meguro

MO-1251

20 MHz OSCILLOSCOPE (DUAL CHANNEL)

INSTRUCTION MANUAL

MEGURO ELECTRONICS CORPORATION

1-5, 2-CHOME CHUO-CHO
MEGURO-KU TOKYO JAPAN

PRECAUTIONS FOR USE

1. Inspect the shipping carton for serious damage which might have caused failure of the instrument during transit. If damage is noted, notify the sales representative before any handling.
2. Before applying power to the oscilloscope, make certain that the voltage selector plug, on rear panel, has been inserted with the arrow marking in direction of the line voltage in use, and at the same time, confirm the fuse rating.
3. Do not leave the bright beam on the CRT screen for long periods. This is to prevent permanent damage to the screen.
4. This instrument is convection-cooled and must always be operated in a position that the cooling vents are not obstructed.
5. To insure stable operation over long periods, care should be taken to avoid subjecting the instrument to vibration, direct sunlight, extreme temperature variations, high humidity, dust and electromagnetic fields.

TABLE OF CONTENTS

SECTION 1
INTRODUCTION

1.1 GENERAL

The Model MO-1251 is a dual trace 20 MHz oscilloscope using a high brightness CRT.
The vertical amplifiers have high sensitivity of 5 mV/DIV and frequency response with smooth rolloff above 20 MHz. The highest triggering sweep speed is 0.2 μs/DIV.

1.2 FEATURES

1. Wide bandwidth and high sensitivity.
2. Component Tester function*.
3. High sensitivity X-Y mode.
4. Z-axis modulation applicable.
5. TV VIDEO SYNC filter included.
6. High frequency rejection filter in trigger circuit.
7. Front panel trace rotator.
8. Regulated power supplies for high stability.
9. Very low power consumption.

* The Component Tester is a special circuit with which a component or components on or out of actual circuit board can be dynamically tested or checked and requires no external driving power. The display shows the good-bad condition and relative value of the component under test.

SECTION 2
SPECIFICATIONS

VERTICAL DEFLECTION

Deflection Factor	5 mV to 20 V/DIV $\pm$3%, 12 steps in 1-2-5 sequence and with fine control.
Bandwidth, –3 dB	DC: DC to 20 MHz.
	AC: 10 Hz to 20 MHz.
Rise Time	Less than 17.5 ns.
Overshoot	Less than 3%.
Input Impedance	1 MΩ shunted by 20 $\pm$3 pF.
Maximum Input	600 Vp-p, or 300V (DC + AC peak).
Operating Modes	CH1, CH2 DUAL and ADD.
Chop Frequency	Approx. 200 kHz.
Channel Separation	Better than 60 dB at 1 kHz.
Channel 2 Polarity	Inversion possible.

TIME BASE

Mode	Automatic or triggered; at automatic, the sweep is obtained without input signal.
Sweep Time	0.2 ns to 0.5 s/DIV, 20 steps in 1-2-5 sequence and with fine control and X-Y.
Magnification	X5 at all ranges.
Linearity	Less than 3% deviation.

TRIGGER

Sensitivity	INT: 1 DIV or better.
	EXT: 1 Vp-p or better.

Source	INT, CH2, Line or EXT.
Trigger Level	Positive and negative, continuously variable at Pull of AUTO control.
Range	20 Hz to above 20 MHz.
Coupling	AC, HF REJect and TV (at + or – for each); TV, TV-H (line) and TV-V (frame) sync signals are switched with SEC/DIV switch: TV-V: 0.5 s/DIV to 0.1 ms/DIV. TV-H: 50 μs/DIV to 0.2 μs/DIV.

HORIZONTAL DEFLECTION

X-Y Operation	Mode selected with SEC/DIV switch: CH1: Y-axis. CH2: X-axis.
Deflection Factor	5 mV to 20 V/DIV, 12 steps in 1-2-5 sequence and with fine control.
Frequency Response	–3 dB: DC to 1 MHz.
Input Impedance	1 MΩ shunted by 20 $\pm$3 pF.
Maximum Input	600 Vp-p, or 300V (DC + AC peak).

INTENSITY MODULATION (Z-axis)

Input voltage	3 Vp-p or greater (Bright at positive-going input.)
Maximum input	50V (DC + AC peak).
Usable frequency range	DC $\sim$ 1 MHz.

GENERAL

CRT Accelerating Voltage	2 kV
Calibration Voltage	0.5 Vp-p $\pm$5%; 1 kHz square wave.
Power Requirements	100V, 117V, 220V or 240V (voltage selector provided), 50/60 Hz; approx. 19W.
Dimensions	294 (W) x 162 (H) x 352 (D) mm.
Weight	Approx. 7 kg.

STANDARD ACCESSORIES

Power Cord	x 1
Fuse	1A x 2, 0.5A x 1
Instruction Manual	x 1

OPTION

Probe (MP-3050)	x 2 (10 : 1/1 : 1 selectable)

SECTION 3
OPERATION

3.1 CONTROLS AND CONNECTORS

A. Front Panel, Fig. 1:

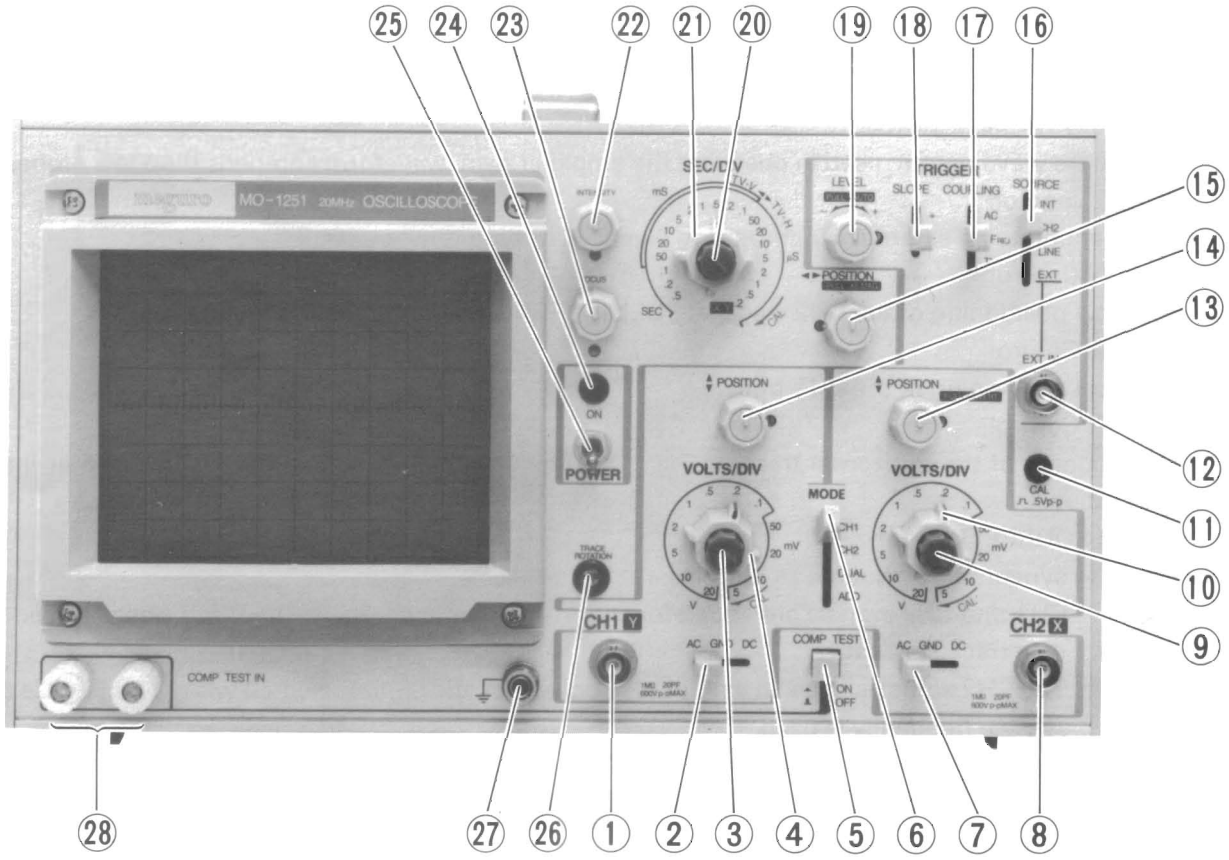


Fig. 1 Front panel controls and connectors

① CH1 (Y) Connector
For vertical input signal to Channel 1; BNC type.

② AC-GND-DC Switch (for CH1 input)
At AC, the DC component is blocked with a capacitor; at GND the internal amplifier input is grounded and the input circuit is at open circuit; at DC, the input signal is directly connected to the amplifier.

③ Knob for variable (uncalibrated) control of VOLTS/DIV; normally set to fully clockwise.

④ VOLTS/DIV Switch
Attenuator for CH1 input in 12 steps, 5mV to 20V per division on the CRT screen (Variable knob ③ at fully clockwise).

⑤ COMPonent TEST Switch
Set to on when making a test of a component. In use the SEC/DIV switch ㉑ is set to (X-Y) and AC-GND-DC switches ② and ⑦ to GND.

⑥ MODE Selector
CH1 and CH2 settings for display of respective inputs.
DUAL for simultaneous display of CH1 and CH2 inputs with alternate or chopped operation controlled with the SEC/DIV switch, chopping at approximately 200 kHz at 0.5s to 1 ms/DIV and alternate in the 0.5 ms to 0.2 μs/DIV ranges.

At ADD, CH1 and CH2 signals are added for the display. When the POSITION control of CH2 ⑬ is pulled, the display will be the difference of the two signals.

⑦ AC-GND-DC Switch (for CH2 input)
The function is identical with that of the switch for CH1 ② except that it applies to the CH2 input.

⑧ CH2 (Y) Connector
For vertical input signal to Channel 2; BNC type.

⑨ Knob for variable (uncalibrated) control of VOLTS/DIV; normally set to fully clockwise.

⑩ VOLTS/DIV Switch
Attenuator for CH2 input in 12 steps, 5mV to 20V per division on the CRT screen (variable knob ⑨ at fully clockwise.)

⑪ CAL 0.5 p-p Terminal
1 kHz square wave output; used in checking the amplifier gain, waveform compensation in a probe, etc.

⑫ EXT IN Connector
For connection to an external synchronizing signal; BNC type.

⑬ POSITION Control
For vertical positioning of the CH2 trace; at PULL INVERT setting, the trace is inverted.

⑭ POSITION Control
For vertical positioning of the CH1 trace.

⑮ POSITION Control
For positioning of the horizontal trace; at PULL X5, the sweep is expanded by a factor of 5 in the time axis direction.

⑯ TRIGGER SOURCE Selector
Selects the synchronizing source as follows:

- INT: CH1 and CH2 signals are added for triggering; in other word, one of the signals is used in the dual trace application.
- CH2: The CH2 signal is used; in single trace operation, the signal selected with MODE ⑥ is used.
- LINE: AC line frequency is used.
- EXT: Input connected to EXT IN connector ⑫ is used.

⑰ TRIGGER COUPLING Selector
Selects the triggering mode as follows:

- AC: For normal operation; the sync signal is fed directly to the trigger circuit.
- HF REJ: A lowpassfilter is used to cut off the high frequency components in the trigger signal.
- TV: For use in observation of TV signals. The TV-V (0.5s ~ 0.1 ms) and TV-H (50 μs ~ 0.2 μs) steps of SEC/DIV switch ㉑ are applicable.

⑱ TRIGGER SLOPE Selector
Selects the slope of the triggering signal to drive the trigger generator circuit.

⑲ TRIGGER LEVEL Control
For setting the starting point level on the waveform of the triggering signal. At automatic operation, the control knob is pulled for the free running condition.

⑳ Knob for variable (uncalibrated) control of SEC/DIV; normally set to CAL position (fully clockwise).

㉑ SEC/DIV Switch
For setting the sweep time; range is 0.2 μs to 0.5s per scale division. At the X-Y setting, operation is for the X-Y mode. The alternate, chop, and TV-V and TV-H operations are possible with the switching.

㉒ INTENSITY Control
For adjusting the beam brightness.

㉓ FOCUS Control
For adjusting the clarity of the beam.

㉔ Pilot Lamp
Lights when the AC power is on.

㉕ POWER Switch
For turning on the AC power.

㉖ TRACE ROTATION Adjuster
Used when offsetting the effect of earth's magnetic field in the trace line.
㉗ Grounding Terminal
㉘ COMP TEST IN Terminals
For connection to a component under test or test leads.

B. Rear Panel, Fig. 1-a:

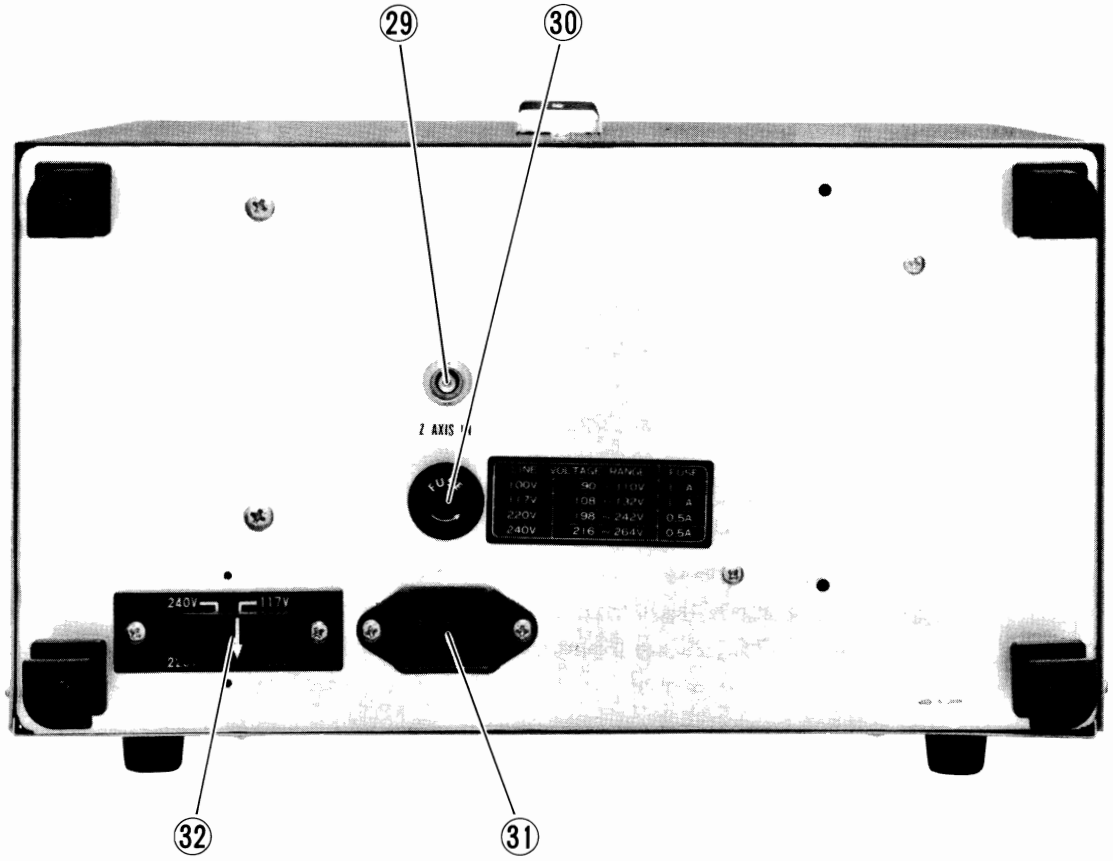


Fig. 1-a Rear panel

㉙ Z-AXIS IN Connector
For connection of input signal used in intensity modulation of the beam.
㉚ FUSE Holder
For the AC line fuse; rating given in the accompanying table.
㉛ Receptacle for AC line cord.
㉜ Voltage Selector Plug and Socket
The plug is inserted with the arrow mark in direction of the line voltage as shown in the accompanying table.

3.2 PRELIMINARY OPERATION

1. Control settings:
   1) Set the POWER switch to off (down).
   2) Set all three POSITION controls to mid-position.
   3) Set INTENSITY control to mid-position.
   4) Push the knob of horizontal POSITION ⑮ for normal condition.
   5) Pull TRIGGER LEVEL ⑲ control for AUTO mode.
   6) Other controls may be at any position.
   7) Check the AC line voltage and plug inserted direction on rear panel.

2. Connect the AC line cord between the AC receptacle (rear panel) and the local mains.
3. Set the POWER switch to ON. After about 20 seconds a trace line will appear on the screen. If not, adjust the INTENSITY control for proper brightness to suit local lighting conditions.
4. Adjust FOCUS and INTENSITY controls for a clear trace line.
5. Readjust vertical and horizontal POSITION control to place the trace line at the desired position on the screen.
6. Connect a 10 : 1 probe to the input of CH1 and hook the tip to CAL 0.5 Vp-p terminal.
7. Set the VOLTS/DIV switch of CH1to 10 mV and also the variable (inner) knob to fully clockwise. Next set the TRIGGER SOURCE selector to CH2. The square wave covering 5 divisions will then be displayed.
8. If the square wave is distorted, adjust the trimmer in the probe.
9. Remove the probe hook from the 0.5 Vp-p terminal. The instrument is now ready for use.

3.3 TRIGGERING THE SWEEP

In general, triggered oscilloscopes include circuits to display stable waveforms. The synchronizing pulse for the triggering is derived from the vertical or an integral number related signal. It is important that the triggering is exactly synchronized with the vertical input. The MO-1251 has four controls for this purpose.

1. SOURCE Selector ⑯
   INT: For internal triggering with the CH1 and CH2 inputs.
   CH2: For internal triggering only with the CH2 input signal.
   LINE: The AC line frequency is used in triggering.
   EXT: For an external triggering signal connected to the EXT IN connector. Three benefits are apparent depending on operating conditions.
   a. Triggering is not affected by vertical signals. For example, the triggering level is dependent on the setting of the VOLTS/DIV switch since the synchronizing source voltage changes. Unless the external trigger voltage is changed, triggering is very stable and free from vertical controls.
   b. The input signal can be delayed with use of the delaying function of a pulse generator.
   c. A composite or modulated signal can be easily triggered.
2. COUPLING Selector ⑰
   Selects the synchronizing circuit coupling. "AC" is for AC coupling and the DC component is blocked. At HF REJ, a lowpass filter is used to suppress any RF noise interference. The TV setting is for the TV signal triggering; selection is made for TV-V or TV-H with the SEC/DIV switch.
3. SLOPE Selector ⑱
   Selects the trigger slope, positive or negative, of the trigger signal. At TV synchronizing, the point is set to the rise or fall time of the pulse.
4. LEVEL Control ⑲
   For stable triggering control. When the knob is at PULL, the sweep is free-running, i.e., without the input signal for 0 level reference.

3.4 X-Y DISPLAY OPERATION

For special cases in using the X-Y apllication, set the SEC/DIV switch to X-Y. All CH2 functions will operate as a horizontal amplifier while CH1 operates as the vertical amplifier.

3.5 VOLTAGE MEASUREMENTS

Peak, peak-to-peak and DC voltages or a specific portion of a complex waveform can be measured with use of the instrument as a voltmeter. Either the CH1 or CH2 inputs may be used.

1. Set the Variable control of the VOLTS/DIV to the CAL position. Next set the VOLTS/DIV switch for the trace amplitude to be used. Adjust the vertical POSITION control to set the reference level.
2. For DC or complex signals, first set the input switch to GND and then adjust the vertical POSITION control for the reference level. A positive voltage will deflect the trace upward and vice versa. For the voltage, multiply the vertical (division) deflection by the setting of the VOLTS/DIV switch.

NOTE: When a 10 : 1 probe is used, the waveform display is only 1/10 of the actual voltage being measured.

3.6 DUAL TRACE DISPLAY

The MODE selector is set to DUAL. In this operating mode, procedures given above are the same.

3.7 SYNCHRONIZING TV SIGNALS

Set the TRIGGER COUPLING selector ⑰ to TV. The TV frame and line waveforms can be selected with use of the SEC/DIV switch.

3.8 ADDITION AND SUBTRACTION OPERATION

Set the MODE selector to ADD; the display will be the added waveforms of CH1 and CH2. The subtracted waveform is displayed when the CH2 vertical POSITION knob is pulled for INVERT.

3.9 APPLICATIONS

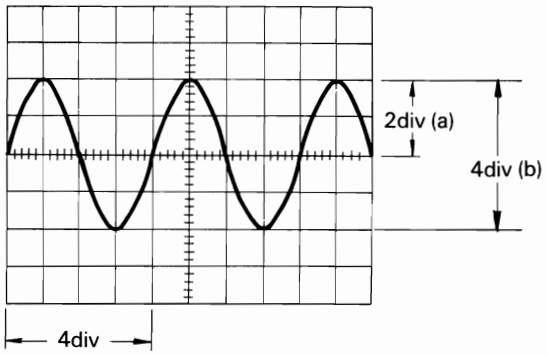
The MO-1251 has full capability of the single trace mode for two traces. In the single trace application, either Channel 1 or Channel 2 can be used. Channel 1 operation will be referred to hereunder for simplicity.
Control settings:

AC-GND-DC switch ..... AC
MODE selector..... CH1
COUPLING selector ..... AC
SOURCE selector..... INT
Probe cable ..... Connect to CH1 input

Connect the probe tip to the point of measurement and ground clip to the chassis or grounded part.
NOTE: The peak-to-peak voltage at the point of measurement should not exceed 600V.

3.9.1 AC Voltage and Frequency Measurements

Initially, set the Variable knobs (inner) of VOLTS/DIV and SEC/DIV switches ③ and ⑳ to the CAL positions. An example is shown in Fig. 2.



VOLTS/DIV ..... at 2V
SEC/DIV ..... at 5ms

Fig. 2 Voltage and frequency measurement

From Fig. 2:

Peak voltage ..... 2V/div × 2 = 4V
P-P voltage..... 2V/div × 4 = 8V
Effective voltage..... Peak V ÷ $\sqrt{2}$ = 2.828V
Frequency, Hz ..... 1/Time (sec), or
Time = No. of DIVs per cycle × value of SEC/DIV

For the waveform in Fig. 2, frequency $= \frac{1}{5\text{ms} \times 4\text{ (div)}} = \frac{1}{20\text{ms}}$

$= 50\text{Hz}$

NOTE: Input impedance of this instrument is 1 MΩ, 20 pF in shunt. With use of a probe with 10 : 1 attenuation (10 MΩ, 22 pF in shunt) multiply the voltage reading by 10.

3.9.2 DC Voltage Measurement

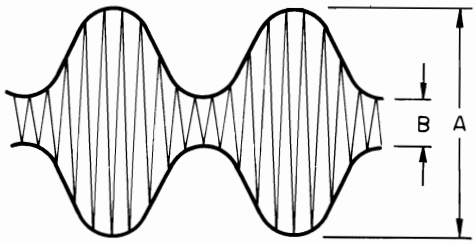
Set the AC-GND-DC switch to GND. Pull the TRIGGER LEVEL knob ⑲ and then position the trace line on the scale for the 0V reference.

Set the AC-GND-DC switch to DC, whereupon the trace will shift upward for + or downward for – polarities.

DC voltage = Shift in Div × VOLTS/DIV setting.

3.9.3 AM Modulation Measurement

There are several methods but herein the envelope method is shown. The method is applicable when the carrier frequency is within the bandwidth of this instrument. Fig. 3 shows the display of a modulated wave.



$$\text{Mod.,\%} = \frac{A-B}{A+B} \times 100$$

Fig. 3 Envelope method of AM measurement

3.9.4 Dual Trace Applications

For this application, set the MODE selector to DUAL. Signals of Channel 1 and 2 will be displayed simultaneously. The two signals can then be compared with respect to level, waveform, phase, etc.

3.9.5 Comparison of Levels

An example of interconnections is shown in Fig. 4 for the output/input level comparison of an amplifier.

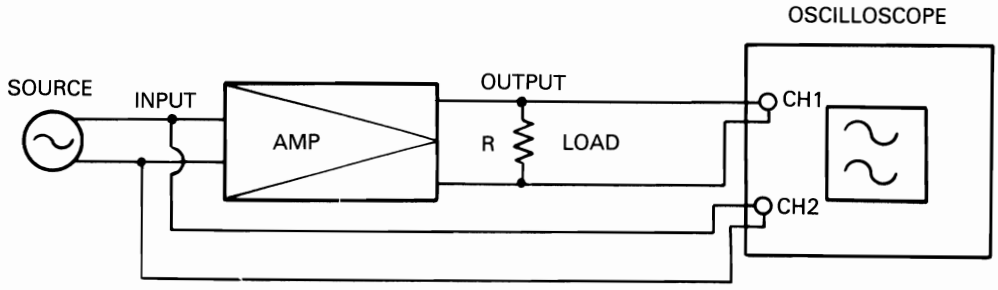


Fig. 4 Level comparison

Set the displays of CH1 and CH2 to be superimposed with use of the POSITION controls. The gain in the amplifier will be the difference in settings of the respective VOLTS/DIV switches. When signals are not matched, even if the Variable controls are adjusted, this difference is due to distortion in the amplifier. In this case, set the MODE selector to ADD and pull the POSITION knob of CH2 to view only the disportion; the trace will be a straight line when distortion is absent.

3.9.6 Checking Stereo Systems

Stereo audio systems have two symmetrical amplifier circuits. Using the dual trace feature, it is possible to compare and check the operation in each circuit. Location of any defective portion is simplified.

3.9.7 Servicing TV Sets

In this application, a triggered oscilloscope is indispensable. This instrument has synchronizing the TV-V (Frame) and TV-H (Line) of the video signal, blanking pedestal, VITS and vertical/horizontal synchronizing pulses.

3.9.11 Component Testing

Set the SEC/DIV switch to the X-Y position, and both VOLTS/DIV switches to 5 V/DIV.
Depress the COMP TEST switch ⑤. Connect the component under test to the COMP TEST IN terminals ㉘ or with leads.
In Fig. 9, displays are shown for relative values of different types of components.

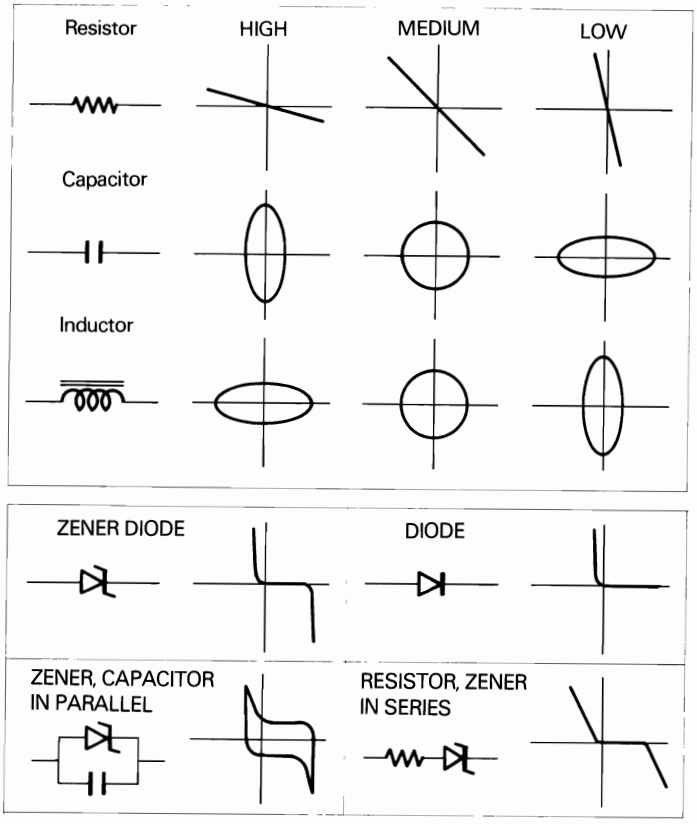


Fig. 9 Displays at COMP. TEST application

NOTE: At COMPONENT TEST operation, the terminal voltage is AC 9 Vrms at no load and the current at short-circuit is about 0.6 mA.

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

The block diagram of the MO-1251 is shown in Fig. 10.
This instrument has two identical input attenuators and preamplifiers. The input signal is attenuated to the required level, preamlified and fed to the trigger pick-off circuit and on to the switching circuit.
At the trigger pick-off circuit, a part of the signal is fed to the trigger select logic for either CH2 or INT (CH1 + CH2) and on to the trigger amplifier of the TIME BASE UNIT.
The switching circuit is made up with a diode-gate and mode control logic to select CH1, CH2 and DUAL. Following the switching circuit, the signal is amplified and fed to the cascade type final stage amplifier for the vertical deflection.
The trigger or an external trigger signal is amplified and reformed to a clock pulse to drive the following sawtooth generator circuit consisting of JKRS flip-flops and sweep controller, FET input Miller integrator and hold-off.
The sawtooth wave generated by the clock pulse is fed to a differential amplifier equipped with a stabilized current supply for the horizontal deflection.
For X-Y operation, the CH2 input signal is applied to the pick-off circuit, sweep X-Y selector and on to the horizontal final amplifier.
The Q signal in the sweep control flip-flop and NAND of chopper rising edges are used for unblanking and chop-blanking. It is then fed to a cascade amplifier with a constant current load, a DC producing circuit and then added to a high voltage, and fed between the control grid and cathode of the CRT. The CRT is blanked during the trace fly-back and while waiting for the trigger and chop changeover time.
All the power supplies are regulated for stability in operation.
A feed-back type DC-DC converter is used in generating the stabilized high voltage to the CRT.

4.2 VERTICAL AMPLIFIER CIRCUIT

The vertical input signal from the BNC connector is selected with the AC-GND-DC switch and applied to the first attenuator for 20 dB attenuation. The output from the protection circuit Q1 (Q25) is fed to the dual FET with high input impedance. The FETs are well-balanced against temperature variation. The output is then applied to the second attenuator IC1 (IC2). The latter attenuators make selection of 1/1, 1/2 and 1/4 steps to modify the gain of IC1 (IC2). After DC balancing, then through VR1, 3 and 4 (VR7, 9 and 10) the output signal is fed to the diode switching circuit, D2-5, 16-19 as well as to the trigger amplifier, Q7, 8, 31 and 32.

The mode logic circuit, controlled by the MODE switch, makes the selection of dual-trace, single-trace chopped and alternate. Dual-trace operation is done with the trigger select logic circuit driven by the TRIGGER SOURCE switch while the vertical MODE switch operates prior to the TRIGGER SOURCE switch and selects a proper trigger signal for single-trace operation. In the single-trace operation, triggering is automatically logic controlled according to the vertical MODE switch prior to the TRIGGER SOURCE selector.

In X-Y operation, the CH2 signal, controlled by the SEC/DIV switch, is supplied to the trigger amplifier and fed to the horizontal amplifier as the X signal.

The vertical signal through diode switching circuit passes the limiter circuit of Q11, 12 and D6-9 to attain adequate level and then fed to the output amplifier, Q15-24. The output is sufficiently amplified in the feedback type amplifier with the constant current circuit, Q19, 20, 23 and 24. The amplifier is equipped with the booster, Q21, 22, for high frequency components to obtain flat response. The signal is then fed to the vertical deflection plates of the CRT.

4.3 HORIZONTAL/TIME BASE CIRCUIT

The time base circuit consists of the following sections: trigger, sawtooth and amplifier. The trigger select output is fed to the sweep X-Y select circuit Q11-14. This latter circuit functions as the internal trigger amplifier and the saw-tooth vave amplifier in normal operation as well as the amplifier for the CH2 signal in X-Y operation. The internal trigger signal is amplified by IC6 and fed to the Schmitt circuit, 1/2 IC1. The external trigger signal is directly fed to IC6. With TRIGGER SOURCE switch set to HF REJ, noise and high frequency components in the trigger source are eliminated. When the TRIGGER SOURCE switch is set to TV, the IC output is connected to the TV sync separator, Q1, 2, for the horizontal sync signal, TV-H, or vertical sync signal TV-V to be supplied to the Schmitt circuit. Changeover of the TV-H and TV-V is done automatically with the SEC/DIV switch. The Schmitt trigger circuit signal is shaped into square waves to be clock pulses for the sweep control gate, IC5. The clock pulse is also supplied to the auto sweep, Q4, 1/2IC3. With no trigger input the auto sweep circuit output will be at low level and therefore the sweep gate starts the automatic sweeping. With the trigger input, or supply of clock pulse, the auto sweep circuit output will be at high level and the gate F-F is inverted by the clock pulses and the Miller integrator becomes charged. Further, the auto-circuit output actuates Q23 on and off. When the gate F-F is inverted and sets Q7 to off, the Miller integrator determines the sweep time with the CR time constant selected with the SEC/DIV switch to generate saw-tooth waves with excellent linearity. At full rise of the Miller integrator output, the hold-off F-F is inverted and the sweep stops during the time determined by the hold-off time constant. After the hold-off time, the next clock pulse is set in the standby mode and thereby the sweep returns to the original status.

The output of the Miller integrator passes through the sweep X-Y select circuit and applied to the horizontal amplifier, Q17-20. In the amplifier, with use of the X5MAG switch, the sweep time is expanded by a factor of 5. With the SEC/DIV switch set to the X-Y position, the sweep X-Y select circuit is switched to separate the Miller integrator from the horizontal amplifier and vertical CH2 input section is used as a horizontal amplifier. In the chopped operation, blanking effects are obtained with use of the horizontal Q output and the Chop signal generator. In the alternate operation, the effects are given by the Q output.

The output from the multivibrator of IC4 is shaped for the calibrating voltage output. The variable resistor, VR3 is used in adjusting the output level to 0.5 Vp-p.

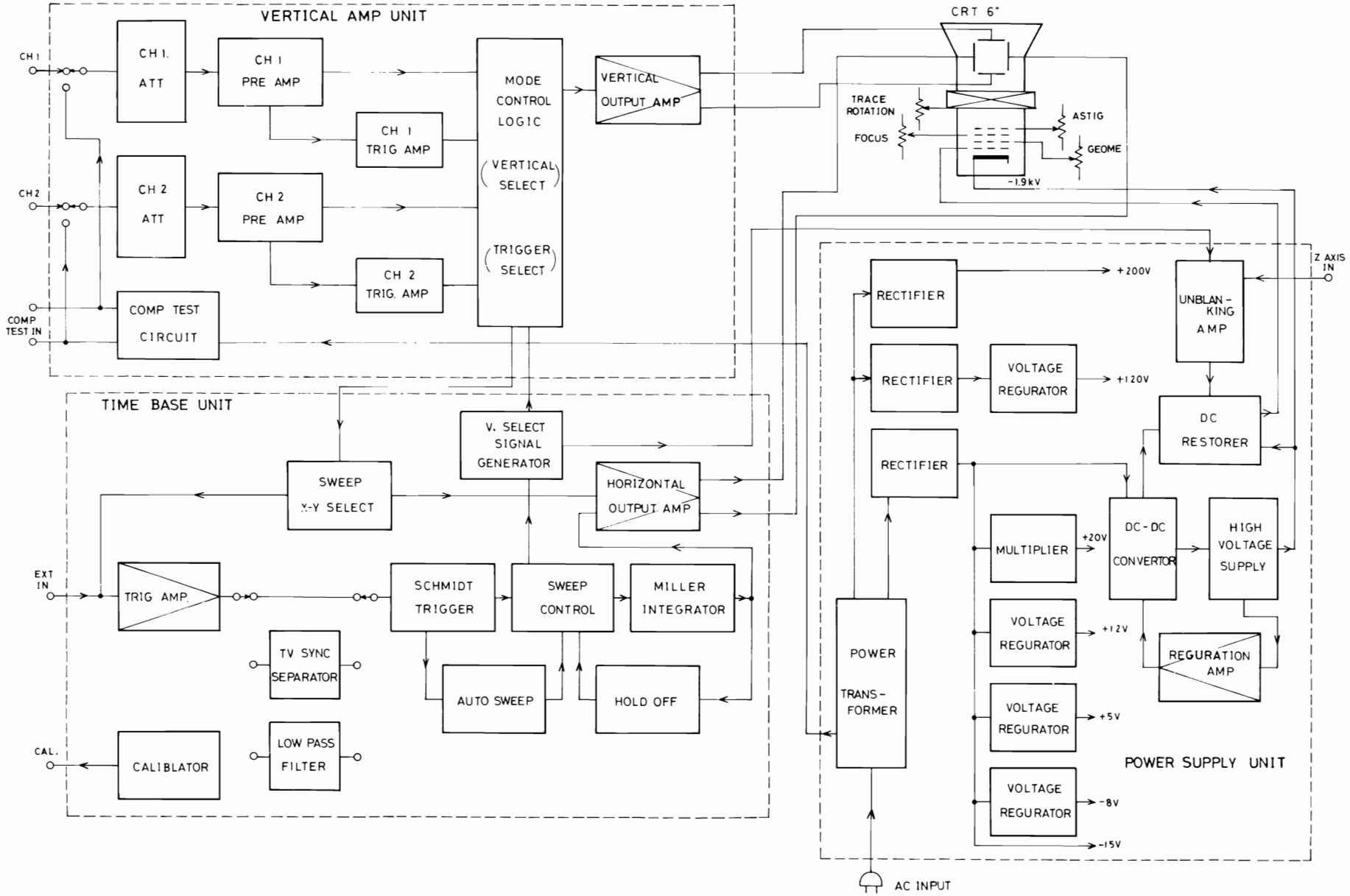


Fig. 10 Block Diagram

SECTION 5
MAINTENANCE & ADJUSTMENTS

5.1 GENERAL

This section contains information for preventive maintenance, adjustment and calibration.

5.1.1 Preventive maintenance

Preventive maintenance consists of periodic cleaning, and recalibration of the oscilloscope. It should be performed on a regular bases to keep the instrument in its best operational and appearance condition.

5.1.2 Cleaning

Accumulation of dirt, dust and grime should be removed whenever they become noticeable. The frequency of cleaning is largely dependent upon the environment in which the instrument is used. Dirt on the outside covers may by removed with a soft cloth moistened with a diluted household cleaning solution.

5.1.3 Recalibration

Recalibration of the instrument at regular intervals will assure that measurements within the accuracy specification. It is recommended that the instrument be recalibrated after 1000 hours of operation, or twice a year. The calibration procedures are provided in the latter part of this section of the manual.

5.2 ADJUSTMENT AND CALIBRATION

Most of the problems resulting in a malfunction will be a defective component or a mechanical defect. Verify that the problem is not due to an incorrect switch position. The CRT display can be a valuable aid in pinpointing the area of many problems. The defect of any of the amplifiers, triggering circuit will be noticeable on the CRT.

5.2.1 Power Supply Unit Adjustments

Some problems may result severe loading on the power supplies.

1. VOLTAGE ADJUSTMENTS
   When voltages are out of adjustments, careful realignments may be necessary.
   a. 175V Adjustment
      Adjust VR6 to obtain 175V ±0.5V between the 1st pin on connector P4 and the ground. +12V, +5V, –8V, –15V, +120V, +20V at 2, 3, 5, 6 and 2nd of pin 3 respectively.
   b. –1.9 kV Adjustment
      Adjust VR1 to obtain –1.9 kV between the 2nd pin of P7 and the ground.
   c. Adjust VR2 to locate the left end of the trace line (0.2 μs/DIV) at the same place as other ranges of SEC/DIV switch.
   d. Adjust VR3 to obtain +70V at the 8th pin of the P7.
   e. Adjust VR5 so that the trace line dims when INTENSITY is at 9 o'clock.
   f. Adjust VR4 for ASTIG.

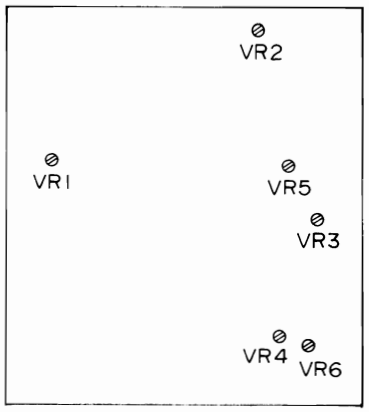


Fig. 12 Power supply unit

5.2.2 Vertical Amplifier Unit Adjustments

1. ADJUSTMENTS OF ATTENUATORS
   When the voltage readings are in error or waveform is distorted.
   a. Adjustments of voltage reading (VOLTS/DIV)
      Adjustments: VR5 for CH1
      VR11 for CH2
   b. Adjusting Balance of attenuator steps
      When trace line shifts with the change of VOLTS/DIV switch.
      Adjustments: VR1 for CH1
      VR7 for CH2
   c. Adjustments of DC Balance (Variable)
      When trace line moves up or down while turning Variable knob.
      Adjustments: VR3 for CH1
      VR9 for CH2
2. ADJUSTMENTS OF VERTICAL AMPLIFIER
   a. When trace lines shift with the change of DC-GND-AC slide switch.
      Short the Test Pin and adjust VR6
   b. Adjustment of Vertical POSITION's Linearity
      Adjust VR4 for CH1 and VR10 for CH2
3. ADJUSTMENT OF X-AXIS AMPLIFIER GAIN
   After both channels are confirmed to be correct in normal operations, Set the SEC/DIV switch to X-Y. If there is difference of sensitivity in Y-axis and X-axis, adjust VR12.
4. ADJUSTMENT OF ATTENUATOR TRIMMERS

   a. CH1

TC1	1/10	ATT Square waveform ADJ
TC2	1/10	ATT Input Capacitance ADJ
TC3	1/100	ATT Square waveform ADJ
TC4	1/100	ATT Input Capacitance ADJ
TC5	1/1000	ATT Square waveform ADJ
TC6	1/1000	ATT Input Capacitance ADJ

   b. CH2

TC7	1/10	ATT Square waveform ADJ
TC8	1/10	ATT Input Capacitance ADJ
TC9	1/100	ATT Square waveform ADJ
TC10	1/100	ATT Input Capacitance ADJ
TC11	1/1000	ATT Square waveform ADJ
TC12	1/1000	ATT Input Capacitance ADJ

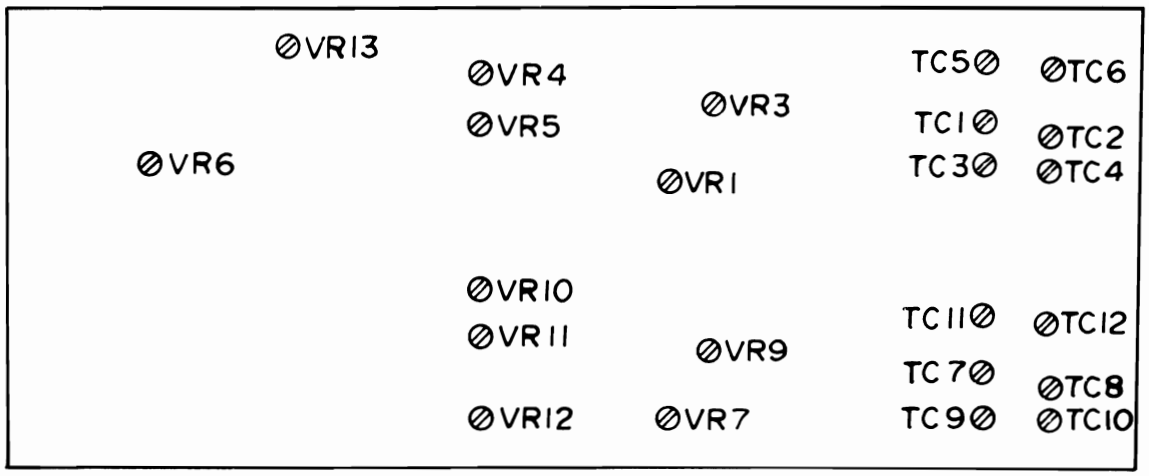


Fig. 13 Vertical Amplifier Unit

5.2.3 Horizontal/Time Base Unit Adjustments

1. ADJUSTMENT OF SEC/DIV (A standard time marker generator required.)
   a. Adjust VR8 for realignment of the range from 0.1 msec/DIV to 0.5 sec/DIV.
   b. Adjust TC2 for realignment of the range from 1 μsec/DIV to 50 μsec/DIV.
   c. Adjust TC1 for realignment of the range of 0.2 μsec/DIV.
2. ADJUSTMENT OF X5 MAGNIFIER
   a. When magnification is inaccurate.
      Adjust VR12
   b. Shift of center position of screen. Adjust VR7 to obtain the same center position when the display is magnified.
3. OTHERS BESIDES TIME BASE CIRCUIT
   a. Adjustment of Horizontal POSITION
      When shift range is unbalanced to left and right. Adjust VR11 to obtain the same shift ranges.
   b. Adjustment of Sweep Linearity
      Adjust VR10
4. ADJUSTMENT OF TRIGGERING
   When the starting point shifts with the change of SLOPE switch (+ to –, or vice versa), Adjust VR5.
5. ADJUSTMENT OF X-AXIS (X-Y) POSITION
   With SEC/DIV control set at (X-Y), check if shift is balanced when X-axis POSITION (CH2 Vertical POSITION) is turned. If there is unbalance, Adjust VR9.
6. ADJUSTMENT OF TRACE LINE LENGTH
   Adjust VR13 to obtain the length of 11 division on CRT screen.
7. ADJUSTMENT OF CAL SQUAREWAVE
   Adjust VR3 to obtain 0.5 Vp-p at the CAL terminal.
8. ADJUSTMENT OF DUTY RATIO OF CAL SQUAREWAVE
   Adjust VR1 and VR2
9. ADJUSTMENT OF UNBLANKING START POSITION
   Adjust TC3
10. ADJUSTMENT OF 0.5 μS/DIV MAG LINEARITY
    Adjust TC4
11. ADJUSTMENT OF 0.5 μS/DIV LENGTH
    Adjust TC5

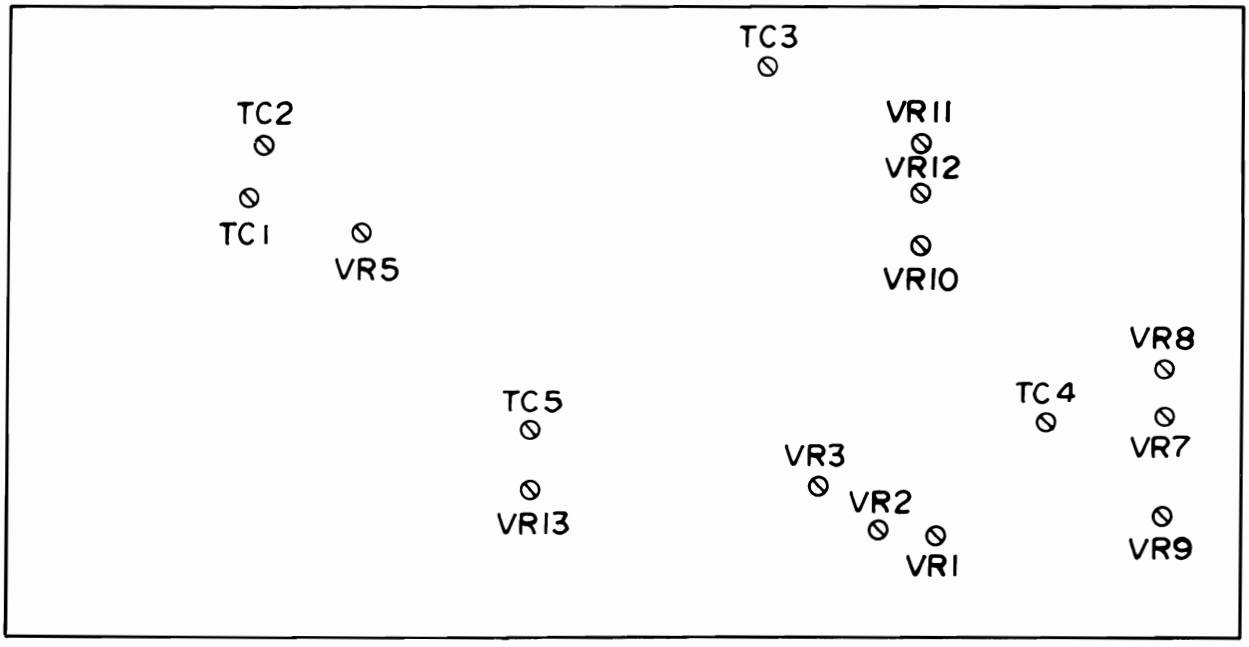


Fig. 13 Horizontal/Time Base Unit

SECTION 6
PARTS LIST

6.1 CHASSIS (700-1110-00)

REF. NO.	PART NO.	DESCRIPTION	
	100-1020-03	Case Top	
	100-1021-03	Case Bottom	
	118-1016-12	Ornamental Panel	
	150-1001-04	Side Escutcheon	
	126-1008-02	Rear Panel	
	140-1033-03	Frame (A)	
	140-1034-03	Frame (B)	
	140-1035-03	Frame (C)	
	140-1036-03	Frame (D)	
	140-1037-03	Frame (E)	
	140-1038-03	Side Frame (right)	
	140-1039-03	Side Frame (left)	
	160-1014-04	P.T.Holder Plate	
	160-1015-03	CRT Holder	
	160-1013-04	VR Mounting Metal	
	160-1017-04	Metal Mount for Slide SW	
	200-1000-03	CAL Terminal	
		GND Terminal	
		Moulded Terminal	
	205-1000-05	Power Connector	
	215-1000-05	CRT Socket	
	235-1000-04	Mould Bearing	
	255-1006-03	CRT Band (A)	
	255-1007-03	CRT Band (B)	
	260-1000-05	BNC Receptacle	
	330-1002-04	Shield Plate	
	330-1032-04	Shield Plate (A)	
	400-1002-05	Handle	
	405-1002-05	Rubber Leg	
	405-1004-03	Moulded Leg	
	405-1005-03	Stand	
	415-1002-03	Bezel	
	420-1017-04	Knob for T.Position, V.Position × 2, Iten, Focus, Trig Level	
	420-1030-04	Knob for T.Rotary SW	
	420-1012-04	Knob for T.Variable, V.Variable × 2	
	420-1029-04	Knob for AC-GND-DC × 2, Slope, Sync, Source, Mode	
	420-1018-04	Knob for Comp Test SW	
	420-1016-04	Knob for V.Rotary SW × 2	
	430-1000-04	CRT Screen Filter	
	002-1000-05	Potentiometer	1kΩ
	002-1001-05	Potentiometer	20kΩ
	002-1017-05	Potentiometer	2MΩ
	002-1007-05	Potentiometer	1kΩ
	002-1012-05	Potentiometer	50kΩ
	002-1016-05	Potentiometer	50kΩ
	020-1006-05	Slide Switch	
	024-1004-05	Push Switch	
	026-1000-05	Toggle Switch	
	040-1007-05	Power Transformer	
	050-1003-05	Rotation Coil	
	080-1002-05	Fuse	1A

REF. NO.	PART NO.	DESCRIPTION			
	080-1004-05	Fuse	0.5A		
		CRT			
		LED			
		LED Holder			

6.2 VERTICAL AMPLIFIER UNIT (734-1040-00)

S1,2	018-1005-05	Rotary Switch			
S3	022-1009-05	Lever Switch			
VR2,8	002-1004-05	Potentiometer	5kΩ		
IC1,2	HA1127G	Linear IC	(CA3046)		
IC5	SN74LS03N	IC(LSTTL)			
IC3	CD4001B	IC(C²MOS)	(MC14001B)		
IC4	CD4011B	IC(C²MOS)	(MC14011B)		
Q2,26	2SK58-1-M	Dual FET			
Q1,25	2SK30A(O)	Dual FET			
Q19,20	2SA818(Y)	Transistor			
Q17,18	2SC1628(Y)	Transistor			
Q7,8,12,13,14,31,32	2SA836(D)	Transistor			
Q11,15,16,23,24,33,34	2SC458(D or E)	Transistor			
Q3,4,5,6,9,10,27,28,29,30	2SC535(B)	Transistor			
Q21,22	2SA781(K)	Transistor			
D1-9,11,15-24	1S1588	Diode			
D10,14	HZ5C2	Zener Diode			
VR3,4,9,11,12	008-1004-05	Potentiometer	100ΩB		
VR1,7,13	008-1006-05	Potentiometer	1kΩB		
VR6	008-1007-05	Potentiometer	470kΩB		
VR4,10	008-1013-05	Potentiometer	680ΩB		
TC1,3,5,7,9,11		Trimmer	4pF		
TC2,4,6,8,10,12,13		Trimer	10pF		
R8,112	RN14BK2H1004F	Metal Film Resistor	1MΩ	±1%	1/2W
R6,110	RN14BK2H9993F	Metal Film Resistor	999kΩ	±1%	1/2W
R4,108	RN14BK2H9903F	Metal Film Resistor	990kΩ	±1%	1/2W
R2,106	RN14BK2H9003F	Metal Film Resistor	900kΩ	±1%	1/2W
R3,107	RN14BK2E1113F	Metal Film Resistor	111kΩ	±1%	1/4W
R78,82	RN14BK2E1003F	Metal Film Resistor	100kΩ	±1%	1/4W
R80	RN14BK2E4302F	Metal Film Resistor	43kΩ	±1%	1/4W
R36,37,139,140	RN14BK2E1202F	Metal Film Resistor	12kΩ	±1%	1/4W
R5,109	RN14BK2E1012F	Metal Film Resistor	10.1kΩ	±1%	1/4W
R21,22,125,126	RN14BK2E8201F	Metal Film Resistor	8.2kΩ	±1%	1/4W
R12,13,116,117	RN14BK2E6801F	Metal Film Resistor	6.8kΩ	±1%	1/4W
R64,66,71	RN14BK2E4701F	Metal Film Resistor	4.7kΩ	±1%	1/4W
R63	RN14BK2E3301F	Metal Film Resistor	3.3kΩ	±1%	1/4W
R44,45,149,150	RN14BK2E3001F	Metal Film Resistor	3kΩ	±1%	1/4W
R85,93	RN14BK2E2201F	Metal Film Resistor	2.2kΩ	±1%	1/4W
R32,136	RN14BK2E1501F	Metal Film Resistor	1.5kΩ	±1%	1/4W
R7,23,57,60,111,127	RN14BK2E1001F	Metal Film Resistor	1kΩ	±1%	1/4W
R24,129	RN14BK2E8200F	Metal Film Resistor	8.7kΩ	±1%	1/4W
R39,40,142,143	RN14BK2E6800F	Metal Film Resistor	6.8kΩ	±1%	1/4W
R29,31,133,135	RN14BK2E4700F	Metal Film Resistor	4.7kΩ	±1%	1/4W
R35,138	RN14BK2E3300F	Metal Film Resistor	3.3kΩ	±1%	1/4W
R26,131	RN14BK2E2200F	Metal Film Resistor	2.2kΩ	±1%	1/4W
R46,153	RN14BK2E82ROF	Metal Film Resistor	82kΩ	±1%	1/4W
C10,12,48	CE04W1C220RC2	Electrolytic Capactor	22μF		16WV
C7,18,22,45,59,63	CE04W1H4R7RC2	Electrolytic Capacitor	4.7μF		50WV

REF. NO.	PART NO.	DESCRIPTION			
C15,16,17,20,25	CE04W1H1RORC2	Electrolytic Capacitor	1μF		50WV
C6,24,44,62	DD600BC104Z12V	Ceramic Capacitor	0.1μF		12WV
C27,32	CQ92M1H103K	Mylar Capacitor	0.01μF	±10%	50WV
C26,31,33,34,38	CK45E2H103P	Ceramic	0.01μF		500WV
C60	CK45E1H103P	Ceramic	0.01μF		50WV
C5,43		Metal Film Capacitor	0.0μF	±10%	600WV
C4,42	CM93D1H152J	Myca Capacitor	1500pF	±5%	50WV
C2,40	CM93D1H221J	Myca Capacitor	220pF	±5%	50WV
C1,39	CM93D1H330J	Myca Capacitor	33pF	±5%	50WV
C29,65,67	CC45CHIH101J	Ceramic Capacitor	100pF	±5%	50WV
C61,36	CC45CHIH560J	Ceramic Capacitor	56pF	±5%	50WV
C55,57,64	CC45CHIH470J	Ceramic Capacitor	47pF	±5%	50WV
C9,13,19,47,52	CC45CHIH220J	Ceramic Capacitor	22pF	±5%	50WV
C35	CC45CHIH200J	Ceramic Capacitor	20pF	±5%	50WV
C21	CC45CHIH150J	Ceramic Capacitor	15pF	±5%	50WV
C8,46,11,50	CC45CHIH5ROD	Ceramic Capacitor	5pF		50WV
C3,41	CC45CH2H2ROD	Ceramic Capacitor	2pF		500WV
C23,28	CC45CH2H1ROD	Ceramic Capacitor	1pF		500WV
C66,68	CC45CH1H180J	Ceramic Capacitor	18pF	±5%	50WV
L7,8		Ferri Inductor	470μH		
L1,2,3,4		Ferri Inductor	47μH		
L5,6		Ferri Inductor	1μH		

6.3 TIME BASE UNIT (736-1040-00)

L2		Ferri Inductor		
L3		Ferri Inductor		
L1		Ferri Inductor		
IC6	μ733DC	IC (VIDEO AMP)		
IC1	SN74LS00	IC (LSTTL)		
IC5	SN74LS76	IC (LSTTL)		
IC2	SN7400	IC (TTL)		
IC3,4	MC14572UB	IC (C^2MOS)		
Q8	2SK30A (0)	FET		
Q4,7,10,11,12,13,14,15	2SA836	Transistor		
Q16,22,24	2SA836	Transistor		
Q1,2,3,6,9,17,18,21,23	2SC458 (D)	Transistor		
Q15,16,25,26	2SC458 (D)	Transistor		
Q19,20	2SC1628	Transistor		
D4	IN60	Diode		
D5,10	IS1587	Diode	(IS2076A)	
D1,2,3,6,7,8,9,13,14,15	IS1588	Diode	(IS2076)	
D16,17,18,20	IS1588	Diode	(IS2076)	
D11,12	HZ5C2	Zener Diode		
D19	HZ12C2	Zener Diode		
VR4,S5	002-1005-05	Potentiometer	20kΩ	
VR6	002-1006-05	Potentiometer	10kΩ	
S4	018-1008-05	Rotary Switch		
S1	022-1011-05	Lever Switch		
S2	022-1010-05	Lever Switch		
S3	022-1009-05	Lever Switch		
VR13,14	008-1017-05	Potentiometer	100kΩ	
VR1,2,5,7,8	008-1018-05	Potentiometer	50kΩ	
VR9	008-1019-05	Potentiometer	20kΩ	
VR3	008-1020-05	Potentiometer	5kΩ	

REF. NO.	PART NO.	DESCRIPTION		
VR11	008-1021-05	Potentiometer	200Ω	
VR10	008-1025-05	Potentiometer	1kΩ	
VR12	008-1026-05	Potentiometer	500kΩ	
VR15	008-1023-05	Potentiometer	10kΩ	
R48	RKS1/4P3MF	Metal Film Resistor	3MΩ	±1% 1/4W
R39,42,44	RN14BK2E1003F	Metal Film Resistor	100kΩ	±1% 1/4W
R45	RN14BK2E3003F	Metal Film Resistor	300kΩ	±1% 1/4W
R46	RN14BK2H5003F	Metal Film Resistor	500kΩ	±1% 1/2W
R47	RN14BK2H1004F	Metal Film Resistor	1MΩ	±1% 1/2W
R94,95	RS14AB3F682G	Metal Film Resistor	6.8kΩ	±2% 3W
TC1,2,3,4,5		Trimmer	10pF	
C19		Metal Film Capacitor	0.47μF	200WV
C20		Metal Film Capacitor	0.0047μF	
C5,13,15,23,30,31,33,45,	DD600BC104Z12V	Ceramic Capacitor	0.1μF	12WV
C51,52,53	CEO4W1A331	Electrolytic Capacitor	330μF	10WV
C50	CEO4W1C221	Electrolytic Capacitor	220μF	16WV
C8	CEO4W1A470	Electrolytic Capacitor	47μF	10WV
C47,48,49	CEO4W1C220RC2	Electrolytic Capacitor	22μF	16WV
C41	CEO4W2E4R7	Electrolytic Capacitor	4.7μF	250WV
C7,12,14,29,34	CEO4W1H1RORC2	Electrolytic Capacitor	1μF	50WV
C40	CK45E2H103P	Ceramic	0.01μF	500WV
C4,18,35	CK45E1H103P	Ceramic	0.01μF	50WV
C24,25	CK45E1H561M	Ceramic	560pF	50WV
C37,38	CK45E1H471M	Ceramic	470pF	50WV
C26,42	CC45CH1H221J	Ceramic	220pF	50WV
C28,43	CC45CH1H151J	Ceramic	150pF	50WV
C39	CC45CH1H680J	Ceramic	68pF	50WV
C1,17,27	CC45CH1H470J	Ceramic	47pF	50WV
C21	CC45CH1H390J	Ceramic	39pF	50WV
C10	CC45CH1H221J	Ceramic	220pF	50WV
C22	CC45CH1H150J	Ceramic	15pF	50WV
C44	CC45CH1H120J	Ceramic	12pF	50WV
C11,16	CC45CH1H100J	Ceramic	10pF	50WV
C3	CC45CH2H5ROD	Ceramic	5pF	500WV
C32	CC45CH2H1ROD	Ceramic	1pF	500WV
C6	CQ92M1H104K	Mylar Capacitor	0.1μF	50WV
C46	CQ92M1H223K	Mylar Capacitor	0.022μF	50WV
C2	CQ92M1H472K	Mylar Capacitor	4700pF	50WV
C9	CQ92M1H222K	Mylar Capacitor	2200pF	50WV
C36	CQ92M1H102K	Mylar Capacitor	1000pF	50WV

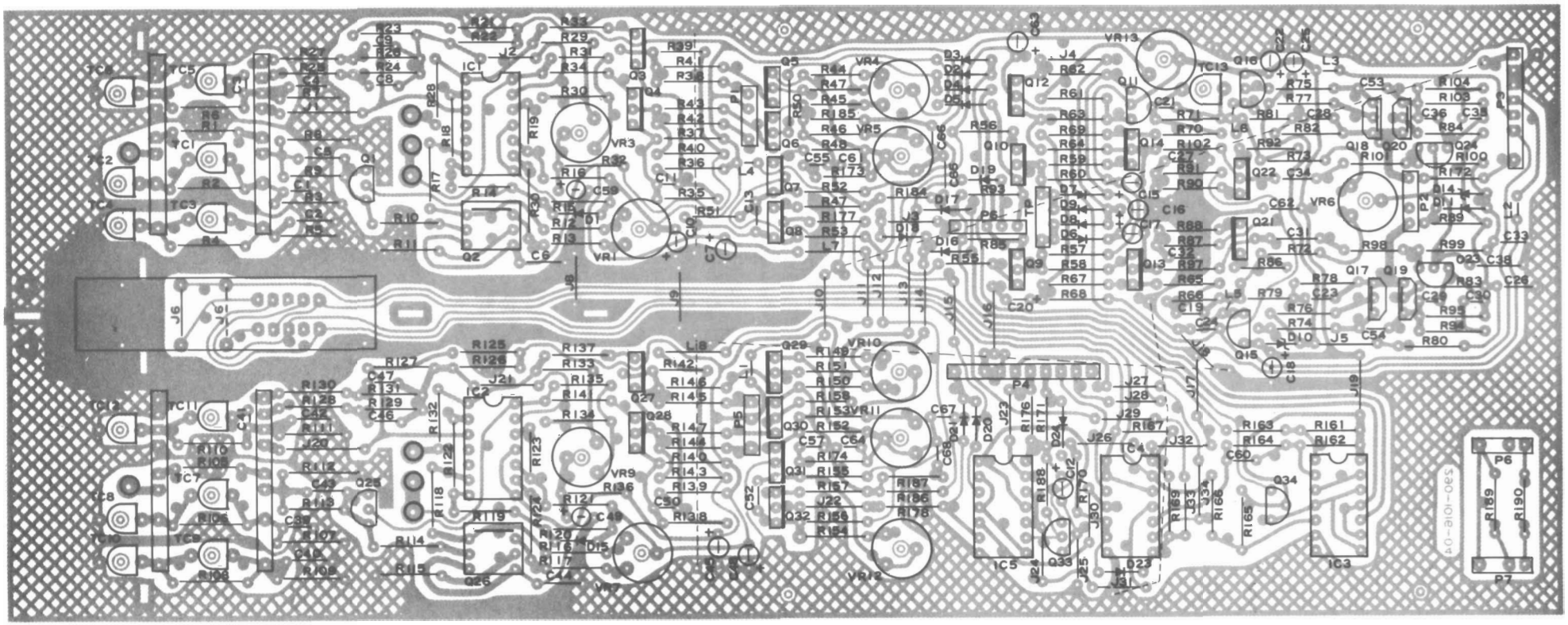
6.4 POWER SUPPLY UNIT (732-1040-00)

F1	080-1003-05	Mini Fuse	0.5A
	225-1000-05	Fuse Holder	
	040-1008-05	Converter Transformer	
L1		Inductor Coil	470μH
L2		Inductor Coil	4.7μH
VR3,4	008-1022-05	Potentiometer	1MΩ
VR5	008-1017-05	Potentiometer	100kΩ
VR1	008-1018-05	Potentiometer	50kΩ
VR2	008-1023-05	Potentiometer	10kΩ
VR6	008-1024-05	Potentiometer	2kΩ
N1,2,3,4	NE38B	Neon Lamp	
IC1	μA741TC	IC	
IC2	μA8912	IC	

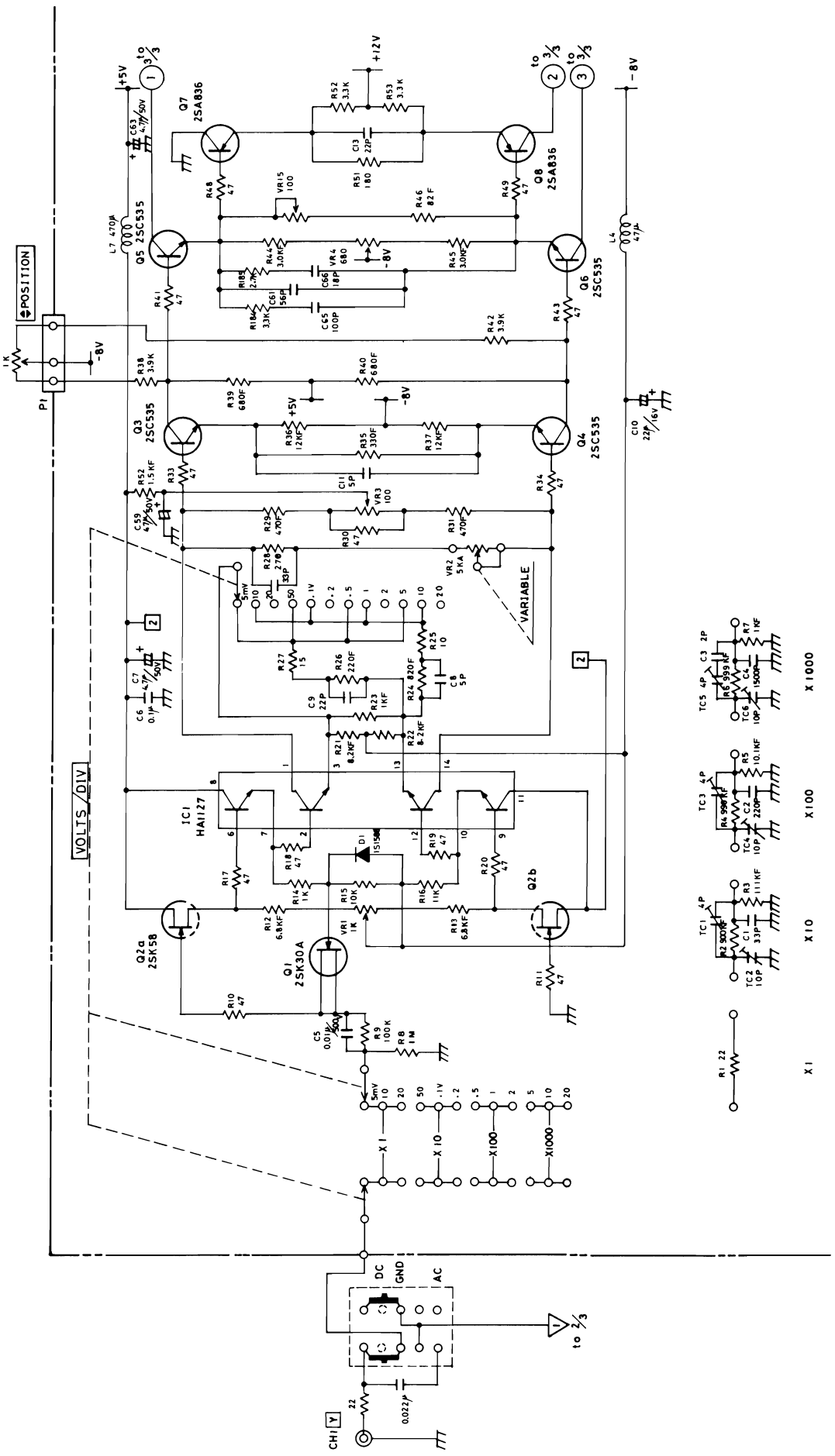
REF. NO.	PART NO.	DESCRIPTION		
IC3	μA7805	IC		
IC4	μA7908	IC		
IC5	μA78L15	IC		
Q3,6,11	2SA836	Transistor		
Q1	2SD596(D)	Transistor		
Q2,5,10	2SC458(D)	Transistor		
Q8,9,12	2SC1885	Transistor		
Q4	2SD401(K)	Transistor		
D1,2,3	2W02	Diode		
D6,18	Y16GA	Diode		
D4,12,13	1S1588	Diode	(1S2076)	
D15,16	V06C	Diode		
D7,8,9,10	1SS83	Diode		
D11,17	HZ5C2	Zener Diode		
D14	HZ4B3	Zener Diode		
S1	SDT 1000	Thermister	10kΩ	
(Ordinary carbon resistors are not listed.)				
R6	RN14BK2E4701F	Metal Film Resistor	4.7kΩ	±1% 1/4W
R5	RN14BK2E1203F	Metal Film Resistor	120kΩ	±1% 1/4W
R10	RN14BK2E3901	Metal Film Resistor	3.9kΩ	±1% 1/4W
C31	CQ92M1H104K	Mylar Capacitor	0.01μF	50WV
C14	CQ92M1H473K	Mylar Capacitor	0.047μF	50WV
C39	CQ92M1H472K	Mylar Capacitor	0.47μF	50WV
C43	CQ92M1H222K	Mylar Capacitor	0.22μF	50WV
C28	DD600BC104Z12V	Ceramic Capacitor	0.1μF	12WV
C30	CC45SL2H1ROD	Ceramic	1pF	500WV
C18,19,30,21,23,25,38	CC45E3D103P	Ceramic	0.01μF	2000WV
C22,27,29,32	CC45E2H103P	Ceramic	0.01μF	500WV
C18,19,21,23,25,30,38	CC45E3D103P	Ceramic	0.01μF	2000WV
C22,27,29,32	CC45E2H103P	Ceramic	0.01μF	500WV
C16	CC45E1H103P	Ceramic	0.01μF	50WV
C34	CC45E2H102P	Ceramic	1000pF	500WV
C35	CC45E1H681M	Ceramic	680pF	50WV
C7,10,42	CE04W1E222	Electrolitic Capacitor	2200μF	25WV
C8	CE04W1E471	Electrolitic Capacitor	470μF	25WV
C37	CE04W1H221	Electrolitic Capacitor	220μF	50WV
C3,40	CE04W2E330	Electrolitic Capacitor	33μF	250WV
C5,6	CE04W2E100	Electrolitic Capacitor	10μF	250WV
C9,13,17,41	CE04W1HRORC2	Electrolitic Capacitor	1μF	50WV
C24	CE04W2E1RO	Electrolitic Capacitor	1μF	250WV
	330-1030-03	Shield Case for DC-DC		

SECTION 7
PARTS LOCATION AND SCHEMATICS

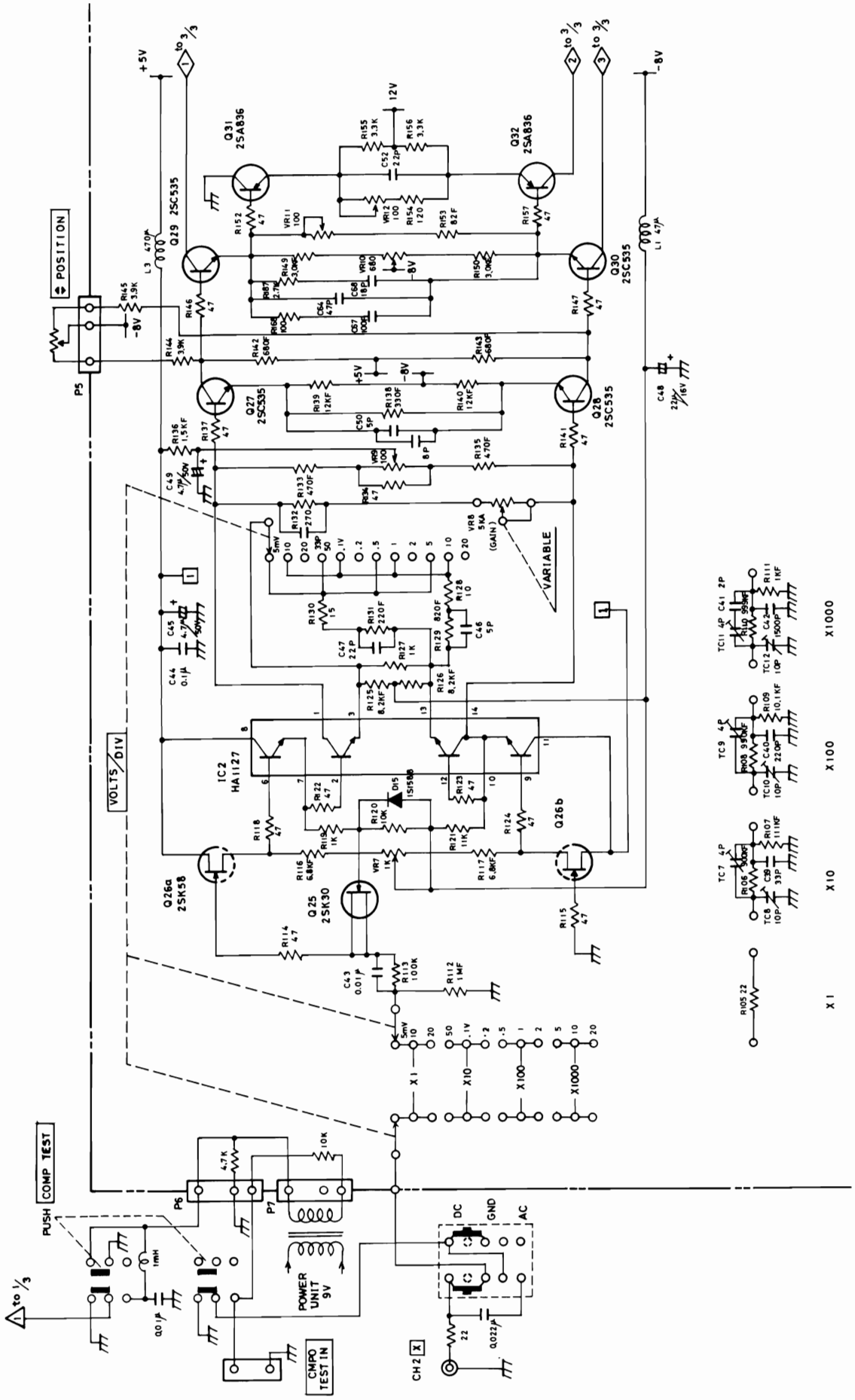
7.1 VERTICAL AMPLIFIER UNIT BOARD



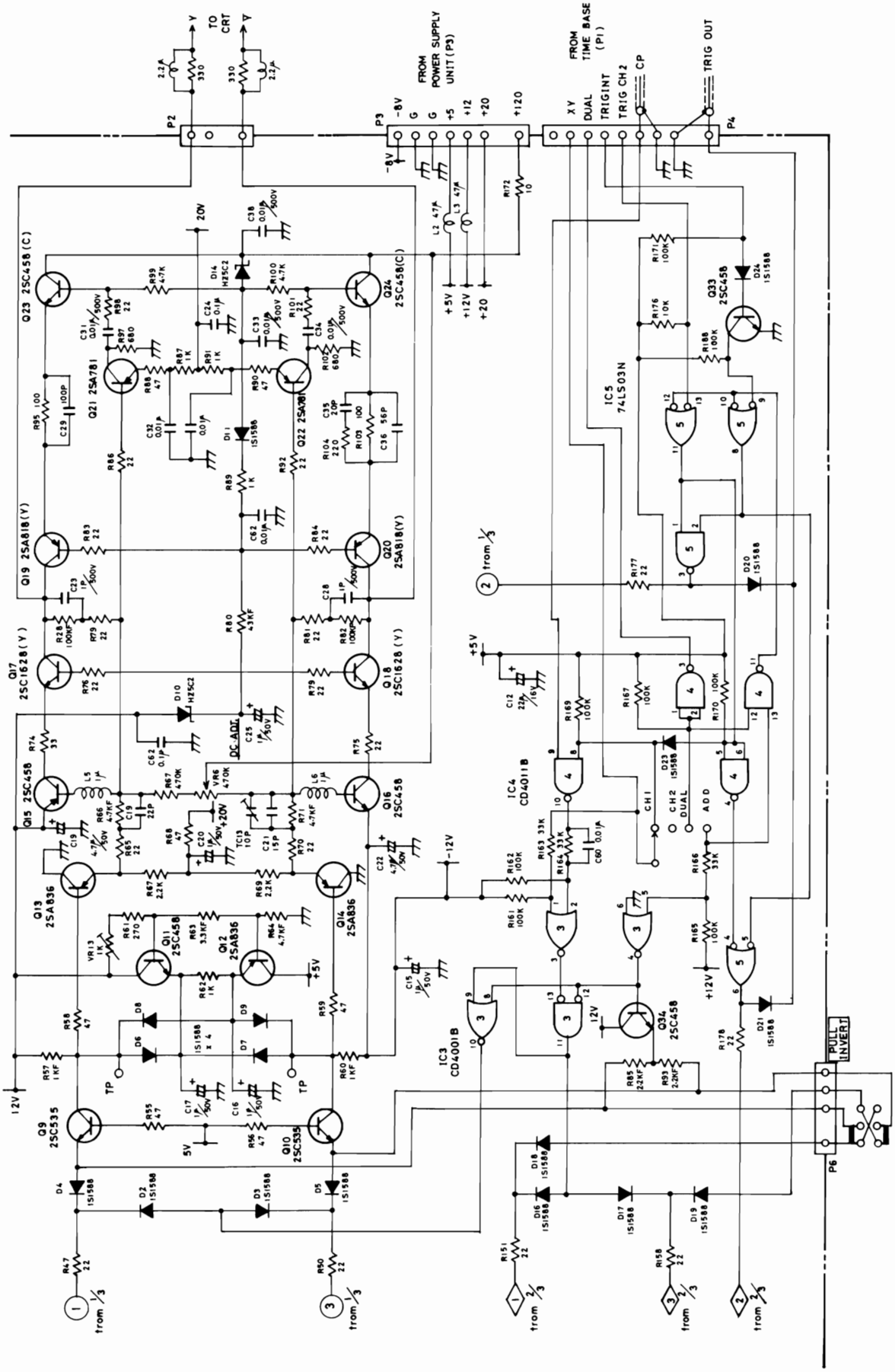
7.1.1 Vertical Amplifier Schematic (1/3)



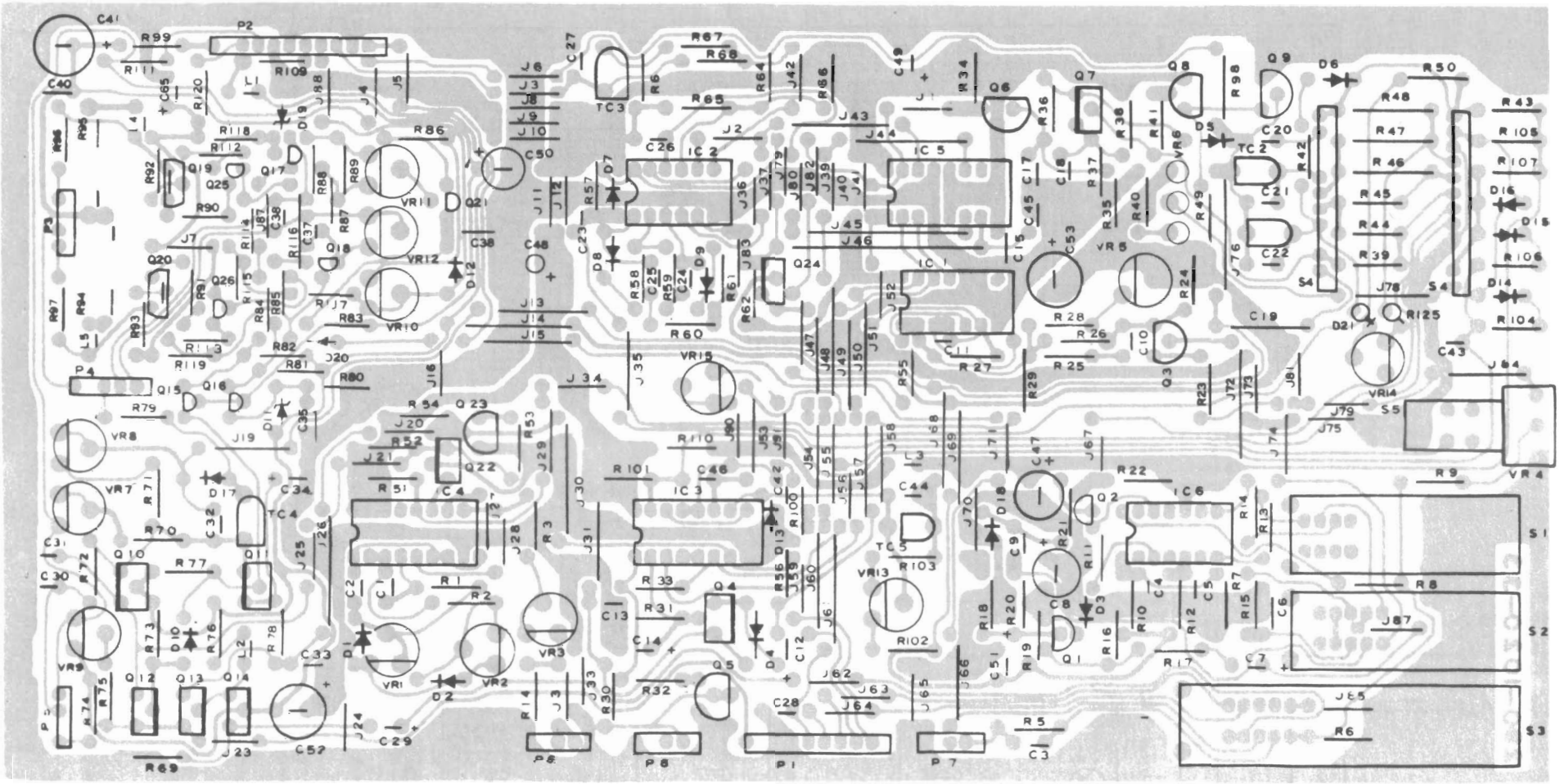
7.1.2 Vertical Amplifier Schematic (2/3)



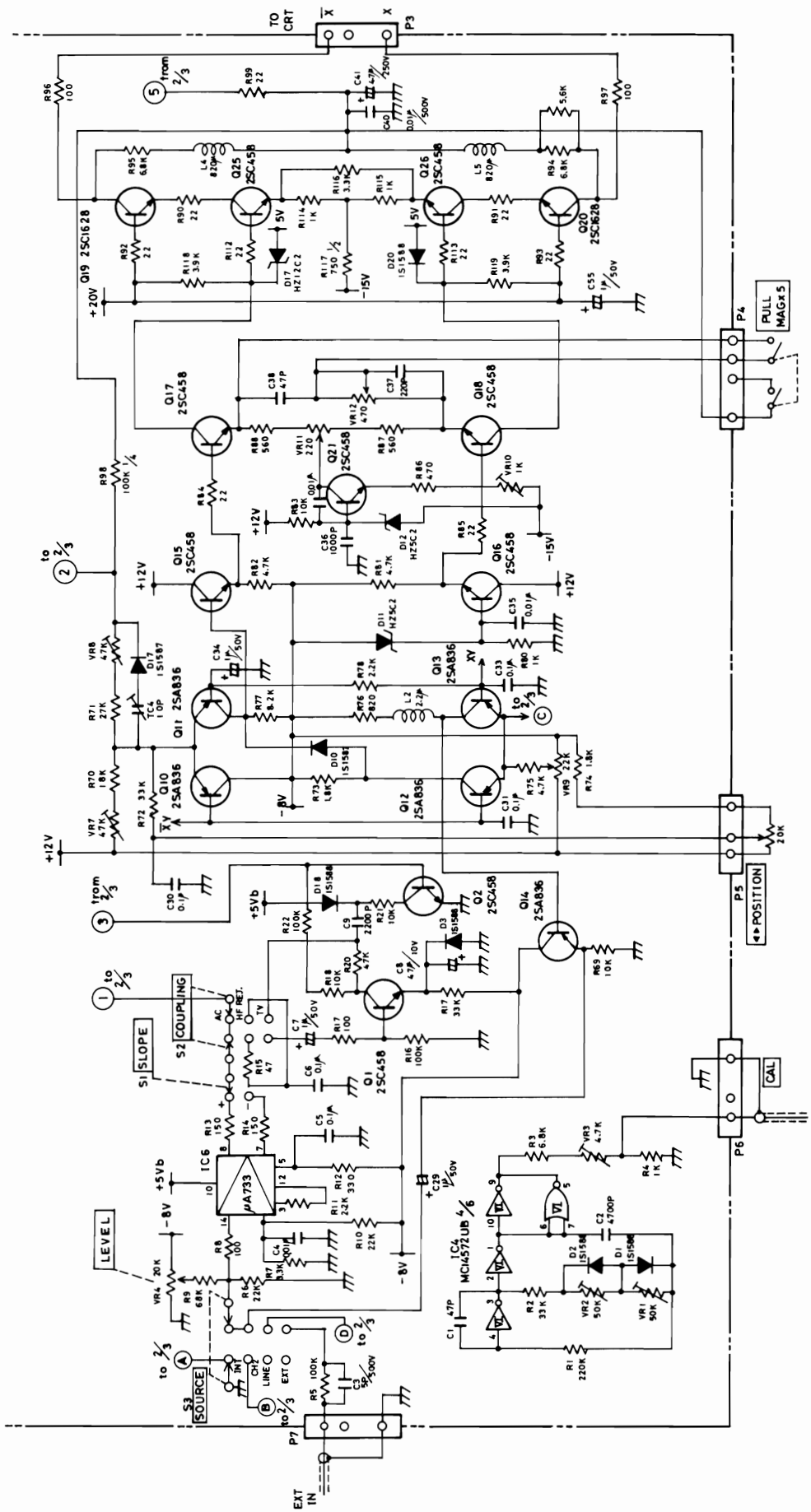
7.1.3 Vertical Amplifier Schematic (3/3)



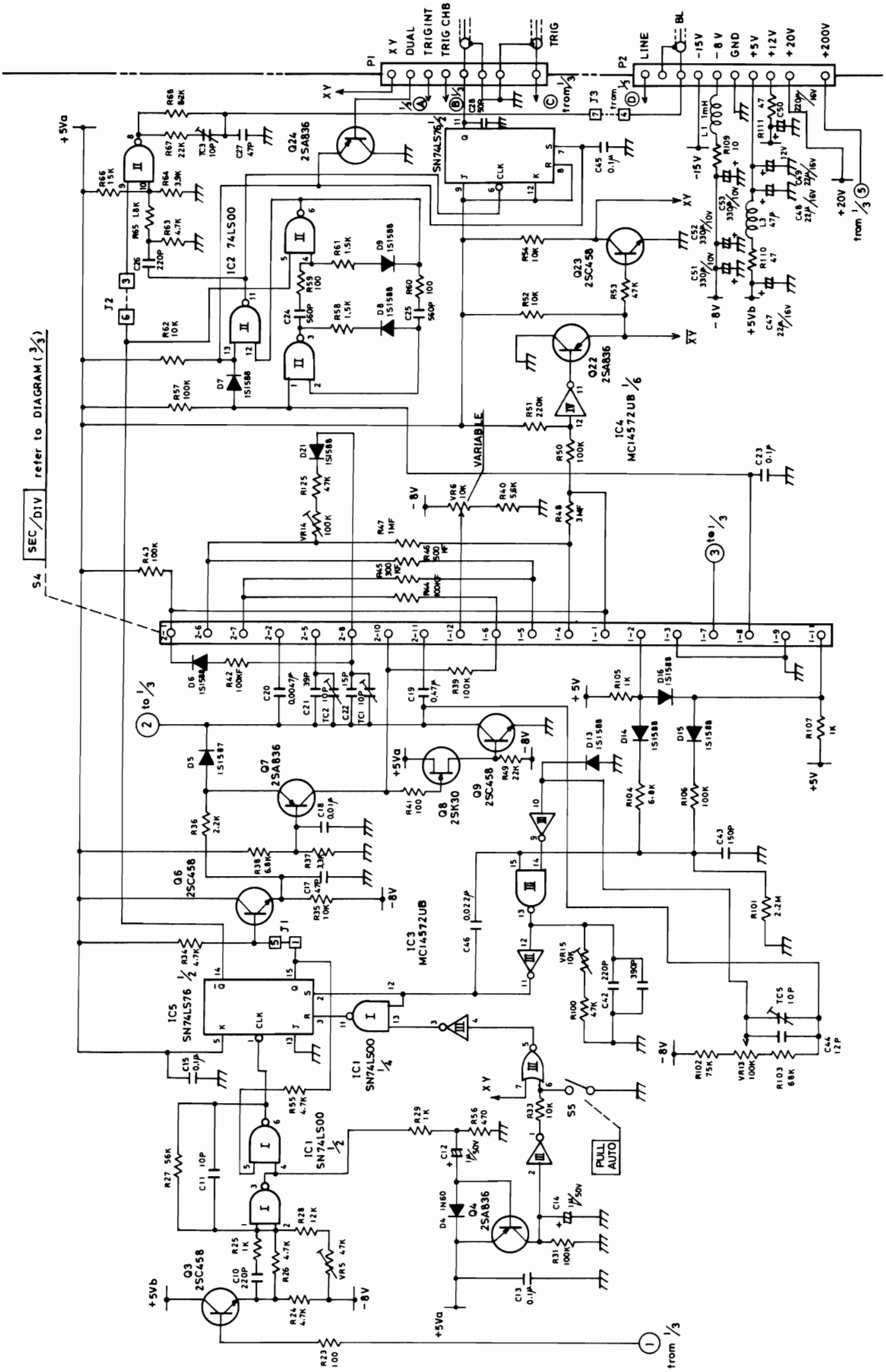
7.2 HORIZONTAL/TIME BASE UNIT BOARD



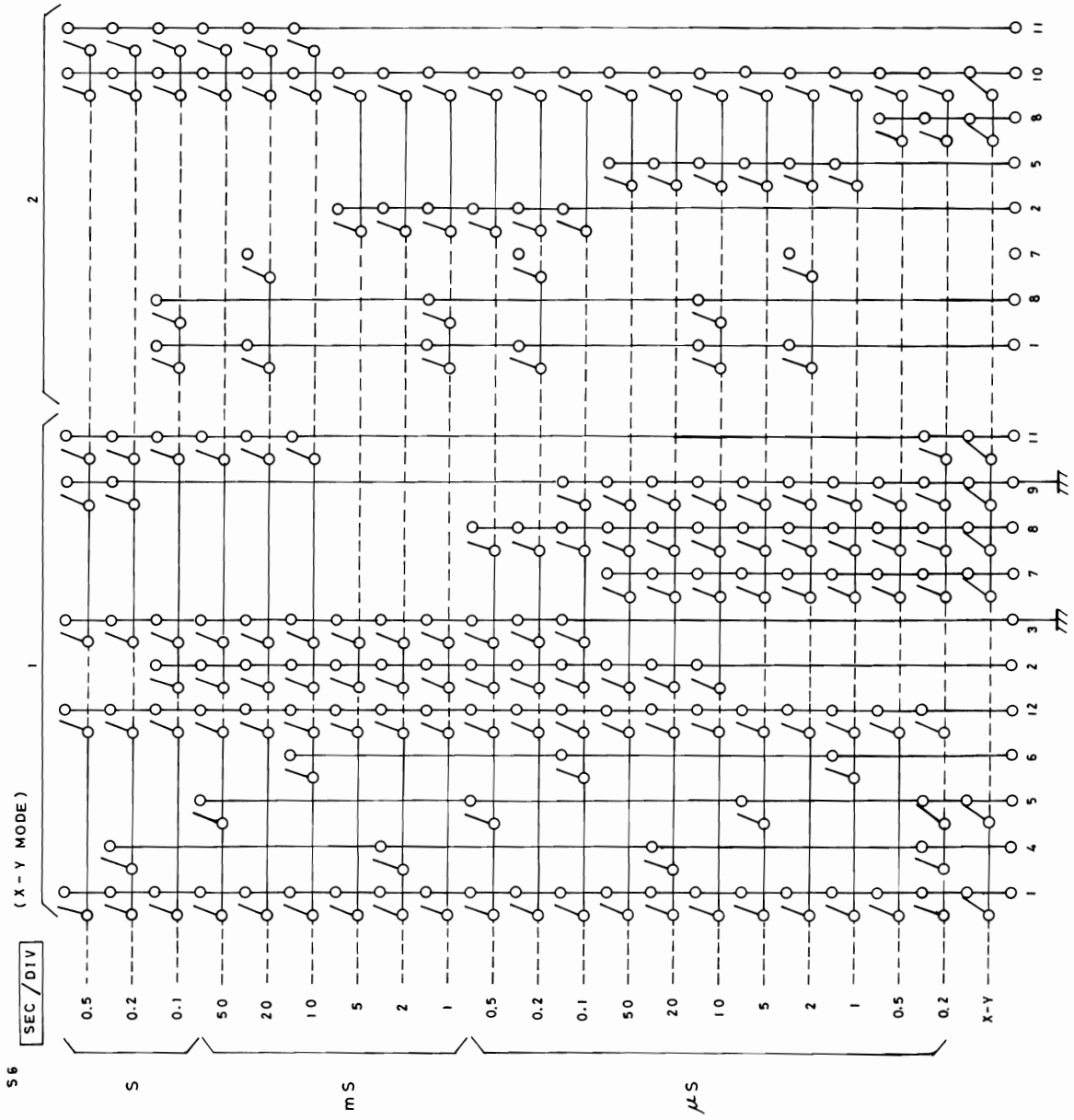
7.2.1 Horizontal/Time Base Schematic (1/3)



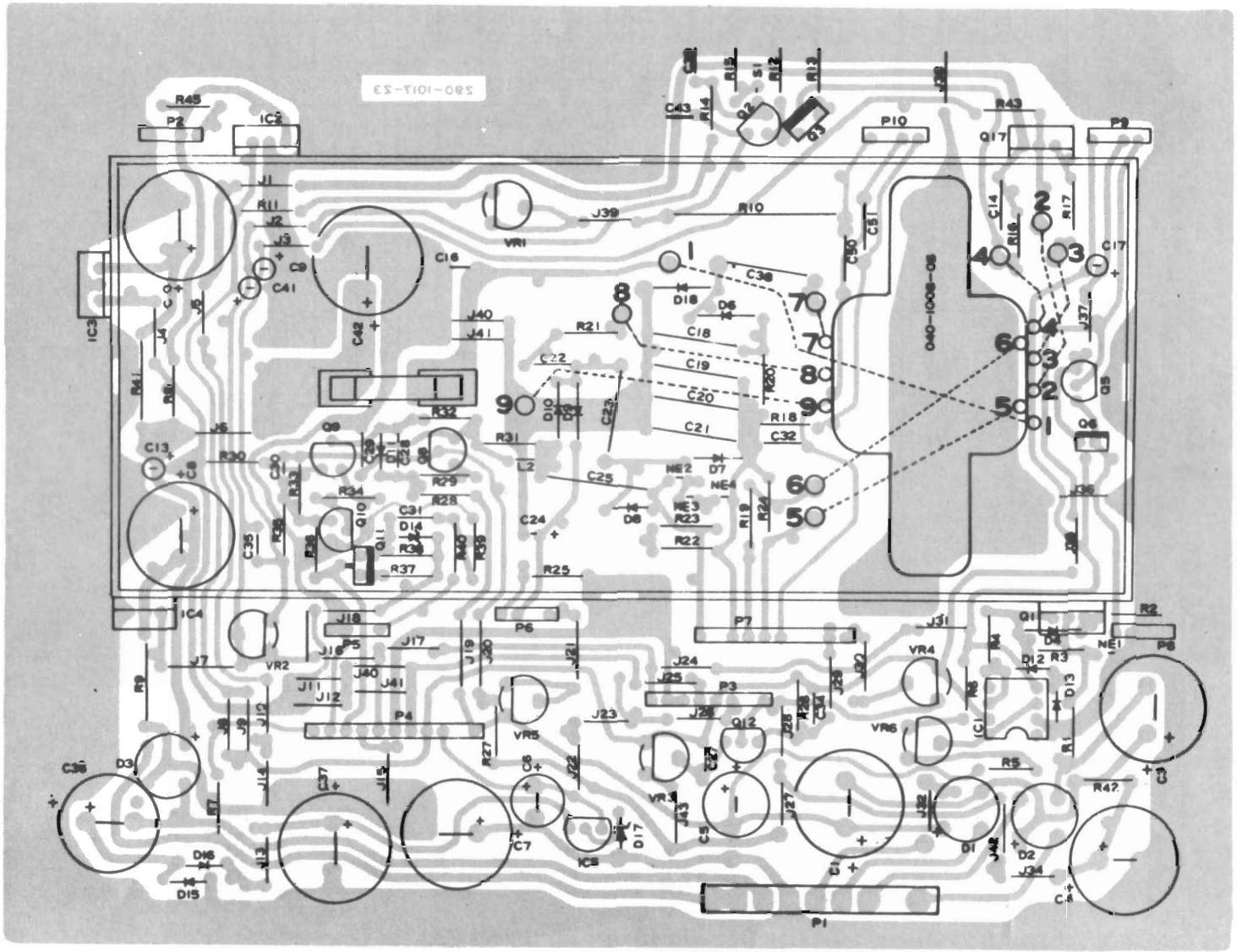
7.2.2 Horizontal/Time Base Schematic (2/3)



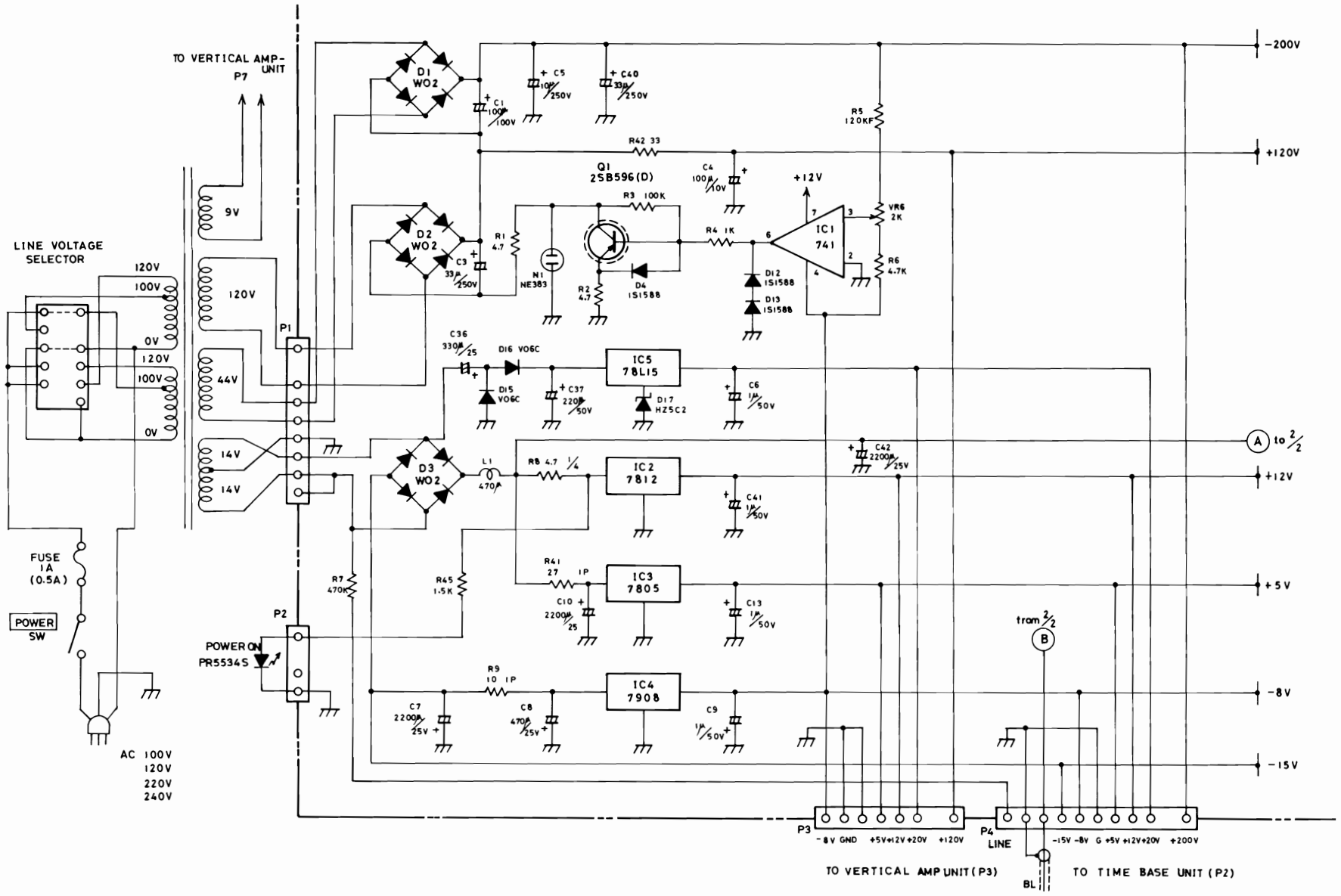
7.2.3 Horizontal/Time Base Schematic (3/3)



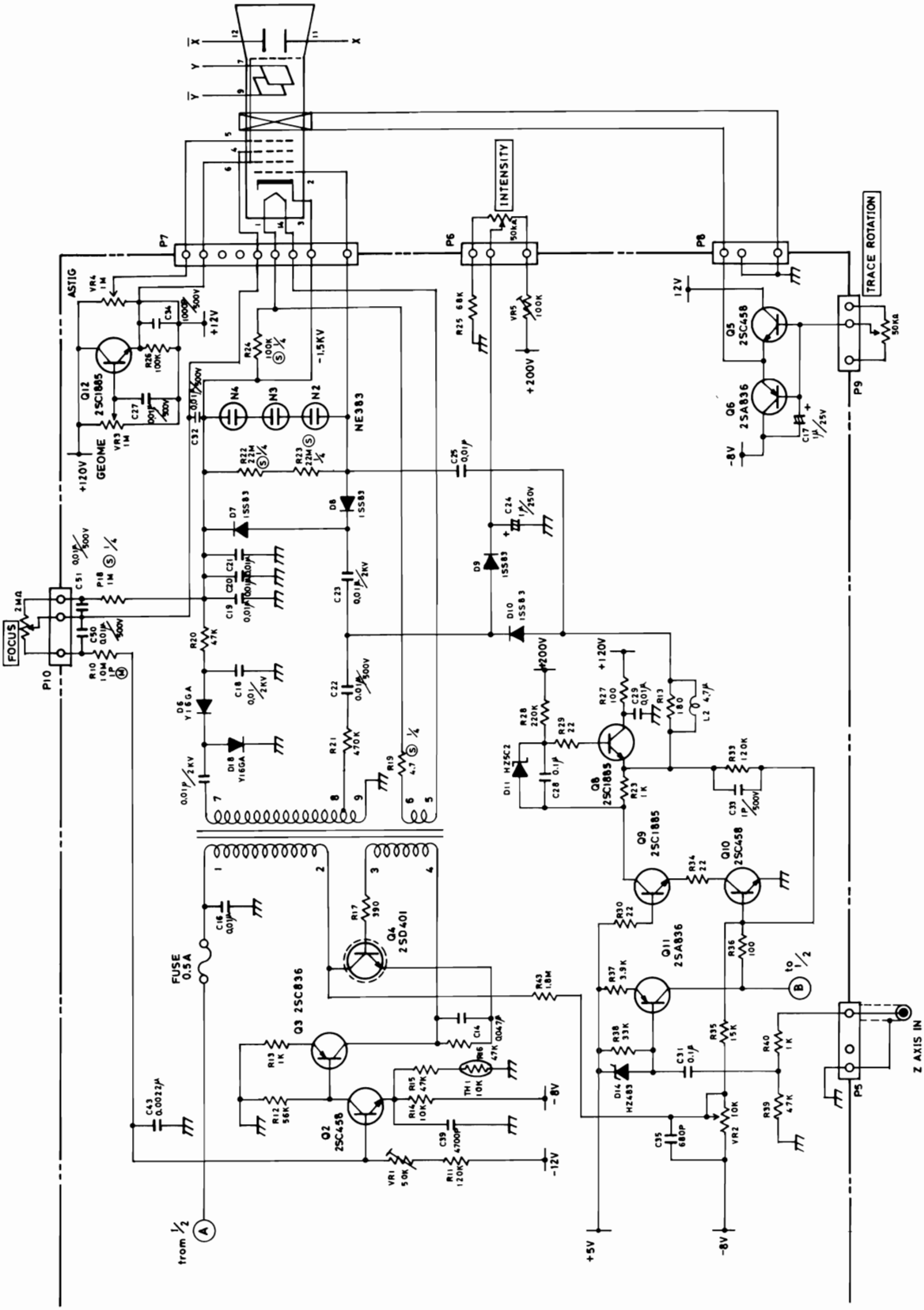
7.3 POWER SUPPLY UNIT BOARD



7.3.1 Power Supply Schematic (1/2)



7.3.2 Power Supply Schematic (2/2)



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