



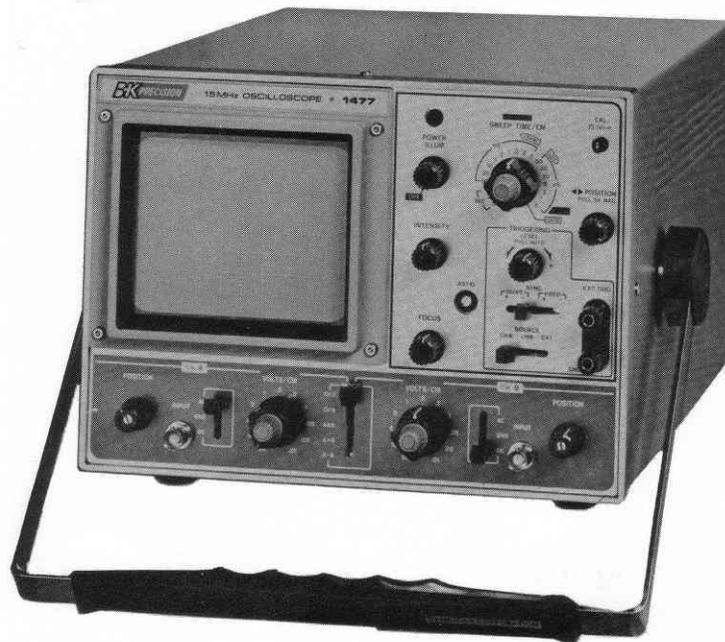
SERVICE MANUAL

1472C

1477

15MHz Triggered Sweep

DUAL-TRACE OSCILLOSCOPE



WARNING

This service manual is intended for use by qualified electronics technicians only. To avoid electric shock, do not perform servicing unless you are qualified to do so.

High voltage up to 2000 VDC is present on the CRT and power supply board when the oscilloscope is operating. High voltage up to 195 VDC is present on the sweep board. Line voltage of 120 VAC (or 240 VAC) is present on the power transformer, on-off switch, and power supply board any time the oscilloscope is connected to an AC power source, even if turned off. Always observe caution when the housing is removed from the unit. Contacting exposed high voltage could result in fatal electric shock.

DIFFERENCES BETWEEN MODELS

This second edition of the service manual is expanded to include Model 1477. Electrically, Model 1477 is very similar to the Model 1472C. A separate schematic is supplied for each model. The circuit board drawings essentially apply to both models. Model 1477 has several changes in appearance from Model 1472C, using a new front panel, new handle, new knobs, etc. A parts list itemizing those parts which are unique for Model 1477 is on page 34.

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REFERENCE PUBLICATIONS

1472C Instruction Manual	480-182-9-001
1472C Composite (Schematic Diagram & Parts List)	499-091-9-001
1477 Instruction Manual	480-263-9-001
1477 Composite (Schematic Diagram & Parts List)	499-160-9-001

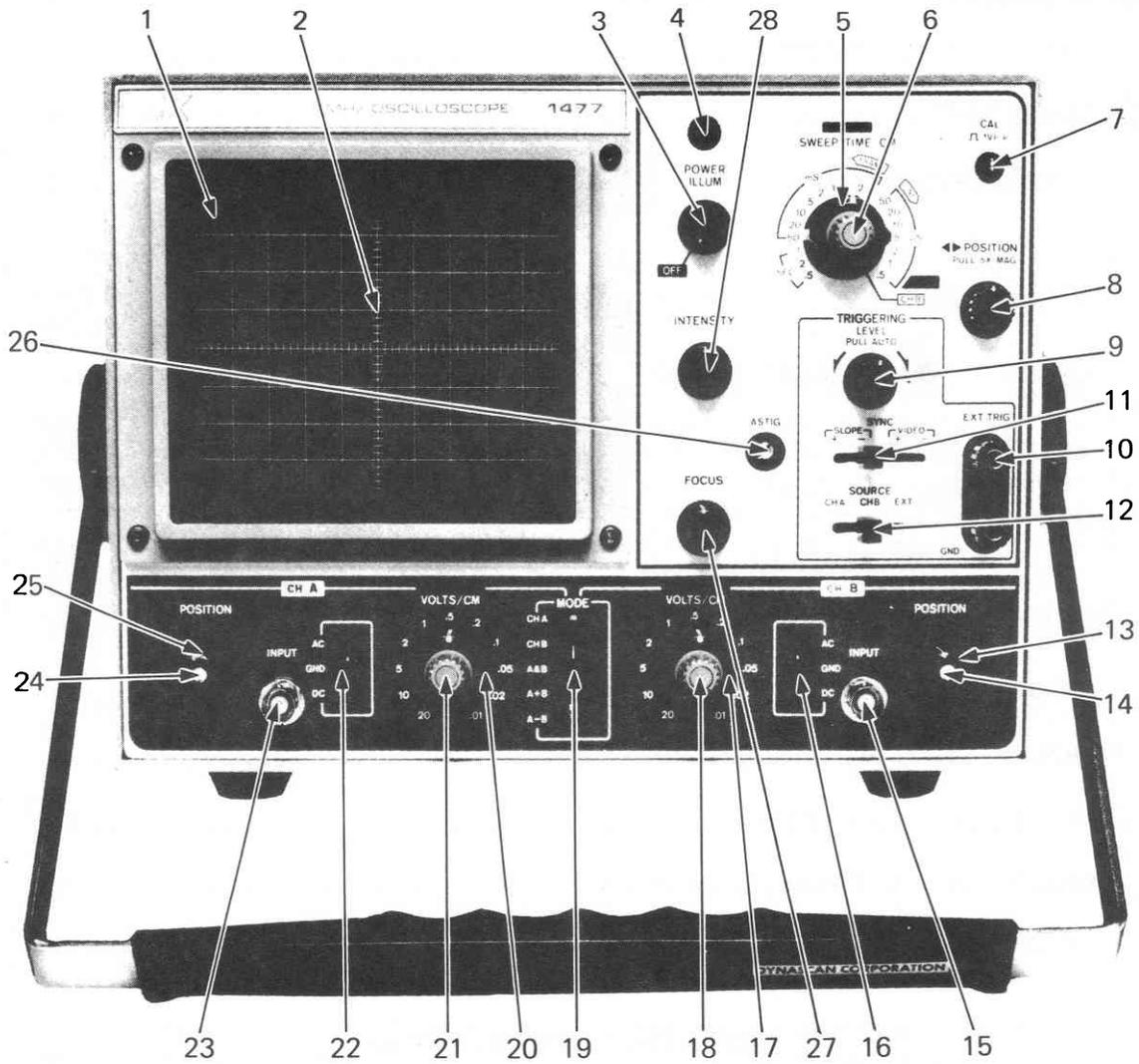


Fig. 1. Front panel controls and indicators.

OPERATOR'S CONTROLS, INDICATORS AND FACILITIES

1. **Cathode Ray Tube (CRT)**. This is the screen on which the waveforms are viewed.
2. **Scale**. The 8 x 10 cm graticule provides calibration marks for voltage (vertical) and time (horizontal) measurements. Illumination of the scale is fully adjustable.
3. **POWER ILLUM** control. Fully counterclockwise rotation of this control (OFF position) turns off oscilloscope. Clockwise rotation turns on oscilloscope. Further clockwise rotation of the control increases the illumination level of the scale.
4. **Pilot lamp**. Lights when oscilloscope is turned on.
5. **SWEEP TIME/CM** switch. Horizontal coarse sweep time selector. Selects calibrated sweep times of 0.5 μ SEC/cm (microsecond per centimeter) to 0.5 SEC/cm in 19 steps when **VARIABLE** control 6 is set to the **CAL** position (fully clockwise). In the **CH B** position, this switch disables the internal sweep generator and permits the **CH B** input to provide horizontal sweep.
6. Sweep speed **VARIABLE** control. Fine sweep time adjustment. In the extreme clockwise (**CAL**) position the sweep time is calibrated.
7. **CAL IV P-P** jack. Provides calibrated 1 kHz, 1 volt peak-to-peak square wave input signal. This is used for calibration of the vertical amplifier attenuators and to check the frequency compensation adjustment of the probes used with the oscilloscope.
8. **◀▶ POSITION** control. Rotation adjusts horizontal position of traces (both traces when operated in the dual trace mode). Push-pull switch selects 5X magnification when pulled out (**PULL 5X MAG**); normal when pushed in.
9. **TRIGGERING LEVEL** control. Sync level adjustment determines points on waveform slope where sweep starts; (-) equals most negative point of triggering and (+) equals most positive point of triggering. Push-pull switch selects automatic triggering when pulled out (**PULL AUTO**). When automatic triggering, a sweep is generated even without an input signal.
10. **EXT TRIG** jack. Input terminals for external trigger signal.
11. **SYNC** switch. Four-position lever switch with the following positions:
 - SLOPE**. The **SLOPE** positions are used for viewing all waveforms except television composite video signals.
 - (+) Sweep is triggered on positive-going slope of waveform.
 - (-) Sweep is triggered on negative-going slope of waveform.
 - TV**. In the **TV** positions, the sync pulses of a television composite video signal are used to trigger the sweep; the vertical sync pulses (frame) are automatically selected for sweep times of 0.5 SEC/cm to 0.1 mSEC/cm, and horizontal sync pulses (line) are automatically selected for sweep times of 50 μ SEC/cm to .5 μ SEC/cm.
 - (+) Sweep is triggered on positive-going sync pulse.
 - (-) Sweep is triggered on negative-going sync pulse.
12. **SOURCE** switch. Three-position lever switch selects triggering source for the sweep. Both sweeps are triggered by the same source in dual trace operation.
 - CH A** Sweep is triggered by Channel A signal.
 - CH B** Sweep is triggered by Channel B signal.
 - EXT** Sweep is triggered by an external signal applied at the **EXT SYNC** jack 10.
13. **Channel B POSITION** control. Vertical position adjustment for Channel B trace. Becomes horizontal position adjustment when **SWEEP TIME/CM** switch 5 is in the **CH B** position.
14. **Channel B DC BAL** adjustment. Vertical DC balance adjustment for Channel B trace.
15. **Channel B INPUT** Jack. Vertical input jack of Channel B. Jack becomes external horizontal input when **SWEEP TIME/CM** switch 5 is in the **CH B** position.
16. **Channel B DC-GND-AC** switch.
 - DC** Direct input of AC and DC component of input signal.
 - GND** Opens signal path and grounds input to vertical amplifier. This provides a zero-signal base line, the position of which can be used as a reference when performing DC measurements.
 - AC** Blocks DC component of input signal.
17. **Channel B VOLTS/CM** switch. Vertical attenuator for Channel B which provides step adjustment of vertical sensitivity. Vertical sensitivity is calibrated in 11 steps from .01 to 20 volts per cm when **VARIABLE** control 18 is set to **CAL** position. This control adjusts horizontal sensitivity when the **SWEEP TIME/CM** switch 5 is in the **CH B** position.
18. **Channel B VARIABLE** control. Vertical attenuator adjustment provides fine control of vertical sensitivity. In the extreme clockwise (**CAL**) position, the vertical attenuator is calibrated. This control becomes the fine horizontal gain control when the **SWEEP TIME/CM** switch 5 is in the **CH B** position.
19. **MODE** switch. Five-position lever switch; selects the basic operating modes of the oscilloscope.
 - CH A** Only the input signal to Channel A is displayed as a single trace.
 - CH B** Only the input signal to Channel B is displayed as a single trace.
 - A & B** Dual trace operation; both the Channel A and Channel B input signals are displayed on two separate traces.
 - A + B** The waveforms from Channel A and Channel B inputs are added and the sum is displayed as a single trace.
 - A - B** The waveform from Channel B is subtracted from the Channel A waveform and the difference is displayed as a single trace. If only a Channel B input is present, the display is inverted.
20. **Channel A VOLTS/CM** switch. Vertical attenuator for Channel A which provides coarse adjustment of vertical sensitivity. Vertical sensitivity is calibrated in 11 steps

OPERATOR'S CONTROLS, INDICATORS AND FACILITIES

- from .01 to 20 volts per cm when VARIABLE control 21 is set to the CAL position.
21. Channel A **VARIABLE** control. Vertical attenuator adjustment provides fine control of vertical sensitivity. In the extreme clockwise (CAL) position, the vertical attenuator is calibrated.
 22. Channel A **DC-GND-AC** switch.

DC	Direct input of AC and DC component of input signal.
GND	Opens signal path and ground input to vertical amplifier. This provides a zero-signal base line, the position of which can be used as a reference when performing DC measurements.
AC	Blocks DC component of input signal.
 23. Channel A **INPUT** jack. Vertical input jack of Channel A.
 24. Channel A **DC BAL** adjustment. Vertical DC balance adjustment for Channel A trace.
 25. Channel A **POSITION** control. Vertical position adjustment for Channel A trace.
 26. **ASTIG** adjustment. Astigmatism adjustment provides optimum spot roundness when used in conjunction with the **FOCUS** control 27 and **INTENSITY** control 28. Very little readjustment of this control is required after initial adjustment.
 27. **FOCUS** control.
 28. **INTENSITY** control. Adjusts brightness of trace.
 29. Fuse holder.
 30. AC line cord. CSA-approved for oscilloscopes.
 31. **INT MOD** jack. Intensity modulation (Z-axis) input.
 32. Combination carrying handle and tilt stand.
 33. Probe (see Fig. 3). The B & K-Precision Model PR-35 combination 10:1/Direct probe has been designed for use with this oscilloscope. However, any probe designed for use with an oscilloscope having a nominal input impedance of 1 megohm shunted by 27 pF and capable of operation up to 15 MHz, can be used.
 34. Vector Overlay (not shown). Interchanges with scale for vectorscope operation.

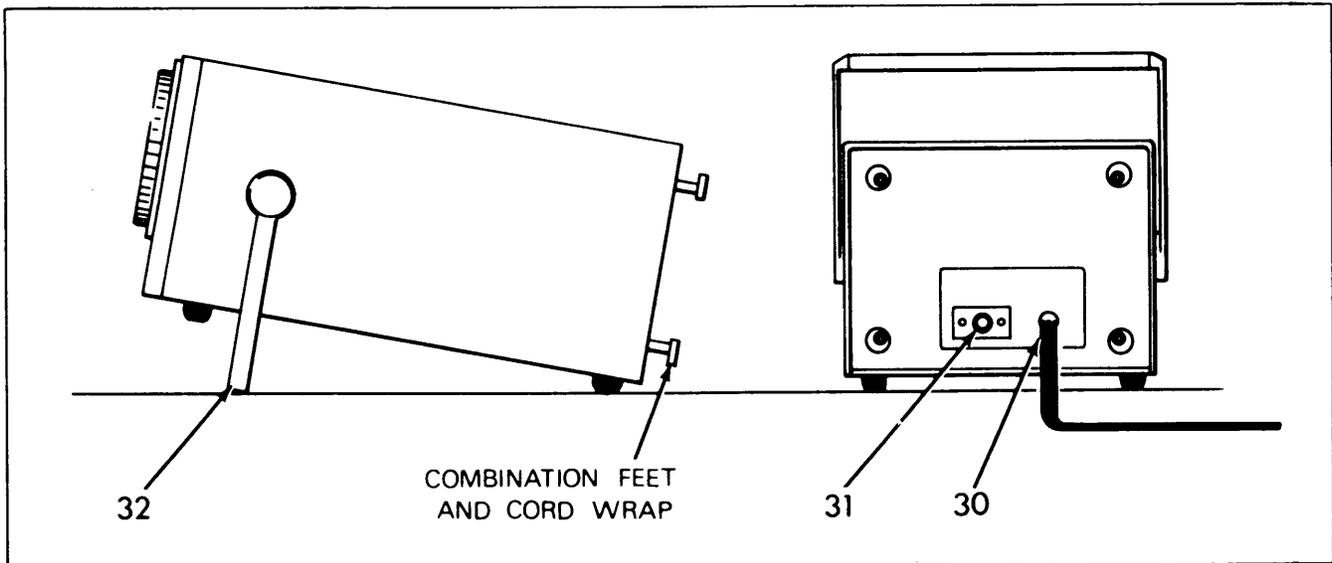


Fig. 2. Rear and side panel facilities.

SPECIFICATIONS

VERTICAL AMPLIFIERS (CH A and CH B)

Deflection factor	0.01 V/cm to 20 V/cm, $\pm 5\%$, in 11 ranges each providing for fine adjustment.
Frequency Response	DC: DC to 15 MHz (-3 dB) AC: 2 Hz to 15 MHz (-3 dB)
Risetime	24 nanoseconds.
Overshoot	3% or less.
Input Resistance	1 megohm (approximate).
Input Capacity	22 pF (± 3 pF).
Tilt	Less than 5%.
Max. Input Voltage	300 V (DC + AC peak) or 600 V p-p.
Operating Modes	Channel A only. Channel B only. A & B (dual trace); trace automatically chopped at all sweep times of 1 mS/cm and slower; alternate trace automatically selected for all faster sweep times. A + B (single-trace algebraic sum of Channels A and B). A - B (single-trace algebraic difference of Channels A and B).
Chop Frequency	200 kHz ($\pm 20\%$)
Channel Separation	Better than 60 dB.

SWEEP CIRCUITS (Common to CH A and CH B)

Sweep System	Triggered and automatic. In automatic mode, sweep is obtained without input signal.
Sweep Time	0.5 μ SEC/cm to 0.5 SEC/cm ($\pm 5\%$) in 19 ranges, in 1-2-5 sequence. Each overlapping range provides for fine adjustment.
Sweep Range of Variable Control	At least 2.5 times.
Sweep Magnification	Obtained by enlarging the above sweep 5 times from center. Maximum sweep speed becomes 0.1 μ SEC/cm.
Linearity	3% or less distortion for 0.5 SEC/cm to 2 μ SEC/cm ranges. 5% or less for 1 μ SEC/cm and 0.5 μ SEC/cm ranges.
Length of Sweep	102 mm to 110 mm.

TRIGGERING

Source	CH A, CH B and EXT: 1 V p-p sensitivity.
Slope	Positive and negative, continuously variable level control; pull for AUTO.
Triggering Range	20 Hz to 15 MHz (min. 0.5 cm deflection as measured on cathode ray tube).

TV Sync

Vertical and horizontal sync separator circuit provided so that any portion of complex TV waveform can be synchronized and expanded for viewing. TVH (line) and TVV (frame) sync switched automatically by SWEEP TIME/CM switch.
TVV = 0.5 SEC/cm to 0.1 mSEC/cm.
TVH = 50 μ SEC/cm to 0.5 μ SEC/cm.

HORIZONTAL AMPLIFIER (Horizontal input thru CH B input)

Deflection Factor	10 mV/cm (nominal).
Frequency Response	DC to 1 MHz (-3 dB).
Input Resistance	1 megohm (nominal).
Input Capacity	22 pF (± 3 pF).
Input Protection	300 V (DC + AC peak) or 600 V p-p.
X-Y Operation	With SWEEP TIME/CM switch in CH B position, the CH A input becomes the Y input (vertical) and the CH B input becomes the X input (horizontal). The CH B position control becomes the horizontal position control.

CALIBRATION VOLTAGE

1 kHz square wave of 1 V p-p ($\pm 5\%$).

INTENSITY MODULATION

Voltage	20 p-p minimum
Input Resistance	470 k Ω (nominal), $\pm 20\%$

POWER REQUIREMENTS

Input	120 VAC, 50/60 Hz, 23 watts. (3-wire line cord, CSA-approved for oscilloscopes.)
Regulation	108 to 132 VAC.

MISCELLANEOUS

Scale	Variable illumination.
Mechanical Features	Carrying handle for tilt stand.

PROBES

Model No.	PR-35 (two required).
Attenuation	Combination 10:1 and direct.
Input Impedances	10:1 = 10 megohms, 18 pF. Direct = 1 megohm, 120 pF.
Connector	BNC
Tip	Spring-loaded hook-on tip.

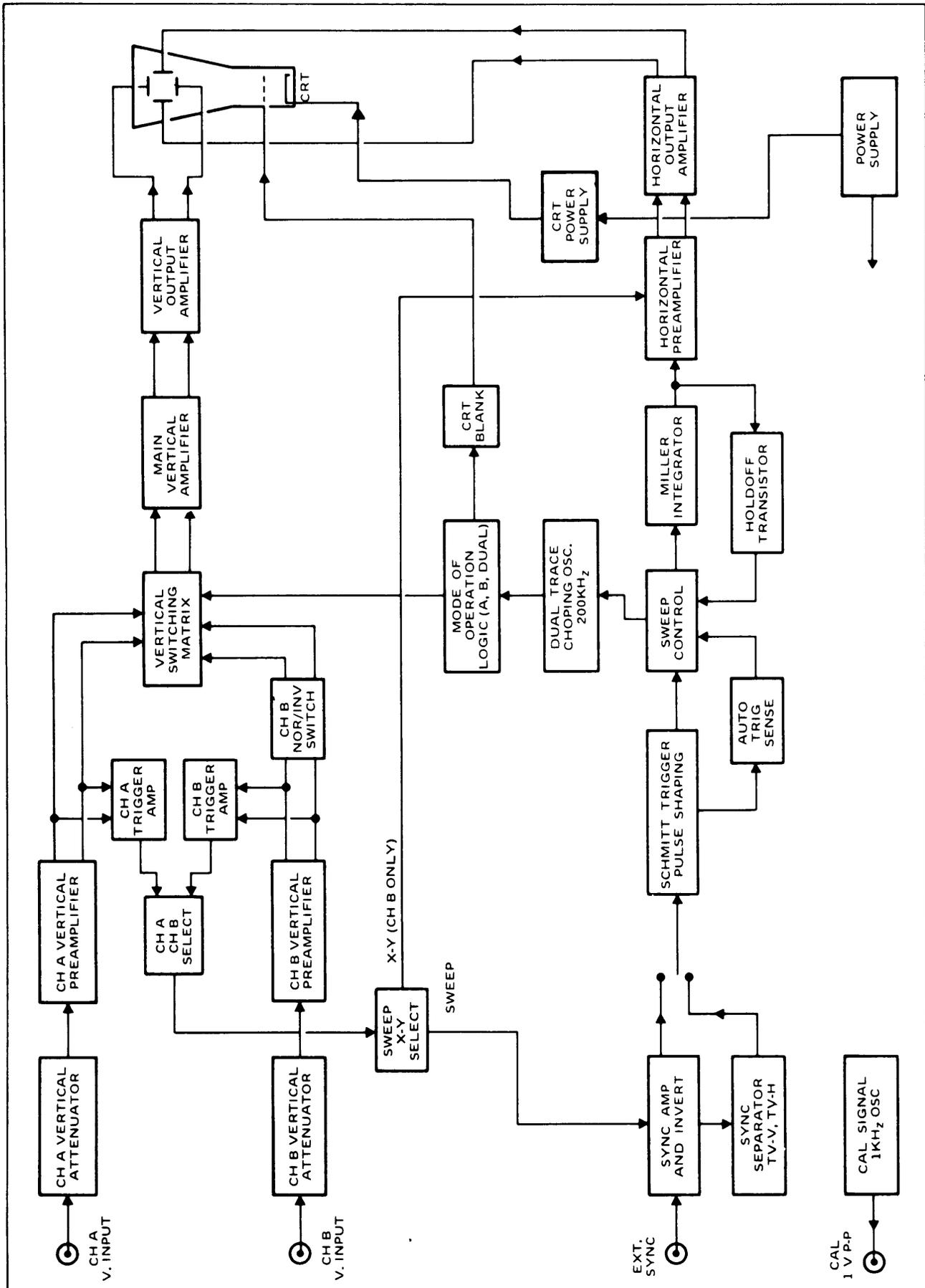


Fig. 3. Block diagram, Model 1472 Dual-Trace Oscilloscope.

CIRCUIT DESCRIPTION

The block diagram, Fig. 3, outlines the circuit breakdown of the oscilloscope. Circuit details are obtained by reference to the schematic diagram.

GENERAL

Basically, the oscilloscope consists of two identical vertical preamplifiers, each having its own input attenuator network. The outputs of the vertical preamplifiers can be switched, as desired, into the main vertical amplifier. The type of switching of the CH A and CH B preamplifiers is determined by the position of the MODE switch and MODE of OPERATION LOGIC. The main vertical amplifier feeds the VERTICAL OUTPUT AMPLIFIER, which drives the vertical deflection plates of the CRT.

Horizontal deflection is provided by the horizontal amplifier. Drive to the horizontal amplifier is furnished by calibrated sweep speed circuits or by the signal from the CH B preamplifier when X-Y operation is selected.

All supply voltages are fully regulated and a DC-to-DC converter provides a regulated 2kV accelerating potential to the CRT.

VERTICAL PREAMPLIFIERS

Channel A and Channel B preamplifiers contain identical circuitry and circuit operation is the same for both.

The vertical attenuator has two sections. The first section of the attenuator provides ratios of 1:1, 10:1, 100:1, 1000:1. The second section provides ratios of 2:1 and 5:1. The combined effect of the two sections is to provide the vertical attenuator ratios in a 1-2-5 sequence.

The vertical preamplifier consists of FET input transistors Q102 and Q103 and transistors Q104 thru Q109. FET's Q102 and Q103 form a balanced differential amplifier pair with output signals of opposite polarity. VR101 is the front panel DC balance control and VR112 an internal balance control. The output of Q102 and Q103 is applied to emitter followers Q104 and Q105 which lower the output impedance to drive conventional amplifier stage Q106 and Q107. VR105 and VR106 are balance pots for the 1/2 and 1/5 attenuator positions. The VARIABLE control adjusts the gain of Q106 and Q107 while VR101 provides a DC component to move the trace vertically across the screen. Amplifier gain is adjusted by VR107 in the emitter circuit of Q108 and Q109 to provide the correct deflection factor for accurate voltage measurements.

The trigger amplifier Q119 and Q120 amplifies the signal at the emitter of Q108 and Q109 and provides a portion of the signal to the trigger circuits.

The only difference between CH A and CH B preamplifiers is that the MODE switch reverses the polarity of the CH B signal when in the A-B position.

MODE LOGIC

The mode of operation (CH A, CH B, A & B, A + B, A - B) is controlled by IC101 and IC102 and diodes D101 - D108 in each of the channel preamplifiers.

When CH A is selected, the output of IC102 Pin 3 is low, which reverse-biases D102 and D103 and forward-biases D101 and D104, allowing the CH A signal into the main vertical amplifier. At the same time IC102 Pin 11 output is

high which forward-biases D106 and D107 and reverse-biases D105 and D108 prohibiting CH B signal from the main amplifier. For CH B, the reverse is true. When A & B is selected, both channels are alternately switched by IC101 at a rate equal to the chopping oscillator frequency (200kHz). For A + B and A - B, both channels are simultaneously applied to the main amplifier. When X-Y operation is selected, CH A is turned on and CH B is switched to the horizontal amplifier.

VERTICAL AMPLIFIER

The selected signal from the preamplifiers is then applied to the vertical amplifier which consists of Q123, Q124 and IC103. The signal level is increased to drive the output amplifier.

The output amplifier consists of transistors Q301 thru Q306 where the signal is amplified to the levels required to drive the vertical deflection plates of the CRT.

TRIGGER CIRCUIT

The trigger source, either CH A or CH B, is selected by SW201. Selecting CH A as the source enables trigger amplifier Q119 and Q120 and CH B enables trigger amplifier Q121 and Q122. The trigger amplifier selected is fed thru transistor switch Q219. Q219 is on in all positions of the SWEEP TIME/CM switch except CH B.

SYNC AMPLIFIER AND INVERTER

Transistors Q201, Q202, Q203, and Q204 are connected as a differential amplifier. The trigger signal is applied to emitter follower Q201 and routed to the base of Q202 or Q203 depending upon the position of the SYNC switch, SW202, + or - respectively. Emitter follower Q204 adds a DC level to the trigger signal depending upon the position of the TRIGGER LEVEL control.

When TV+ or TV- is selected, the output of Q203 is routed to the SYNC SEPARATOR circuit consisting of Q205 and Q206. Q205 is biased near cutoff. Q205 is held cutoff by the negative voltage developed across Q205 corresponding to an average value of the input signal. Positive-going pulses drive Q205 out of cutoff. The output of Q205 corresponds to the sync tips of the composite video signal.

When in TVV positions of time base switch (.1mS to .5 SEC), capacitor C207 is switched in by Q206 to filter out the horizontal sync pulses.

The trigger signal passes thru emitter follower Q207 and the SCHMITT TRIGGER circuit consisting of two gates of IC201. The output pulses from IC201 PIN 8 clock the SWEEP CONTROL flip-flop IC202. On the negative edge of the clock waveform, the Q output goes low, turning off Q213 to initiate to sweep.

Transistors Q216 and Q216 and the timing capacitors and resistors selected by the SWEEP TIME/CM switch form a MILLER INTEGRATING circuit to provide a linear ramp voltage. The sweep ramp from the collector of Q217 is fed to the RS flip-flop consisting of two gates from IC201 thru transistor Q211 and Q212.

As soon as the Q output of IC202 goes low, the reset of IC202 is held low by Q211 to exclude any new clock pulses until the sweep ramp is terminated. Transistor Q212 turns on and sets pin 13 of IC202 LOW which turns Q213 on and terminates the sweep.

CIRCUIT DESCRIPTION

Transistors Q208, Q209, and Q210 form the AUTO TRIGGER SENSE switch. When the TRIG LEVEL control is adjusted so that the slope is not triggered, transistor Q8 and Q9 produce pulses which keep Q210 ON. The on condition is applied to the RESET of IC202. A low on the reset of IC202 allows a sweep to recirculate at a rate determined by the resistor and capacitor selected by the TIME/CM switch.

The sweep ramp from the collector of Q217 is applied to the input of the horizontal amplifier consisting of Q218, Q220, Q221 – Q225.

When in the CH B position of SWEEP TIME/CM switch, mode, transistor Q219 is turned off thru IC203 and the CH B signal is applied to Q220 and to the horizontal amplifier. The output of transistors Q224 and Q225 is applied to the horizontal deflection plates of the CRT.

SERVICING

WARNING

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HOUSING REMOVAL

1. Remove five Phillips head screws, one from each side, one from top, and two from bottom of housing.
2. Slide complete oscilloscope chassis out through the front of the housing.

CRT TILT

WARNING: Keep hands away from CRT socket. High voltage (2000 VDC) present.

1. Remove housing.

2. Loosen the two screws which clamp the band around the neck of the CRT.
3. Turn on the oscilloscope and adjust controls to obtain a single trace.
4. Grasp the CRT through the finger holes in the shield toward the front of the CRT and rotate the CRT so the trace is parallel with a horizontal line on the graticule.
5. Tighten the CRT band, making sure that the trace remains horizontal.

SERVICING

230 VAC OPERATION

1. Remove housing from scope.
2. Remove voltage selector plug (see Fig. 8).
3. Rotate plug 180° and re-insert plug.
4. Replace 0.7A fuse with 0.3A fuse.
5. Replace housing.

GRATICULE REMOVAL (see Fig. 4)

1. Grasp bezel with both hands at top and bottom. Pull bezel uniformly forward to unlock mounting legs from front panel. Caution should be used to keep bezel parallel to front panel when removing, to avoid breakage of mounting legs.

2. Lift off graticule from bezel.
3. Reinsert graticule on bezel and snap bezel into front panel mounting holes.

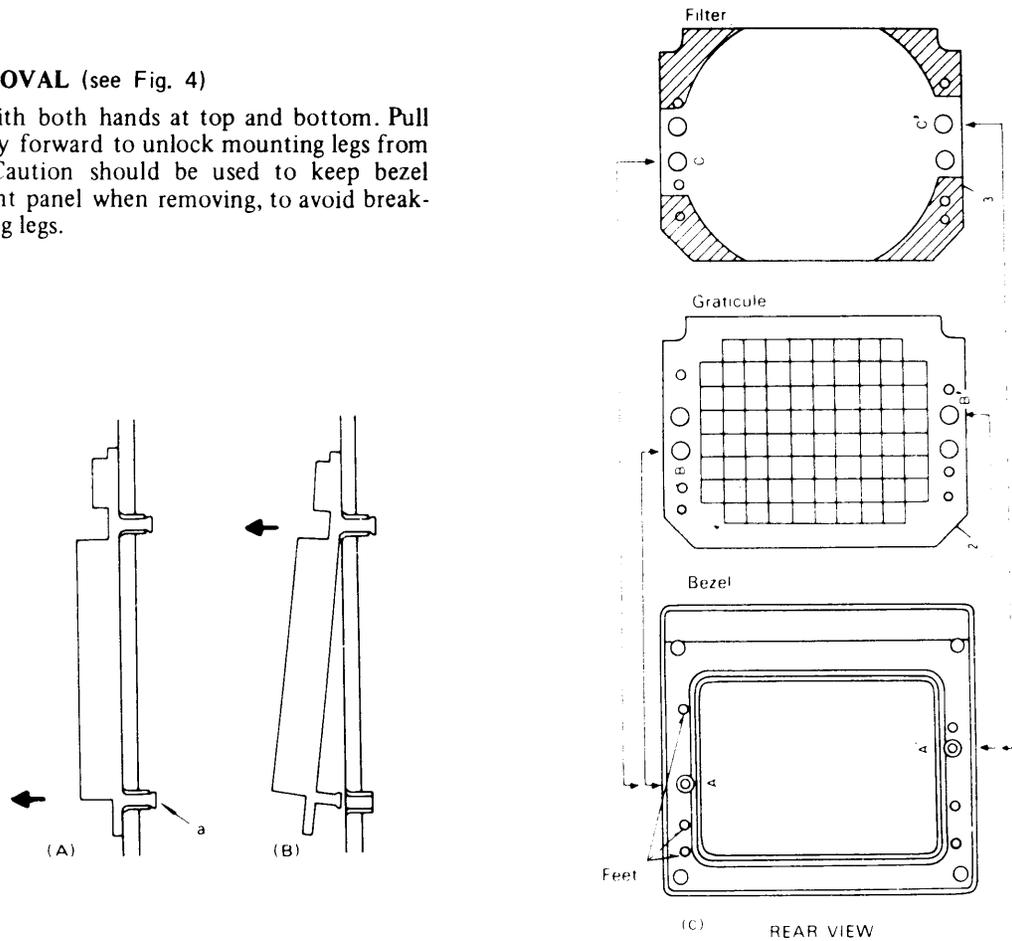
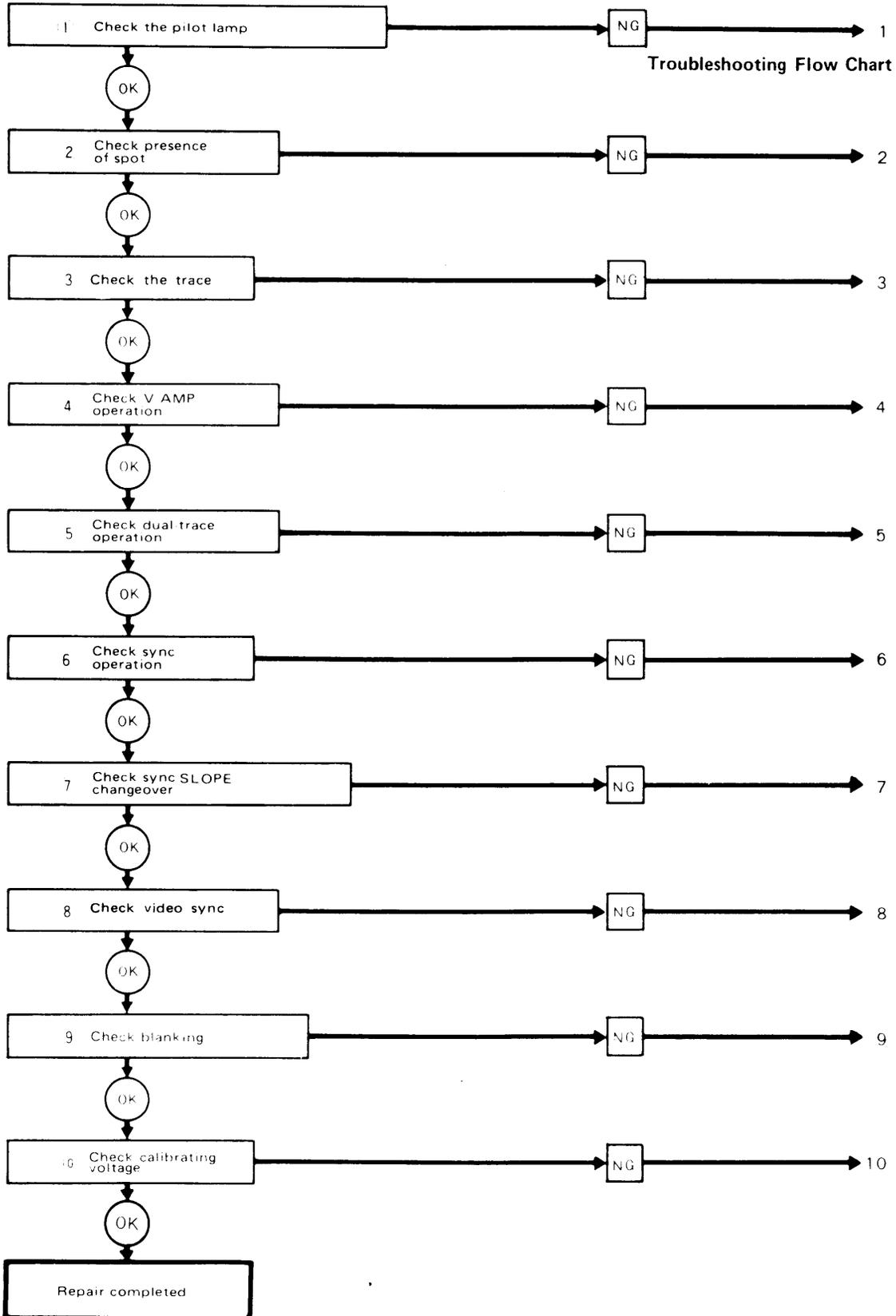


Fig. 4 Removing the Bezel

TROUBLESHOOTING

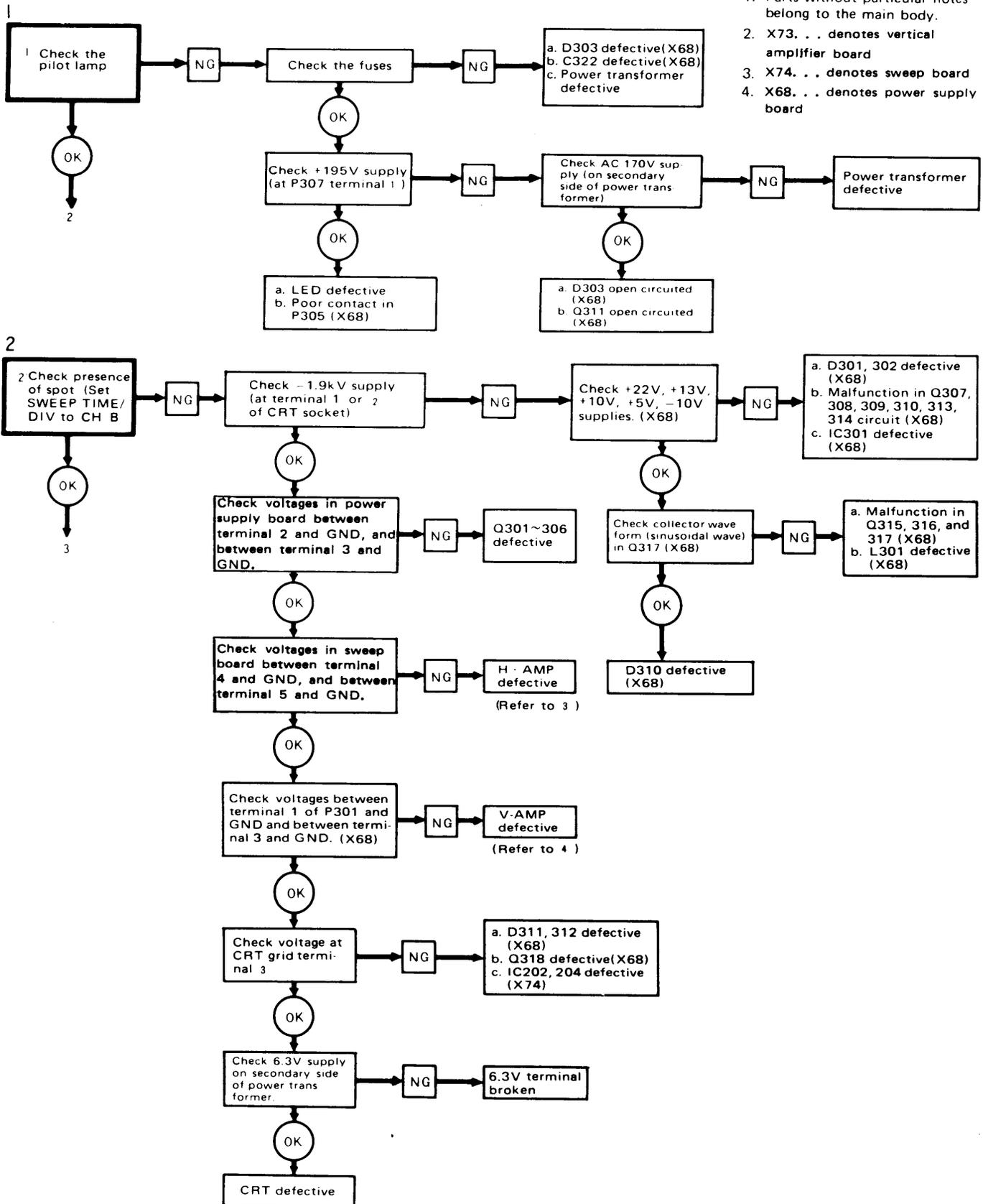
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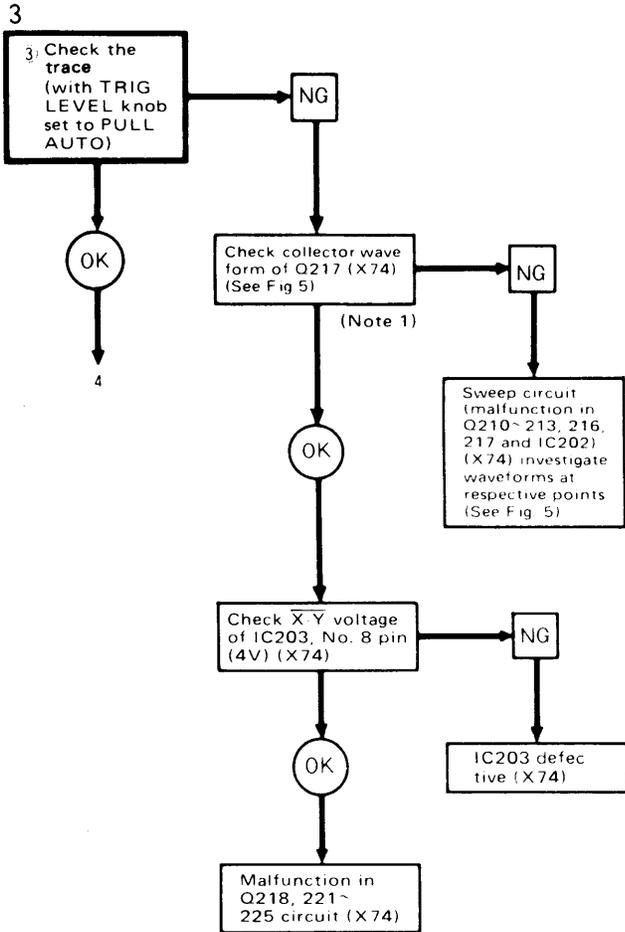
Notes:

1. Parts without particular notes belong to the main body.
2. X73. . . denotes vertical amplifier board
3. X74. . . denotes sweep board
4. X68. . . denotes power supply board

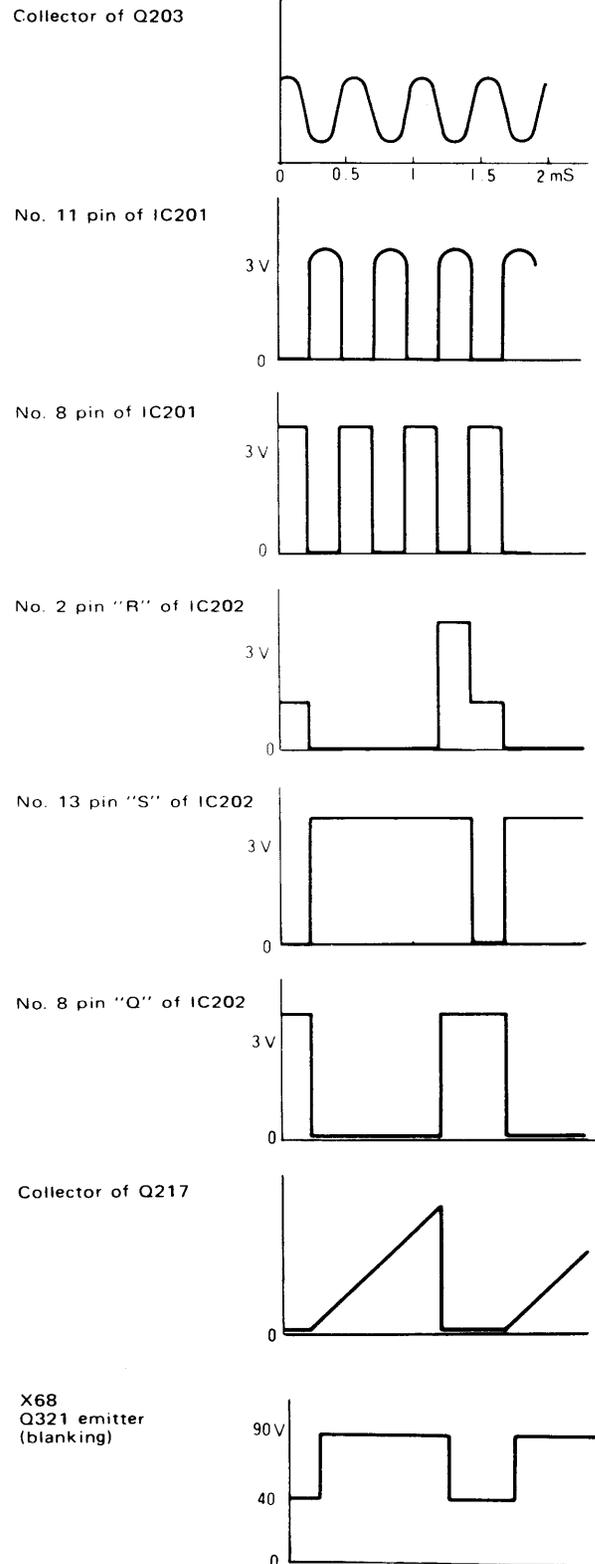


TROUBLESHOOTING

Fig. 5 Waveform in SWEEP Circuit
(Input Signal 2 kHz Sine Wave)
(SWEEP TIME 0.1mS/DIV)



Note 1:
Add sine wave of 2 kHz to CH A or CH B vertical input terminal.



TROUBLESHOOTING

Note: Add sine wave of 2 kHz to CH A or CH B vertical input terminal when checking items No. 4 ~ 9 (except No. 8).

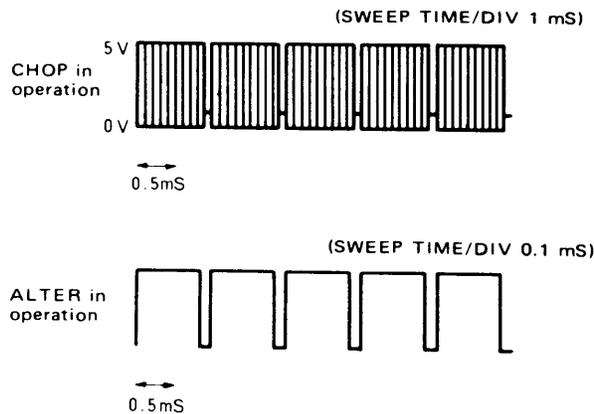
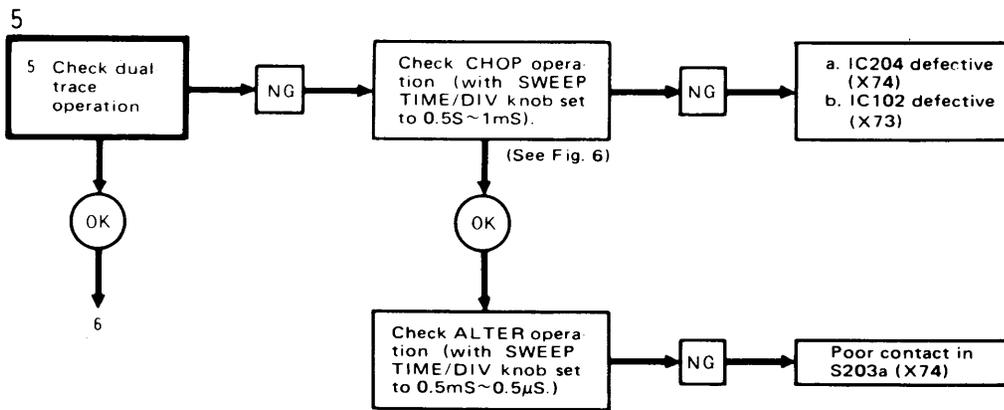
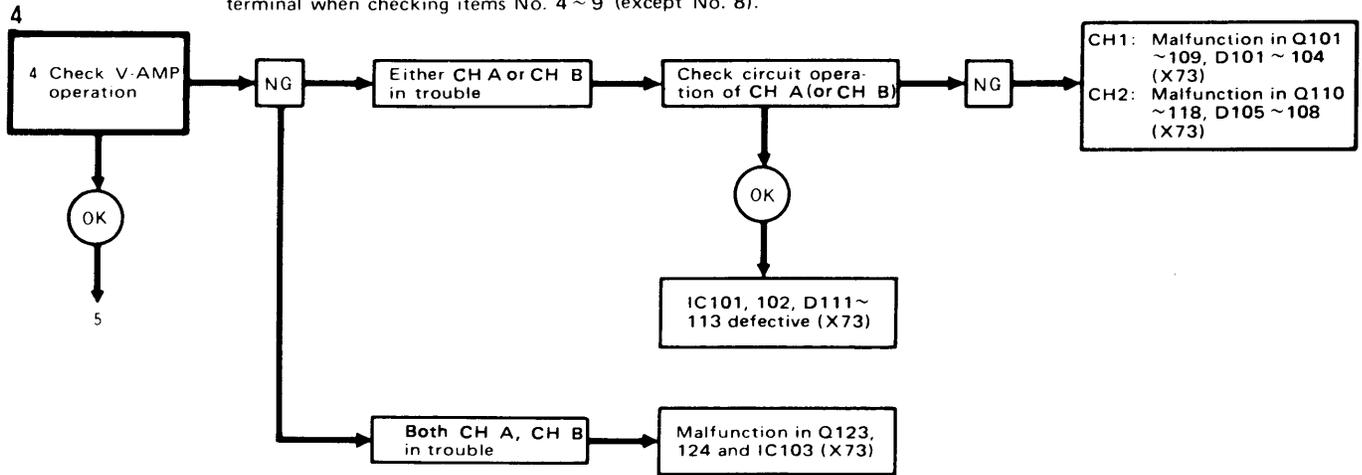
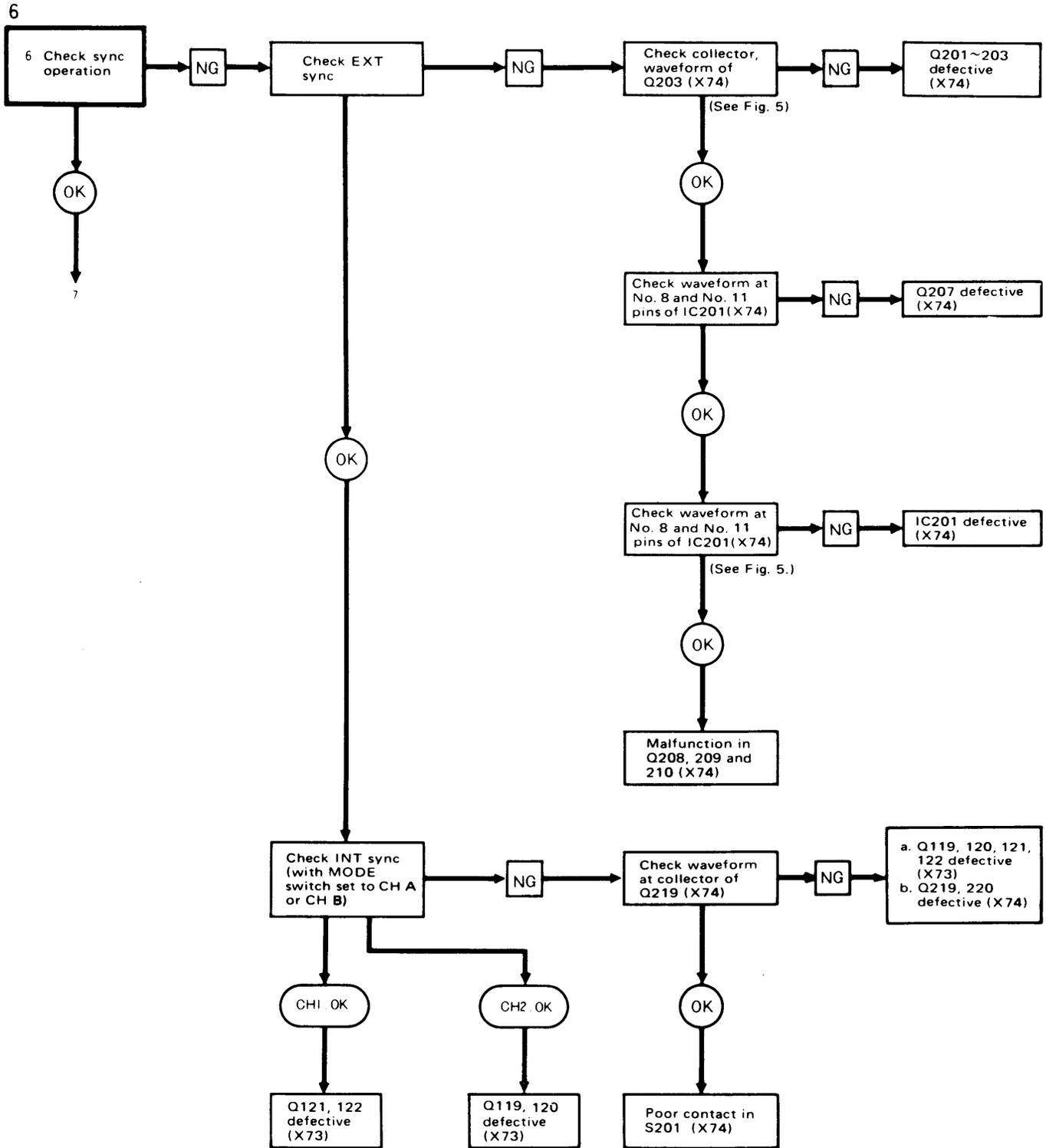
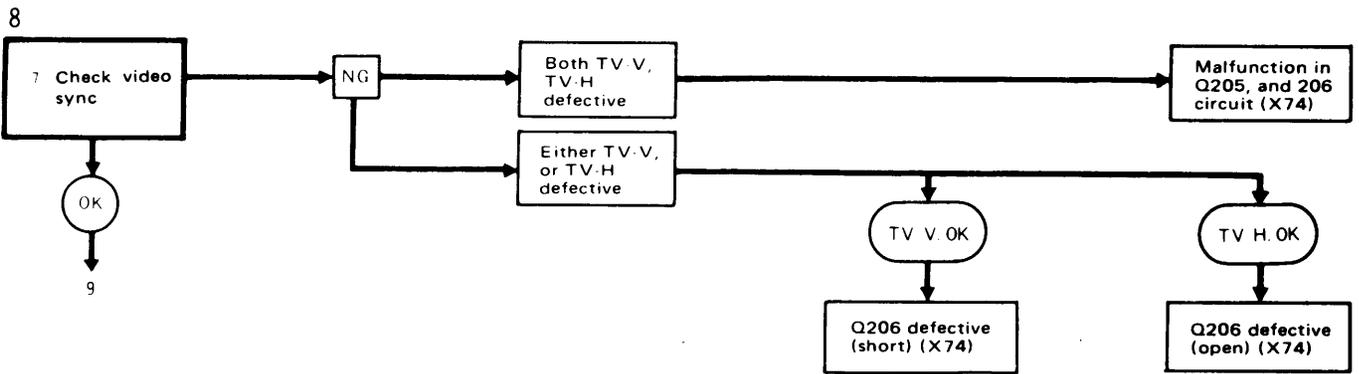
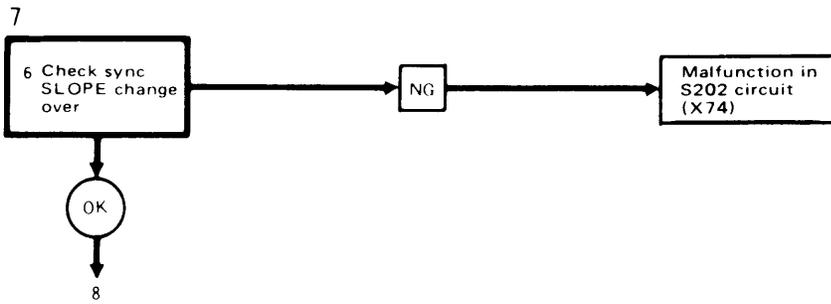


Fig. 6 Waveforms at No. 1 Pin of P102 (X73)

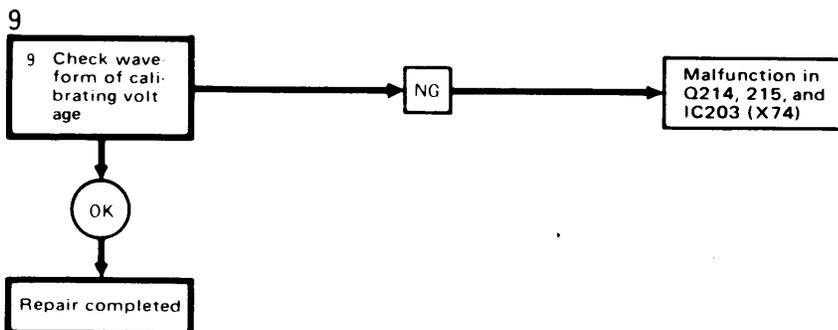
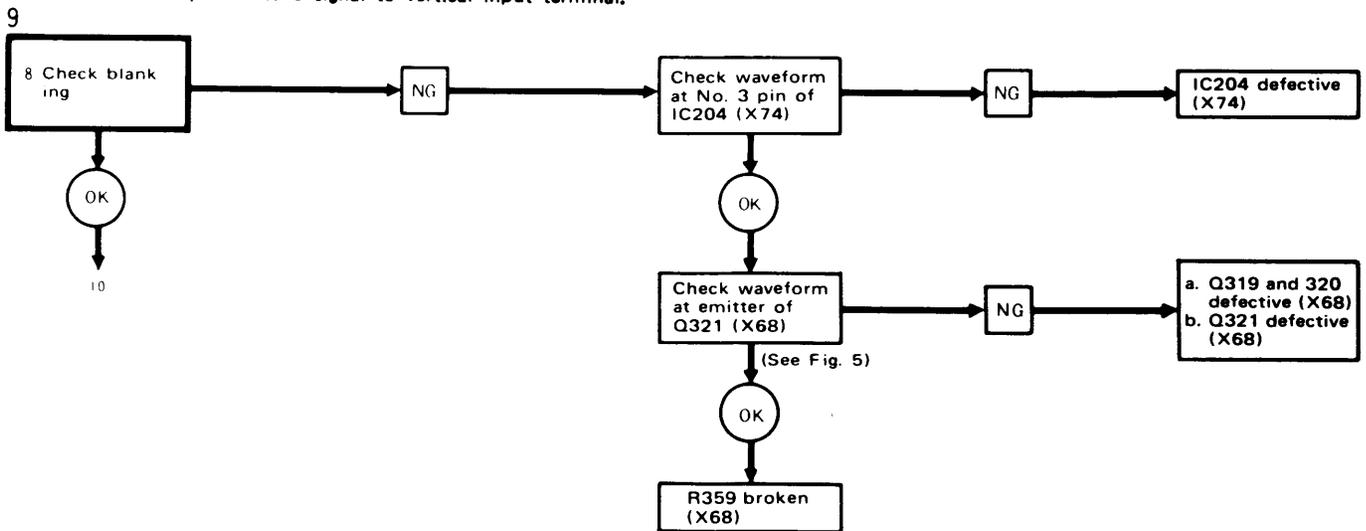
TROUBLESHOOTING



TROUBLESHOOTING



Note:
Add composite video signal to vertical input terminal.



ADJUSTMENTS

WARNING

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TEST EQUIPMENT REQUIRED

Minimum Requirements

Sine & Square Wave Generator, 20 Hz to 1 MHz, constant voltage over tuning range (B & K Precision Model E310B Sine/Square Wave Generator or Model 3010 or 3020 Function Generator)

Sine Wave Generator, 1 MHz to 15 MHz, constant voltage output over tuning range (B & K Precision Model E200D)

DC Voltmeter 1% accuracy or better. AC Voltmeter, 1% accuracy at 1 kHz, 100 mV to 100 V ranges (B&K Precision Model 2830)

Frequency Counter, 1% or better accuracy to 15 MHz (any B & K Precision Frequency Counter)

Desirable

Oscilloscope Calibrator, calibrated square wave levels of 1% accuracy at 50 mV, 0.5 V, 5 V and 50 V peak-to-peak (Tektronix Model PG506)

Marker Generator, accurate time marks at intervals of 0.1 mS, 10 uS and 0.5 uS (Tektronix Model TG501)

PRELIMINARY PROCEDURE

Observe the following before making adjustments:

1. The items given below are pre-adjusted at the factory before shipment. Should re-adjustment be required, it should be performed after calibrating the power source voltage (no adjustment is required on the probe).

ADJUSTMENTS

- All adjustments should be made with the semi-fixed resistors or the trimmers mounted on the printed circuit board. For adjustment, use a well-insulated flat-blade screwdriver.
- A high voltage (about 2000V) is present on the lower circuit board. Be sure to turn the power off before removing the bottom cover.
- For optimum adjustment, turn the power on and warm up the oscilloscope sufficiently before starting.
- Switch to .05 V/CM and adjust VR106 (CH A) or VR109 (CH B) until trace is at vertical center.

CH A AND CH B DC BALANCE

- Adjust controls to obtain a horizontal trace (CH A or CH B).
- Adjust CH A or CH B POSITION control to center the trace vertically on the CRT.
- Rotate the VARIABLE control from maximum CCW to maximum CW while observing the trace.
- If the trace moves vertically more than 5mm while performing STEP 3, adjust the CH A or CH B DC BAL (front panel screwdriver adjustment) so that the vertical movement of the trace does not exceed 5mm while performing STEP 3.

1/2 & 1/5 ATTENUATOR BALANCE

- Position trace to vertical center of screen CH A or CH B, with V ATTENUATOR in .01 V/CM and input at GND.
- Switch to .02 V/CM and adjust VR105 (CH A) or VR108 (CH B) until trace is at vertical center.

VERTICAL ATTENUATOR ADJUSTMENT (VOLTS/DIV)

- Remove the case.
- Connect a 1 kHz (output: 50 mV to 100 V p-p) square wave signal generator to the vertical input terminal.
- With VOLTS/DIV set to 0.1V, adjust the trimmer TC101 (TC107 for CHB) on the lower printed circuit board until optimum square wave is obtained.
- Successively change the range to 1V and 10V, and adjust the trimmers TC103 and TC105 (TC109 and TC111 for CHB) in the same manner.

PROBE AND INPUT CAPACITANCE ADJUSTMENT

- Set VOLTS/DIV to 0.01V.
- Set the probe to 10 : 1 and connect it to the vertical INPUT terminal. Apply a 1 kHz square wave signal to the probe and adjust its trimmer for the optimum square waveform. In this case, input voltage is attenuated to 1/10, but input resistance is increased to 10MΩ and input capacitance is reduced to less than 18pF.

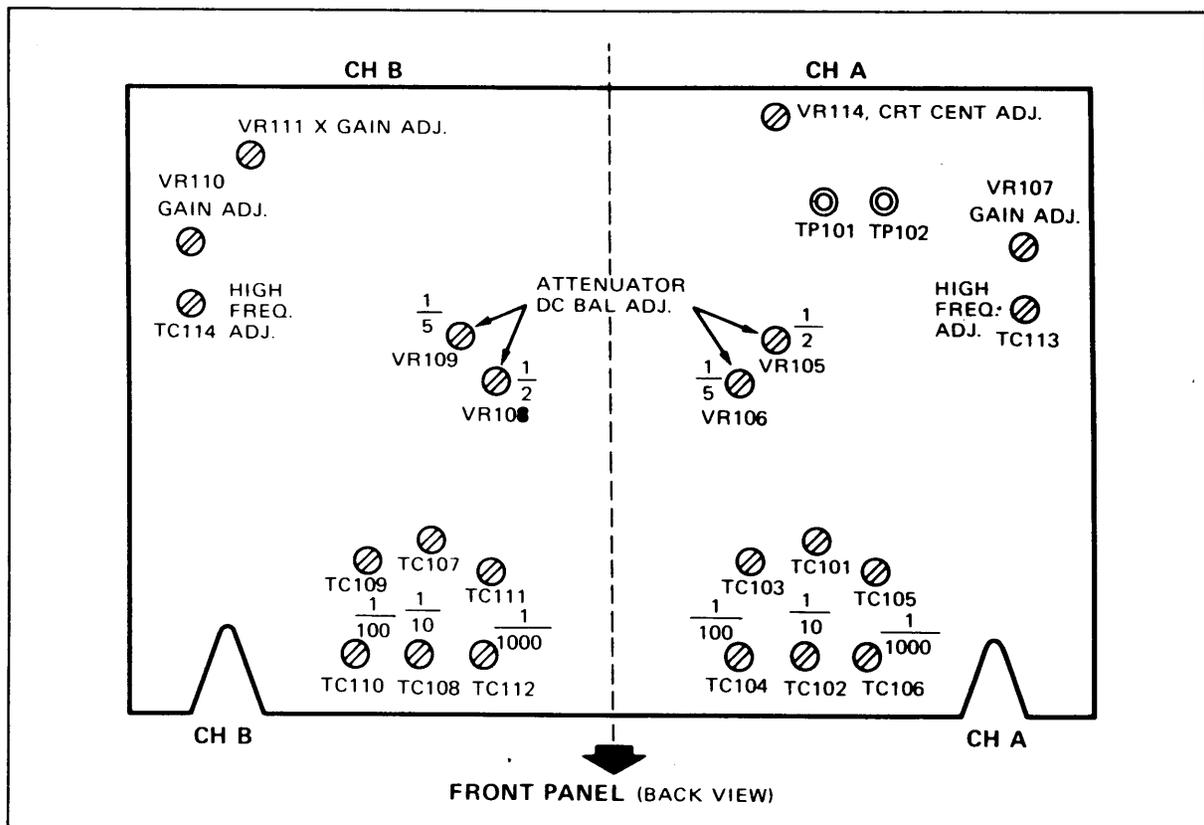


Fig. 7 Lower Printed Circuit Board (Vertical Amplifier)

ADJUSTMENTS

3. Set VOLTS/DIV to 0.1V and adjust the trimmer TC 102 (TC108 for CHB) on the lower printed circuit board so that optimum square wave can be obtained.
4. Adjust the trimmers TC104 and TC106 (TC110 and TC112 for CHB) in the 1V and 10V ranges in the same manner.

VERTICAL SENSITIVITY ADJUSTMENT

1. Remove the case according to the procedures described for REMOVING THE CASE.
2. Set VOLTS/DIV to 0.01V and turn VARIABLE fully clockwise to CAL.
3. Apply 0.05V p-p square wave signal to the vertical input.
4. Adjust VR107 GAIN ADJ (VR110 GAIN ADJ for CHB) on the lower printed circuit board to obtain 5 div of vertical amplitude.

CRT CENTERING ADJUSTMENT

1. Short the test terminals TP101 and TP102 on the lower printed circuit board.
2. With a horizontal bright line displayed in CRT, adjust VR114 on the same printed circuit board until the bright line is centered.

FREQUENCY CHARACTERISTICS AND OVERTHOOT ADJUSTMENT

1. Apply a 100 kHz square wave signal having a good rise characteristic to the input.
2. Adjust the middle range of the square wave (after rising) with TC301 on the rear printed circuit board.
3. Adjust the high range of the square wave (rising portion) with VR305 on the same printed circuit board.
4. Adjust the high range for each channel; for CHA with TC113 on the lower printed circuit board, and for CHB with TC114.

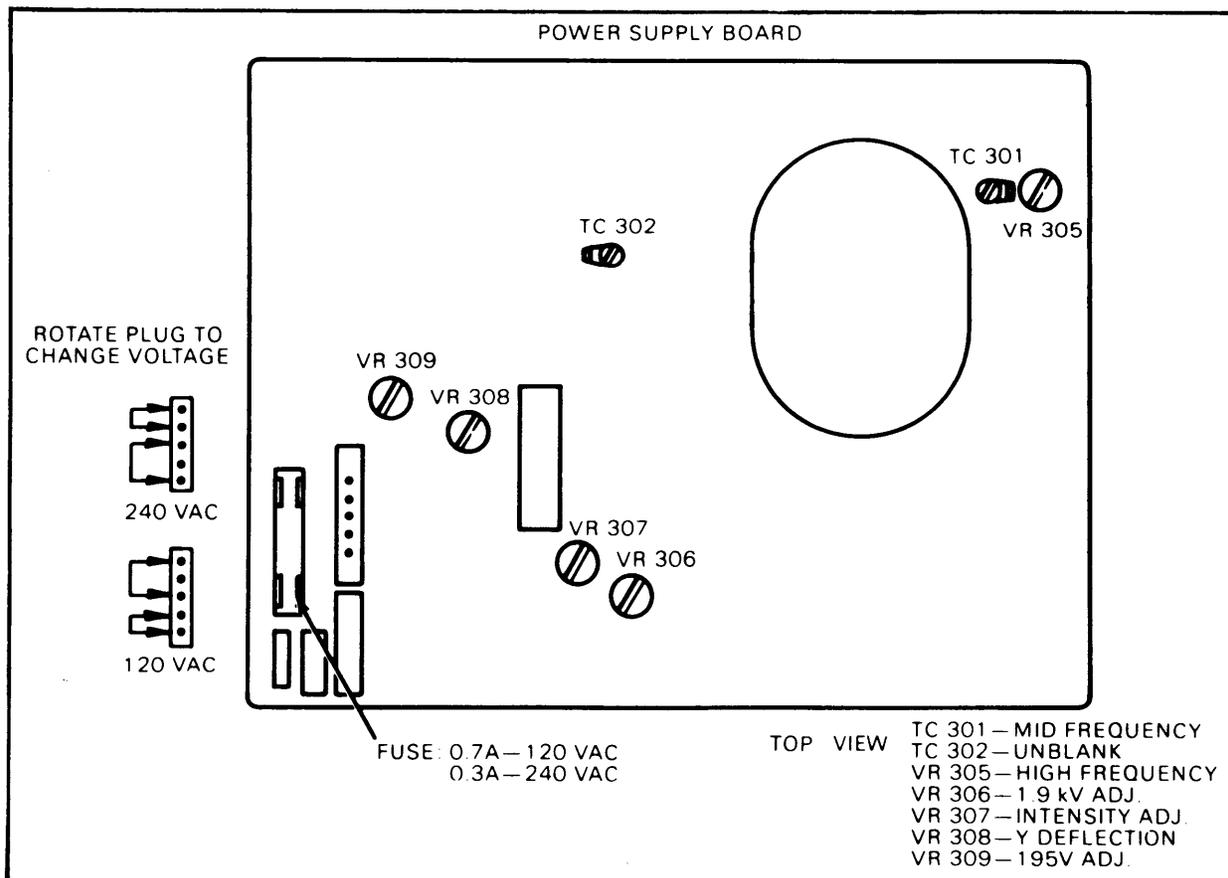


Fig. 8. Rear Printed Circuit Board (Power Supply)

ADJUSTMENTS

SWEEP TIME (HORIZONTAL SENSITIVITY) AND BRIGHT LINE LENGTH ADJUSTMENT

1. Remove the case.
2. Set SWEEP TIME/DIV to 0.1ms and turn VARIABLE fully clockwise to CAL.
3. Apply a 1 kHz frequency-calibrated sinusoidal wave signal to the input and adjust each POSITION so that the waveform is centered vertically and its starting point is positioned to the extreme left of the scale.
4. Adjust VR207 (TIME ADJ) on the side circuit board within the case so that 1 cycle of the 1 kHz sinusoidal wave corresponds to 10 div on the scale. At that time, length of the horizontal bright line will also vary. Adjust it with VR204 (LENGTH ADJ) on the same printed circuit board. Since the VR204 adjustment merely varies the end position of the waveform, length of the bright line can be adjusted without affecting the starting point and the sweep time. During this adjustment, manipulate ◀▶ POSITION and TRIG LEVEL in order to hold the starting point always in the center of the extreme left of the scale.
5. The above adjustment applies to the ranges of 0.1s to 0.1ms. For the ranges of 50 μ s to 0.5 μ s, the variable resistors VR204 and VR207 should not be moved on the printed circuit board. Instead, trimmers TC201 and TC202 (side printed circuit board) should be adjusted for the ranges of 10 μ s and 0.5 μ s as shown in Table 1.

Table 1

SWEEP TIME/DIV	Input frequency	Trimmers on side printed circuit board
10 μ s	10 kHz	TC 201
0.5 μ s	200 kHz	TC 202

X 5 MAG ADJUSTMENT

1. Set SWEEP TIME/DIV switch to 1ms and apply a 1 kHz sinusoidal wave signal to the vertical input.
2. Adjust the oscillator frequency and ◀▶ POSITION to obtain 11 peaks of the waveform. Each peak should be on the vertical line on the scale.
3. With MAG switch pulled toward you, adjust VR209 (MAG ADJ) on the side printed circuit board so that the span between peaks is 5 div.

MAG CENTER ADJUSTMENT

1. Set SWEEP TIME/DIV to 0.1ms and apply a 1 kHz square wave signal to the input until 1 cycle is spread over the entire scale.
2. Set ◀▶ POSITION to its mechanical center position. (Waveform may deviate in the horizontal direction.)
3. With MAG switch pulled toward you, adjust VR208 (MAG CENT) on the side printed circuit board until the rising (or falling) portion in the center of the waveform comes to the point obtained at "X1" (MAG switch depressed).

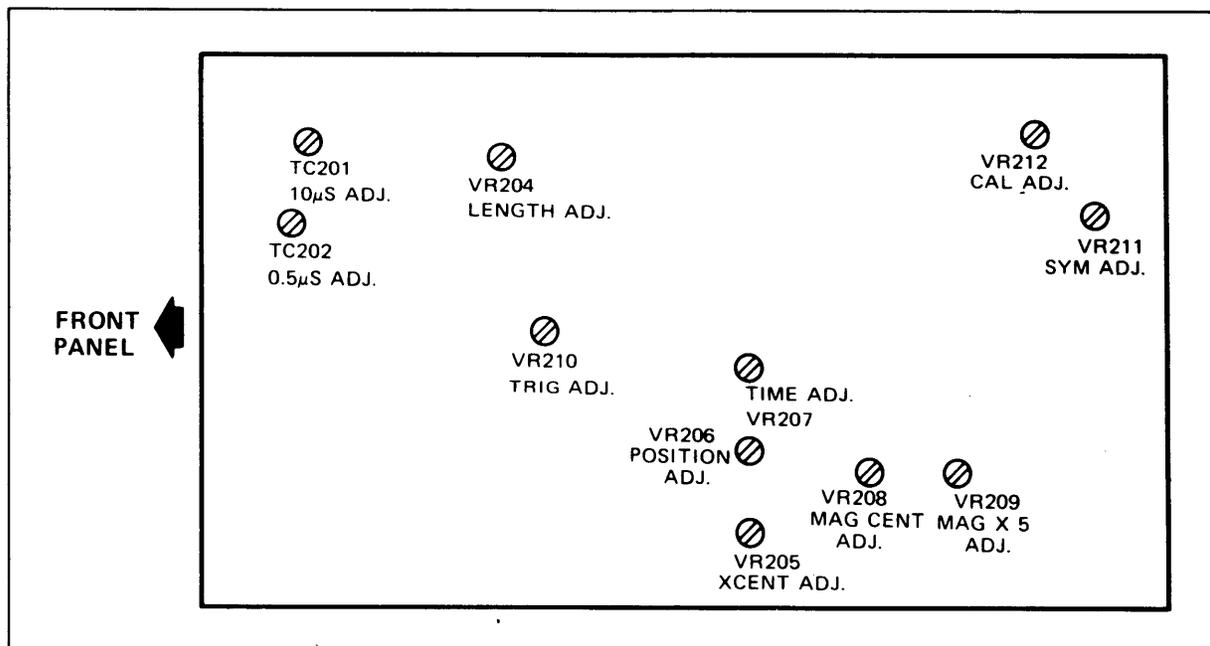


Fig. 9. Side Printed Circuit Board (Sweep Board)

ADJUSTMENTS

- Repeat this adjustment until the position of the rising (or falling) portion in the center of the waveform is not deflected regardless of the position of the MAG switch.
- Adjust VR206 (POS ADJ) on the side printed circuit board until the starting point of the waveform comes to the extreme left of the scale.

HORIZONTAL POSITION ADJUSTMENT

- To adjust the horizontal position during ordinary sweep time, set ◀▶ POSITION to its mechanical center position and adjust VR206 (POS ADJ) on the side printed circuit board until the starting point of the waveform comes to the extreme left of the scale.
- When SWEEP TIME/DIV is in CHB setting, adjust VR 205 on the same printed circuit board after the above adjustment until the spot comes to the center of the scale.

SYNCHRONIZING LEVEL ADJUSTMENT

- Apply a 1 kHz sinusoidal wave signal to the input. Set SYNC switch to SLOPE + or -.
- Adjust VR210 (TRIG ADJ) on the side printed circuit board so that the waveform can be started in the same position on the reverse slope when SLOPE is switched between + and -.

CALIBRATING VOLTAGE ADJUSTMENT

Adjust VR212 on the side printed circuit board so that 1V p-p of 1 kHz square wave calibrating output voltage can be obtained.

ASTIG ADJUSTMENT

Adjust ASTIG on the front panel to unify thickness of the waveform bright line. This adjustment is made together with FOCUS.

HIGH VOLTAGE ADJUSTMENT

- Connect a DC voltmeter having high input impedance (more than 100 MΩ) to CRT's socket terminal 1, 7, or 14.
- Adjust VR306 on the rear printed circuit board for a reading of -1.9 kV on the voltmeter.

BLANKING VOLTAGE ADJUSTMENT

- By pulling PULL AUTO, display a bright line on the CRT screen.
- Adjust VR307 on the rear printed circuit board so that the bright line disappears in 9 ~ 11 o'clock position of the brightness control knob.

195V ADJ ADJUSTMENT

Adjust VR309 on the rear printed circuit board until voltage of No. 1 pin of the connector P307 on the rear printed circuit board equals 195 volts.

VERTICAL DYNAMIC RANGE ADJUSTMENT

- Use a measuring circuit shown in Fig. 10.
- Connect the two lead wires with the terminals 10 and 12 (vertical deflection terminal) of the CRT socket.
- Set the input to GND and display the bright line in the center of the scale.
- Adjust VR308 on the rear printed circuit board until the DC voltmeter indicates 85 volts.

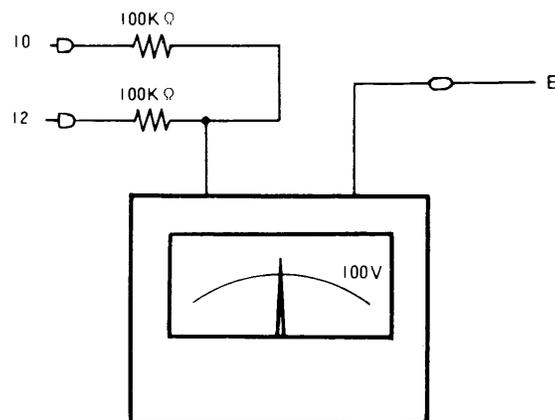
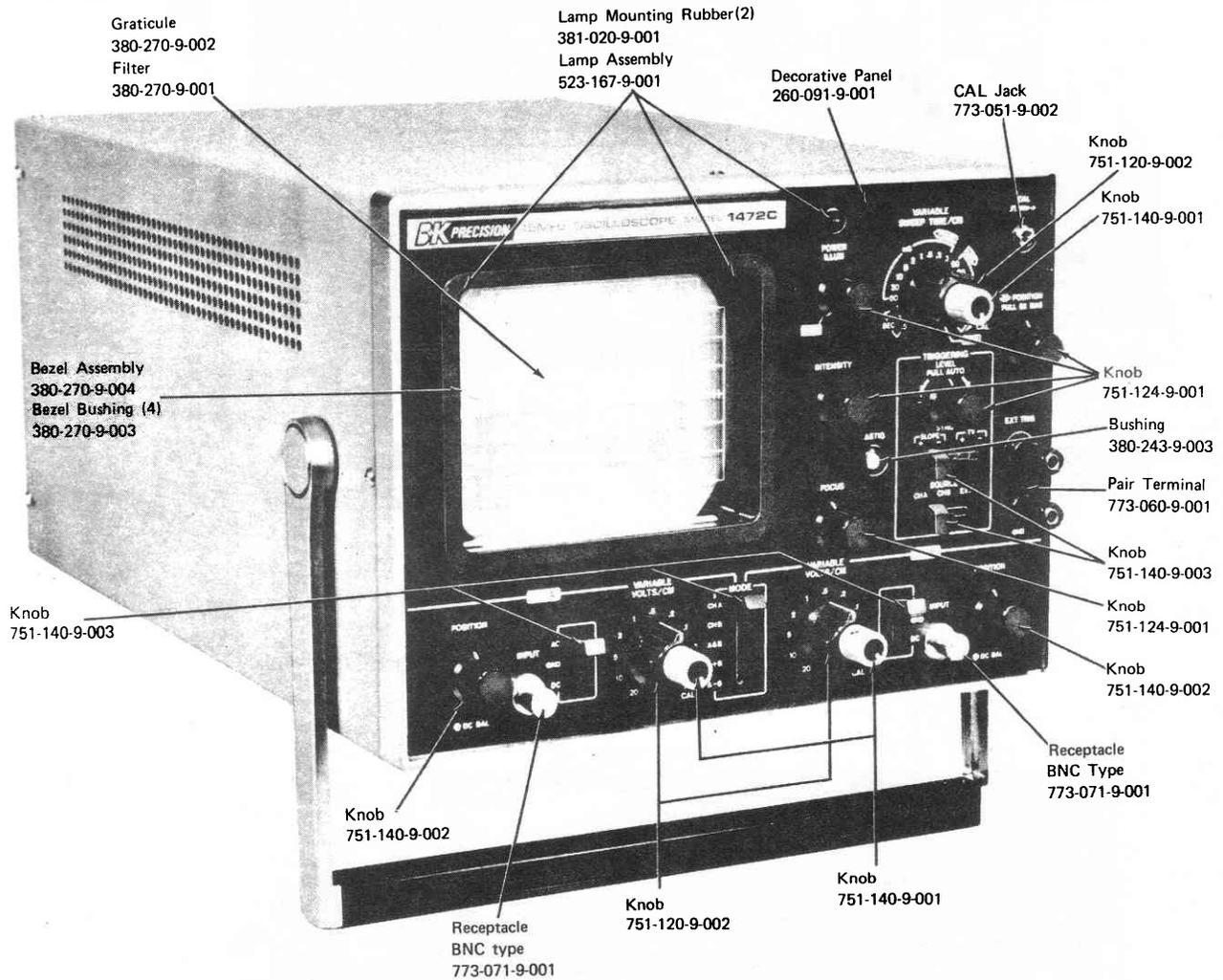


Fig. 10

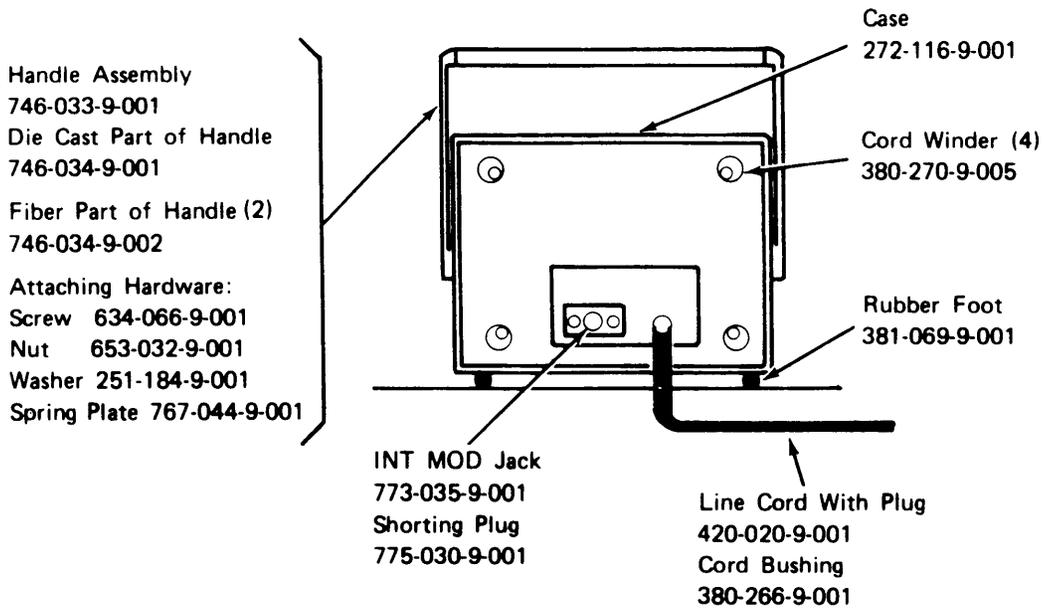
PARTS LIST

Front Panel



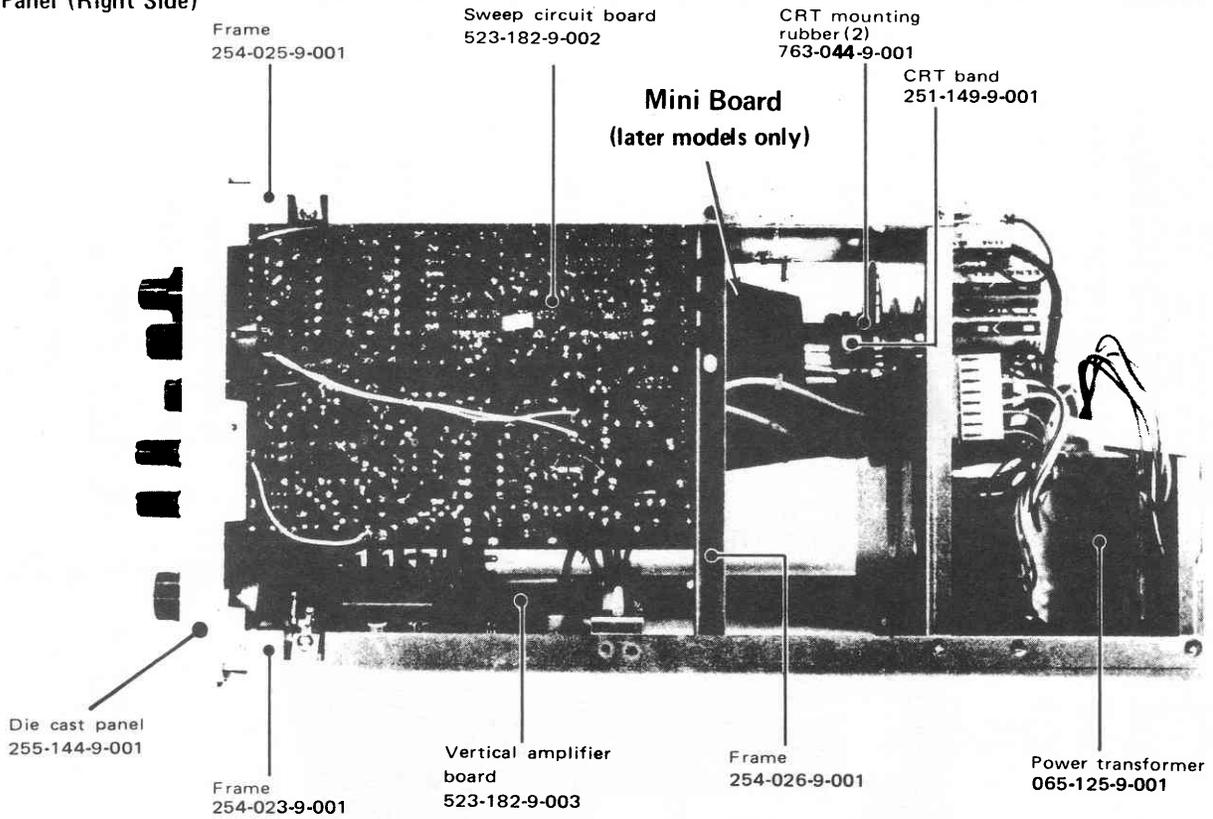
PARTS LIST

Rear Panel

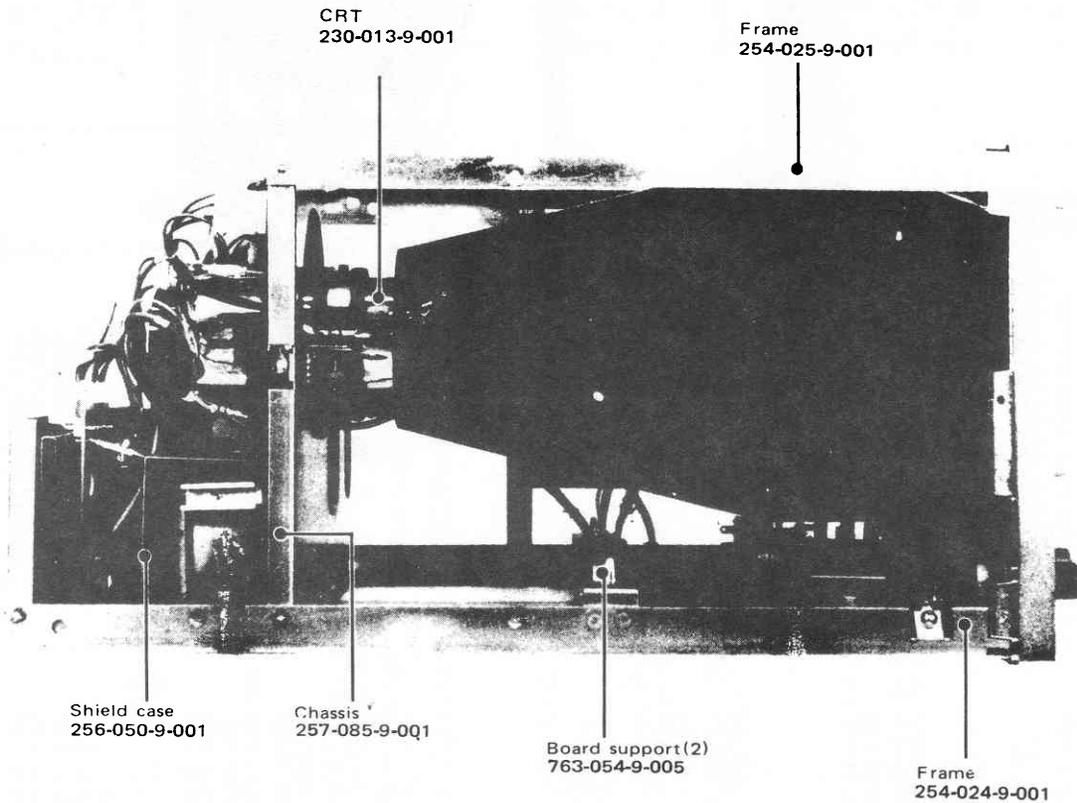


PARTS LIST

Panel (Right Side)

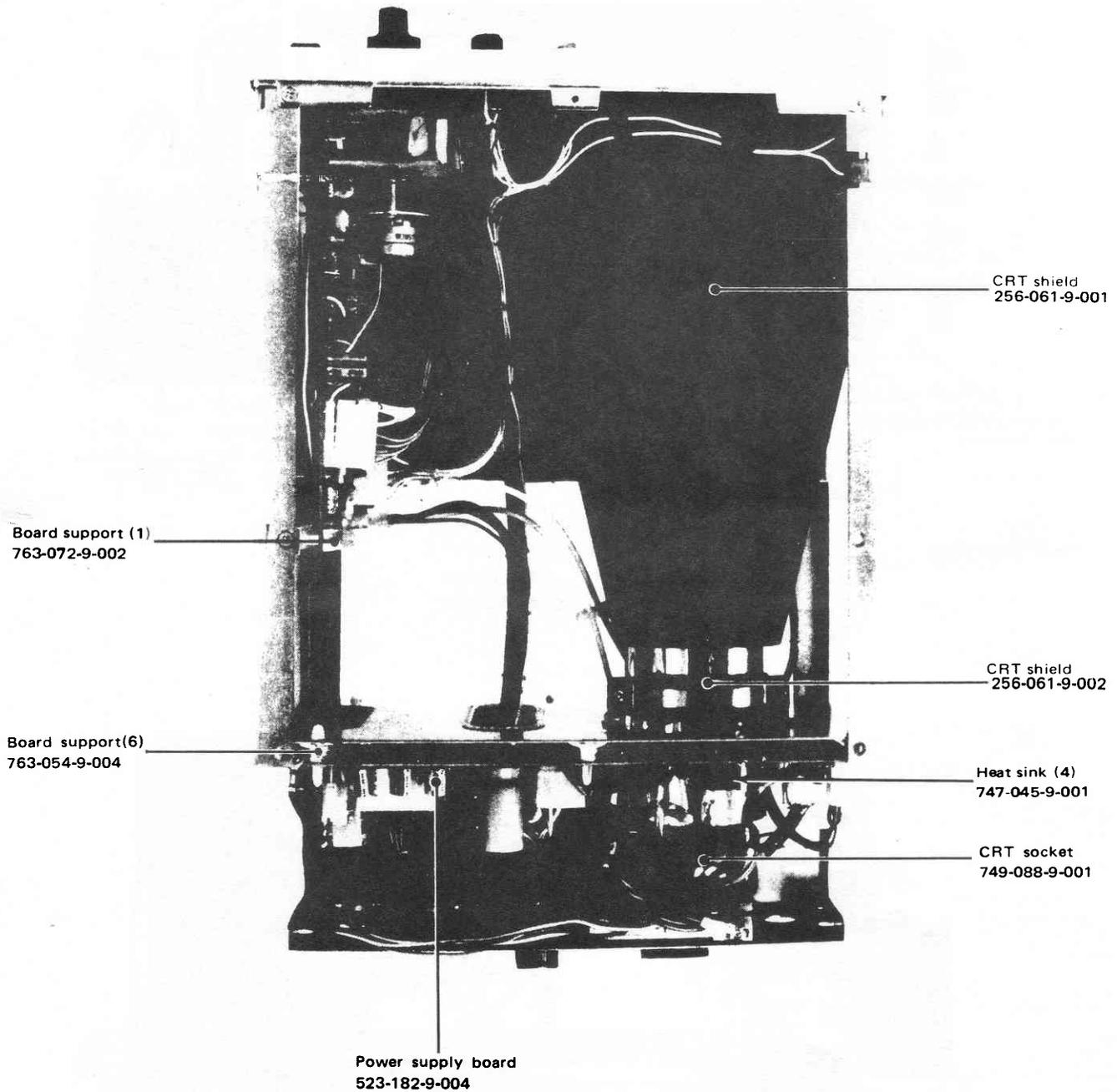


Panel (Left Side)



PARTS LIST

Chassis (Upper)



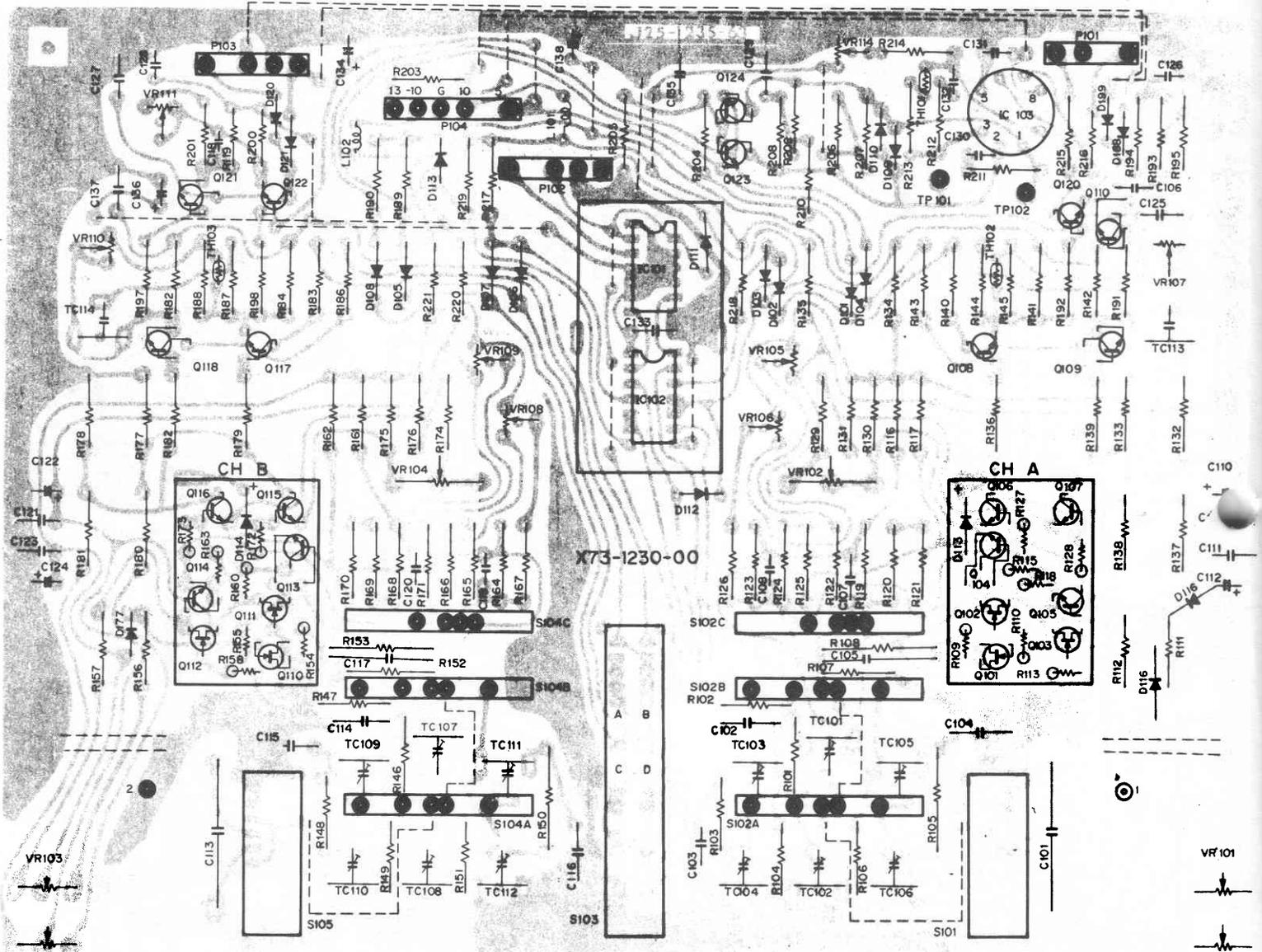
PARTS LIST

SCHEMATIC SYMBOL	DESCRIPTION	B & K PART NO.
VERTICAL AMPLIFIER BOARD		
RESISTORS & CONTROLS		
R101, 146	900K Ω , 1/2W, Metal Film	013-012-9-013
R102, 147	111K Ω , 1/4W, Metal Film	013-012-9-012
R103, 148	990K Ω , 1/2W, Metal Film	013-012-9-014
R104, 149	10.1K Ω , 1/4W, Metal Film	013-010-9-008
R105, 150	999K Ω , 1/2W, Metal Film	013-012-9-015
R106, 119, 120 151, 164, 165	1K Ω , 1/4W, Metal Film	013-010-9-004
R107, 152	1M Ω , 1/2W, Metal Film	013-012-9-003
R123, 168	2K Ω , 1/4W, Metal Film	013-012-9-010
R124, 169	500 Ω , 1/4W, Metal Film	013-012-9-009
R137, 138, 180, 181	3.9K Ω , 1/4W, Metal Film	013-012-9-011
VR101a, b 103a, b	1K Ω , 5K Ω , Variable Resistor, "Position"	008-226-9-001
VR102, S102a, b, c VR104, S104a, b, c	With switch, "Volts/CM", "Variable"	083-181-9-001
VR105, 106, 108 109, 114	47K Ω Potentiometer	008-155-9-003
VR107, 110, 111	330 Ω Potentiometer	008-291-9-004
CAPACITORS & TRIMMERS		
C110, 112, 122, 124	47 μ F, 16WV, Electrolytic	022-090-9-003
C134	220 μ F, 10WV, Electrolytic	022-126-9-001
C136, 138	100 μ F, 16WV, Electrolytic	022-073-9-003
C105, 117	4700pF, 600V, Mylar	025-110-9-005
TC101, 103, 105, 107, 109, 111, 113, 114	10pF Trimmer	028-032-9-001
TC102, 104, 106, 108, 110, 112	20pF Trimmer	028-032-9-002
SEMICONDUCTORS & IC'S		
D101-108, 111-121	Diode, Silicon	151-028-9-007
D109, 110	Diode, Silicon	151-048-9-001
Q101-103, 110-112	Transistor, Field Effect 2SK30A-O	182-040-9-001
Q104-109, 113-124	Transistor, NPN Silicon, Signal 2SC35-B	176-036-9-001
IC101	IC, TD-3472AP	307-069-9-003
IC102	IC, TD-3403AP	307-069-9-002
IC103	IC, RC733T	307-069-9-001
COILS & CHOKES		
L101, 102	47 μ H \pm 10%, Fixed Inductor	041-068-9-002
VERTICAL AMPLIFIER BOARD		
RESISTORS & CONTROLS		
R325, 326	10K Ω , 1/4W, \pm 1% Metal Film	013-012-9-005
R335	1.5K Ω , 3W, 5% Metal Film	013-012-9-007
R337	200K Ω , 1/4W, \pm 1% Metal Film	013-012-9-006
R345	15M Ω , 2W, Metal Film	004-165-9-002
VR1, S1	100 Ω Potentiometer w/switch "Illumination"	008-194-9-001
VR2	500 Ω Potentiometer "Intensity"	008-226-9-004
VR3	3M Ω Potentiometer "Focus"	008-235-9-001
VR4	250K Ω Potentiometer "Astigmatism"	008-169-9-003
VR305	1K Ω Potentiometer	008-155-9-005
VR306	68K Ω Potentiometer	008-291-9-003
VR307	47K Ω Potentiometer	008-291-9-002
VR308	4.7K Ω Potentiometer	008-291-9-001
VR309	6.8K Ω Potentiometer	008-169-9-009
CAPACITORS & TRIMMERS		
C313, 314	470 μ F, 50WV Electrolytic	022-135-9-003
C315, 326	100 μ F, 50WV Electrolytic	022-073-9-007
C316, 319, 325	47 μ F, 16WV Electrolytic	022-090-9-003
C320	1000 μ F, 10WV Electrolytic	022-126-9-002
C322, 344	47 μ F, 250WV Electrolytic	021-060-9-002
C337	1 μ F, 250WV Electrolytic	021-091-9-001
C342	100 μ F, 10WV Electrolytic	022-123-9-002
TC301	10pF Trimmer	028-027-9-001
TC302	20pF Trimmer	028-020-9-002
SEMICONDUCTORS & IC'S		
D301-303	Diode (Bridge)	157-005-9-001
D304	Diode, Zener	152-069-9-002
D305, 306, 309 316, 317, 318	Diode, Silicon	151-028-9-007
D307, 308, 315	Diode, Zener	152-069-9-001
D310	Diode, High Voltage	151-048-9-003
D311, 312, 313	Diode, Silicon	151-048-9-002
D314	Diode, Silicon	151-052-9-001
Q301, 302, 310, 313, 314, 315, 320	Transistor, NPN Silicon, Signal 2SC458-C	176-016-9-001
Q303, 304, 305, 306	Transistor, NPN Silicon, Signal 2SC1628-Y	176-055-9-005
Q307, 308, 309	Transistor, NPN Silicon, Signal 2SC1419-C	176-055-9-004
Q311, 312	Transistor, NPN Silicon, Signal 2SC1507	176-055-9-006
Q316	Transistor, PNP Silicon, Signal 2SA733-O	177-018-9-001
Q317	Transistor, NPN Silicon, Signal 2SD401M	172-039-9-001
Q318, 319, 321	Transistor, NPN Silicon, Signal 2SC983-Y	176-053-9-002
IC301	IC Linear, RC4558-T	307-099-9-005

SCHEMATIC SYMBOL	DESCRIPTION	B & K PART NO.	SCHEMATIC SYMBOL	DESCRIPTION	B & K PART NO.
COILS & CHOKES					
L301	Converter Transformer	064-017-9-001	L201	10μH, 10% Fixed	041-068-9-003
L302, 303	68μH, ±10%	041-068-9-009	L202	22μH, 10% Fixed	041-068-9-004
L304, 305	3.3μH, ±30%	041-068-9-001	L203, 204	1mH Fixed	041-079-9-002
L306	330μH, ±10%	041-068-9-005	L206, 206, 207, 209	47μH Fixed	041-068-9-002
L307	4.7μH, ±10%	041-068-9-008	L208	27μH Fixed	041-079-9-001
SWEEEP BOARD					
RESISTORS & CONTROLS					
R242	1MΩ, ½W, 1% Metal Film	013-012-9-003	S201a, b	Lever, "SOURCE"	080-003-9-004
R243	500KΩ, ½W, 1% Metal Film	013-012-9-002	S202a, b, c, d	Lever, "SYNC"	080-003-9-003
R244	300KΩ, ½W, 1% Metal Film	013-008-9-021	S203a, b, c, d w/VR203	Rotary, w/Potentiometer, "SWEEP TIME/CM", "VARIABLE"	.083-181-9-002
R245, 246	100KΩ, ½W, 1% Metal Film	013-008-9-020			
R285	549Ω, ½W, 1% Metal Film	013-012-9-001	MISCELLANEOUS		
R286, 287	12KΩ, 3W, 2% Metal Film	013-012-9-004	J1	Fuse, 0.7A (for 120 V operation)	.191-011-9-001
VR201, S205	5KΩ, w/switch; Potentiometer, "Triggering"	008-226-9-003	J3	Fuse, 0.3A (for 240 V operation)	.191-010-9-001
VR202, S204	5KΩ, w/switch; Potentiometer, "◀ Position"	008-226-9-002	J4	Fuse clip	.742-031-9-001
VR204	4.7KΩ Potentiometer	008-155-9-002	J5	Connector, 3 pin w/leads	.527-059-9-003
VR205, 211	47KΩ Potentiometer	008-155-9-003	J6	Connector, 4 pin w/leads	.527-059-9-006
VR206, 207	10KΩ Potentiometer	008-155-9-004	J4	Connector, 5 pin w/leads	.527-069-9-001
VR208, 209	150Ω Potentiometer	008-174-9-002	J6	Connector, 7 pin w/leads	.527-069-9-002
VR210, 212	2.2KΩ Potentiometer	008-169-9-007	J7	Connector, 3 pin w/leads (CRT)	.527-069-9-003
CAPACITORS & TRIMMERS					
C246	47μF, 10WV Electrolytic	022-119-9-004	J8	Connector, w/leads	.527-068-9-001
C202	1μF, 50WV Electrolytic	034-006-9-001	J9, 10, 11	Connector, w/leads	.527-069-9-004
C205, 209, 210, 211, 247	1μF, 50WV Electrolytic	022-073-9-001	J12	Connector, w/leads	.527-069-9-005
C206, 214, 230, 231	100μF, 10WV Electrolytic	022-123-9-002	J13	Connector, 5 pin w/leads	.527-068-9-004
239, 244	100μF, 10WV Electrolytic	021-060-9-001	L1, 2	Inductor, 3.3 μH	.041-068-9-001
C227	100μF, 25WV Electrolytic	021-060-9-001	SEMICONDUCTORS & IC'S		
C237	100μF, 16WV Electrolytic	022-073-9-002	Q201, 204, 205, 207	Transistor, NPN Silicon, Signal 2SC458-C	176-016-9-001
C238	470μF, 16WV Electrolytic	022-073-9-003	Q202, 203	Transistor, NPN Silicon, Signal SCS35-B	176-036-9-001
TC201	10pF Trimmer	028-032-9-001	Q206, 216	Transistor, Field Effect 2SK30A-GR	182-029-9-002
TC202	50pF Trimmer	028-037-9-001	Q211, 213	Transistor, PNP Silicon, Signal 2SA733-Q	177-018-9-001
			Q224, 225	Transistor, NPN Silicon, Signal 2SC1507	176-055-9-006
D1-D3, D201-D213	Diode, 1S1555	151-028-9-007			
IC201, 203, 204	IC, TD-3400AP	307-069-9-004			
IC202	IC, TD-3472AP	307-069-9-003			

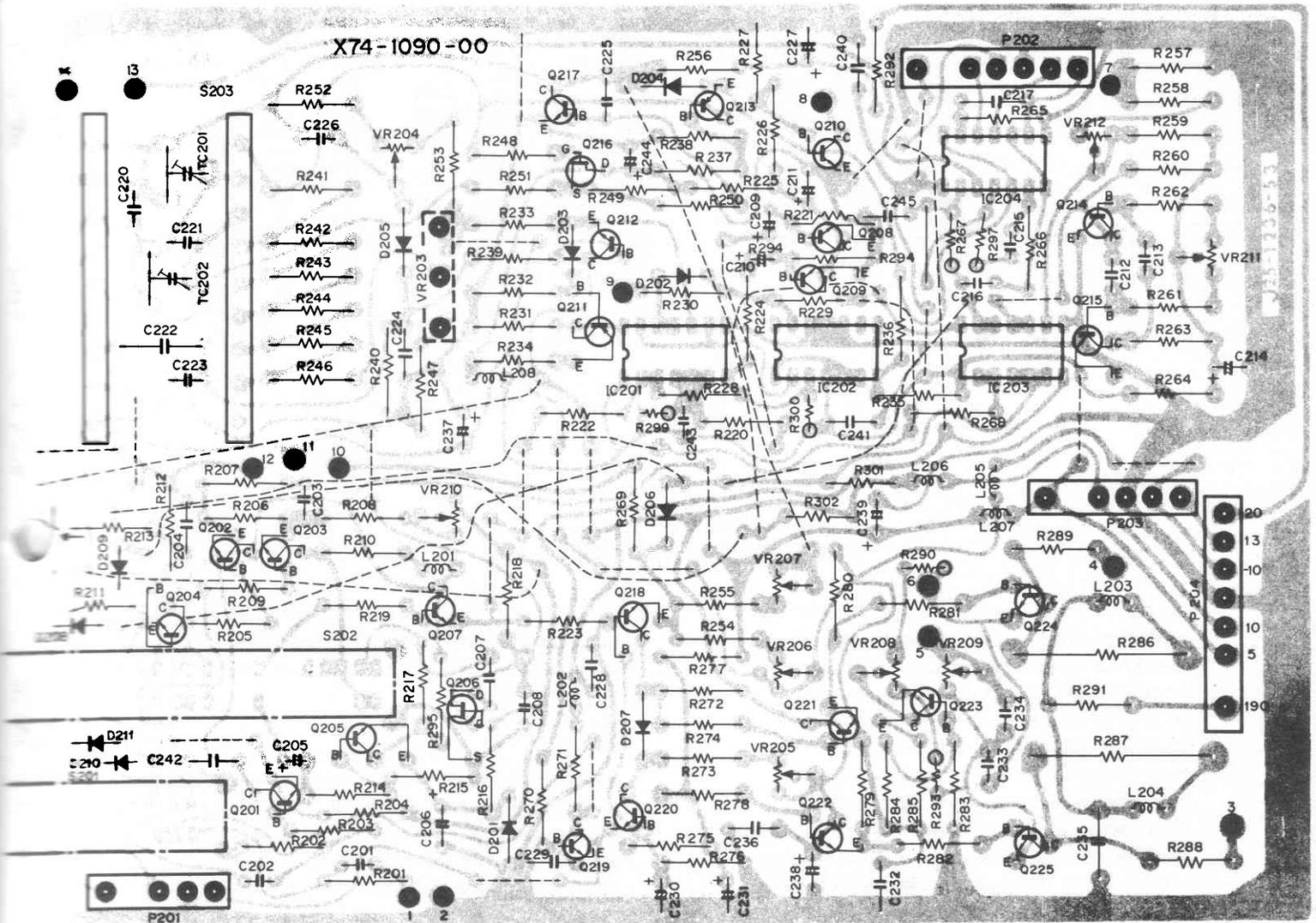
NOTE: Standard value resistors and capacitors are not listed. Values may be obtained from schematic diagram. Minimum charge \$5.00 per invoice. Orders will be shipped C.O.D. unless previous open account arrangements have been made or remittance accompanies order. Advance remittance must cover postage or express charges. Specify serial number when ordering replacement parts.

VERTICAL AMPLIFIER BOARD (X73)



IC 101: TD3472AP, IC 102: TD 3403AP, IC 103: RC 733T, Q101-103, I10-112: 2SK 30A(O), Q104-109, I13-124: 2SC 535(B), D101-108, I11-117: IS 1555, D109, I10: IS 1587

SWEEP BOARD (X74)

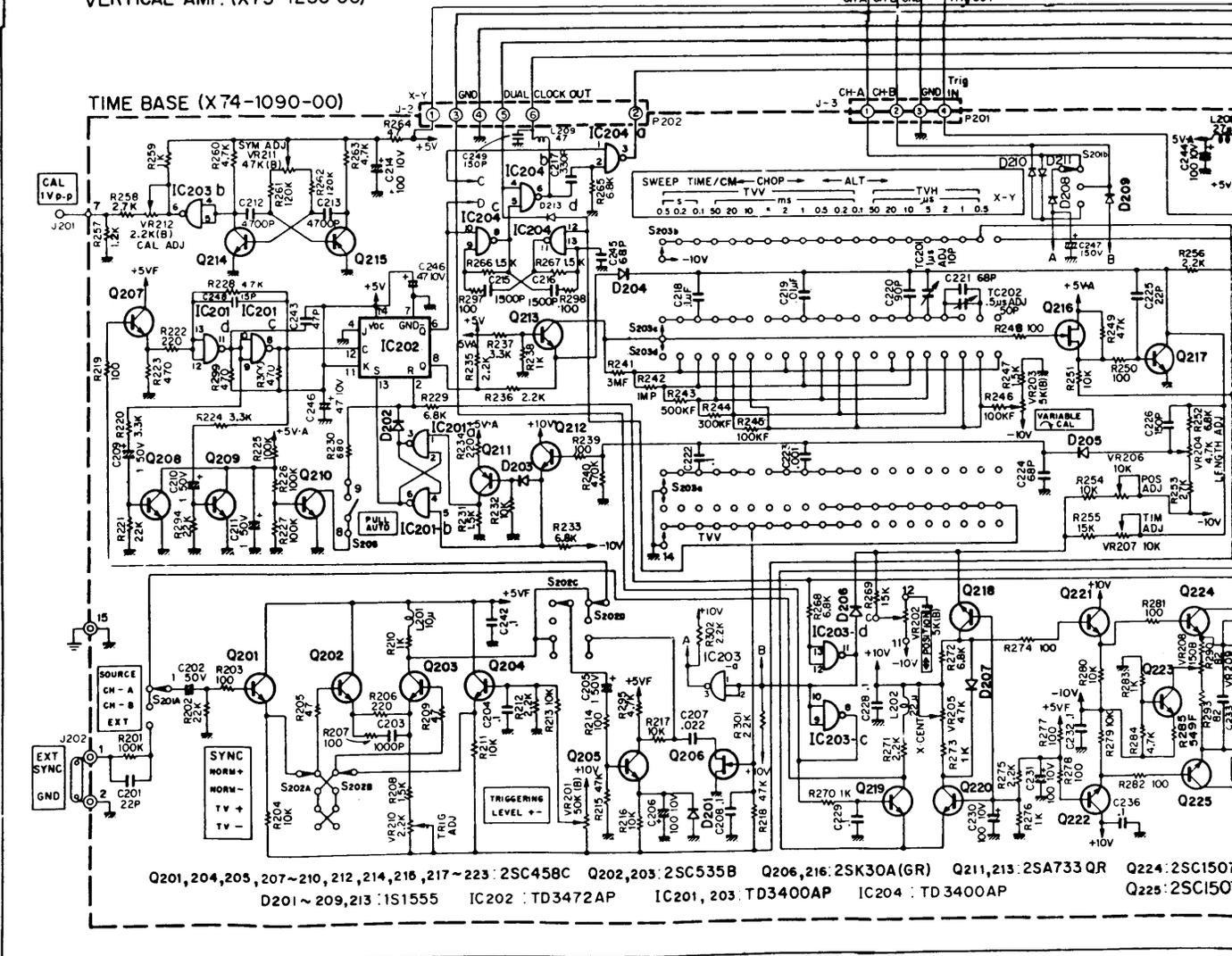
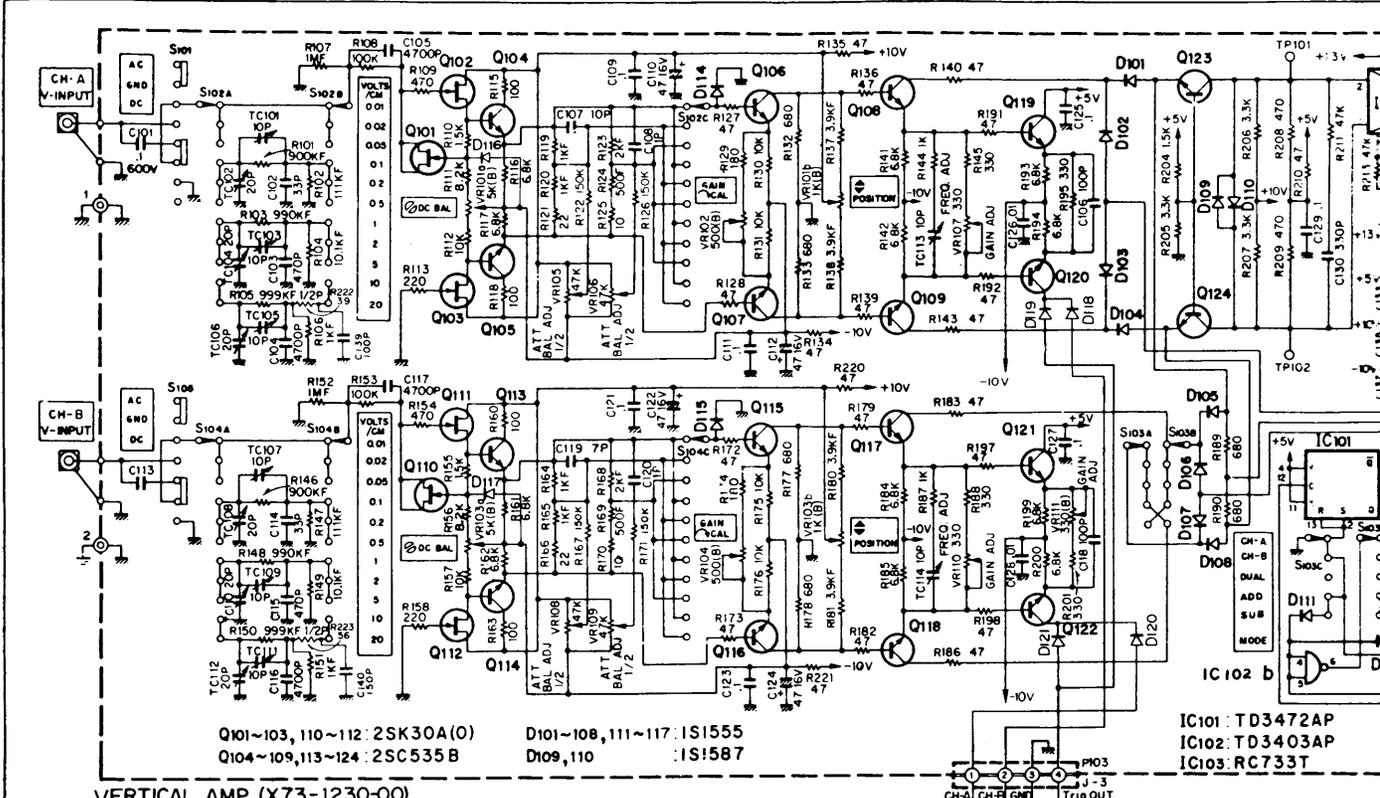


IC201, 203, 204: TD-3400AP, IC202: TD-3472AP, Q201, 204, 205, 207~210, 212, 214, 215, 217~223: 2SC458-C, Q202, 203: 2SC535-B
 Q206, 216: 2SK30A-GR, Q211, 213: 2SA733-QorR, Q224, 225: 2SC1507, D201~203, 205~209: 1S1555, D204: 1S1587

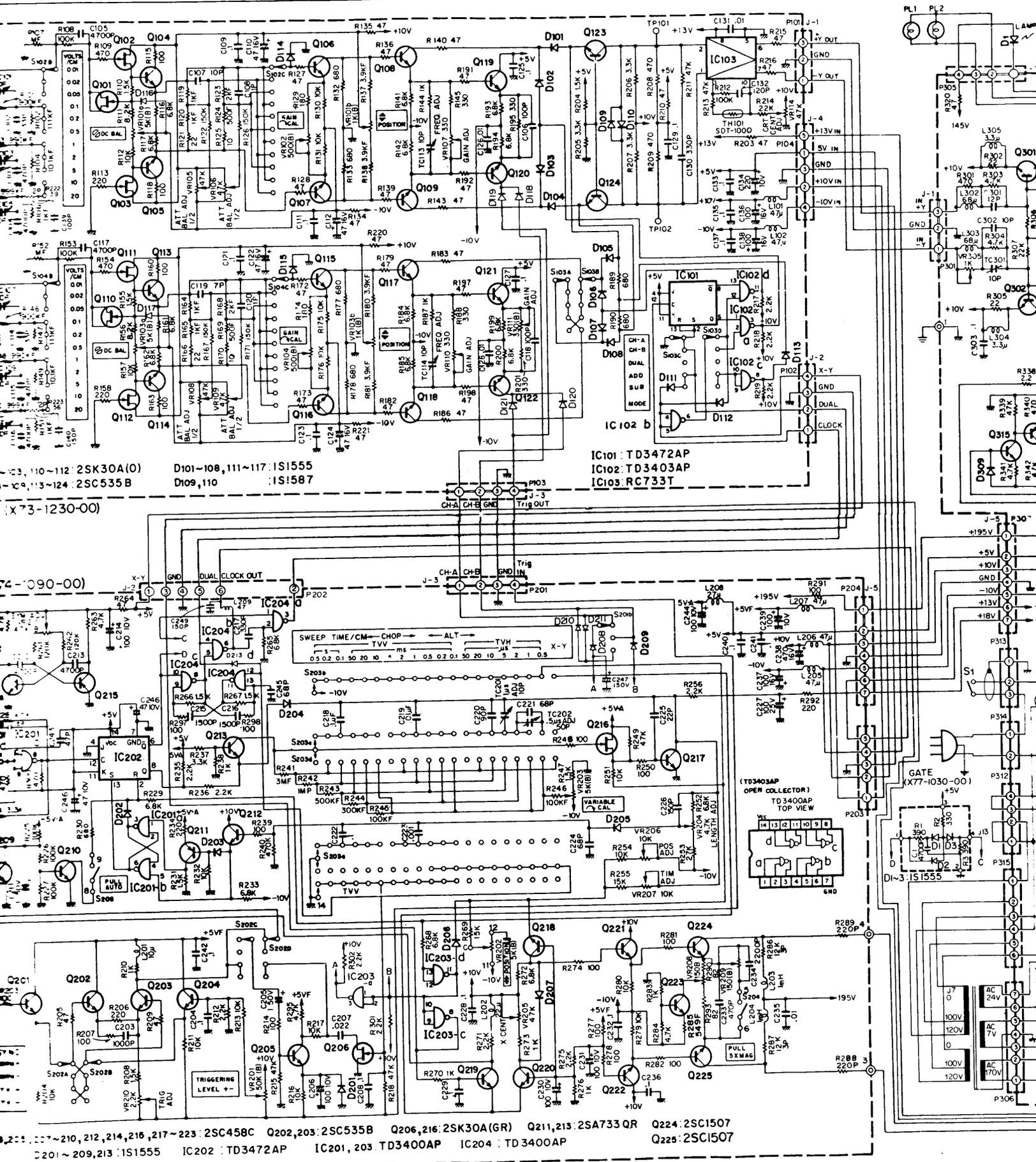
1472C**PRODUCTION CHANGES**

Itemized list of differences between earlier production units (page 32) and later production units (page 31)

1. Mini circuit board added. Contains C1, D1, D2, D3, R1, R2, and R3 (shown next to power plug, connects between IC204a, pin 1, and IC204c, pin 10).
2. Vertical amplifier Board (X73)
 - a. Diodes D118-D121 added, resistors R196, R202 deleted (wiring from P103 to Q120 and Q122 also modified; associated with change 3a on Sweep Board).
 - b. R122, R126, R167 and R171 changed from 220 k Ω to 150 k Ω (Q104 and Q105 output, Q113 and Q114 output).
 - c. R222, C139 added, and R223, C140 added (Channel A and Channel B vertical attenuator, 10 and 20 V/CM section).
3. Sweep Board (X74)
 - a. C247, D210, D211, IC203a, R301, and R302 added (into triggering SOURCE selection circuit P201, S201b, and IC203c/d pins 10 and 11; associated with change 2a on Vertical Amplifier Board).
 - b. C246 added (IC202 pin 7).
 - c. R230 changed from 820 Ω to 680 Ω (Q210 collector).
 - d. R228 changed from 6.8 k Ω to 4.7 k Ω
C248 added (IC201d pin 13)
 - e. C249, L209 added (P202 pin 6 to IC204b pin 6).
 - f. R262 changed from 100 k Ω to 120 k Ω (Q214 base).
 - g. D213 added (IC204b pin 4 to IC204d pin 12).
4. Power Supply Board (X68)
 - a. R365 added (in parallel with R335 in Q312 base circuit).
 - b. Q303-Q306 changed from type 2SC154C to type 2SC1628Y (use type 2SC1628Y for replacement).



For later production units with mini circuit board only (see other side of sheet for earlier units)



D101~108, 111~117 :S1555
 D109, 110 :S1587

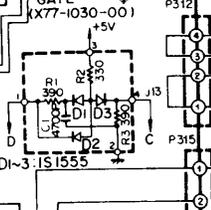
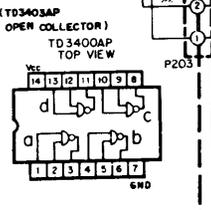
IC101 : TD3472AP
 IC102 : TD3403AP
 IC103 : RC733T

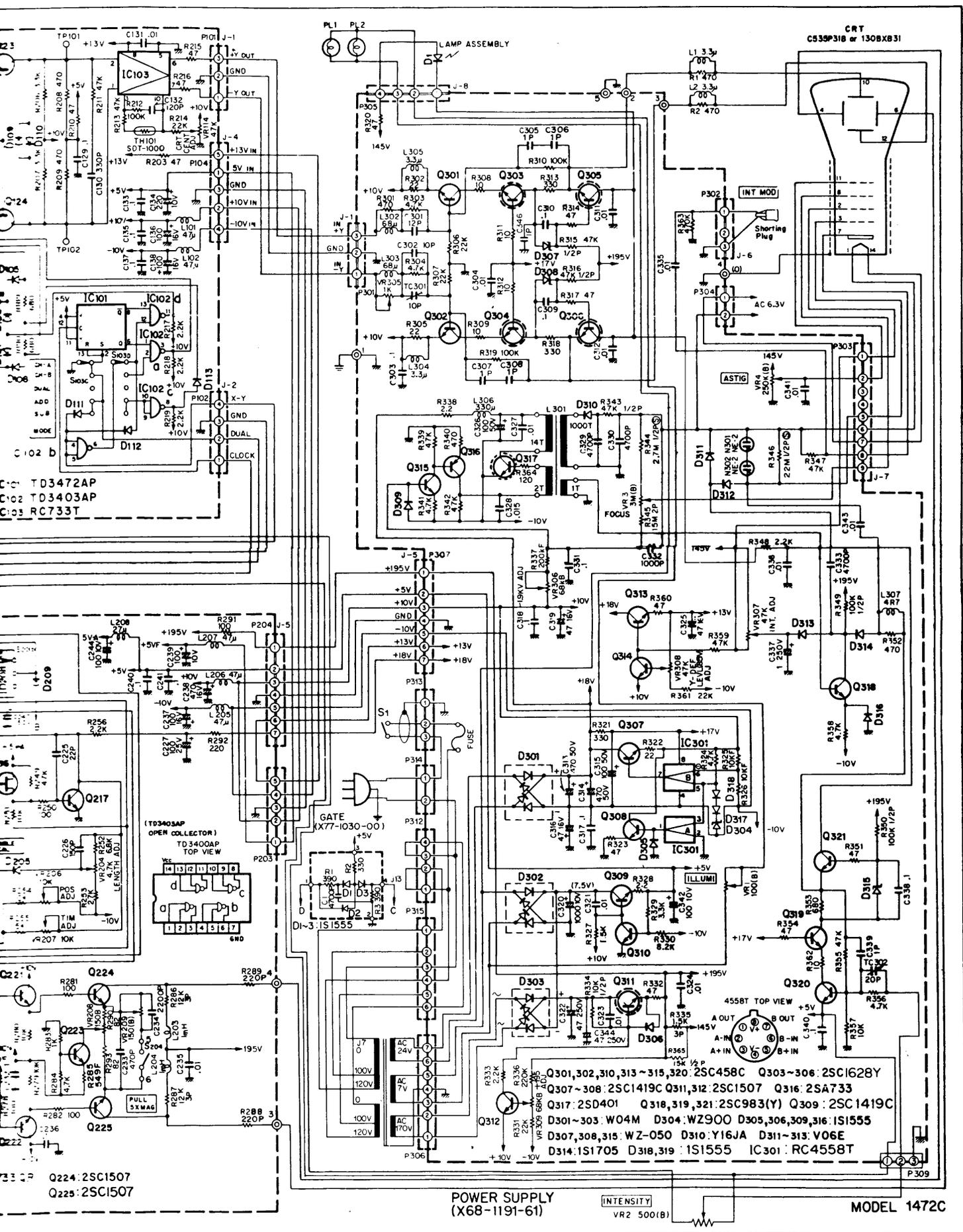
Q101~110 : 2SK30A(O)
 Q111~124 : 2SC535B
 (X73-1230-00)

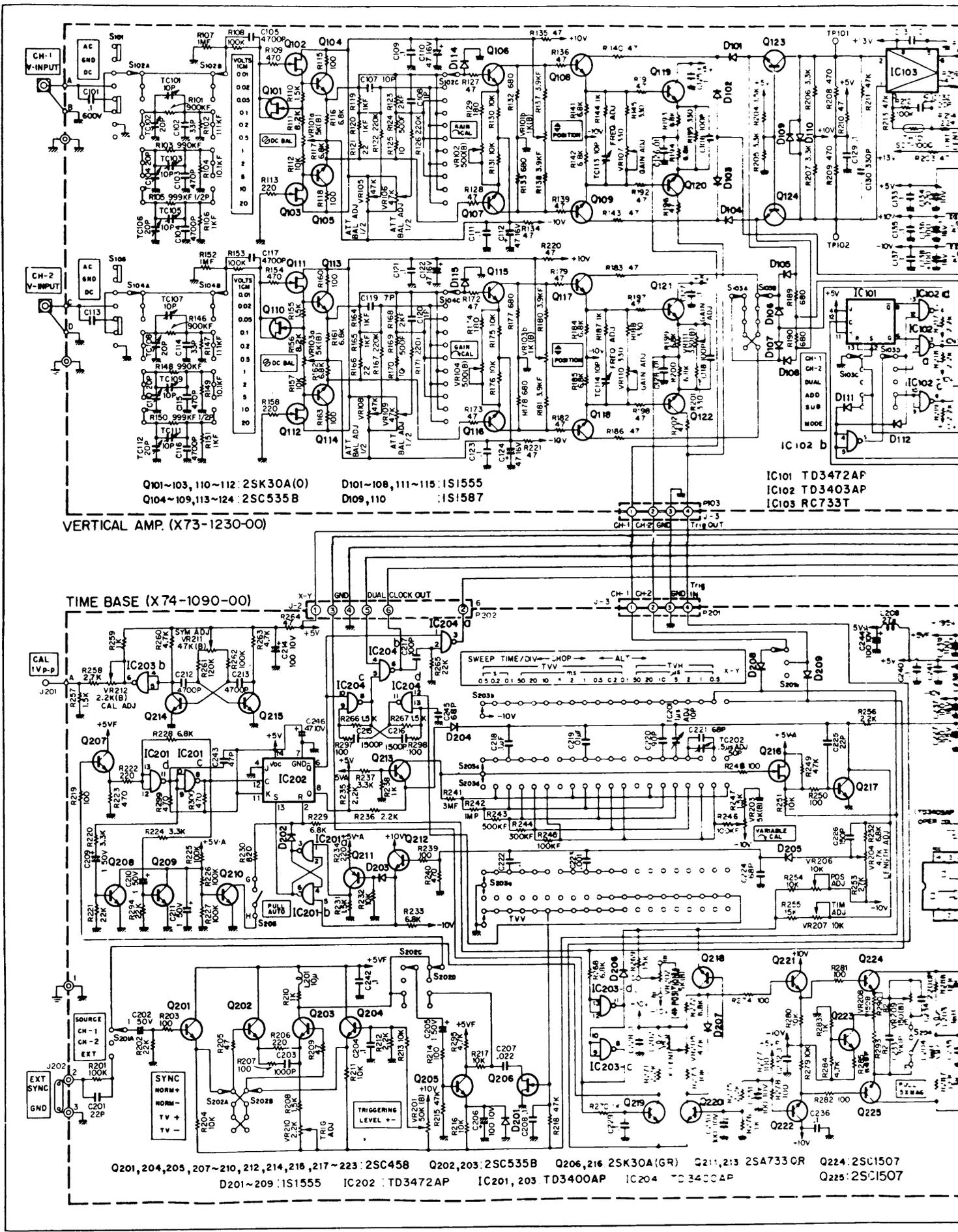
(X74-090-00)

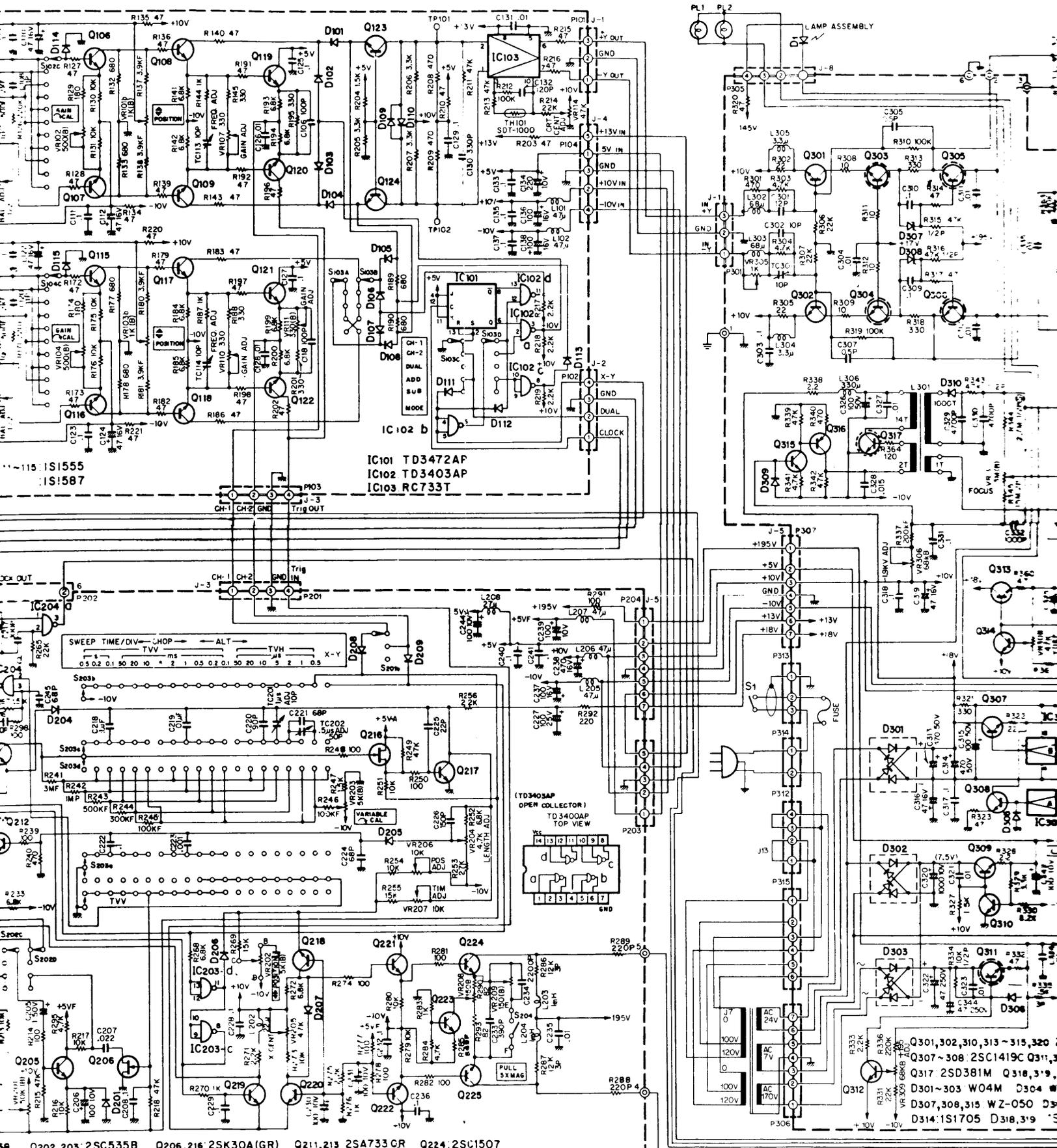
Q201~210, 212, 214, 216, 217~223 : 2SC458C
 Q202, 203 : 2SC535B
 Q206, 216 : 2SK30A(GR)
 Q211, 213 : 2SA733 QR
 Q224 : 2SC1507
 Q225 : 2SC1507

IC201~209, 213 : S1555
 IC202 : TD3472AP
 IC201, 203 : TD3400AP
 IC204 : TD3400AP

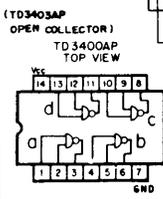








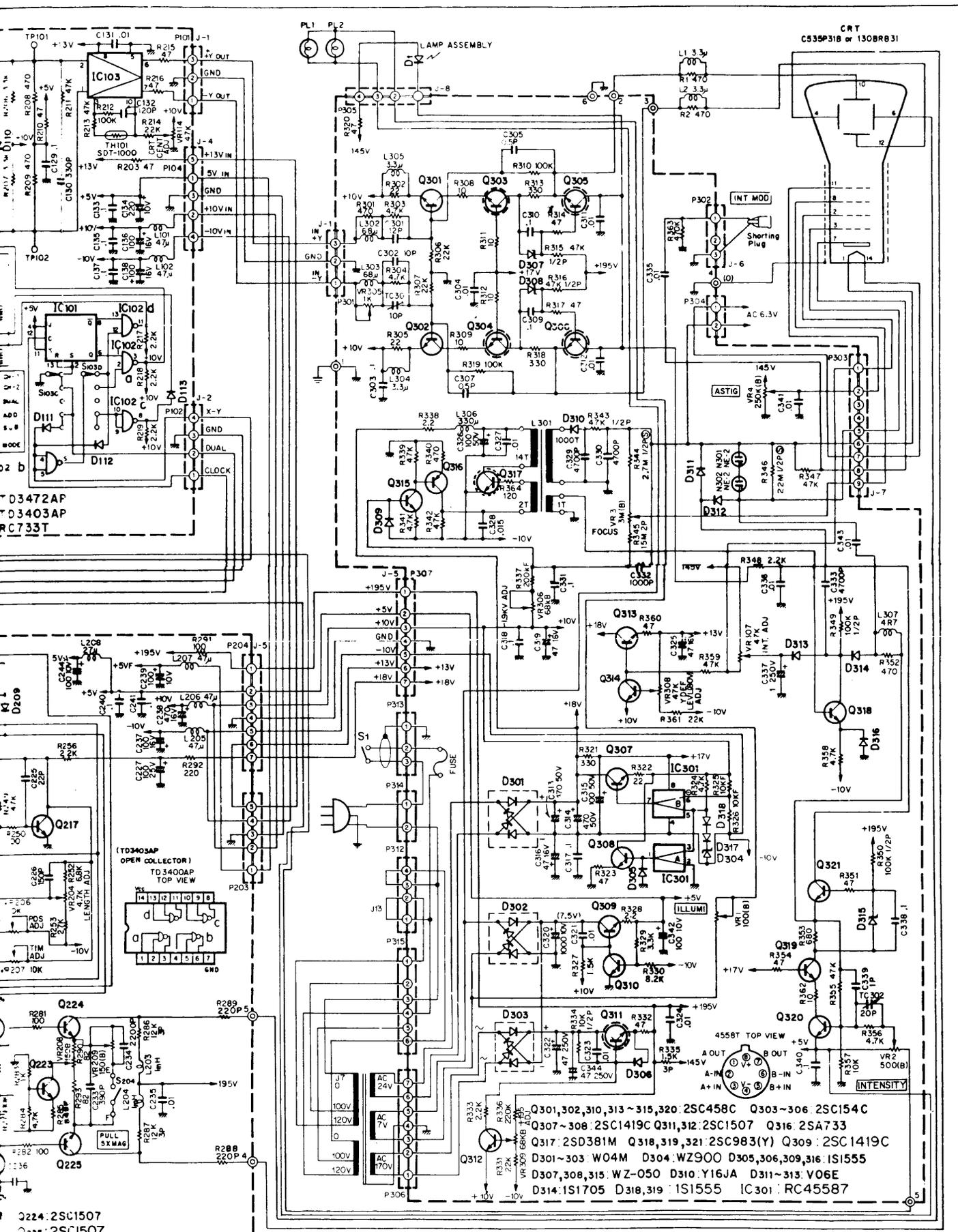
IC101 TD3472AP
 IC102 TD3403AP
 IC103 RC733T



POWER SUPPLY
 (X68-1191-61)

Q202, 203: 2SC535B Q206, 216: 2SK30A (GR) Q211, 213: 2SA733 CR Q224: 2SC1507
 Q225: 2SC1507
 IC201, 203: TD3400AP IC204: TD3400AP

(see other side of sheet for later units)



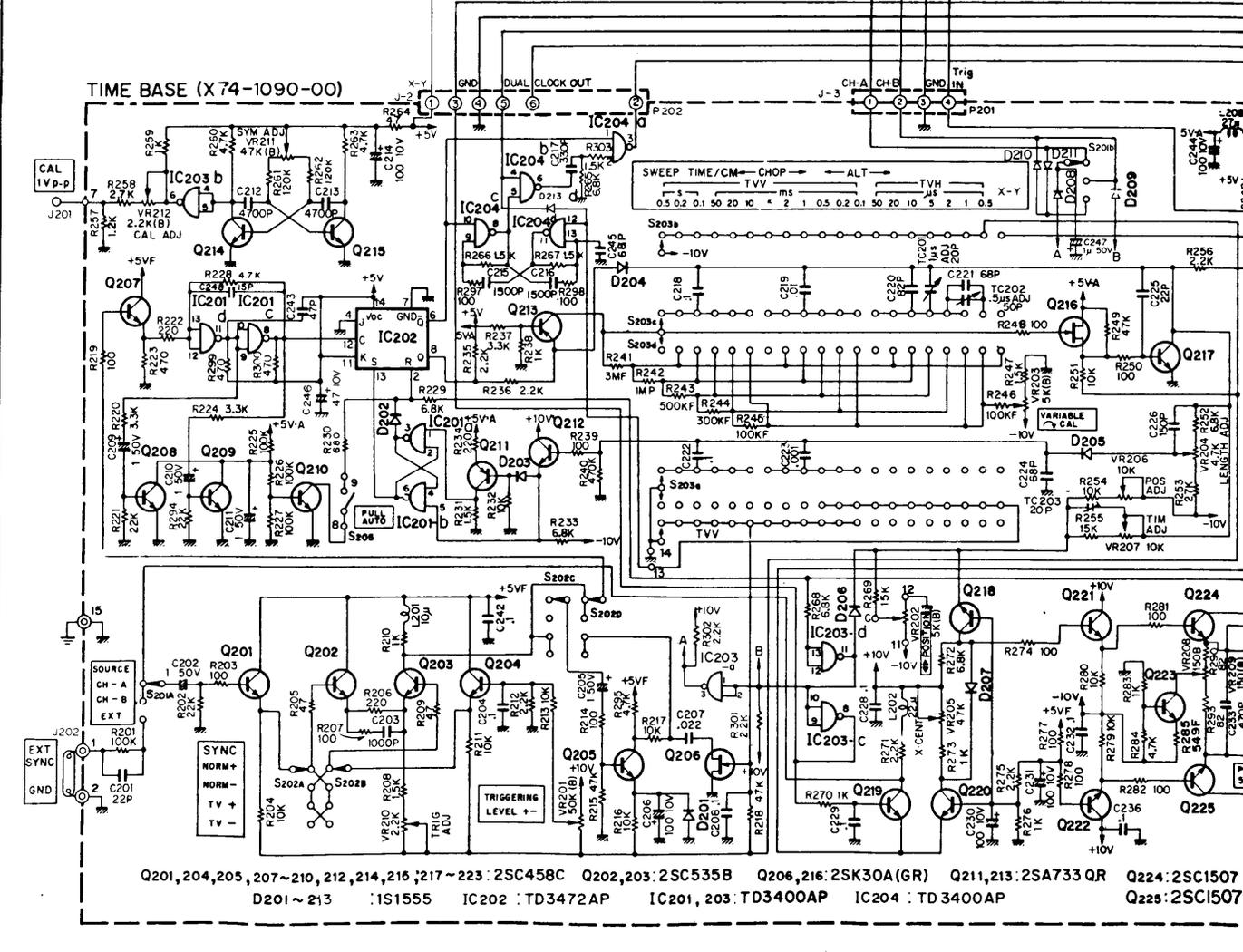
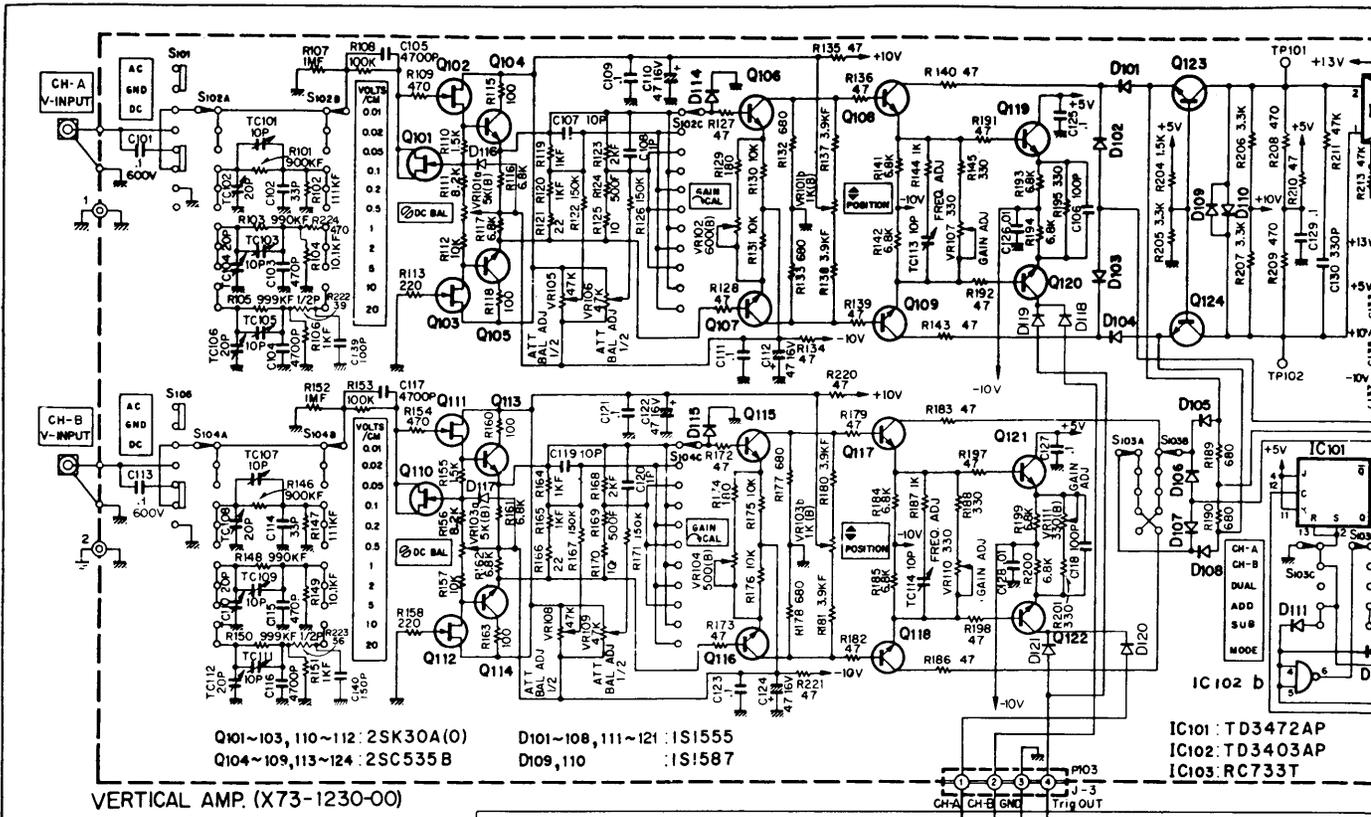
Q3472AP
 D3403AP
 RC733T

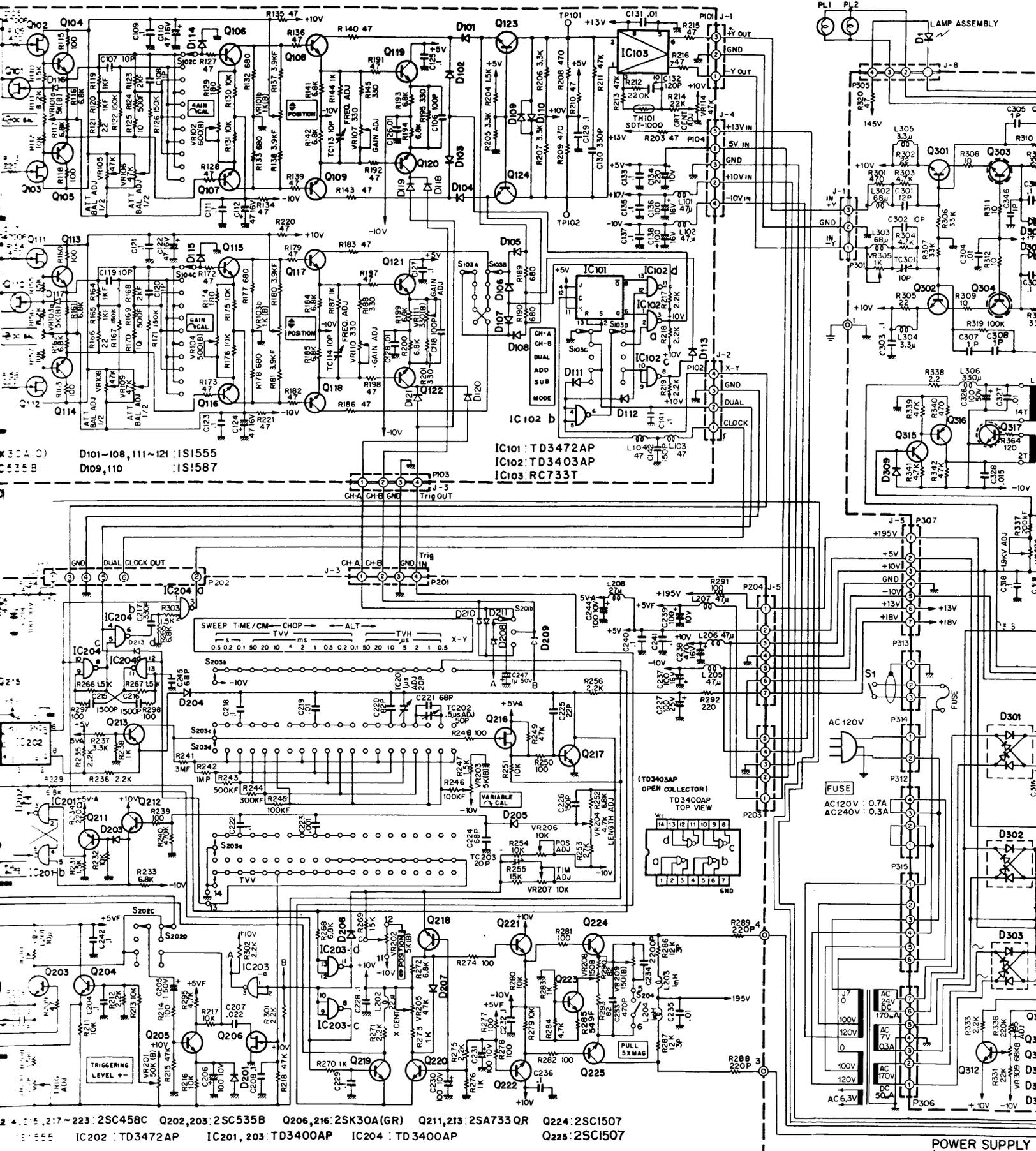
Q224: 2SC1507
 Q225: 2SC1507

Q301,302,310,313~315,320: 2SC458C Q303~306: 2SC154C
 Q307~308: 2SC1419C Q311,312: 2SC1507 Q316: 2SA733
 Q317: 2SD381M Q318,319,321: 2SC983(Y) Q309: 2SC1419C
 D301~303: W04M D304: WZ900 D305,306,309,316: 1S1555
 D307,308,315: WZ-050 D310: Y16JA D311~313: V06E
 D314: 1S1705 D318,319: 1S1555 IC301: RC45587

POWER SUPPLY
 (X68-1191-61)

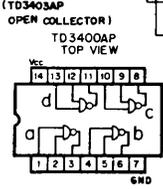
MODEL 1472C





D101-108, 111-121 : IS1555
 D109, 110 : IS1587

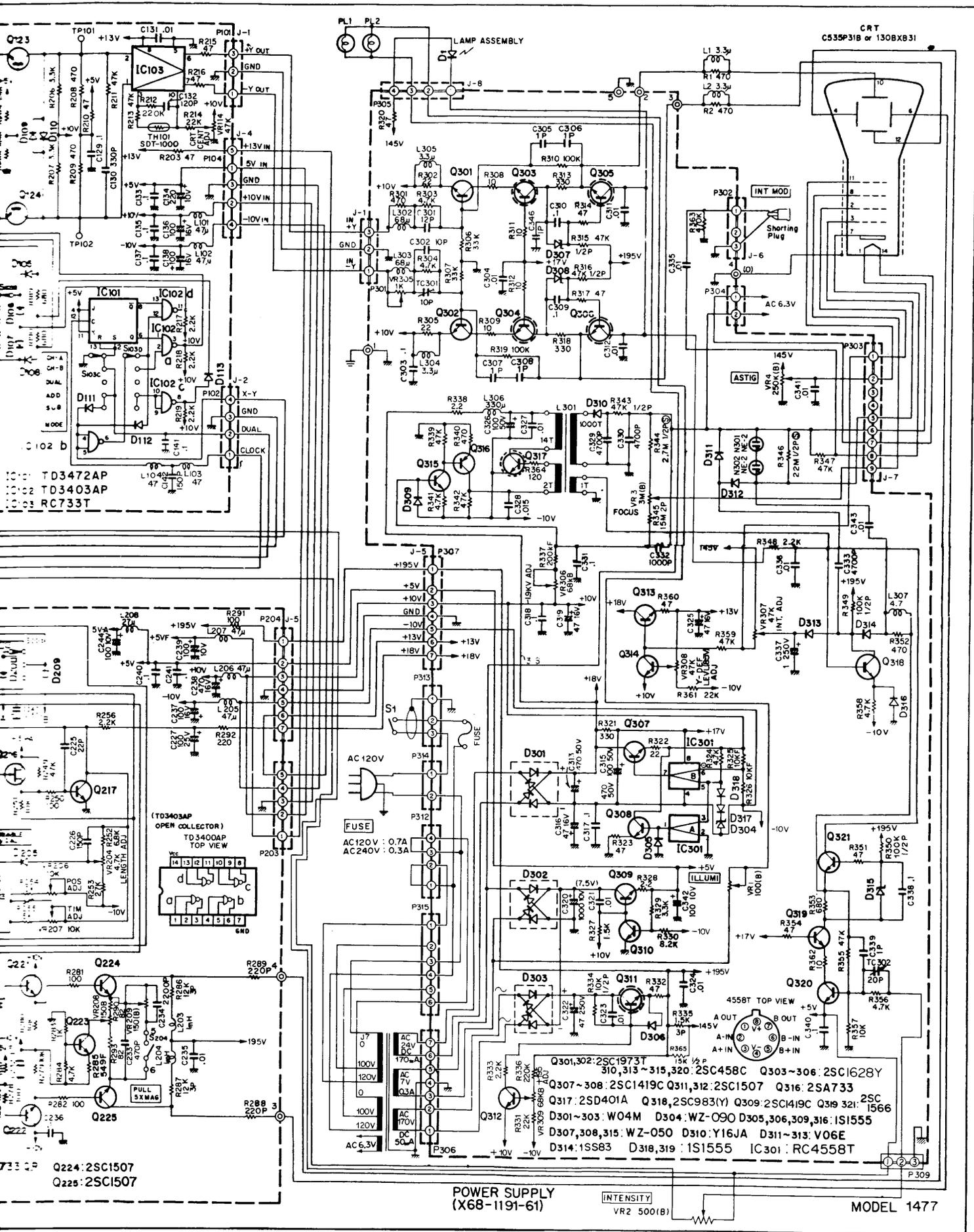
IC101 : TD3472AP
 IC102 : TD3403AP
 IC103 : RC733T



AC 120V : 0.7A
 AC 240V : 0.3A

Q201, 202, 203 : 2SC458C Q202, 203 : 2SC535B Q206, 216 : 2SK30A(GR) Q211, 213 : 2SA733 QR Q224 : 2SC1507
 IC202 : TD3472AP IC201, 203 : TD3400AP IC204 : TD3400AP Q225 : 2SC1507

POWER SUPPLY (X68-1191-61)



1477 PRODUCTION CHANGES

Itemized list of differences between first production run of Model 1477 and time of printing of this service manual.

**DYNASCAN PART NO.
FOR NEW PART**

Below Serial No. 41-06176:

As shown in schematic diagram.

Serial No. 41-06176 and higher:

R306, 307 changed from 22 k Ω \pm 5% to 33 k Ω \pm 5%.

Serial No. 41-06776 and higher:

R303 changed from 1.5 k Ω \pm 5% to 2.2 k Ω \pm 5%.

Q317 changed from 2SD401 to 2SD401A(K) 172-057-9-001

Serial No. 41-07826 and higher:

R340 changed from 470 Ω \pm 5% to 2.2 k Ω \pm 5%.

Serial No. 41-09201 and higher:

Q319, 321 changed from 2SC983(Y) to 2SC1566 172-053-9-003

Serial No. 41-09276 and higher:

Q318 changed from 2SC983(Y) to 2SC2229(Y) 176-123-9-001

Serial No. 41-09476 and higher:

Q318 changed from 2SC2229(Y) to 2SC2271(E) 176-147-9-003

R224 changed from 330 Ω \pm 5% to 180 Ω \pm 5%.

R303 changed from 202 k Ω \pm 5% to 1.5 k Ω \pm 5%.

Serial No. 41-12601 and higher:

D304 changed W2-090 to MTZ9.1JC 152-141-9-001

D307, 308,

315 changed from W2-050 to MTZ5.1JB 152-134-9-003

C302 changed from 10 pF to 12 pF 020-167-9-002

Serial No. 41-12901 and higher:

Q303-306 changed from 2SC1628(Y) to 2SC2441(E,F) 176-163-9-001

Serial No. 41-14051 and higher:

C335, 343 part number changed to 033-071-9-003

Serial No. 41-14201 and higher:

R340 changed from 2.2 k Ω \pm 5% to 3.9 k Ω \pm 5%.

R364 changed from 120 Ω \pm 5% to 470 Ω \pm 5%.

Serial No. 41-14401 and higher:

Q202, 203 changed from 2SC535(B) to 2SC1047(B) 176-175-9-001

Q307-309 changed from 2SD1135(C) to 2SD613(E) 176-104-9-002

