TM 9-6625-646-14&P

TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS)

FOR

OSCILLOSCOPE, TEKTRONIX, MODEL 212
NSN 6625-01-061-5519

MULTIPLE LAUNCH ROCKET SYSTEM

DEPARTMENT OF THE ARMY

JUNE 1984

SECTION 1
INTRODUCTION

The 212 Oscilloscope is a dual-channel portable oscilloscope using all solid state and integrated circuitry (except the CRT). The small size of the 212 makes it an extremely portable oscilloscope for on-location maintenance in many fields of application.

The 500 kilohertz vertical system provides vertical deflection factors from one millivolt (at a reduced bandwidth) to 50 volts/division at the tip of either of the two integral high-impedance probes. Both single-trace and dualtrace modes of operation are offered. Single-trace displays are achieved by turning off either vertical channel with its position control. In the dual-trace mode, the instrument automatically chops or alternates, depending upon the sweep rate. The trigger circuits provide stable triggering over the full bandwidth capabilities of the vertical system.

The horizontal deflection system provides calibrated sweep rates from 500 milliseconds to five microseconds/ division. It also provides uncalibrated sweep rates, via a variable sweep magnifier, to at least five times the indicated sweep rate for a maximum of at least one microsecond/ division. In addition, X-Y operation is provided. Channel 1 supplies the horizontal (X) deflection, with a range from less than one millivolt to 50 volts/division (at a reduced bandwidth of 50 kilohertz), and Channel 2 the vertical (Y) deflection. The resultant CRT display is presented on a 6 X 10 division graticule (each division equals 0.203 inch).

The 212 is operated either from AC line voltage or from internal rechargeable batteries. The internal batteries are recharged from the AC power line by the integral battery charger.

This instrument will meet the following electrical characteristics after complete instrument calibration. These characteristics apply over an ambient temperature of -15°C to +55°C (+5°F to +131°F), except as otherwise indicated. Warmup time for given accuracies is five minutes.

VERTICAL DEFLECTION SYSTEM

DEFLECTION FACTOR:

Calibrated Range: One millivolt to 50 volt/division. 15 steps in 1-2-5 sequence.

Accuracy: Within 5% with VOLTS/DIV VAR control in CAL position and gain correctly set at 5 mV/div.

Uncalibrated (variable) Range: Continuously variable between calibrated settings. Extends maximum deflection factor to at least 125 volts/division.

BANDWIDTH (with six-division reference):
10 mV/DIV to 50 V/DIV: DC to at least 500 kilohertz.
5 mV/DIV: DC to at least 400 kilohertz.
2 mV/DIV: DC to at least 200 kilohertz.
1 mV/DIV: DC to at least 100 kilohertz.
Lower Bandwidth Limit, AC (capacitively) Coupled: about 2 hertz at all deflection factors.

INPUT RESISTANCE:
Approximately one megohm.

INPUT CAPACITANCE:
1 mV/DIV to 50 mV/DIV: Approximately 160 picofarads.
100 mV/DIV to 50 V/DIV: Approximately 140 picofarads.

MAXIMUM USABLE INPUT VOLTAGE:
50 V/DIV to .1 V/DIV: 600 volts (DC + peak AC). 600 volts peak-to-peak AC (five megahertz or less).
50 mV/DIV to 1 mV/DIV: 600 volts (DC + peak AC). AC not over 2 kilohertz or risetime not less than 100 nanoseconds.

CHOPPED MODE:
From 500 ms/DIV to 2 ms/DIV of time base at approximately 50 kilohertz.

ALTERNATE MODE:
From 1 ms/DIV to 5ps/DIV of time base.

INPUT IMPEDANCE MATCHING:
Matched to within approximately 10%.

GAIN ACCURACY BETWEEN CHANNELS:
Within 5% with both VOLTS/DIV VAR controls in CAL position and gain correctly set at 5 mV/DIV.

TRIGGERING

TRIGGER SENSITIVITY:
Internal: COMP: 0.2 division from DC to 500 kilohertz.
CH 2: 0.2 division from 2 hertz to 500 kilohertz.
External:
1.0 volt from DC to 500 kilohertz.

PRESET TRIGGER LEVEL:
Triggered at preset level on positive slope of triggering signal. Sensitivity same as stated above.

DISPLAY JITTER:
0.5 microsecond or less at 500 kilohertz.

EXTERNAL TRIGGER:
Input Resistance: Approximately one megohm.
Input Capacitance: Approximately 30 picofarads.
Maximum Usable Input Voltage: 8 volts (DC + peak AC) 16 volts peak-to-peak AC (one megahertz or less).

HORIZONTAL DEFLECTION SYSTEM

SWEEP RATE:

Calibrated Range: 500 milliseconds to five microseconds/ division. 16 steps in 1-2-5 sequence.

Accuracy (over center eight divisions): Within 5% with HORIZ MAG control in CAL position and timing correctly set at 1 ms/DIV (disregard first 0.5 microsecond of total sweep length).

Linearity (any two division portion within center eight divisions): Within 5% (disregard first 10% of total sweep length).
Variable Magnifier: Continuously variable between calibrated settings. Extends maximum sweep rate to at least 1.0 microsecond/division.

CH 1 HORIZONTAL INPUT:

Calibrated Deflection Factor: 1 millivolt to 50 volts/ division.
Variable: At least five times (using HORIZ MAG).
Accuracy: Within 10% (with HORIZ MAG control in CAL position).
X-Y Phasing: Less than 3° at five kilohertz.
Maximum Input Voltage: 600 volts (DC + peak AC); 600 volts (peak-to-peak AC).

DISPLAY

GRATICULE:
Type: Internal black line, non-illuminated.
Area: Six divisions vertical by 10 divisions horizontal. Each division equals 0.203 inch.

PHOSPHOR:
P31 Standard.

ISOLATION

PROBE COMMON TO 212 CASE EXTERIOR: (When battery operated with AC power plug secured in the insulated cover.) Maximum safe potential between probe common (floating circuit ground) and 212 case exterior not to exceed 500 V RMS sinusoidal, or 700 V (DC + peak AC).

PROBE COMMON TO AC LINE: Maximum safe potential between probe common (floating circuit ground) and the AC power line is not to exceed 250 V RMS sinusoidal minus the AC power line RMS voltage. (i.e., when the AC power line RMS voltage is 117 V, the maximum allowable potential on the probe common is 250 -117 = 133 V RMS.)

AC OPERATION

CAUTION

Due to the capacitive line input circuit, sudden voltage changes may cause damaging input current transients. Avoid operating this instrument from squarewave inverter supplies, or other sources that produce large voltage transients.

LINE VOLTAGE RANGE: 110 to 126 volts, AC. Batteries can not be charged during AC operation. Instrument can be operated between 104 and 110 volts with resulting slow discharge of internal batteries.

LINE FREQUENCY: 58 to 62 hertz.

NOTE

Refer to Option and Corrective Maintenance information for other line voltages and frequencies.

MAXIMUM POWER CONSUMPTION: Three watts or less at 126 volts, 60 hertz.

INTERNAL BATTERY OPERATION

BATTERIES: 10 rechargeable A nickel-cadmium cells.

CHARGE TIME (from AC line): 16 hours for full charge (instrument off during charge cycle).

POWER (BATTERY) INDICATOR: When extinguished, indicates less than 10 minutes of scope operating life left in the batteries.

BATTERY EXCESSIVE DISCHARGE PROTECTION: Instrument operation automatically interrupted when battery charge drops to 10 volts +0.5 volt.

TYPICAL OPERATING TIME (at maximum trace intensity after full charge cycle at +20°C to +30°C): Three to five hours. Longest operating time provided at lower trace intensity.

TYPICAL CHARGE CAPACITY (reference to charge/ discharge at +20°C to +30°C):

CHARGE TEMPERATURE	**OPERATING TEMPERATURE**		
	15°C (+5°F)	**+20°C to +30°C (+68°F to +860F)**	**+55°C (+131°F)**
0°C (+32°F)	40%	60%	50%
+20°C to +30°C (+68° F to +86° F)	65%	100%	85%
40°C (+104°F)	40%	65%	55%

GENERAL

ENVIRONMENT:

Temperature:

Operating from Batteries, -15°C to +55°C (+5°F to +131°F).

Charging or operating from AC line, 0°C to +40°C (+32°F to +104°F).

Storage, -40°C to +60°C (-40°F to +140° F).

Altitude:

Operating, to 25, 000 feet (maximum operating temperature decreased by 10C per 1, 000 feet above 15, 000 feet).

Non-operating, to 50, 000 feet.

Humidity (operating and non-operating): 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F.

Shock (operating and non-operating): Tested with two shocks at 150 g, one-half sine, two millisecond duration each direction along three major axes.

WEIGHT (without accessories):

3.4 pounds (1.5 kilograms)

DIMENSIONS (measured at maximum points):

Height: 3.0 inches (7.6 centimeters).

Width: 5.25 inches (13.2 centimeters).

Depth: 8.9 inches (22.6 centimeters).

SECTION 6
CIRCUIT DESCRIPTION

The following circuit description begins with a discussion of the instrument using the block diagram located in the Diagrams section at the rear of this manual. Then each circuit is described in detail, using detailed diagrams where necessary to show the interconnections between the stages in each major circuit and the relationship of the side-panel controls to the individual stages. In addition to the block diagram, complete schematics are given in the Diagrams section.

Block Diagram

Signals to be displayed on the CRT are applied to the tips of the signal probes. The signals are then amplified by the appropriate channel Input Amplifier circuit, consisting of a two-section source-follower stage and two feedback amplifiers. The Input Amplifier circuits also contain the vertical deflection, position (with channel on-OFF), input coupling, variable attenuation, and balance controls.

The Trigger Generator circuit initiates the sweep signal produced by the Sweep Generator. The input signal to the Trigger Generator can be selected internally either from the capacitively coupled CH 2 Input Amplifier signal, or from the directly coupled COMPosite signal of the Feedback Amplifier. The Trigger Generator input signal can also be selected from the external signal applied to the EXT TRIG jack. The Trigger Generator circuit contains coupling and source controls in addition to a combination level/slope control.

The Sweep Generator circuit produces a linear sawtooth output signal when initiated by the Trigger Generator circuit. The slope of the sawtooth signal is controlled by the SEC/DIV switch. The Sweep Generator circuit also produces an unblanking gate signal coincident with the sawtooth waveform. This gate signal unblanks the CRT to permit display presentation.

The output of U370 is amplified by the Horizontal Amplifier circuit to produce the correct horizontal deflection for the CRT for all positions of the SEC/DIV switch. The Horizontal Amplifier contains a variable magnifier to increase the sweep rate up to at least a maximum of five times in any position of the SEC/DIV switch.

The Power Supply and CRT circuits provide all the voltages necessary for operation of this instrument.

Circuit Operation

In the following description of the electrical operation and relationship of the circuits in the 212, circuitry commonly used by TEKTRONIX is only briefly explained. If more information is desired on the commonly used circuits, refer to the following textbooks:

Phillip Cutler, "Semiconductor Circuit Analysis", McGraw-Hill, New York, 1964.

Lloyd P. Hunter (Ed.), "Handbook of Semiconductor Electronics", second edition, McGraw-Hill, New York, 1962.

Jacob Millman and Herbert Taub, "Pulse, Digital, and Switching Waveforms", McGraw-Hill, New York, 1965.

Vertical Input Amplifiers

Input signals for vertical deflection of the CRT of the 212 are applied to the tips of the attached probes. Each Input Amplifier provides control of input coupling, variable attenuation, vertical deflection factor, balance, and vertical position (with channel on-OFF) for the appropriate channel. Figure 6-1 shows a detailed block diagram of the Vertical Input Amplifier circuit. A schematic of this circuit is shown on diagram 1.

Input signals applied to the tips of the probes are connected to the appropriate Attenuation Stage through the INPUT COUPLING switches (S305 and S405). The deflection factor in each channel is determined by the VOLTS/DIV switch (S310 or S410). In all positions of the VOLTS/DIV switches below .1 V/DIV, the correct deflection factor is achieved by changing the gain of Feedback Amplifiers U320-A and U320-B. In switch positions .1 V/DIV and up, precision attenuators are used (in addition to changing the gain of U320-A and U320-B) to achieve the correct deflection factors. When the VOLTS/DIV VAR control is rotated, the signal is attenuated across R320 or R420. This offers variable (uncalibrated) deflection factors between the calibrated settings of the VOLTS/DIV switch. The STEP ATTEN BALance adjustments (R315 and R417) control the trace shift when switching between deflection factors.

The 212 can be operated single trace by turning either vertical POSition control to the OFF detent; this disables that channel in the last feedback stage of the Input Amplifier through the operation of the Vertical Mode Multivibrator U440. The CH 2 trigger signal is present regardless of the CH 2 POS control setting. In the dual-trace mode, the instrument will automatically chop or alternate, depending upon the sweep rate.

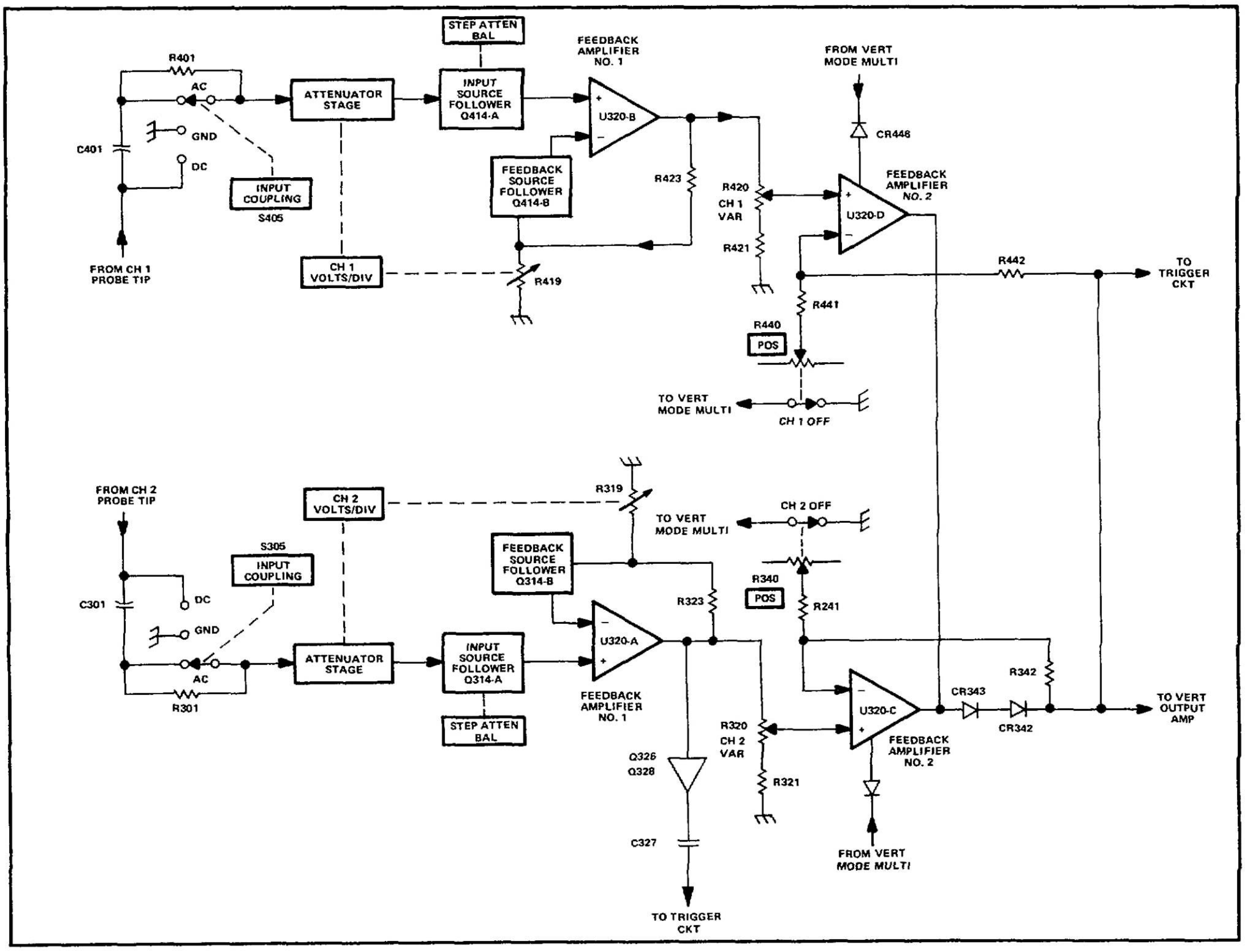


Figure 6-1. Vertical input amplifiers detailed block diagram.

Vertical and Horizontal Output Amplifiers

The Vertical and Horizontal Output Amplifiers provide the final amplification for the deflection signals. Figure 6-2 shows a detailed block diagram of these Output Amplifiers. A schematic of these circuits is on diagram 2.

Both amplifiers contain the same basic circuitry. The single-ended input signals are applied to paraphase amplifiers, U105-A and U105-B, to convert the signal into push-pull output signals. The Vertical Paraphase Amplifier stage contains the VERT GAIN adjustment (R470) that sets the over-all gain of the vertical system, and a Vertical Centering adjustment (R101) to set DC centering. The Horizontal Paraphase Amplifier stage contains the HORIZ GAIN adjustment (R475), the HORIZ MAG control (R476), and the Horizontal POSition control (R480). The output signals from the Paraphase Amplifiers receive final amplification in the common base Output Amplifier stages.

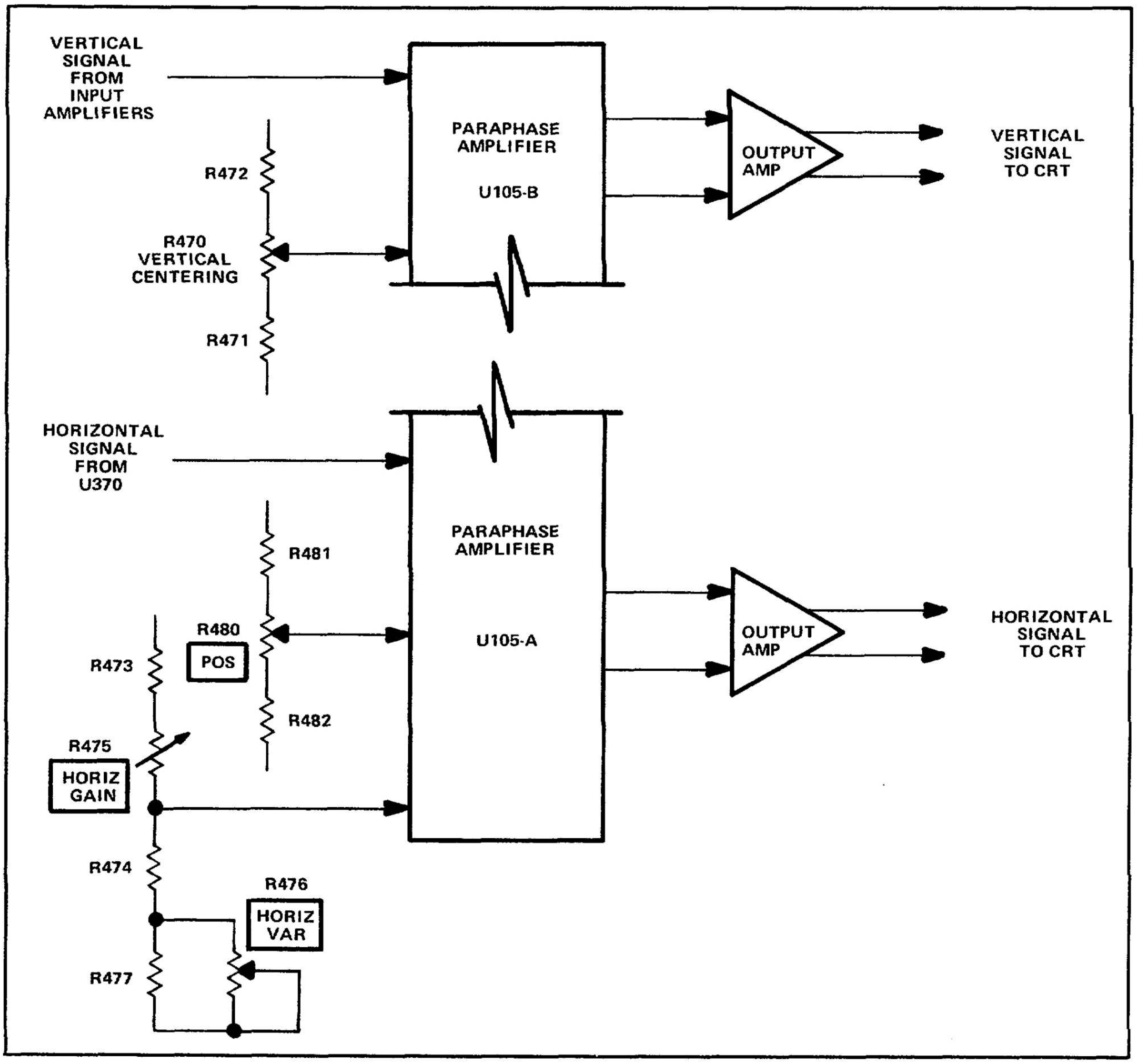


Figure 6-2. Vertical and Horizontal output amplifiers detailed block diagram.

Trigger/Sweep Generator

Integrated circuit U370 is a combination Trigger/Sweep Generator. The Trigger portion derives trigger signals internally, either from the capacitively coupled CH 2 Vertical Input Amplifier, or from the directly coupled COMPosite signal from the input of the Vertical Output Amplifier. The Trigger portion can also select signals from an external signal applied to the EXT TRIG banana jack. Controls are provided in this circuit to select trigger level, slope, and source. Figure 6-3 shows a detailed block diagram of the Trigger/Sweep Generator circuit. A schematic of this circuit is on diagram 2.

The Sweep Generator portion of U370 serves a multiple purpose. In all positions of the SEC/DIV switch except X-Y, the Sweep Generator is an integrator, which generates a linear sawtooth voltage waveform. The slope of the sawtooth voltage is controlled by the setting of the SEC/DIV switch. U370 also produces an unblanking gate signal coincident with the sawtooth waveform. This gate signal is amplified by Unblanking Amplifier Q134 and applied to the CRT to unblank the CRT during sweep presentation. In addition, the Sweep Generator supplies the clock pulses to the Vertical Mode Multivibrator for alternate switching between channels. In the X-Y position, the Sweep Generator section becomes a feedback amplifier to amplify the signal applied to the probe tip of CH 1.

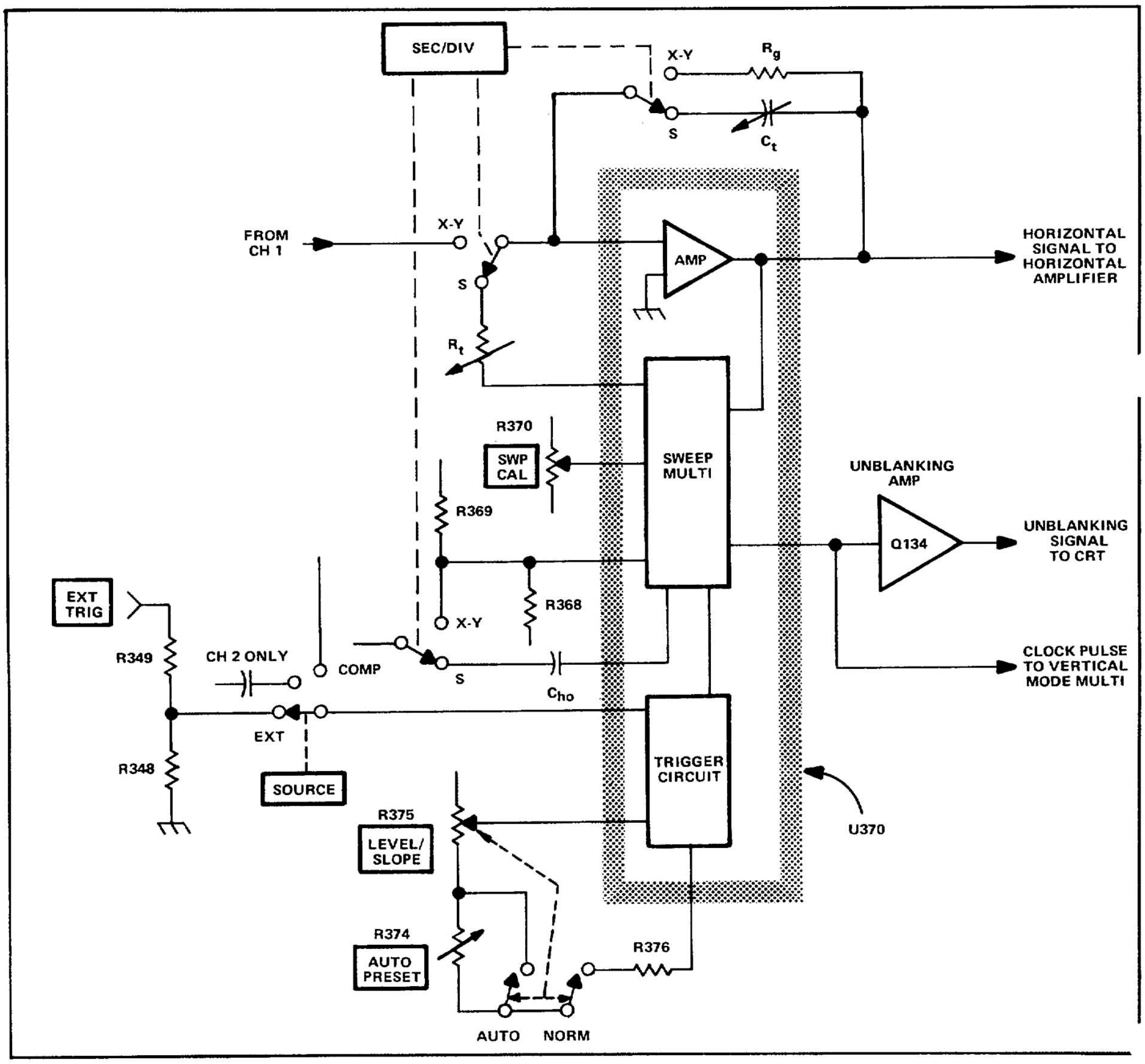


Figure 6-3. Trigger/Sweep Generator detailed block diagram.

Power Supply

The Power Supply provides the power necessary to operate this instrument or, if the instrument is turned off, to recharge the batteries. Figure 6-4 shows a detailed block diagram of this circuit. A schematic of this circuit is shown on diagram 4.

When the instrument is connected to a power line the AC power is capacitively coupled to the Power Rectifier. The rectified DC is used to either run the instrument or recharge the internal batteries. The batteries act as a large filter capacitor for the Input Rectifier in the AC line mode of TM 9-6625-646-14&P operation. When the instrument is not connected to a power line, operating power is provided by the batteries. The POWER (BATTERY) indicator, light emitting diode DS310, is illuminated when the 212 is operating from line voltage or adequately charged batteries. When about 10 minutes of operating time remains, the battery charge drops to a point where DS310 will extinguish. The Discharge Protection circuit (0231, Q235) prevents the Converter Multivibrator (Q242, Q249) from functioning, and thereby overdischarging the 'batteries, when the charge level of the batteries falls below approximately 10 volts. The Converter Multivibrator changes DC into AC, which is applied across T250 and then rectified into the appropriate DC voltages in the Rectifier circuit.

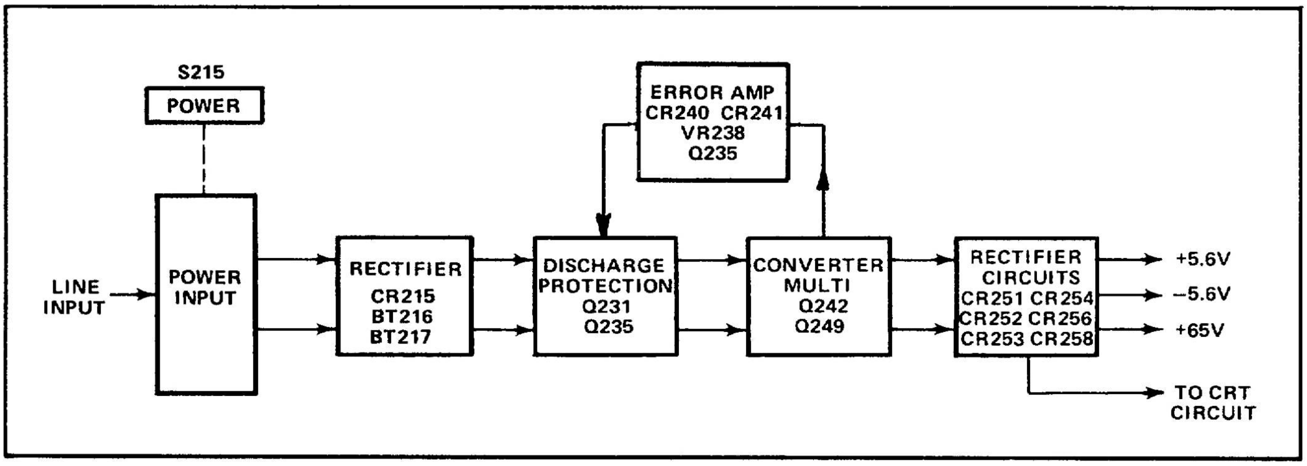


Figure 6-4. Power Supply detailed block diagram.

CRT Circuit

The CRT circuit provides the high voltage and control circuits necessary for operation of the cathode-ray tube (CRT). Figure 6-5 shows a detailed block diagram of the CRT circuit. A schematic of this circuit is given on diagram 3.

Rectifiers CR261 through CR268 provide the negative accelerating potential for the CRT. Voltage output is approximately -1000 volts at the CRT cathode. Filament voltage for the CRT is provided by a spearate winding of the power transformer. Display intensity and focus are controlled by R395 and R398 respectively. The Trace Rotation adjustment controls the current through L300 and affects both the vertical and horizontal alignment of the CRT beam.

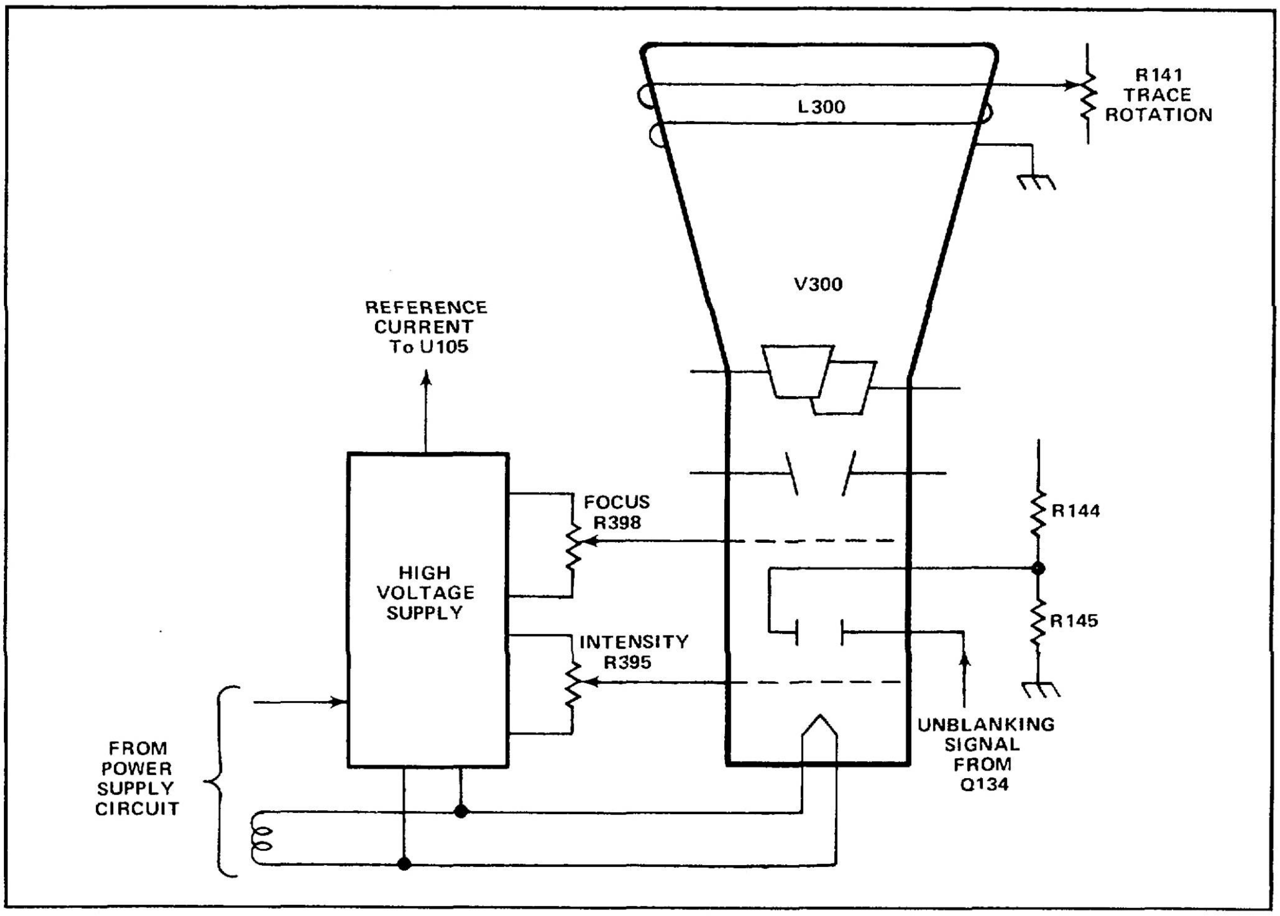


Figure 6-5. CRT Circuit detailed block diagram.

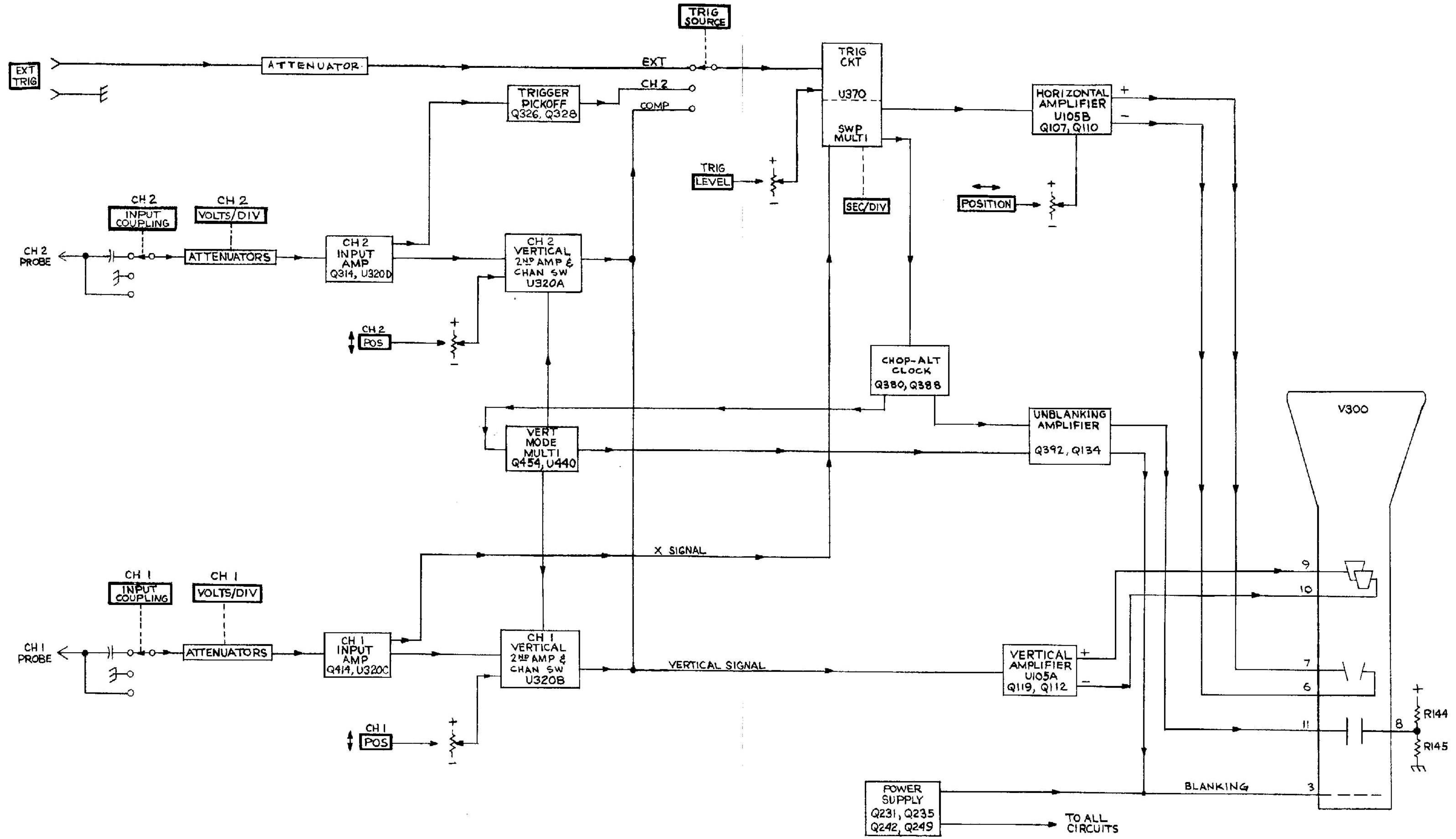
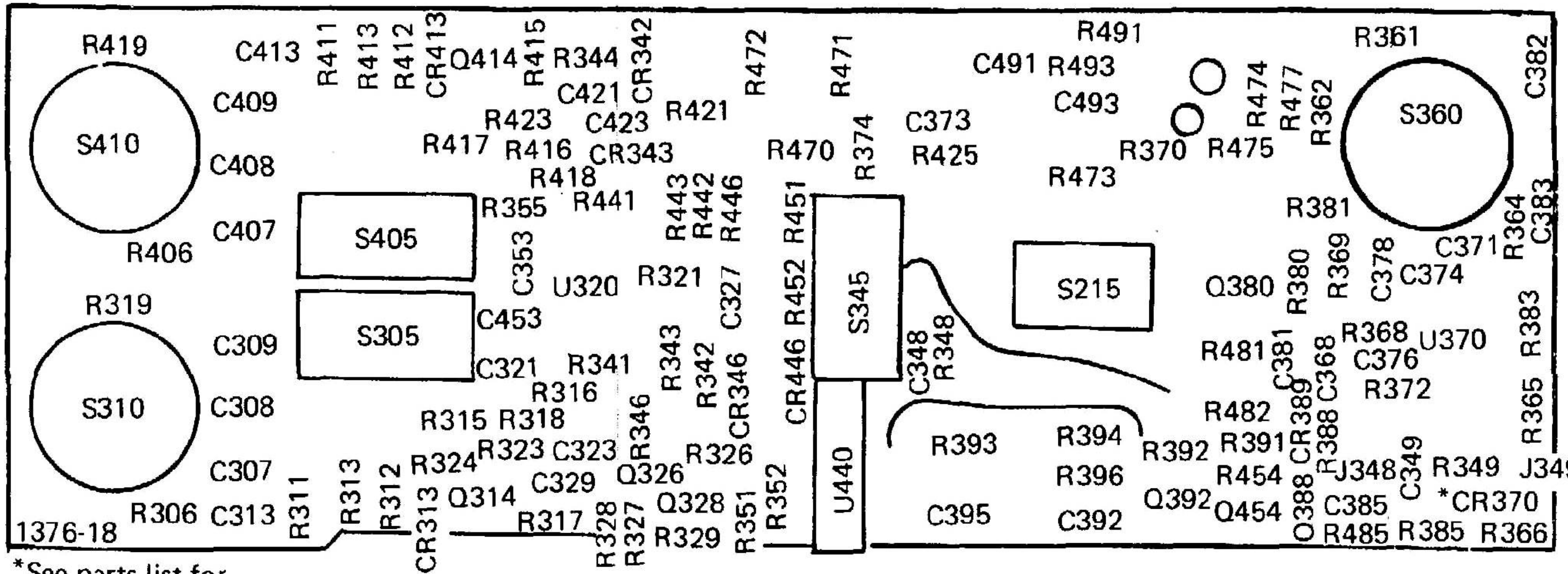


Figure 8-1. Block Diagram.



*See parts list for
serial number ranges.

Figure 8-1A. A1 Input Circuit Board (Front).

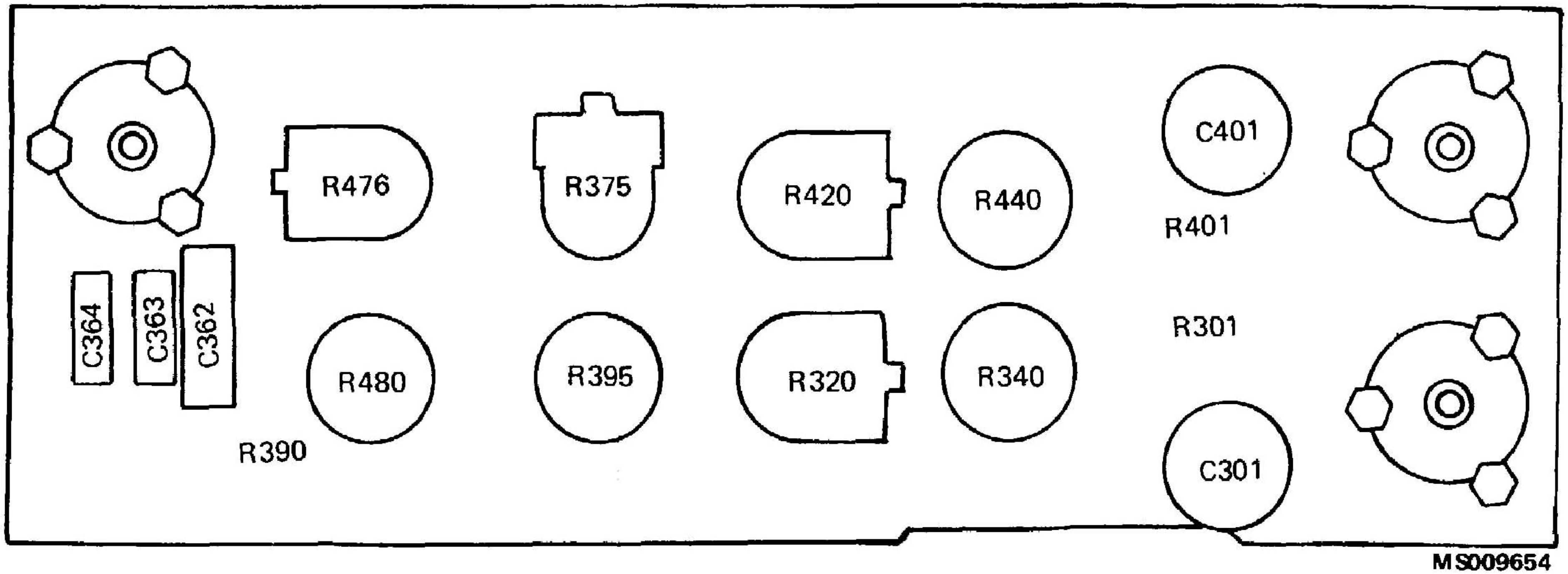


Figure 8-1B. A1 Input Circuit Board (Rear).

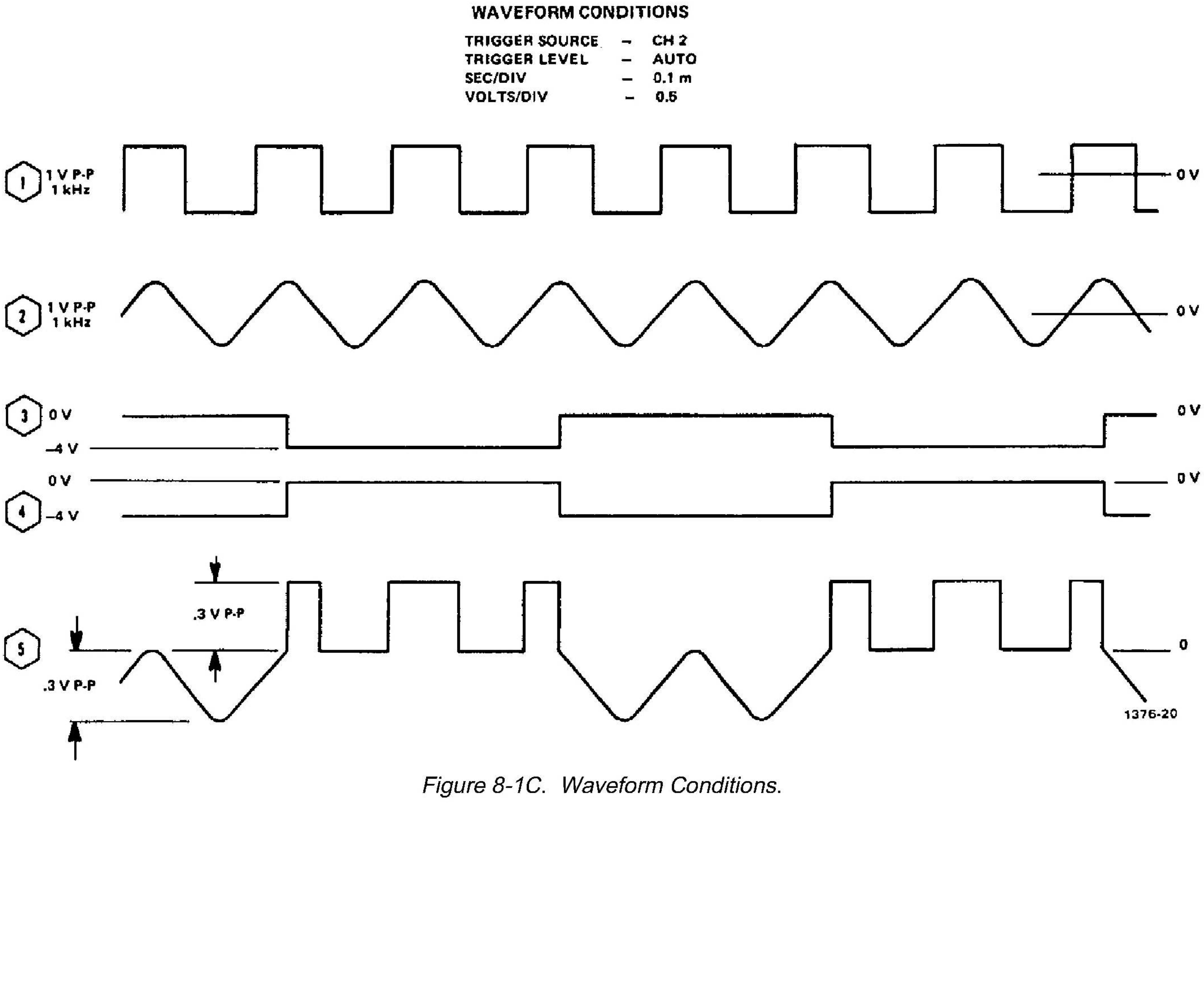


Figure 8-1C. Waveform Conditions.

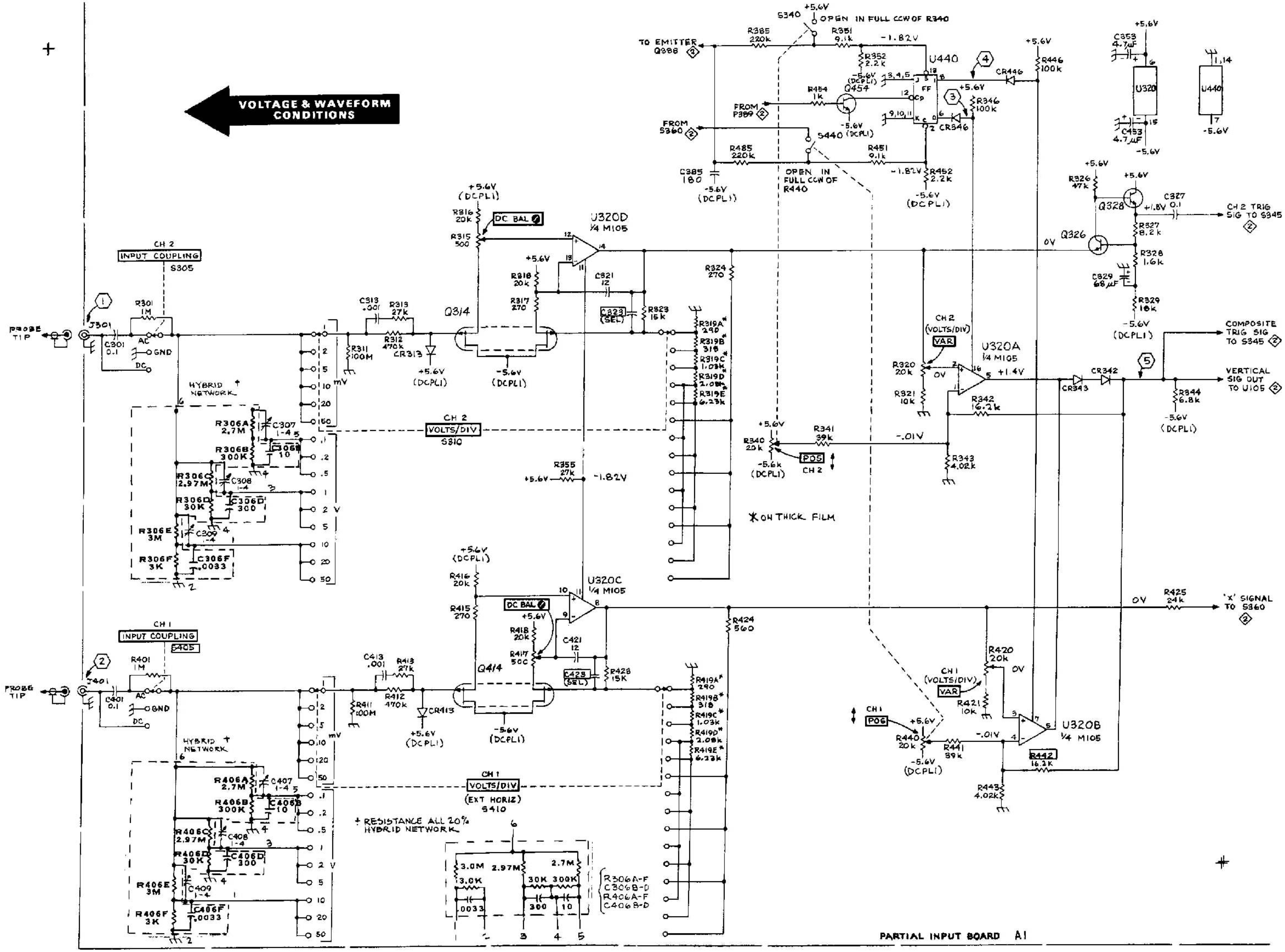


Figure 8-1D. Vertical Amplifier

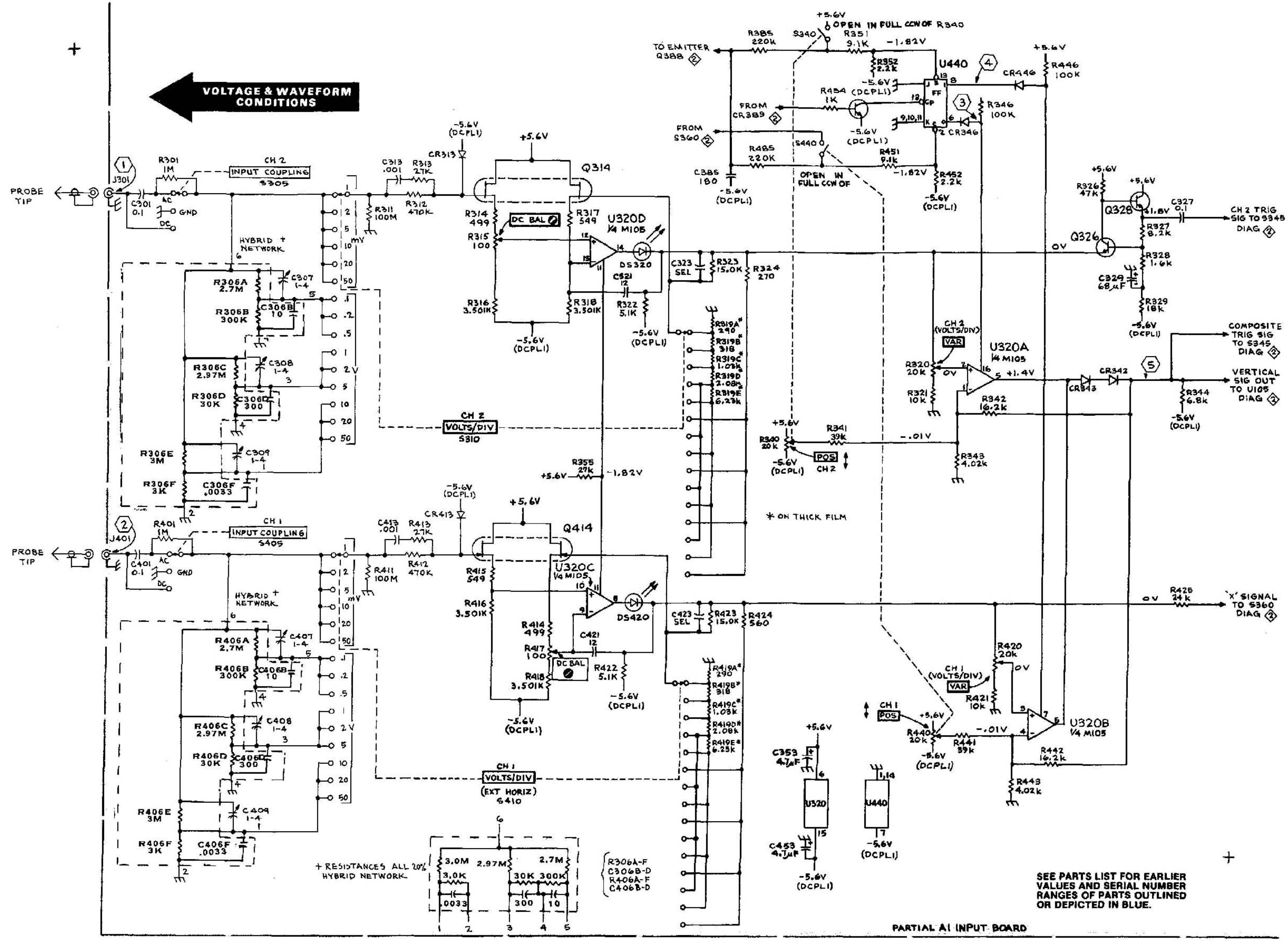


Figure 8-1E. Vertical Amplifier.

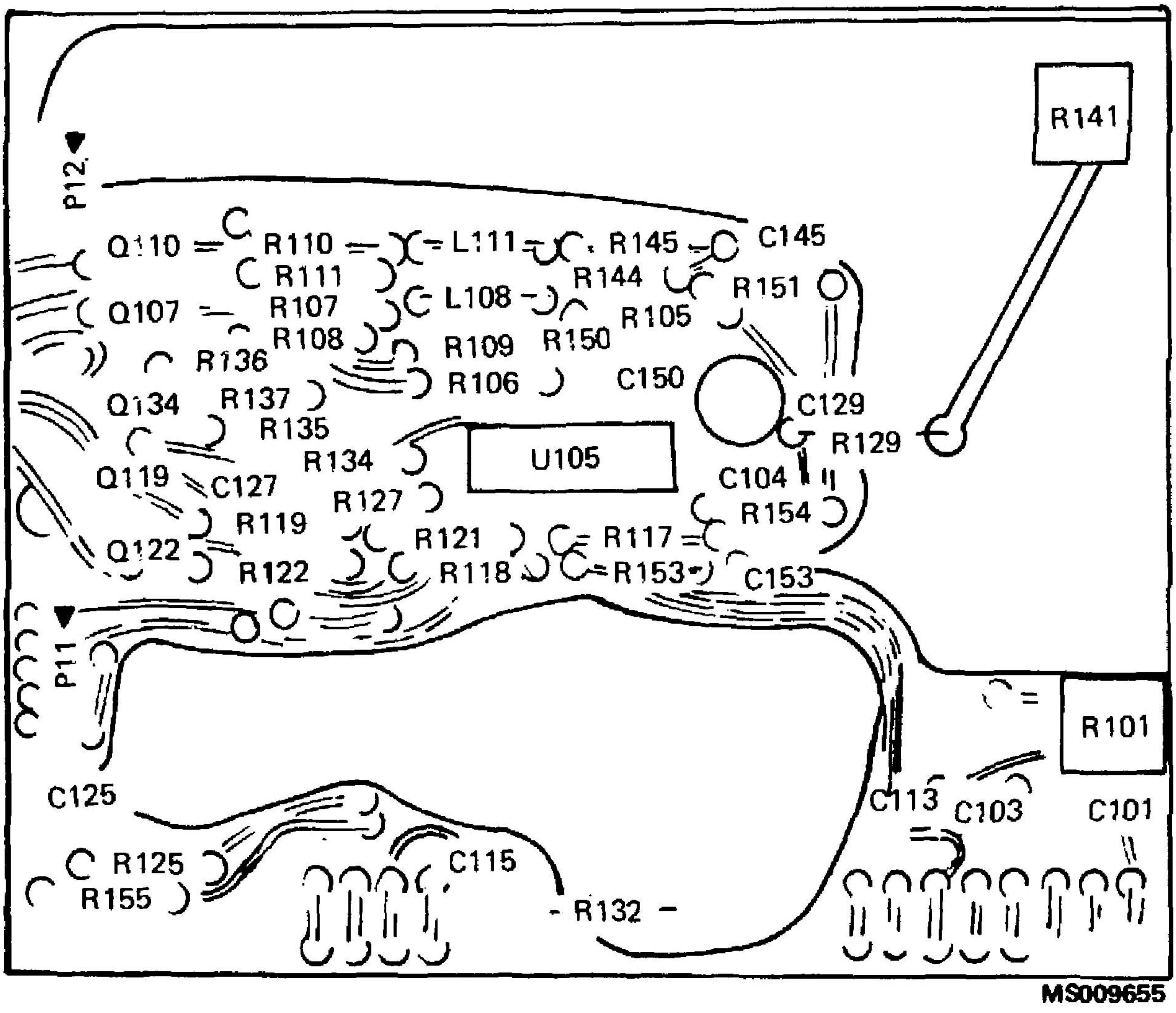


Figure 8-2. A2 Amplifier Circuit Board.

WAVEFORM CONDITIONS

TRIGGER SOURCE – CH 2
TRIGGER LEVEL – AUTO
SEC/DIV – 0.1 m
VOLTS/DIV – 0.5

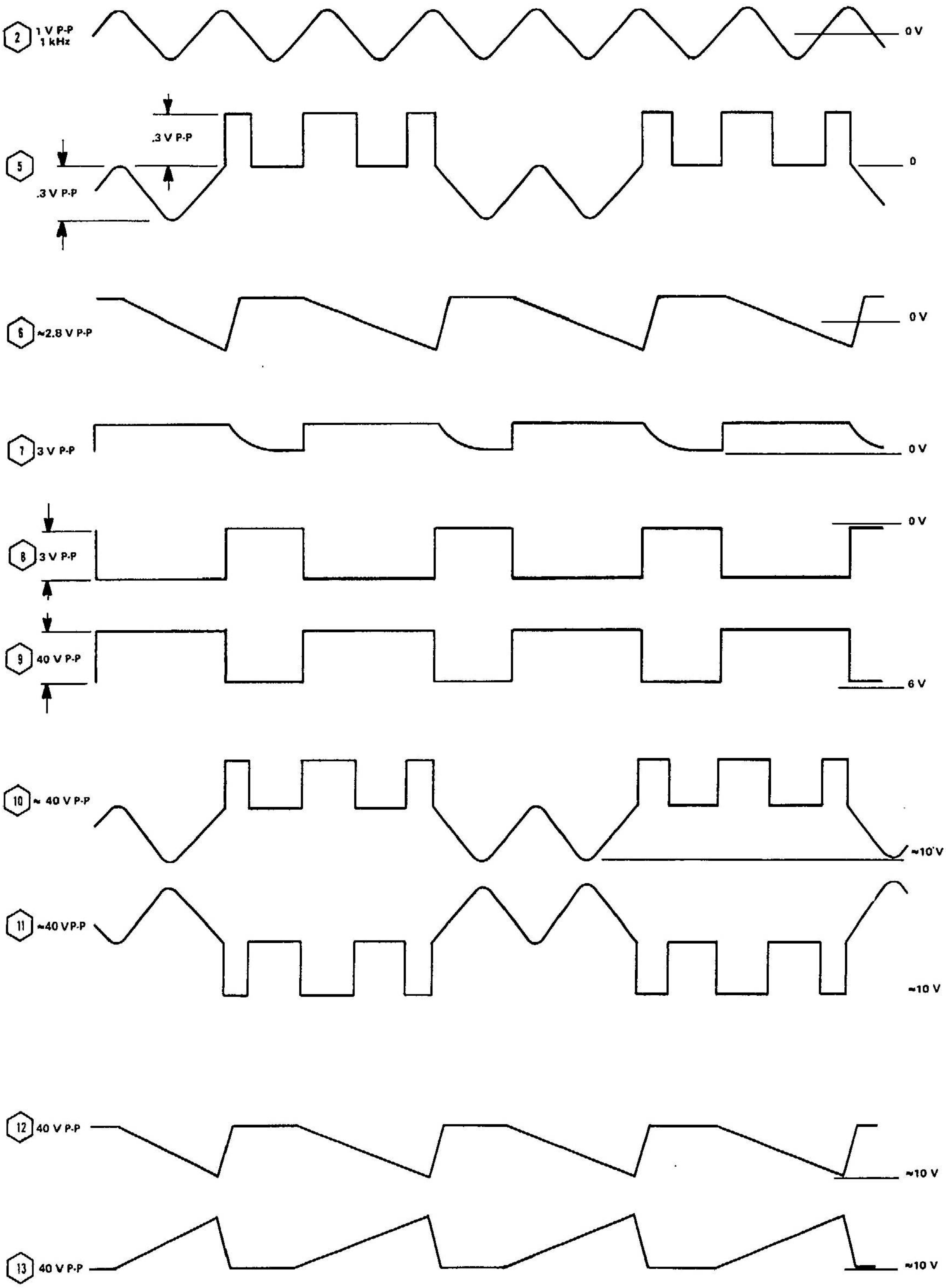


Figure 8-2A. Waveform Conditions.

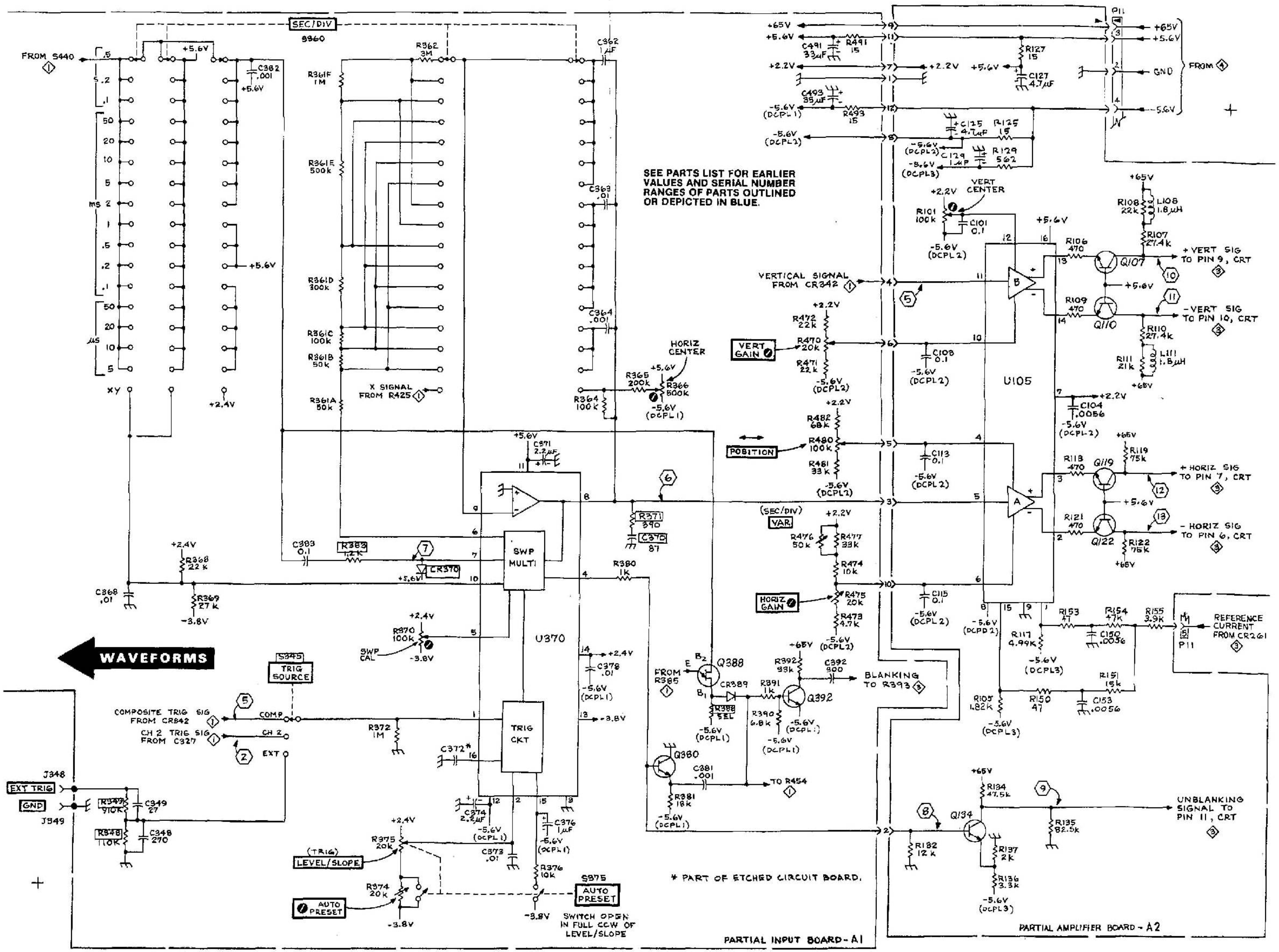


Figure 8-2B. Horizontal and Vertical Output Sweep and Trigger.

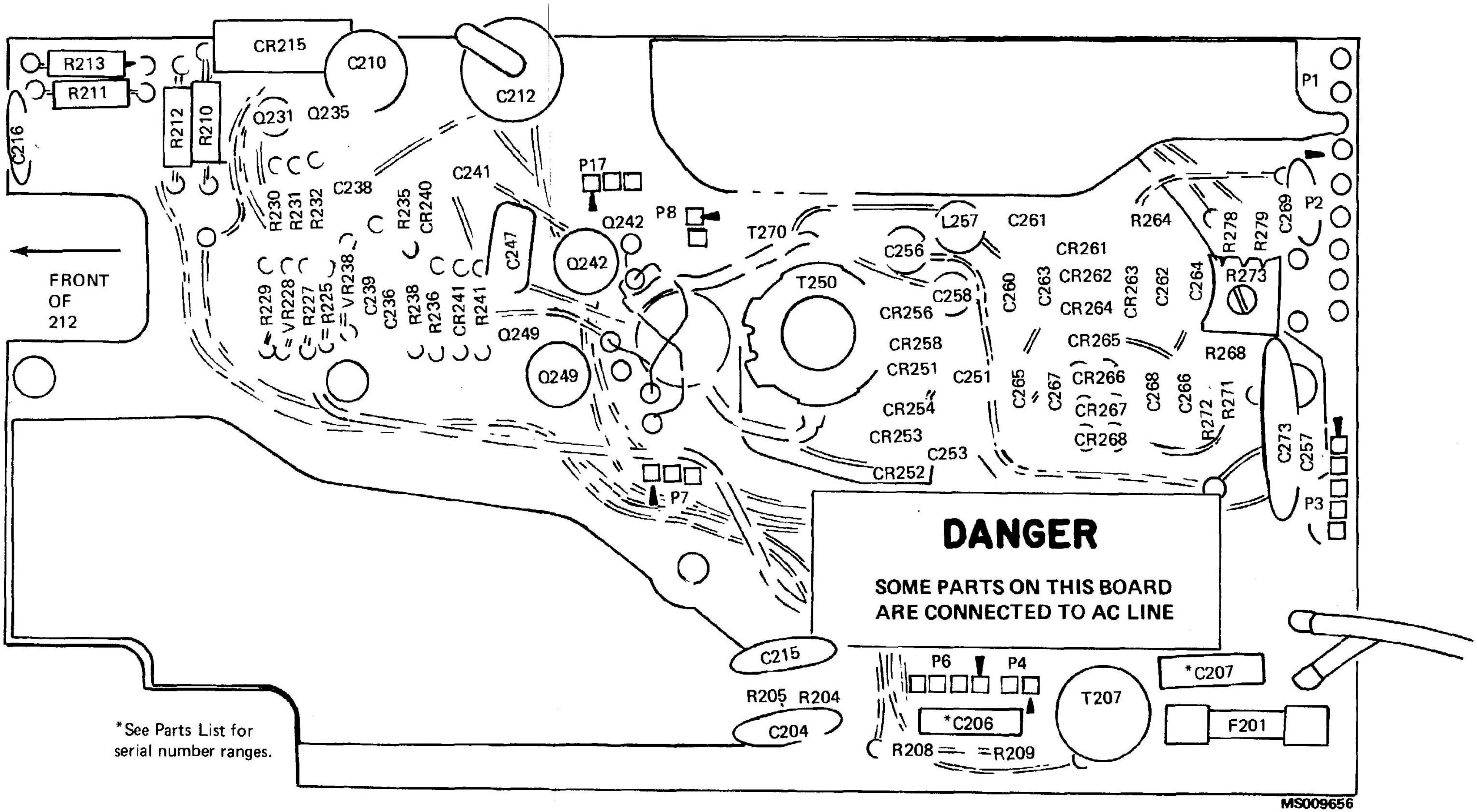


Figure 8-3A. A3 Power Supply Circuit Board, SN B040000-up.

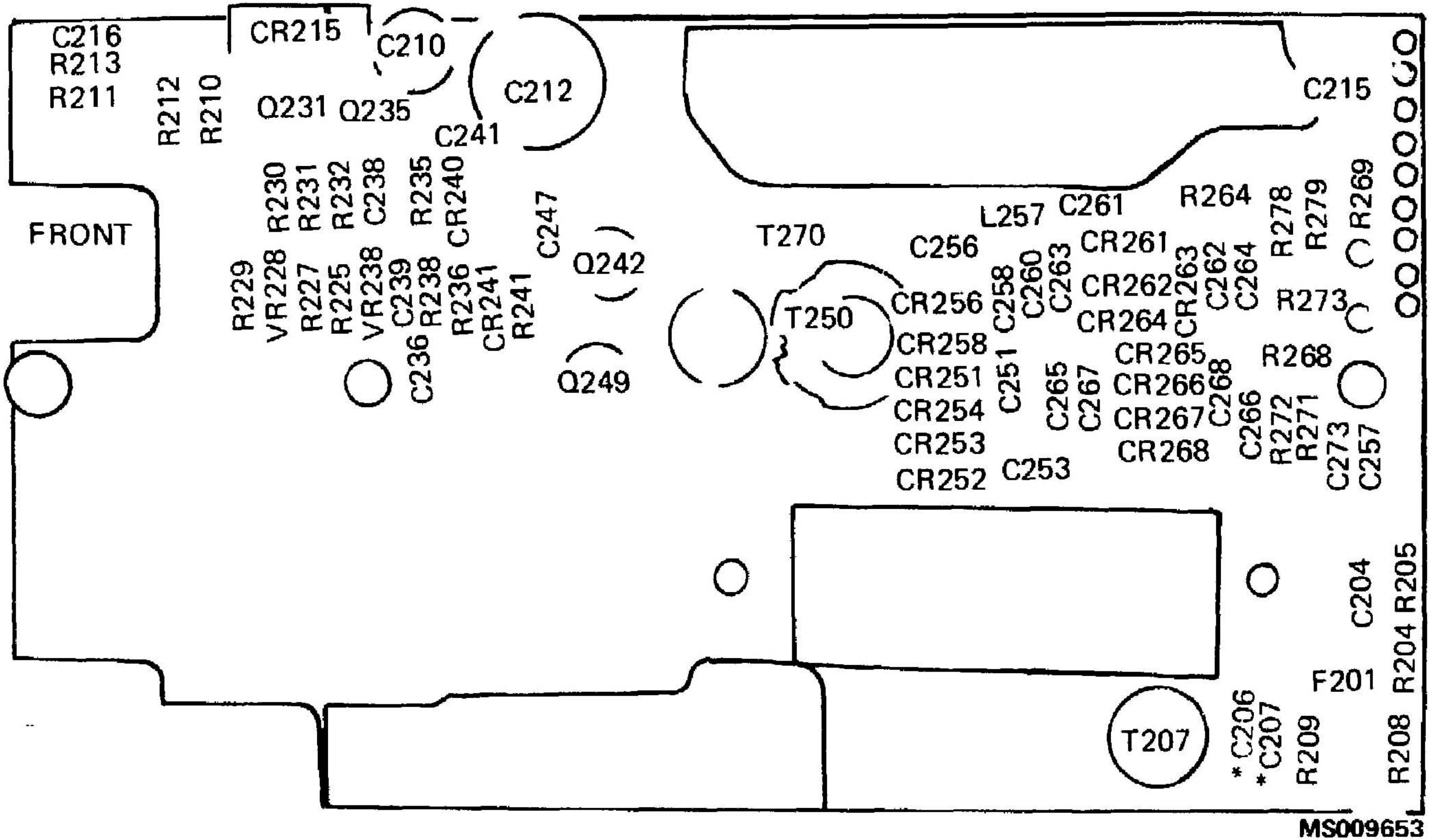


Figure 8-3B. A3 Power Supply Circuit Board, below SN B040000.

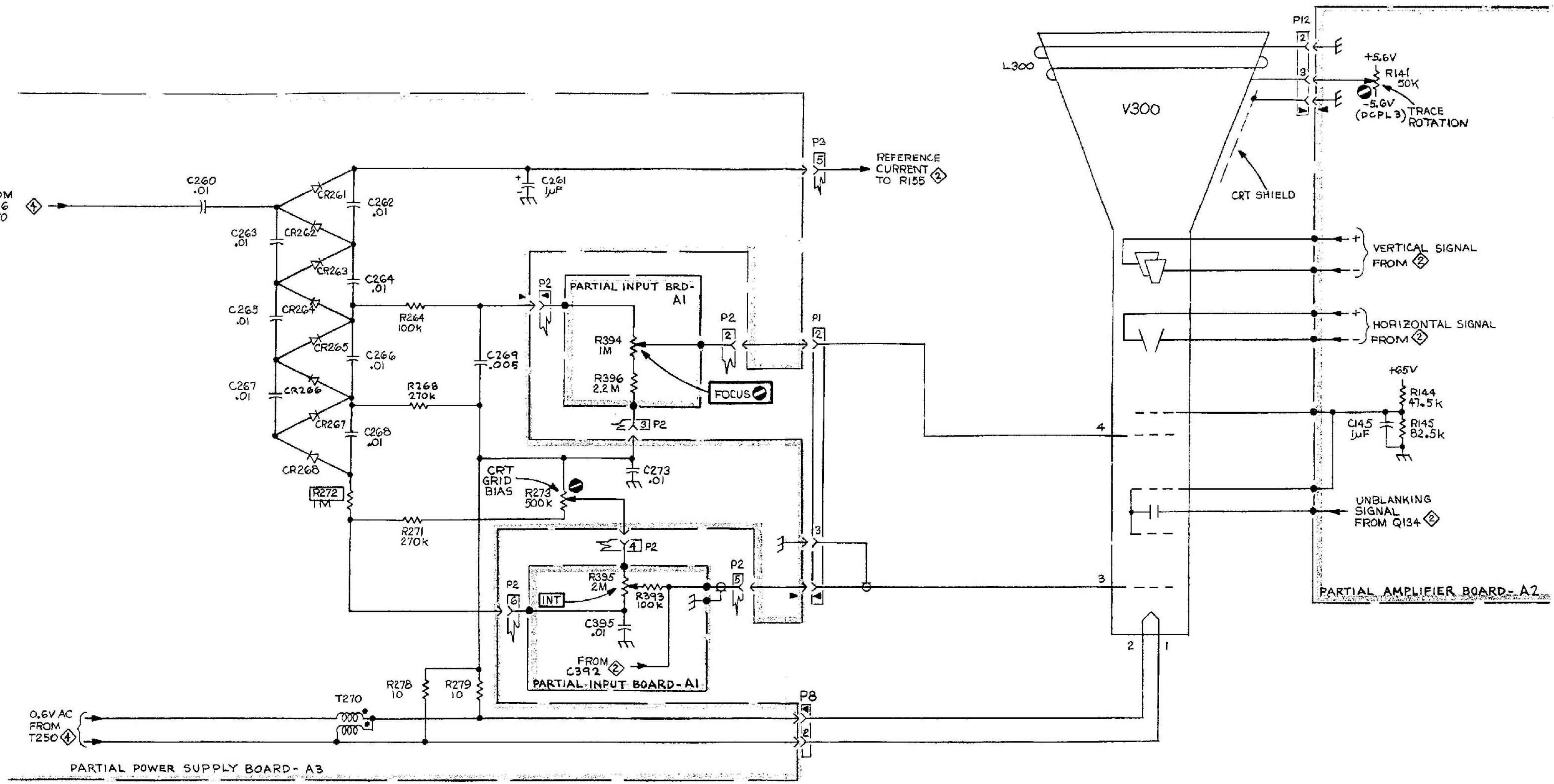


Figure 8-4. CRT Circuit.

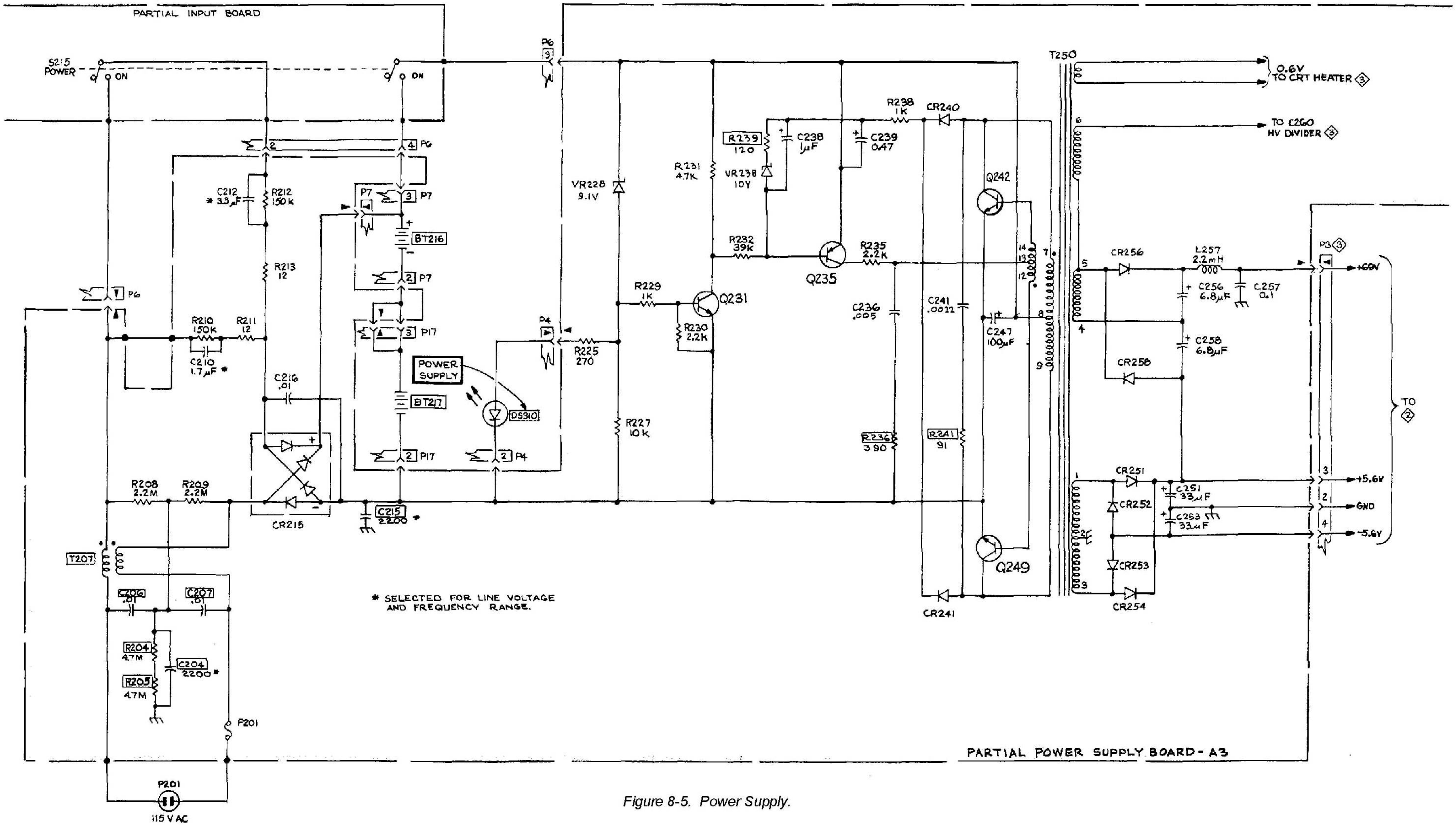


Figure 8-5. Power Supply.