_1 = 1.24 T_m - 0.24 T_o$$

T_1 is the initial case temperature, T_m is the temperature read from the associated multimeter, and T_o is the ambient temperature.

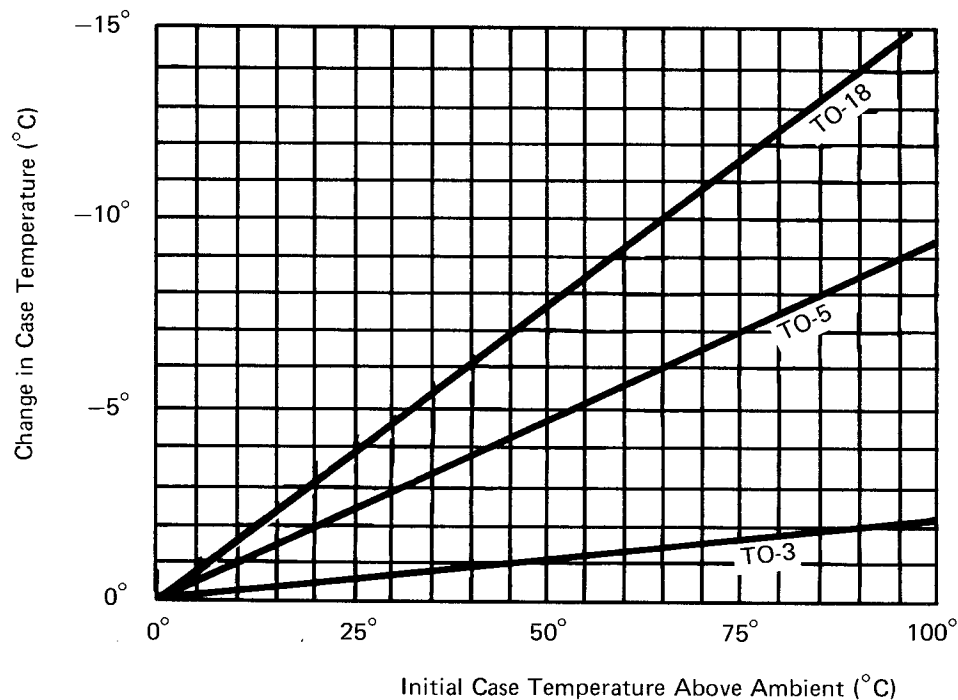
Calibration

There are no adjustments in the P6430. Procedures for calibrating the digital multimeter to match the probe are included in the Digital Multimeter instruction manual. The multimeter should be recalibrated if the probe sensor tip is replaced.



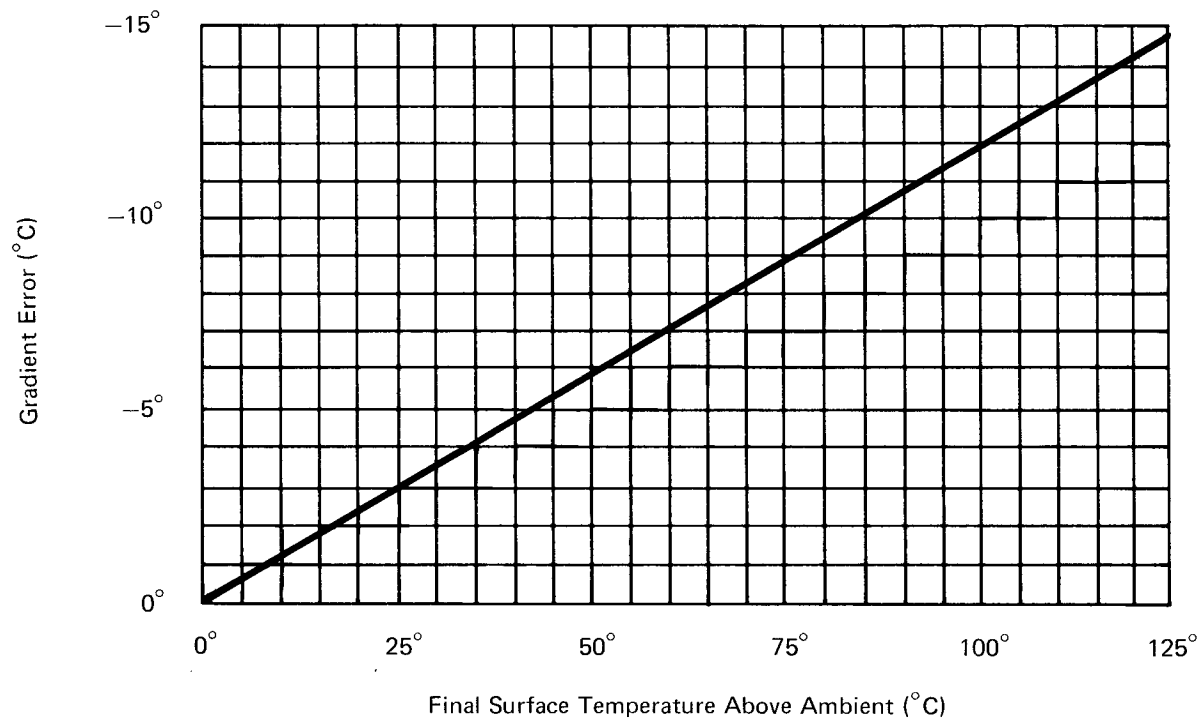
1793-06

Fig. 2. Correct and incorrect method of applying sensor tip for temperature measurement.



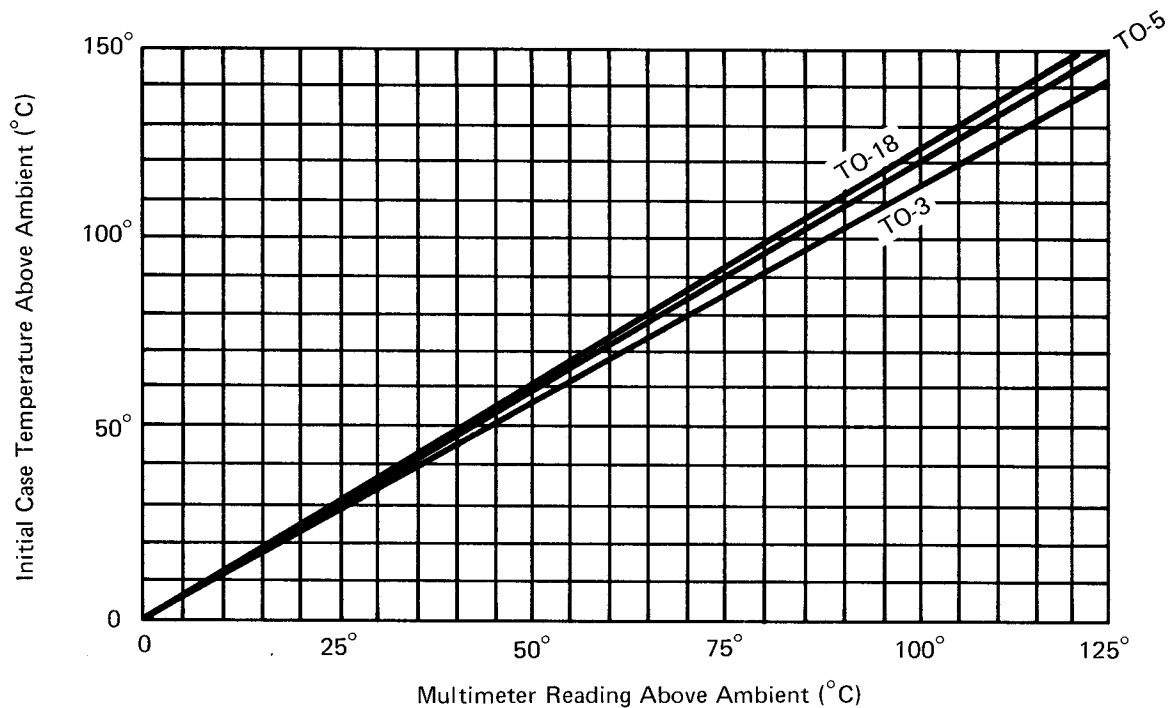
1793-03

Fig. 3. Typical decrease in device case temperature in °C due to probe heat-sinking effect on various devices (with silicon thermal joint compound applied).



1793-04

Fig. 4. Thermal gradient effect on temperature measurement.



1793-05

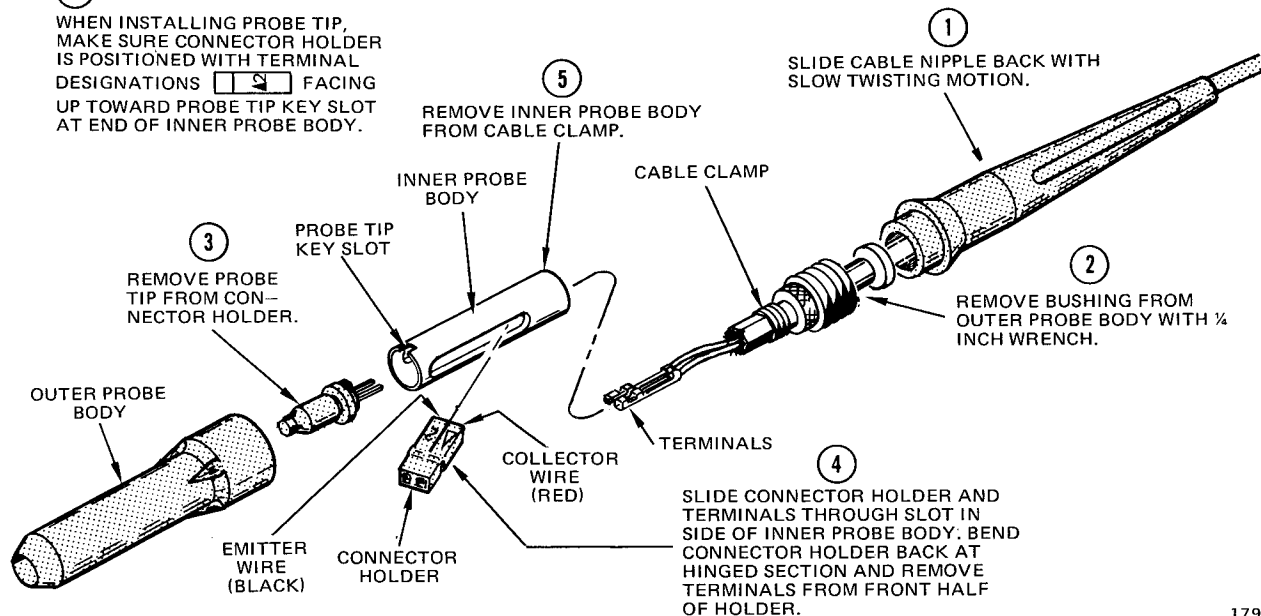
Fig. 5. Typical initial case temperature above ambient vs multimeter reading above ambient. (Subtract ambient temperature from multimeter reading, then use graph to determine actual device case temperature above ambient.)

CABLE AND SENSOR TIP REPLACEMENT

NOTE

PERFORM STEPS ① THROUGH ③ TO REMOVE PROBE TIP ONLY.

WHEN INSTALLING PROBE TIP, MAKE SURE CONNECTOR HOLDER IS POSITIONED WITH TERMINAL DESIGNATIONS  FACING UP TOWARD PROBE TIP KEY SLOT AT END OF INNER PROBE BODY.



1793-07

TEKTRONIX®

1106

BATTERY PACK

INSTRUCTION MANUAL

Serial Number _____ First Printing FEB 1974

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97005

070-1713-00

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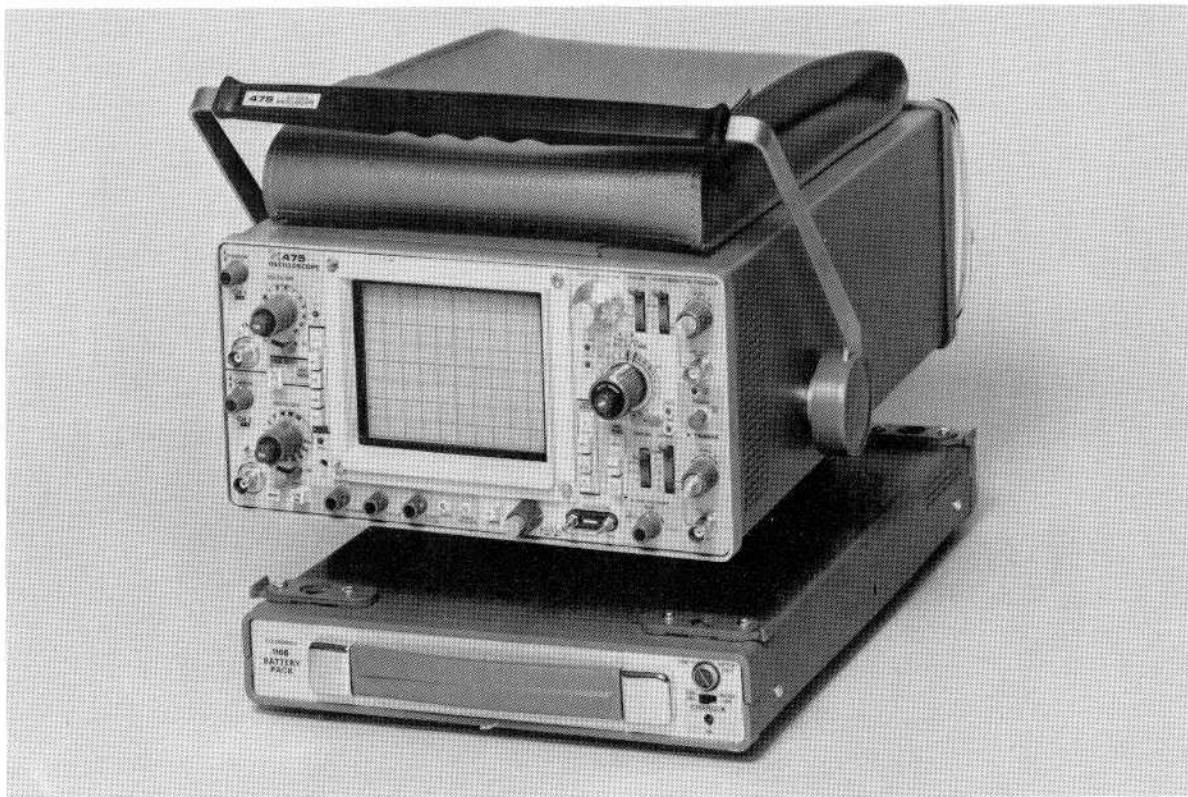


Fig. 1-1. 1106 Battery Pack.

SPECIFICATION

INTRODUCTION

The 1106 is a dc power source for operating Tektronix Oscilloscopes that are equipped with Option 7.

Battery power allows operation away from ac power sources, measurements with floating grounds and isolation from user circuits and their line transients, EMI, etc.

The separate battery pack capability permits a choice of battery operation or ac line operation. During charging of the battery pack, the oscilloscope may be operated from the ac line without detaching the 1106 Battery Pack. The oscilloscope may be detached from the 1106 Battery Pack, while it is charging, and used elsewhere with either another battery pack or ac line. The battery pack and oscilloscope may be separated easily and quickly for carrying ease.

SPECIFICATIONS

AC Requirements. Ac power source is required only for battery charging. Standard instrument: 100 to 132 Vac or 200 to 264 Vac, 50 to 400 Hz. Standard instrument with an internal connection change: 90 to 120 Vac or 180 to

240 Vac, see the Maintenance section of this manual for further information; 50 to 400 Hz. Power line consumption is 40 watts maximum at 115 Vac, 60 Hz.

Power Output. 22 to 24 Vdc for 7 ampere-hours. 5 A maximum.

Battery Operating Time. Approximately 140 watt-hours from fully-charged batteries.

Battery Charge Time. 14 to 16 hours (0°C to 40°C).

Temperature. Operating, 0°C to 40°C . 0°C to 40°C will not noticeably reduce the battery capacity. Storage outside this range will reduce battery efficiency and capacity. Non-operating; with batteries -40°C to $+60^{\circ}\text{C}$; without batteries, -55°C to $+75^{\circ}\text{C}$.

Physical. Weight is 16 pounds. 11.5 inches wide. 17.0 inches long, including feet and handle. 2.6 inches high, including feet. Combined height of 1106 and oscilloscope is approximately 8.4 inches.

SAFETY CONSIDERATIONS

Charging

AC Power Sources. The instrument is intended to be operated from a single-phase power source having one current-carrying conductor (the Neutral Conductor) at ground (earth) potential. Operation from power sources where both current-carrying conductors are live with respect to ground (such as phase-to-phase on a three-wire system) is not recommended, since only the Line Conductor has over-current (fuse) protection within the instrument.

AC Power Cord. The instrument has a three-wire power cord with a three-terminal polarized plug for connection to the power source and safety-earth. The ground (earth)

terminal of the plug is directly connected to the instrument frame. For electric-shock protection, insert this plug only in a mating outlet with a safety earth contact.

Operating

The potential at the chassis (frame) of the 1106 is established by the oscilloscope being powered through the safety-earth conductor system. For electric-shock protection, connect the oscilloscope cabinet (frame) to a ground (earth) reference.

If the 1106 ac power cord is connected to a correctly-wired ac power source, an additional shock protection circuit is established through the safety-earth conductor system.

FIRST TIME OPERATION & INSPECTION

FUNCTION OF CONTROLS AND CONNECTORS

BATTERY LEVEL Meter indicates the approximate state of charge of the batteries while under load.

CHARGER

Mode Switch

FULL

Permits the maximum safe charging rate. Charge rate should be changed to the trickle-charge rate when the batteries have received a full charge.

TRICKLE

Reduces the charging rate to maintain fully-charged batteries.

ON

Lamp indicates charger is on. Charging occurs as long as the 1106 Battery Pack is connected to the ac power line.

Line Selector

Selects 115 Vac or 230 Vac operation.

DC Output
(Attached Cord)

Connects to the oscilloscope external dc input.

AC Input

Allows ac operation of the battery charger circuit only, as long as the ac line is connected.

OPERATION AND INSPECTION

The instrument may be operated with less than fully charged batteries. For first-time operation, however, charge the batteries at the full-charge rate for 14 to 16 hours.

Attach the 1106 to an oscilloscope with Option 7 as follows (see Fig. 1-1):

Open the latches on the 1106 by pulling them outward. Set the oscilloscope on top of the 1106 with the feet in the holes in the latches. Push the latches in until they lock in

the feet of the oscilloscope. Check each corner to verify that each foot has been latched to the 1106.

Set the oscilloscope for 24 Vdc operation and connect the 1106 output to the oscilloscope (Option 7) dc input. Turn the oscilloscope on. Check that the 1106 powers the oscilloscope. Observe the BATTERY LEVEL meter. The meter reading is only indicative of the remaining charge if the battery pack is powering an oscilloscope. Under no-load conditions, the battery pack will read full, even if it is almost discharged.

Connect the oscilloscope frame to a ground (earth) reference before using.

BATTERY OPERATION

WARNING

The nickel-cadmium (NiCd) cells used in this instrument are capable of delivering a large amount of current in a short time. Care must be taken not to short-circuit the cells. The battery pack is fused at 6 amperes.

Operating Time. Battery operating time depends on the load selected and the charge-discharge temperatures. Optimum charge and discharge is obtained when the batteries are operating at temperatures between 20°C to 30°C. Relative capacities for other temperatures are shown in Table 2-1. Battery pack discharge curves are given in Fig. 2-1.

Optimum operating time is obtained by having the 1106 vertical (handle on top) during battery charging.

TABLE 2-1

**Typical Battery Charge Capacity
(referenced to charge-discharge
at +20°C to +30°C)**

Charge Temperature	Operating Temperature		
	-15°C	+20°C to +30°C	+55°C
0°C	40%	60%	50%
+20°C to +30°C	65%	100%	85%
+40°C	40%	65%	55%

The approximate battery pack operating time may be roughly estimated using Fig. 2-1. For individual oscilloscope times see the Option 7 Specification portion of the oscilloscope service manual.

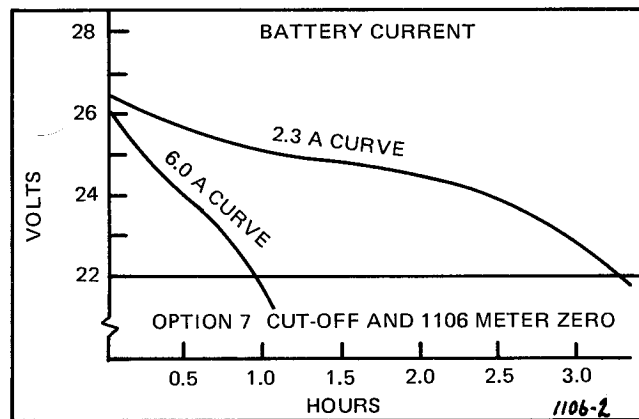


Fig. 2-1. Typical battery-pack discharge curves.

NOTE

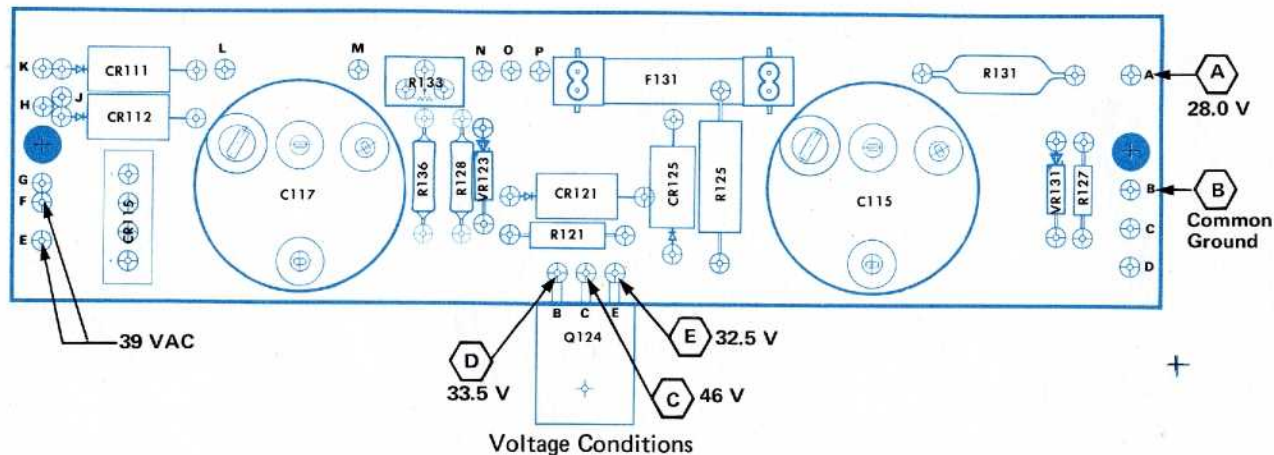
High discharge rates or high ambient temperatures may raise the battery temperature enough to lower their 140 watt-hour capability.

Battery Discharge. Deep discharge of the batteries may cause one or more of the cells to reverse polarity. Repeated reversal shortens the useful life of the batteries. The

Option 7 has a circuit to cut off its inverter when the external dc source drops below approximately 22 Vdc. This prevents the battery from going into deep discharge.

Battery Charge. A thermal cutout in the Battery Pack protects the batteries from overheating during charge time. The batteries normally become warmer as they reach full charge potential. If the temperature surrounding the batteries exceeds the safe operating level, a thermal cutout switches the charge rate from 620 milliamperes full-charge to the 60-milliamperes trickle-charge rate. When the temperature returns to a safe operating level, the thermal cutout returns the charge rate to the 620-milliamperes level. The batteries may be damaged by over-charging for long periods (in excess of 24 hours). Repeated over-charging shortens the useful life of the batteries.

During normal usage or storage, each battery cell in the battery pack acquires a slightly different charge characteristic. To provide the best overall operation and maximum operating life, the charge on the individual battery cells should be equalized periodically. This can be done without damage to the battery cells by charging the batteries at the full-charge rate for 24 hours. Charging should be done after every 15 charge-discharge cycles or every 30 days, whichever occurs first.



Voltmeter: 20,000 Ω /VDC and 5,000 Ω /VAC multimeter.

Voltage readings will vary with line voltage and battery charge level.

Battery charged

Line Selector: Correct line voltage

Mode Switch: FULL CHG

Fig. 6-1. Circuit Board Layout with Test Voltages.

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	1	2	3	4	5	Description
		Eff	Disc							
56	348-0254-00			1						PAD, cabinet foot
57	131-1084-00			1						CONNECTOR, receptacle, electrical
	- - - - -			-						mounting hardware: (not included w/connector)
58	211-0071-00			2						SCREW, 4-40 x 0.375 inch, THS
59	210-0586-00			2						NUT, keps, 4-40 x 0.25 inch
60	352-0326-00			1						HOLDER, fuse
61	161-0095-00			1						CABLE, power, electrical
62	358-0372-00			1						BUSHING, strain relief, bottom
63	200-1004-00			1						CABLE NIPPLE, electrical
64	358-0371-00			1						BUSHING, stain relief, top
65	386-2632-00			1						PANEL, rear
	- - - - -			-						panel includes:
66	343-0401-01			1						RETAINER, clip
67	310-0631-00			1						EYELET
68	204-0374-01			1						BODY, fuseholder
69	260-1300-01			1						SWITCH, slide
	- - - - -			-						mounting hardware: (not included w/switch)
70	211-0105-00			2						SCREW, 4-40 x 0.188 inch, 100° csk, FHS
71	348-0080-01			4						FOOT, cabinet
72	441-1168-00			1						CHASSIS, main
	- - - - -			-						chassis includes:
73	344-0118-00			2						CLIP, capacitor mounting