INSTRUCTION MANUAL

MODELS 513, 516, 517

FUNCTION GENERATORS

REV 1/79

® Box 347 Tillamook OR 97141
Telephone 503-842-8441
TWX 510-590-0918
EXACT electronics, inc.

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

TABLE OF CONTENTS

SECTION 1
SPECIFICATIONS

WAVEFORMS:
Model 513 - sine, square, triangle, sync.
Models 516 and 517 - sine, square, triangle, sync,ramp, pulse.

MODES OF OPERATION:
Model 516 - run, gate, trigger, pulse, burst, sweep.
Model 517 - run, gate, trigger, pulse, burst, linear sweep, log sweep.

DYNAMIC FREQUENCY RANGE: 0.01Hz to 11MHz.

FREQUENCY ACCURACY:
± (1% of setting plus 1% of range) 1Hz to 1MHz.
± (2% of setting plus 2% of range) 1MHz to 11MHz.

MAIN OUTPUT: 50Ω output impedance.
20V P-P into open circuit.
10V P-P into 50Ω.

MODELS 516 AND 517 RAMP 10V peak into open circuit.
5V peak into 50Ω

ATTENUATOR: 60db in 10db steps plus 20db continuously variable (80db total).

DC OFFSET: Variable, may be switched in or out.
+10 to -10 volts open circuit.
+5 to -5 volts into 50 ohms.
NOTE: Waveform will clip if D.C. offset plus signal exceeds maximum peak voltage.

SQUARE WAVEFORM: Rise and fall, <20nsec.
Overshoot and ringing, <5% of maximum P-P amplitude.

SYMMETRY (time): ± (1% + 10nsec).

SINE WAVE DISTORTION: <0.5% to 100KHz.
No harmonics <30db down 100KHz to 11MHz.

SINE FREQUENCY RESPONSE: <0.1db to 100KHz. < 2db to 11MHz.

TRIANGLE LINEARITY: 99% to 100KHz.

SYNC OUTPUT: Square wave, 4V P-P open circuit. 100Ω output impedance.

VCF: (Voltage controlled frequency) Approx. 5V input for 1000:1 (three decades) frequency control.

FREQUENCY STABILITY: 0.05% of setting for 10 min.
0.25% of setting for 24 hrs.

AMPLITUDE STABILITY: 0.05% of max. P-P amplitude for 10 min.
0.25% of max. P-P amplitude for 24 hrs.

GATE AND TRIGGER MODES: (Models 516 and 517 only).
Input - D.C. coupled, approx. 1KΩ input impedance. Requirements - manual or external voltage of approx. 1 volt for turn on.

RAMP GENERATOR (Models 516 and 517 only).
Frequency range: 100 sec to 10μsec.
Modes: run, trigger, cal.
Aux ramp output: Typically 5V peak open circuit. 100Ω output impedance.

V:F
Output voltage directly related to frequency. Approx. 5mV to 5V for 1000:1 range.

SECTION 2
OPERATING INSTRUCTIONS

2.1 FRONT PANEL FAMILIARITY (Fig. 2.1.1)

Controls Common to all models.

1. POWER SWITCH. Connects power to the instrument. Refer to the rear panel for line voltage and fuse requirements.
2. POWER LIGHT. Indicates when power is being applied to the instrument.
3. RANGE. Sets the frequency in decade steps from 10Hz to 10MHz and a 20KHz audio range.
4. START FREQ. (MULTIPLIER). Sets the frequency between decades. The outer knob has 10 steps covering 1 decade below the RANGE setting. The inner knob provides vernier adjustment between steps. The S position (search) on the outer knob allows the inner knob to cover the 3 decades below the RANGE setting. In the sweep mode, Models 516 and 517 only, START FREQ sets the frequency from which the sweep starts.
5. FUNCTION. Selects the output waveform; sine, triangle, square, or ramp.
6. AMPLITUDE. Provides a vernier adjustment of output amplitude from maximum amplitude to $>$ 20db below maximum amplitude.
7. OFFSET. Enables the DC OFFSET control when depressed.
8. DC OFFSET. Provides ± 10V of DC OFFSET (±5V into 50Ω) at the output.
9. ATTENUATOR. Provides 10db step attenuation from 0db to -60db.
10. OUTPUT. 50Ω output for all waveforms.
11. SYNC OUT. Square wave coincident with the peaks of the output waveforms. ± 2V P-P open circuit, 100Ω output impedance.

Controls common to Model 516 and 517 only.

12. RAMP TIME. Sets the decade range in period for the ramp from 10μsec to 10sec.
13. RAMP VARIABLE. Provides $>$10 to 1 vernier control over ramp period above each RAMP TIME setting.
14. RAMP SYNC OUT. Provides a pulse coincident with the peaks of the ramp. ± 1V, 100Ω output impedance.
15. MODE. Controls the mode of operation.
    - RUN. The main generator is in free run.
    - GATE. The main generator will run for the duration of an externally applied trigger signal or for as long as MAN is depressed and complete the last cycle.
    - TRIG. The main generator will run for 1 cycle for each externally applied trigger signal or each time MAN is depressed.
    - PULSE. The main generator is internally triggered from the ramp generator and runs for 1 cycle at the start of each ramp.
    - BURST. The main generator is internally gated from the ramp. Burst width is set by BURST WIDTH and repetition rate is set by RAMP TIME and RAMP VARIABLE.
16. START PHASE. Sets the start and stop phase for triggered and gated signals.
17. MAN. Provides for manually triggering or gating.
18. TRIG IN. Input for externally triggering and gating both generators. The trigger level is set at approximately 1 volt, 1KΩ input impedance.

19. STOP FREQ/BURST WIDTH (B). Sets the stop frequency for sweeping. In burst mode, with the outer knob set to B (Burst), the inner, vernier dial, sets the burst width.
20. RAMP CAL. In sweep mode, it provides for holding the main generator at either START FREQ or STOP FREQ.
21. RAMP RUN/TRIG. Sets ramp into either free run or trigger mode.

Model 517 only

22. LIN/LOG. When depressed, frequency control will be converted from linear to logarithmic.

Model 513 only

23. VCF IN. For external control of frequency.

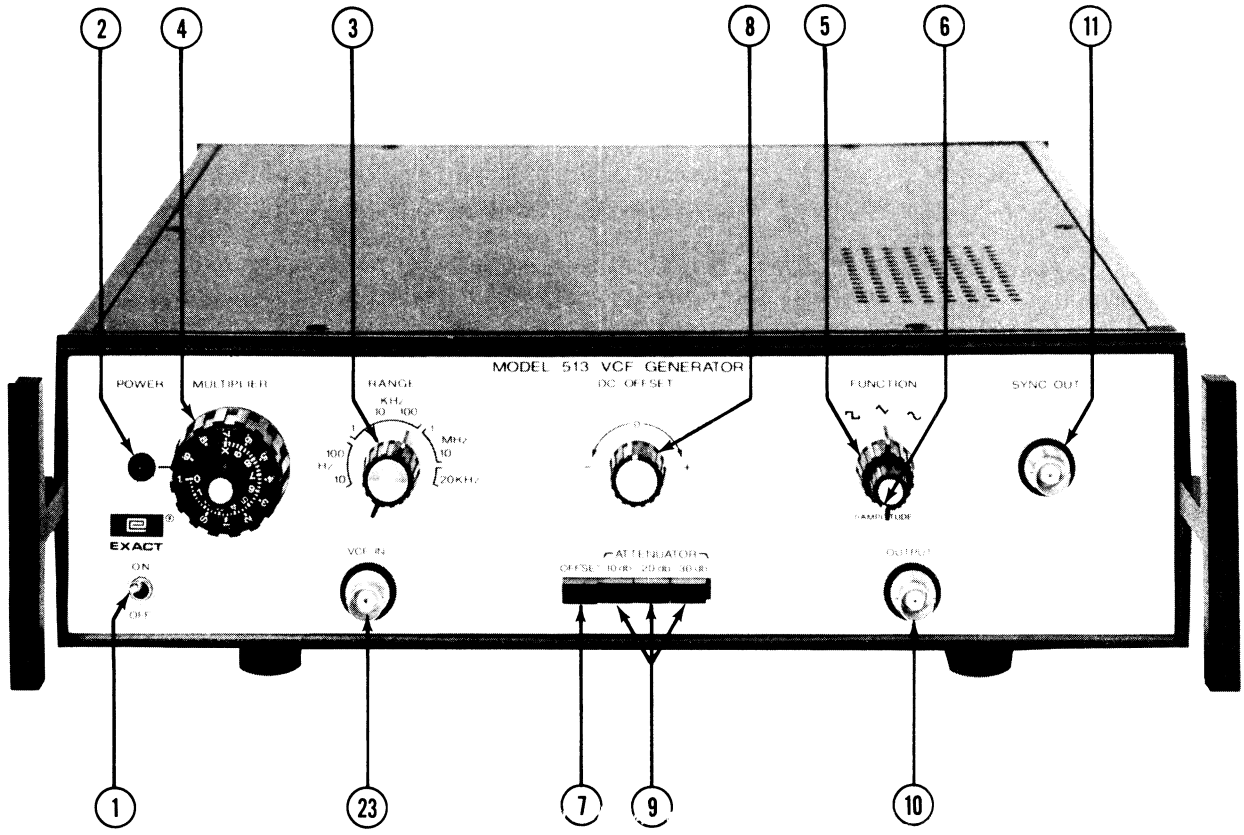


Figure 2.1.1. MODEL 513 FRONT PANEL FAMILIARITY

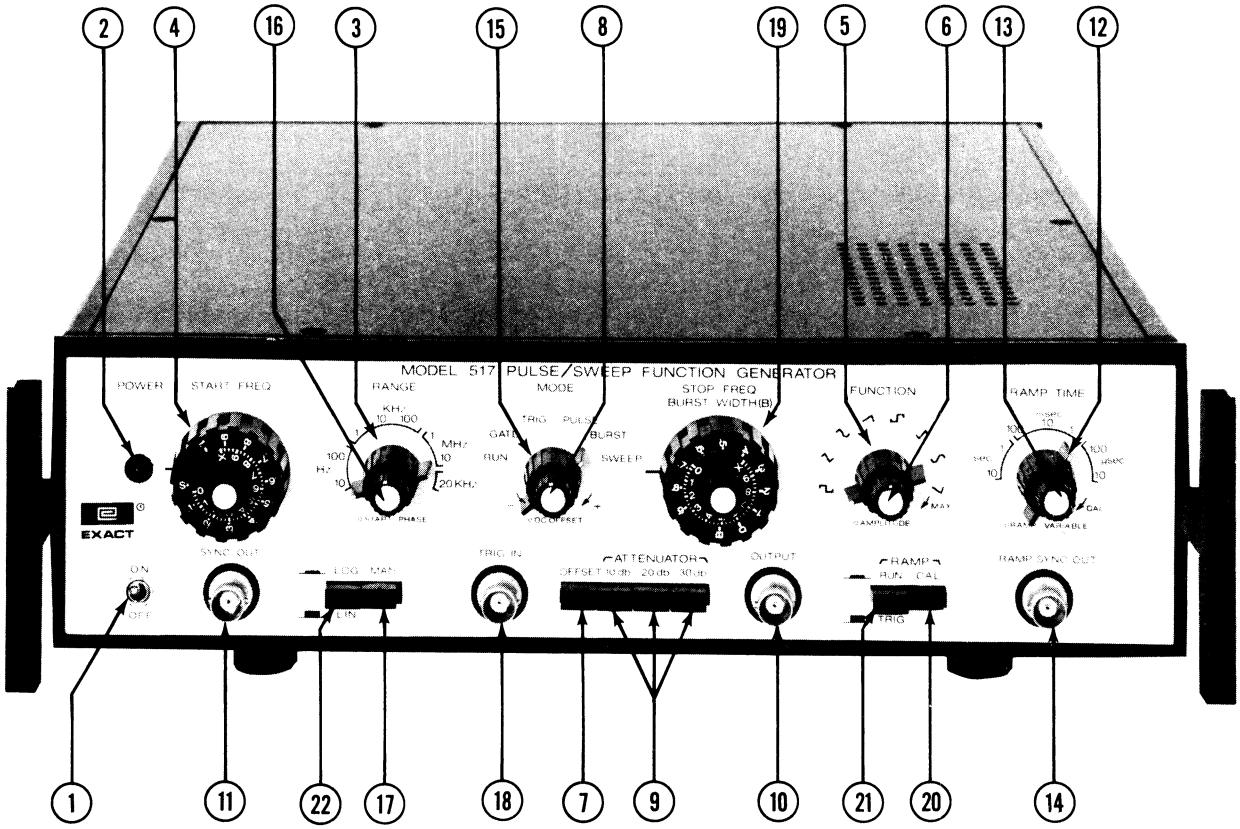


Figure 2.1.2. MODELS 516 AND 517 FRONT PANEL FAMILIARITY

2.2 REAR PANEL FAMILIARITY (Fig. 2.2.1)

Controls common to all models.

1. LINE CORD. Connects to power source, 50Hz to 60Hz and voltage shown on FUSE DATA label.
2. FUSE HOLDER. Holds fuse of type shown in FUSE DATA label.
3. CHASSIS COMMON. Electrically connected to instrument case.
4. CIRCUIT COMMON. Electrically connected to circuit common.

Common to Model 516 and 517 only.

5. RAMP OUT. Auxiliary 5V ramp 100Ω output impedance.
6. V:F OUT. Voltage proportional to frequency, 0 to 5V, 100Ω output impedance.
7. VCF IN. For external control of frequency.

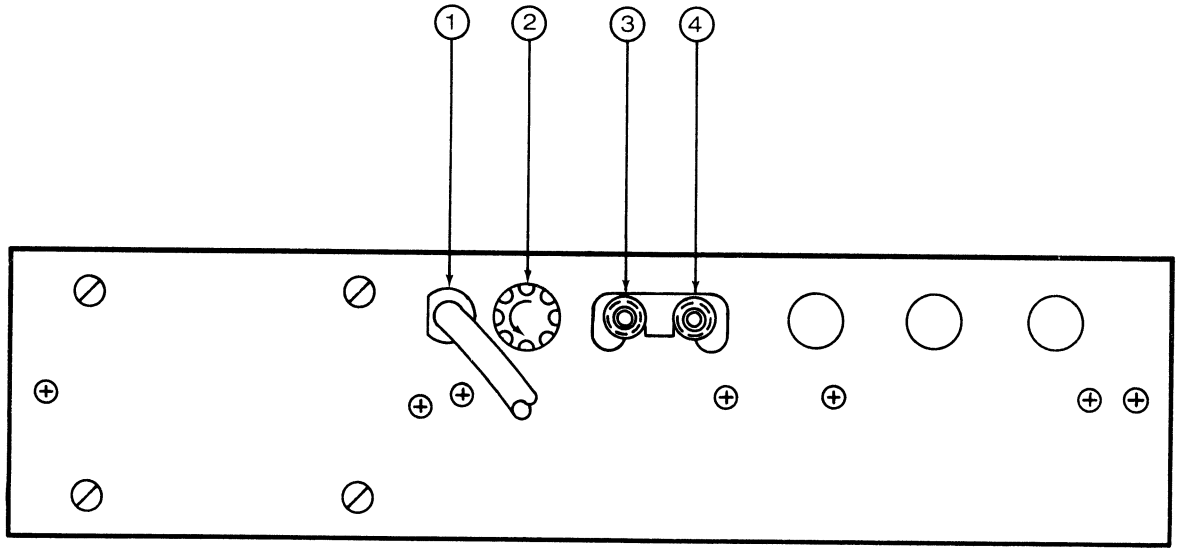


Figure 2.2.1 MODEL 513 REAR PANEL FAMILIARITY

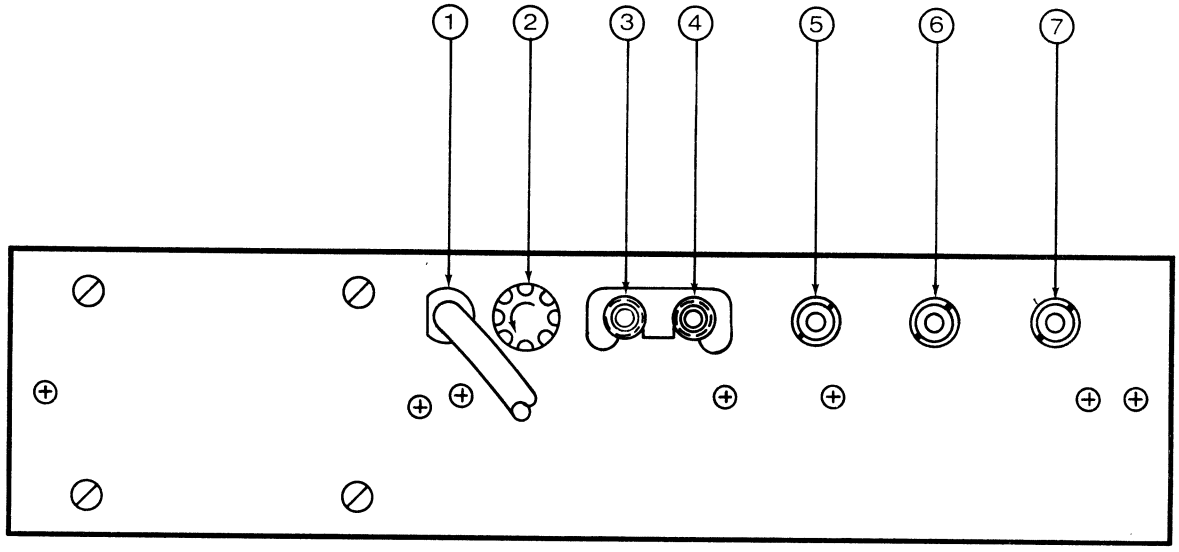


Figure 2.2.2 MODELS 516 AND 517 REAR PANEL FAMILIARITY

2.3 OPERATING INSTRUCTIONS

Common to all models.

2.3.1 FREQUENCY CONTROL

With VCF IN not used, the frequency is defined at START FREQ (MULTIPLIER) times RANGE.

EXAMPLE: Set RANGE to 100KHz; START FREQ (MULTIPLIER) to .37. The frequency is 37KHz. With the START FREQ (MULTIPLIER) outer dial set to S (search) the inner, vernier dial, linearly cover the 3 decades of frequency below RANGE. A typical use for this could be manually sweeping over the audio range, 20Hz to 20KHz. When it is not necessary to have this broad range of vernier frequency control it is recommended that search not be used below the 0.1 mark or degradation of frequency accuracy and stability will occur.

The VCF IN adds considerable versatility to the instrument. With the START FREQ (MULTIPLIER) at S0, fully CCW, VCF IN voltage from 0V to approximately 5V controls the frequency linearly over the 3 decades below RANGE setting with approximately 5V bringing the frequency up to the maximum frequency. This voltage varies slightly from instrument to instrument but should not be allowed to go high enough to cause the frequency to be more than 1.1 times RANGE or waveform distortion will occur. VCF IN can be used for remote frequency programming, phase locking, sweeping, etc.

EXAMPLE: It is desired to sweep from 10KHz to 30KHz in 50msec. Set RANGE to 100KHz; START FREQ (MULTIPLIER) to S0; ramp applied to VCF IN starting at 0.5V and running up to 1.5V in 50msec. An alternative method is to set the START FREQ (MULTIPLIER) to 0.1 and applying a ramp running from 0.0V to 1.0V.

2.3.2 OUTPUT WAVEFORM

There is an endless combination of AMPLITUDE, OFFSET, ATTENUATOR and FUNCTION combinations. As an example, say it is desired to obtain a square wave to drive TTL logic.

EXAMPLE: Set FUNCTION to Square; AMPLITUDE set for 4V P-P into 50Ω; set DC OFFSET to bring the negative peak up to +0.4V.

Care should be taken when using DC OFFSET to prevent amplifier clipping. The output amplifier clips at about ±7V into 50Ω. The ATTENUATOR will not prevent clipping, therefore, at 20db pushbutton engages, the maximum output voltage is ±0.7V.

Common to Models 516 and 517 only.

2.3.3 GATING AND TRIGGERING

There are three methods of gating and triggering the instrument, externally, manually, and internally. Internal gating and triggering are explained in the next section, PULSE AND BURST MODES.

When triggered, the instrument runs for one complete cycle, starting and stopping at the phase or voltage set by START PHASE. Start/stop phase may be set between -90° and +90° with FUNCTION set to normal sine or triangle and from 90° to 270° with FUNCTION set to inverted sine or triangle. Normal square always starts at the negative peak and inverted square always starts at the positive peak.

External triggering is accomplished by setting MODE to TRIG and applying a signal to TRIG IN. The trigger level is approximately 1V and the trigger signal must drop approximately 100mV below the trigger level before retriggering. The shape of the trigger signal does not matter.

EXAMPLE: To obtain one cycle of a 10KHz sine wave every 1msec starting at 180°, set RANGE to 10KHz; MULTIPLIER to 1.0; MODE to TRIG; START PHASE centered; FUNCTION to inverted sine. Apply a signal to TRIG IN of 1KHz and at least 1V peak. CAUTION: The frequency of the trigger signal must be less than the generator frequency for proper operation.

Manual triggering is possible using MAN. Each time MAN is depressed, the generator runs for one cycle.

The ramp can be triggered when RAMP RUN/TRIG is disengaged. A triggered ramp always starts at 0V and returns to 0V after one cycle.

For external gating set MODE to GATE. In this mode the generator will run for the time the external trigger signal is above the trigger level and complete the last cycle.

EXAMPLE: To obtain 3 cycles of a 10KHz sine wave every 1msec starting at 180°. Use the same control settings as in the previous example but with MODE set to GATE and apply a trigger signal of 1KHz that is above 1 volt for at least 0.2msec but less than 0.3msec.

For manual gating, MAN is held in for the desired gate time.

2.3.4 PULSE AND BURST MODES

In these modes the ramp generator is used in place of the external trigger signal.

For pulse mode MODE is set to PULSE and RAMP RUN/TRIG is engaged. The pulse repetition rate is set by RAMP TIME and RAMP VARIABLE.

EXAMPLE: To obtain a .1msec positive square pulse every 2msec. Set START FREQ to 0.5; RANGE to 10KHz; MODE to PULSE; FUNCTION to square; RAMP TIME to 1msec; measure RAMP SYNC OUT and adjust RAMP VARIABLE for a 2msec period; RAMP RUN/TRIG engaged. Note that, when triggering a square wave, the period of the pulse is one half that of sine and triangle.

To obtain bursts, the MODE is set to BURST, RAMP RUN/TRIG is engaged and STOP FREQ/BURST WIDTH is set to 8 with the vernier knob used to control burst width.

EXAMPLE: To obtain a burst of 5, 0.1msec pulses, 1msec apart, once every 2msec. Use same control settings as the previous example but with MODE to BURST and STOP FREQ/BURST WIDTH to 8.5. BURST WIDTH may need to be adjusted slightly to get 5 pulses.

CAUTION: In both PULSE and BURST, the ramp must run slower than the main generator for proper operation.

2.3.5 SWEEP MODE

In sweep mode the ramp is used to sweep the frequency of the main generator. START FREQ sets the sweep start freq, STOP FREQ/BURST WIDTH is used to set the stop freq, RANGE sets the maximum possible frequency. The frequency may be swept up or down depending on the start and stop freq settings. RAMP TIME and RAMP VARIABLE is used to set the sweep period or sweep rate. A triggered sweep is available by disengaging RAMP RUN/TRIG and either applying an external trigger signal or using MAN. When sweep is triggered, the main generator sweeps from the start frequency to the stop frequency, returns to the start frequency and holds at that frequency. In this mode, the start frequency may be measured when the ramp is not triggered. Stop frequency can be measured by depressing RAMP CAL which causes the main generator to jump to the stop frequency and hold.

EXAMPLE: To sweep a sine wave from 50KHz to 30KHz at a rate of 1KHz per msec or in 20msec each time MAN is depressed. Set START FREQ to 0.5; STOP FREQ to 0.3; RANGE to 100KHz. MODE to SWEEP; FUNCTION to SINE; RAMP TIME to 10msec; adjust RAMP VARIABLE for the positive portion of RAMP SYNC OUT to be 20msec; RAMP RUN/TRIG released. Depress MAN.

An auxiliary ramp output is provided which can be used for driving an X:Y recorder when making frequency response plots.

Model 517 only

2.3.6 LOG FREQUENCY CONTROL

When LIN/LOG is depressed, the main generator frequency is controlled logrithmically instead of linearly, i.e., frequency is proportional to the exponential of the applied voltage. This is useful in frequency response plots when it is desired that the frequency scale be logarithmic. The auxiliary RAMP OUT can be used to drive the frequency scale.

Models 516 and 517 only

2.3.7 DC OUTPUT.

The instrument may be used as a source of DC voltage by placing it in a triggered square mode and not applying a trigger signal. AMPLITUDE and ATTENUATOR are used to set the voltage. Positive or negative voltage is obtained by selecting negative or positive square respectively.

SECTION 3
CALIBRATION PROCEDURE

3.0 CALIBRATION PROCEDURE (Fig. 3.0.1)

This unit must be on for one hour with the covers in place and the output terminated into 50Ω before calibration.

The following equipment or suitable equivalents of known accuracy are required for complete calibration.

Oscilloscope D.C. to 100MHz with Differential input with 5MV/cm sensitivity.
Tektronix 7704 with 7A13 plug-in.

Counter-Timer 10Hz to 10MHz.
DANA 8010B or equivalent.

Digital Voltmeter .01% accuracy with 100 megohm input impedance floating inputs.
DANA 4300.

Harmonic Distortion Analyzer .1% Residual Distortion
Hewlett Packard 333.

Model 517 only.

Voltage source 0V to +5V with 3 digit accuracy.

3.0.1 INITIAL CONTROL SETTINGS

POWER SWITCH	ON
START FREQUENCY (MULTIPLIER)	S0 (FULLY CCW)
RANGE	100KHz
FUNCTION	NORMAL SQUARE
AMPLITUDE	FULLY CW
OFFSET	OFF
ATTENUATOR	OFF

Model 516 and 517 only.

MODE	RUN
STOP FREQUENCY	.9X
RAMP TIME	1msec
RAMP VARIABLE	FULLY CW
RAMP RUN/TRIG	TRIG
RAMP CAL	CAL

Model 517 only.

LIN/LOG	LIN

Use TP276 as common for all steps of calibration.

3.0.2 POWER SUPPLIES

A. Probe to TP112 and adjust the -15V ADJ for -15.000V ± .01V.
B. Probe to TP104 and adjust the +15V ADJ for +15.000V ± .01V.
C. Repeat A and B until both are within ± .01V.

3.0.3 VCF BALANCE

A. Connect OUTPUT to scope. A square wave of approximately 100Hz or above should be seen on scope. If there is no signal or the frequency is too low, dial up on START FREQUENCY.
B. Adjust VCF BAL for no change in frequency when VCF IN is shorted to common.
C. Set START FREQUENCY to bottom of SEARCH (fully CCW). Connect DVM from common to TP230 and adjust SEARCH RANGE ADJ for -0.005mV ± .5mV.
D. Connect OUTPUT to scope. Adjust SEARCH SYM ADJs A and B for a symmetrical square of period 11 msec.

Models 516 and 517 only.

E. Connect DVM from common to TP220 and measure voltage. Move DVM to TP1130 and adjust RAMP CAL ADJ for same voltage as at TP220.
F. Switch MODE to SWEEP and move DVM to TP220. Adjust SWEEP BAL for 0.000V ± 1mV. Switch MODE to RUN.
G. Repeat E and F until no more improvement can be obtained.

Model 517 only.

H. Depress LIN/LOG. Connect clip lead from common to TP241 and connect DVM from common to TP1310 and adjust AMP 1 BAL for 0.000V as close as possible. Remove clip lead.
I. Connect DVM (floated) between TP1350 and TP1351 and adjust AMP 3 BAL for 0.000V as close as possible. Release LIN/LOG.

3.0.4 SINE DISTORTION

A. Connect OUTPUT into 50Ω to distortion analyzer. Set RANGE to 1KHz, START FREQUENCY to 1.0 and FUNCTION to SINE. Center up the 4 SINE DIST. ADJs.
B. Adjust SINE INPUT and SINE OUTPUT for minimum distortion.
C. Adjust the 4 SINE DIST. ADJs for minimum distortion.
D. Repeat B and C until no further improvement can be obtained.

3.0.5 FREQUENCY

A. Connect SYNC OUT to counter. Adjust FREQ ADJ for 1KHz ± 10Hz.

B. Set RANGE to 100Hz and adjust 100Hz ADJ for 100Hz ± 1.0Hz.
C. Set RANGE to 1MHz and adjust 1MHz ADJ for 1MHz ± 10KHz.
D. Set RANGE for 10MHz and adjust 10MHz ADJ for 10MHz ± 100KHz.
E. Repeat D and E until no further improvement can be obtained.

Model 517 only.

F. Set START FREQUENCY to bottom of search (fully CCW) and RANGE to 100KHz. Depress LIN/LOG and adjust AMP 3 BAL for same frequency as in LIN.
G. Set START FREQUENCY to 1.0 and adjust SPAN ADJ for same frequency in LOG as in LIN.
H. Depress LIN/LOG and set START FREQUENCY for 100Hz ± 2Hz.
J. Apply positive voltage at VCF IN until frequency increases to 100KHz ± 1KHz (approximately 4.5V) and record voltage.
K. Apply 1/2 of voltage measured in step 1 and adjust ORIGIN ADJ. for 3.16KHz ± 40Hz.
L. Repeat steps F through K until no further improvement can be obtained.

3.0.6 RAMP

Models 516 and 517 only.

A. Connect OUTPUT to scope. Set MODE to SWEEP, set FUNCTION to SQUARE, set RANGE to 100KHz, and START FREQUENCY fully CCW and release RAMP CAL. Adjust RAMP LOCKOUT ADJ for frequency, with MODE in SWEEP, to be the same as when MODE in in RUN.
B. Set FUNCTION to RAMP. Depress RAMP RUN/TRIG and adjust RAMP DC ADJ for the negative peak to be equal to the same DC voltage as measured when RAMP RUN/TRIG is released +0V -.010V. Leave RUN/TRIG depressed.
C. Adjust RAMP PEAK ADJ for the positive peak to be equal to the DC voltage measured when RAMP CAL is depressed -0V + .010V. Release RAMP CAL.
D. Connect RAMP SYNC OUT to counter reading time interval A to B (positive to negative slope) and adjust RAMP TIME ADJ for 1msec ± 10µsec. Set MODE to RUN, release RAMP RUN/TRIG and set START FREQUENCY to 1.0.

3.0.7 OUTPUT WAVEFORMS

A. Connect OUTPUT to scope, set RANGE to 100Hz, START FREQUENCY (MULTIPLIER) to 1.0 and AMPLITUDE fully CCW. Connect a clip lead across R800 and adjust PA BAL for zero offset. Remove clip lead and rotate AMPLITUDE fully CW.
B. Set FUNCTION to TRIANGLE. Adjust TRI AMPL ADJ and TRI D.C. ADJ for ±5V + 100mV -0mV.
C. Set FUNCTION to SINE. Adjust SINE AMPL ADJ and SINE D.C. ADJ for ±5V + 100mV -0mV.

D. Set FUNCTION to SQUARE. (Allow 1 min. warmup time). Adjust SQU AMPL ADJ and SQU D.C. ADJ for ±5V + 100mV -0mV.

Models 516 and 517 only.

F. Set FUNCTION to INVERTED SQUARE. (Allow 1 min. warmup time). Adjust INV SQU AMPL ADJ and INV SQU D.C. ADJ for ±5V + 100mV -0mV.
G. Set FUNCTION to INVERTED TRIANGLE. Adjust INV AMP GAIN ADJ and INV AMP D.C. ADJ for ±5V + 100mV -0mV.

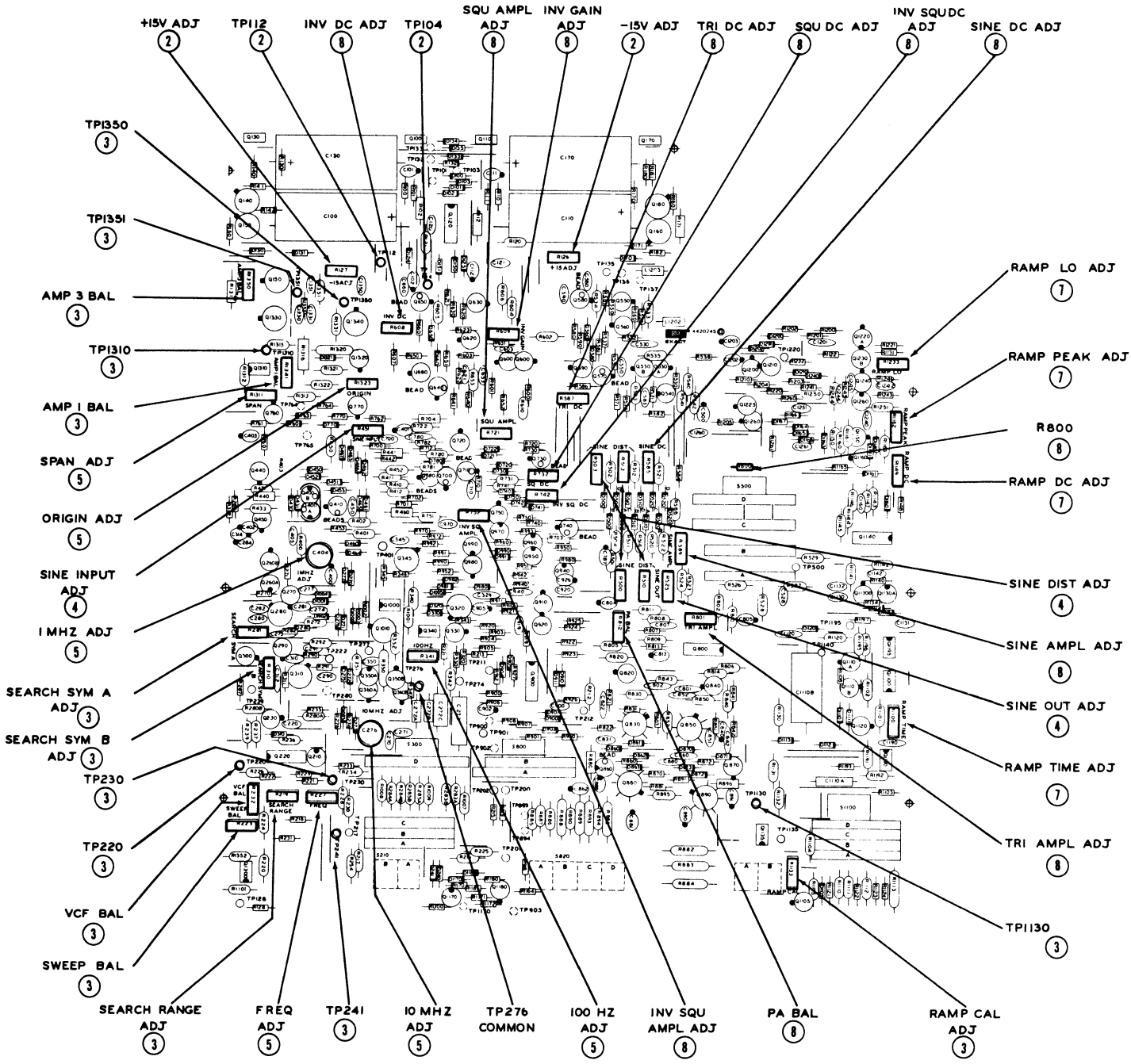


Figure 3.0.1 ADJUSTMENT LOCATION DETAIL

SECTION 4
TROUBLE SHOOTING

4.1 CIRCUIT DESCRIPTION (Fig. 4.1.1 or 4.1.2)

4.1.1 MAIN GENERATOR

Common to all models.

The instrument contains a triangle generator loop. The process of generating the triangle also generates a square wave. The triangle is shaped into a sine wave. The selected waveform is then amplified and sent to the output.

The VCF AMPLIFIER is a summing amplifier accepting input, from the MULTIPLIER and VCF IN.

The output voltage of the VCF AMPLIFIER is level shifted to generate the voltage levels required by the POSITIVE CURRENT SOURCE and the NEGATIVE CURRENT SOURCE. The current sources are voltage to current converters. A capacitor is alternately charged and discharged by the two current sources through a current switching bridge. Frequency range selection is made by changing current setting resistors in the current sources and by changing the timing capacitor and by use of the CAPACITANCE MULTIPLIER. The capacitor voltage is routed to the LEVEL DETECTOR through the high input impedance, low output impedance TRIANGLE BUFFER. The LEVEL DETECTOR is a bistable, voltage level detector which switches states as the capacitor voltage reaches the preset plus and minus triangle peak voltages. The square wave thus generated drives the current switching bridge, the SYNC OUT BUFFER and the SQUARE SWITCH.

When triangle is selected, the FUNCTION SWITCH routes the triangle to the PRE AMP and then the POWER AMP. The PRE AMP is a non-inverting operational amplifier. The POWER AMP as an inverting, high output current operational amplifier with feed forward. When sine is selected, the triangle is routed through the SINE SHAPER prior to the PRE AMP. The SINE SHAPER has three diode bridges which shape the triangle into a sine wave. The square wave is routed directly to the POWER AMP from the SQUARE SWITCH. The ATTENUATOR is a series of 50Ω 'T' attenuators.

Models 516 and 517 only.

The 516 and 517 have additional circuitry in the main generator to generate inverted waveforms. The PRE AMP output is fed to the INVERTING AMP which is a unity gain inverting operation amplifier. When inverted triangle or sine are selected, the FUNCTION switch routes the output at this amplifier to the POWER AMP. The SQUARE SWITCH has another stage which generates the inverted square.

Sweep start and stop sweep frequency are generated by summing the ramp, inverted, with the 1V already present at the top of the START FREQ control and summing the output of START FREQ into the VCF AMP with the output of the STOP FREQ control which also is driven with the ramp.

4.1.2 TRIGGER AND GATE CIRCUITRY

Models 516 and 517 only.

The TRIGGER COMPARATOR accepts inputs from MAN, TRIG IN and the ramp generator. It is a Schmitt trigger which conditions the trigger signal to a square pulse. In PULSE mode, the ramp level detector pulse is used for triggering. In BURST mode, the ramp and a DC voltage from the BURST WIDTH control are summed at the trigger comparator input. The LOCKOUT FLIP-FLOP is of the set-reset type, with one input connected to the trigger comparator and the other input to the LEVEL DETECTOR. When the flip-flop receives a signal from the TRIGGER COMPARATOR, it is set to allow the generator to run and a signal from the LEVEL DETECTOR resets it to stop the generator. In a trigger mode the signal from the trigger comparator is AC coupled whereas in a gate mode it is DC coupled so the level detector cannot reset the flip-flop until the TRIGGER COMPARATOR has reset. The mechanism of lockout is accomplished by summing positive current at the timing capacitor equal and opposite to the current from the NEGATIVE CURRENT SOURCE on the negative slope of the triangle to hold the voltage. This current is from the LOCKOUT CURRENT SOURCE which tracks the POSITIVE CURRENT SOURCE at twice the current. The lockout voltage level is set by the LOCKOUT VOLTAGE SOURCE. As the triangle approaches the lockout voltage, the lockout diode bridge begins to switch current to the timing capacitor until each side of the bridge is running at half current and the triangle holds. When not locked out, the lockout current is drawn by lockout flip-flop.

4.1.3 RAMP

Models 516 and 517 only

The ramp generator is similar to the main generator triangle generator in that two current sources charge and discharge a timing capacitor with the peak voltage controlled by a level detector.

The POSITIVE CURRENT SOURCE generates a current inversly proportional to the position of RAMP VARIABLE so that it tracks a period linearly rather than the frequency. The NEGATIVE CURRENT SOURCE tracks the POSITIVE CURRENT SOURCE and only it is switched to and from the timing capacitor by the level detector. The negative, or reset, current is 15 times the positive current giving a reset time 14 times faster than the rise time. The RAMP BUFFER and LEVEL DETECTOR are the same as in the main generator except the level detector switch points are at +1V

and 0V. Ramp lockout uses a somewhat different scheme than the main generator. The LOCKOUT FLIP-FLOP receives signals from the LEVEL DETECTOR and TRIGGER COMPARATOR to enable or disable the LOCKOUT AMP. The LOCKOUT AMP is an inverting operational amplifier with current mode output. Its inputs are connected to the output of the RAMP BUFFER and common and the output is connected to the timing capacitor. It sums enough current at the timing capacitor to hold the voltage at 0V. RAMP CAL is simply a voltage source set at the same voltage as the ramp peak to simulate the ramp being held at its peak.

4.1.4 LOG CONVERTER

Model 517 only.

The log converter is connected between the VCF inputs and the VCF AMP when LIN/LOG is depressed. It converts the 0V-5V linear VCF control voltage to a 0V-5V exponential curve by making use of the exponential characteristics of the base emitter junction of a transistor.

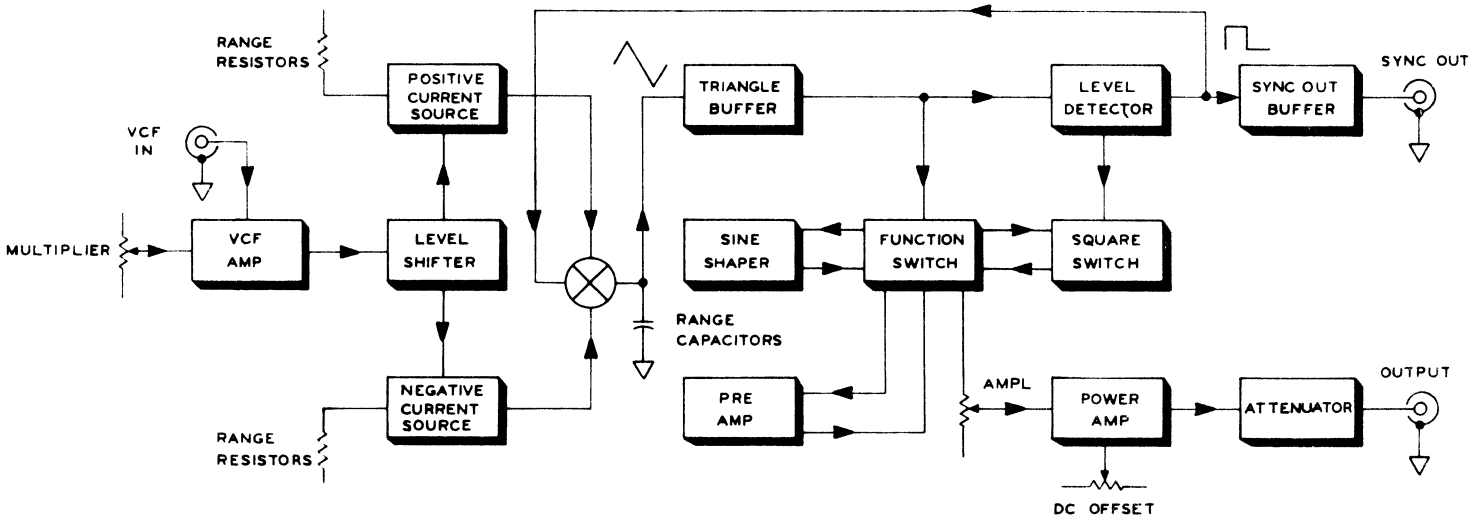


Figure 4.1.1 MODEL 513 BLOCK DIAGRAM

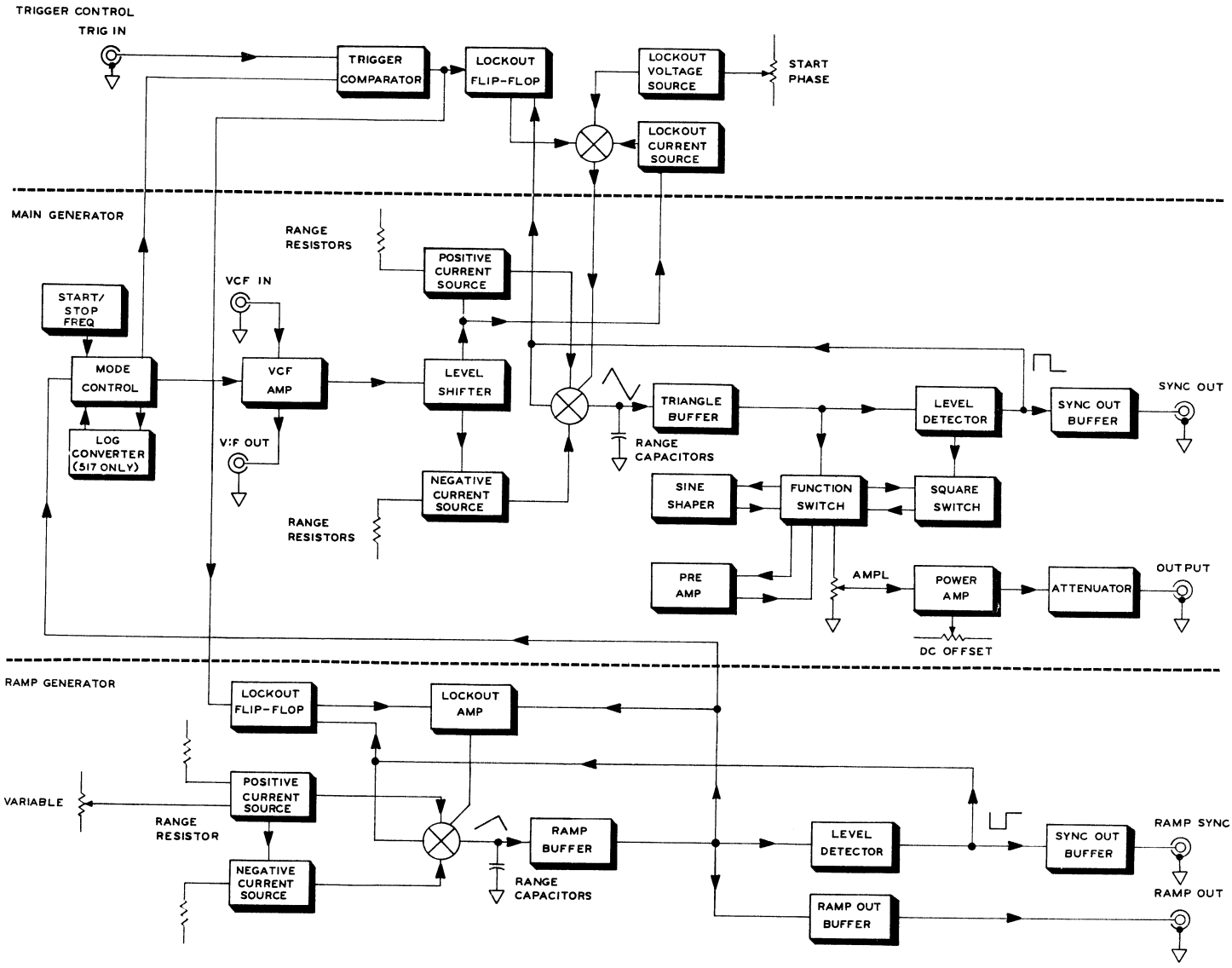


Figure 4.1.2 MODELS 516 AND 517 BLOCK DIAGRAM

4.2 USE OF TROUBLE SHOOTING TREES (Fig.4.3.1 and 4.3.2)

The trouble shooting trees are designed to point to the malfunctioning circuit block. Beyond this, refer to the proper schematic and check voltages and waveform at the indicated points to determine the actual problem. Start with the following initial control setting.

On all models.

START FREQ (MULTIPLIER)	1.0
RANGE	1K
FUNCTION	TRIANGLE
AMPLITUDE	FULL CW
OFFSET	DISENGAGED
ATTENUATOR	DISENGAGED

Models 516 and 517 only.

MODE	RUN
START PHASE	CENTERED
STOP FREQ	.9X
RAMP TIME	1msec
RAMP VARIABLE	FULL CW
RAMP RUN/TRIG	ENGAGED
RAMP CAL	DISENGAGED

Model 517 only.

LIN/LOG	DISENGAGED

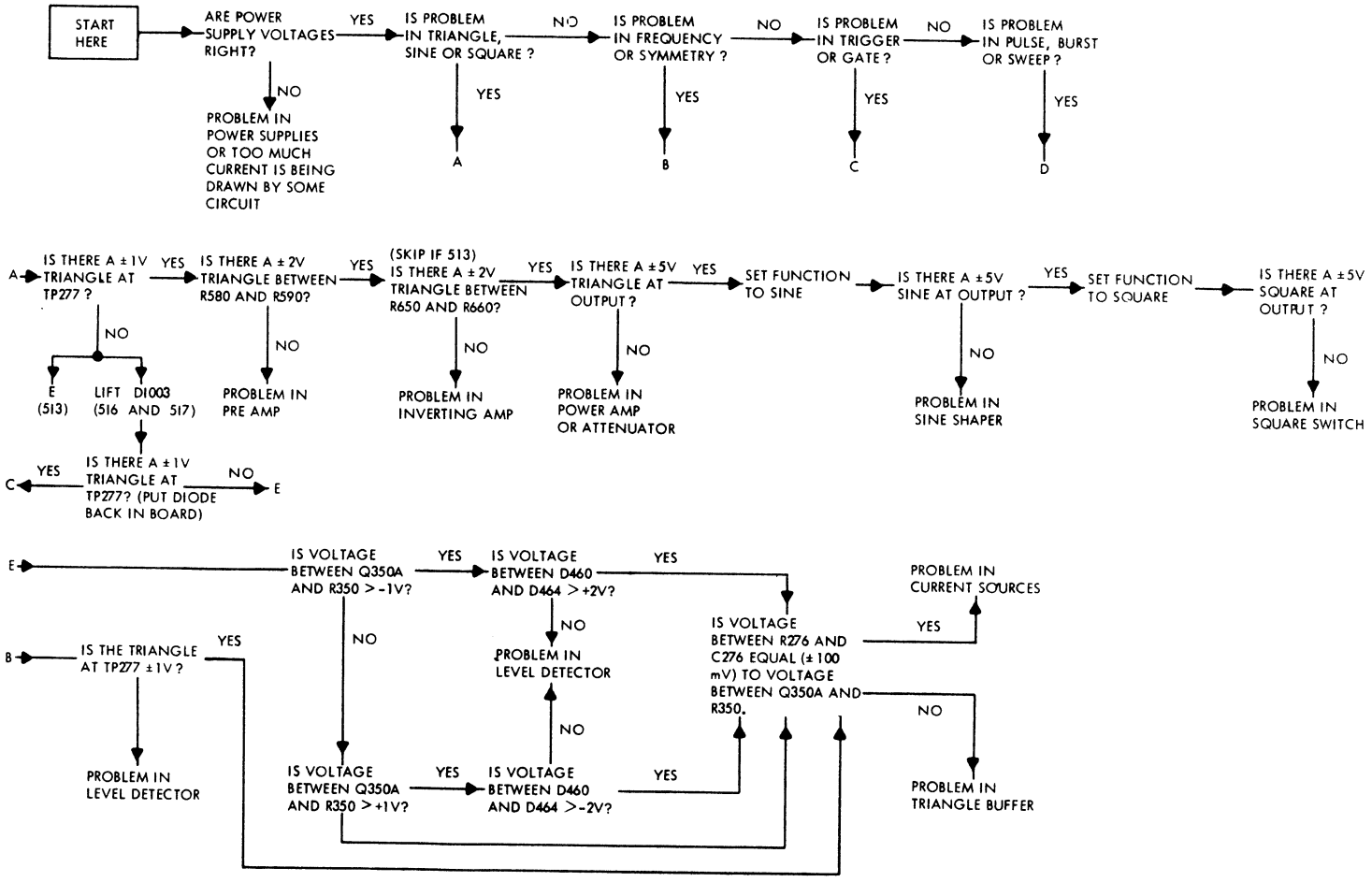


Figure 4.2.1 TROUBLE SHOOTING TREE, page 1

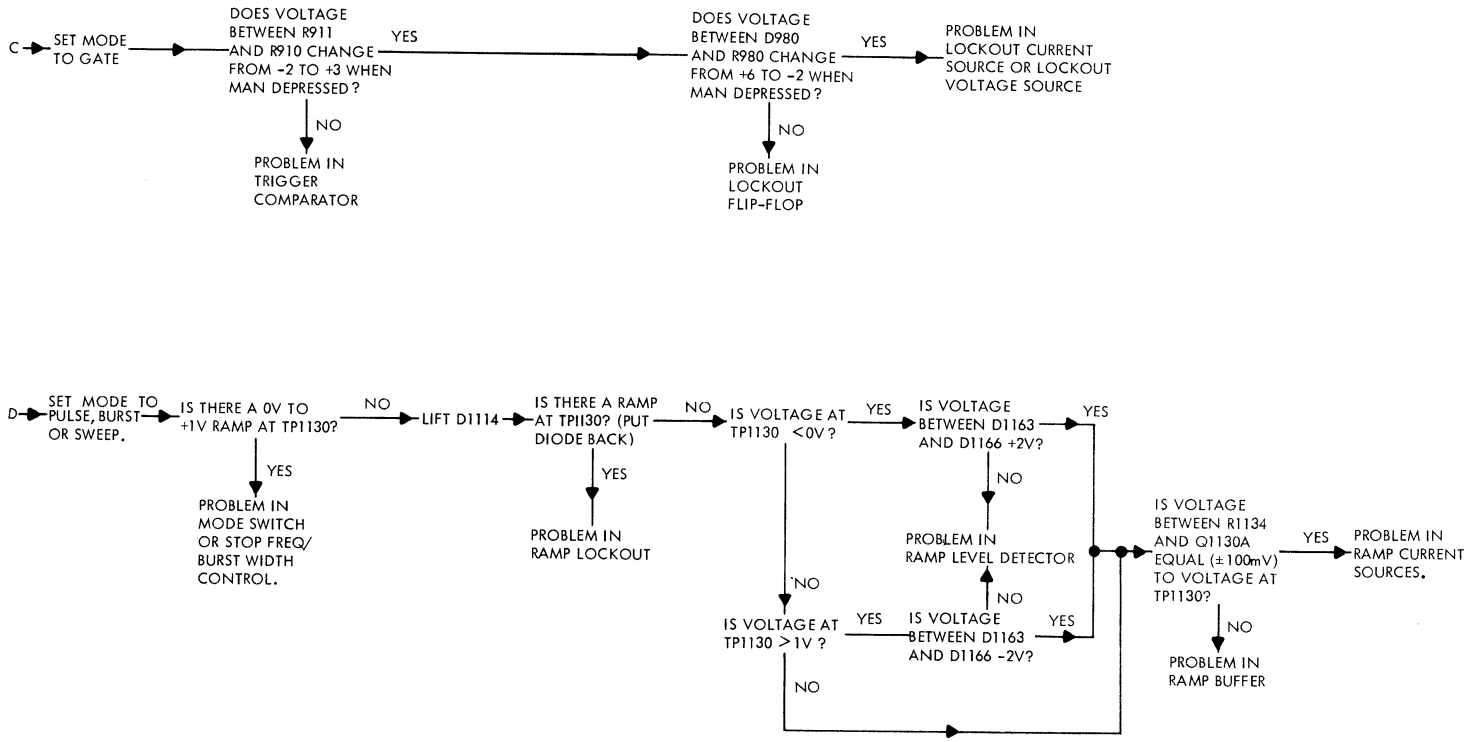


Figure 4.2.2 TROUBLE SHOOTING TREE, page 2

SECTION 5
PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Spgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidaire Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Orgill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04272	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Arizona
04732	Filtron Co/Western Div.	Culver City, Calif.
04772	Automatic Electric Co.	Northlake, Illinois
04773	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05870	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst.Co.	Penacook, N.H.
06751	U.S. Semicon Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co, West Div.	Van Nuys, Calif.
06983	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07251	Avnet Corp.	Los Angeles, Calif.
07262	Fairchild Semiconductor Corp.	Mountain View, Calif.
07327	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp.	Los Angeles, Calif.
07390	Technical Wire Products	Springfield, N.J.
07410	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Sheckley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08318	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co., Phoenix Div	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indinnapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atomm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Arbkeley, Calif.
10597	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G,M,B,H,)	Honnover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Word Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Ossoso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst. Div. Daystrom	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
71707	Coto Coil, Co., Inc.	Providence, R.I.
72354	John E Fast and Company	Chicago, Illinois
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Illinois
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Illinois
73138	Helipot, Div. Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Phillips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. H. Winns and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77068	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Phaell Manufacturing Co.	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co,	Norwalk, Conn.
81349	Military Specifications	----------
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Gleesner Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R.M. Bracamonte and Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco
87664	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tower Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoor, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield, Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Monmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Comp. Div, Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Illinois
95712	Dage Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gurdena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div. Controls Co. of America	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
C0100	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0101	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0102	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0103	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0110	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0111	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0112	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0120	CAPACITOR, 1500 PF DISCAP	2830012	91418
C0121	CAPACITOR, 1500 PF DISCAP	2830012	91418
C0130	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0170	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0211	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0212	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0220	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0270	CAPACITOR, 56PF	2810561	853
C0271	CAPACITOR, 56PF	2810561	853
C0272	CAPACITOR, TIMING SET	2950012	10597
C0273	CAPACITOR, 1MF 100V	2900065	10597
C0274	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0275	CAPACITOR, 0.1 UF DISCAP	2830002	56289
C0276	CAPACITOR, 5.5-18PF TRIM	2810011	72982
C0277	RESISTOR, SELECTED VALUE		
C0280	TO		
C0282	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0284	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0290	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0291	RESISTOR, SELECTED VALUE		
C0310	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0312	CAPACITOR, 0.1 UF DISCAP	2830002	56289
C0314	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0329	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C0345	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0350	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0400	TO		
C0403	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0404	CAPACITOR, 5.5-18PF TRIM	2810011	72982
C0405	CAPACITOR, 47PF MICA	2810532	853
C0450	CAPACITOR, 10PF MICA	2810529	853
C0500	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0528	CAPACITOR, 270PF MICA	2810540	853
C0530	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C0550	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0580	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0583	CAPACITOR, 3PF MICA	2810500	853
C0590	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0603	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C0621	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0653	CAPACITOR, 3PF MICA	2810500	853
C0660	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0700	CAPACITOR, 22PF MICA	2810530	853
C0710	CAPACITOR, 22PF MICA	2810530	853
C0780	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C0787	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0801	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0802	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0804	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0805	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0807	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0813	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0822	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0831	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0840	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0842	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0851	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0852	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0860	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0880	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0881	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0888	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0890	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0891	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0898	CAPACITOR, 2PF MICA	2810542	10597
C0899	CAPACITOR, 2PF MICA	2810542	10597
C0900	CAPACITOR, 68PF MICA	2810523	853
C0902	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0905	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0919	CAPACITOR, 10PF MICA	2810529	853
C0920	CAPACITOR, 22PF MICA	2810530	853
C0926	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0940	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0970	CAPACITOR, 10PF MICA	2810529	853
C1110	CAPACITOR, TIMING SET	2950013	10597
C1120	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C1130	CAPACITOR, 1000 PF DISCAP	2830000	91418
C1131	CAPACITOR, 1000 PF DISCAP	2830000	91418
C1132	CAPACITOR, 1000 PF DISCAP	2830000	91418
C1142	CAPACITOR, 390PF MICA	2810556	853
C1160	CAPACITOR, 3PF MICA	2810500	853
C1190	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1201	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C1202	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1203	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1240	CAPACITOR, 100PF MICA	2810537	853
C1242	CAPACITOR, 100PF MICA	2810537	853
C1244	CAPACITOR, 68PF MICA	2810523	853
C1245	CAPACITOR, 68PF MICA	2810523	853
C1251	CAPACITOR, 100PF MICA	2810537	853
C1260	CAPACITOR, 68PF MICA	2810523	853
C1261	CAPACITOR, 1000 PF DISCAP	2830000	91418
C1330	CAPACITOR, 1000 PF DISCAP	2830000	91418
C1331	CAPACITOR, 100PF MICA	2810537	853
C1350	CAPACITOR, 1000 PF DISCAP	2830000	91418
C1351	CAPACITOR, 100PF MICA	2810537	853
D0100	TO		

PART	DESCRIPTION	EXACT NO	MFG
D0103	DIODE, 1N4001	1524001	1295
D0104	LED, MLED650	1520002	4713
D0124	TO		
D0125	DIODE, 1N4001	1524001	1295
D0130	DIODE, 1N5241	1525241	4713
D0131	DIODE, 1N5241	1525241	4713
D0132	TO		
D0135	DIODE, 1N4001	1524001	1295
D0150	TO		
D0151	DIODE, 1N4001	1524001	1295
D0170	DIODE, 1N5241	1525241	4713
D0171	DIODE, 1N5241	1525241	4713
D0240	TO		
D0241	DIODE, 1N914	1520914	7910
D0270	DIODE, 1N914	1520914	7910
D0271	DIODE, HOT CARRIER	1522835	10597
D0272	DIODE, HOT CARRIER	1522835	10597
D0273	DIODE, 1N914	1520914	7910
D0274	DIODE, HOT CARRIER	1522835	10597
D0275	DIODE, 1N914	1520914	7910
D0276	DIODE, 1N914	1520914	7910
D0277	DIODE, HOT CARRIER	1522835	10597
D0280	DIODE, 1N756	1520756	1295
D0310	DIODE, 1N756	1520756	1295
D0320	DIODE, 1N914	1520914	7910
D0330	DIODE, 1N914	1520914	7910
D0430	TO		
D0431	DIODE, HOT CARRIER	1522835	10597
D0450	TO		
D0453	DIODE, HOT CARRIER	1522835	10597
D0460	DIODE, HOT CARRIER	1522835	10597
D0461	TO		
D0463	DIODE, 1N914	1520914	7910
D0464	DIODE, HOT CARRIER	1522835	10597
D0465	TO		
D0467	DIODE, 1N914	1520914	7910
D0500	DIODES, MATCHED 2835	1532835	10597
D0510	DIODES, MATCHED 2835	1532835	10597
D0520	DIODES, MATCHED 2835	1532835	10597
D0560	DIODE, 1N914	1520914	7910
D0580	DIODE, 1N914	1520914	7910
D0650	DIODE, 1N914	1520914	7910
D0660	DIODE, 1N914	1520914	7910
D0720	DIODE, 1N914	1520914	7910
D0721	DIODE, 1N914	1520914	7910
D0722	DIODE, 1N914	1520914	7910
D0730	DIODE, 1N914	1520914	7910
D0740	DIODE, 1N914	1520914	7910
D0741	DIODE, 1N914	1520914	7910
D0742	DIODE, 1N914	1520914	7910
D0750	DIODE, 1N914	1520914	7910
D0760	DIODE, 1N914	1520914	7910
D0770	DIODE, 1N914	1520914	7910
D0780	DIODE, 1N914	1520914	7910
D0860	TO		
D0863	DIODE, 1N914	1520914	7910
D0870	TO		
D0873	DIODE, 1N914	1520914	7910
D0900	DIODE, 1N914	1520914	7910
D0901	DIODE, 1N914	1520914	7910
D0903	DIODE, 1N914	1520914	7910
D0904	DIODE, 1N914	1520914	7910
D0905	DIODE, 1N914	1520914	7910
D0910	DIODE, 1N914	1520914	7910
D0911	DIODE, 1N914	1520914	7910
D0980	TO		
D0982	DIODE, 1N914	1520914	7910
D0990	DIODE, 1N914	1520914	7910
D0991	DIODE, 1N914	1520914	7910
D1000	DIODE, HOT CARRIER	1522835	10597
D1001	TO		
D1002	DIODE, 1N914	1520914	7910
D1003	DIODE, HOT CARRIER	1522835	10597
D1004	DIODE, 1N914	1520914	7910
D1005	DIODE, HOT CARRIER	1522835	10597
D1105	DIODE, 1N914	1520914	7910
D1110	DIODE, CD1541	1521541	14655
D1111	TO		
D1112	DIODE, 1N914	1520914	7910
D1113	TO		
D1114	DIODE, CD1541	1521541	14655
D1115	DIODE, 1N914	1520914	7910
D1120	DIODE, 1N914	1520914	7910
D1140	DIODE, 1N914	1520914	7910
D1141	DIODE, 1N914	1520914	7910
D1160	TO		
D1161	DIODE, 1N914	1520914	7910
D1163	TO		
D1168	DIODE, 1N914	1520914	7910
D1170	DIODE, 1N914	1520914	7910
D1180	DIODE, 1N914	1520914	7910
D1200	DIODE, 1N914	1520914	7910
D1201	DIODE, 1N914	1520914	7910
D1202	DIODE, 1N914	1520914	7910
D1210	DIODE, 1N914	1520914	7910
D1240	DIODE, 1N914	1520914	7910
D1321	DIODE, 1N914	1520914	7910
F0100	FUSE, 3AG 1/2 AMP SLO BLO	1590024	71400
L0400	TO		
L0402	BEAD, FERRITE G303	1140034	1121
L0580	BEAD, FERRITE G303	1140034	1121
L0570	BEAD, FERRITE G303	1140034	1121
L0740	BEAD, FERRITE G303	1140034	1121

PART	DESCRIPTION	EXACT NO	MFG
L0730	BEAD, FERRITE G303	1140034	1121
L0650	BEAD, FERRITE G303	1140034	1121
L0640	BEAD, FERRITE G303	1140034	1121
L0860	BEAD, FERRITE G303	1140034	1121
L1202	CHOKE, 22 MICROHENRY	1140045	99848
L1203	CHOKE, 22 MICROHENRY	1140045	99848
Q0100	TRANSISTOR, 2N4918	1564918	4713
Q0110	TRANSISTOR, 2N4921	1564921	4713
Q0120	INTEGRATED CIRCUIT,SG4501	1584502	10597
Q0130	TRANSISTOR, 2N4921	1564921	4713
Q0140	TRANSISTOR, 2N2905	1562905	1295
Q0150	TRANSISTOR, 2N2219	1562219	1295
Q0160	TRANSISTOR, 2N2905	1562905	1295
Q0170	TRANSISTOR, 2N4918	1564918	4713
Q0180	TRANSISTOR, 2N2219	1562219	1295
Q0210	TRANSISTOR, 2N4250	1564250	7263
Q0220	QUAD OP AMP, LM324	1580324	10597
Q0230	TRANSISTOR, 2N5485	1565485	4713
Q0260	TRANSISTOR, MATCHED 2N4250	1574250	10597
Q0270	TRANSISTOR, 2N4250	1564250	7263
Q0280	OP AMP, CA3130	1583130	2735
Q0290	TRANSISTOR, EN2484	1562484	7263
Q0300	TRANSISTOR, EN2484	1562484	7263
Q0310	OP AMP, CA3130	1583130	2735
Q0320	TRANSISTOR, 2N2219	1562219	1295
Q0330	TRANSISTOR, 2N4121	1564121	7263
Q0340	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0345	OP AMP, CA3130	1583130	2735
Q0350	TRANSISTORS, MATCHED PAIR MPS3646	1570008	10597
Q0360	TRANSISTORS, MATCHED 2N5485	1575485	10597
Q0400	TRANSISTORS, MATCHED TIS87	1570087	10597
Q0410	TRANSISTOR, TIS87	1560087	1295
Q0440	TRANSISTOR, 2N4258	1564258	7263
Q0450	TRANSISTOR, 2N4258	1564258	7263
Q0530	TRANSISTORS, MATCHED MPS3563	1573563	10597
Q0540	TRANSISTOR, MPS3646	1563646	4713
Q0550	TRANSISTOR, 2N4258	1564258	7263
Q0560	TRANSISTOR, 2N4258	1564258	7263
Q0570	TRANSISTOR, TIS87	1560087	1295
Q0580	TRANSISTOR, TIS87	1560087	1295
Q0590	TRANSISTOR, 2N4121	1564121	7263
Q0600	TRANSISTORS, MATCHED MPS3563	1573563	10597
Q0620	TRANSISTOR, 2N4258	1564258	7263
Q0630	TRANSISTOR, 2N4258	1564258	7263
Q0640	TRANSISTOR, TIS87	1560087	1295
Q0650	TRANSISTOR, TIS87	1560087	1295
Q0660	TRANSISTOR, 2N4121	1564121	7263
Q0700	TRANSISTOR, MPS3563	1563563	4713
Q0710	TRANSISTOR, MPS3563	1563563	4713
Q0720	TRANSISTOR, 2N4121	1564121	7263
Q0730	TRANSISTOR, TIS87	1560087	1295
Q0740	TRANSISTOR, TIS87	1560087	1295
Q0750	TRANSISTOR, 2N4121	1564121	7263
Q0760	TRANSISTOR, MPS3646	1563646	4713
Q0770	TRANSISTOR, 2N4121	1564121	7263
Q0780	TRANSISTOR, MPS3563	1563563	4713
Q0800	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q0820	TRANSISTOR, 2N4258	1564258	7263
Q0830	TRANSISTOR, 2N2905	1562905	1295
Q0840	TRANSISTOR, MPS3646	1563646	4713
Q0850	TRANSISTOR, 2N2219	1562219	1295
Q0860	TRANSISTOR, TIS87	1560087	1295
Q0870	TRANSISTOR, 2N4121	1564121	7263
Q0880	TRANSISTOR, 2N2219	1562219	1295
Q0890	TRANSISTOR, 2N2905	1562905	1295
Q0900	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q0910	TRANSISTOR, 2N4121	1564121	7263
Q0920	TRANSISTOR, 2N4121	1564121	7263
Q0940	TRANSISTOR, 2N4121	1564121	7263
Q0950	TRANSISTOR, 2N4121	1564121	7263
Q0960	TRANSISTOR, 2N4121	1564121	7263
Q0970	TRANSISTOR, 2N4121	1564121	7263
Q0980	TRANSISTOR, MPS3646	1563646	4713
Q0990	TRANSISTOR, MPS3646	1563646	4713
Q1000	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1010	TRANSISTOR, 2N2905	1562905	1295
Q1100	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1105	TRANSISTOR, MPS3646	1563646	4713
Q1110	TRANSISTOR, MATCHED 2N4250	1574250	10597
Q1120	TRANSISTOR, MPS3646	1563646	4713
Q1130	TRANSISTORS, MATCHED 2N5485	1575485	10597
Q1135	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1140	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q1150	TRANSISTOR, 2N4258	1564258	7263
Q1160	TRANSISTOR, 2N4258	1564258	7263
Q1170	TRANSISTOR, MPS3646	1563646	4713
Q1180	TRANSISTOR, 2N4121	1564121	7263
Q1190	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1195	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1200	TRANSISTOR, MPS3563	1563563	4713
Q1210	TRANSISTOR, 2N5485	1565485	4713
Q1220	TRANSISTOR, MATCHED 2N4121	1574121	10597
Q1225	TRANSISTOR, MPS3646	1563646	4713
Q1240	TRANSISTOR, 2N4258	1564258	7263
Q1250	TRANSISTOR, 2N4258	1564258	7263
Q1260	TRANSISTOR, MPS3646	1563646	4713
Q1300	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1310	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1320	TRANSISTOR, 2N4250	1564250	7263
Q1330	INTEGRATED CIRCUIT, LM312	1580312	10597
Q1340	TRANSISTOR, 2N2916	1562916	4713
Q1350	INTEGRATED CIRCUIT, LM312	1580312	10597
R0100	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0101	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750	1121
R0102	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010	1121
R0110	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0111	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750	1121
R0112	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010	1121
R0120	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0121	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0126	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0127	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0128	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0130	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0131	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0140	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0141	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R0142	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0150	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0160	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0170	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0171	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0180	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R0181	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0182	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0200	TO		
R0210	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000	7115
R0211	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0212	RESISTOR, 1400 OHM 1/4W 1% METAL FILM	3131401	7115
R0215	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0216	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0217	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0218	RESISTOR, 9100K OHM 1/4W 5% CARBON	3070915	1121
R0219	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0220	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0221	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0222	RESISTOR, 2000K OHM 1/4W 5% CARBON	3070205	1121
R0223	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0224	RESISTOR, 150K OHM 1/4W 1% METAL FILM	3131503	7115
R0225	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0226	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0227	POTENTIOMETER, 250 OHM	3110145	71450
R0228	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0229	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R0230	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500	7115
R0231	RESISTOR, 2000K OHM 1/4W 5% CARBON	3070205	1121
R0232	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0233	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0234	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0235	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0236	TO		
R0237	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0239	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0240	TO		
R0251	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000	7115
R0253	RESISTOR, SELECTED VALUE		
R0254	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0270	TO		
R0271	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R0272	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0276	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0280	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0281	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0282	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R0283	RESISTOR, 4990 OHM MATCHED PAIR	3124991	10597
R0284	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0285	RESISTOR, 10000 OHM MATCHED PAIR	3121002	10597
R0286	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0287	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0290	TO		
R0291	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R0292	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0310	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0311	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R0312	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0320	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0330	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0331	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R0340	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0341	POTENTIOMETER, 250 OHM	3110145	71450
R0342	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531	7115
R0343	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911	1121
R0345	TO		
R0346	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0347	RESISTOR, 82K OHM 1/4W 5% CARBON	3070823	1121
R0350	RESISTOR, 499 OHM 1/2W 1% METAL FILM	3104990	7115
R0351	RESISTOR, 301 OHM 1/4W 1% METAL FILM	3133010	7115
R0352	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499	7115
R0400	TO		
R0401	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0402	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0410	RESISTOR, 8250 OHM 1/4W 1% METAL FILM	3138251	7115
R0411	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0412	RESISTOR, 1400 OHM 1/4W 1% METAL FILM	3131401	7115
R0421	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531	7115
R0433	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531	7115
R0440	RESISTOR, 220 OHM 1/2W 5% CARBON	3010221	1121
R0441	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R0442	RESISTOR, 130 OHM 1/4W 5% CARBON	3070131	1121
R0450	RESISTOR, 2610 OHM 1/4W 1% METAL FILM	3132611	7115
R0451	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0452	RESISTOR, 2800 OHM 1/4W 1% METAL FILM	3132801	7115
R0453	RESISTOR, 130 OHM 1/4W 5% CARBON	3070131	1121
R0460	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R0500	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0501	TO		

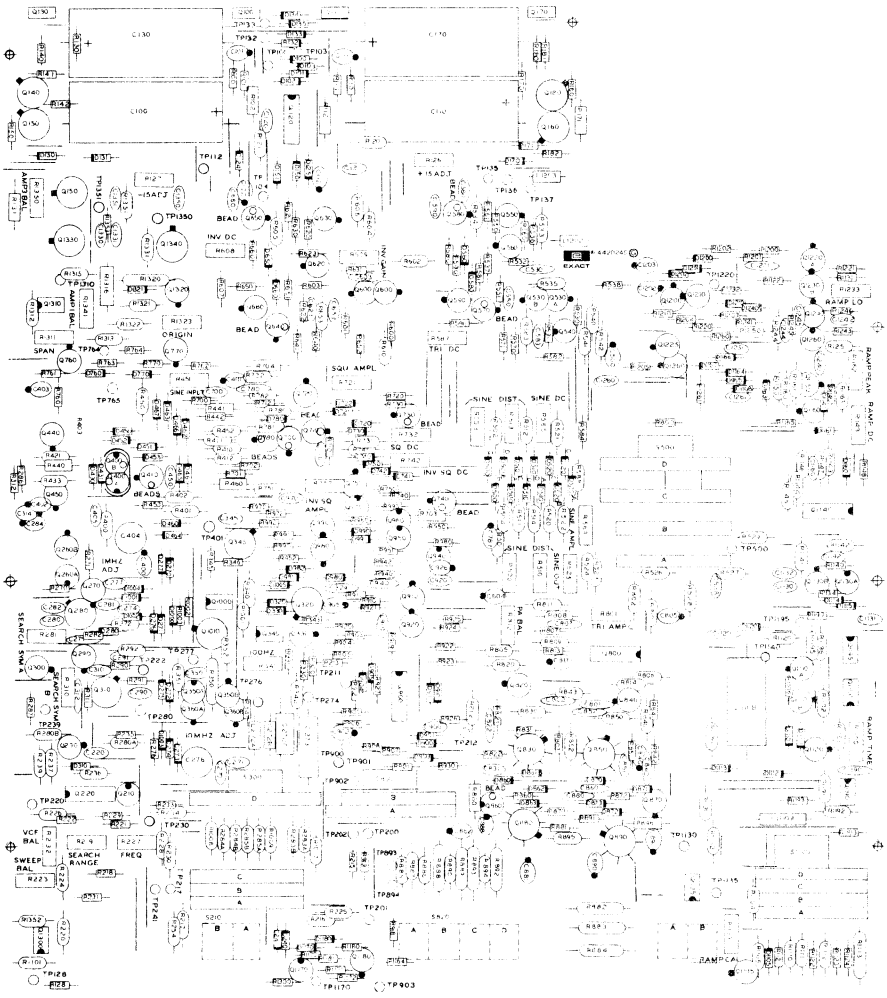
PART	DESCRIPTION	EXACT NO	MFG
R0502	RESISTOR, 13000 OHM 1/4W 1% METAL FILM	3131302	7115
R0503	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0504	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0510	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0511	RESISTOR, 17400 OHM 1/4W 1% METAL FILM	3131742	7115
R0512	RESISTOR, 17400 OHM 1/4W 1% METAL FILM	3131742	7115
R0513	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0514	RESISTOR, 392 OHM 1/4W 1% METAL FILM	3133920	7115
R0520	TO		
R0521	RESISTOR, 21000 OHM 1/4W 1% METAL FILM	3132102	7115
R0522	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0523	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499	7115
R0524	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0525	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0526	RESISTOR, 88.7 OHM 1/4W 1% METAL FILM	3130887	7115
R0527	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0528	RESISTOR, 392 OHM 1/4W 1% METAL FILM	3133920	7115
R0529	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500	7115
R0530	TO		
R0531	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0532	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0533	TO		
R0534	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0535	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0536	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0537	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0538	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0540	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0541	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0542	RESISTOR, 1330 OHM 1/4W 1% METAL FILM	3131331	7115
R0550	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0551	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0560	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0561	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0570	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R0571	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0580	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0581	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0582	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0583	RESISTOR, 590 OHM 1/4W 1% METAL FILM	3135900	7115
R0584	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563	1121
R0585	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0586	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563	1121
R0587	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0588	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0589	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0590	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0600	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0601	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0602	RESISTOR, 953 OHM 1/4W 1% METAL FILM	3139530	7115
R0603	RESISTOR, 36 OHM 1/4W 5% CARBON	3070360	1121
R0604	TO		
R0605	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0606	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500	7115
R0607	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R0608	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0609	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0610	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131821	7115
R0620	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390	1121
R0621	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0622	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0623	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0630	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390	1121
R0631	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0640	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R0641	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0650	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0651	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0652	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0653	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0660	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0700	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0701	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0702	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R0703	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047	1121
R0704	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047	1121
R0710	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0717	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0720	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0721	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0722	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0730	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0731	RESISTOR, 1620 OHM 1/4W 1% METAL FILM	3131621	7115
R0732	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0740	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0741	RESISTOR, 1620 OHM 1/4W 1% METAL FILM	3131621	7115
R0742	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0750	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0751	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0752	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0760	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0761	TO		
R0762	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0763	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0764	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0770	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0780	RESISTOR, 249 OHM 1/4W 1% METAL FILM	3132490	7115
R0781	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0782	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0800	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0801	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0802	RESISTOR, 174 OHM 1/4W 1% METAL FILM	3131740	7115
R0803	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0805	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R0806	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0807	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0808	TO		
R0809	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R0810	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500	7115
R0811	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R0812	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0813	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R0814	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0815	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0820	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0821	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0822	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330	1121
R0830	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060	7115
R0831	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0840	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0841	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750	1121
R0842	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0843	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0850	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060	7115
R0851	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0852	RESISTOR, 7150 OHM 1/4W 1% METAL FILM	3137151	7115
R0860	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0870	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0872	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0880	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047	1121
R0881	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0882	TO		
R0884	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0885	TO		
R0886	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0887	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3130348	7115
R0888	TO		
R0889	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R0890	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R0891	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0892	TO		
R0893	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R0894	RESISTOR, 3.16 OHM 1/8W 1% DEP, CARBON	3193160	7115
R0895	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0896	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047	1121
R0900	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R0901	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0903	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0904	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0905	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R0906	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R0907	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R0908	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0910	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R0911	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0912	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0913	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0918	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0919	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0920	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0921	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R0922	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392	1121
R0923	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R0924	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R0925	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R0926	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392	1121
R0927	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391	1121
R0930	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682	1121
R0940	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0942	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0950	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0951	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0952	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0960	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0970	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0972	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0980	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0990	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391	1121
R0991	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0992	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R0993	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R1001	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R1002	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R1003	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R1007	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R1008	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R1009	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R1100	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1101	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R1102	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1103	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R1104	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131821	7115
R1105	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1106	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R1110	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R1111	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R1112	RESISTOR, 499K OHM 1/4W 1% METAL FILM	3134993	7115
R1113	RESISTOR, 5000K OHM 1/2W 1% DEP, CARBON	3095004	75042
R1120	RESISTOR, 1100 OHM 1/4W 1% METAL FILM	3131101	7115
R1121	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331	1121
R1122	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R1123	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R1124	RESISTOR, 330K OHM 1/4W 5% CARBON	3070334	1121
R1130	RESISTOR, 15000 OHM 1/4W 1% METAL FILM	3131502	7115
R1131	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1132	RESISTOR, 150K OHM 1/4W 1% METAL FILM	3131503	7115
R1133	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R1134	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R1140	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1141	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1142	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115

PART	DESCRIPTION	EXACT NO	MFG
R1143	RESISTOR, 1650 OHM 1/4W 1% METAL FILM	3131651	7115
R1144	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R1145	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1146	RESISTOR, 1540 OHM 1/4W 1% METAL FILM	3131541	7115
R1147	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1148	RESISTOR, 68K OHM 1/4W 5% CARBON	3070683	1121
R1149	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1150	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1160	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1161	RESISTOR, 221 OHM 1/4W 1% METAL FILM	3132210	7115
R1162	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1163	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R1164	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1165	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R1170	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1171	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1172	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1180	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1181	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1191	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1192	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531	7115
R1193	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911	1121
R1195	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1196	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R1197	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R1200	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R1201	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R1202	RESISTOR, 3600 OHM 1/4W 5% CARBON	3070362	1121
R1203	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1204	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R1205	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R1210	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R1220	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R1221	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R1222	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1231	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R1232	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1233	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1240	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1241	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R1243	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511	1121
R1244	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R1245	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R1250	RESISTOR, 604 OHM 1/4W 1% METAL FILM	3136040	7115
R1251	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R1260	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R1261	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1300	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1301	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1311	POTENTIOMETER, 2.5K OHM TRIM	3110148	71450
R1312	RESISTOR, 21500 OHM 1/4W 1% METAL FILM	3132152	7115
R1313	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R1314	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R1315	RESISTOR, 26100 OHM 1/4W 1% METAL FILM	3132612	7115
R1316	RESISTOR, 1000 OHM THERMISTOR	3171001	1295
R1320	RESISTOR, 3500K OHM 1/2W 1% DEP. CARBON	3093504	75042
R1321	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R1322	RESISTOR, 26100 OHM 1/4W 1% METAL FILM	3132612	7115
R1323	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1331	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1350	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1351	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R1352	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R1353	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
S0100	SWITCH, TOGGLE SPDT	2600103	100005
S0200	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0210	SWITCH, MAN/LOG	2600386	10597
S0240	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0300	SWITCH, RANGE	2600380	10597
S0500	SWITCH, FUNCTION	2600382	1059
S0800	SWITCH, MODE	2600381	10597
S0810	SWITCH, ATTEN	2600385	10597
S1100	SWITCH, RAMP RANGE	2600383	10597
S1120	SWITCH, RAMP TRIG	2600384	10597
T0100	TRANSFORMER, POWER	1200057	10597

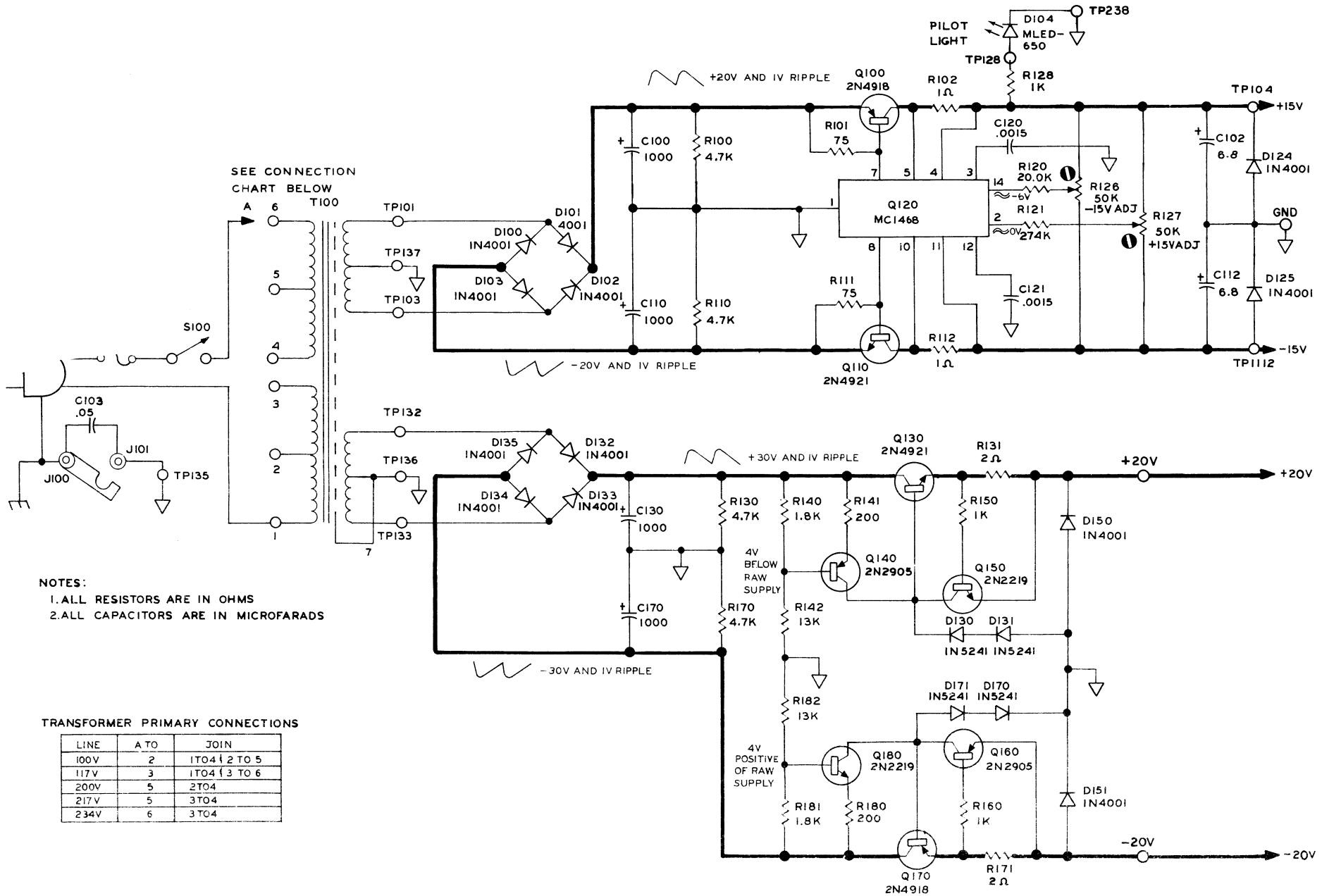
SECTION 6
SCHEMATICS

FOREWORD TO SCHEMATICS

To facilitate quick reference to inter-connections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection. Use the Connection Reference Chart to locate where reference numbers are shown, but no actual schematic exists for that particular model.



PARTS LAYOUT

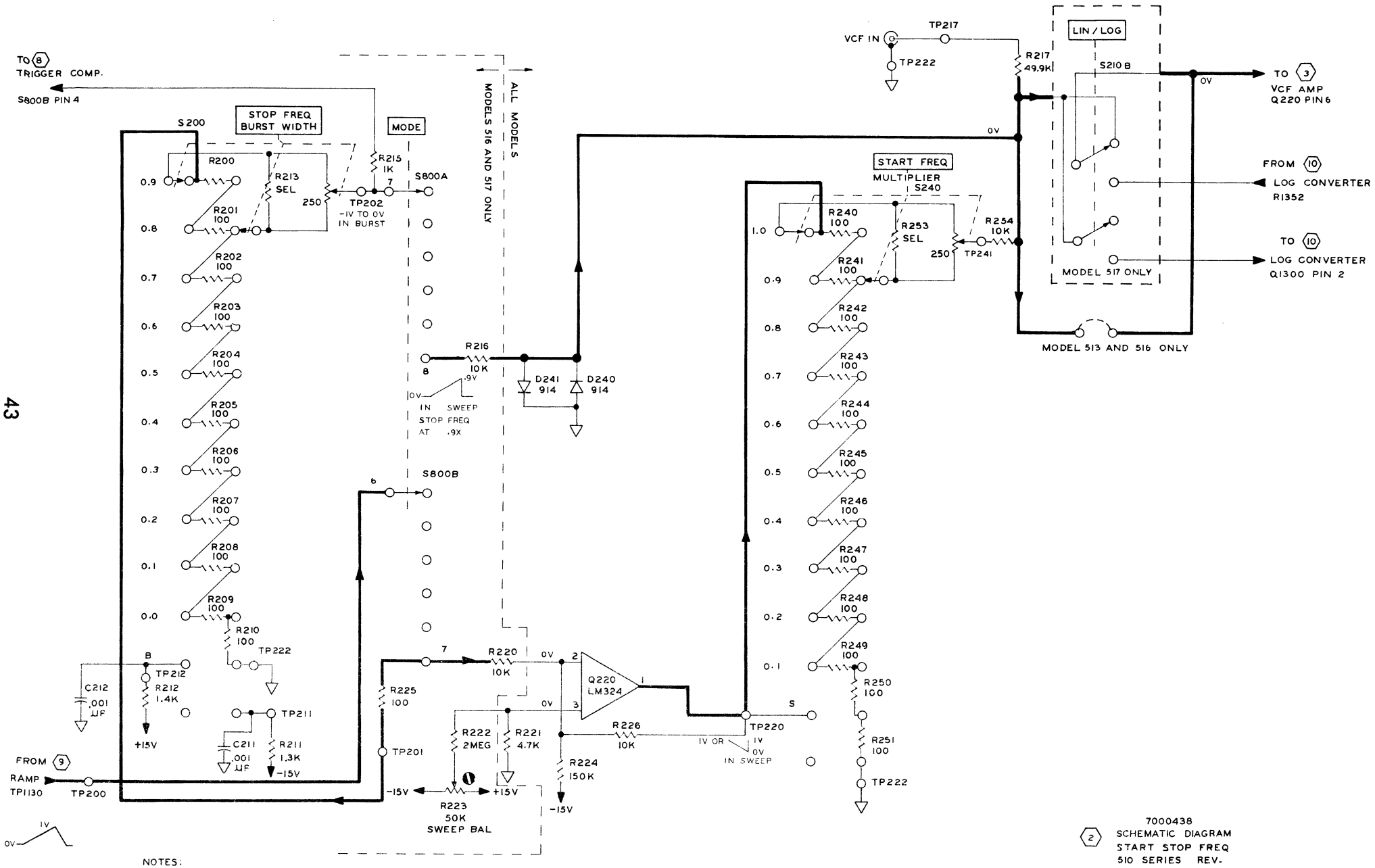


NOTES:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

TRANSFORMER PRIMARY CONNECTIONS

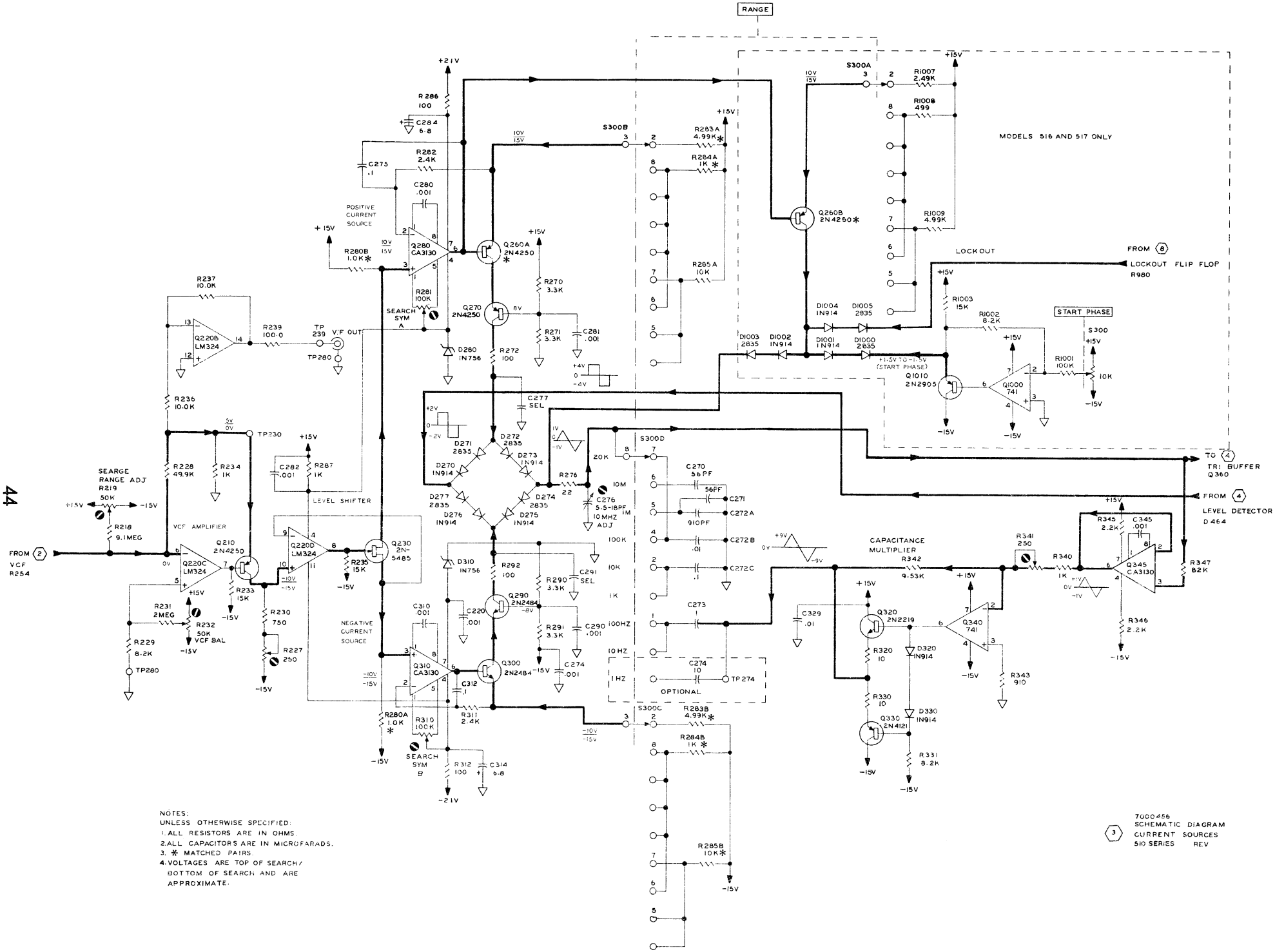
LINE	A TO	JOIN
100V	2	1 TO 4 | 2 TO 5
117V	3	1 TO 4 | 3 TO 6
200V	5	2 TO 4
217V	5	3 TO 4
234V	6	3 TO 4

7000437
(1) SCHEMATIC DIAGRAM
POWER SUPPLY
510 SERIES REV. A



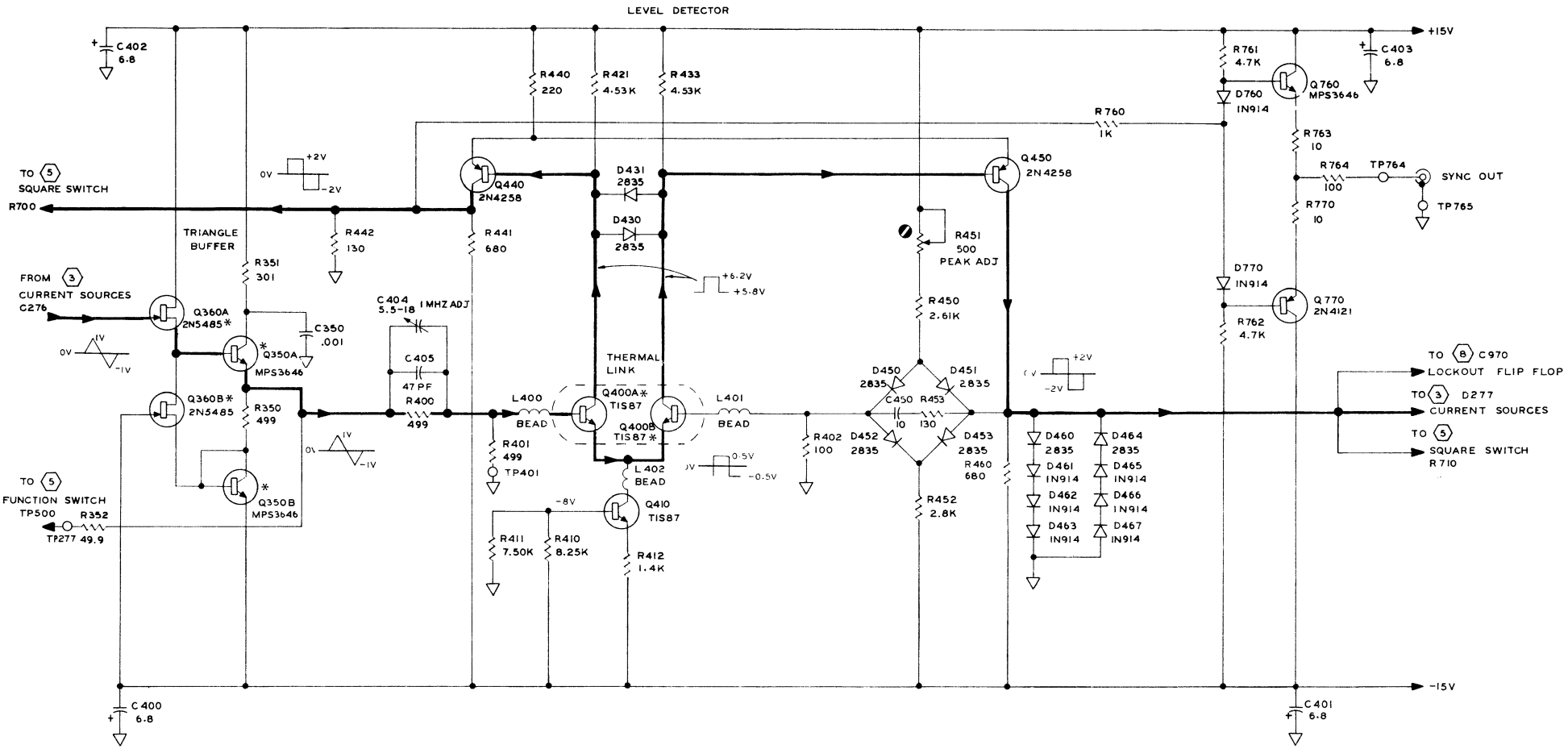
NOTES:
1. ALL RESISTORS ARE IN OHMS

7000438
2 SCHEMATIC DIAGRAM
START STOP FREQ
510 SERIES REV-



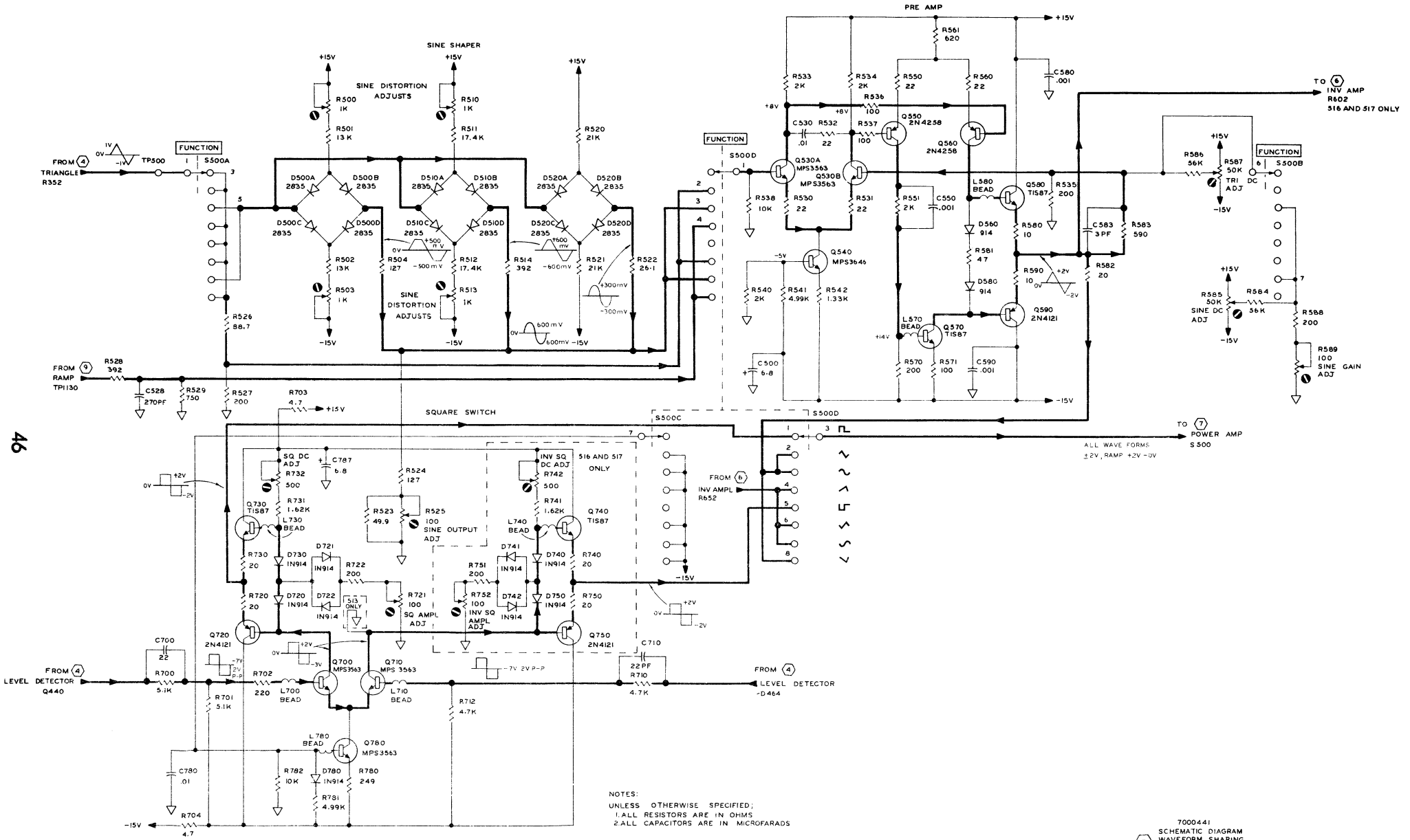
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. * MATCHED PAIRS.
4. VOLTAGES ARE TOP OF SEARCH/ BOTTOM OF SEARCH AND ARE APPROXIMATE.

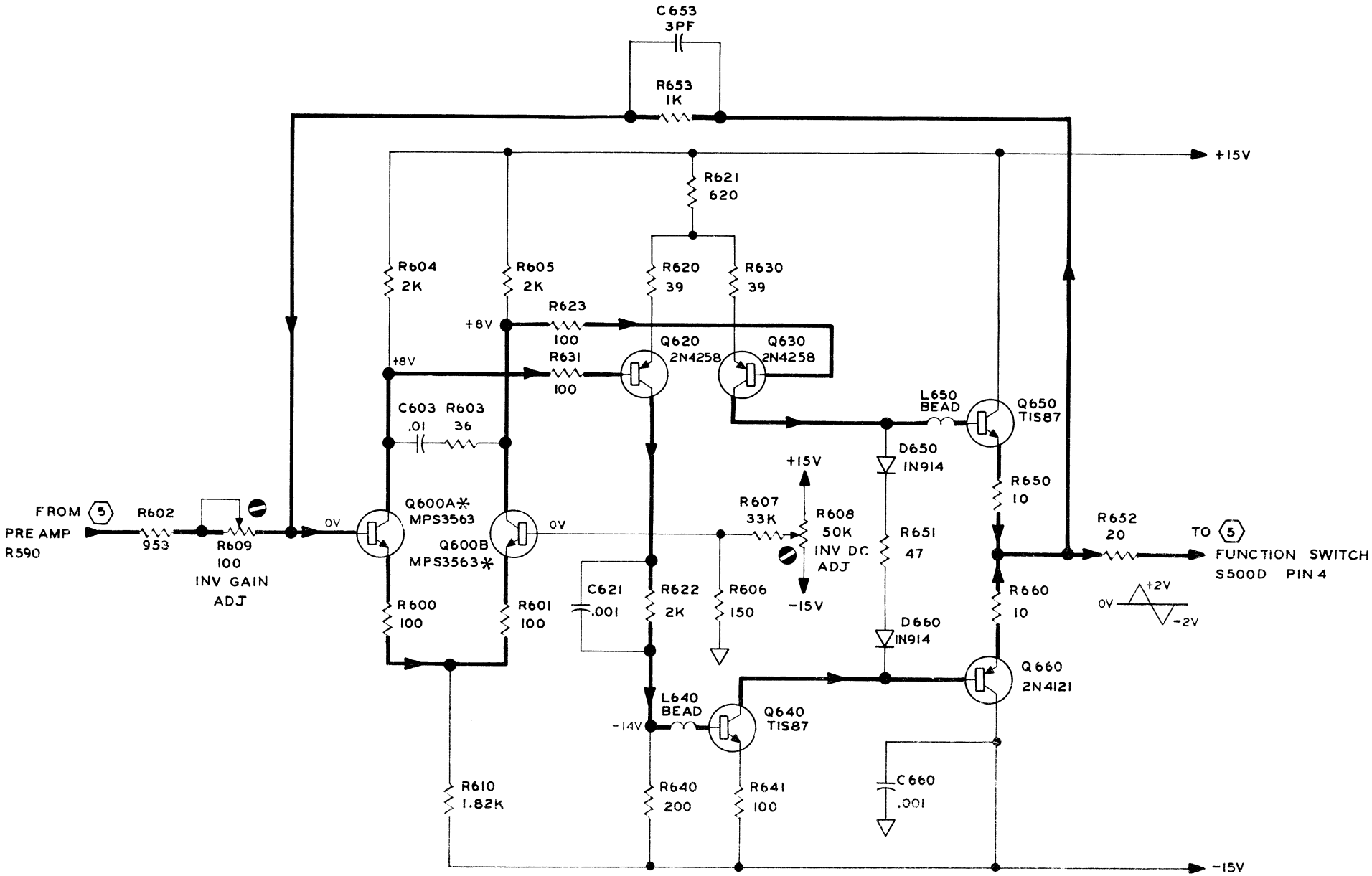
(3) 7000456
SCHEMATIC DIAGRAM
CURRENT SOURCES
510 SERIES REV



NOTES:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. * MATCHED PAIRS

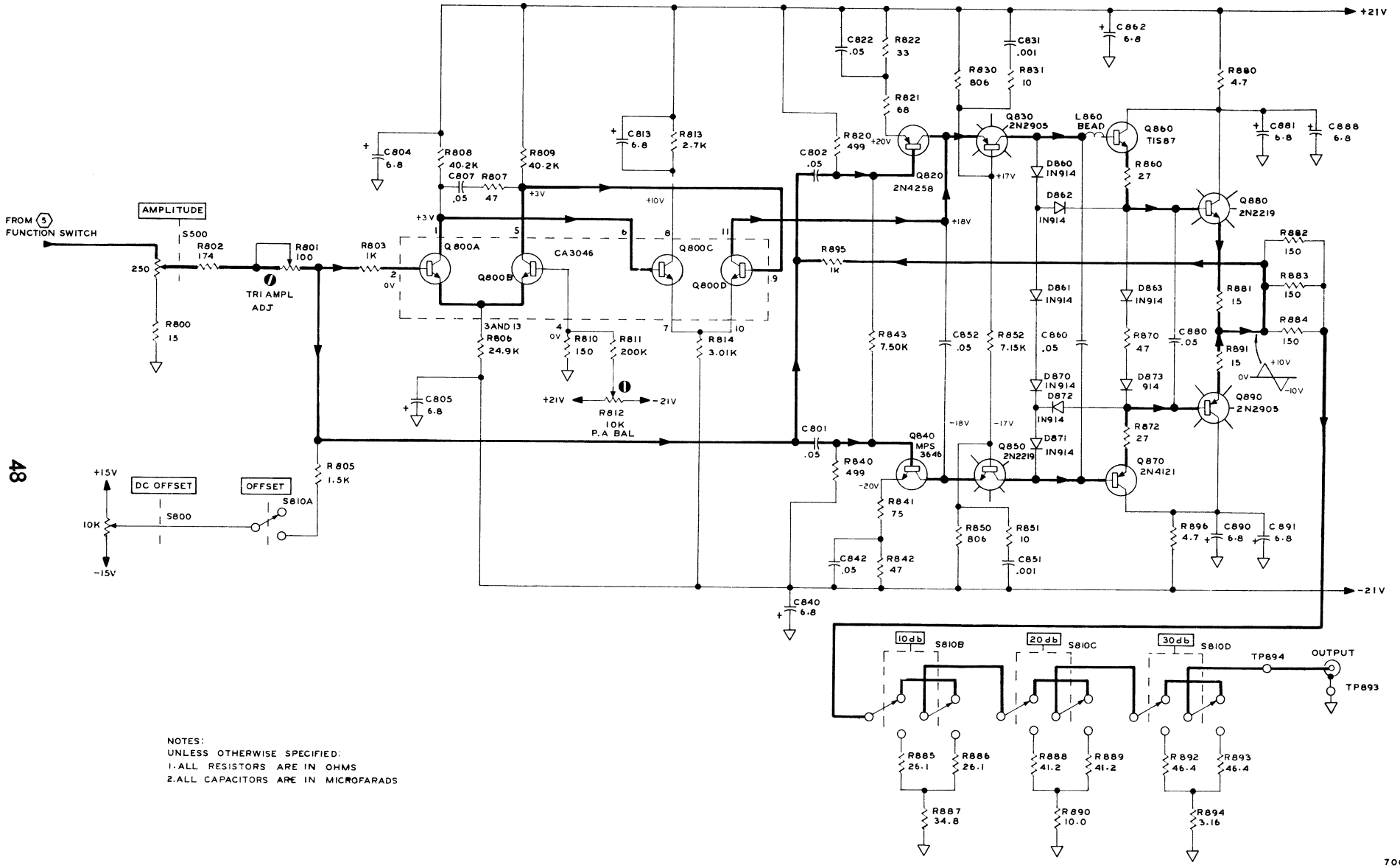
4 7000440
SCHEMATIC DIAGRAM
LEVEL DETECTOR
510 SERIES REV A


PRE AMP
SINE SHAPER
SINE DISTORTION ADJUSTS
FUNCTION
S500A
S500D
S500B
FROM 4 TRIANGLE R352
TP500
TO 6 INV AMP R602 516 AND 517 ONLY
FROM 9 RAMP TP1130
SQUARE SWITCH
S500C
TO 7 POWER AMP S500
ALL WAVE FORMS ±2V, RAMP +2V -0V
SQ DC ADJ
INV SQ DC ADJ
516 AND 517 ONLY
SINE OUTPUT ADJ
SQ AMPL ADJ
INV SQ AMPL ADJ
FROM 6 INV AMPL R652
FROM 4 LEVEL DETECTOR Q440
FROM 4 LEVEL DETECTOR D464
TRI ADJ
SINE DC ADJ
SINE GAIN ADJ
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
7000441
5 SCHEMATIC DIAGRAM WAVEFORM SHAPING MODEL 513, 516/517 REVA



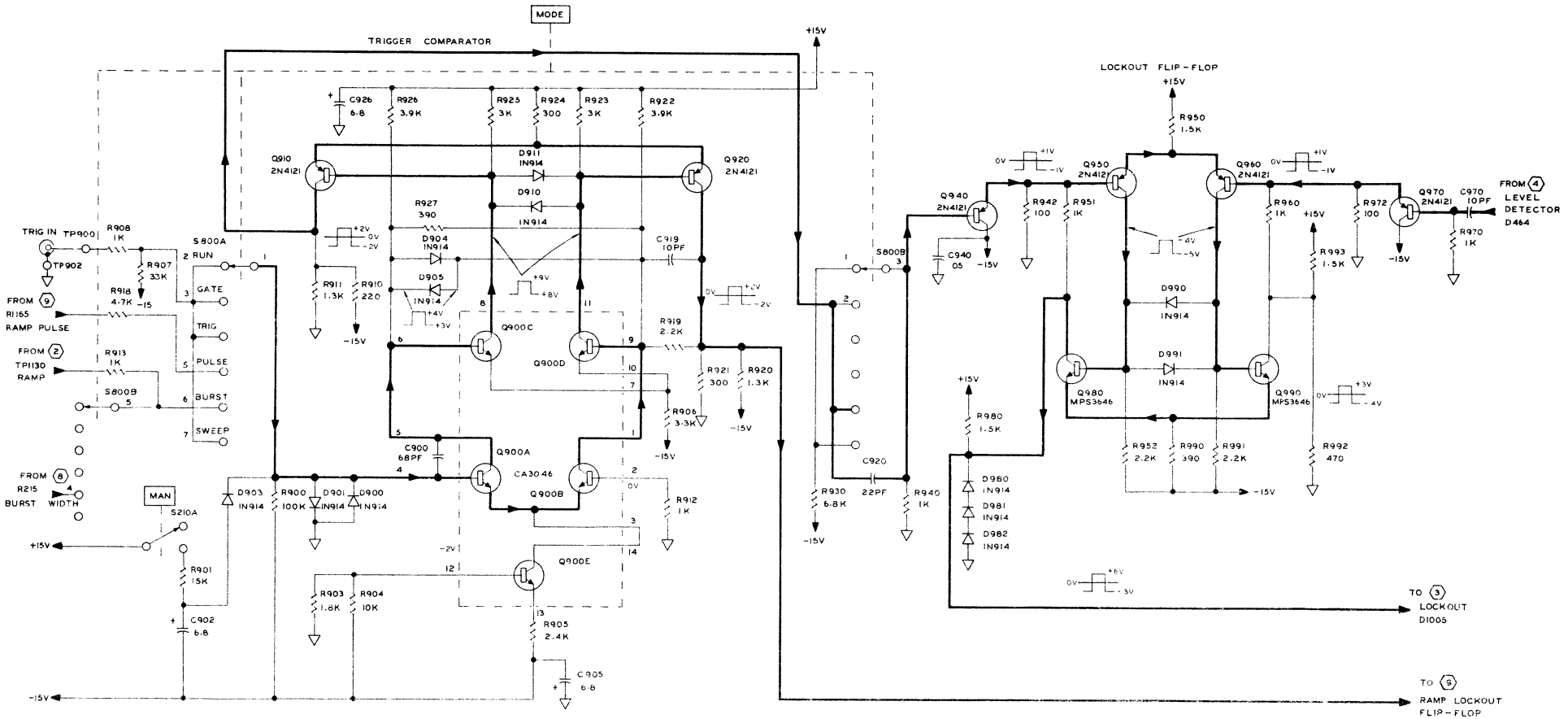
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. * DENOTES MATCHED PAIR

7000443
6 SCHEMATIC DIAGRAM
INVERTING AMP
MODEL 516 517 REV



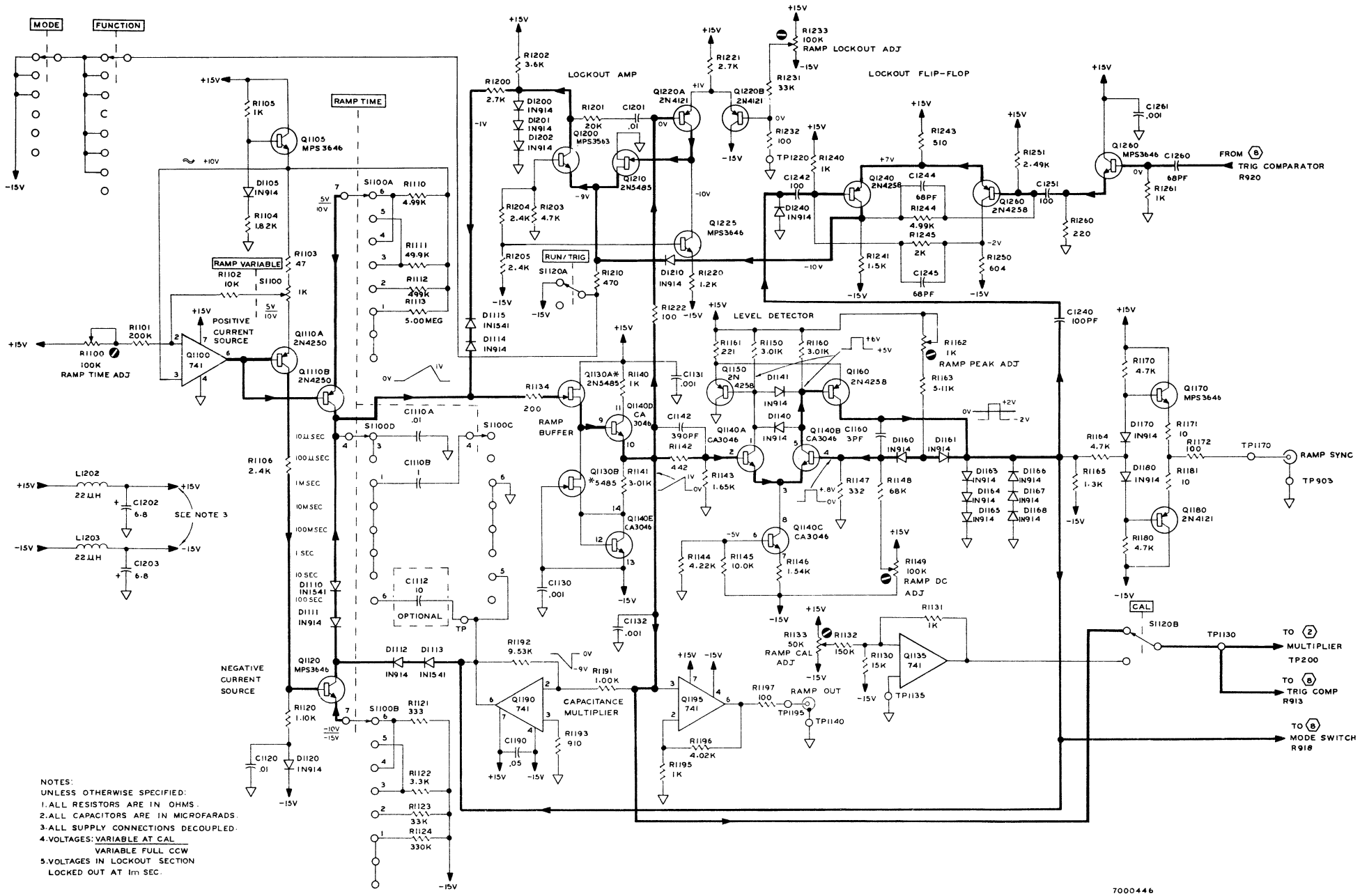
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

7000445
(7) SCHEMATIC DIAGRAM
POWER AMP.
510 SERIES REV.



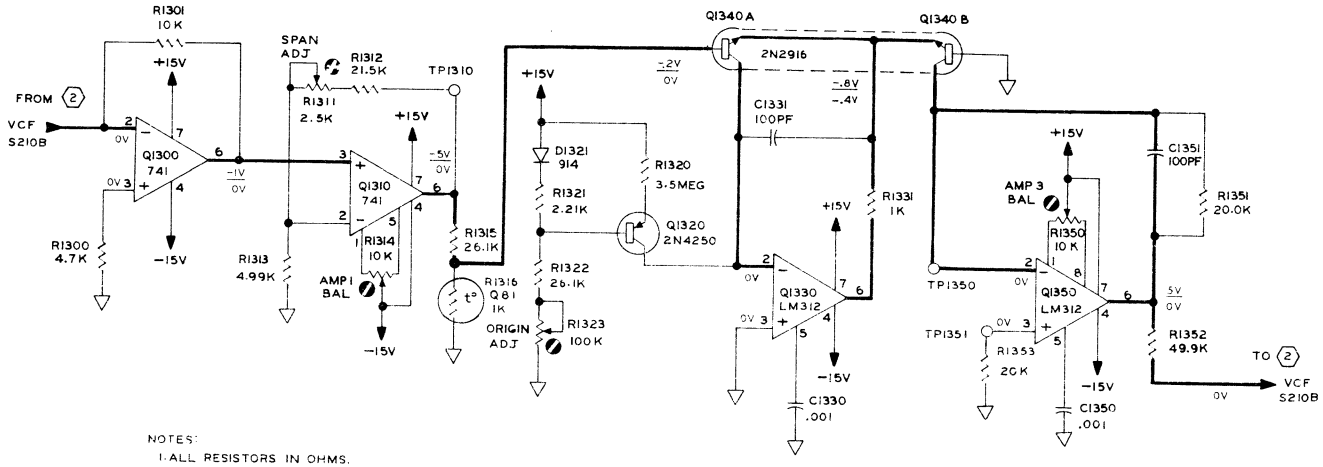
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS.
2. ALL CAPACITORS ARE IN MICROFARADS.

7000453
6 SCHEMATIC DIAGRAM
TRIGGER CIRCUITRY
MODEL 516 AND 517 REV



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. ALL SUPPLY CONNECTIONS DECOUPLED.
4. VOLTAGES: VARIABLE AT CAL / VARIABLE FULL CCW
5. VOLTAGES IN LOCKOUT SECTION LOCKED OUT AT 1m SEC.

7000446
SCHEMATIC DIAGRAM
(9) RAMP GENERATOR
MODELS: 516, 517 REV



NOTES:

1. ALL RESISTORS IN OHMS.
2. ALL CAPACITORS IN MICROFARADS
3. VOLTAGES $\frac{SX}{SO}$ ON START FREQ.

(10) 7000447
SCHEMTIC DIAGRAM
LOG CONVERTER
MODEL 517 REV.
3/12/75

SECTION 7
ADDENDA

As changes are made to the 510 series instruments, the manual changes will be printed on the following pages or, depending on printing schedules, an insert will be provided. Changes will be identified with the serial numbers of the instruments containing the changes.