

**TEKTRONIX®**

**465 M**  
OSCILLOSCOPE

INSTRUCTION MANUAL

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Serial Number \_\_\_\_\_

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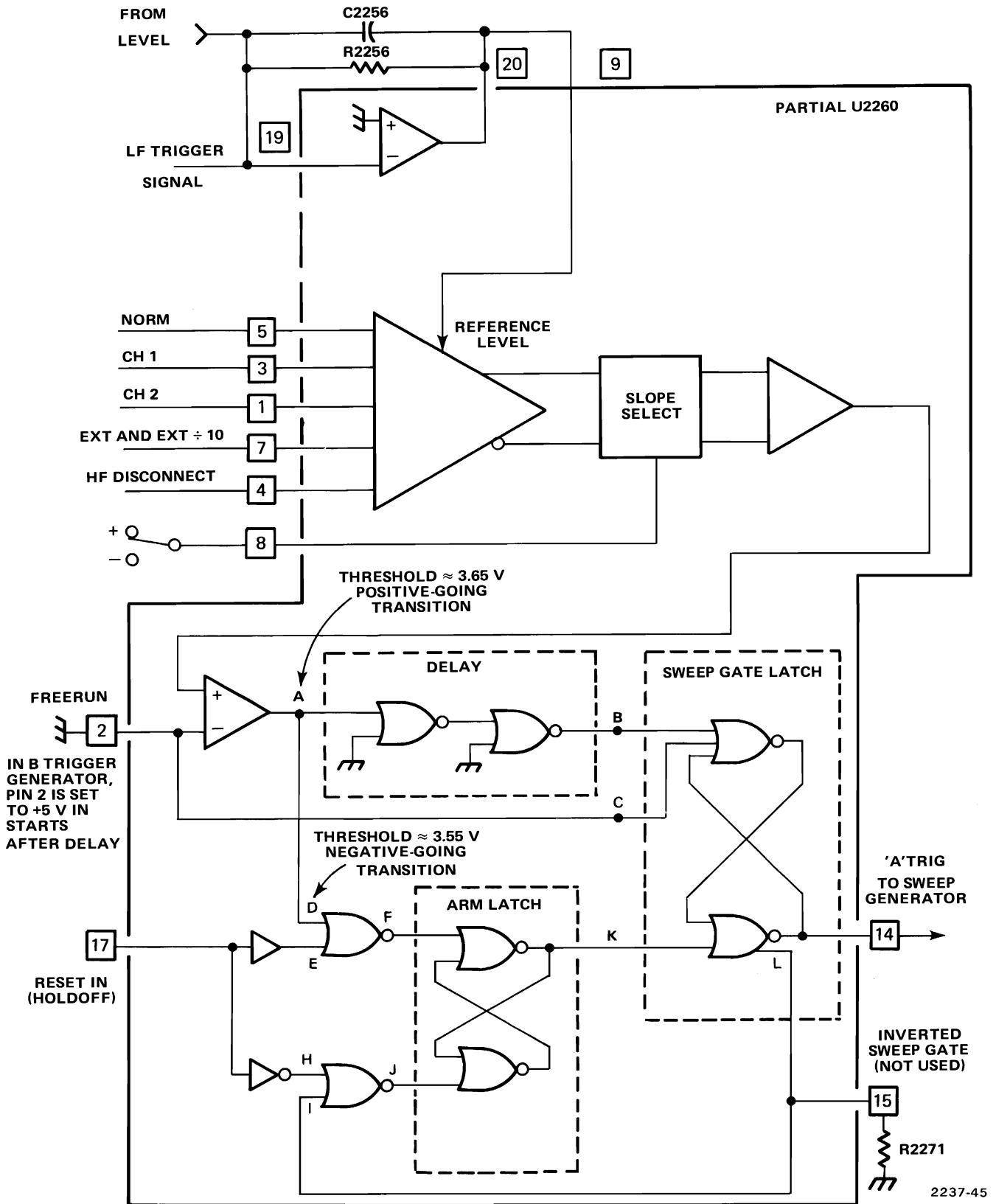


Figure 4-5. A trigger generator.

**(d) Hysteresis Adjustment.** The hysteresis adjustment (R2245) sets the difference in the trigger threshold and the arm threshold. The closer the levels are to each other, the more susceptible the circuit will be to triggering on noise. If the levels are too far apart, the circuit will require excessive input signal amplitude to generate a sweep gate.

**(e) Trigger View Pickoff.** A sample of the trigger input signal is supplied to pins 10 and 11 of U2260. This paraphase signal passes through emitter followers Q2350 and Q2356 to the TRIG VIEW switch (S4380). When the TRIG VIEW switch is pushed, the signal from the Delay Line Driver is disconnected from the Delay Line and the trigger view signal is connected in its place.

**(3) B Trigger Generator.** The B Trigger Generator operates in the same manner as the A Trigger Generator except in the STARTS AFTER DELAY position of the HORIZ DISPLAY switch. In the STARTS AFTER DELAY mode, +5 volts is connected to pin 2 of U2160 through S2100 and S2650 (see Figure 4-5). This disconnects the trigger signal from point B, sets point D LO, and sets point C HI. At the end of holdoff, point E goes LO causing point F to go HI. This sets point K LO and, because of the HI always present on point C, causes a sweep gate to be generated.

**(4) A Sweep Generator.** A sweep generator consists of U2790 and associated circuitry. Figure FO-6 shows a complete schematic diagram of the circuit. Figure 4-6 shows a simplified diagram of the circuit. Figure 4-7 shows the waveforms produced during A sweep generation.

**(a) Sweep Generator Integrated Circuits.** Both the A and B Sweep Generator integrated circuits (U2790 and U2690 respectively) are the same. However, the functions of some of the pins are different. The following lists the pin numbers and their functions:

1 Pin 1 is the input for the DELAY TIME POS control. This pin is only used in the A Sweep Generator. When the A ramp on pin 2 is equal to the voltage on pin 1, a delayed gate is produced at pin 16.

2 Pin 2 is the input for the ramp voltage from the output Miller circuit. This voltage is internally connected to pin 5 when pin 7 is LO.

3 Pin 3 sets internal current levels.

4 Pin 4 sets the Miller null and retrace currents for the A Sweep Generator only. This function is performed by another circuit in the B Sweep Generator.

5 Pin 5 is the sweep ramp output. The ramp at pin 5 is connected to the Horizontal Preamp. Pin 5 is switched on or off by the voltage on pin 7.

6 Pin 6 sets the internal current levels which, along with R2682 or R2782, determine the sweep start voltage.

7 Pin 7 controls the sweep ramp output at pin 5. When pin 7 is LO the sweep ramp at pin 2 is internally connected to pin 5. When pin 7 is HI, the sweep ramp at pin 2 is disconnected from pin 5 and pin 5 is set to -5 volts.

8 Pin 8 is the connection for the -5 volt supply.

9 Pin 9 is the ground connection.

10 In the A sweep Generator, pin 10 produces an output which initiates holdoff. In the B Sweep Generator, pin 10 produces an output which is supplied to the +B GATE OUT Amplifier in the Main Module.

11 The voltage connected to pin 11 sets the amplitude of the unblanking signal at pin 12.

12 The signal at pin 12 is supplied to the Z Axis Amplifier in the Main Module to unblank the crt. The amplitude of this signal, and therefore the brightness of the crt display, is controlled by the voltage on pin 11.

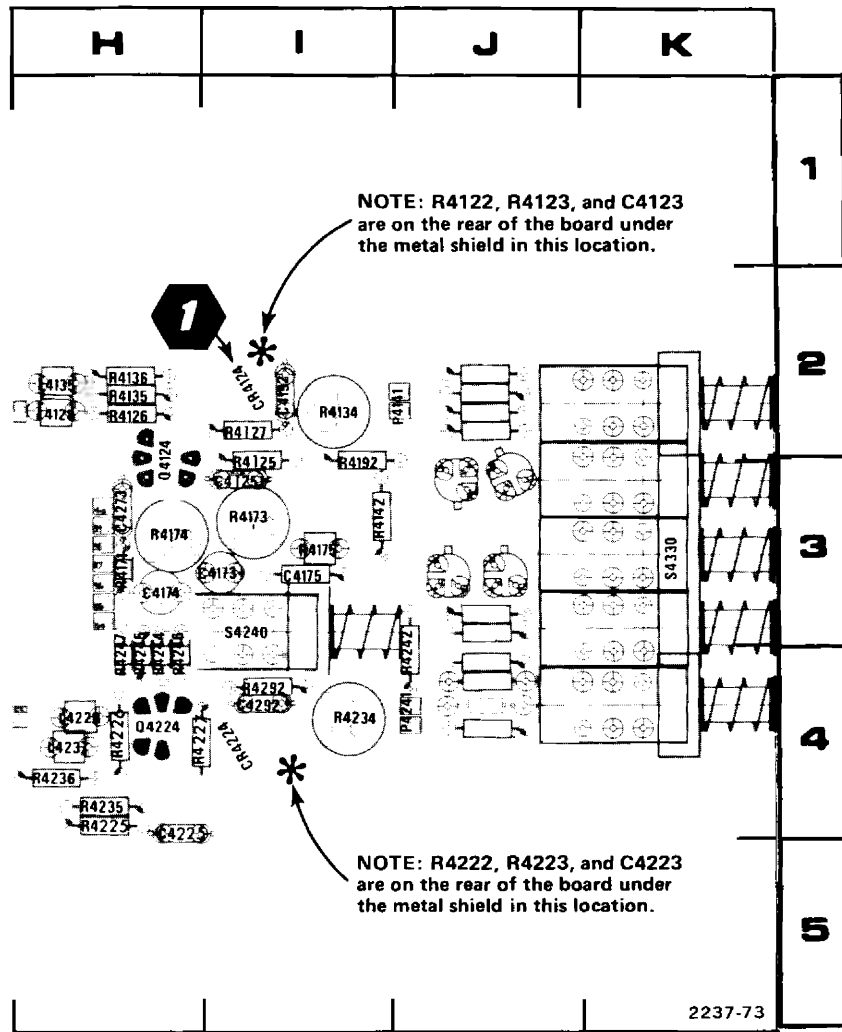
13 Pins 13 and 14 work together. A HI on either pin prevents sweep generation. Both must be LO to start sweep generation. In the A Sweep Generator, pin 13 is held LO through a resistor to ground and only pin 14 controls sweep generation. In the B Sweep Generator pin 14 goes LO when the A Sweep Generator starts but pin 13 doesn't go LO until the B Trigger Generator produces a sweep gate. In the STARTS AFTER DELAY position of the B SOURCE switch, a B sweep gate is produced as soon as pin 16 of U2790 produces a delayed gate. In other settings, a B sweep gate is produced when the first adequate trigger signal occurs after a delayed gate is produced at pin 16 of U2790.

14 Pin 14 works with pin 13. See the pin 13 discussion.

15 Pin 15 is the connection for the +5 volt supply.

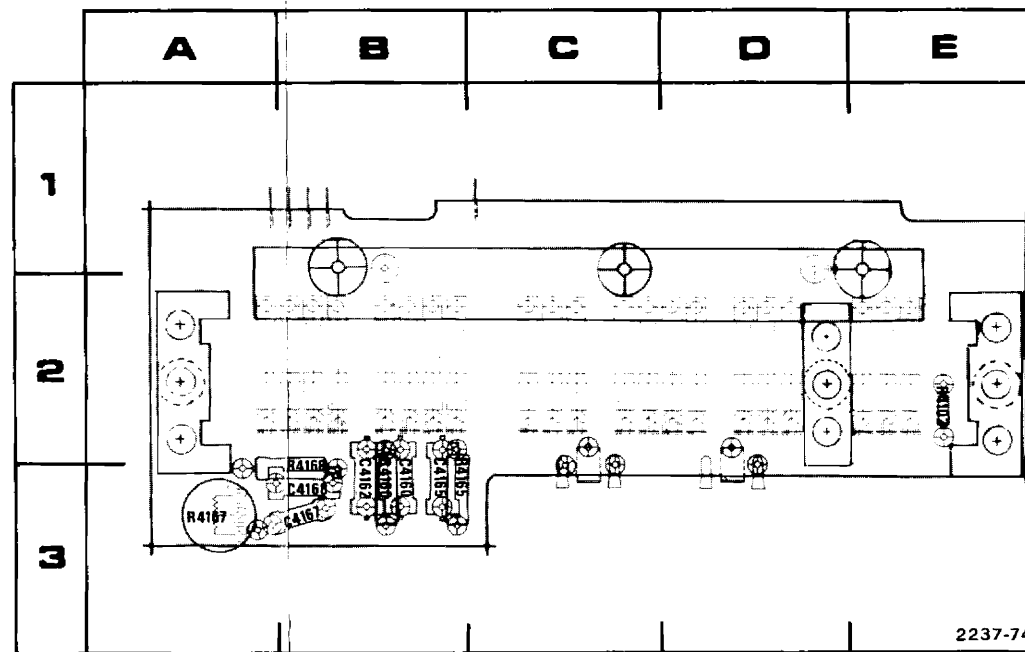
16 Pin 16 of the A Sweep Generator produces a delayed gate to remove the holdoff condition from the B Trigger Generator. This output is produced when the A ramp voltage on pin 2 reaches the dc level on pin 1.





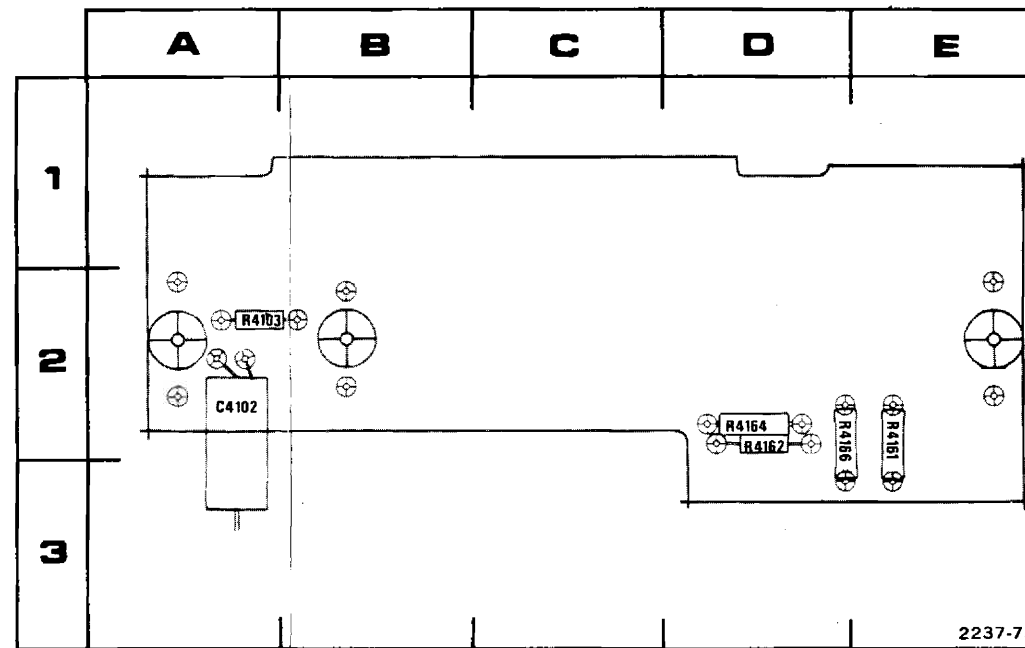
A. PARTIAL A5 VERTICAL BOARD.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4125	3I	CR4224	4I	R4125	2I	R4226	4I
C4129	2I	L4128	2H	R4126	2H	R4227	4H
C4225	4H	L4228	4H	R4127	2I	R4292	4I
C4292	4I	Q4124	2H	R4192	2I		
CR4124	2I	Q4224	4H	R4225	4H		



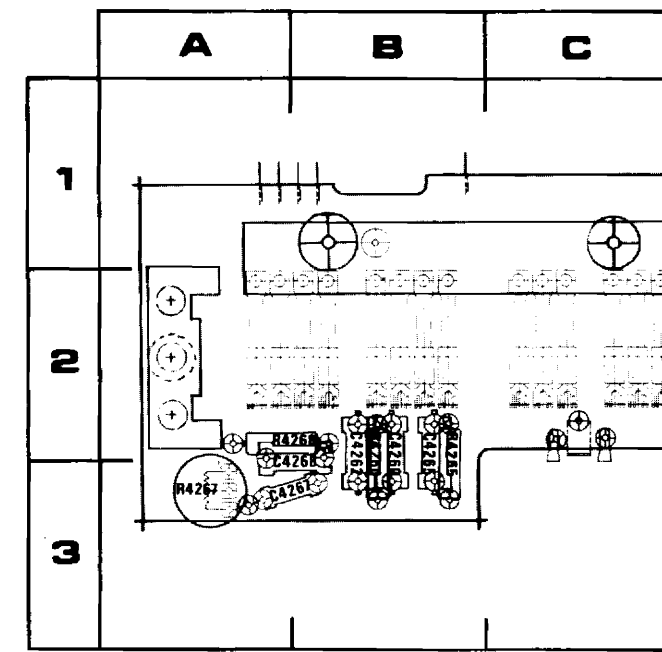
B. A1 CAM SWITCHING BOARD (TOP).

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4160	3B	C4167	3B	C4168	3B	R4160	3B	R4167	3A
C4162	3B	C4168	3B	R4102	2E	R4165	3B	R4168	3B



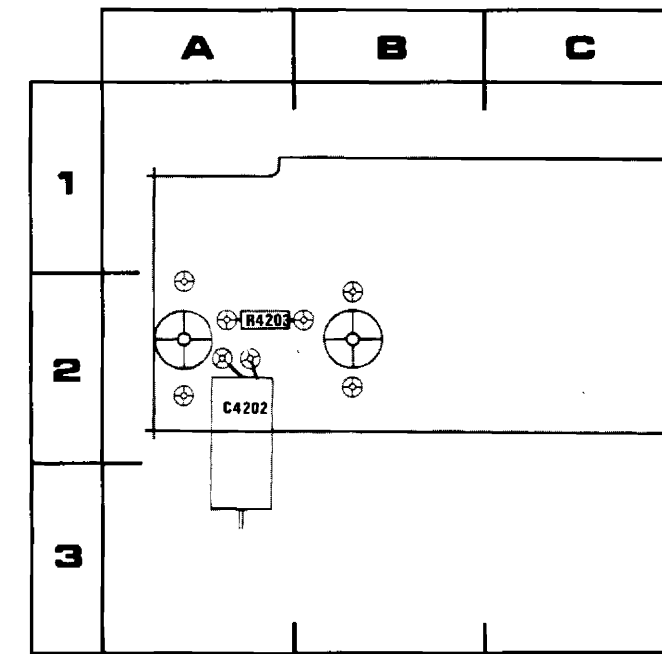
C. A1 CAM SWITCHING BOARD (BOTTOM).

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4102	2A	R4161	2E	R4164	2D
R4103	2A	R4162	2D	R4166	2D



D. A3 CAM SWITCHING BOARD (TOP).

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4260	2B	C4265	2B	C4268	2A	R4260	2B
C4262	2B	C4267	3A	R4202	2E	R4265	2B



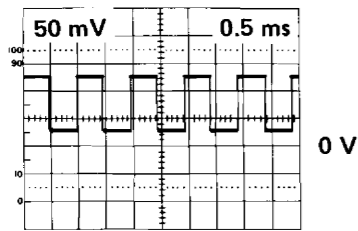
E. A3 CAM SWITCHING BOARD (BOTTOM).

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4202	2A	R4203	2A	R4262	2D	R4266	2D
C4266	3E	R4261	2E	R4264	2D	R4269	2E

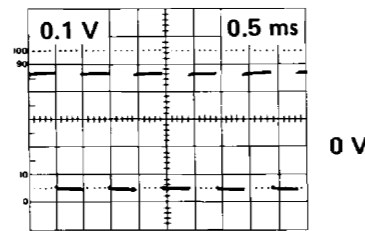


Refer to paragraph 6-3 for waveform and voltage test conditions.

**4**

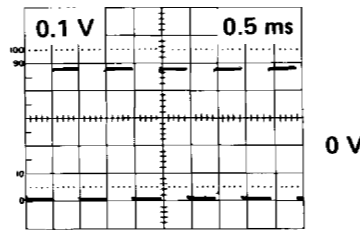


**5**



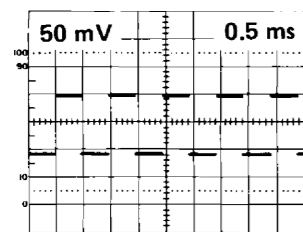
0 volt point depends on setting of instrument vertical POSITION control.

**6**



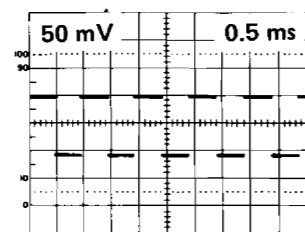
0 volt point depends on setting of instrument vertical POSITION control.

**7**



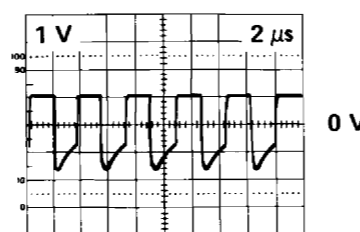
AC Coupled

**8**



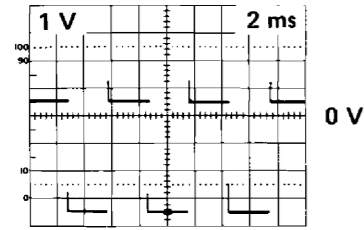
AC Coupled

**9A**



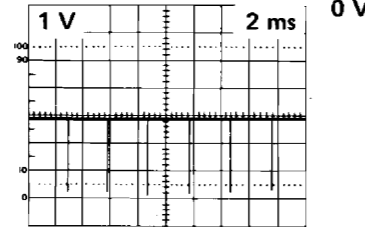
Instrument VERT MODE to CHOP  
Test oscilloscope trigger SOURCE to CH 1

**9B**



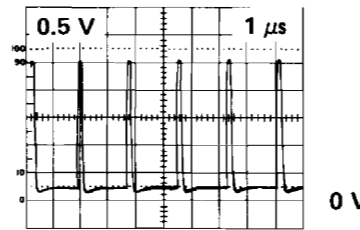
Instrument VERT MODE to ALT

**10**

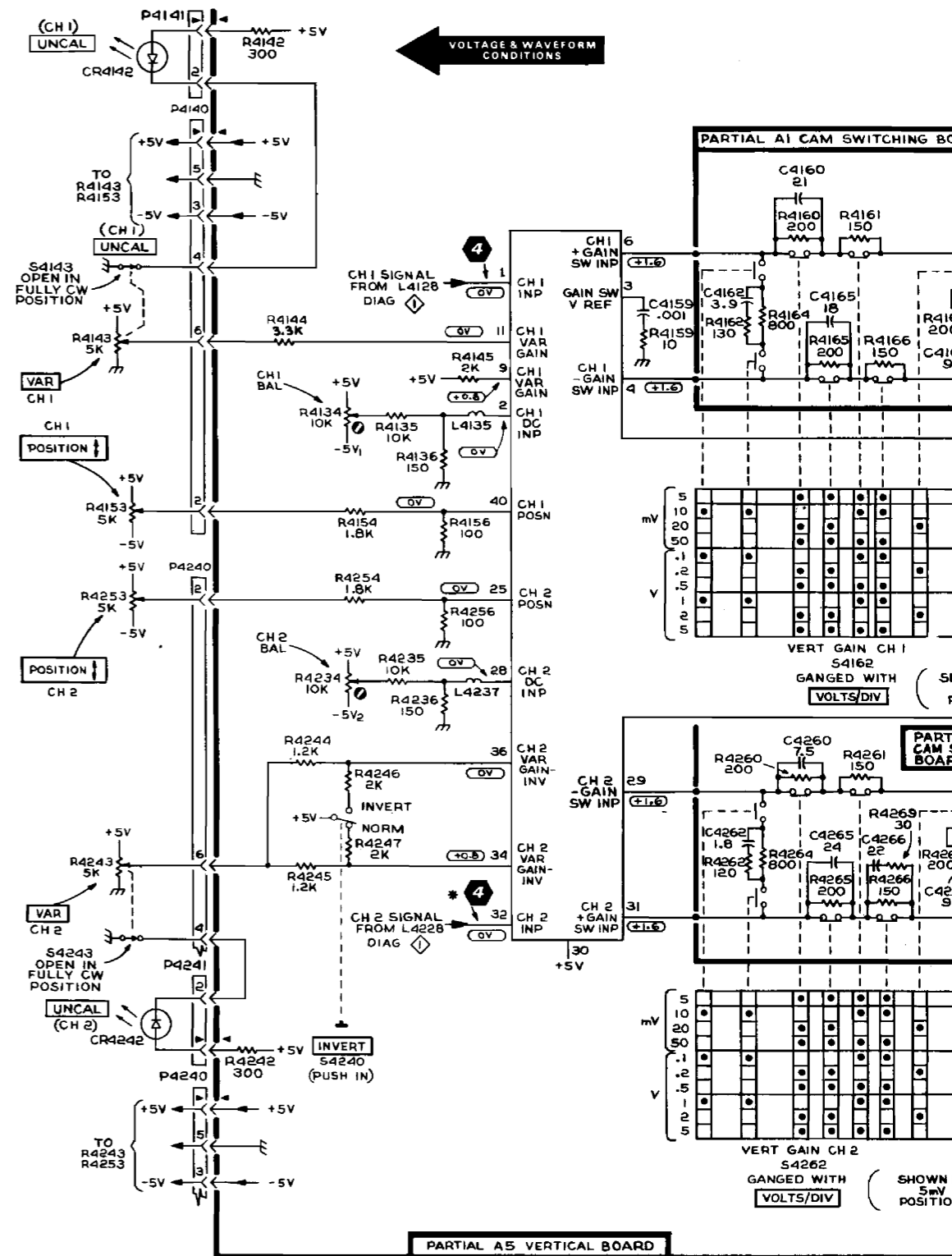


Instrument VERT MODE to ALT

**11**



Instrument VERT MODE to CHOP  
Test oscilloscope trigger SOURCE to CH 1



ALT TR  
SYNC PI  
FRC  
CR2  
DIA  
S

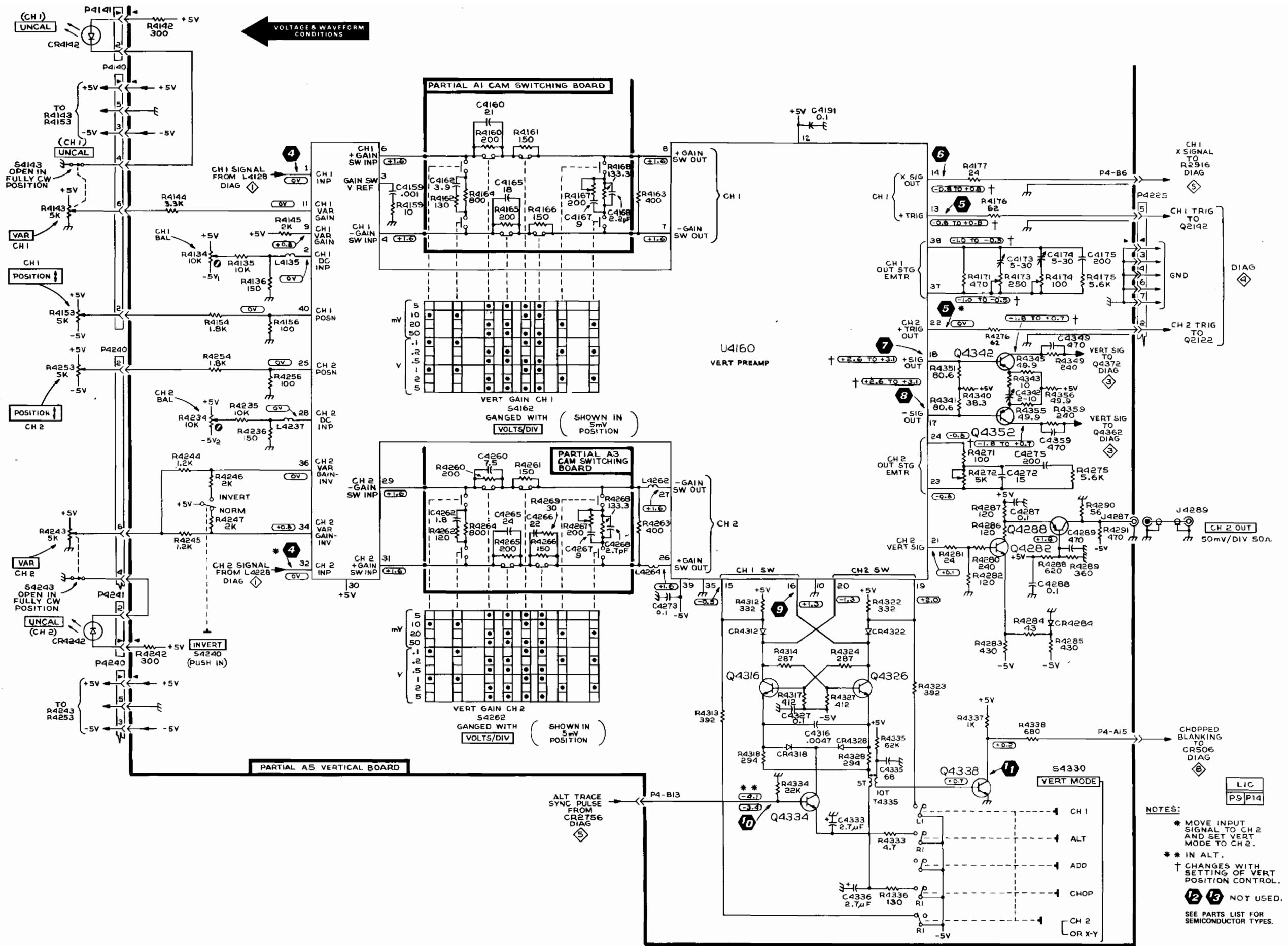


Figure FO-3 (Front). Vertical Preamplifier and Switching schematic diagram.

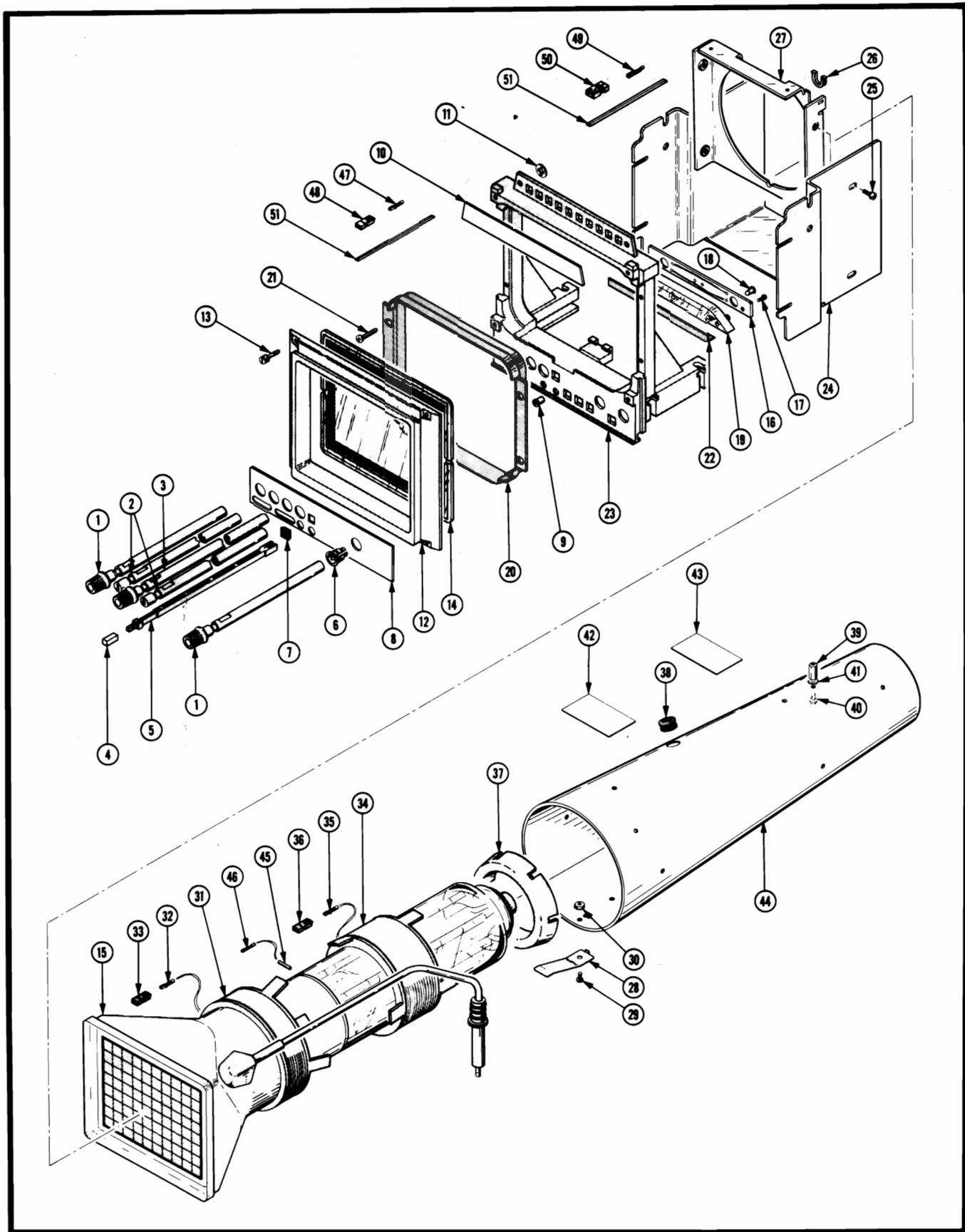
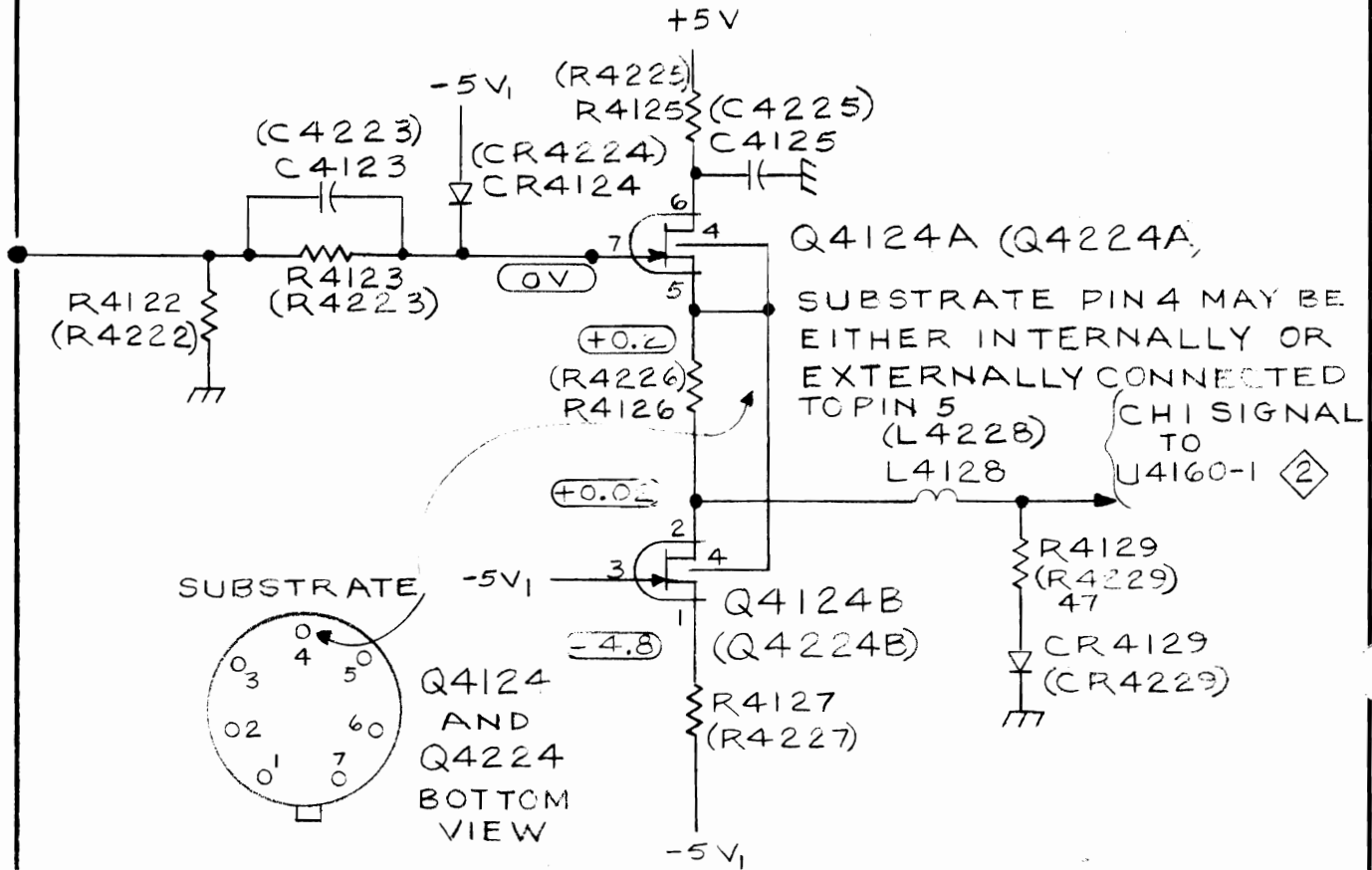


Figure 8-12. Electron Tube Assembly.

FIG. & INDEX NO.	PART NUMBER	FSCM	DESCRIPTION							UNITS PER ASSY	USABLE ON CODE
			1	2	3	4	5	6	7		
8-12-	-----	80009	ELECTRON TUBE ASSEMBLY,NHA Figure 1-7.....							REF	
-1	384-1350-02	80009	. KNOB,0.28 OD X 4.415 inch long,plastic.....							2	
-2	384-1348-00	80009	. EXTENSION SHAFT,0.25 OD X 6.623 inch long,.. plastic							2	
-3	384-1350-00	80009	. EXTENSION SHAFT,0.2 OD X 12.215 inch long,.. with Knob							1	
-4	366-1559-00	80009	. PUSH BUTTON,gray.....							1	
-5	384-1129-00	80009	. EXTENSION SHAFT,5.607 inch long.....							1	
-6	358-0550-00	80009	. BUSHING,SHAFT,0.15 ID X 0.3 inch OD,plastic.							5	
-7	426-1072-00	80009	. FRAME,PUSH BUTTON,plastic.....							1	
-8	333-1994-01	80009	. PANEL,FRONT,electron tube.....							1	
-9	450-4352-01-0318	71279	. JACK,TIP,gray (80009 No. 136-0387-00).....							2	
-10	334-3053-00	80009	. PLATE,IDENTIFICATION.....							1	
-11	354-0195-00	80009	. RING,RETAINING.....							2	
-12	343-0523-00	80009	. RETAINER,IMPLOSION,5.65 X 4.705 inch,plastic							1	
-13	213-0313-00	80009	. THUMBSCREW,4-40 X 0.45 inch,knurled.....							4	
-14	337-2122-00	80009	. SHIELD,IMPLOSION,blue.....							1	
-15	154-0777-00	80009	. ELECTRON TUBE,P31.....							1	
-16	388-4703-00	80009	. CIRCUIT BOARD,scale illumination.....							1	
-17	211-0001-00	80009	. SCREW,MACHINE,2-56 X 0.25 inch,pnh,steel.... (AP)							2	
-18	2112D	08806	. LAMP,INCANDESCENT,6.3V,200MA (80009 No..... 150-0129-00)							2	
-19	378-0614-00	80009	. REFLECTOR,LIGHT,molded plastic.....							1	
-20	386-3336-00	80009	. SUPPORT,ELECTRON TUBE,front.....							1	
-21	213-0183-00	80009	. SCREW,TAPPING,THREAD FORMING,6-32 X 0.25.... inch,pnh,steel (AP)							4	
-22	337-2262-00	80009	. SHIELD,LIGHT,electron tube scale.....							1	
-23	426-1240-00	80009	. FRAME SECTION,SCOPE,electron tube front.... support							1	
-24	337-2207-00	80009	. SHIELD,ELECTRICAL,vertical and horizontal... support							1	
-25	211-0534-00	80009	. SCREW,ASSEMBLED WASHER,6-32 X 0.312 inch,... pnh,steel (AP)							4	
-26	348-0171-00	80009	. GROMMET,PLASTIC,u-shaped.....							1	
-27	386-3518-00	80009	. SUPPORT,SHIELD,electron tube,front.....							1	
-28	214-2270-00	80009	. SPRING,GROUND,electron tube to shield.....							1	
-29	211-0007-00	80009	. SCREW,MACHINE,4-40 X 0.188 inch,pnh,steel... (AP)							1	
-30	210-0586-00	80009	. NUT,PLAIN,EXTENDED WASHER,4-40 X 0.25 inch,.. steel (AP)							1	
-31	108-0818-00	80009	. COIL,TUBE DEFLECTION,trace rotation.....							1	
-32	47439	22526	. CONTACT,ELECTRICAL,0.48 inch long,22-26... AWG wire (80009 No. 131-0707-00)							2	
-33	352-0169-01	80009	. CONNECTOR BODY,PLUG,ELECTRICAL,2 wire..... brown							1	
-34	108-0819-00	80009	. COIL,TUBE DEFLECTION,x-y alignment..... brown							1	
-35	47439	22526	. CONTACT,ELECTRICAL,0.48 inch long,22-26... AWG wire (80009 No. 131-0707-00)							2	
-36	352-0169-00	80009	. CONNECTOR BODY,PLUG,ELECTRICAL,2 wire..... black (80009 No. 352-0169-00)							1	

CHANGE:	DESCRIPTION
---------	-------------

F0-2 (FRONT)  
 DIAGRAM 1  
 PARTIAL



F0-2 (REAR) A5 Vertical Circuit Board layout and component locator. REF  
 SEE: Changes for A5 board listed with F0-1 (REAR). All changes for  
 A5 board are listed there.

F0-3 (FRONT) Vertical preamplifier and Switching schematic diagram 2.  
 ADD:

C4158 (2.7 PF) from U4160 pin 4 to ground (only when required) PC 27

CHANGE:	DESCRIPTION		
ADD cont:			<u>REF</u>
C4258 (2.7 PF)	from U4160 pin 29 to ground (only when required)		PC 27
C4259 (9 PF)	in series with R4259 (220 Ω) across R4261 (SN B011100-up)		PC 30
R4332 (200 Ω)	in series between collector of Q4334 and the junction		
	of CR4318-CR4328 (ALL SN).		PC 16
C4176 (27 PF)	in parallel with R4176 (ALL SN).		PC 23
C4276 (27 PF)	in parallel with R4276 (ALL SN).		PC 23
C4340 (4.7 PF)	from emitter of Q4342 to emitter of Q4352 (ALL SN)		PC 19
C4271 (2.5-9 PF)	from U4160 pin 23 to U4160 pin 24 (ALL SN).		PC 16
C4286 (150 PF)	in parallel with R4286 (ALL SN)		PC 19
CHANGE TO:			
R4154 value to 1.6K	(SN B011100-up)		PC 30
R4254 value to 1.6K	(SN B011100-up)		PC 30
C4167 value to 7.8 PF	(ALL SN)		PC 21
C4260 value to 10 PF	(ALL SN)		PC 24
C4262 value to 2.2 PF	(ALL SN)		PC 24
R4262 value to 270 Ω	(ALL SN)		PC 21
C4267 value to 13 PF	(SN B011100-up)		PC 30
C4268 value to 3.3 PF	(SN B010100-B011099)		PC 21
C4268 value to 2.2 PF	(SN B011100-up)		PC 30
R4175 value to 8.2 KΩ	(SN B010350-up)		PC 28
R4176 value to 47 Ω	(ALL SN)		PC 23
R4276 value to 47 Ω	(ALL SN)		PC 23
FO-3 (REAR) A5 Vertical Circuit Board layout and component locator.			
SEE: Changes for A5 board listed with FO-1 (REAR); all changes for A5 board are listed there.			
FO-4 (FRONT) Delay Line Driver, Vertical Amplifier, and Interface Connector schematic diagram 3.			
ADD:			
Dash shield lines around DL44 delay line leads, and connections from shield to a ground symbol on A5 board. (ALL SN)			
R4400 (47 Ω) from center of delay line shield to a ground symbol on A5 board (ALL SN).			PC 19
C4475 (0.1 UF) in parallel with R4475 (SN B010375-up)			PC 29



CHANGE:	DESCRIPTION			REF
CHANGE TO cont:				
C4210	281-0808-00	ALL SN	CAP., FXD, CER DI:7 PF, 20%, 100V	PC 24
C4260	281-0634-00	ALL SN	CAP., FXD, CER DI:10PF, +7-0.25PF, 500V	PC 24
C4262	281-0610-00	ALL SN	CAP., FXD, CER DI:2.2PF, 10%, 500V	PC 24
C4267	281-0657-00	SN B011100-up	CAP., FXD, CER DI:13PF, 2%, 500V	PC 30
C4268	281-0626-00	B010100-B011099	CAP., FXD, CER DI:3.3PF, 10%, 500V	PC 21
C4268	281-0610-00	SN B011100-up	CAP., FXD, CER DI:2.2PF, 10%, 500V	PC 30
C4404	281-0625-00	SN B010350-up	CAP., FXD, CER DI:35PF, 5%, 500V	PC 28
C4412	281-0221-00	ALL SN	CAP., VAR, CER DI:2-10PF, 100V	PC 22
R2127	315-0100-00	ALL SN	RES., FXD, CMPSN:10 OHM, 5%, 0.25W	PC 23
R2147	315-0100-00	ALL SN	RES., FXD, CMPSN:10 OHM, 5%, 0.25W	PC 23
R2352	315-0100-00	ALL SN	RES., FXD, CMPSN:10 OHM, 5%, 0.25W	PC 16
R2356	315-0100-00	ALL SN	RES., FXD, CMPSN:10 OHM, 5%, 0.25W	PC 16
R4105	315-0330-00	ALL SN	RES., FXD, CMPSN:33 OHM, 5%, 0.25W	PC 19
R4108	311-1259-00	ALL SN	RES., VAR, NONWIR:100 OHM, 0.5W	PC 24
R4154	315-0162-00	SN B011100-up	RES., FXD, CMPSN:1.6K OHM, 0.25W	PC 30
R4175	317-0822-00	SN B010350-up	RES., FXD, CMPSN:8.2K OHM, 5%, 0.125W	PC 28
R4176	315-0470-00	ALL SN	RES., FXD, CMPSN:47 OHM, 5%, 0.25W	PC 23
R4205	315-0330-00	ALL SN	RES., FXD, CMPSN:33 OHM, 5%, 0.25W	PC 19
R4208	311-1259-00	ALL SN	RES., VAR, NONWIR:100 OHM, 0.5W	PC 24
R4254	315-0162-00	SN B011100-up	RES., FXD, CMPSN:1.6K OHM, 5%, 0.25W	PC 30
R4262	315-0271-00	ALL SN	RES., FXD, CMPSN:270 OHM, 5%, 0.25W	PC 21
R4276	315-0470-00	ALL SN	RES., FXD, CMPSN:47 OHM, 5%, 0.25W	PC 23
R4405	315-0431-00	SN B010350-up	RES., FXD, CMPSN:430 OHM, 5%, 0.25W	PC 28
R4416	321-0117-00	ALL SN	RES., FXD, FILM:162 OHM, 1%, 0.125W	PC 22
VR552	152-0289-00	ALL SN	SEMICOND DEVICE; ZENER:0.4W, 180V, 5%	PC 21

CORRECTION:

Circuit number following C4466 on page 10-4 should read C4471.

80009 part number for R4143 and R4243 listed as item 8-4-96 on page 8-11 should read 311-1792-00.

The 80009 part number for Q4124 and Q4224 (see page 8-16, item 8-5-14) should read 151-1090-02.