

SUPPLEMENTAL CALIBRATION
AND
TROUBLESHOOTING PROCEDURES
OSCILLOSCOPE
Part No. LA-545
(Lavoie)

(NOTE: These supplemental procedures are to be used in conjunction with Technical Manual T.O. 33A1-13-97-1 which they reference.)

LAVOIE LABCRATORIES, INC.

Morganville
New Jersey

12/61

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SUPPLEMENTAL CALIBRATION AND TROUBLESHOOTING PROCEDURES
OSCILLOSCOPE

Part No. LA-545

(Lavoie)
FSN 6625-897-4658

1. PURPOSE: These calibration and troubleshooting procedures have been prepared by Lavoie Laboratories, Inc. to furnish information supplemental to that contained in Technical Manual T.O.33A1-13-97-1, in order to facilitate maintenance and calibration of these oscilloscopes at a Depot level. The information contained herein will also serve to point up certain basic differences in the procedures employed for the Lavoie LA-545 and compatible oscilloscopes such as the Tektronix, Inc., 545 or Hickock 1805. It is realized that considerable familiarity exists with the latter two oscilloscopes in most repair depots and it is imperative that the differences between these and the Lavoie instruments be thoroughly understood before calibration is attempted.

These differences are briefly summarized below and their effect on calibration and operation is covered in more detail in the individual calibration and troubleshooting steps.

1. HIGH VOLTAGE POWER SUPPLY - The separate negative supply for the grid of the CRT is not used. In its place a negative voltage is taken from the main high voltage winding, rectified and applied to one end of a block of encapsulated neon regulator lamps which provide a constant voltage based from and following the unblanking pulse pedestal. The negative voltage applied to the CRT grid therefore follows this pulse. See schematic diagram. Ref. Fig. 6.12. As these regu-

lator blocks are supplied with selectable caps, the troubleshooting section describes the proper selection procedure.

2. CRT BALANCE CONTROL - A potentiometer R862 has been added to provide a better overall CRT balance. See schematic diagram Ref. Fig. 6.12.

AUTOMATIC SWEEP MODE - The sweep will not continue to run with the signal removed, in the Automatic sweep mode.

3. LOCKOUT LEVEL ADJUSTMENT - A difference exists in the calibration procedure for this adjustment.

4. OUTPUT AT "A" SAWTOOTH TERMINAL - Due to the greater deflection sensitivity of the cathode ray tubes employed, the sawtooth output at this terminal is reduced from 150V to 140 V.

5. "A" SWEEP RATE ADJUSTMENTS. - Due to the redesign of the horizontal output system, trimmer capacitors, Tektronix symbol numbers C364 and C384, used in the compatible oscilloscopes, have been eliminated. (See schematic diagram, Ref. Fig. 6.6) The .1 usec (X5) sweep calibration procedure therefore reflects this change.

6. PLATE LINE REVERSE TERMINATION - This termination is of a different design than that used in the compatible oscilloscopes. Inductors L1071 and L1073 and capacitors C1075, C1077 and C1078 (Tektronix symbol numbers) are not used. The only required adjustment being potentiometer R1043. The calibration procedure for this termination therefore reflects these differences. See schematic diagram Ref. Fig. 6.2.

2. FORMAT: These procedures are intended for use in conjunction with the Technical Manual T.O. 33A1-13-103-1. A sequential calibration procedure will be outlined, and each calibration step will reference a paragraph in the Manual covering the same step, where available. Where no

further information can be added to that contained in the Manual, only the paragraph reference will be shown.

2.1 Note all references in the following paragraphs pertain to "Technical Manual, Operation and Service Instructions, Oscilloscope Part No. LA-545 (Lavoie) FSN6625-897-46587

3. TEST EQUIPMENT REQUIRED FOR CALIBRATION AND TROUBLESHOOTING

The test equipment listed below may be replaced by equivalents.

- a. Oscilloscope (calibrated and tested) Lavoie LA-545
- b. Preamplifier (calibrated and tested) Lavoie LA-545-54L
- c. Multimeter - AN/PSM-6B
- d. Differential Voltmeter - John Fluke Mod. 801
- e. Time Mark Generator - Tektronix 180A
- f. Constant amplitude Signal Generator - Tektronix 190B
- g. Square Wave Generator - Tektronix 107
- h. Gain Adjust Adapter - Tektronix EP53A
- i. Test Load - Tektronix TU-2
- j. Type P plug-in - Tektronix
- k. Adjustable Line Voltage Autotransformer - Variac W10
- l. AC Voltmeter (150V) - Weston 433
- m. Square Wave Generator - H.P. 211
- n. Wheatstone Resistance Bridge - Industrial Instruments

4. CALIBRATION

4.1 INITIAL SETUP - Connect oscilloscope with Test Load TU-2 inserted, to the power line through the Variac. Adjust Variac to supply 117 V. AC as indicated by the AC voltmeter. Set INTENSITY control full CCW. Switch Test Load to LO LOAD. Allow 10 minutes warmup.

4.1.1 LOW VOLTAGE POWER SUPPLIES ADJUSTMENT AND CHECK - Ref. Par. 7.7.

a. After setting -150 volt adj. check voltage at #100, #225, #350 and #500 supplies. The voltages shall be within $\pm 2\%$.

b. Using shop standard oscilloscope and head, check ripple voltage at the points stipulated in a.

1. With line voltage at 125 V, TEST LOAD unit switched to LO LOAD.

2. With line voltage at 105 V, TEST LOAD switch to HI LOAD.

The ripple voltage shall not exceed 10 millivolts at any test point.

4.2 Amplitude Calibrator Adjustment - Ref. Par. 7.8.

a. After setting CAL. ADJ. potentiometer, remove tube V875 (1/2 of calibrator multivibrator) and connect Differential Voltmeter to the CAL. OUT connector. Measure DC output voltage at the 10 AMPLITUDE calibrator knob settings of .1 volt to 100 volts. Voltage readings shall correspond to the knob settings within $\pm 3\%$. This check establishes the accuracy of the step voltage divider resistors R885 through R893 and the 1000:1 (millivolt) dividers R896 and R897.

b. Replace tube V875. Remove differential voltmeter and connect shop standard scope in its place. Check AC output at remaining 8 amplitude calibrator settings (.2 to 50 millivolts) Note symmetry of calibrator waveform. As the divider accuracies have already been established in (a), this test merely checks for proper operation of the remaining switch positions.

4.3 HIGH VOLTAGE POWER SUPPLY ADJUSTMENT. Ref. Par. 7.8

4.4 BRILLIANCE AND H.V. REGULATION CHECK

a. Set "A" TIME/CM to 1 millisecond and STABILITY control full CW. Advance INTENSITY control to observe trace. Check action of INTENSITY control. Trace should be extinguished with INTENSITY control full CCW and should begin to be discernable at approximately half rotation. If trace cannot be extinguished or normal brilliance cannot be obtained, see trouble shooting section, Par. 5.1Q.1

b. Using VARIAC, vary line voltage input between 105 and 125 volts. Observe trace brilliance to check high voltage regulation. Brilliance should remain the same and there should be no evidence of blooming.

4.5 CRT ADJUSTMENT, Ref. Par. 7.10

4.6 CRT GEOMETRY ADJUSTMENT, Ref. Par. 7.11

4.7 CRT BALANCE ADJUSTMENT - After completing GEOMETRY adjustment, optimize FOCUS and ASTIGMATISM controls, then adjust CRT Balance control (R862) for best overall trace quality.

4.8 VERTICAL AMPLIFIER BALANCE CHECK - Insert TU-2 LOAD unit. Short together vertical deflection plates of the CRT to find electrical center. Remove short and position trace to this point. Using shorting strap (Ref. Fig. 6.13) jumper grid lines of 6DK6 stages together. Connect lead from #225 volt output of TU-2 to cathodes of each pair of 6DK6 tubes in order, beginning with the last pair of tubes toward the rear of the oscilloscope. Unbalance should not exceed 2 mm in the 6DK6 stages. Continue forward to the 6DJ8 stage and check balance by jumpering together the plates of the 12BY7S. Unbalance should not exceed 1 cm in the 6DJ8 stage. Check 12BY7 stage by jumpering the grids and pressing the zero reference button on the TEST LOAD TU-2. Unbalance

in this stage should not exceed 1 cm and overall amplifier unbalance should not exceed 1.5 cm. If unbalance is found in any of the stages, restore balance in each stage by replacement or transposition of tubes. Follow the same order in which the balance was checked.

4.9 VERTICAL COMPRESSION CHECK - Display 2 cm of amplitude calibrator signal with trace vertically centered on the screen. Position trace to the upper and lower extremes of the calibrated portion of the screen, noting the display amplitude. Expansion or compression should not exceed .5 MM.

4.10 VERTICAL GAIN ADJUSTMENT - Set TU-2 Test Load to 250:1 and AMPLITUDE CALIBRATOR output to 100 volts. Set Gain Adj. potentiometer (Ref. Fig. 7.8) to obtain 4 cm of vertical deflection.

4.11 ALTERNATE TRACE CIRCUITRY CHECK

a. Switch TU-2 Test Load NORMAL-DUAL TRACE switch to DUAL TRACE and set ALTERNATE-CHOPPED switch to ALTERNATE position. Check for dual trace with HORIZONTAL DISPLAY on A and then on B.

b. Set ALTERNATE-CHOPPED switch to the chopped position. Set switch on rear of oscilloscope to DUAL-TRACE Chopped Blanking. Check for absence of switching transients on both A and B sweeps.

If improper functioning is noted in steps a or b see troubleshooting section.

4.12 DC SHIFT ADJUSTMENT

a. Remove TU-2 Test Load from oscilloscope and install LA-545-54L preamplifier. Connect 211A square wave generator to input and adjust for a 1 cycle square wave output. Adjust oscilloscope sweep controls to display several cycles of the 1 cycle square wave. Set amplitude for 4 cm of vertical deflection.

b. Adjust DC SHIFT ADJ. potentiometer (R1091) to remove any upward or downward slope on the flat top of the square wave.

4.13 TIME BASE A TRIGGERING LEVEL ADJUSTMENT, Ref. Par. 7.12

4.14 TIME BASE A TRIGGER LEVEL CENTERING AND TRIGGER SENSITIVITY ADJUSTMENT, Ref. Par. 7.13

4.15 "A" INTERNAL TRIGGERING DC LEVEL ADJUSTMENT, Ref. Par. 7.14

4.16 "A" PRESET ADJUSTMENT, Ref. Par. 7.15

4.17 TIME BASE B TRIGGER LEVEL ADJUSTMENT, Ref. Par. 7.16

4.18 "B" INTERNAL TRIGGERING DC LEVEL ADJUSTMENT, Ref. Par. 7.17

4.19 "B" TRIGGER LEVEL CENTERING ADJUSTMENT, Ref. Par. 7.18

4.20 "B" PRESET ADJUSTMENT, Ref. Par. 7.19

4.21 A and B TRIGGER CHECKS

The following checks should be made after completing the trigger adjustments of 4.13 through 4.20, to check that proper adjustments have been accomplished and to spot possible trouble.

4.21.1 AUTOMATIC MODE

Special Note: Unlike the compatible oscilloscopes referred to in paragraph 1, the LA-545 Oscilloscope sweep does not run in the AUTO Mode without a triggering signal. The sweep will free run in any other mode, at the selected sweep rate, by advancing the stability control beyond the normal triggering position.

a. Connect AMPLITUDE CALIBRATOR output to vertical INPUT. Set amplitude to obtain 2 millimeters of vertical deflection.

b. Set HORIZONTAL DISPLAY to A, TRIGGER MODE to AUTO, SLOPE to \neq or - INT and TIME/CM to 1 MSec. A stable display should be obtained without adjustment of the STABILITY or TRIGGERING LEVEL controls.

c. Repeat (b) above to check the "B" trigger, with HORIZONTAL DISPLAY on B and sweep controls as set for "A".

4.21.2 DC MODE

a. With AMPLITUDE CALIBRATOR and sweep controls set up as in 4.21.1a and b switch TRIGGER MODE to DC. A stable display should result from adjustment of the STABILITY and TRIGGERING LEVEL controls.

Note: In the DC mode the VERTICAL POSITION and TRIGGERING LEVEL controls will be interactive.

b. Repeat step (a) with HORIZONTAL DISPLAY on "B" and B SWEEP controls set correspondingly to check the B TRIGGER.

4.21.3 AC MODE

Repeat tests as in 4.21.2 a and b with TRIGGER MODE switch set to AC. Rotate TRIGGER SLOPE switch to opposite polarity. A 180° phase shift in the displayed signal should result.

4.21.4 AC LF REJECT MODE

Repeat test as in 4.21.2 a with TRIGGER MODE switch at AC LF REJECT.

4.21.5 HF SYNC MODE

Connect CONSTANT AMPLITUDE signal generator to vertical INPUT. Set frequency at 30 Mc and amplitude to obtain 2 centimeters of vertical deflection. Set HORIZONTAL DISPLAY to A, TIME/CM to .1 usec, TRIGGER SLOPE to \neq or - INT and TRIGGERING MODE to HF SYNC. Adjustment of the STABILITY control should produce a stable display.

4.22 5X MAGNIFICATION GAIN ADJUSTMENT, Ref. Par. 7.20

4.23 5X MAGNIFICATION ALIGN ADJUSTMENT, Ref. Par. 7.21

4.24 SWEEP ADJUSTMENT, Ref. Par. 7.24

4.25 SWEEP A TO SWEEP B ADJUSTMENT, Ref. Par. 7.25

4.26 SWEEP A LENGTH ADJUSTMENT, Ref. Par. 7.26

4.27 TIME BASE A SWEEP SPEED ADJUSTMENT, Ref. Par. 7.27

If referenced Manual does not contain revisions, substitute
table below for Fig. 7.7.

TIME/CM	TIME MARK GENERATOR	ADJUSTMENT	DISPLAY
10 uSEC	10 MICROSEC	C160E	One MKR/CM
.1 uSEC, 5X Mag.	50 Mc	*C160A For time C375 For linearity	One CYC/CM
.1 uSEC	10 Mc	C348 For time	One CYC/CM
1 uSEC	1 MICROSEC	C160C	One MKR/CM

*NOTE: C375 only affects the first part of the display. Tuning adjustments should be made between the first and ninth centimeter lines of the graticule.

Technical Manual, Fig. 7.7 (Revised) SWEEP SPEED ADJUSTMENT

4.28 "B" SWEEP LENGTH CHECK

Set B TIME/CM to .5 MSec and STABILITY for a free running sweep. Check that the B LENGTH control limits are from 3.2 to 3.8 cm minimum to 10.2 to 10.8 cm maximum. If not, see trouble shooting section for resistor selection procedure.

4.29 DELAY START AND STOP ADJUSTMENT, Ref. Par. 7.28

4.30 TIME BASE B SWEEP SPEED ADJUSTMENTS, Ref. Par. 7.29

4.31 TIME BASE SWEEP RATE CHECKS

4.31.1 TIME BASE B (1 millisecond to 1 sec) - Set up oscilloscope as in 4.24 (Ref. Par. 7.24) and check the sweep rates as shown in the table.

<u>TIME BASE B</u>	<u>TIME MARK GEN.</u>	<u>MARKERS DISPLAYED</u>
1 Millisecond	1 Millisecond	1/CM
2 Millisecond	1 Millisecond	2/CM
5 Millisecond	5 Millisecond	1/CM
10 Millisecond	10 Millisecond	1/CM
20 Millisecond	10 Millisecond	2/CM
50 Millisecond	50 Millisecond	1/CM
.1 Sec	100 Millisecond	1/CM
.2 Sec	100 Millisecond	2/CM
.5 Sec	500 Millisecond	1/CM
1 Sec	1 Second	1/CM
2 Microsec	1 Microsecond	2/CM
5 Microsec	5 Microsecond	1/CM
10 Microsec	10 Microsecond	1/CM
20 Microsec	10 Microsecond	2/CM
50 Microsec	50 Microsecond	1/CM
.1 Millisecond	100 Microsecond	1/CM
.2 Millisecond	100 Microsecond	2/CM
.5 Millisecond	500 Microsecond	1/CM

4.31.2 TIME BASE A (1 millisecond to 5 sec) - Set up A SWEEP as set for B SWEEP in 4.30.1 and check the sweep rates as shown in the table.

<u>TIME BASE A</u>	<u>TIME MARK GEN.</u>	<u>MARKERS DISPLAYED</u>
.2 Microsec	10 MC	2/CM
.5 Microsec	1 Microsec	1/2 CM
2 Microsec	1 Microsec	2/CM
5 Microsec	5 Microsec	1/CM
1 Millisecond	1 Millisecond	1/CM
2 Millisecond	1 Millisecond	2/CM
5 Millisecond	5 Millisecond	2/CM
10 Millisecond	10 Millisecond	1/CM
20 Millisecond	10 Millisecond	2/CM
50 Millisecond	50 Millisecond	1/CM
.1 Second	100 Millisecond	1/CM
.2 Second	100 Millisecond	2/CM
.5 Second	500 Millisecond	1/CM
1 Second	1 Second	1/CM
2 Second	1 Second	2/CM
5 Second	5 Second	1/CM

If "B" sweep rates are out of calibration see trouble shooting section for recalibration, including resistor replacement instructions.

4.32 "A" VARIABLE TIME/CM CONTROL CHECK

Set A TIME/CM to 1 millisecond and VARIABLE control to calibrated.

Display 5 millisecond markers from TIME MARK GENERATOR. There should be 1 marker each 5 cm. Rotate VARIABLE control full CCW. Markers should be displayed 1 marker each 2 cm or less. UNCALIBRATED neon should light.

4.33 DELAY TIME MULTIPLIER LINEARITY CHECK - Check for linearity on 5 usec and 50 usec ranges. Maximum error should not exceed 2 minor divisions from 1 to 9.

4.34 A DELAYED BY B JITTER CHECK - Set oscilloscope controls as follows:

"B" TIME/CM - 1 MSec
 "A" TIME/CM - 1 USec
 HORIZ DISPLAY - A INTENSIFIED BY B

Obtain 1 millisecond markers from TIME MARK GENERATOR. Set the DELAY-TIME-MULTIPLIER to 1.00 so that the brightened portion of the sweep coincides with the first marker. Switch the HORIZONTAL DISPLAY control to "A" DELAYED by B. The horizontal jitter in the observed marker shall not exceed 3 mm. Repeat to observe the 9th marker. The horizontal jitter observed in the 9th marker shall not exceed 5 mm.

4.35 LOCKOUT LEVEL ADJUSTMENT, Ref. Par. 7.30

1:18,000 abs.
 1:20,000 F5

NOTE: If referenced Manual does not contain revisions, change as follows:

Step (e) - Change 2.4 centimeters to 1.4 centimeters.

4.36 OUTPUT WAVEFORM CHECK

a. Using test scope, check amplitudes on \neq Gate "A" and \neq Gate "B" output terminals with appropriate sweep running, minimum output at each shall be 20 volts.

b. Check output at sawtooth "A" terminals. The minimum sawtooth amplitude should be 140 volts.

4.37 EXTERNAL HORIZONTAL DC BALANCE ADJUSTMENT, Ref. Par. 7.22

4.38 ~~EXT.~~ HORIZONTAL INPUT DEFLECTION FACTOR CHECK - Set HORIZONTAL DISPLAY to EXT X1 and "A" STABILITY full CW. Connect CAL. OUT to HORIZ. INPUT. Set CALIBRATOR for .2 volt. Turn VARIABLE 10-1 full CW. One CM of horizontal deflection should result. Increase CALIBRATOR to 2 volts and set VARIABLE 10-1 for 10 centimeters of horizontal deflection. Switch HORIZONTAL DISPLAY to EXT X10. Horizontal deflection should be 1 centimeter (tolerance 2%).

4.39 EXTERNAL HORIZONTAL INPUT COMPENSATION ADJUSTMENT, Ref. Par. 7.23.

4.40 DELAY LINE AND HIGH FREQUENCY COMPENSATION ADJUSTMENT.

Before attempting to alter the present adjustments, the necessity for readjustment and areas where it is required should first be carefully determined as described below.

Using a type L (or K) plug-in with 400 Kc input from 107 square wave generator display 3 vertical centimeters of square wave at the sweep rates to be stipulated, and check the following display characteristics. (Also see troubleshooting, Par. 5.7.1 herein.)

a. Top Slope - Set sweep TIME/CM to 5 USec. Obtain a stable display. Check top of waveform. There should be no upward or downward slope anywhere along the top. If slopes exist they are a collective effect of all the delay line capacitors. Note conditions observed.

b. Bumpiness on top portion - Set sweep TIME/CM to .2 USec.

Obtain stable display. Check bumps in the top portion immediately following the rise. If fairly long duration bumps occur it indicates misadjustment of a group of capacitors in the delay line. Short bumps at random intervals indicate general delay line misadjustment. A single short duration bump would indicate a single misadjusted capacitor. Bumps occurring at regular rhythmic intervals can be due to amplifier high frequency compensators and would not require delay line adjustment. An upward or downward step from the leading edge to the termination bump indicates a maladjusted reverse plate line termination. Note display observed.

c. Rise - Set sweep TIME/CM to .1 USec and observe leading edge of displayed waveform. This should be a sharp cornered step with no overshoot, undershoot, wrinkles or bumps in this section. If a roll-off (undershoot) is observed it may be due to misadjustment of the delay line capacitors nearest the CRT or the inductors following between the line and deflection plates. It can also be caused by insufficient H.F. peaking in the vertical amplifier or an amplifier tube with low GM. Overshoot and ringing can be caused by a mistuned delay line, also an overcompensated input amplifier or cathode interface on one of the amplifier tubes. Note display observed and possible trouble.

4.40.1 Adjustment - After analyzing the three basic characteristics of the waveform as described in 4.39 a, b and c, the operator should first check any other possible trouble source mentioned before attempting to adjust the delay line. Below is described a complete delay line adjustment procedure followed by vertical amplifier H.F. compensation. If the trouble appears to be H.F. compensation, these adjustments should be tried before adjusting the delay line.

CAUTION: In adjusting the delay line watch the displayed pattern very carefully to note changes occurring in any part of the display as a result of the adjustment in process. While one bump is being eliminated, another aberration may be being created in a different portion of the display. It is easy for the entire procedure to get completely out of control in this manner. Never turn an adjustment without noting the effect of a slight touch. In many cases only a small fraction of a turn is required at strategic points to restore normal operation.

4.40.2 INITIAL ADJUSTMENTS - If the operator has not had considerable experience in delay line adjustments, error will be avoided by turning the slugs on the inductors in the vertical amplifier and at the CRT end of the delay line, so that they are just out of the coils. (Flash a light through the forms to locate this position). This adjustment will produce a roll-off in the leading edge of the display, but will decrease the effect of the inductors during the delay line adjustment, after which their proper position can be restored. Before starting adjustment, note that a properly adjusted line will generally have all screws about equal height which is about 3/8 inch above the capacitor body.

4.40.3 CORRECTING THE DISPLAY

a. Flattening the top. With oscilloscope off, adjust the termination network as follows:

Using an appropriate ohmmeter range on the multimeter, measure the resistance across the extremes of resistors R1030 through R1035 in series and adjust potentiometer R1043 to obtain a reading of 620 ohms.

After completing this adjustment, turn on oscilloscope with L head inserted and adjust vertical amplitude to 3 cm. Set TIME/CM to 5 USec and obtain a stable display. Progressing in the direction of the CRT touch up each capacitor in a direction so as to level the display. When a good average level is attained, switch TIME/CM to 2 USec and repeat procedure to smooth the trace between bumps and maintain a satisfactory level. After proper adjustment the bumps should not exceed a trace width in amplitude. If an upward or downward step from the leading edge to the termination bump persists after these adjustments it may indicate resistive unbalance in the termination. See Troubleshooting section, par. 5.7.2.

b. Removing the Bumps. - Set TIME/CM to .5 uSec. Obtain a stable display. Starting at the end of the delay line furthest from the CRT, proceed to the first group of 5 delay line capacitors and touch up adjustments to smooth the portion of the trace which they affect. Switch TIME/CM to 5 USec and check that the level of the display has been maintained. Return to 5 USec/CM sweep and continue adjustments, proceeding towards the CRT, touching up the capacitors in groups of 4 or 5 and each time checking the display level. After all sections have been covered, repeat the procedure with TIME/CM at .02 USec. Extreme care and a very light touch should be used in this final adjustment to prevent the possibility of ruining the adjustment already achieved.

c. Restoring the High Frequency Compensation. - The square corner of the display should now be restored by means of the high frequency compensators. Set TIME/CM to .2 USec and adjust display to provide a good view of the leading edge of the waveform. Carefully

adjust the vertical amplifier inductors and those at the end of the delay line, a pair at a time, to square off the leading edge. The setting of each inductor of a pair should be approximately the same. Check that display level is maintained and no bumps are introduced by these adjustments. It may be necessary to touch up the adjustment of the last few delay line capacitors near the CRT to finalize the squaring of the display.

d. Measure Rise Time

Upon completion of all adjustments, the risetime of the main vertical amplifier should be measured.

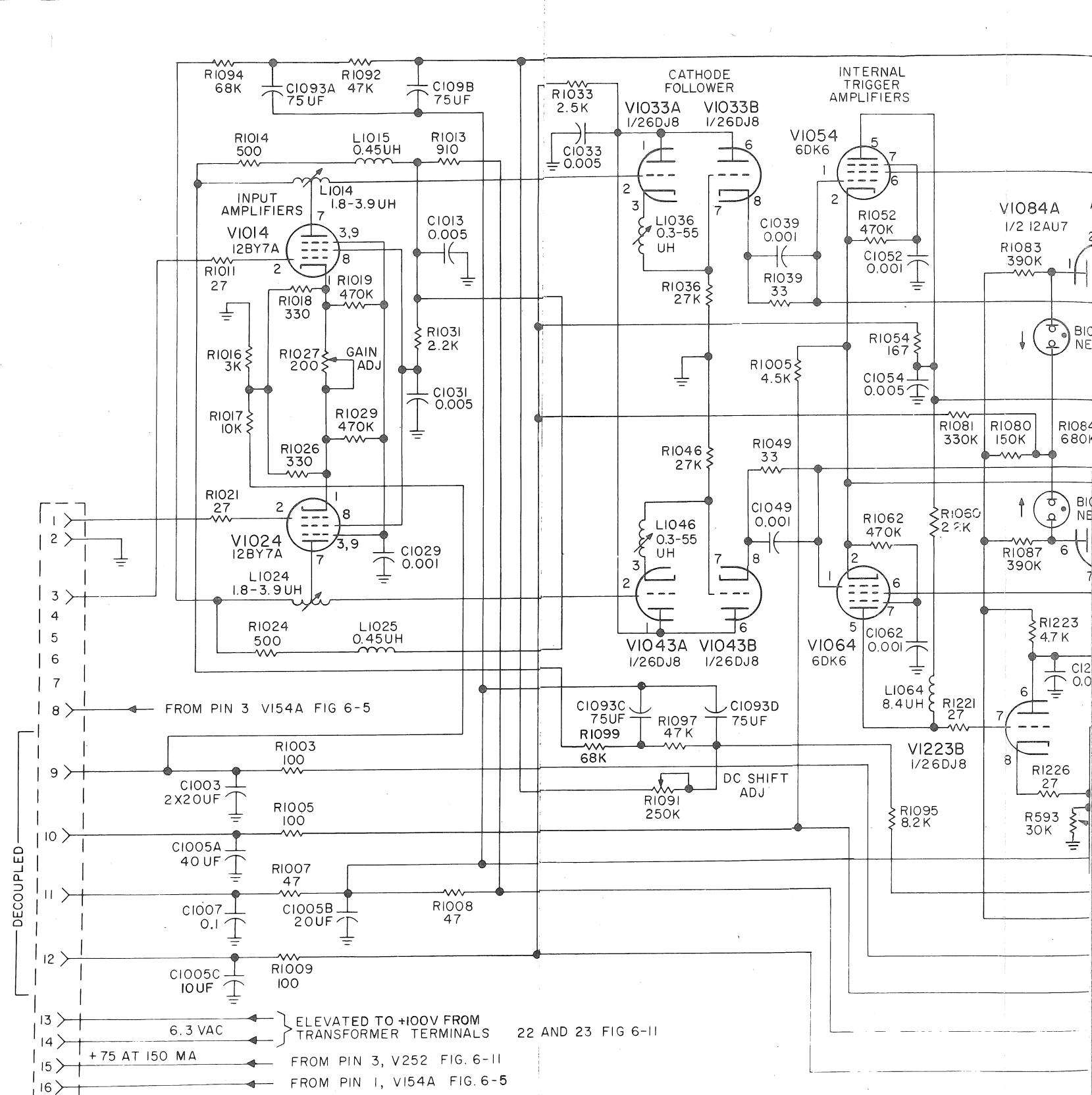
Using type P plug-in unit, adjust display amplitude to 3 cm and set TIME/CM to .1 USec. Measure risetime of displayed waveform. It should be no greater than 10 nanosec. Overshoot should not exceed 2-1/2%.

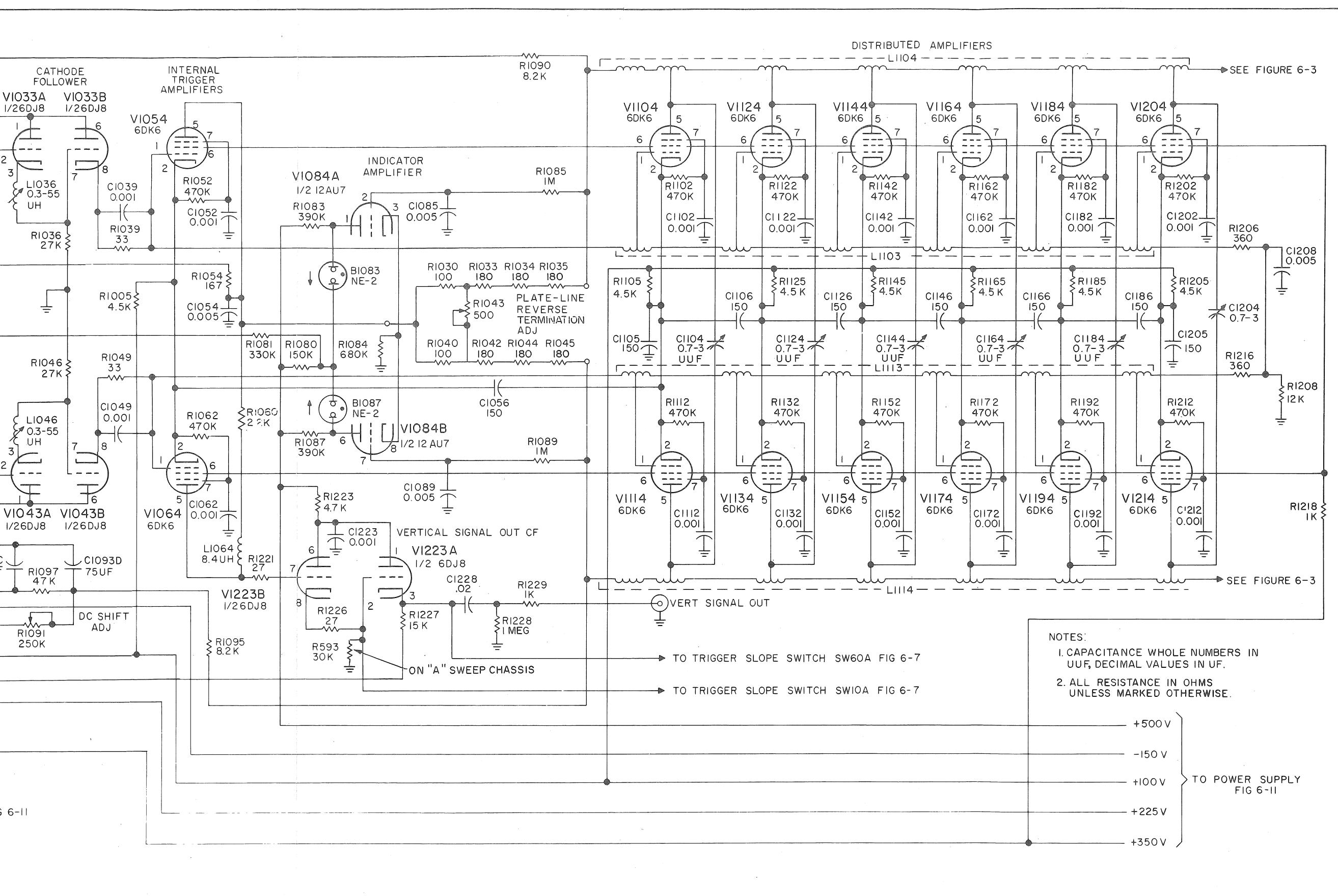
4.41 BANDPASS CHECK - Install a type L (or K) plug-in and connect a 500 Kc signal from the 190 CONSTANT AMPLITUDE SIGNAL GENERATOR to the input. Set ATTENUATOR and SIGNAL LEVEL for 4 cm vertical deflection. Increase frequency of generator to 30 Mc. Vertical deflection should be no less than 2.8 cm.

4.42 LOW FREQUENCY RESPONSE CHECK - Connect 211 square wave generator to input. Set generator frequency to 10 cps and set attenuator and level for 3 cm vertical deflection. Set sweep TIME/CM to 20 MSec and adjust for a stable display. Check for a good quality square wave with no slope or droop.

CONDITIONS:
1. SEE PARAGRAPH 5-16

TUBE	V OR R	PIN NO.	1	2	3	4	5	6	7	8	9
VI014	R		2.8K	7.3K					5K		
VI024	R		2.8K	7.3K	400K	110K	110K	110K	4.7K	6.3K	400K
VI054	R		12K	4.3K			15K	11K			
VI064	R		12K	4.3K			15K	11K			
VI084	R		340K	800K	600K	90K	90K	370K	830K	590K	90K
VII04	R		12K	4.3K			15K	1K			
VII14	R		12K	4.3K			15K	1K			
VII24	R		12K	4.3K			15K	1K			
VII34	R		12K	4.3K			15K	1K			
VII44	R		12K	4.3K			15K	1K			
VII54	R		12K	4.3K			15K	1K			
VII64	R		12K	4.3K			15K	1K			
VII74	R		12K	4.3K			15K	1K			
VII84	R		12K	4.3K			15K	1K			
VII94	R		12K	4.3K			15K	1K			
VI204	R		12K	4.3K	100K	100K	15K	1K	4.3K		
VI214	R		12K	4.3K	100K	100K	15K	1K	4.3K		
VI223	R		11K	5.4K	28K	100K	100K	11K	25K	12K	

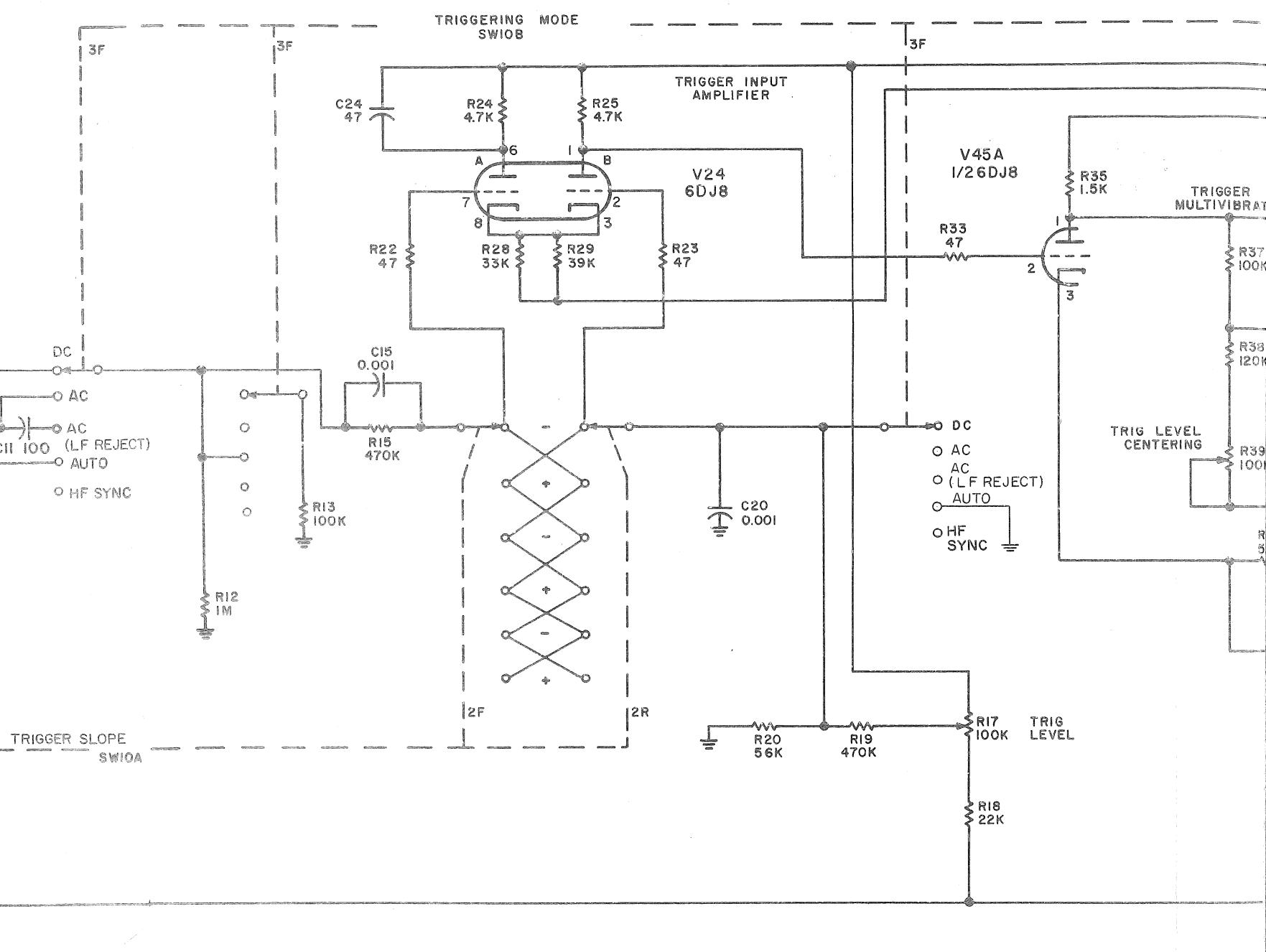
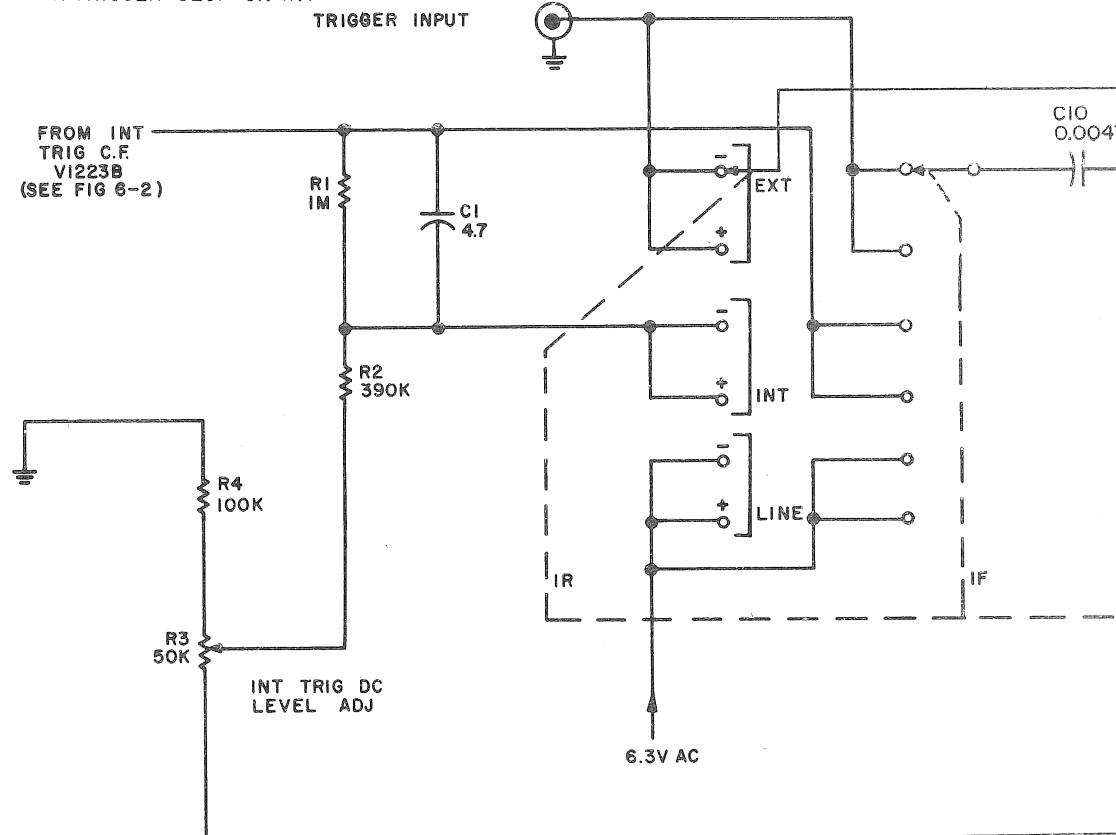




CONDITIONS:
 1. TRIGGERING LEVEL - UPPER VOLTAGE CCW
 LOWER VOLTAGE CW
 2. SEE PARA 5-16

TUBE	V OR R	PIN NO.	1	2	3	4	5	6	7	8	9	
V24	R			60K	50K*							
V24	V		+65	+100				+102	-12			
								+61	+11			
V45	R		5K	4.5 K								
V45	V							+195				
V45	V		JUNCTION OF R25(4.7K) AND R33(47) FROM PIN 2	+ 58.5V				+ 100V				
V45	V		JUNCTION OF R37(100K),AND R41(47) FROM PIN 7	+ 84V				+ 73V				

* TRIGGER SLOP ON INT -



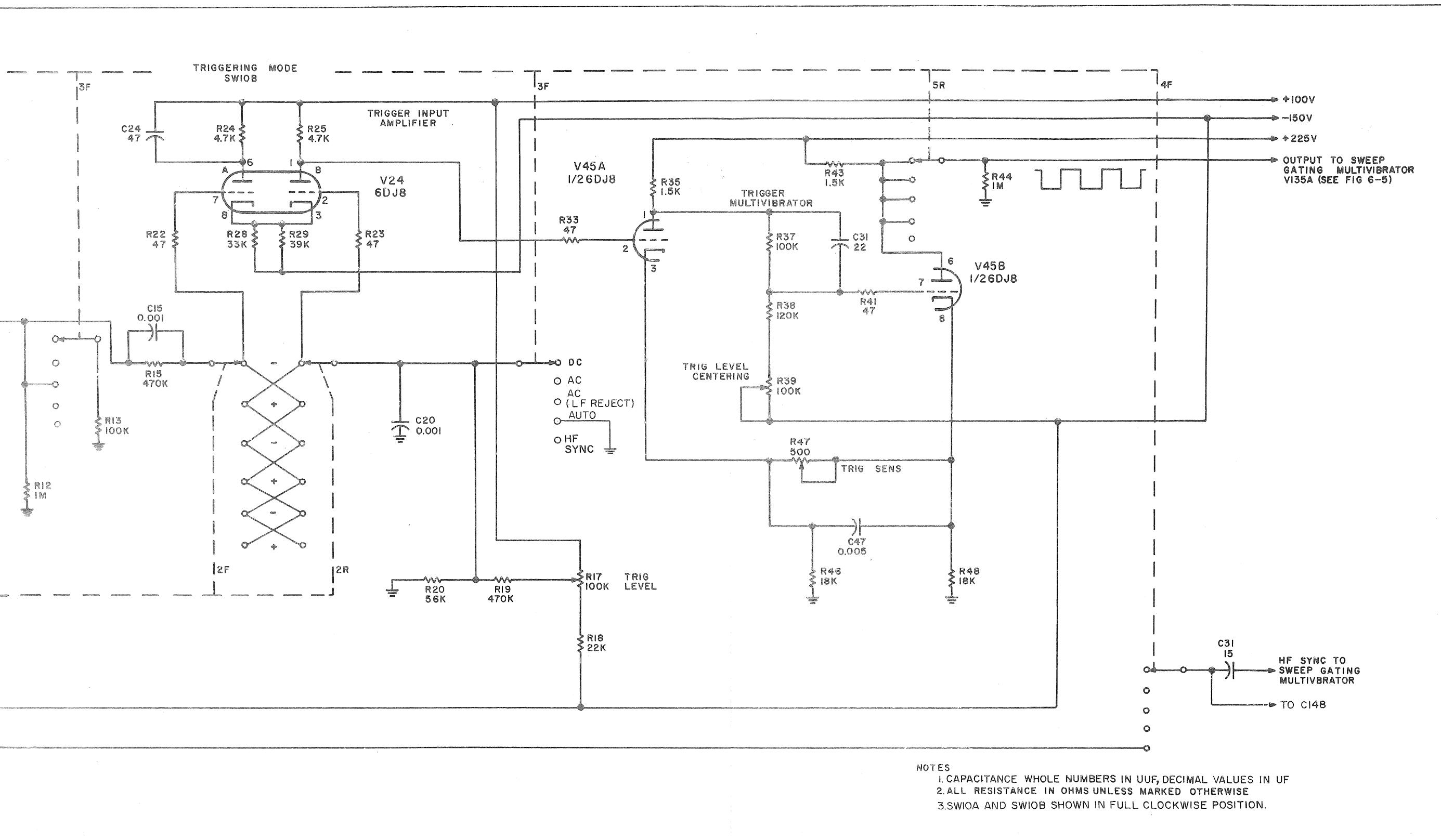


Figure 6-4. Sweep Generator A Trigger, Schematic Diagram

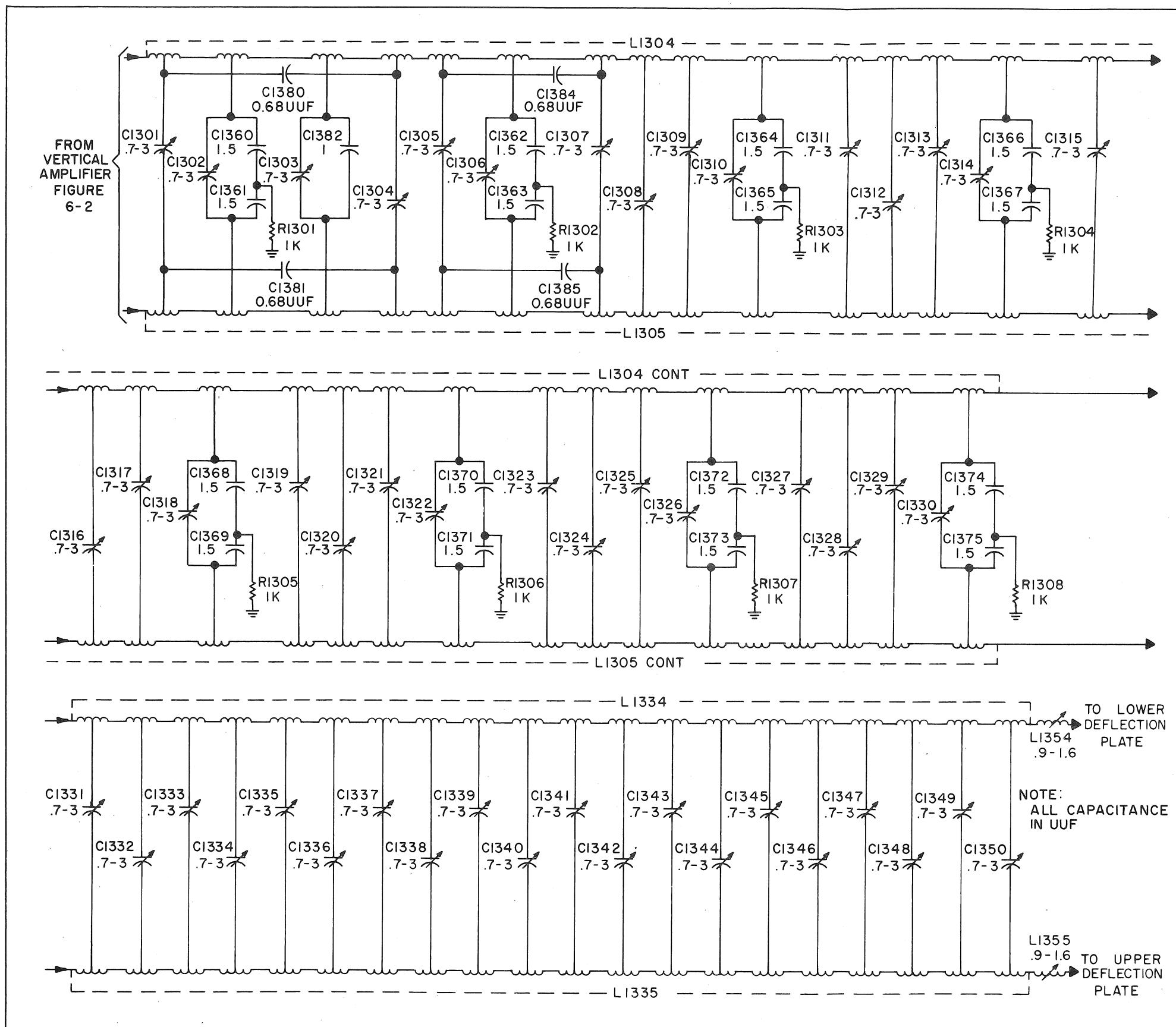
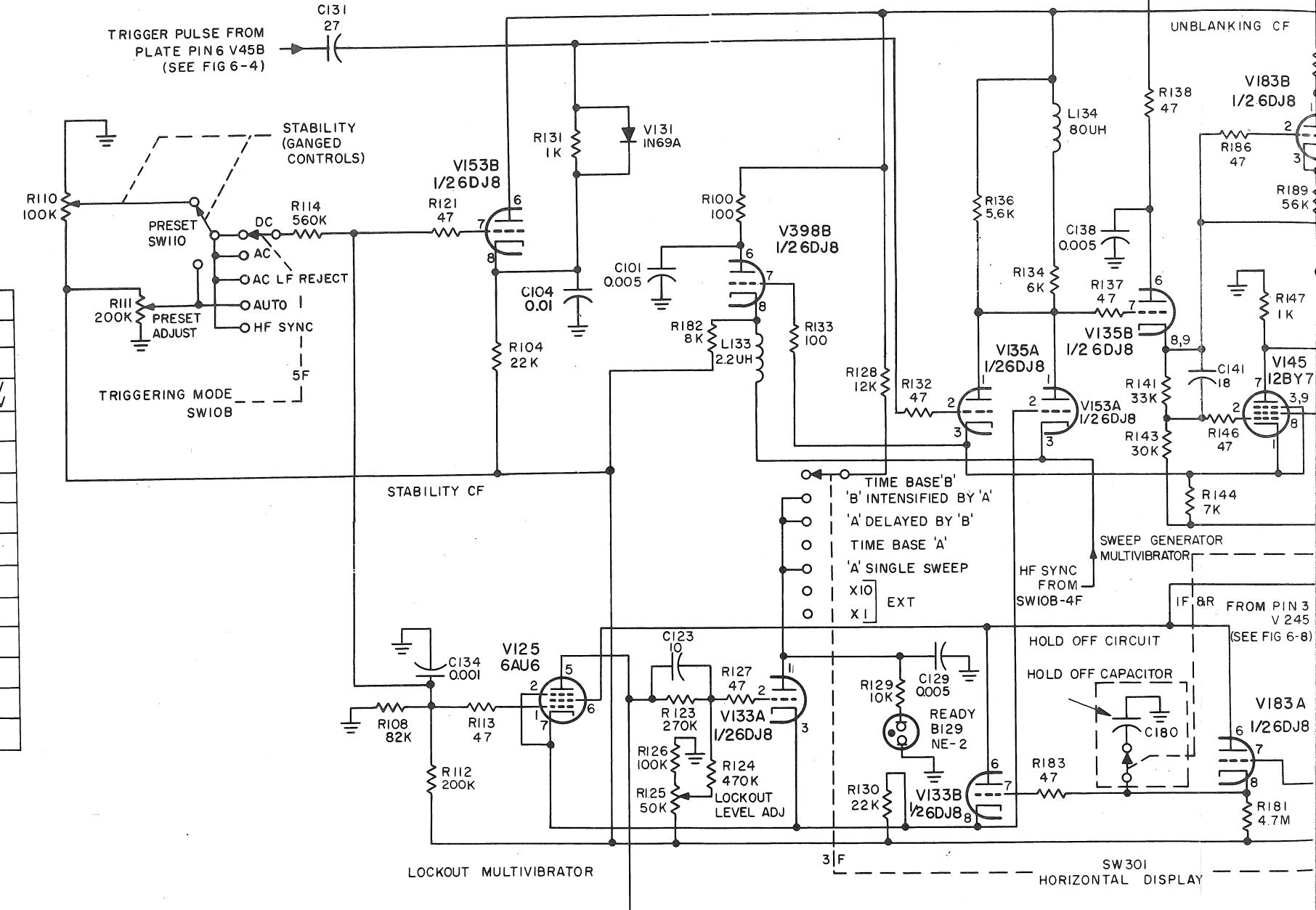
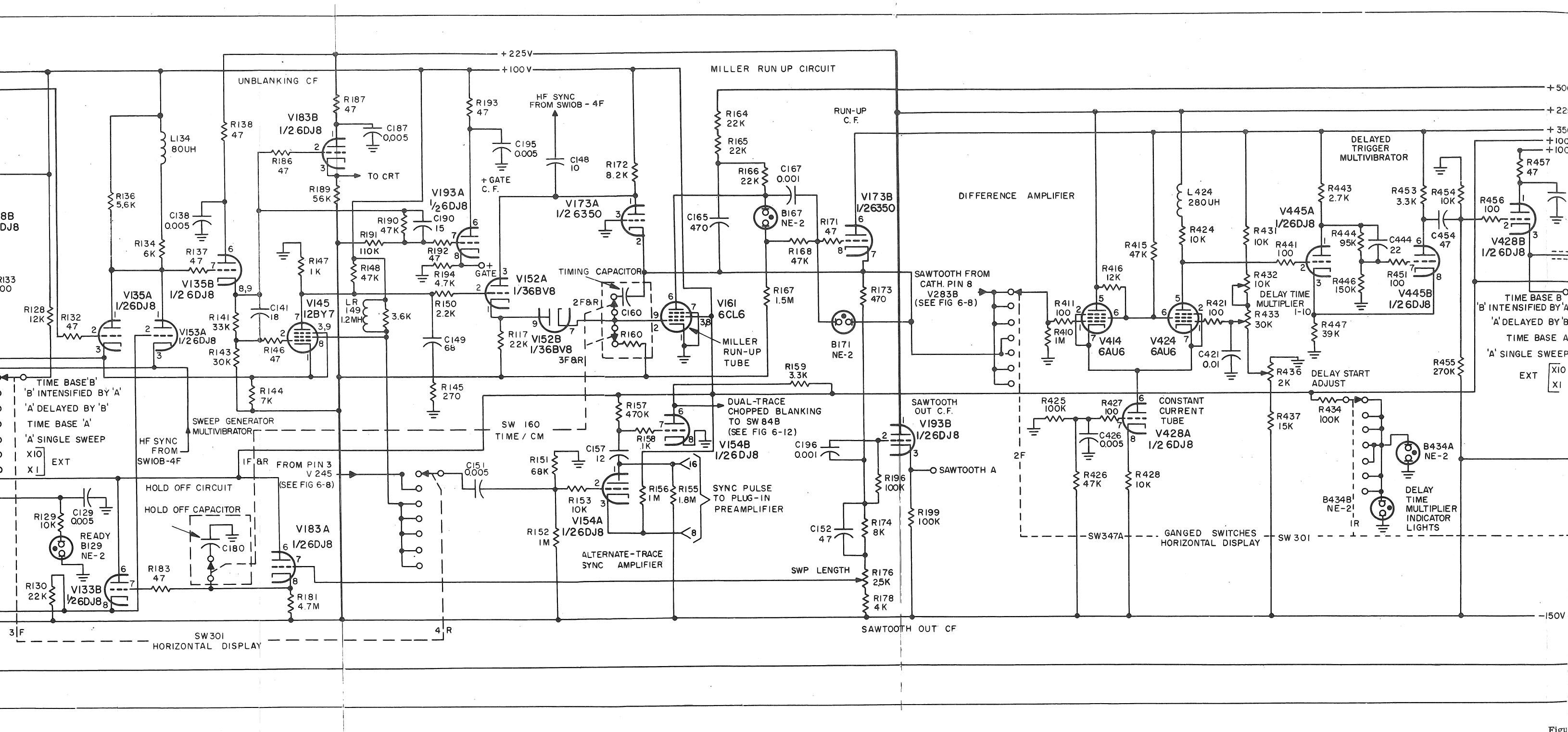


Figure 6-3. Balanced Delay Line Network, Schematic Diagram

CONDITIONS:
I. STABILITY CONTROL - CCW BUT NOT PRESET (SWEEP
DISABLED) UPPER VOLTAGE
CW (SWEEP FREE RUNS)
LOWER VOLTAGE

2. SEE PARAGRAPH 5-16





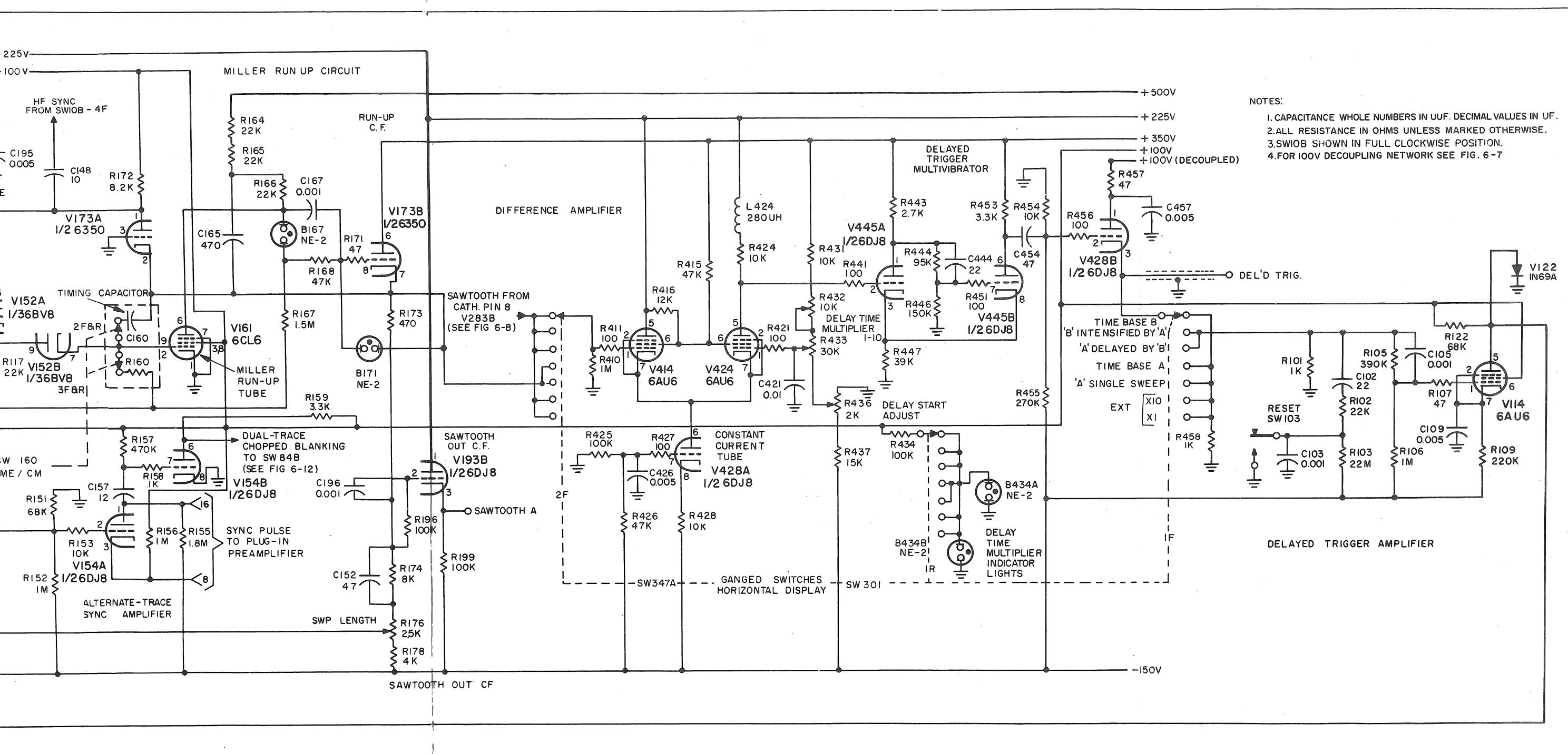


Figure 6-5. Sweep Generator A, Schematic Diagram

CONDITIONS:

1. EXT HOR INPUT SIGNAL -NONE
2. HORIZONTAL DISPLAY -EXT X10
3. HORIZONTAL POSITION -CCW FOR UPPER VOLTAGE
CW FOR LOWER VOLTAGE
4. SEE PARAGRAPH 5-16

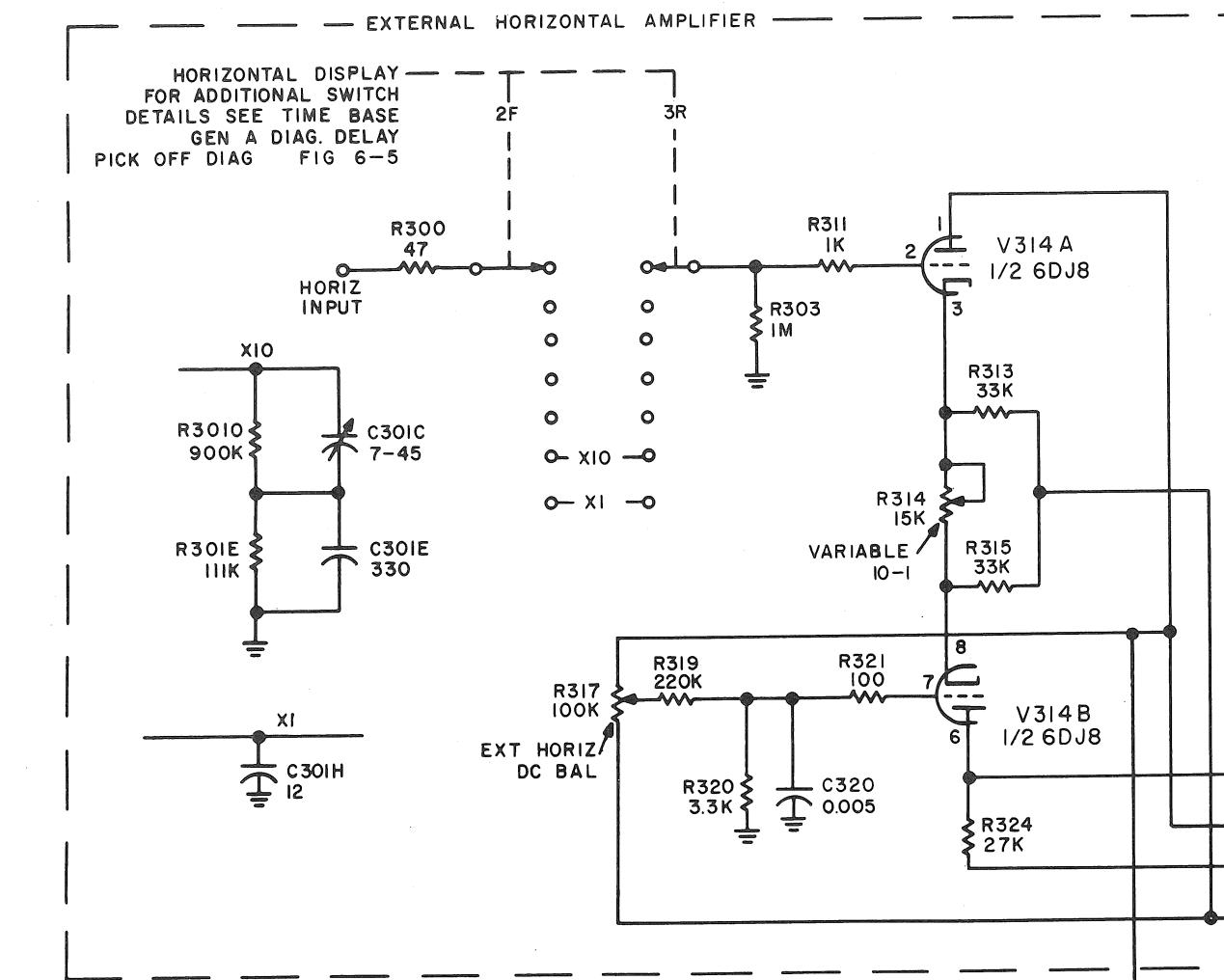
TUBE	V OR R	PIN NO.	1	2	3	4	5	6	7	8	9	
V343	R			100K					900K	90K		
V343	V			+85	+105					-30	+115	
JUNCTION R336(12.1M OHM) AND R341(100 OHM) FROM PIN 7												
V343	V											- .2 V
V364	R		40K									+ 57 V
V364	V		+420	+235		+97	+107			+420	+235	
V384	R		40K		3.5K				3.5K			
V398	R		30K	37K	70K	97K	97K	3.5K	24K			
V398	V				+174	+322						

NOTES:

1. CAPACITANCE WHOLE NUMBERS IN UUF,
DECIMAL VALUES IN UF
2. ALL RESISTANCE IN OHMS
UNLESS MARKED OTHERWISE.
- 3 SW347A & SW347B SHOWN IN
FULL COUNTERCLOCKWISE POSITION
4. FOR 100V DECOUPLING NETWORK
SEE FIG 6-7 SWEEP GENERATOR B TRIGGER

SAW TOOTH FROM
CATH PIN 8 V283B
SEE FIG 6-8

SAW TOOTH FROM
CATH PIN 7 V173
SEE FIG 6-5



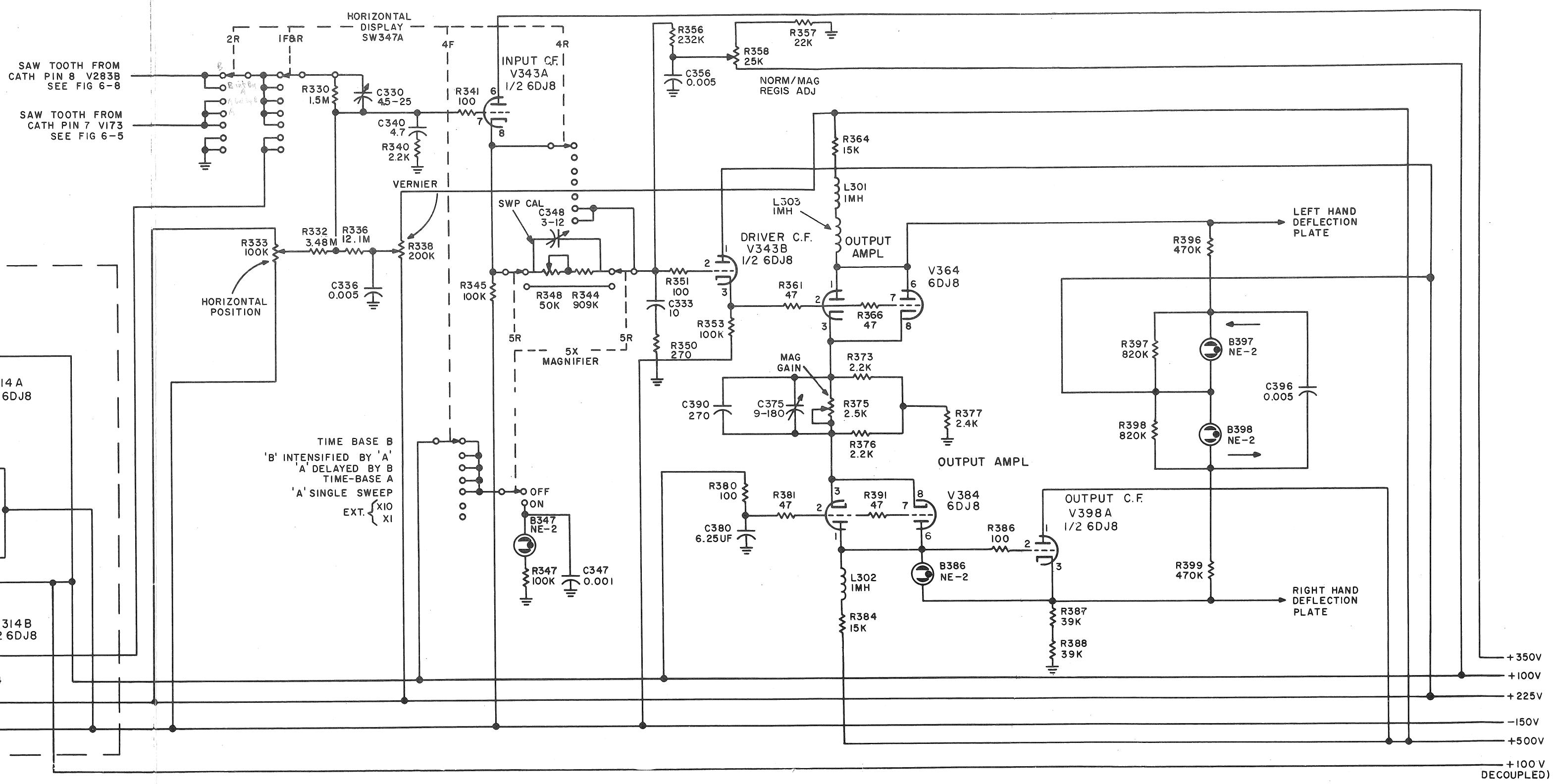


Figure 6-6. Horizontal Amplifier, Schematic Diagram

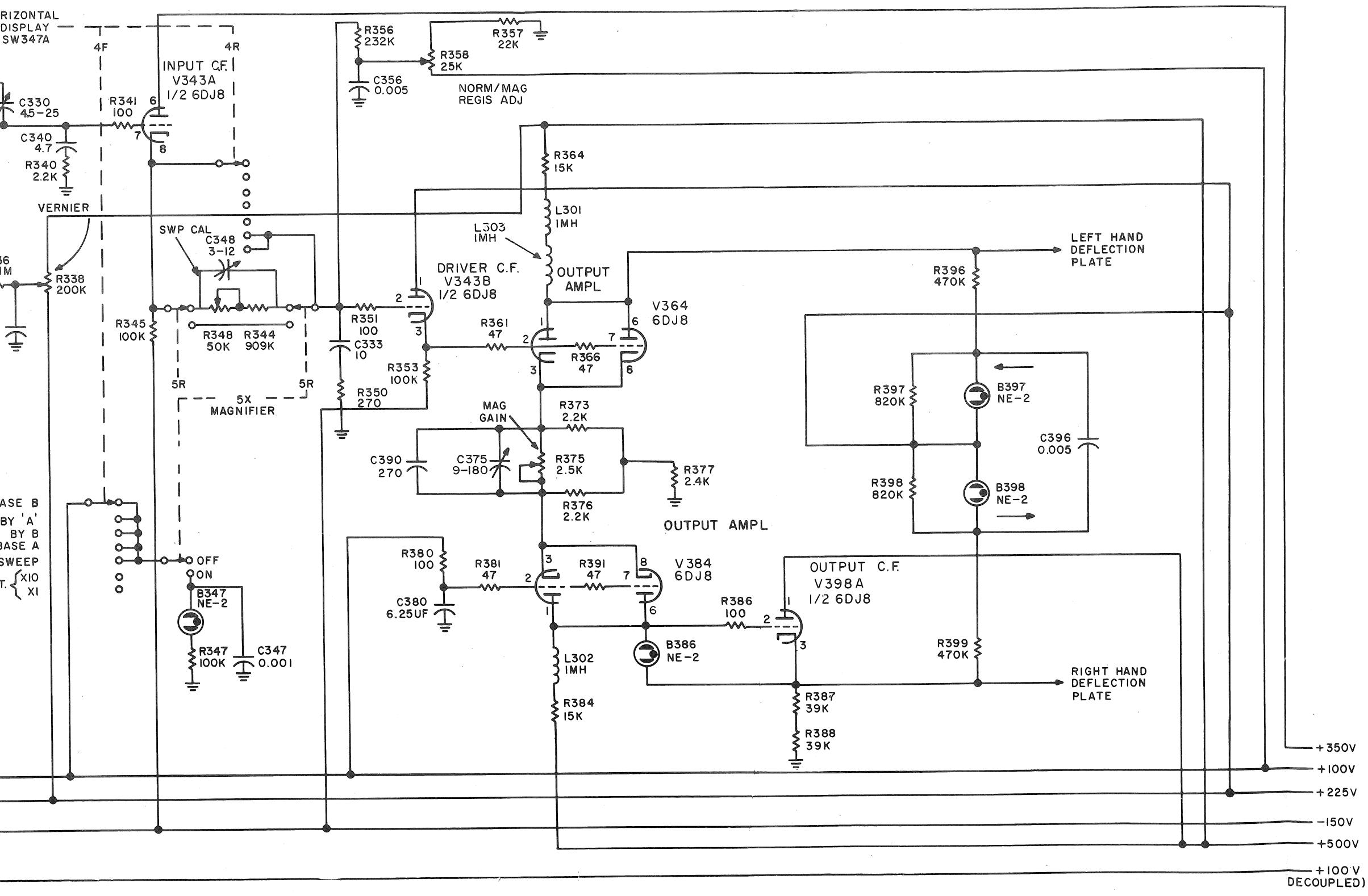


Figure 6-6. Horizontal Amplifier, Schematic Diagram

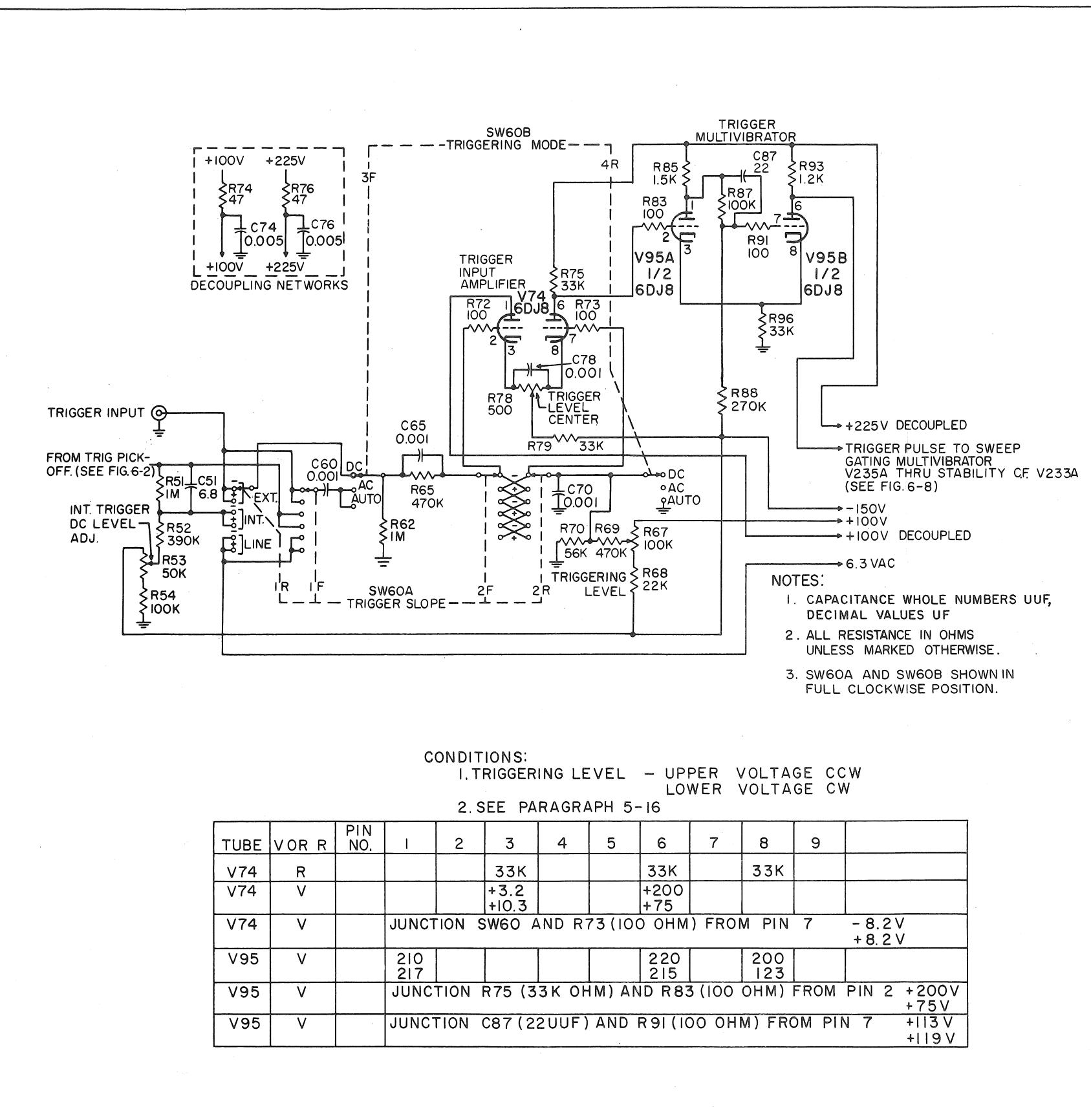
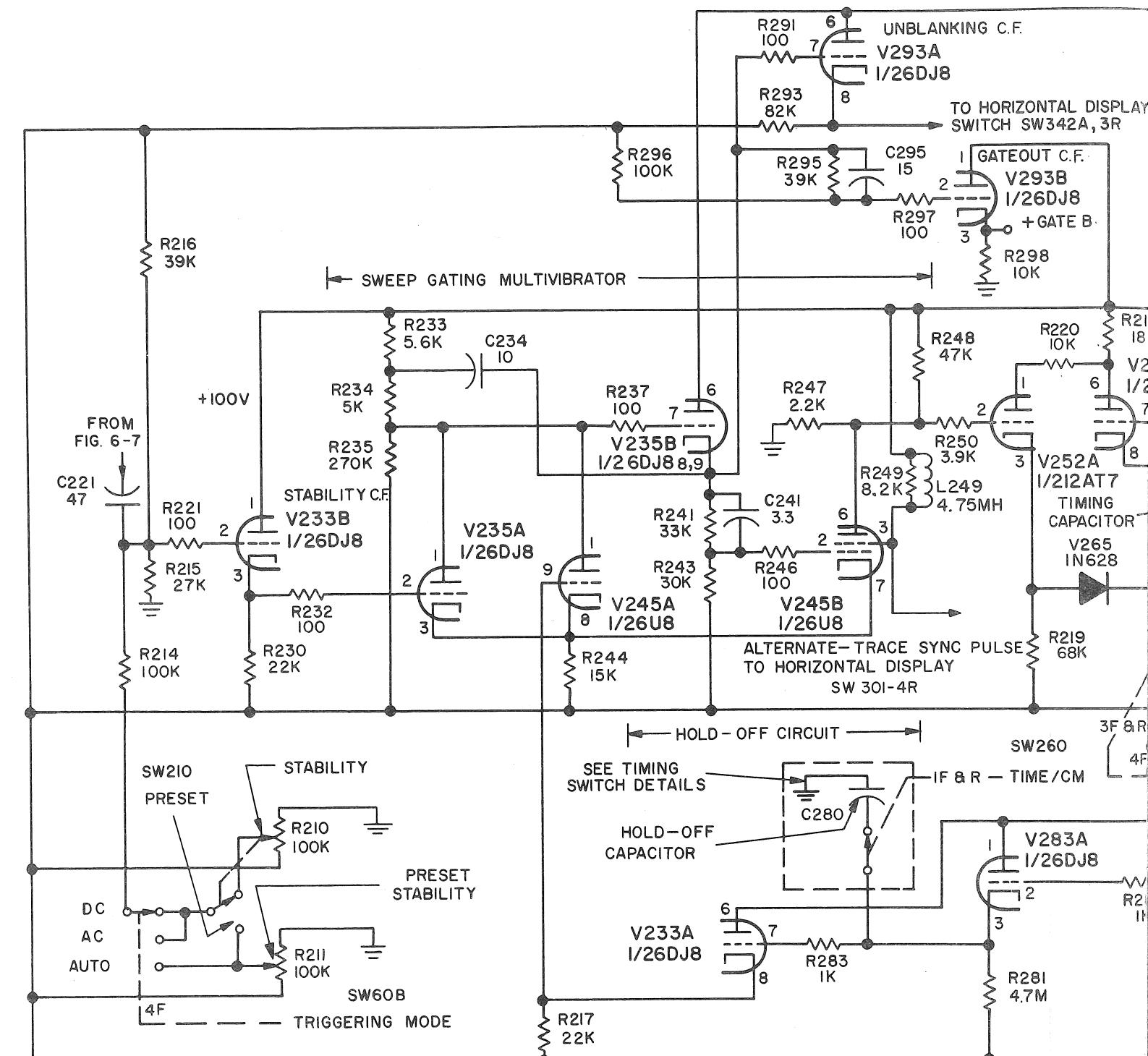


Figure 6-7. Sweep Generator B Trigger, Schematic Diagram

2. STABILITY CONTROL - CCW BUT NOT PRESET (SWEEP DISABLED) UPPER VOLTAGES
CW (SWEEP FREE RUNS)
LOWER VOLTAGES

2. SEE PARAGRAPH 5-16

TUBE	V OR R	PIN NO.	1	2	3	4	5	6	7	8	9	
V233	R			13.5K	20K				42			
V233	V				-70 -50					-55 -73		
V235	R		9.5K	22K	16K			4.2K	10K	40K	40K	
V235	V				-39 -45					+56 +27		
V245	R		9.5K	20K	9.5K	4K			9.5K	40K	40K	
V245	V							-1.2 +2.3				
V261	R		160K				260K					
V261	V		-1.7 -1.8									
V283	R			16K	1M				1.6M	30K		
V283	V			JUNCTION R268 (100K OHM) AND R271 (100 OHM)						-0.4 +22		
V283	V										-13V +10V	



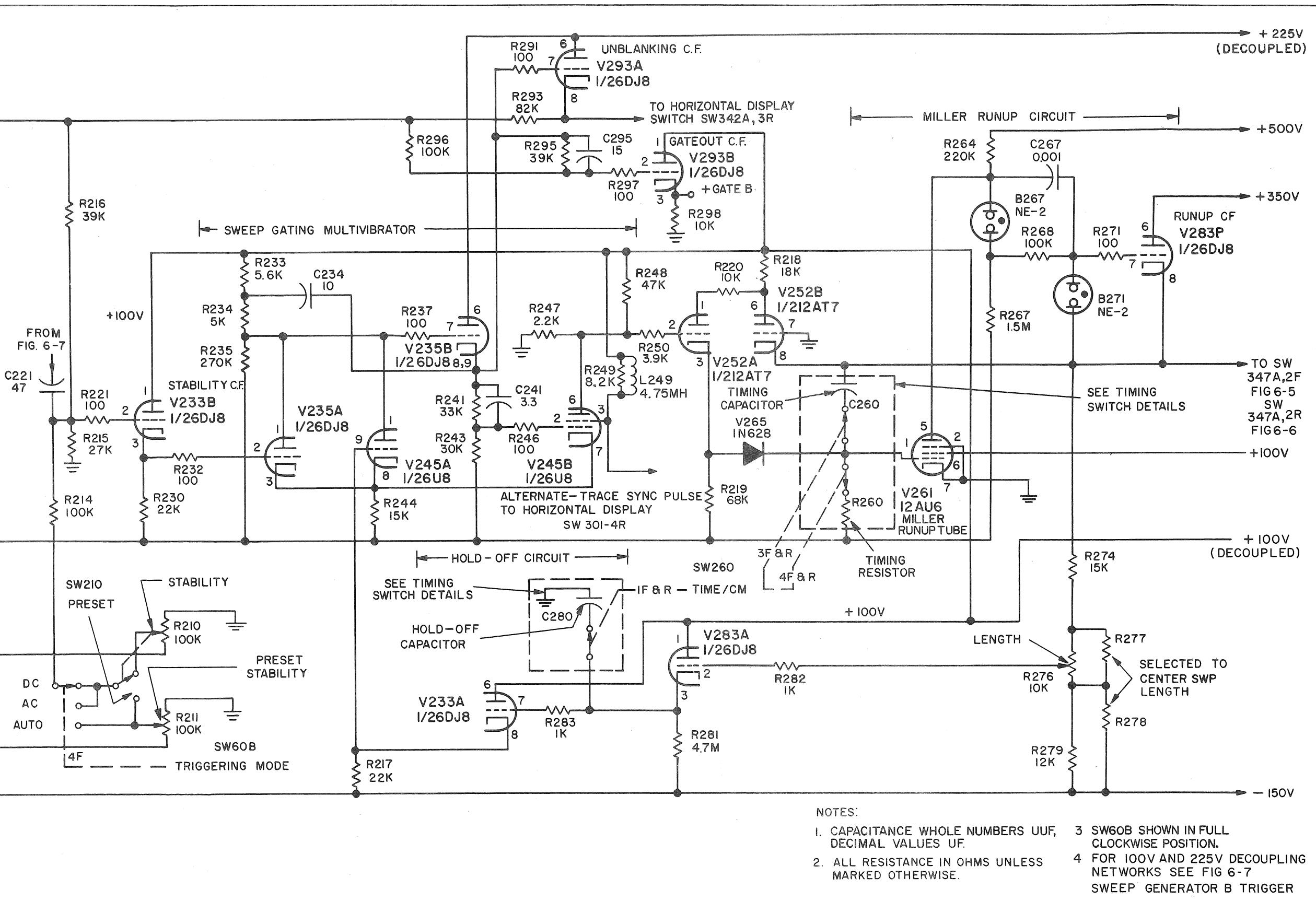
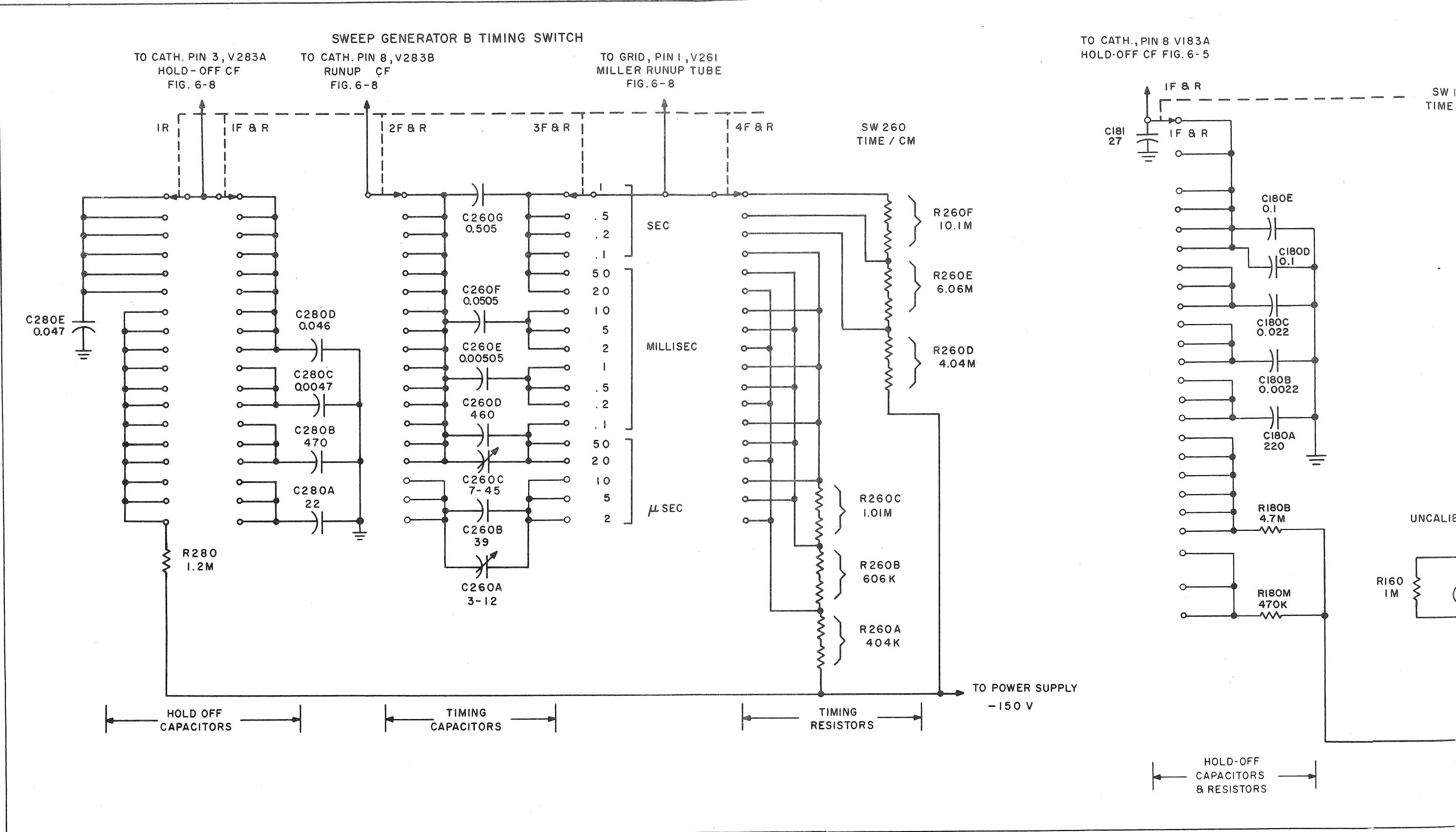


Figure 6-8. Sweep Generator B, Schematic Diagram



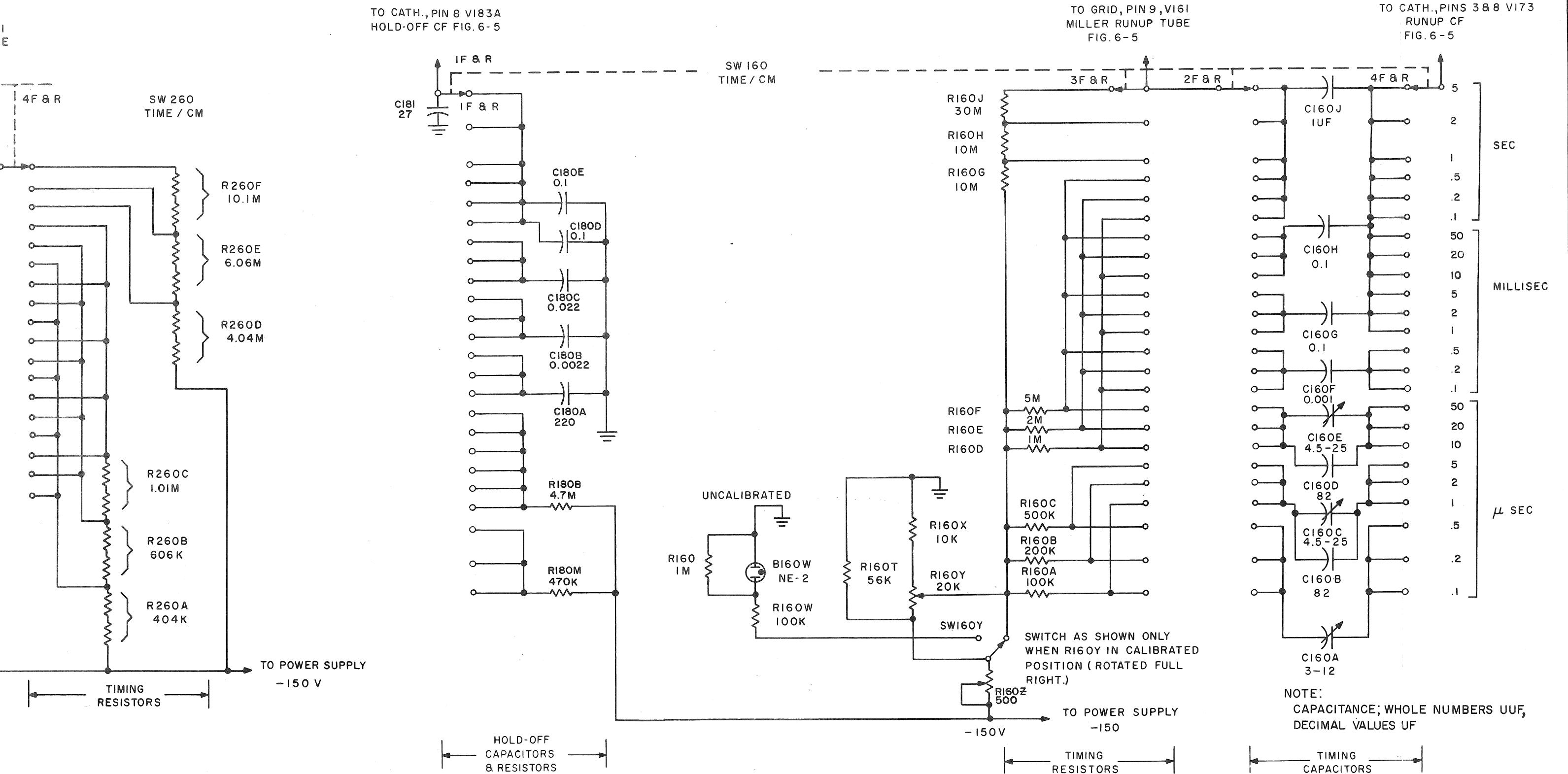


Figure 6-9. Sweep Generator A and B Time/CM Switch, Schematic Diagram

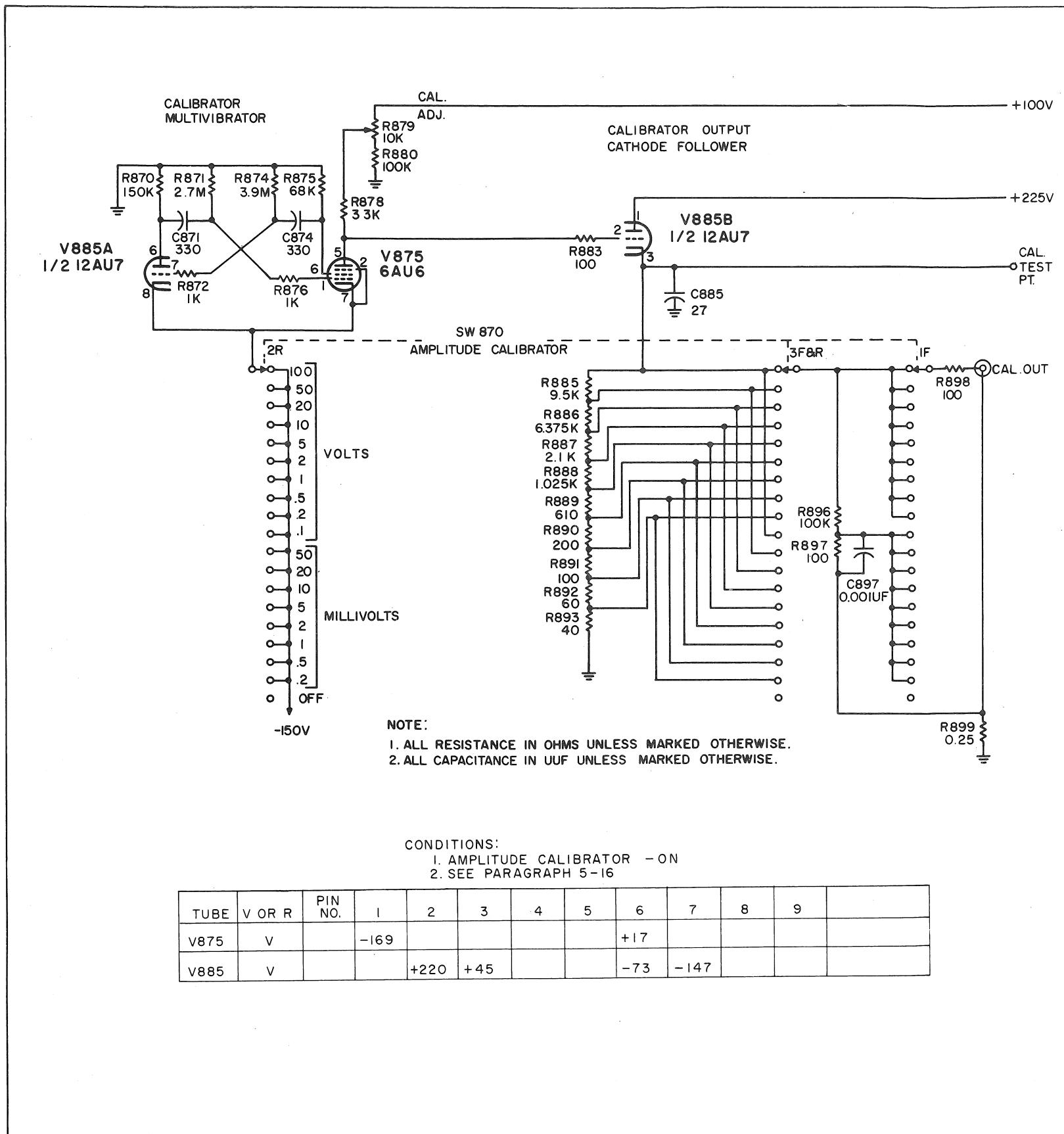


Figure 6-10. Calibrator, Schematic Diagram

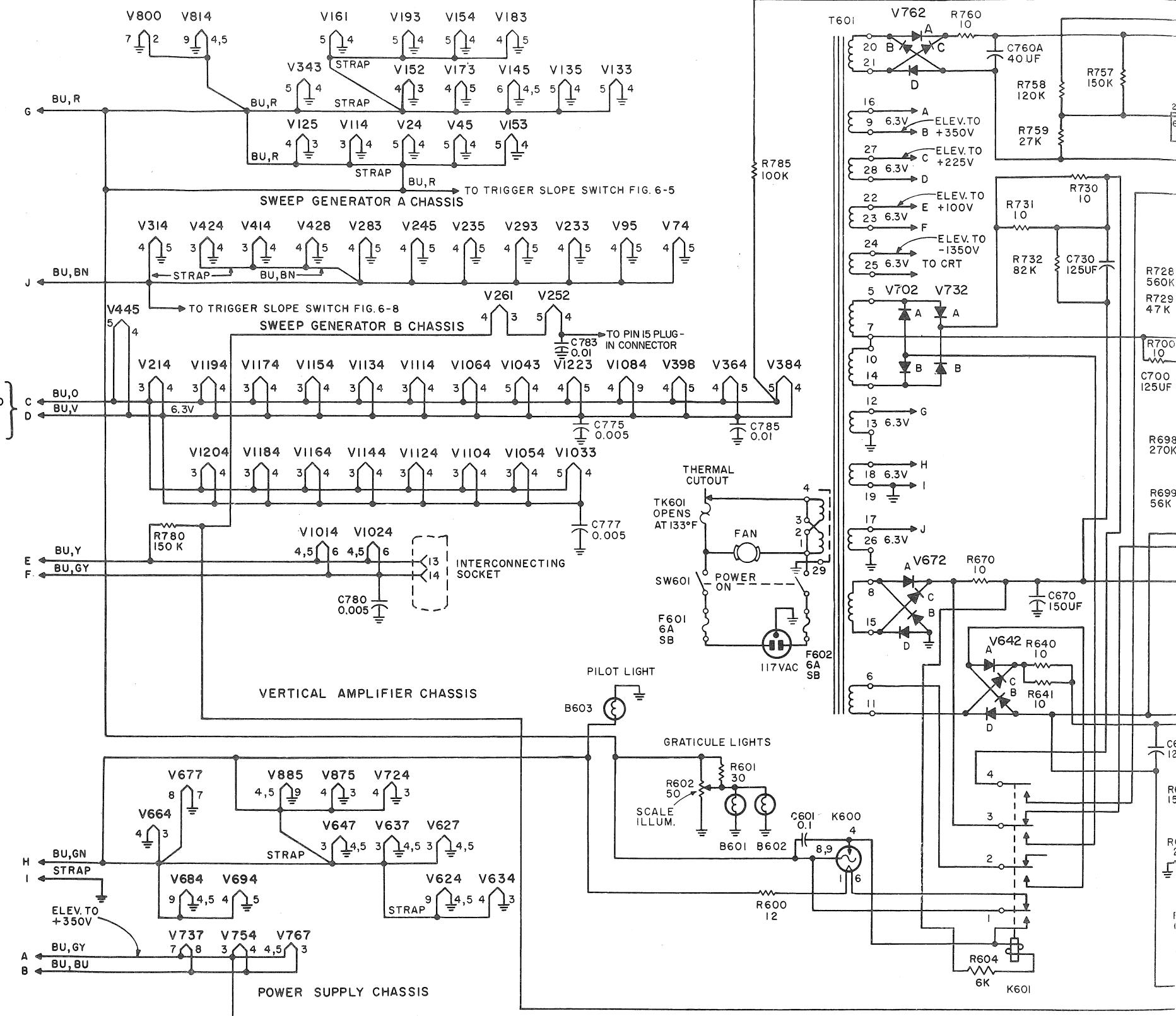
CONDITIONS:

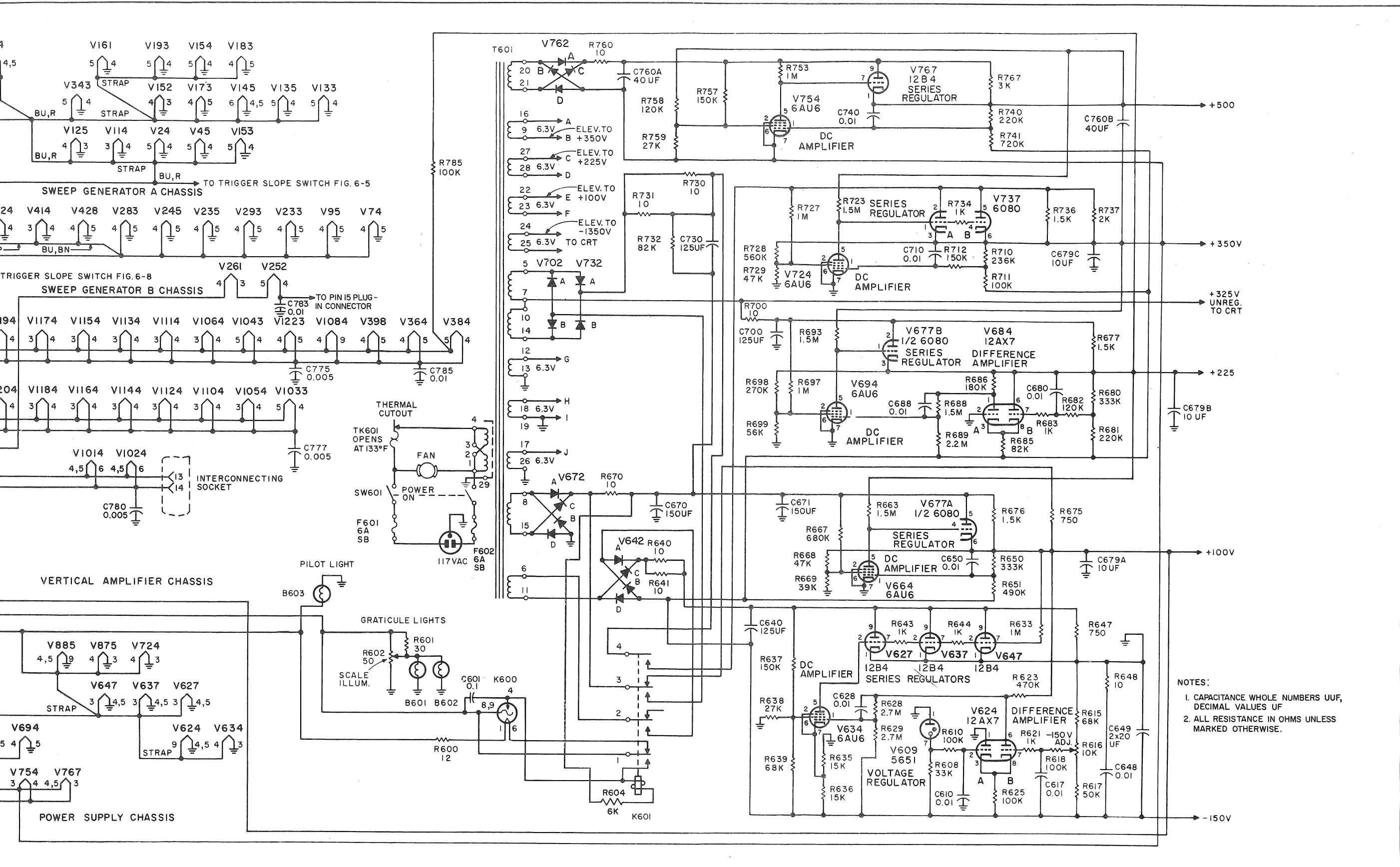
1. VERTICAL INPUT SIGNAL - NONE
2. TRIGGER INPUT SIGNAL - NONE
3. LINE VOLTAGE - 117 VAC
4. STABILITY (BOTH SWEEPS) - CCW, BUT NOT PRESET.
5. POWER TRANSFORMER (VOLTAGE MEASURED ACROSS TERMINAL PAIRS LISTED)

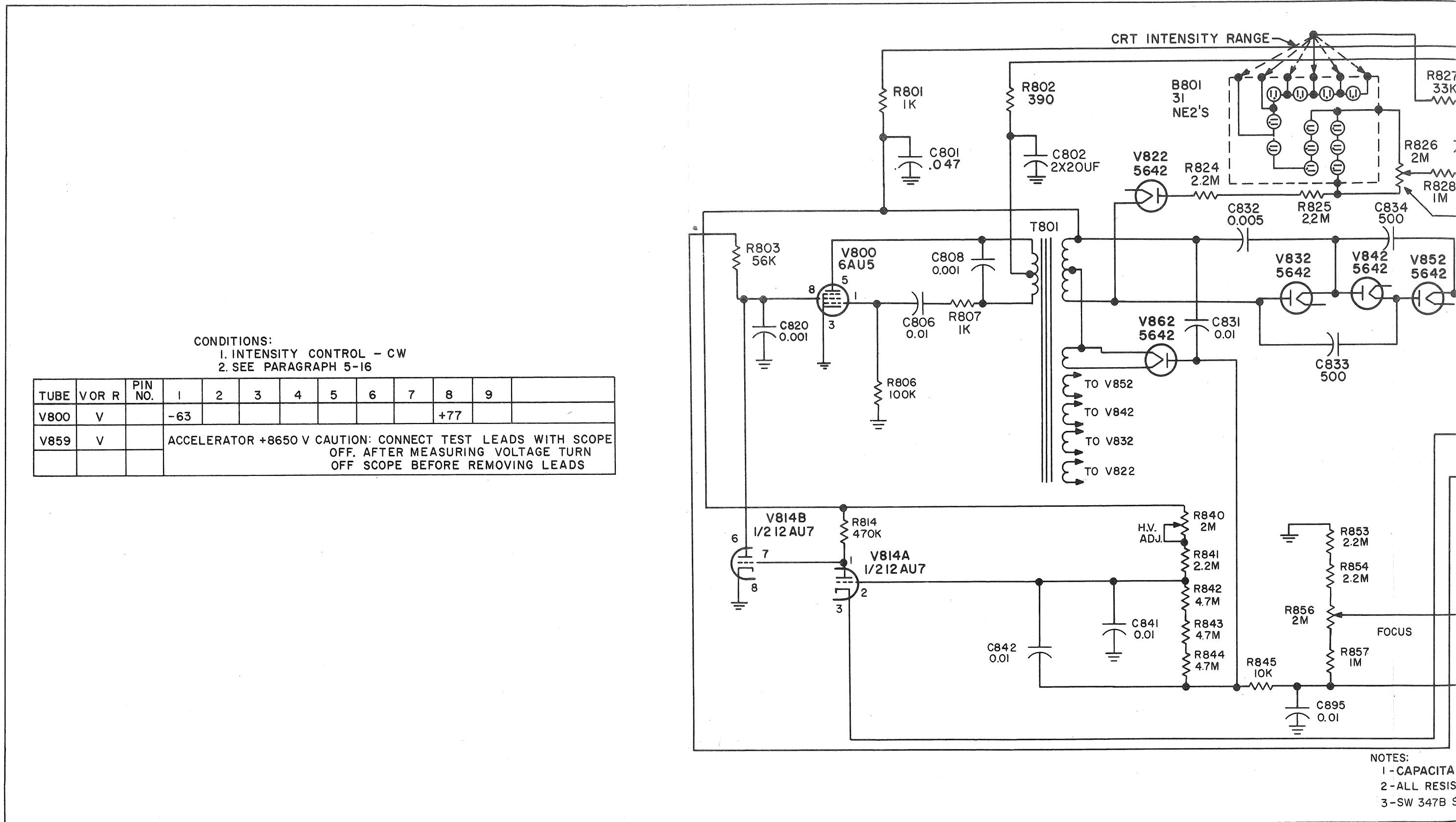
TERMINALS	VOLTAGE (RMS)
20 AND 21	186V
5 AND 7	117V
10 AND 14	115V
8 AND 15	139V
6 AND 11	200V

6. SEE PARAGRAPH 5-6

TUBE	V OR R	PIN NO.	1	2	3	4	5	6	7	8	9	
V609	R								20K			
V609	V								-70			
V627	R	.7K								20K		
V634	R	1.4M				920K			7K			
V634	V	-46							-24.5	-76		
V637	R									20K		
V647	R									20K		
V664	V	-1.5					+220	+46				
V677	R	1.5M	5.5K	4.1K								
V677	V		+345				+176					
V694	R						1.33M	62K				
V694	V						+179	+46				
V724	R			210K					1.35M			
V724	V								+42			
V737	R		1.5M	31K	30K							
V737	V						+320					
V754	R			180K					970K	48K		
V754	V			+365					+495	+405		
V767	V									+575		







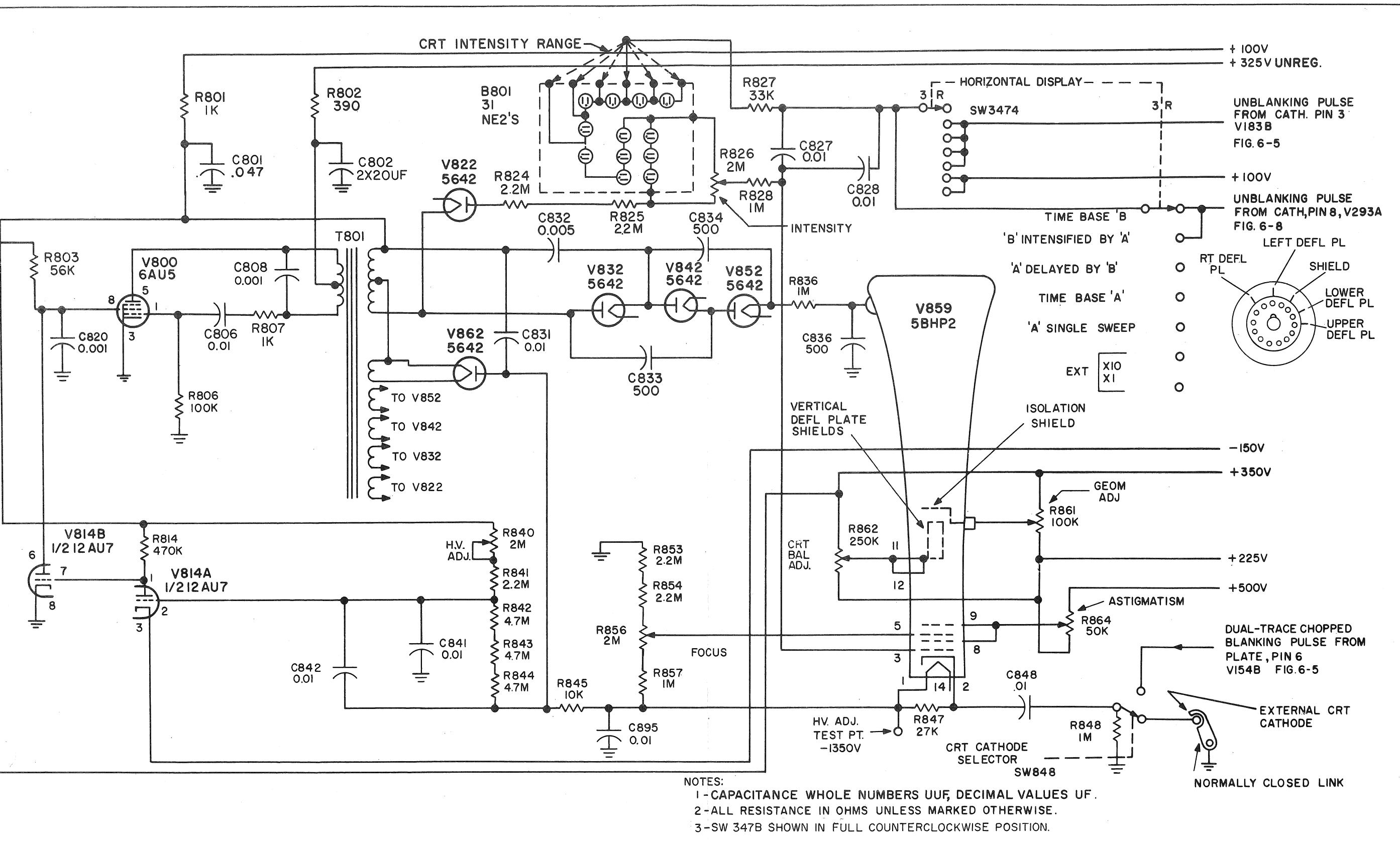


Figure 6-12. Cathode Ray Tube Circuits, Schematic Diagram