WAVETEK

9045 BALBOA AVENUE, SAN DIEGO, CALIFORNIA

INSTRUCTION MANUAL

MODEL 114

SWEEP/TRIGGER VCG

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11/74 REV G

Model 114. Sweep/Trigger VCG

Product Improvement Notice

Wavetek maintains a continuing program to make improvements to their instruments that will take advantage of the latest electronic developments in circuitry and components.

Due to the time required to document and print instruction manuals, it is not always possible to incorporate these changes in the manual.

Wavetek has manufactured your instrument, using metal film 1% tolerance resistors in place of 5% carbon resistors, wherever practical. This results in a substantial improvement in the overall performance of your instrument. Therefore, there may exist a discrepancy between the resistor used to manufacture your instrument and the resistor called out in the Parts List and Schematic Diagrams in this manual.

If field replacement of an affected resistor does become necessary, replacement may be made in accordance with the manual call outs. Wavetek, however, recommends replacement with the same type of resistor used in the manufacture of your instrument, whenever possible.

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WARRANTY

All Wavetek instruments are warranteed against defects in material and workmanship for a period of one year after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during this period. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which in Wavetek's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

This warranty does not apply to any products repaired or altered by persons not authorized by Wavetek, or not in accordance with instructions furnished by Wavetek. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

Wavetek assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. Wavetek assumes no liability for secondary charges or consequential damages and, in any event, Wavetek's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by Wavetek for use of its products are based upon tests believed to be reliable, but Wavetek makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for Wavetek any liability in connection with the sale of our products other than set forth herein.

INSTRUCTION MANUAL ADDENDUM
–For–
MODEL 114 SWEEP/TRIGGER VCG

ACCEPTABLE SUBSTITUTES

1. The Elpac ZX3022 capacitor (five per instrument) may be replaced with American Radionics capacitor 5WVTK2MFW2106F (matched set of five 2-μF capacitors).

2. The Fairchild 2N3640 transistor may be replaced with a Motorola MPS3640 when necessary.

SECTION I
GENERAL DESCRIPTION AND OPERATION

GENERAL

The WAVETEK Model 114 Sweep/Trigger VCG is a semi-precision source of waveforms from servo to video frequencies. This unit is an extremely rugged, completely transistorized portable package. It features complete plug-in printed circuit board construction with individually calibrated PC boards utilizing silicon semiconductors throughout. The extremely clean and stable waveform signals from 0.0015 Hz to 1 MHz makes this generator a highly versatile general purpose piece of equipment for the laboratory or the field.

The Models 114 and 114B are identical in size and performance, except that the Model 114B has a battery charger in place of the power amplifier. Both models feature a main output with function selector switch and amplitude attenuator, and in addition, simultaneous 5 volt peak to peak 50Ω outputs of sine, square and triangle waveforms and 2.5 volt peak offset sine waveform. They also offer a 1 volt 10 nsec. rise and fall time square wave and -10 volt sync pulse. There is also a selectable differential output that provides signals identical to, but 180° out of phase with, the fixed sine, square, triangle and offset sine output waveforms. The main output can be selected to be in phase or 180° out of phase with the fixed outputs. Frequency is controlled by an eight position range switch at 20:1 range, thus providing good overlap.

All outputs may be shorted simultaneously and the generator will continue to oscillate internally with less than 0.5% change in frequency. Voltage may be applied back into the generator so long as this voltage does not exceed the maximum output voltage. Up to ±50 volts may be applied to the VCG input without damage.

MODEL 114

The Model 114 features VCG voltage control of frequency, by the frequency dial operating in parallel with the VCG input terminals. The generated frequency is the resultant of the VCG input voltage and the dial setting. In the Continuous Mode without an externally applied voltage, the dial governs and the generator operates like the basic WAVETEK function generator, the Model 110. By adding a positive voltage to the input terminals, the frequency is increased; by adding a negative voltage to the input terminals, the frequency is decreased. The applied voltage may be either a DC programming voltage or an AC frequency modulating voltage. The modulation band width is 100 KHz (it is possible to have a higher modulation frequency than carrier frequency, with a resultant triangle wave that may look like a staircase). The Models 114 and 114B have an independent internal sweep generator for frequency sweeping, the output available at a rear panel connector. In the sweep modes of operation, the output of the sweep generator is connected through a variable attenuator (sweep width control) to the imput of the VCG amplifiers. The sweep generator when triggered or free run will sweep the frequency of the Model 114 from the frequency set by the dial and frequency controls to a higher frequency set by the sweep width control. The maximum repetition rate of the sweep is selectable from the front panel in seven decades from 0.1 Hz to 100 KHz. The rep rate may be varied at least 60:1 on each decade for good range overlap.

The sweep and hold mode is a WAVETEK feature that allows both the upper and lower limits of the frequency band being swept to be read and set without highly specialized equipment. In this mode, the generated frequency will sweep up to, and will hold, the frequency determined by the sweep width control when the manual trigger on the front panel is operated. While in this hold condition, the sweep width control may be adjusted for the desired frequency, up to 100 times the lower frequency. When manual reset is actuated, the generator will return to the lower frequency limit, set by the frequency dial and, if desired, the VCG input.

The frequency dial is a continuously variable quality composition potentiometer. In addition to sine, square and triangle, the Model 114 also offers offset sine. The offset sine available on the front panel binding post can be selected to be positive or negative going. The offset sine on the differential output on the rear panel when selected is a positive going offset sine. The fixed offset sine has a positive excursion to zero volts, and a negative excursion to -2.5 volts.

MODELS 114 and 114B

The model 114 incorporates a power amplifier which offers the maximum of 32.5 volts peak to peak (16.25 volt offset sine) at the front panel binding post output. An attenuator is included on the input of this output amplifier. The amplifier will supply 30 volts peak to peak (15 volt offset sine) into a 600Ω load at maximum output setting. Ten volts peak to peak (5 volt offset sine) may be driven into a 50Ω load with undistorted waveform by rotating the output attenuator counter-clockwise until clipping no longer occurs. Very low impedance loads can be driven without distortion by further rotation of the output attenuator in the counter-clockwise direction.

NOTE

When a relatively low output signal is needed, it is recommended that the output be attenuated by an external pair of resistors to a level approximating that required and the internal attenuator be used as the amplitude vernier, attenuating the output by 10:1, 100:1, or 1000:1, etc. The use of a pair of external resistors increase resolution by the internal attenuator in low level applications.

The Model 114B incorporates an internal battery charger in place of the power amplifier. These units will operate independent of the AC line from the internal batteries. It may be charged completely in 16 hours. The charger is designed so that charging occurs while the unit is in operation. A screwdriver adjustment enables the operator to set the desired charge rate. In the maximum clockwise position, the charge time from discharge to charge is 14 hours. Frequent operation with the instrument plugged into AC power with the charge rate set this high could result in damage to the batteries. The maximum counter-clockwise position of the rear control sets the charge rate to maintain the batteries at full charge without overcharge. The units are wired so that when plugged into AC power, but turned off, a trickle charge maintains the batteries at full charge.

The power amplifier used in the Model 114 is not utilized in the Model 114B and is thus bypassed. The signal appearing on the binding post in the Model 114B is a maximum 5 volt peak to peak (2.5 volt offset sine) at a 600Ω output impedance. Because no inverting amplifier is used, output signals on the binding post are directly in phase with those on the BNC connectors on the rear panel.

CONTROLS AND TERMINALS

Controls and outputs for the Models 114 and 114B are identical except for the output impedances and voltage levels at the binding posts. For the Model 114, these are 50Ω and zero to 32.5 volts peak to peak (or, by removing one jumper, an impedance of 600Ω is obtained). Output impedance of the Model 114B is 600Ω at voltage levels of up to five volts peak to peak (zero to 2.5 volts peak to peak offset sine). No zero adjustment is provided for this output on the Model 114B, but internal controls permit setting of the balance of each function independently.

POWER/DIAL MULTIPLIER SWITCH

This switch incorporates two ON positions, X.3 and X1. This switch, in conjunction with the frequency range switch and the frequency dial, determines the generated frequency. For example, if the dial is set at 3.5,the frequency range switch setting at X100, and the dial multiplier switch at X1, the generated frequency is 350 Hz. With the dial multiplier switch at X.3, the frequency is 105 Hz. This feature greatly increases the versatility of these instruments.

In the Model 114B, when the switch is in the OFF position, the batteries are disconnected from the instrument but connected to the charger. In this position, the charger is set for a trickle charge when the instrument is connected to line power. In the ON position, the batteries are connected to the line power, the batteries are discharging; but, if connected, the charger supplies sufficient current to operate the instrument and charge the batteries. The amount of charge current available is variable through the potentiometer at the rear panel. In the maximum counter-clockwise rotation, the charge current is minimum. In the maximum clockwise position, the charge current maximum. The maximum counter-clockwise position is recommended for optimum battery life unless maximum charge rate is required due to duty use cycle.

CAUTION

> If the batteries are allowed to completely discharge, the instrument power supply cannot provide adequate power to simultaneously operate and charge. If this condition exists, the instrument should be allowed to recharge for a period of time before it is used in the AC mode.

FREQUENCY HERTZ SWITCH

The frequency hertz switch selects the appropriate timing resistor and capacitor for proper frequency range.

FREQUENCY DIAL

The frequency dial is a high quality composition potentiometer providing continuous frequency control.

FUNCTION SELECTOR SWITCH, OUTPUT ATTENUATOR, and DC ZERO ADJUST (rear-mounted screwdriver adjustment).

The main output impedance is 50Ω, but the output current is limited to drive approximately ±100 ma into a short circuit. The output at maximum clockwise attenuator position is 32.5 volts peak to peak open circuit and 30 volts peak to peak into a 600Ω load. If the load impedance is less than 600Ω, the attenuator must be rotated counter-clockwise or clipping will result. Maximum undistorted output into a 50Ω load is 10 volts peak to peak.

The output attenuator covers a 50 db range. For output voltages less than 20 db below maximum output, it is recommended that an external attenuator using a pair of resistors be used and the internal attenuator be used as a fine control. For a 10:1 attenuator, use a 470Ω resistor in series with a 56Ω resistor in shunt with the load. For a 100:1 attenuator, use a 1K resistor in series and a 10Ω resistor in shunt with the load; or, 4.7KΩ in series and a 51Ω resistor in shunt with the load (these values are indicative and not critical). The attenuator is located in the input of the output amplifier. As a result, the zero adjust will be most critical at minimum setting. The rear-mounted dc adjustment control should be adjusted with the attenuator in the maximum counter-clockwise position.

The function selector switch selects the function delivered to the main power amplifier and also selects the output available on the differential output BNC connector on the rear panel is always 180° out of phase with the associated fixed output on the rear panel no matter what position the function selector switch is in. The output delivered to the front panel binding post, however, can be selected to be in phase or 180° out of phase with the signal delivered to the fixed output BNC connectors on the rear panel.

NOTE

Zero adjust control is a high resolution Zero Adjust Potentiometer, not a dc offset control. A minor modification, however, will allow this control to be used as a dc offset control (see detailed circuit description).

Switch selected sine, square, and triangle waves will have equal peak to peak amplitude for all attenuator settings.

THE 5V TRIANGLE, 5V SINE and 5V SQUARE OUTPUTS

These outputs are accurate 5 volt, 50Ω sources balanced about ground. They will drive 5 volts peak to peak into a 50Ω load and supply ±50 ma peak into a short circuit.

THE 10 NSEC. SQUARE WAVE OUTPUT

The 10 nsec. square wave output is approximately 1 volt peak to peak open circuit, and 0.5 volts peak to peak into a 50Ω load with less than 10 nsec. rise and fall time. Always use a 50Ω cable and a 50Ω termination when using this output.

SYNC OUTPUT

At least -10 volts sync signal, less than 5 μsec. in pulse width (typically 1.5 μsec. pulse width). The pulse occurs once per cycle coincident with the positive transition of the 5 volt square wave and the positive peak of the sine and triangle waves.

NOTE

Due to its very narrow pulse width, the sync pulse is difficult to observe at low frequencies. However, it will trigger wide band oscilloscopes such as the Tektronix Model 453 at all frequencies.

MINUS 2.5 VOLT OFFSET SINE

This output is a minus going 2.5 volt output whose base line is at zero volts ±25mv (5mv. typical). Open circuit voltage is a 2.5 volt negative going offset sine wave.

VCG INPUT

The VCG input permits remote control of dial frequency and frequency modulation. The calibration factor is 0.5 volts per major dial division (±1%). A positive voltage results in an increase in frequency and a negative voltage results in a decrease. The setting of the frequency dial determines the base frequency. The VCG input impedance is 10KΩ. Up to ±50 volts can be applied to the VCG input without damage.

MODE SWITCH

The Model 114 Mode Switch allows the selection of five modes of operation: Trigger with Sweep, Continuous with Sweep, Continuous, Sweep and Hold, and Trigger. In addition, a sixth mode of operation, Tone Burst, may be obtained when Trigger with Sweep is selected and the Sweep Width control is set to zero.

Continuous: This may be considered to be the basic mode of operation. When Continuous is selected, the Model 114 acts as a function generator with nine simultaneous outputs. The output frequency is determined by the Frequency Hz range Switch, the Dial and the range switch multiplier (X.3 or X1) and the VCG input.

Trigger: As in the Continuous mode, the sweep circuits are disconnected. There is no output from the generator, however, until the Manual Trigger Sw Switch is operated or an appropriate triggering signal is applied to the front panel Trigger Input. When triggered, the Model 114 generates a single cycle, the starting and stopping point of which will be determined by the Start-Stop Point potentiometer. The generator will complete one cycle, stopping at the point at which it started.

Sweep and Hold: In this mode, operation is initially the same as in the continuous mode. When a trigger is applied to the Trigger Input on the front panel or the Manual Trigger Switch is operated, the output frequency sweeps up to the frequency determined by the Sweep Width control. The rate at which the frequency rises is determined by the Sweep Rate Hz switch and its Variable potentiometer. While the sweep generator is in the hold condition, the Sweep Width control may be used to vary the upper frequency to which the generator will sweep. When the Manual Reset switch is operated, the generator returns to the lower frequency.

Continuous with Sweep: Operation in this mode differs from that in the continuous mode in that the sweep generator may be gated by operating the manual trigger control or by applying a gating signal, or may be free run by rotating the Trigger Level control to one of its extremes (in the same polarity as the Slope selection). The output frequency, when the sweep is free running, rises from the lower frequency to the upper frequency (see Note) at the rate set by the Max Sweep Rate Hz switch and its potentiometer. When the upper frequency is reached, the output frequency returns rapidly to the lower frequency and then begins to rise again.

NOTE

> The lower frequency is determined by the setting of Frequency Hz switch and dial and the range multiplier (X.3 or X1)
>
> The upper frequency is determined by the Sweep Width control. When it is desired to operate as a VCG function generator with no sweep, it is recommended that the continuous mode be selected rather than continuous with sweep.

Trigger with Sweep: In the Trigger with Sweep mode, the generator is initially non-operative, as in the Trigger Mode. When a triggering signal is applied or the Manual Trigger switch is operated, the generator becomes operative; and the output increases in frequency from the lower frequency to the upper frequency at the rate set by the Sweep Rate Hz switch and its potentiometer. When the upper frequency is reached, the generator again becomes non-operative and the output returns to the level set by the Start-Stop Point potentiometer. until another trigger is received.

Tone Burst Operation: This is not a position on the mode switch. To obtain tone burst operation, trigger with sweep should be selected and the Sweep Width control turned counter-clockwise all the way. This is equivalent to setting the upper frequency equal to the lower frequency. When triggered, the generator becomes operative and remains operative for a period of time determined by the setting of the Sweep Rate Hz switch and its potentiometer. This gate may be varied from 10 microseconds to 10 minutes. At the end of the gate period, the generator again becomes non-operative and the output returns to the level set by the Start-Stop Point potentiometer, until another trigger is received. The Sweep Rate controls are used to select the number of cycles in the burst.

MANUAL TRIGGER AND SWEEP RESET

The manual trigger switch generates one cycle on command when the generator is in the trigger mode. It triggers both the sweep generator and main generator in the trigger with sweep mode. It triggers the sweep generator in the continuous with sweep and sweep and hold modes. The sweep reset position resets the sweep in the sweep and hold mode.

NOTE

> Trigger level control should be in its extreme clockwise or counter-clockwise rotation in all modes, with the exception of continuous, for best operation without double triggering when operating manual trigger.

START-STOP POINT CONTROL

The start-stop point control allows the starting point of the integrator to be varied through $\pm 90^\circ$ when in the trigger, or trigger with sweep modes. The start-stop point potentiometer will allow the starting point to go beyond the -90° position in the fully counter-clockwise rotation, and beyond the $+90^\circ$ starting point in the fully clockwise position. To start and stop at -90°, the control can be rotated fully counter-clockwise and then backed-off until the starting point is -90°. The same is true of the $+90^\circ$ position of rotation. This insures that in all frequency ranges the operator will be able to achieve a starting and stopping point of $\pm 90^\circ$.

SWEEP WIDTH CONTROL

The sweep width control varies the amplitude of the sweeping waveform applied to the VCG amplifiers from zero to maximum. In the maximum position of the sweep width control, the generator is capable of sweeping the frequency 100:1. Specifications for output waveform quality, etc., for the Model 114 are between 0.5 and 10 on the dial. If it is desired to use the generator at lower than 0.5 on the dial, the specifications do not hold. This is a convenience for those users desiring to sweep at greater than 20:1 frequency. One internal resistor change in the Model 114 will allow the sweep width control to have a range of from zero to 10:1, allowing a more precise vernier adjustment of the sweep width control, if this is desired.

SWEEP RATE HZ SWITCH AND VARIABLE CONTROL

The Sweep Rate Hz switch selects the timing resistors and capacitors in the sweep integrator allowing different repetition rates to be selected for the sweep generator. The variable control varies the rep rate of each range by at least a 60:1 ratio, giving good range overlap and allowing sweep periods of from 10 microseconds to at least 10 minutes.

TRIGGER SLOPE/LEVEL CONTROL

The Trigger Slope switch allows the operator to select the negative portion or the positive portion of a triggering signal on which it is desired to trigger the level.

SECTION II
SPECIFICATIONS AND TEST PROCEDURES

This section contains specifications for the WAVETEK instruments discussed in this handbook, and procedures for testing their accuracy. This table provides specifications for the Models 114 and 114B.

VERSATILITY

Waveforms

Sine, square, triangle, offset sine; and sync pulse.

Dynamic Frequency

0.0015 Hz to 1 MHz (10 min. to 1 μsec.).

Ranges:

X.01	= 0.005 Hz to 0.1 Hz
X.1	= 0.05 Hz to 1 Hz
X1	= 0.5 Hz to 10 Hz
X10	= 5 Hz to 100 Hz
X100	= 50 Hz to 1 KHz
X1K	= 500 Hz to 10 KHz
X10K	= 5 KHz to 100 KHz
X100K	= 50 KHz to 1 MHz
X.003	= 0.0015 Hz to 0.03 Hz
X.03	= 0.015 Hz to 0.3 Hz

Ranges (cont.)

X.3	= 0.15 Hz to 3 Hz
X3	= 1.5 Hz to 30 Hz
X30	= 15 Hz to 300 Hz
X300	= 150 Hz to 3 KHz
X3K	= 1.5 KHz to 30 KHz
X30K	= 15 KHz to 300 KHz

Nine Simultaneous Outputs

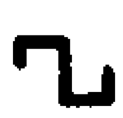
1)  , or  selectable with variable amplitude. Specifications apply from 10% to 100% of maximum amplitude setting. 50Ω output impedance. (600Ω output impedance available by removing one jumper wire.)

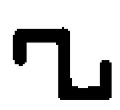
   30v p-p (15v offset sine) into 600Ω load.

   10v p-p (5v offset sine) into 50Ω load.

   Short circuit output current ±100 ma.

   Model 114B: 5v p-p into open circuit, 600Ω output impedance.

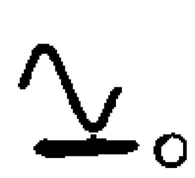
2)  1v p-p

3)  5v p-p

4)  5v p-p

5)  5v p-p

6)  2.5v p-p offset -1.25v

7)  , or  selectable .5v p-p differential output 180° out of phase with outputs 2 through 6.

8) Sweep monitor. (Output of sweep generator) 2.5v nominal

9) Sync pulse: At least -10v into open circuit; less than 5 μsec. duration.

NOTE: Outputs 2 through 8 are 50Ω output impedance. Output voltage stated is into open circuit

OPERATIONAL MODES

Generator Modes:

Continuous Mode

Operates as a standard VCG. Frequency determined by dial/range settings in parallel with VCG input.

Trigger Mode

One complete cycle is generated by activating the manual trigger or applying a pulse or gate to the trigger input. Start-stop point of the waveform may be adjusted through 360°.

Sweep Generator Modes:

Sweep and Hold Mode

Generator runs at the selected frequency until triggered by the manual trigger or external pulse. When thus activated, the unit sweeps to a new frequency determined by the sweep width control and holds this frequency until manually reset.

Continuous with Sweep Mode

The main generator operates in the continuous mode until the sweep is activated. The sweep generator may be gated by operating the manual trigger, by applying a gating signal, or it may be free-run. When swept, the main generator frequency rises from the frequency set by the dial and range settings to a frequency selected by the sweep width control. Sweep rate is set by panel controls.

Trigger with Sweep Mode

No output is generated until manual trigger is activated or trigger input is applied. The unit starts at the frequency selected by the dial and range settings and sweeps to a frequency controlled by the sweep width control. The generator stops oscillating at this point and will not restart until triggered again. Sweep rate is selected by front panel controls. Tone burst operation may be obtained in this mode by setting the sweep width control to zero; the number of cycles generated for each trigger applied is determined by sweep rate controls.

Trigger Controls

Input impedance is 10KΩ.

Input voltage is ±0.5v min., ±100v max.

Trigger level and slope are adjustable by front panel controls. (These controls are similar to trigger adjustments of an oscilloscope.)

The start-stop point of the generated waveform is adjustable through 360°.

Sweep Controls

Sweep width is adjustable from 0 to 100:1. Accuracy of the sweep repetition rate is ±5% of setting with variable control set at maximum. Repetition rate is variable from 0.0015 Hz to 100 KHz. Burst lengths in tone burst operation may be varied from 10 μsec. to 10 min.

VCG - Voltage Controlled Generator

Over 20:1 frequency ratio (selectable in ranges of 3:1 allowing excellent range overlap). 4.75v input for 20:1 frequency ratio (0.5v per major dial division ±1%). Input impedance 10 KΩ.

HORIZONTAL PRECISION

Dial Accuracy

±1% of full scale to 100 KHz.

±2% of full scale 100 KHz to 1 MHz.

Dial is high-quality composition potentiometer allowing true continuously variable frequency control.

Typical VCG Linearity

±0.1% frequency versus input voltage (frequency error 0.1% of total deviation - best straight line method). 0.0015 Hz to 100 KHz generated frequency. From 10% to 100% of maximum dial frequency.

VCG Bandwidth

100 KHz.

Jitter

±0.025% cycle-to-cycle stability

STABILITY*

Short term: ±0.05% for 10 min.

Long term: ±0.25% for 24 hr.

*Percentages apply to amplitude, frequency and dc offset of main generator.

VERTICAL PRECISION

Frequency Response

Amplitude change with frequency less than 0.1 db 0.0015 Hz to 100 KHz and 0.5 db 100 KHz to 1 MHz.

Peak-to-Peak Voltage Accuracy

±1% for outputs 3 through 7

±1% for output 1 at 30v out

±10% for output 2

Symmetry

All waveforms, except offset sine, are symmetrical about ground within ±1% of maximum p-p amplitude. Rear dc zero adjustment, 114; charge rate adjustment, 114B.

PURITY

Sine Wave Distortion

Less than:	0.5%	0.0015 Hz to 10 KHz
	1.0%	10 KHz to 100 KHz
	2.0%	100 KHz to 600 KHz.
	3.0%	600 KHz to 1 MHz.

Triangle Linearity

Greater than:	99%	0.0015 Hz to 100 KHz
	95%	100 KHz to 1 MHz

Square Wave Rise and Fall Time

Less than 10 nsec., output 2

Less than 15 nsec., output 3

Less than 100 nsec., output 1

Total Aberrations

Less than 5% (overshoot, preshoot, etc.).

Tilt

Less than 0.5%

Time Symmetry, all waveforms:	99.5%	0.0015 Hz to 100 KHz
	99%	100 KHz to 1 MHz

ENVIRONMENTAL

Temperature

All specifications listed, except stability, are for 25°C ±5°C.

For operation from 0°C to 55°C, derate all specifications by a factor of 2.

MECHANICAL

Dimensions

7-3/4 inches wide, 5-1/4 inches high, 11-1/2 inches deep

Weight

10 pounds net, 15 pounds shipping

Power

Model 114: 105v to 125v or 200v to 250v, 50 Hz to 400 Hz.

Model 114B: DC rechargeable ni-cad batteries provided with built-in charger. Five hours of operation on batteries for every 16 hours of charge; simultaneous operation and charge. 105v to 125v or 200v to 250v, 50 Hz to 400 Hz. Less than 15 watts.

Specifications apply from 0.5 to 10 on frequency dial.

GENERAL INFORMATION

Specifications apply only when the dial setting is between 0.5 and 10. Instruments should be within specifications within 15 minutes' warm-up time. All specifications are for 25°C ± 5°C and 105 to 125 volts AC, 50 Hz to 400 Hz. All measurements must be made as described herein. Frequency stability specifications refer to constant temperature, line voltage, panel setting, and loads; testing must be made after one hour's warm-up at defined conditions.

TESTING INFORMATION

All frequency measurements should be made with the function selector switch on sine ∿, output attenuator set in the maximum counter-clockwise position, all outputs disconnected (and VCG input disconnected) except the 10nsec. square wave output which should be connected to a counter through a 50Ω cable using 50Ω termination at the counter. The frequency vernier should be at maximum clockwise position ("cal"). The generated frequency should be within specifications for all combinations of the range switch and frequency dial.

Time symmetry measurements should be made using this setup and by measuring the positive and negative half cycles of the square wave. The two half cycle measurements should differ by no more than 1% of the total one cycle measurement.

Cycle-to-cycle jitter measurements should be made with this same setup. An oscilloscope with a delaying sweep or frequency counter may be used for cycle-to-cycle time jitter measurement.

VCG linearity should be made by again using the same setup as above, with the addition of a low impedance (50Ω maximum) source connected to the VCG input.

VCG input voltage should be measured with a high accuracy voltmeter such as a DVM or a differential voltmeter.

OTHER KINDS OF TESTS

All voltage measurements should be made with an accurate wide band peak measuring device. It is strongly suggested that a Tektronix type W, or type Z plug-in with an appropriate oscilloscope be used for making these voltage measurements. The measuring device should have at least 50 KΩ input impedance and sufficient band width so that waveform peaks are accurately measurable. The measurements should be made individually with no other leads connected to the instrument.

The output amplifier may have a tendency to oscillate when operating in the 100KHz to 1MHz range into a cable terminated in an open circuit (very high impedance). Oscillation, when it occurs, is due to reflections back into the output amplifier and so, may be affected by signal level and cable length.

When making very accurate peak measurements, minor aberrations will be noted on the waveform due to the switching of the square wave. The peak value is that voltage which associates immediately prior to these minor aberrations. Accurate peak waveform measurements should be made at 1KHz with the dial set at 10. Accurate high frequency measurements are difficult to make and require considerable care in lead connection, current and cable termination.

Lack of symmetry is defined as the difference in the plus and minus peak voltages. For example: a 5v signal with 1% dissymmetry could read +2.525v and -2.475v.

All fixed outputs should be measured individually with the function selector switch on sine ∿ , and the amplitude attenuator in maximum counter-clockwise position. The switch selectable output should be measured with the attenuator in maximum clockwise position and the appropriate function selected. Nothing should be connected to the binding posts when making this measurement.

When measuring the selectable output amplitude of the Model 114B, the measuring device should have at least 500K input impedance. Sine distortion, triangle and offset sine linearity rise and fall time, total aberrations and tilt specifications should be made independently connecting only one output to the appropriate measuring device at a time.

BNC outputs (except sync) should be connected to the measuring device with a 50Ω cable properly terminated for making all high frequency measurements.

NOTE

> Sine waveform distortion will be slightly less from 300KHz to 1MHz if the cable is not terminated.

Sync output and selectable output should be evaluated using maximum attenuator setting commensurate with the load.

GENERAL NOTE

The test procedures very specifically define individually made measurements without simultaneous load of the various connectors. Simultaneous loading of all outputs will have only a minor effect on the frequency, amplitude, and purity performance.

SECTION III
THEORY OF OPERATION

Figure 3-1 is a block diagram of a basic function generator capable of delivering triangle, square and sine wave outputs. A discussion of the basic block diagram leads to easier understanding of the Model 114.

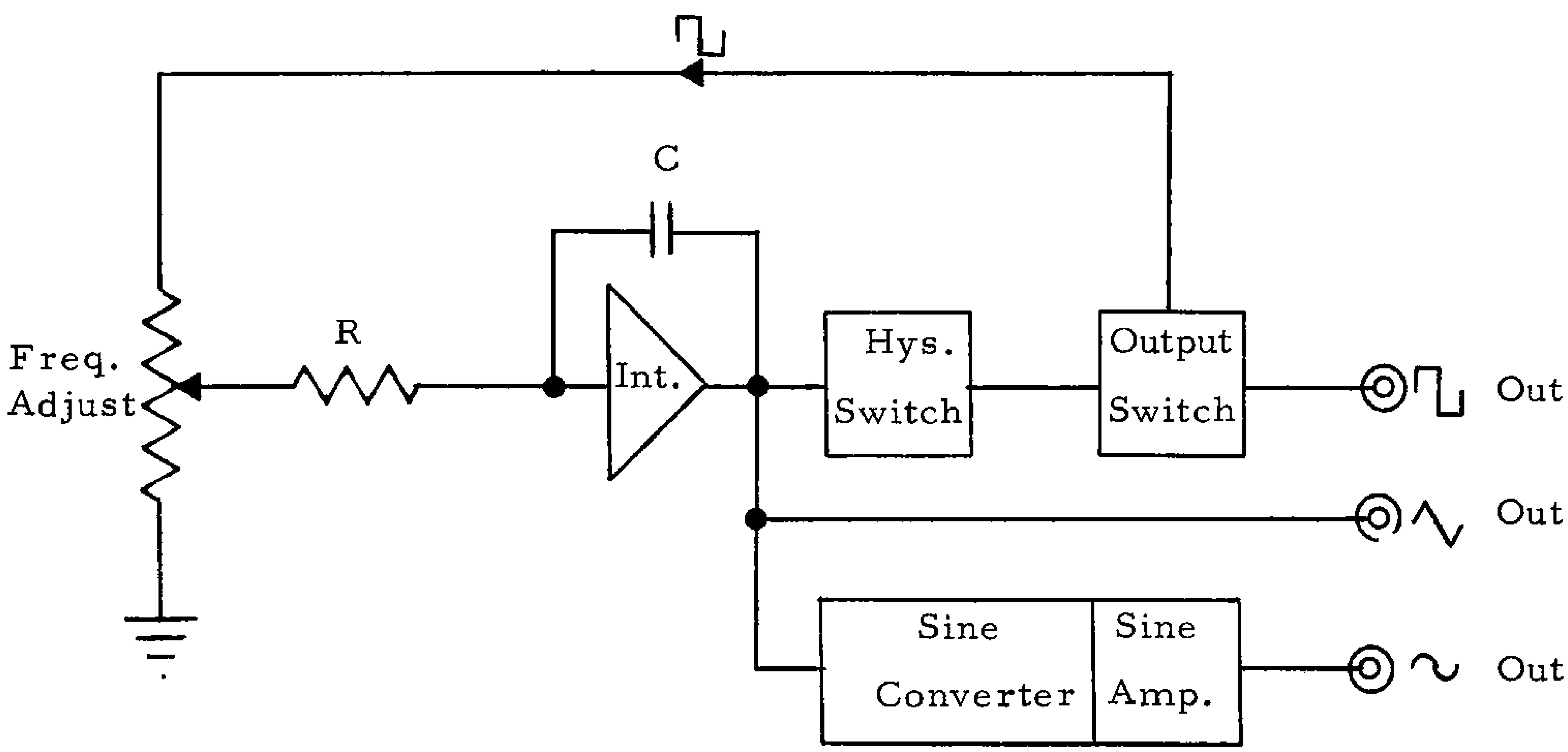


Figure 3-1

The heart of the basic function generator shown above in figure 3-1 is the integrator, a high gain, wide band d-c amplifier in an operational amplifier configuration connected for integration. Application of the negative half cycle of a square wave to resistor R results in a current directly proportional to the d-c level of the negative portion of the square wave and inversely proportional to the value of resistor R. The operational amplifier configuration offers a very high input impedance and most of the current in resistor R flows in and charges capacitor C. The right-hand side of capacitor C, and therefore the output point of the amplifier, is a positive going voltage slope. At a predetermined level, the positive going slope switches the bi-stable hysteresis switch which in turn switches the output switch, and the square wave switches to its positive half cycle. The current in resistor R changes direction and capacitor C charges in the opposite polarity. The output of the integrator is now a negative going voltage slope completing the triangle waveform. When the negative going slope reaches a predetermined level, it switches the hysteresis switch, which in turn switches the output switch, and the negative portion of the square wave is once again applied to resistor R. With the hysteresis switching levels fixed, the generated frequency is governed by the values of R and C and the amplitude of the applied square wave. With fixed values of R and C, varying the amplitude of the square wave picked off and applied to the integrator by the frequency adjust pot (shown in figure 3-1) will vary the frequency. By changing either the value of R or C, the range of frequencies over which the unit will operate with the same frequency adjust pot can be changed. A square wave is available from the output switch and a triangle wave at the output of the integrator. The triangle wave is also fed into a converter which shapes it into a sine wave. Some attenuation is involved; therefore, a sine amplifier is added and a sine wave output is available.

The Model 114 uses analog control of frequency rather than the frequency pot shown in figure 3-1. Figure 3-2 is a simplified block diagram of the Model 114 in the continuous mode.

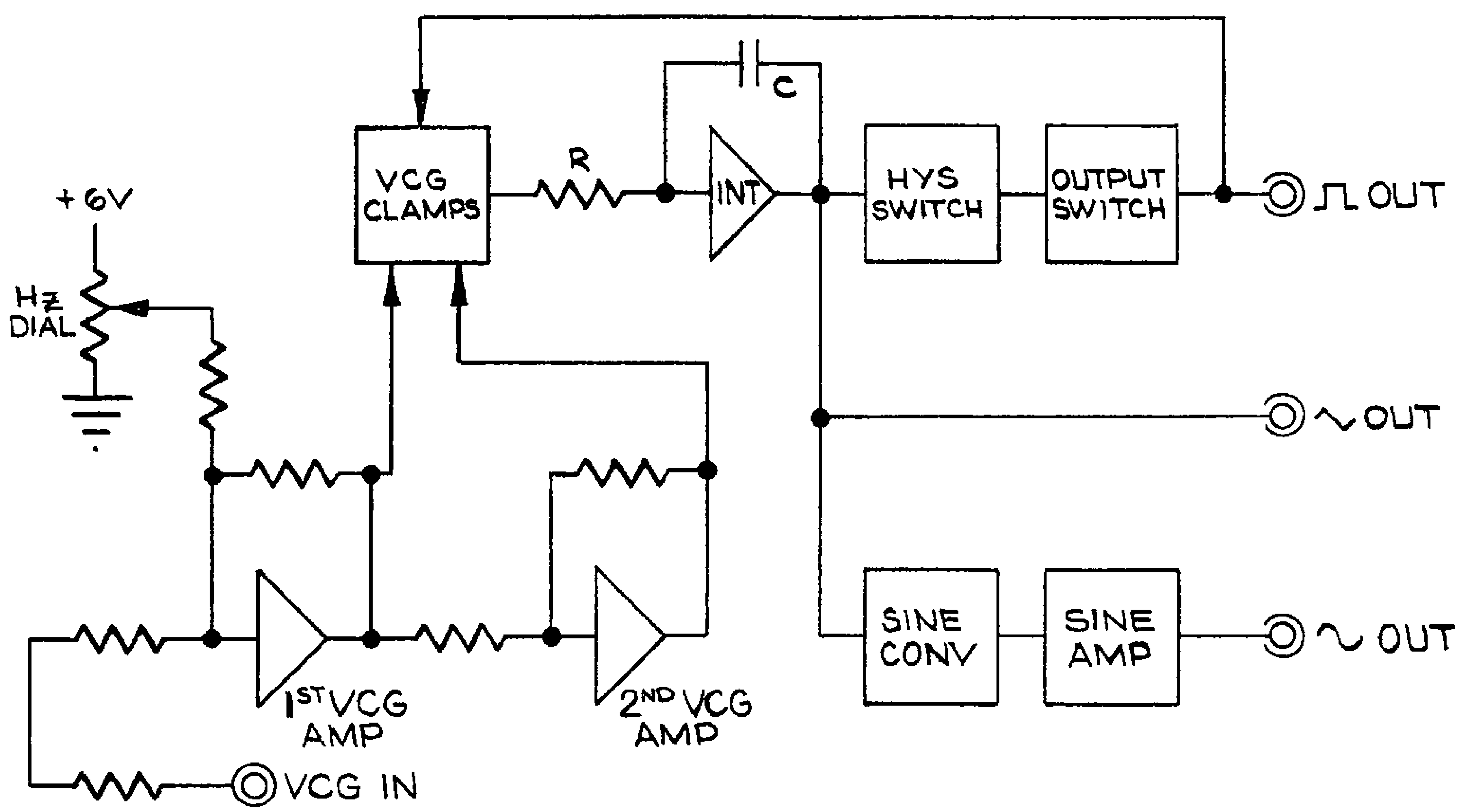


Figure 3-2
Basic VCG (Continuous Mode)
Simplified Block Diagram

Basic operation is the same with the exception of frequency control. Changing the range over which the analog frequency control operates is done with the "Freq Hz" switch which changes the value of R or C, or both. The square wave is not applied to the integrator, but alternately turns on one of a pair of transistor clamps. The transistor clamps connect the output of two operational amplifiers alternately to the input of the integrator. The negative portion of the square wave turns on a clamp that connects the output of the first VCG amplifier to the integrator input. The positive portion of the square wave turns on a clamp that connects the output of the second VCG amplifier to the input of the integrator. The result is a square wave applied to the integrator, the amplitude of which is determined by the levels at the outputs of the two VCG amplifiers.

The VCG amplifiers are similar d-c wide band amplifiers in inverting operational amplifier configurations. The first amplifier has a gain of approximately 3/5 and the second, a gain of unity. Applying +5 volts to the input of the first VCG amplifier results in a -3 volts at its output. This -3 volts is applied to the second VCG amplifier resulting in +3 volts at its output. The square wave under these conditions would operate the clamps and a ±3 volt square wave would be applied to the integrator. Since the VCG amplifiers are wide band, an a-c signal up to 100 KHz can be applied and the generator frequency modulated. The input summing node of the first VCG amplifier sums the dial input and any voltage applied to the VCG input jacks. With no VCG input voltage applied, the dial controls the frequency.

Figure 3-3 is a simplified block of the triggered mode with waveforms. When the Model 114 is in the triggered mode and ready, the output of the tunnel diode trigger gate is near ground potential. CR1 in figure 3-3 is nonconducting and CR2 is on, clamping the output of the integrator at the level set by the start-stop point potentiometer, through the trigger clamp amplifier. When a triggering signal is applied to the trigger input connector which overcomes the level set by the trigger level control, the tunnel diode trigger gate steps to approximately -6 volts turning on CR1. The output of the clamp amplifier is driven negative, disconnecting or turning off diode CR1 which allows the integrator to start. The d-c level at which it starts is set by the Start-Stop Point potentiometer. The tunnel diode trigger gate is reset by the square wave from the output switch. Resetting the trigger gate enables the clamp amplifier once again; however, the triangle output must reach the start-stop level before the clamp amplifier takes control. This insures that the integrator output always starts and stops at the level set by the Start-Stop Point potentiometer. The Start-Stop Point potentiometer allows adjustment of $\pm 90^{o}$ to the starting and stopping point of the integrator. By using the output of the -1 amplifier (selected output) or by using the inverted output of the power amplifier, the start-stop point becomes adjustable over 360^{o}. When in the triggered position, one cycle is generated each time a triggering signal is applied or the manual trigger is depressed.

In the sweep modes of operation, a third input is added to the VCG amplifiers. It is the output of the sweep integrator. The sweep integrator is a differential amplifier in a Miller integrator configuration. The input stage of the amplifier is a differential pair of FET source followers in order to minimize loading of the input summing junction. When enabled, the sweep integrator output voltages rises linearly from zero at a rate determined by the timing capacitor and resistor (Cs and Rs) and the variable sweep rate potentiometer. The Sweep Width potentiometer allows this voltage to be applied to the VCG

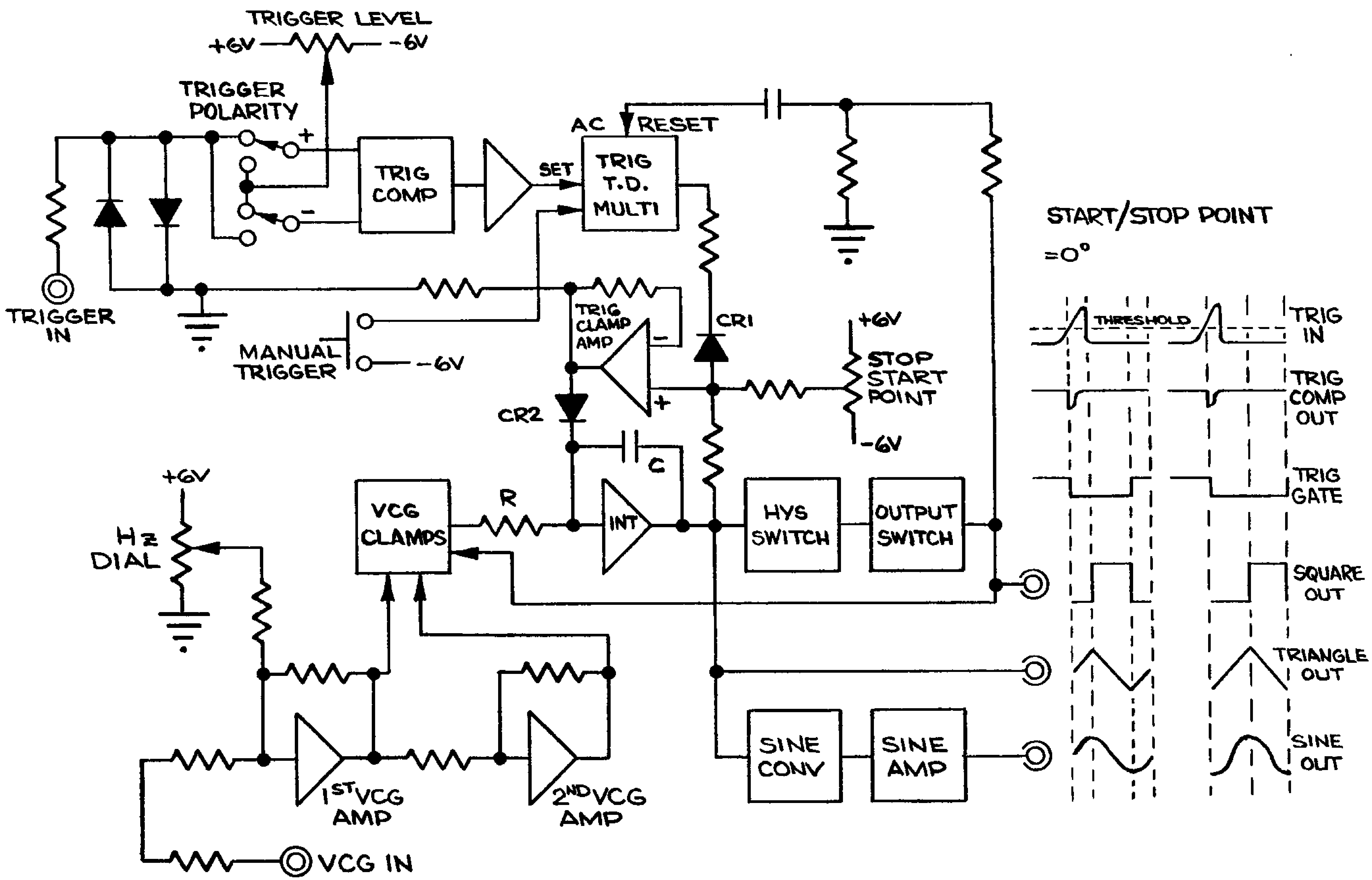


Figure 3-3
Trigger Mode Simplified Block Diagram

amplifiers, which cause the main integrator output frequency to rise linearly. Cs and Rs may be changed by the sweep rate Hz switch.

Figure 3-4 indicates the operation in the sweep and hold mode. When the trigger tunnel diode multivibrator is set, by either the manual trigger switch on the front panel or by an external trigger, the output is fed to the sweep gate circuitry by way of an inverting circuit. Prior to receiving a trigger, the sweep gate was driving current into the summing junction of the sweep integrator. This action will not drive the integrator output negative because the zero detect circuit causes the sweep gate to disconnect at zero voltage. Upon receiving a trigger, the sweep gate opens and the sweep integrator output voltage rises until it reaches a predetermined level, at which time it is detected by the sweep stop comparator; and the sweep gate is reconnected through the sweep hold inverter pair, holding the integrator output voltage at that value in much the same way as the zero detect loop held the output at zero. The setting of the sweep width control determines what portion of the sweep integrator output voltage is applied to the VCG amplifiers. Thus, when in the "hold" condition, the sweep width control may be used to manually sweep the main integrator frequency or to set the upper frequency to which it will sweep.

In the continuous with sweep mode, the sweep generator may be gated by operating the manual trigger or by applying a gating signal to the trigger in connector, or it may be free run by rotating the trigger level control to one of its extremes (in the same polarity as the Slope selection). In this mode, each time the sweep integrator output voltage reaches its predetermined maximum level, the sweep stop circuit triggers a one shot multivibrator, shown as "Reset O.S." in Figure 3-5. The output of the reset one shot causes the trigger tunnel diode multivibrator to return to ground (from -6v) for a very brief period. The sweep gate closes and the sweep integrator output goes to zero. When free running, or while a gating signal is being applied, the sweep output automatically begins to rise again. The sweep rate Hz switch and its variable control select the repetition rate.

Figure 3-6 is a simplified block diagram of the Model 114 in the trigger with sweep mode. No new circuitry is introduced in this diagram. As the label implies, this mode may be thought of as a combination of the trigger mode and the continuous with sweep mode. Both the main integrator and the sweep integrator are initially inoperative. The trigger clamp amplifier clamps the output of the main integrator at the level set by the start-stop point potentiometer. When an input triggering signal is applied, or the manual trigger switch is operated, the output of the trigger tunnel diode multivibrator steps from zero to approximately -6 volts. This starts the sweep generator running and simultaneously steps the output of the trigger clamp amplifier negative, allowing the main integrator to start running. The main integrator will begin operation at the frequency set by the the Hz dial and the freq Hz range switch and multiplier (X.3 or X1; not shown). As the sweep integrator output starts

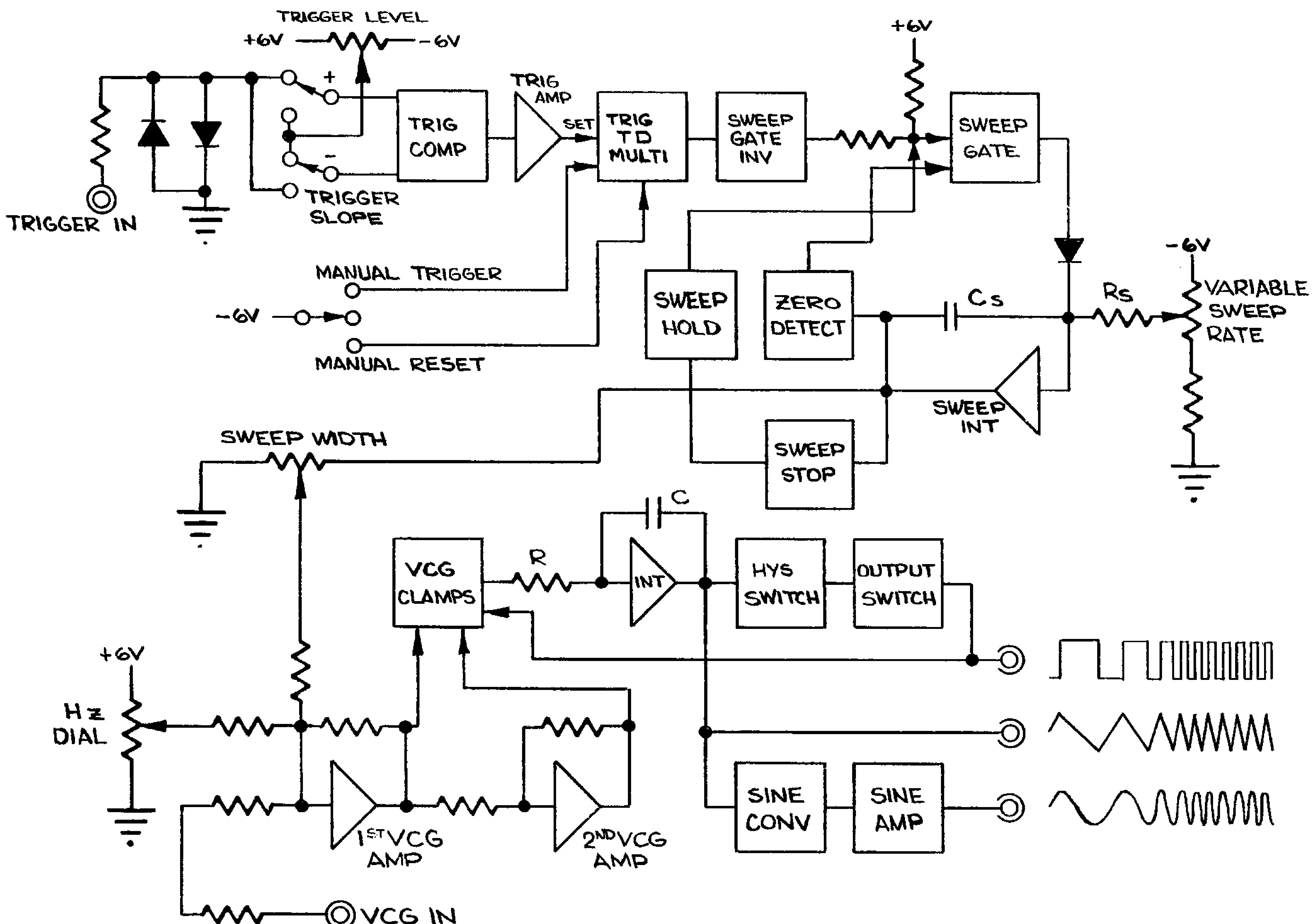


Figure 3-4
Sweep and Hold Mode
Simplified Block Diagram

moving positive, the frequency will be increased since the output of the sweep integrator is coupled through the sweep width control to the VCG amplifiers. When the sweep integrator output reaches the level predetermined by the sweep stop comparator, the reset one shot multivibrator resets the trigger tunnel diode multivibrator. The trigger clamp amplifier is once again enabled and will take control once the main integrator output arrives on the last cycle at the level set by the start-stop point potentiometer.

As may readily be seen, if the sweep width control is turned counter-clockwise to zero, the main integrator frequency will not be swept by the sweep integrator. In the trigger with sweep mode, this allows tone burst operation, in which the number of cycles out of the main integrator is determined by the sweep rate Hz switch and its variable potentiometer. The tone burst period may, therefore, be varied from as little as 10μsec. to more than 10 minutes.

Refer to the Switching and Logic Diagram of Model 114.

This is a block diagram of the Model 114, indicating all functional circuit interconnections, switching, and generator output circuits. In addition to the block just discussed, an offset sine circuit, a sync circuit, an emitter follower for the 5 volt square wave output, a -1 amplifier, an output amplifier and a TWS coincidence gate are shown. The purpose of these circuits is to increase the variety of available outputs.

The offset sine circuitry adjusts the level of the sine wave available from the sine wave amplifier so that its most positive excursion is ground and its most negative excursion is -2.5 volts. This output is available at a BNC connector on the rear panel.

The 10 volt peak to peak square wave is differentiated, amplified and clipped by the sync circuit to provide a -10 volt sync spike, having a duration of less than 5μsec, at a rear panel BNC connector.

The square wave from the output switch is also fed to a super emitter follower that provides a 5 volt peak to peak square wave, with a rise time less than 15 nanoseconds. This output is symmetrical about ground and is also available at a BNC connector on the rear panel.

The -1 amplifier provides, at a rear panel BNC connector, an inverted output (equal in amplitude and opposite in polarity) of the 5 volt sine, the 5 volt triangle, the 2.5 volt offset sine, or the 5 volt square wave depending upon the setting of the function selector switch.

The function selector switch also feeds one of these four waveforms, or their inversions from the output of the -1 amplifier, by way of a variable attenuator to an output amplifier that is operated from a separate power supply. The selected output is made available at the binding posts on the front panel.

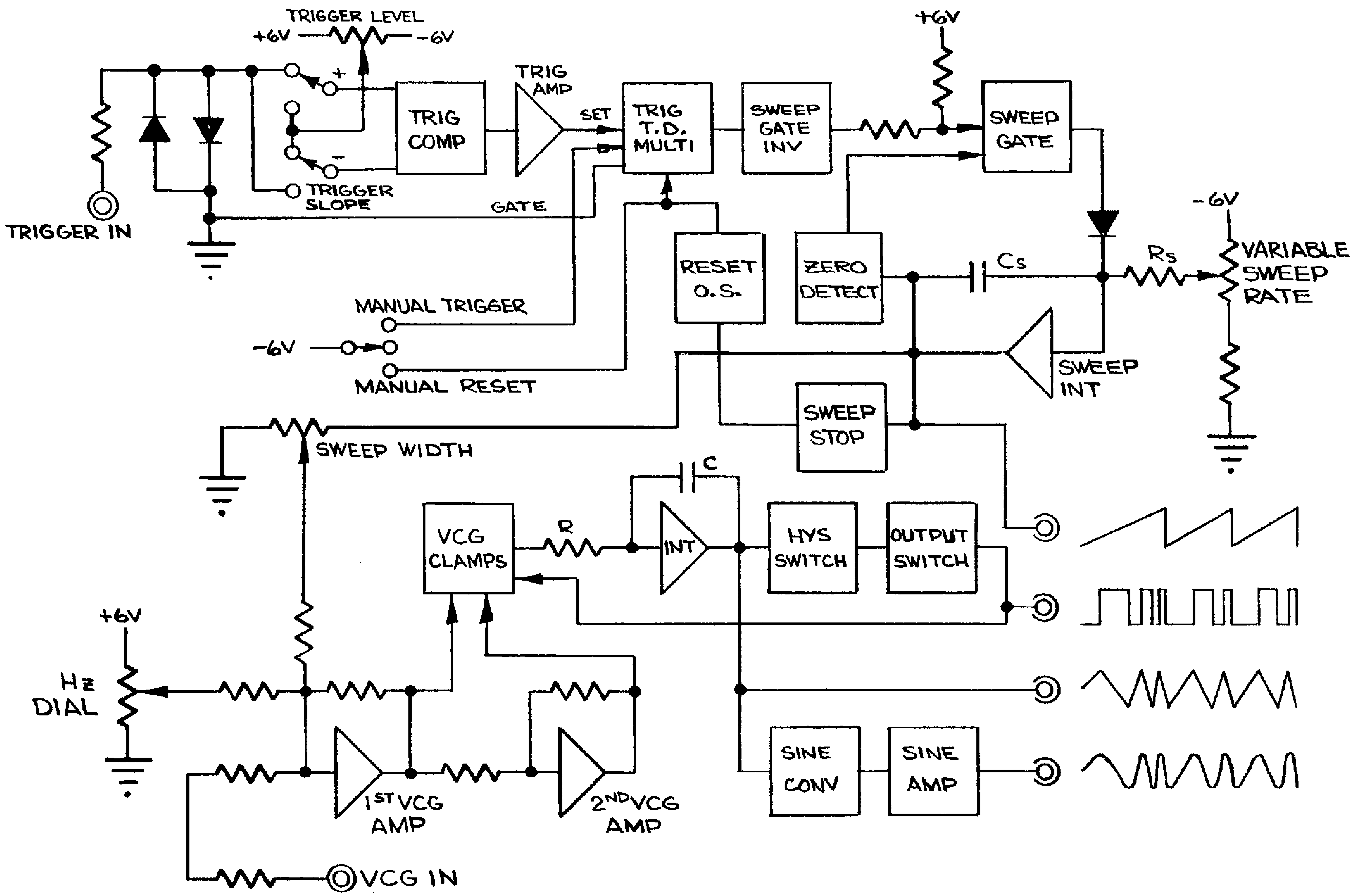


Figure 3-5
Continuous with Sweep Mode
Simplified Block Diagram

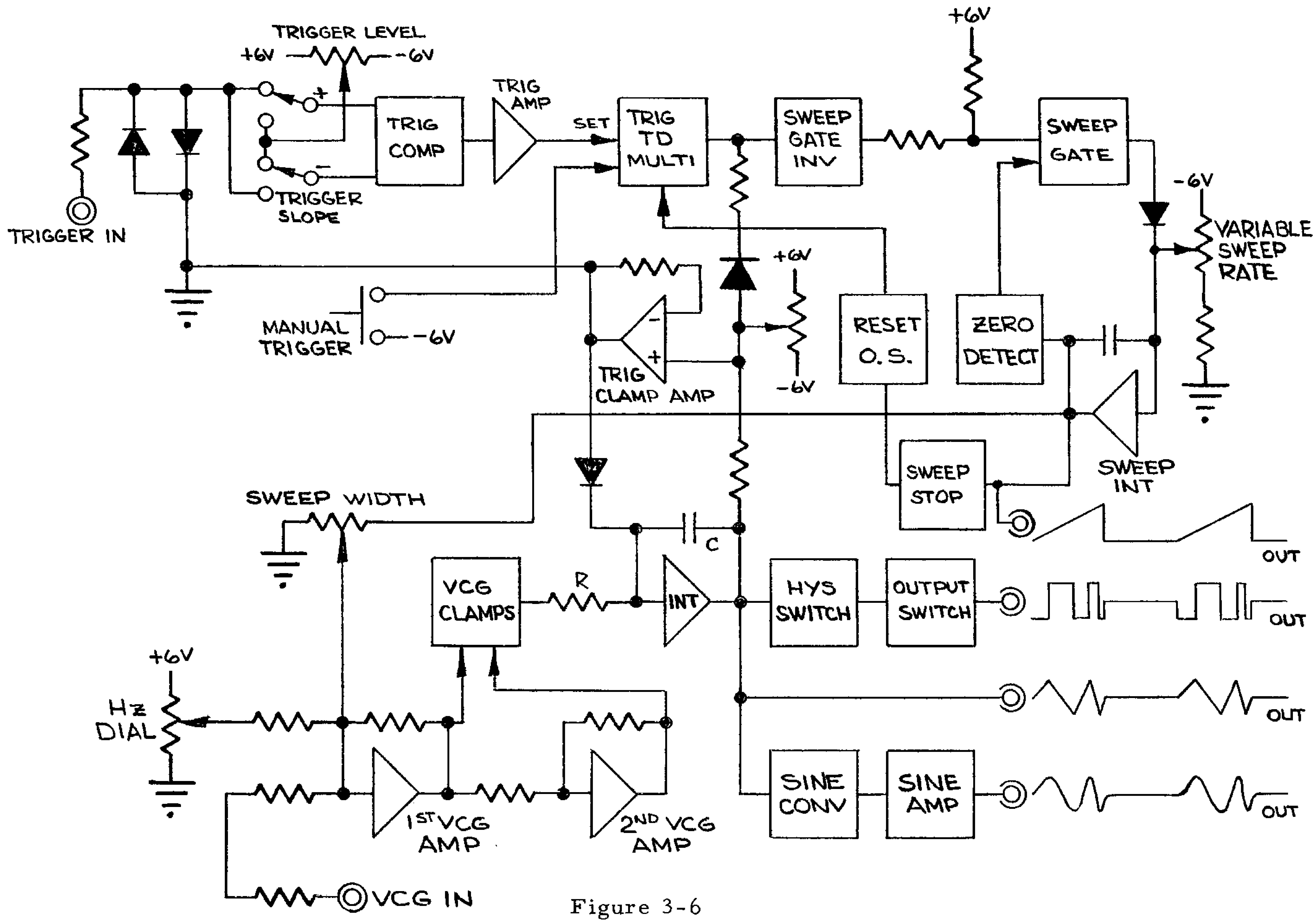


Figure 3-6
Trigger with Sweep Mode
Simplified Block Diagram

The TWS coincidence gate insures that, in the trigger with sweep mode, the reset one shot will not be enabled until the main generator has completed its last cycle.

DETAILED CIRCUIT DESCRIPTION

MAIN BOARD (Refer to Schematic Diagram)

Main Integrator

Q1 through Q10 and their associated circuitry make up the wide band dc integrator amplifier. The frequency Hz switch on the front panel selects the appropriate integrating resistors and capacitors for frequency ranging.

Q1 and Q2 are a Darlington input pair for the minus input; Q4 and Q3 are a Darlington pair in the plus input. Transistors Q1 through Q4 are low current, high gain, wide band transistors which allow the inputs to operate with less than 40 nanoamps of source current. The collectors of Q2 and Q3 work into a complex load made up of R1, R3, R4, C3 and the input impedance of Q5 and Q6. Q5 and Q6 form a differential amplifier stage driving the differential stage made up of Q7 and Q8. The output is taken off single ended at the collector of Q7 through the push-pull emitter follower, Q9 and Q10. CR1 and CR2 provide the bias voltage for Q9 and Q10 to prevent crossover distortion. R8 allows the dc levels in the two sides of the amplifier to be balanced throughout. The triangle output is connected to pin 1. It is also fed through R22 to the sine converter and to the hysteresis switch made up of Q25 through Q30.

Hysteresis and Output Switch

The transistors in the hysteresis switch are connected to form a bi-stable switch. Either the Q25, Q26 side or the Q28, Q30 side can be on but not both at the same time. When the positive going triangle reaches the firing level set by R77, the Q26 side turns on and the Q28 side turns off. The triangle starts its negative slope and when it reaches the firing level set by R78, the Q28 side turns on and the Q26 side turns off. The hysteresis switch is dc coupled to the bi-stable output switch made up of Q31 through Q34. The square wave available from this output switch has a rise time of less than 10 nanoseconds. The square wave is coupled to pin 10.

The 10 volt peak to peak square wave is differentiated, amplified and clipped by Q35, R96, C25, CR15, R101, C27 and R110 to provide a -10 volt sync spike which has a duration of less than 5μsec. The sync pulse is coupled to pin 13. The square wave is also coupled to a push-pull super emitter follower made up of Q36 through Q39. R104 allows the output amplitude to be adjusted, R99 adjusts the waveform so that it is symmetrical about ground. Diodes CR16 through CR19 provide temperature compensation. The output of the super emitter follower is a 5v peak to peak square wave with a rise time less than 15nsec. coupled to pin 11.

Sine Converter and Amplifier

Transistors Q11 through Q18 are emitter followers in the sine converter that bias and temperature compensate the clipping diodes, CR3 through CR10. Diodes CR3, CR5, CR7, and CR9 clip the positive portion of the triangle at points set by the pots in the base of their associated emitter follower transistors. Diodes CR4, CR6, CR8, and CR10 clip the negative portion of the triangle. The diodes do not, however, clip the most positive and negative peaks of the triangle. Therefore, the input to the sine amplifier is a sine wave with small peaks at the top and bottom. The sine wave is fed to the plus input of the sine amplifier through R64. The sine amplifier is a d-c wide band operational amplifier connected in a potentiometric configuration. R69 is the feedback resistor. The peaks on the sine wave are also seen at the collectors of the emitter followers in the sine converter. These peaks are coupled through R54 and R56 to the minus input of the sine amplifier and peak cancellation occurs in the amplifier giving a clean sine wave at the output. The sine wave is coupled to pin 9. R60 adjusts the sine wave symmetry about ground and R64 adjusts the sine wave amplitude.

POWER SUPPLY BOARD (Refer to Schematic Diagram).

Power Supply

A-c voltage is coupled from the transformer to pins 14 and 15 to drive the bridge rectifier made up of diodes CR1 through CR4. Filtering is provided by C1 and C2. Q1 is a transistor connected and operated as a zener diode providing a reference voltage for the +6 volt supply. Q2 and Q3 make up a comparator type differential amplifier. Q2 and Q3 drive Q6 and Q7 which in turn drive the +6 volt pass transistor, Q10. R24 allows the base of Q3 to be adjusted slightly negative with respect to ground. Q1 has a zener voltage of approximately 6.3 volts setting the base of Q2 slightly negative. R24 is adjusted to give an output of +6.00 volts. If the +6.00 volts tries to increase due to a change in line voltage or load current, the collector of Q1 becomes more positive. The base of Q2 becomes less negative (moves in a positive direction with respect to ground) and Q2 draws more current. The collector of Q2 moves less positive and this change is coupled through Q6 and Q7 to the base of Q10. This increases the resistance of Q10, returning the supply to +6.00 volts.

Q4 and Q5 form a comparator type differential amplifier in the -6.00 volt regulator. The base of Q4 is returned to ground through R6. The divider of R26 and R27 between the plus and minus 6 volt supplies sets the base of Q5 at ground. R9 allows a small adjustment of the currents in Q4 and Q5 to set the output at -6.00 volts. An increase in the -6 volts due to line voltage variation or load current variation results in the base of Q5 moving negative. The collector of Q5 moves less negative (in a positive direction). This change is coupled to the bases of Q11 and Q12. Q11 and Q12 form a Darlington connected pass transistor pair for added gain. The positive going change, increases the resistance of Q11 and Q12, returning the output to -6.00 volts.

Output Amplifier

Q13 through Q18 form an operational output amplifier with a gain of approximately -6 set by feedback resistor R37 and the input resistor made up of R31 and R32. Transistors Q13 and Q14 are a differential input stage driving a second differential stage of Q15 and Q16. The output is taken off single ended at the collector of Q16 and coupled to the push-pull emitter follower, Q17 and Q18. Diodes CR5 and CR6 provide bias for the push-pull emitter follower to prevent crossover distortion. The output is coupled through R50 and R51 to pin 3. The input is selected on the front panel and comes in on pin 5. C11 allows the amplifier to be high frequency compensated and is adjusted to give the best Gaussian response when a 1 MHz square wave is applied.

A-c is coupled from the transformer to pins 1 and 2 and drives the bridge rectifier made up of diodes CR7 through CR10. The outputs of the bridge rectifier are filtered by C14 and C15 providing the supply voltages for the output amplifier. R41 is the zero adjust control allowing the output to be adjusted for symmetry about ground. R41 is a screwdriver adjustment available from the rear panel.

D-C Offset Modification. To convert the output amplifier Zero Adjust control to a d-c offset control, remove R40 and R42, 10K 1%, and replace them with 2K 5% carbon resistors. The Zero Adjust control, R41, may now be used to provide approximately ±5 vdc offset to the power amplifier output signal. Note the CAUTION below.

The input available on pin 5 and delivered to the power amplifier is coupled through an attenuator potentiometer on the front panel. The signal delivered to the attenuator pot is selected by the front panel function selector switch. In the "in phase" position of the selector switch, the signals are passed through a -1 amplifier prior to being delivered to the power amplifier; therefore, the output of the power amplifier is in phase with the fixed outputs available at the rear panel. In the "out of phase" position of the function selector switch, the selected signals are delivered directly to the attenuator potentiometer from the signal sources and the signals are inverted only once, in the power amplifier. The result is an output that is out of phase with the fixed outputs at the rear panel. The function selector switch also selects the signal that is delivered to the -1 amplifier and available on the rear panel selected differential output connector. The signal, when selected and delivered to the BNC connector on the rear panel, is identical to, but always 180° out of phase with, the other fixed outputs on the rear panel.

The output amplifier will deliver 100 ma into a short circuit at the front panel connector, and 32.5 volts peak to peak into an open circuit. When terminated in 600Ω (the jumper across R53 on the front subpanel should be removed), the amplifier will deliver 30 volts peak to peak. When terminated in 50Ω, the amplifier will deliver 10 volts peak to peak.

CAUTION: The output amplitudes listed are absolute, in that, they include offset voltage. For example, when offset +5vdc, the amplifier is capable of swinging only +10 volts peak, when terminated in 600Ω; and the output would be at its positive going limit point, when terminated in 50Ω.

VCG BOARD (Refer to Schematic)

VCG Amplifiers and Clamps

The two VCG amplifiers are integrated circuits in similar inverting operational amplifier configurations. The first VCG amplifier accepts, at its summing node, inputs from the frequency Hz dial, the VCG input and via the sweep width control, the sweep integrator output.

Pin 2 of the integrated circuits is the inverting input (summing node). R51, R52 and R53 form a summing node zero adjustment network. CR1 and CR2 provide overvoltage protection. R12 and R13 comprise the feedback network for the 1st VCG amplifier. R8 allows a calibration of the effect of a VCG voltage applied at the front panel to the output frequency of the instrument. R9, R10 and R11 provide a zero adjustment network for the non-inverting input pin3 of IC1. R45 and C3 are a lag compensation network.

Pin 7 of IC1 is the output of the operational amplifier, and Q1 serves as an emitter follower to provide added current swing in the negative direction. The output at the emitter of Q1 is coupled through the saturated transistor Q3 of the feedback network (R13, R12) and to the input of the 2nd VCG amplifier, by way of input resistors, R14 and R15.

R23, R24 and R46 form a zero adjustment network on the non-inverting input of the 2nd VCG amplifier. C5 and R25 comprise the feedback network, and C6 and R50 are the lag compensation network. The amplifier output at pin 7 of IC2 is coupled through the saturated transistor Q5 to the feedback network.

R13 is adjusted to obtain a gain of approximately -3/5, with respect to the frequency dial, for the 1st VCG amplifier, and R14 is adjusted to obtain a gain of -1 for the 2nd VCG amplifier. This may be thought of as a time symmetry adjustment for the main generator output. As a result, the outputs, at the collectors of Q3 and Q5 are equal, but opposite in polarity.

The square wave output from the output switch on the main board is available at pin 13 and is applied, through R17, to the base of Q2 and, through R26, to the base of Q4. Q2 and Q4 are the VCG clamps, operated as inverted switches. When the square wave is negative, Q2 is saturated, and the output of the 1st VCG amplifier is applied to pin 7. When the square wave is positive, Q4 is saturated, and the 2nd VCG amplifier output is applied to pin 7. The resultant signal at pin 7 is a square wave, the frequency and phase of which is the same as the output of the switch set on the main board, and the amplitude of which is determined by the output of the VCG amplifiers. This output drives the input to the main integrator.

The saturation voltage of the VCG clamps, Q2 and Q4, is very low, but it cannot be ignored because the VCG output voltages are required to be quite precise even at very low levels. This explains the inclusion of the saturated transistors, Q3 and Q5, in the feedback loops of the amplifiers. Q3 and Q5 compensate for, and tract with temperature, the voltage offset of the VCG clamps.

The IC's operate from +12 volts, on pins 8, and -6 volts, on pins 4. The +12 VDC is obtained by connecting Q6, a 6 volt zener to the +6 volt regulated supply and, by way of pin 5, through a current limiting resistor on the mother board to the +25 volt supply.

R22 provides an initial unbalance to allow the integrator to start. Without it, a properly calibrated system is so well balanced that it cannot start. Once the machine is running, R18 and R28 offset the unbalance, so that the system is once again balanced.

Offset Sine Wave

The output of the sine amplifier is available at pin 1. It is offset and attenuated by R32 and R33 to Gnd. and R34 and R35 to -6 volts. The offset sine is delivered to pin 12 through two emitter followers, Q7 and Q8. The two opposing base to emitter voltages insure that the offset sine starts at ground, and the emitter followers temperature compensate for one another. R33 is adjusted for the proper offset, and R34 is adjusted for the proper attenuation. The output, available at a rear panel BNC connector, is a sine wave with the most positive excursion at ground and the most negative excursion at -2.5 volts.

TRIGGER BOARD (Refer to Trigger Board Schematic).

Q1 and Q2 make up a comparator type amplifier with Q3 providing a constant current source. The divider of R2 and R4 provide the bias level for the base of Q3. When the front panel Trigger Slope switch is in the plus position, the triggering signal is fed via pin 12 through R9 to the base of Q2. The base of Q1 is returned to the Trigger Level control via pin 13. When a positive going input triggering signal overcomes the reference level established by the Trigger Level control in the base of Q1, the current of Q2 decreases allowing its collector to move in the negative direction. In the triggered mode, pin 15 is open and Q5 is biased to saturation providing a current path for the tunnel diode, CR2. Trigger Slope and Trigger Level control are applied to pins 13 and 12 respectively when negative triggering is desired.

The tunnel diode, CR2, is quiescently biased in its low voltage state. A negative going excursion at the base of Q4 coupled through CR1 causes CR2 to switch to its high voltage state. Tunnel diode CR4 is quiescently biased in its low voltage state. When tunnel diode CR2 switches to its high voltage state, this change is coupled through C4 and results in CR4 switching to its high voltage state, turning on transistor Q7. The output coupled to pin 19 is initially at ground potential. When Q7 turns on, its collector moves in the positive direction and the output steps to approximately -6 volts. A reset pulse, from the output switch is coupled in through pin 21, in the trigger mode, through C5 to the base of Q6. This is a negative going reset pulse coincident with the negative going portion of the output square wave. This reset pulse results in the collector of Q6 moving positive and resetting tunnel diode CR4 to its low voltage state. Transistor Q7 returns to its off state and the output returns to ground. A d-c reset pulse, from the reset one shot or the Manual Reset on the front panel, is coupled to the base of Q6 by R16 R16 via pin 14.

When the front panel mode switch is in the continuous with sweep position, the base of Q5 is returned to ground by grounding pin 15. Transistor Q5 is turned off removing the current path for tunnel diode CR2. The triggering will now couple through CR1 and cause CR4 to switch to its high state; however, CR4 will remain in its high state until the triggering signal is removed. Therefore, the trigger gate will have a duration determined by the width of the trigger pulse applied at the input.

TRIGGER CLAMP AMPLIFIER

The trigger clamp amplifier is a d-c operational amplifier connected in a potentiometric configuration. Transistors Q10 and Q11 form an input differential pair driving the differential pair of Q12 and Q13. The collector of Q12 is returned to ground while the output is taken off single ended from the collector of Q13, which drives the push-pull emitter follower, made up of Q14 and Q15.

CR7 and CR8 provide the bias for Q14 and Q15. R43 is the feedback resistor. R29 allows the amplifier to be d-c balanced so that the Start-Stop Point potentiometer is adjustable between $\pm 90^{o}$ of the generated cycle. The output is taken off the junction of R40 and R41 to pin 3. In the triggered and triggered with sweep mode, the output is coupled through a diode to the minus input of the main integrator. The output of the main integrator is coupled in on pin 7 through R38 to the base of Q11. The trigger gate is coupled through a diode to pin 6 and the base of Q11 as well. The Start-Stop Point potentiometer provides the reference level at lin 1 and, therefore, at the plus input of the trigger clamp amplifier.

In the triggered or triggered with sweep mode, the trigger gate is initially at ground potential allowing the Start-Stop potentiometer to set the reference level at the plus input of the trigger clamp amplifier. This sets the level at the output of the trigger clamp amplifier and, therefore, clamps the minus input of the main integrator to the level set by the Start-Stop potentiometer through the diode from the output of the trigger clamp amplifier. R29 allows the trigger circuit to be balanced so that the Start-Stop point, through the diode from the output of the trigger clamp amplifier, moves between -90 and +90 degrees. When a triggering signal is applied, the trigger gate steps to a -6 volts driving the plus input of the integrator to start. When the trigger gate is reset, the trigger clamp amplifier is once again enabled; however, the triangle wave coupled in on pin 6 must overcome the reference level set by the start-stop potentiometer before the clamp amplifier will once again clamp the main integrator. This insures that an integer number of cycles are generated and that the start-stop point will always be set by the start-stop point potentiometer.

Minus 1 Amplifier

The -1 amplifier has two main functions: 1) to provide a differential or out of phase output with the fixed output at the rear panel, and 2) to allow the power amplifier to generate signals that are in phase or 180° out of phase with the fixed outputs on the rear panel. The start-stop point potentiometer only allows the start-stop point to be varied $\pm 90^{\circ}$. By using the output from the -1 amplifier or the inverted output from the power amplifier, the start-stop point can be made to operate over 360° since the start-stop point is inverted as well as the signal.

The -1 amplifier is an operational inverting dc amplifier with a gain of unity set by potentiometer R63. Q20 and Q21 form a differential input pair driving the differential pair of Q18 and Q19. The output is taken off single ended from the collector of Q18 through push-pull emitter follower Q16 and Q17. CR9 and CR10 provide the bias for the push-pull emitter follower to prevent crossover distortion. R63 and R64 make up the feedback resistor while R62 is the input resistor. C15 and C18 are for high frequency compensation. R60, R50, C13 and C14 are to shape the frequency response characteristics of the amplifier. C12 places the plus input of the amplifier at signal ground. R48 allows the amplifier to be dc balanced so that the signal is symmetrical about ground.

FRONT SUBPANEL (Refer to Schematic)

Front Panel Output

In Model 114, the output of the power amplifier is available at pin 24. R54 and R55 combine with the output circuitry on the power supply board to set the output impedance at a nominal 50Ω. Remove R60, C15 and jumper around R53 for 600Ω output impedance.

In Model 114B, there is no power amplifier. The output is taken from the arm of attenuator R42 and jumpered to pin 24. R60, C15 and jumper around R53 are removed and R53 is changed to a 430Ω, 5% carbon resistor. This results in a nominal 600Ω output impedance.

Frequency Hz Dial

The case of the frequency Hz dial, R52, is tied by a wire to chassis ground. To eliminate the possibility of high frequency interference due to fields between chassis ground and circuit ground C14 and R48 have been added. R49 and R50 insure that some voltage is always present at the VCG inputs. Voltage at the arm of the frequency Hz dial goes to pin 6 and on to the VCG board.

VCG Input

The VCG input is shunted by C13 and R47 in series. The VCG input voltage is delivered to pin 2.

Trigger Input, Trigger Slope Switch and Trigger Level Control

The trigger input from the front panel BNC connector goes through R46 to a pair of back to back protective diodes, CR4 and CR5, and to the trigger slope switch SW-2. The trigger slope switch determines which side of the trigger comparator, on the trigger board, receives the trigger input and which side receives the voltage set by the trigger level control, R45. The trigger level control is a 10K potentiometer tied between ±6v; the voltage at its arm is connected to the trigger slope switch through R44. The trigger comparator side of the trigger slope switch goes to pins 12 and 13.

Manual Trigger and Sweep Reset Switch

This switch is a three position, spring loaded toggle switch, with its OFF position in the center. Its function is described on page 1-7. In the up, or trigger position, -6v is applied to the trigger board via pin 11, setting the T. D. trigger multivibrator. In the down, or RESET position, -6v is placed on pin 7. This also goes to the T. D. trigger multivibrator, resetting it.

Function Selector Switch

The fixed output triangle, sine, offset sine and square waves are fed to the function selector switch, SW-1, via pins 1, 17, 19 and 20. The selected function is coupled by the switch to pin 26, which goes to the -1 amplifier input. The output of the -1 amplifier returns the inverted signal, by way of pin 25, to the function selector switch. The two right-hand sections of the switch, as drawn, determine whether the "in phase" or the inverted signal is delivered to the attenuator, R42, in the input circuit of the power amplifier. Remember that the power amplifier is also an inverting amplifier, so that if the "out of phase" function from the output of the -1 amplifier is fed to the power amplifier, the output available at the front panel is in phase with the fixed output.

In the Model 114B, no power amplifier is included, and no second inversion may take place. When the "in phase" signal is selected, no inverting amplifiers are utilized, and the output at the front panel is in phase with the fixed outputs.

Sweep Rate Hz Switch

The A section of the sweep rate Hz switch, SW-3, chooses the input resistor for the sweep integrator while the B section chooses the integrating capacitor. The C section switches the coupling capacitor for the reset one shot whenever the sweep integrator capacitor is switched. This is to compensate for changes in discharge rates at the end of the sawtooth.

Reset One Shot

The reset one shot is a typical astable multivibrator. In the quiescent state, Q10 is conducting since its emitter is tied to -6v and its base is connected through R31 to +6v. As a result, its collector is very near -6v, so that the base of Q11, at the junction of R34 and R35 is also nearly -6v, holding Q11 off. The output, at the collector of Q11, is at approximately +0.5v as determined by the voltage divider action of R32 and R33.

When a positive voltage is dc coupled through pin 21 to the base of Q11, that transistor turns on. The output collector voltage goes towards -6v, and this negative excursion is coupled by the capacitor selected by the C section of the sweep rate Hz switch to the base of Q10, turning that transistor off. This is an unstable state, since the selected coupling capacitor recharges through R31 until the base voltage of Q11 reaches approximately -5.3v; at which time Q10 fires and the circuit returns to its quiescent state to await another pulse.

The RESET position of the manual trigger and reset switch is also tied to the collector of Q11. When activated, this switch applies -6 volts, which is reflected into the base of Q10 causing the reset one shot to cycle. The pulse width of the reset one shot is shorter than the make-break time of the manual reset, so that no effect is noticed.

Sweep Gating Circuits

In the trigger with sweep, continuous with sweep, and sweep and hold modes, the output of the T.D. trigger multivibrator is applied to the base of the sweep gate inverter, Q9. In the quiescent condition, this voltage is near ground potential, so that the voltage divider action of R28 and R29 hold the base of Q9 positive, and Q9 is normally on.

When Q9 is on, its collector current through R26 and R27 holds the base of Q8 to approximately +3 volts. The base of Q7 is normally at approximately +3.6 volts, as determined by R20 and R21. Therefore, Q7 is normally off and Q8 is normally on. The collector current of Q8 serves to forward bias the disconnect diode, CR3, which is connected to the summing node of the sweep integrator. C4 is a rolloff in the loop including the sweep integrator. See the simplified block diagrams, Figures 3-4, 3-5 and 3-6. C4 primarily prevents ringing at the end of the sawtooth, during the return to zero.

When CR3 is forward biased, current is pumped into the sweep integrator summing junction and the output would drive negative, were it not for the action of the zero detect circuitry on the 2nd subpanel. When the sweep integrator output attempts to go negative with respect to ground, the zero detect circuitry applies a negative voltage through pin 10 to the base of Q7. Q7 turns on and Q8 turns off. The anode of CR3 goes to a negative voltage determined by the voltage divider consisting of R25 and R58. CR3 becomes back biased and disconnects, allowing the integrator to start again, thus releasing the zero detect circuit. The overall effect of this loop is to hold the output at zero, provided the T. D. trigger multivibrator output is near ground.

In the trigger with sweep and the continuous with sweep modes, whenever a trigger is accepted, the output of the T. D. trigger multivibrator steps to -6 volts and this voltage is applied to pin 8, cutting off the sweep gate inverter, Q9. The voltage at the base of Q8 steps to +6 volts, holding Q8 off and thereby disconnecting CR3. The output of the sweep integrator is, therefore, allowed to rise until the T. D. trigger multivibrator is reset.

In the sweep and hold mode, the sweep stop circuitry is connected to the sweep hold circuitry. See Figure 3-4. The sweep hold circuitry applies a negative voltage through pin 9 to the base of Q8, controlling its conduction to hold the sweep integrator output at approximately +2.5 volts in much the same manner as the zero detect loop holds the output at zero.

Sweep Integrator

When the disconnect diode, CR3, is back biased, the only input to the sweep integrator is the voltage appearing on the arm of the sweep rate variable control, R2. R1 calibrates this voltage when R2 is turned fully clockwise. R3 determines the range of operation of the sweep rate variable control. Users not requiring extremely slow sweeps (less than 0.01Hz) may convert the variable control to a "vernier" by changing the value of R3. Substitution of a 1K resistor for the 150Ω would result in a vernier potentiometer having a range of approximately 11:1.

The voltage at the arm of R2 is applied through the input resistor selected by the A section of the sweep rate Hz switch to the inverting input of the amplifier. The sweep integrator is basically a differential operational amplifier in a Miller integrator configuration. The integrating, feedback capacitor is chosen by section B of the sweep rate Hz switch.

The input stage of the amplifier consists of a pair of matched FET's, Q1 and Q2, operated as a differential source follower. FET's are used to take advantage of the very high input impedance of these devices. Negligible input current is required, as a result, for excellent operation. No voltage gain is obtained in this stage. The source follower configuration was chosen to minimize input offset voltage drift. These FET's have been matched for Idss, Vp, and drain current at the operating point. R8, R9 and R10 form a zero adjust network at the non-inverting input.

The first amplifying stage of the integrator is IC1, which is operated as a differential pair with a transistor current source. R13 was chosen to balance and adjust the operating levels of the IC1. C3 and R12 form a high frequency rolloff at the collectors of the differential pair.

The 2nd amplifier stage is matched transistors, Q3 and Q4. C17 is an additional rolloff. The output is taken off single ended and is fed to a push-pull emitter follower consisting of Q5 and Q6. CR1 and CR2 provide bias for the emitter follower transistors to prevent crossover. The output of the sweep integrator is taken from the junction of R17 and R18 and is delivered to pin 15. R19 acts as a load resistor.

SECOND SUBPANEL (Refer to Schematic)

Frequency Hz Switch and OFF, X.3, X1 Switch

Switch SW-1 is the main frequency Hz switch. It selects the appropriate integrating capacitors and resistors for the main integrator, on the main board. Switch SW-2 is the off, X.3, X1 switch, that allows the selection of differential integrating resistors in the X.3 position, thus changing the range of frequencies over which the dial will operate.

Mode Switch

SW-3 is the mode switch, which selects trigger with sweep, continuous with sweep, continuous, sweep and hold or trigger operation. Section A connects the output of the main integrator to the trigger clamp amplifier input in the trigger and trigger with sweep modes. Section B provides ac reset from the output switch to the T.D. trigger multivibrator in the trigger position. Section C connects the sweep width control, at the output of the sweep integrator, to the input of the VCG amplifiers, when any of the sweep modes are selected. Section D grounds the EXT point on the T.D. trigger multivibrator in the continuous with sweep mode. Section E connects the output of the T.D. trigger multivibrator to the trigger clamp amplifier input when either triggered mode is selected; while Section F connects the output of the T.D. trigger multivibrator to the sweep gate circuitry when the sweep modes are selected. Section G connects the output of the trigger clamp amplifier, via the disconnect diode, to the summing node of the main integrator. Section H disconnects the output of the sweep stop comparator from the reset one shot in the sweep and hold mode and connects it to the sweep hold circuit. Section I introduces the TWS coincidence gate between the sweep stop circuit and the reset one shot in the trigger with sweep mode.

Sweep Stop Circuit

Matched transistors, Q1 and Q2, form a differential comparator. The reference voltage is set at approximately 2.5 volts by R4 and R5 at the base of Q2. The sweep integrator output is fed to the base of Q1, from pin 15 through R2. As long as the sweep integrator output is less positive than the reference voltage, Q1 is on and Q2 is off. When the sweep voltage tries to become more positive, Q2 turns on; and the collector current of Q2 is delivered to the reset one shot or to the sweep hold circuit, as determined by the mode switch.

Sweep Hold Circuit

When the sweep and hold mode is selected, collector current of Q2 is connected through Section H of the mode switch to the base of Q4, which is tied through R10 to -6 volts. Q4 shares emitter resistor R9 with Q3, the base of which is returned to ground through R7. As a result, until Q2 turns on, Q3 is on and Q4 is off. When Q2 conducts through R10, Q4 turns on and its collector current is delivered out pin 23 to the sweep gate circuitry on the front subpanel. C3, R6 and C6 act to prevent oscillations in the sweep and hold loop.

TWS Coincidence Gate

The 10 nanosecond square wave is available at pin 19. It is fed through R47 to the wiper of Section B of the mode switch and on, through R46, to the emitter of Q5, where the negative portion is clipped by CR3. The base of Q5 is at ground, so that when the square wave is positive, Q5 is turned on; and the positive voltage is fed to the base of Q6, saturating that transistor. The emitter of Q6 is at -6 volts and in trigger with sweep, the collector goes through Section I of the mode switch and pin 25 to the input base of the reset one shot. Q6, therefore, shunts the input base resistor of the reset one shot, so that when Q6 is saturated, the sweep stop circuit cannot trigger the reset one shot. When the square wave goes negative, coincident with the completion of a cycle from the main integrator, Q5 and Q6 cut off, allowing the sweep stop circuit to trigger the reset one shot.

Zero Detect

IC1 is operated as a differential comparator with a transistor current source. The output of the sweep integrator, available at pin 15, is applied to the pin 1 base through R13, while the voltage at the pin 5 base is set by the zero detect adjust network consisting of R16, R17 and R18. When the sweep output attempts to go negative, collector current flows at pin 6. This output is delivered through R15 and pin 22 to the sweep gating circuitry. R14 is chosen to balance the current in the zero detect circuit so as to minimize zero drift.

SECTION IV
CALIBRATION

CALIBRATION PROCEDURE

EQUIPMENT REQUIRED

1. Voltmeter, 1% accuracy, 1mv resolution (WAVETEK Model 201 or equivalent).

*2. Oscilloscope, Tektronix 530 Series or equivalent.

*3. Plug-in, Tektronix Type W or equivalent.

4. Plug-in, Tektronix Type CA or equivalent.

5. Frequency counter, 5 digit resolution.

6. Distortion analyzer, Hewlett/Packard Model 330C or equivalent.

7. Two 50Ω cables with BNC connectors, 50Ω termination.

8. Time marker or signal source at 100Hz and 1KHz.

*If Tektronix scope and typw W plug-in are not available, any peak reading device with an accuracy of 1% or better can be used.

Remove cover from instrument.

Set mode switch on continuous, sweep width counter-clockwise, maximum sweep rate 100Hz, vernier clockwise.

POWER SUPPLY BOARD (SEE CHASSIS ASSEMBLY)

The 100µf bypass capacitors are located in the bottom of the instrument which are filter capacitors for the +6 volt and -6 volt power supplies. The capacitor on the rear right of the instrument is in the +6 volt supply, and the one on the rear left is in the -6 volt supply. The capacitor leads are convenient voltage test points. Connect an appropriate indicating device between the end marked + of the rear 100µf capacitor and circuit ground. Adjust R24 for +6.00 volts ±1mv. Move the indicating device to the other capacitor between the end marked - and circuit ground. Adjust R9 for -6.00 volts ±1mv. To compensate for the effects of interaction, repeat these adjustments.

There is no adjustment in the + and -24 volt supplies.
Typical 120 cycle ripple, ±6 volt supplies, is 25mv.
Typical 120 cycle ripple, ±24 volt supplies, is 500mv.

Power Amplifier Adjustments

Set the output amplifier function selector (front panel) switch on square wave (fully clockwise position). Set attenuator fully clockwise. Observe front panel output GR connector on oscilloscope open circuited; adjust R31 for a 32.5 volt peak to peak square wave.

Adjust square wave with output attenuator fully counter-clockwise for symmetry about ground with R41. Adjust 1MHz square wave into open circuit with C11 for optimum square wave with no overshoot. Check for less than 100nsec. rise time. Check for 30 volts into 600Ω and 10 volts into 50Ω.

BATTERY REGULATOR BOARDS (REPLACES POWER SUPPLY BOARD IN MODEL 114B)

1. Connect an appropriate indicating device between circuit ground and the end marked + of the 100µf capacitor on the right rear of the mother board. Adjust R25 for +6.00 volts ±1mv. Move the indicating device to the end marked - of the other 100µf capacitor on the left rear of the mother board. Adjust R41 for -6.00 volts ±1mv. To compensate for interaction, repeat these adjustments.

2. R32 & R48 are selected for equal regulator currents through R27 & R42. Only one of these resistors is used. This maintains equal discharge rates of the ±6 volt battery packs.

R12 is the charge rate screwdriver adjustment available at the rear panel. See page 1-3.

Model 114B does not include a power amplifier.

MAIN BOARD (SEE CHASSIS ASSEMBLY)

Triangle and Square Wave Adjustments

1. Set freq Hz switch to X100 and rotate the frequency dial clockwise to its extreme bottom setting. Select cont on the mode switch. On the VCG board jumper from pin 3 to pin 7; on the main board, install a 100K resistor between pin 1 and pin 3. Observe the main integrator output with an appropriate indicating device at pin 1 on the main board. Adjust R8 for zero volts to circuit ground. REMOVE JUMPER AND 100K RESISTOR.

2. Rotate the frequency dial counter-clockwise to "10" (1KHz signal out). Set function selector to $\wedge\!\vee$. Using the Tektronix scope and type W plug-in (or equivalent peak reading device), observe the triangle waveform at the front panel connector. DO NOT ATTACH A LOAD. Adjust R77 for triangle break at +2.50 volts ±5mv and R78 for triangle break at -2.50 volts ±5mv. To compensate for interaction, repeat adjustments.

3. Connect the oscilloscope to the 15nsec. square wave output connector on the rear panel using a 50Ω cable, terminated in 50Ω. Adjust R99 for 5 volts amplitude and R104 for symmetry about ground to obtain ±2.50 volts ±5mv. Tolerance on leading edge spikes is 5% of peak to peak amplitude.

4. Set the freq Hz switch to X10K and the frequency dial to "10" (100KHz). Using a 50Ω cable terminated in 50Ω, connect an oscilloscope to the 5 volt triangle output. With R4 turned maximum clockwise, high frequency ringing will be observed; turned counter-clockwise, ringing will be noted at a lower frequency. Adjust R4 so that no oscillations are noted on the waveform, just short of the lower frequency side.

5. Switch the freq Hz switch to X100K, and check for a bump on the negative peak. If a bump exists, repeat step 4. (If the waveform cannot be corrected by this method, it may be necessary to replace pair Q5-Q6 (matched pair) or, possibly, pair Q7-Q8 (matched pair).

6. Observe sync signal without 50Ω load at 100KHz. The peak should be at least 10 volts and the width approximately 1μsec. although spec is 5μsec.

Sine Waveform Adjustments

1. Using Tektronix scope and type W plug-in, set frequency dial at "10", range at X100. Place main board on extender cable. Observe sine at BNC connector.

2. Adjust R64 for sine wave out of ±2.5 volts ±1mv. Adjust R60 for sine symmetry about ground. Using distortion analyzer, adjust R20, R24, R30, R33, R46 and R49 for minimum harmonic distortion. Readjust R64 and R60 for amplitude and symmetry about ground.

NOTE: Although WAVETEK calibration technicians, experienced with the sine waveform adjustments, commonly complete the waveform adjustments in a few minutes or less; for a technician attempting the process for the first time, some patience may be necessary, due to interaction of the effects of all eight potentiometers. If while making adjustments, the sine wave at the output looks bad, but looks good at the junction of CR9 and CR10, matched amplifier parts Q19-Q20 and Q21-Q22 should be checked.

VCG BOARD (SEE CHASSIS ASSEMBLY)

Set mode switch to cont. Sweep rate off.

1. Set freq Hz switch to X100. Set the frequency dial to "10". Frequency dial voltage comes into the VCG board on pin 9. It is also available at a convenient test point near the right hand side of the printed circuit board. Under the conditions described, this voltage is specified as +5.750 volts ±2mv. If the dial voltage is incorrect, reinstall the dial.

2. It is convenient to make up a device, such as a pushbutton switch, to alternately short and open the VCG input. Set freq Hz switch to X1K and dial at "1". Observe 1 cycle of the square wave output on an oscilloscope set to trigger on the negative excursion. Alternately short and open the VCG input. Adjust R9 so that no shift of the waveform can be noticed.

3. Set freq Hz switch to X100 and dial at "1". Observe one cycle of the square wave output on an oscilloscope. While switching the oscilloscope trigger polarity alternately from + to -, adjust R46 so that the square wave transition point does not shift. Rotate the frequency dial to "10", and adjust R14 in the same manner. Repeat these adjustments to counteract the effects of interaction.

4. Set freq Hz switch to X100 and dial at "1". Trigger the oscilloscope with a time mark generator at 100Hz and adjust R51 for one cycle of the square wave output on the scope.

5. Set freq Hz switch to X100 and dial at "10". Trigger the oscilloscope with a time mark generator at 1KHz and adjust R13 for one cycle of the square wave output on the scope.

6. Check steps 1 through 5. If R51 or R13 require readjustment, repeat all steps again.

7. Set freq Hz switch to X100. Trigger the oscilloscope with a time mark generator at 100Hz, and observe the square wave output. Set the frequency dial to "10" by noting exactly 10 cycles on the scope, with the VCG input shorted. No jitter should be observable when the short is removed. From a calibrated source, apply -4.500 volts to the VCG input. Adjust R8 for 100Hz, one cycle on the scope. Alternate methods of reading the frequency may be used, but the method described uses test equipment likely to be most convenient.

8. Observe the offset sine wave output using a 50Ω cable without a 50Ω load. Adjust R33 to set the top of the waveform at zero volts, and adjust R34 for 2.50 volts amplitude.

TRIGGER BOARD

Minus 1 Amplifier

1. Set the freq Hz switch to X100 and the frequency dial to "10". Select cont mode. Observe the selected differential output on the rear panel with the Tektronix scope with a type W plug-in (or equivalent peak reading device) and adjust the -1 amplifier gain, R63, and balance, R48, for ±2.50 volts ±5mv.

Trigger Clamp Amplifier

1. With the freq Hz switch set to X100 and the frequency dial set at "10", the

start-stop point centered, the trig slope to plus, and the trig level centered, apply a 5 volt sine wave to the trig in connector. It is most convenient to select the triangle waveform for observation. Adjust the trig level control for proper triggering. Adjust R29 so that rotating the start-stop point potentiometer will cause the observed waveform to shift beyond $\pm 90^{\circ}$.

2. Check all frequency ranges for proper operation of the start-stop point potentiometer.

3. Check triggering operation at 0.01Hz.

4. Check manual trigger operation.

5. Check triggering with trig slope set to minus.

Front Panel Output

1. Observe power amplifier output with scope externally triggered from sync output. Rotate function selector through its positions and insure that all outputs are available and in proper phase.

SUBPANELS

Model 114 Subpanels

1. Mode switch in cont, center all front panel potentiometers except sweep width counter-clockwise, trig slope in plus, trig level counter-clockwise.

2. Visual check all connectors including BNC; connect BNC cable to BNC connector and be sure all centers are sound.

3. X.3, X1 switch at X1, freq Hz to X100, dial at "10" (counter-clockwise). Check all outputs for proper amplitude and quality with 50Ω load and open circuit.

4. Function selector at sine, attenuator counter-clockwise, freq Hz to X100, dial counter-clockwise. Set at 1KHz with dial potentiometer (dial is then at "10").

5. Check all lower ranges at "10" on the dial for ±0.03 with respect to 1KHz. If one lower range is out, change associated trim resistor.

6. Freq Hz to X100K, "10" on the dial. Adjust variable capacitor for ±0.05 with respect to 1KHz. Check to see that there is enough range for ±0.10.

7. Freq Hz to X10K, balance out error between X10K and X1K range so that total error is ±0.03 on each range with respect to 1KHz, using variable

capacitor. Check to see that there is enough range for ±0.05.

NOTE: Variable capacitors in steps 6 and 7 have interaction.

8. Freq Hz to X100K, dial at "10", X.3, X1 switch at X.3. Check frequency to be ±0.06 with respect to 1MHz.

9. Check all lower ranges on X.3 range to be ±0.03 with respect to 1KHz.

10. NOTE: No vernier Model 114.

11. Freq Hz to X100, dial at "10", X.3, X1 switch at X1. Apply -4.50 volts to VCG input and check that frequency changes from 10KHz to 1000Hz.

12. Place X.3, X1 switch in the X1 position.

13. Apply trigger source to trig in connector, trigger source at X100, dial at "5". Model 114 generator freq Hz to X100, dial at "10". Switch mode switch to trig, trig slope switch to plus slope, rotate trig level control until proper triggering occurs. Switch to minus slope. Rotate start-stop point potentiometer through its range and insure that trigger start-stop point moves through 180^{o}. Insure that $\pm 90^{o}$ operation is obtainable on X100Hz and X1KHz ranges at the top and bottom of the dial.

14. Freq Hz to X.1, dial at "10". Trigger mode in trig, trigger start-stop point at zero. Remove trigger source, depress manual trig switch and observe proper manual trigger operation.

15. Check operation in all modes.

16. Set mode switch cont, maximum sweep rate switch to off. Rotate potentiometer on second subpanel counter-clockwise. Observe sweep output connector with scope and type W plug-in. Adjust variable resistor on front panel for "0" volts at sweep output connector (sweep integrator balance potentiometer).

17. Sweep rate switch to X100KHz. Sweep rate vernier clockwise, trig level counter-clockwise, trig slope negative; adjust variable resistor on second subpanel so that base line is at "0" volts.

18. Mode switch to cont w/sweep. Trig slope negative, trig level clockwise (free running sweep). Observe sweep out connector with frequency counter. Sweep rate X100 should be 100Hz, ±5%.

19. Check all sweep rate ranges for output frequency ±5%. Check for 60:1 sweep variable range at 10KHz.

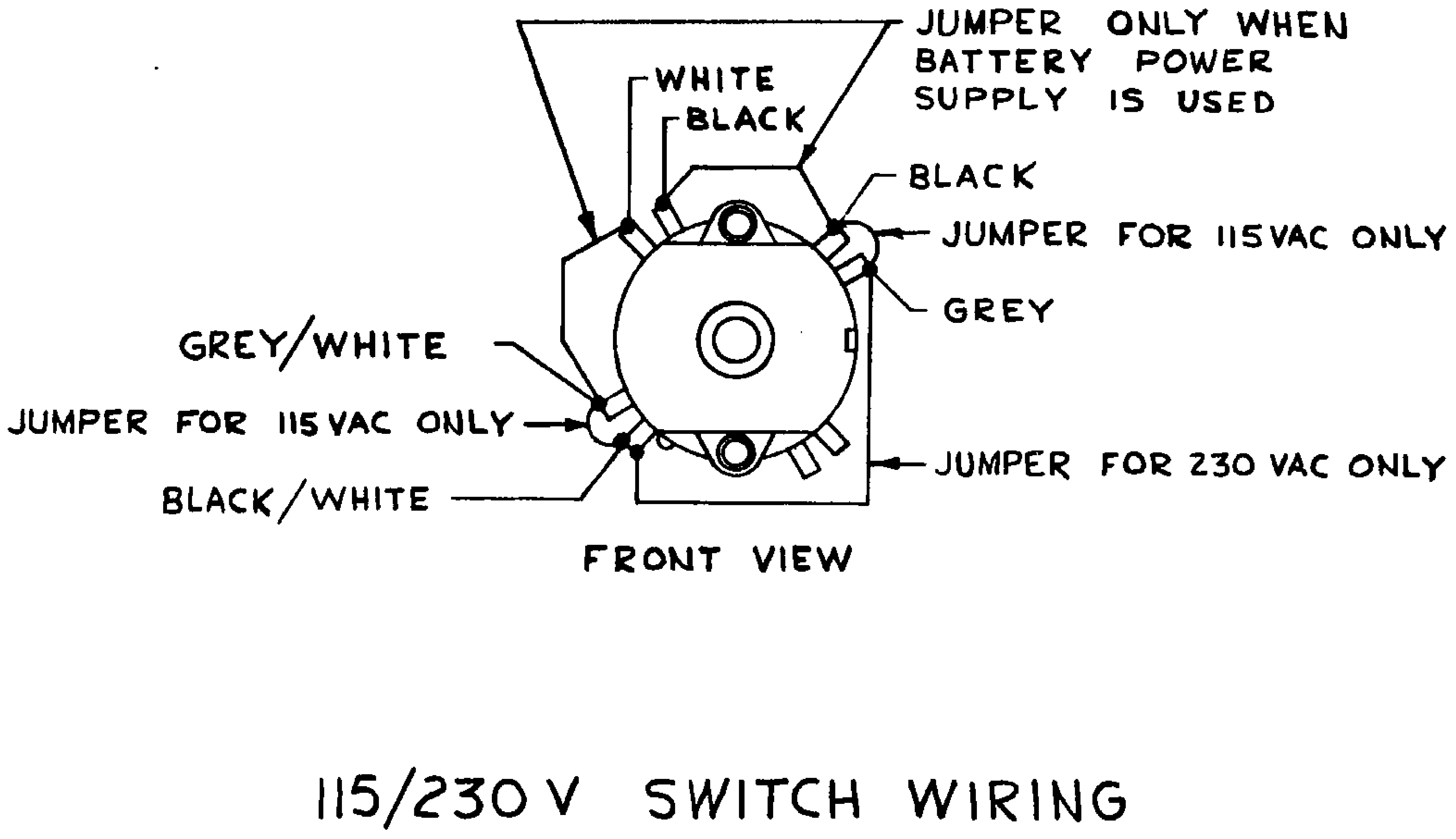
20. Check "0" base line on all ranges; sweep not free running, should be 0, ±20mv.

21. Place in X1 position. Place mode switch in cont.

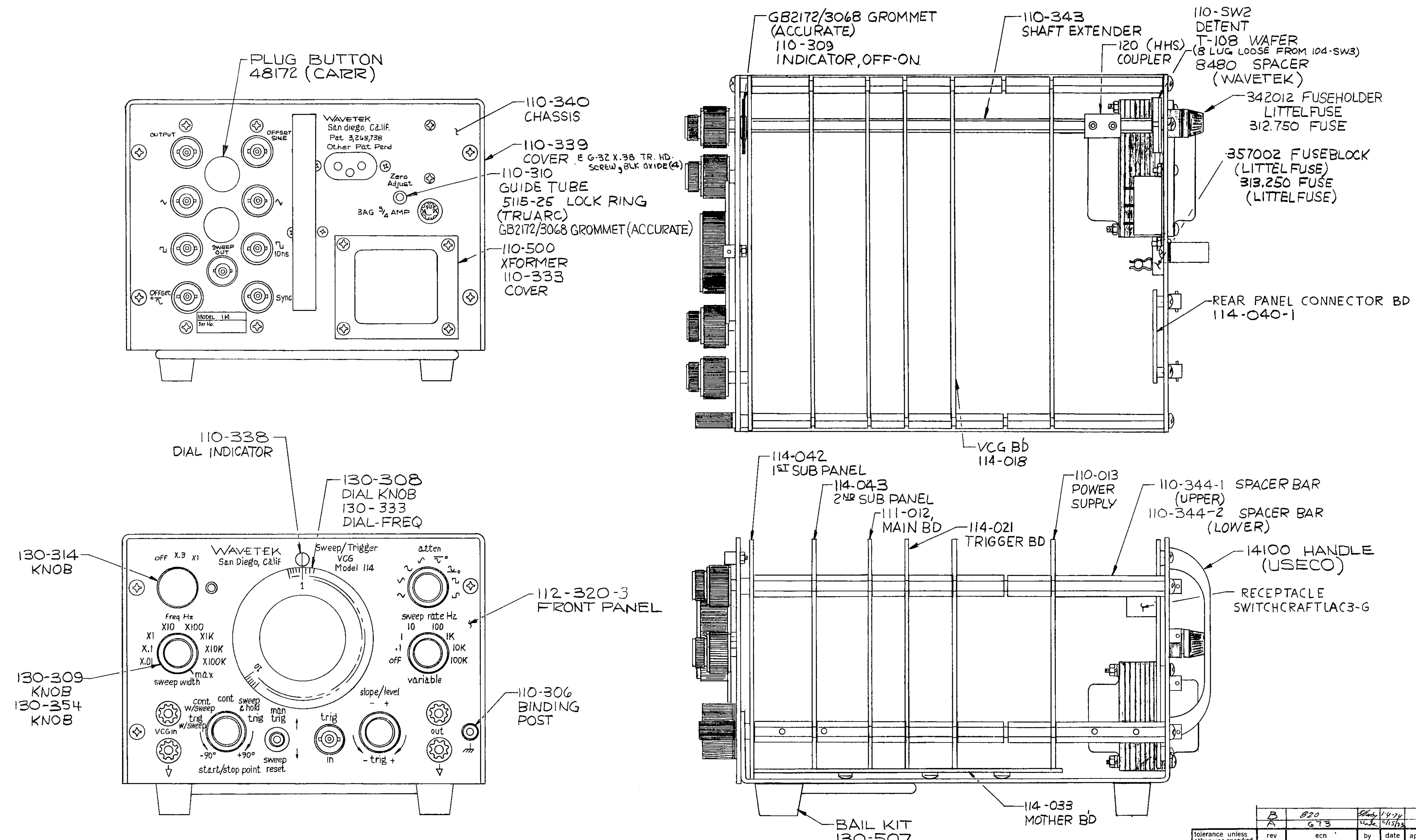
22. Mode switch to trig w/sweep. Freq Hz (main generator) to X100KHz, dial to "1", sweep width counter-clockwise. Connect 5 volts fixed sine (WAVETEK Model 110 or equivalent) at 5KHz to trig in BNC connector. Sweep rate switch to 10KHz, sweep variable clockwise. Adjust trig level for "tone burst". Adjust sweep variable for length of tone burst (number of cycles).

23. Adjust sweep width for swept tone burst. Turn the sweep width control fully clockwise and assure that the instrument does not free run.

SECTION V
SCHEMATIC DIAGRAMS



115/230 VAC Switch Wiring Schematic Diagram



1. THE BATTERY MODEL (114B) REQUIRES THE FOLLOWING CHANGES:
   - 1.1 REMOVE 110-013 P.S. ASSY, ADD 112-022 BATTERY REGULATOR ASSY.
   - 1.2 ADD 112-023 BATTERY PACK ASSY.
   - 1.3 REMOVE 110-500 TRANSFORMER, ADD 112-500 TRANSFORMER.
   - 1.4 REMOVE .25 AMP SLO-BLO FUSES, ADD 1.0 AMP SLO BLO FUSES.
   - 1.5 REMOVE 112-320-3 FRONT PANEL, ADD 112-320-4 FRONT PANEL.

NOTE: UNLESS OTHERWISE SPECIFIED

rev	ecn	by	date	app.
B	820	[illegible]	1-4-74	
A	673	[illegible]	6/15/73	

tolerance unless otherwise specified .XXX ± .010 .XX ± .030

scale 1:1

material

finish

WAVETEK san diego, calif

by M E Bo | date 6-5-72 | app.

title CHASSIS ASSY.

model no. 114 | dwg no. D114-041 SHEET 1 OF 2 | rev B

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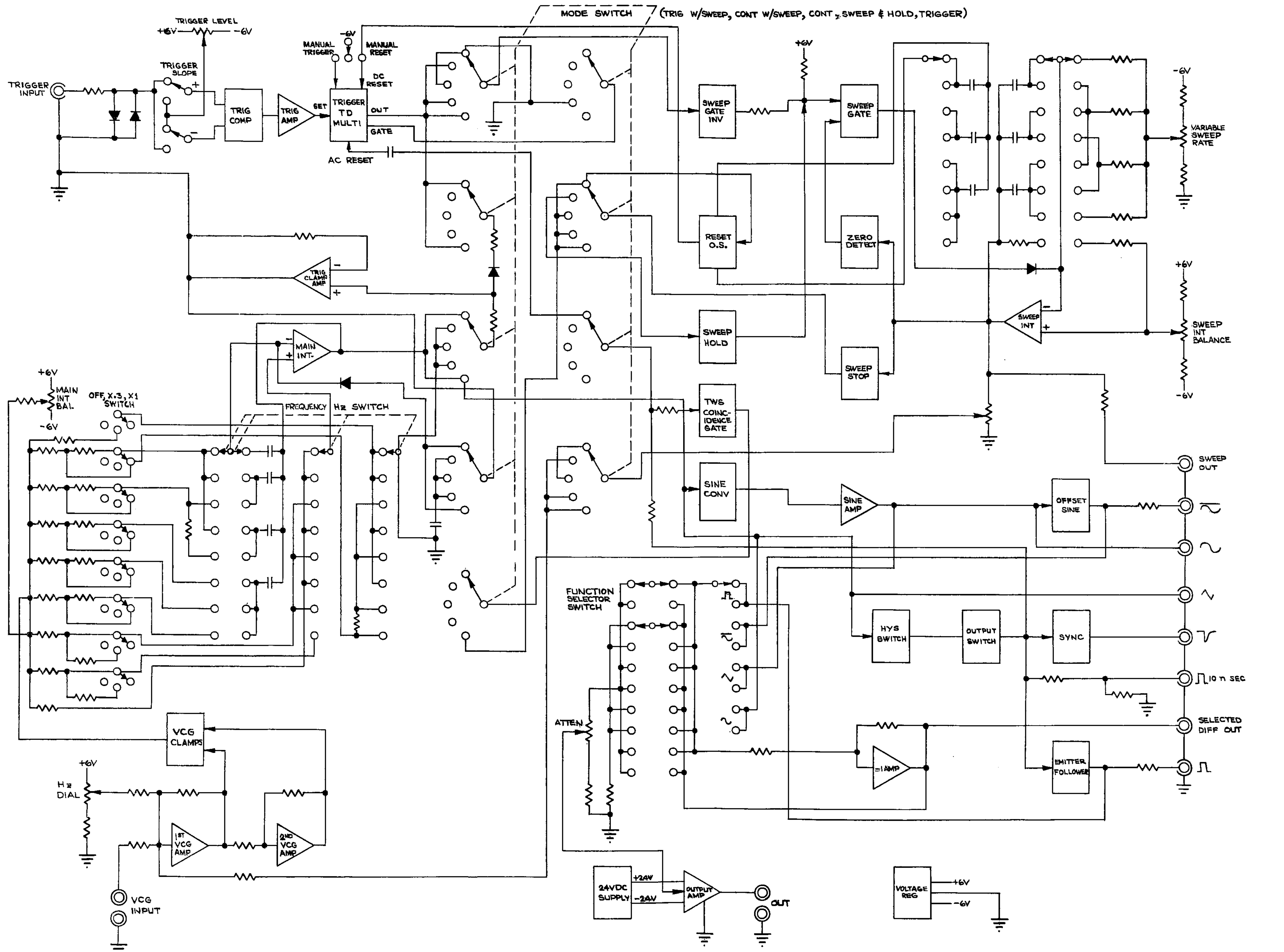
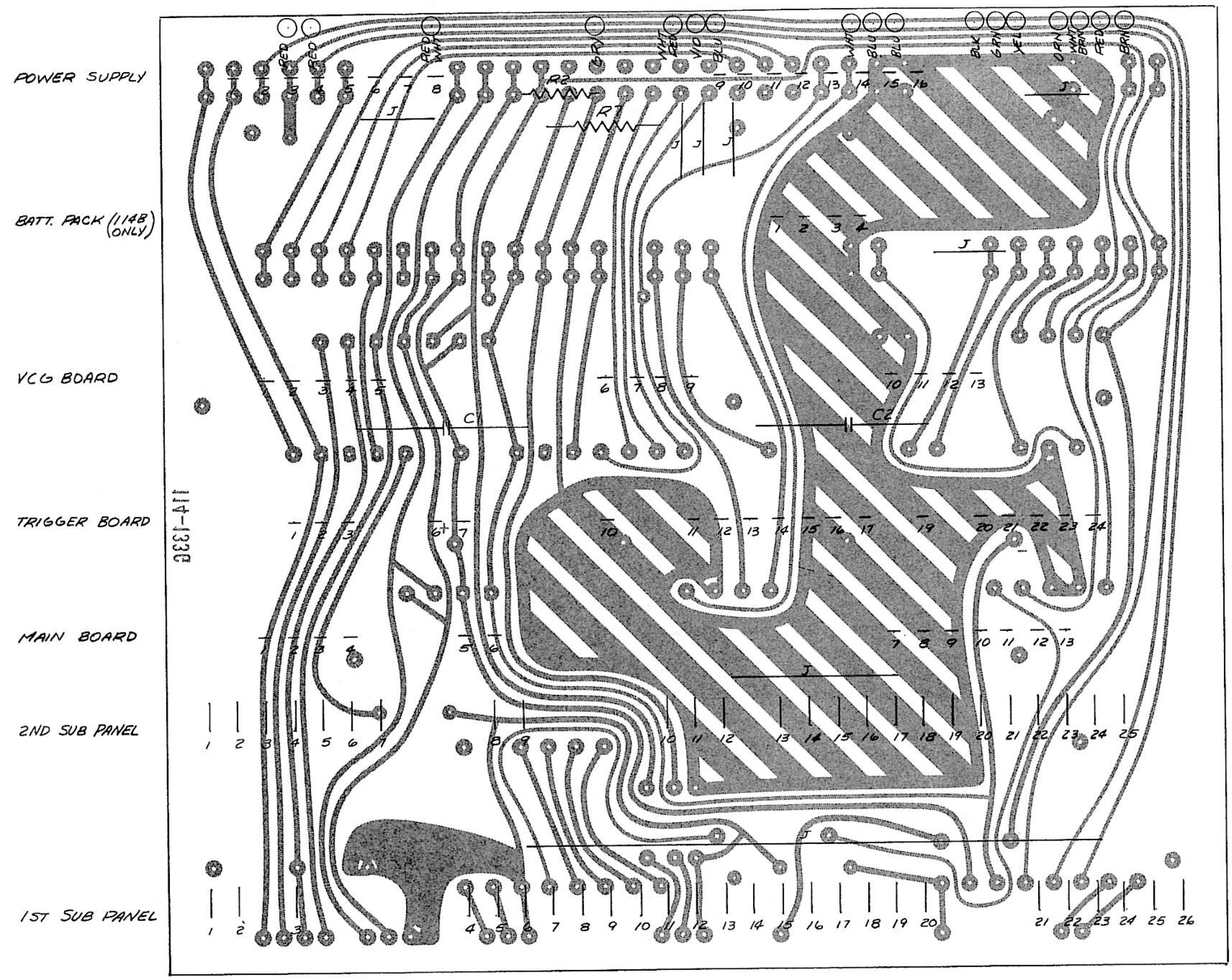


tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale NONE	by L. ADAMSON	date 5/26/67	app. [signature]		
material N/A	title SWEEP/TRIGGER VCG SWITCHING & LOGIC DIAGRAM				
finish N/A	model no. 114	dwg no. 114-600	rev A		



Mother Board Assembly (114-033)

NOTE:
1. PINS NUMBERED LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF BOARD.
② FOR "114B" MODELS USE JUMPER
3.(*) F1 & F2 ARE 1 AMP G.B. FOR 114B

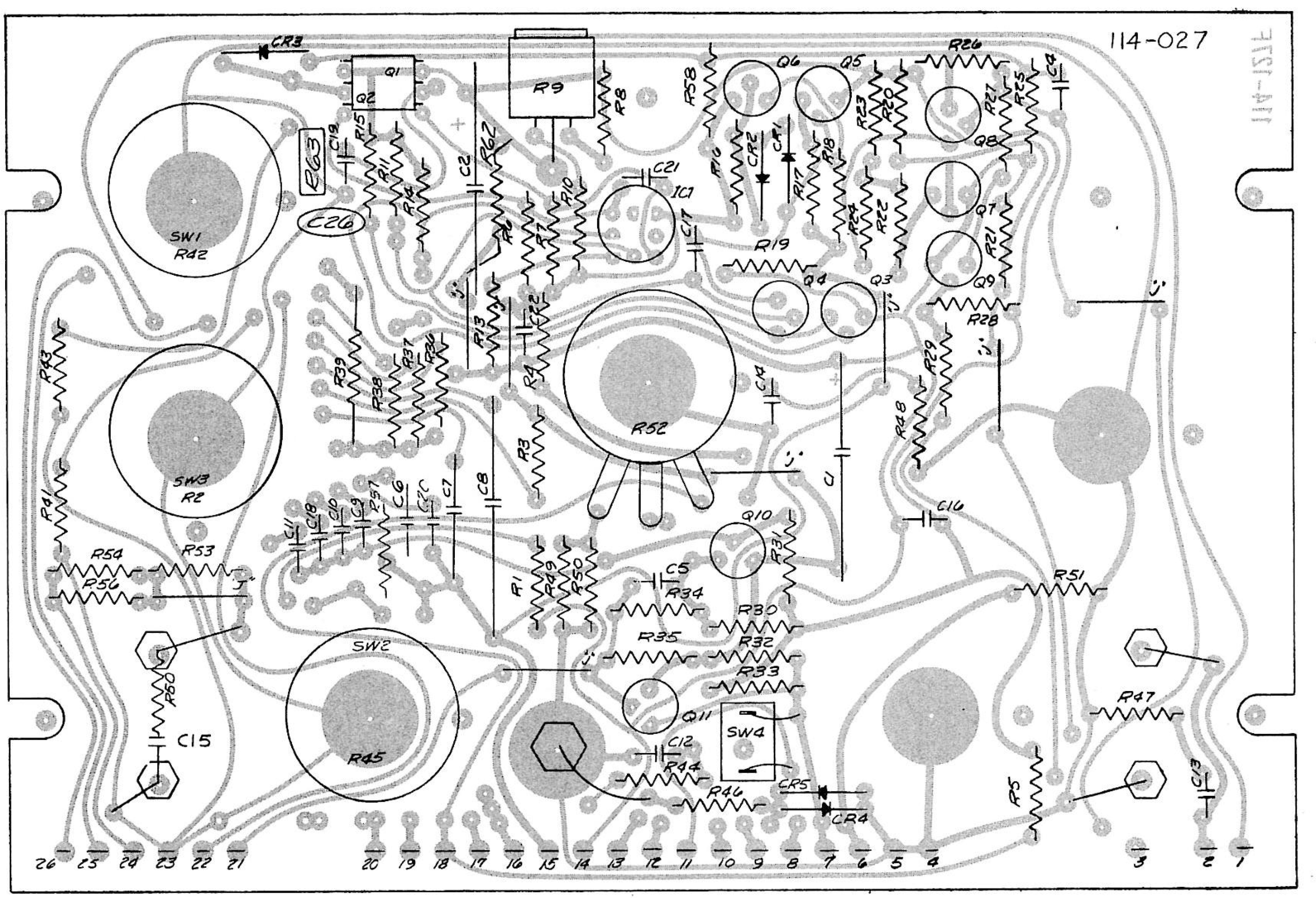
CHG	ECN NO.	BY	DATE	APP'D
H	ECN 291	[illegible]	1-6-70	
G	ECN #270	MB	11/3/68	
F	ECN #166	[illegible]	9/7/67	
E	ECN #167	EHH	9-5-67	
D	162	MB	8/1/67	
C	146	MEB	6-21-67	
B	128	PRM	3-16-67	
A	112 (WAS DWG 114-226)	JW	1-5-67	

WAVETEK SAN DIEGO, CALIF

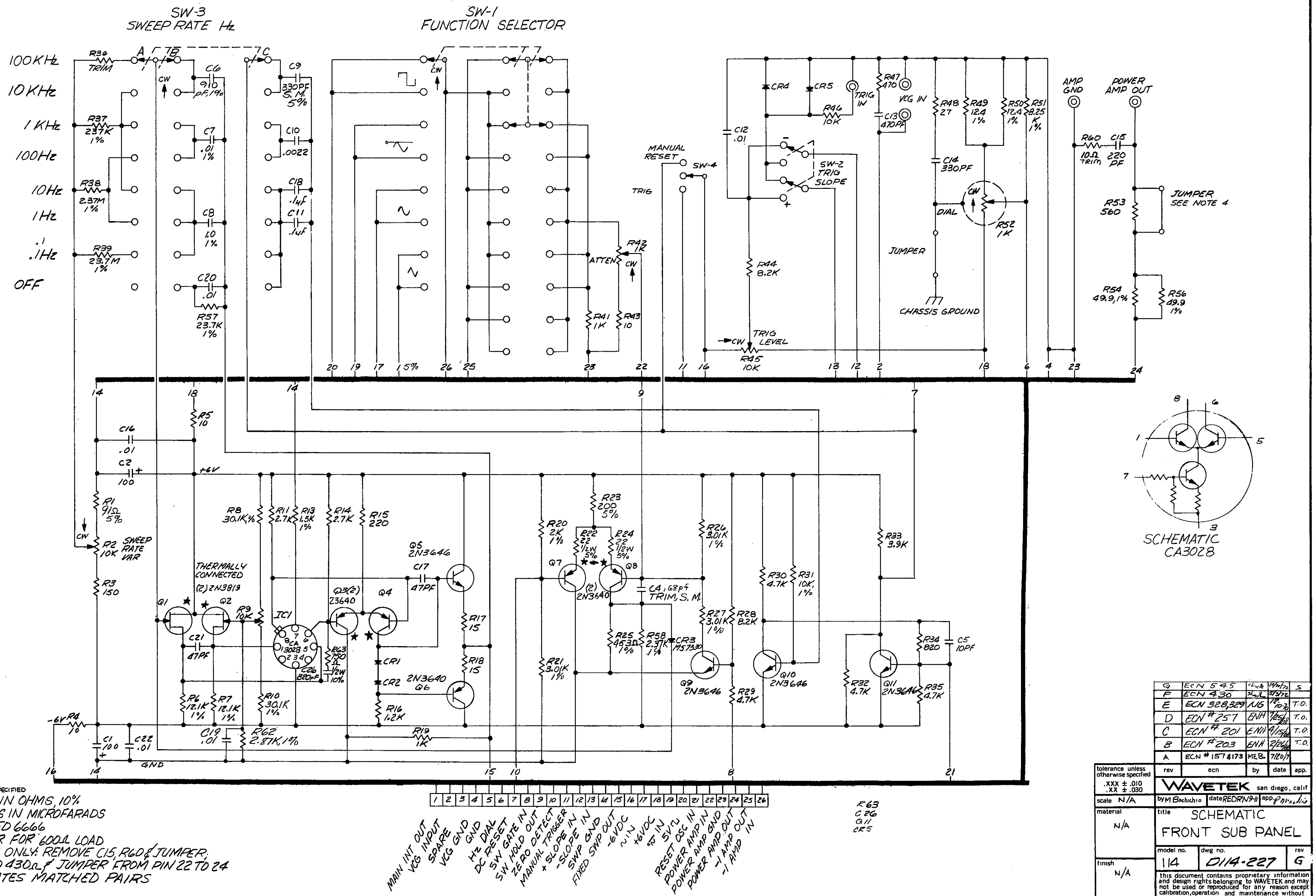
DWN: WHITELOCK DATE: 7-20-6 APP'D: P Markin

SCHEMATIC-
MOTHER BOARD

MODEL: 114 NO: 114-233H



Front Sub-Panel Assembly (114-042)



NOTES UNLESS OTHERWISE SPECIFIED

1 RESISTANCE IS IN OHMS, 10%
2 CAPACITANCE IS IN MICROFARADS
3 DIODES ARE FD 6666
4 REMOVE JUMPER FOR 600Ω LOAD
5 FOR MODEL 114B ONLY: REMOVE C15, R60 & JUMPER; CHANGE R53 TO 430Ω & JUMPER FROM PIN 22 TO 24
6 ★←→★ INDICATES MATCHED PAIRS

rev	ecn	by	date	app.
G	ECN 545		11/4/72	S
F	ECN 430		5/3/72	
E	ECN 328,329	NG	12/10/70	T.O.
D	ECN #257	ENH	7/25/69	T.O.
C	ECN #201	ENH	4/15/69	T.O.
B	ECN #203	ENH	2/26/69	T.O.
A	ECN #157 &173	M.E.B.	7/20/68	

tolerance unless otherwise specified .XXX ± .010 .XX ± .030

scale N/A

material N/A

finish N/A

WAVETEK san diego, calif

by M Bochichio | date REDRN 9-11 | app.

title SCHEMATIC FRONT SUB PANEL

model no. 114 | dwg no. D114-227 | rev G

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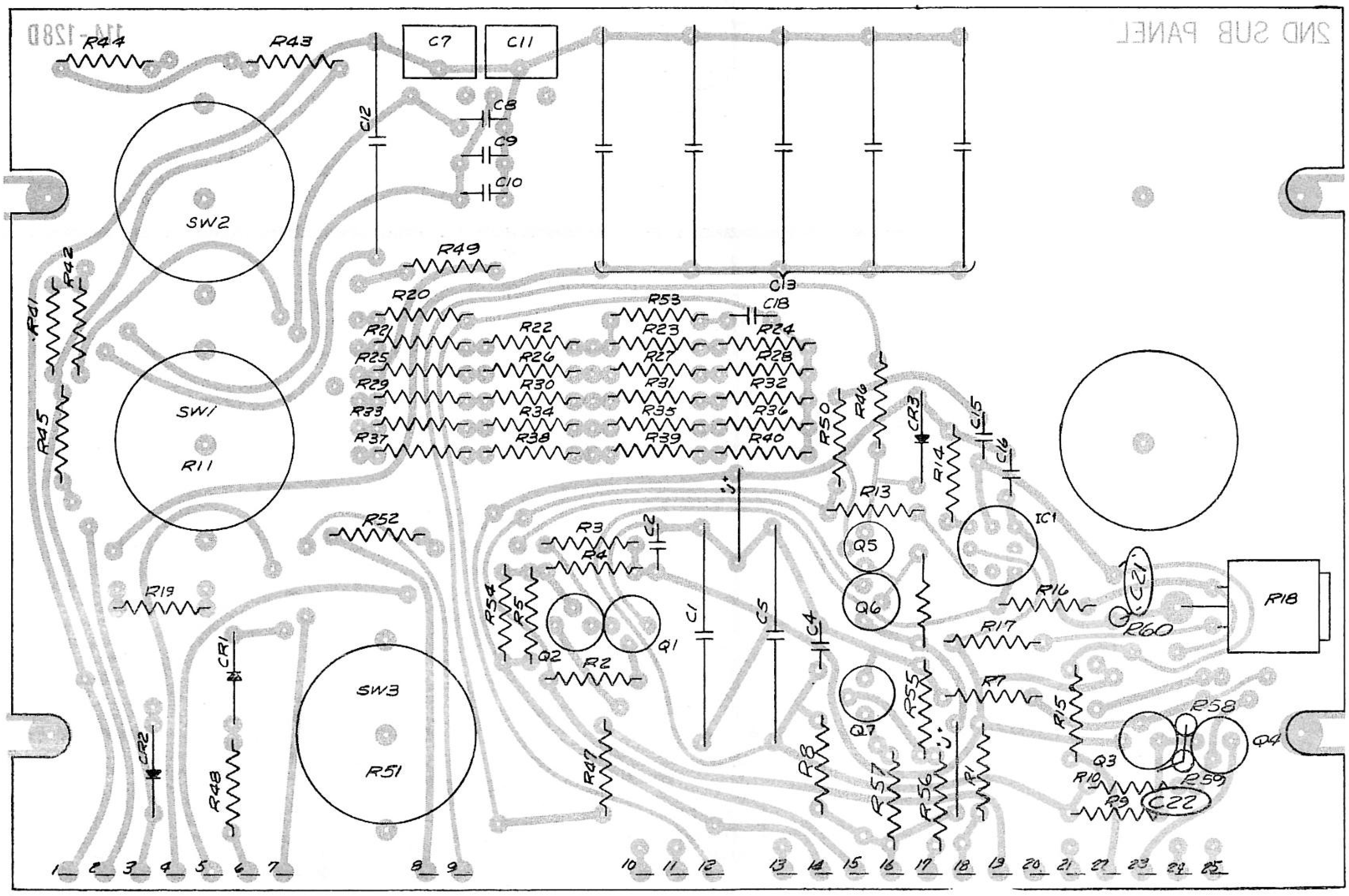
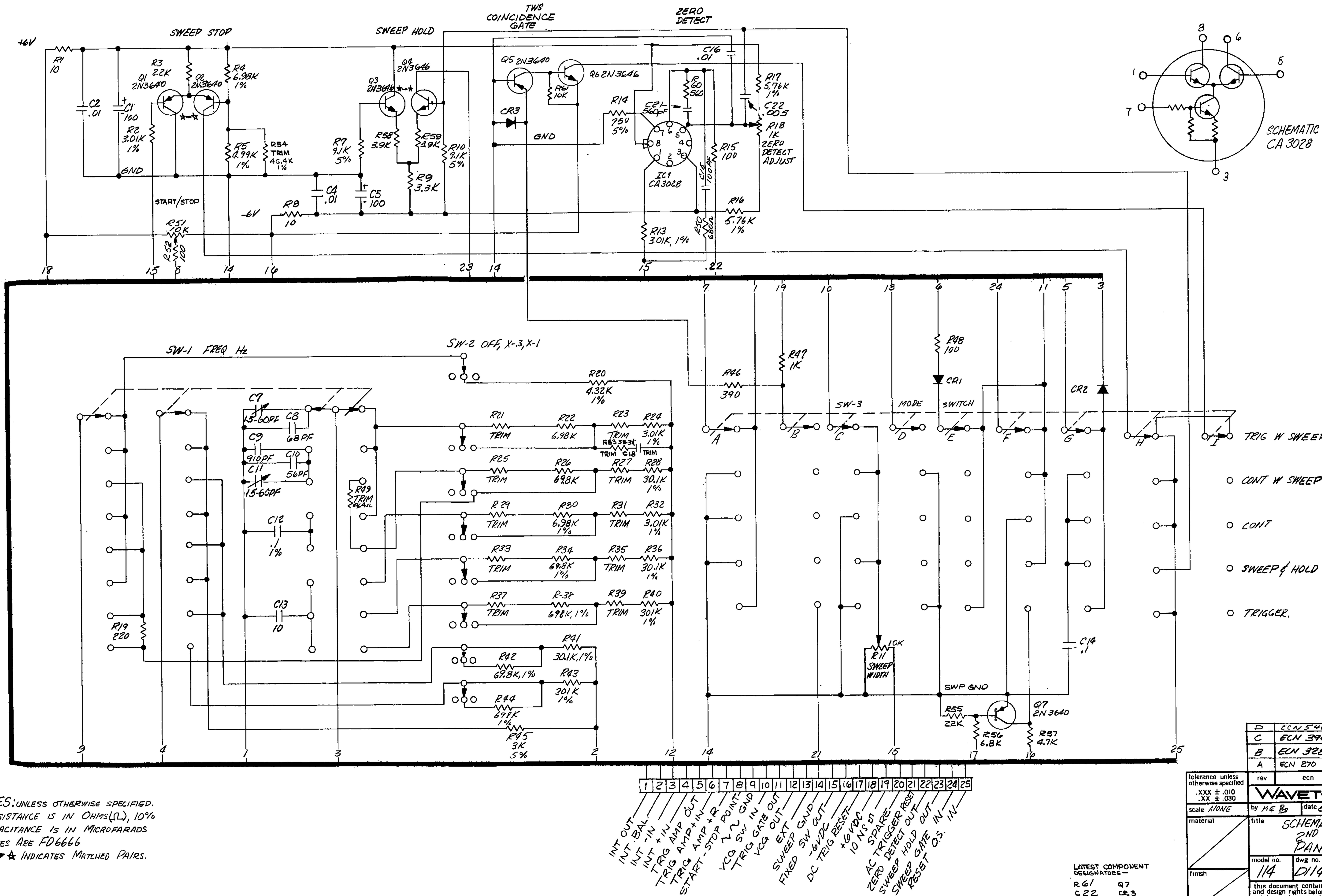


Second Sub-Panel Assembly (114-043)



NOTES: UNLESS OTHERWISE SPECIFIED.
1. RESISTANCE IS IN OHMS(Ω), 10%
2. CAPACITANCE IS IN MICROFARADS
3. DIODES ARE FD6666
4. ★ ↔ ★ INDICATES MATCHED PAIRS.

LATEST COMPONENT DESIGNATORS —
R61 Q7
C22 CR3
IC1

rev	ecn	by	date	app.
D	ECN 546		11/22/72	S
C	ECN 396	Bo	12-2871	
B	ECN 328	AG	11-16-70	T.O.
A	ECN 270	Bo		T.O.

tolerance unless otherwise specified .XXX ± .010 .XX ± .030
scale NONE
material
finish

WAVETEK san diego, calif
by ME Bo date 5-2867 app.
title SCHEMATIC DIAGRAM— 2ND. SUB PANEL
model no. 114 dwg no. D114-228 rev D

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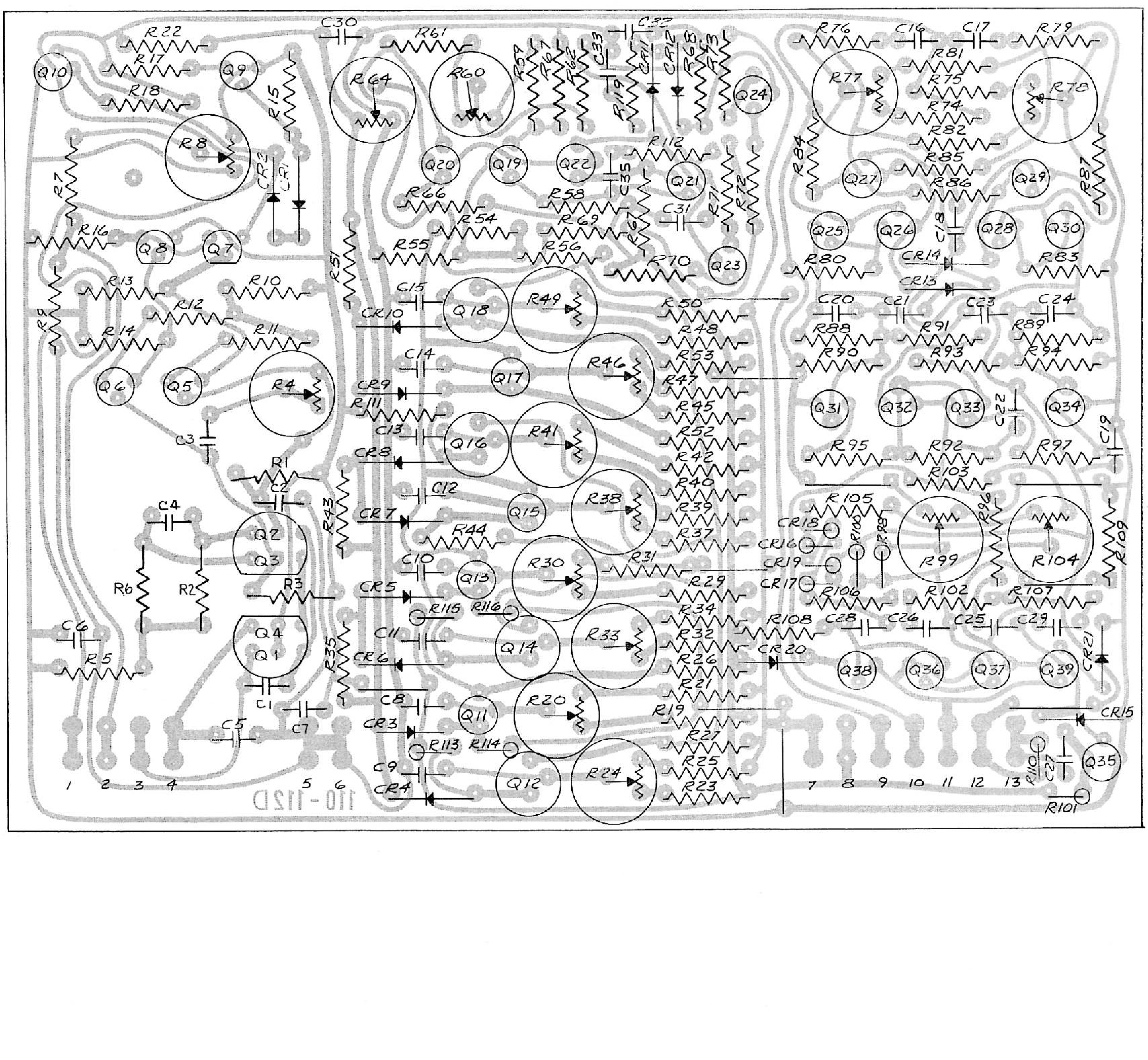


Main Board Assembly (110-012)

NOTE

UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE IN OHMS, ±10%
2. CAPACITANCE IN MICROFARADS, ±10%
3. DIODES ARE FAIRCHILD FD6666
4. PINS ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD
5. * MATCHED PAIR - MATCHED FOR β AND V_{BE}
6. ALL DIFFERENTIAL PAIRS MATCHED FOR 10% β MATCH
7. GMV; GUARANTEED MINIMUM VALUE
8. Δ INDICATES THERMALLY CONNECTED PAIRS
9. * FOR MODEL 110 USE 220PF, MODEL 113 USE 150 PF, ALL OTHERS USE 100PF.

1 R119
2 C36
3 CR21
4 Q39

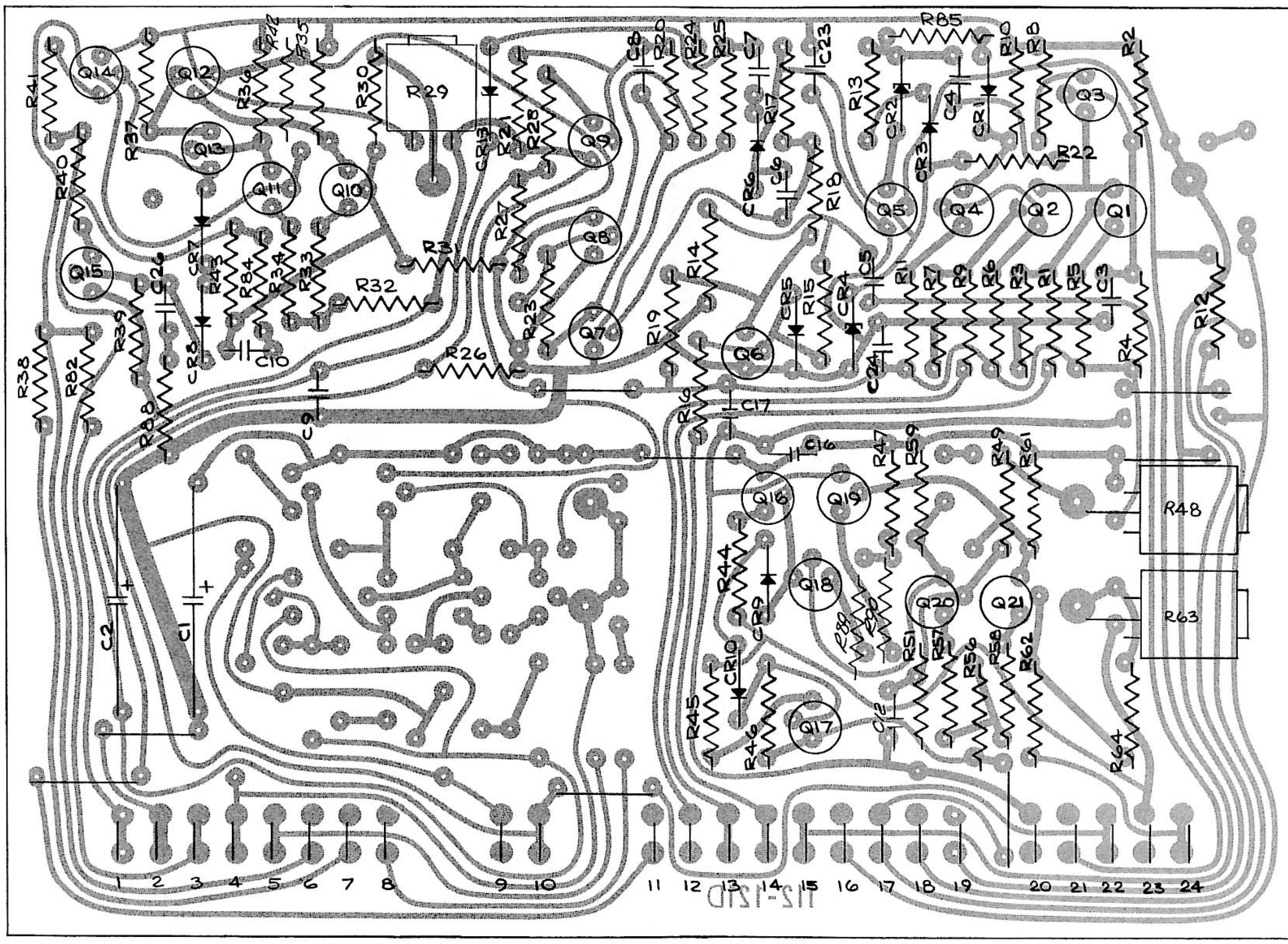
CHG	ECN NO	BY	DATE	APP
K	ECN #475	JH	9-25-72	
J	ECN #258	ENH	9/6/68	TD
H	ECN #242	ENH	5/7/68	T.O.
G	ECN #197	ENH	12-11-67	T.O.
F	ECN #175	ENH	10-4-67	T.O.
E	ECN #160	MEB	7-26-67	T.O.
D	ECN #150	ENH	6-30-67	T.O.
C	ECN #147	MEB	6-21-67	T.O.
B	ECN #126	JW	3-27-67	AP
A	ECN #94 (WAS DWG # 110-202)	JW	12-12-66	T.O.

WAVETEK SAN DIEGO, CALIF

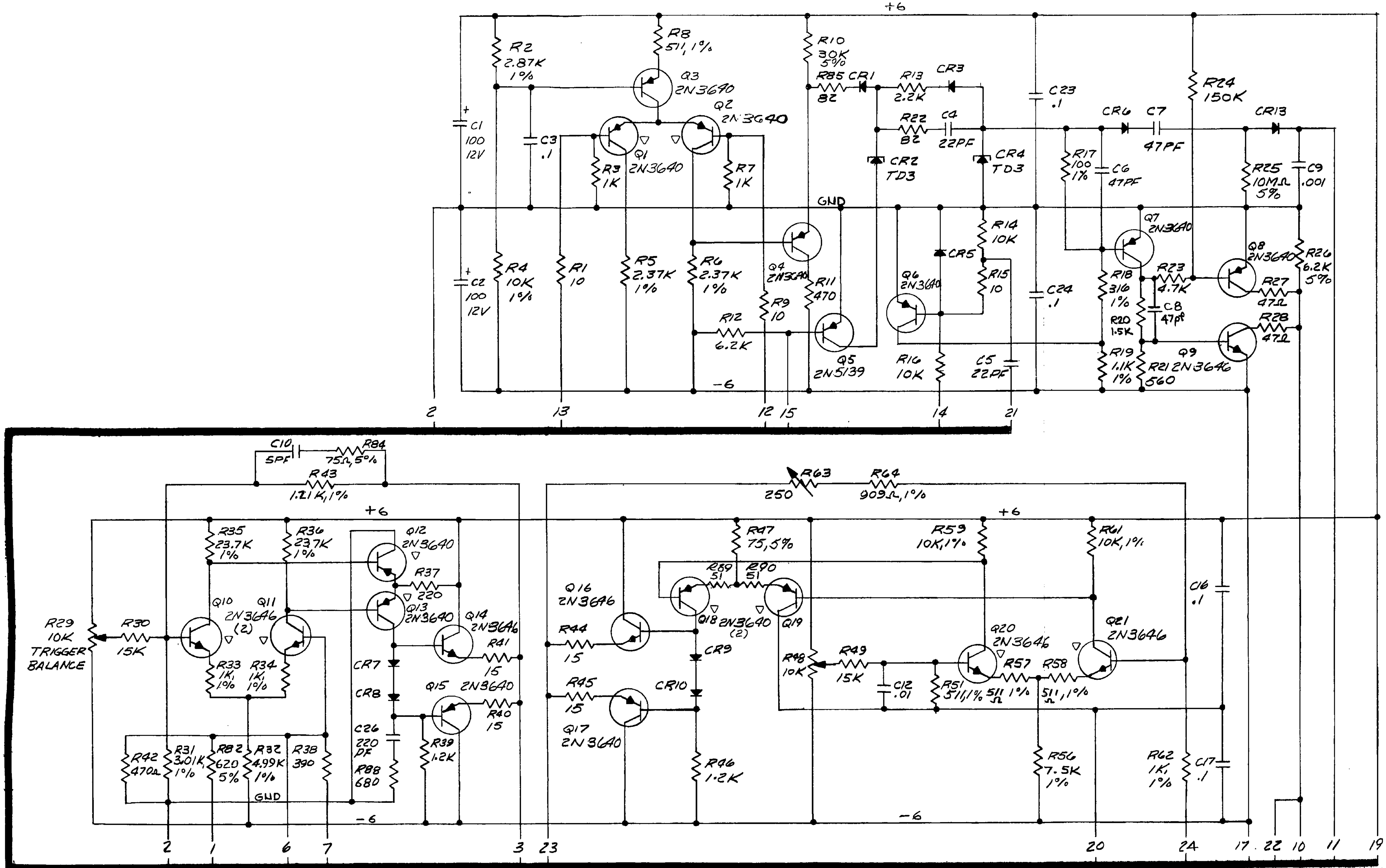
DRN PA Marsh DATE 1-14-66 APP P Marki

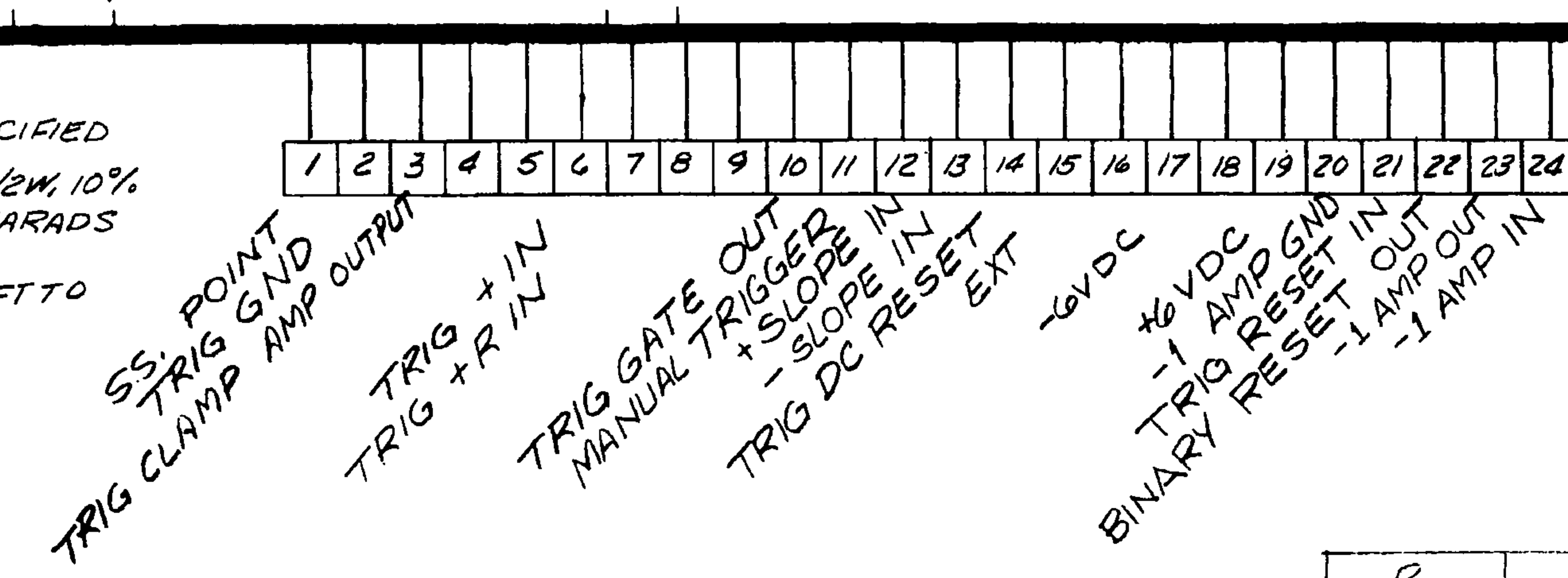
MAINBOARD SCHEMATIC

MODEL 110, 110B, 111, 111B, 112, 112B, 115, 115B, 113 NO. D110-212 K



Trigger Board Assembly (114-021)





NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE IN OHMS, 1/2W, 10%
2. ALL CAPACITANCE IS IN MICROFARADS
3. ALL DIODES ARE FD 6666
4. PINS ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM THE COMPONENT SIDE OF THE CIRCUIT BOARD
5. ▽ INDICATES MATCHED PAIRS

1. R90
2. C26
3. CR13
4. Q21

REV	ECN	BY	APP
B	# 207	ENH	

rev	ecn	by	date	app.
A	165, 166, 170		8/1/67	

tolerance unless otherwise specified: .XXX ± .010, .XX ± .030

WAVETEK san diego, calif

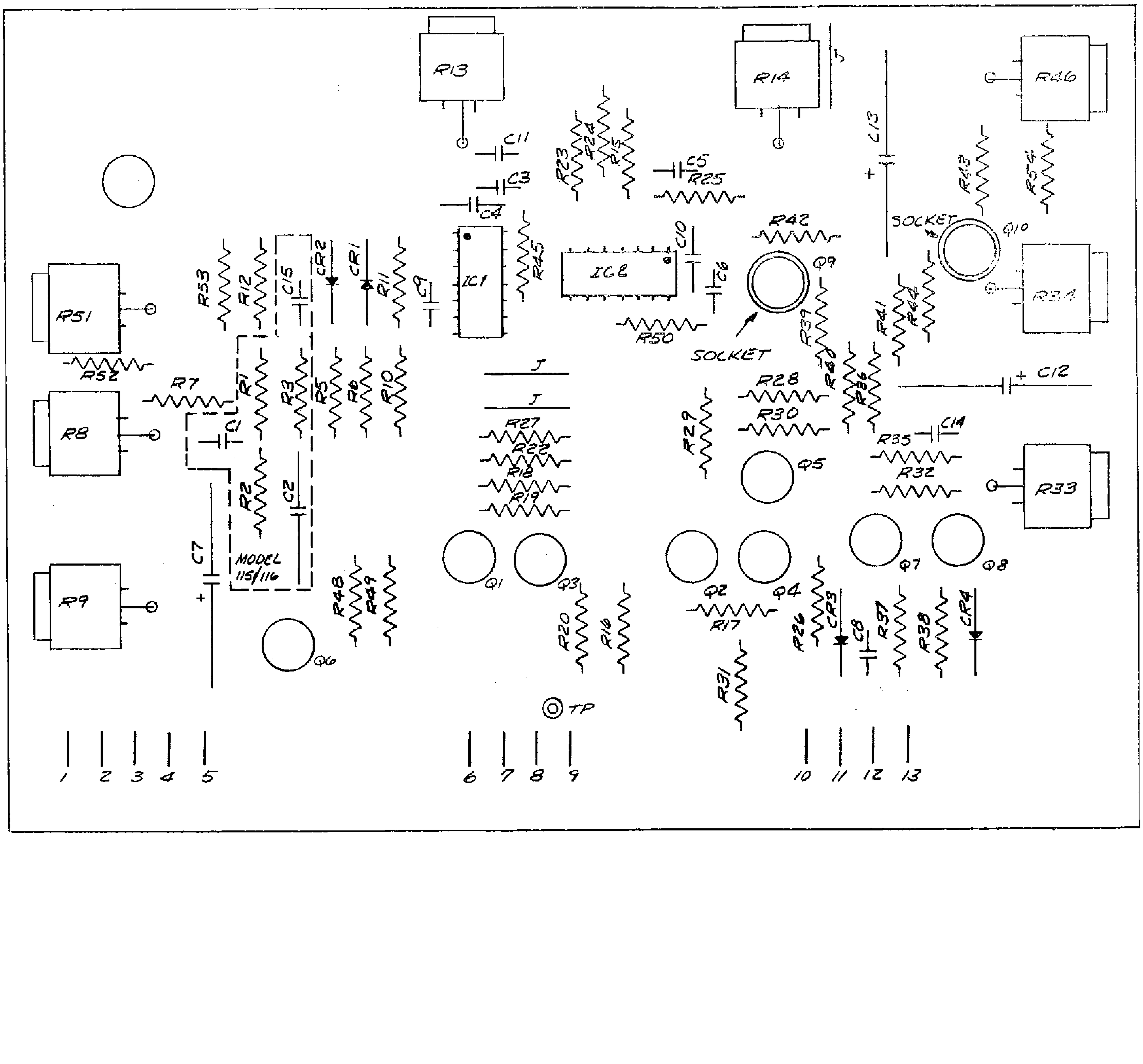
scale N/A | by M E B. | date 7/17/67 | app.

material N/A

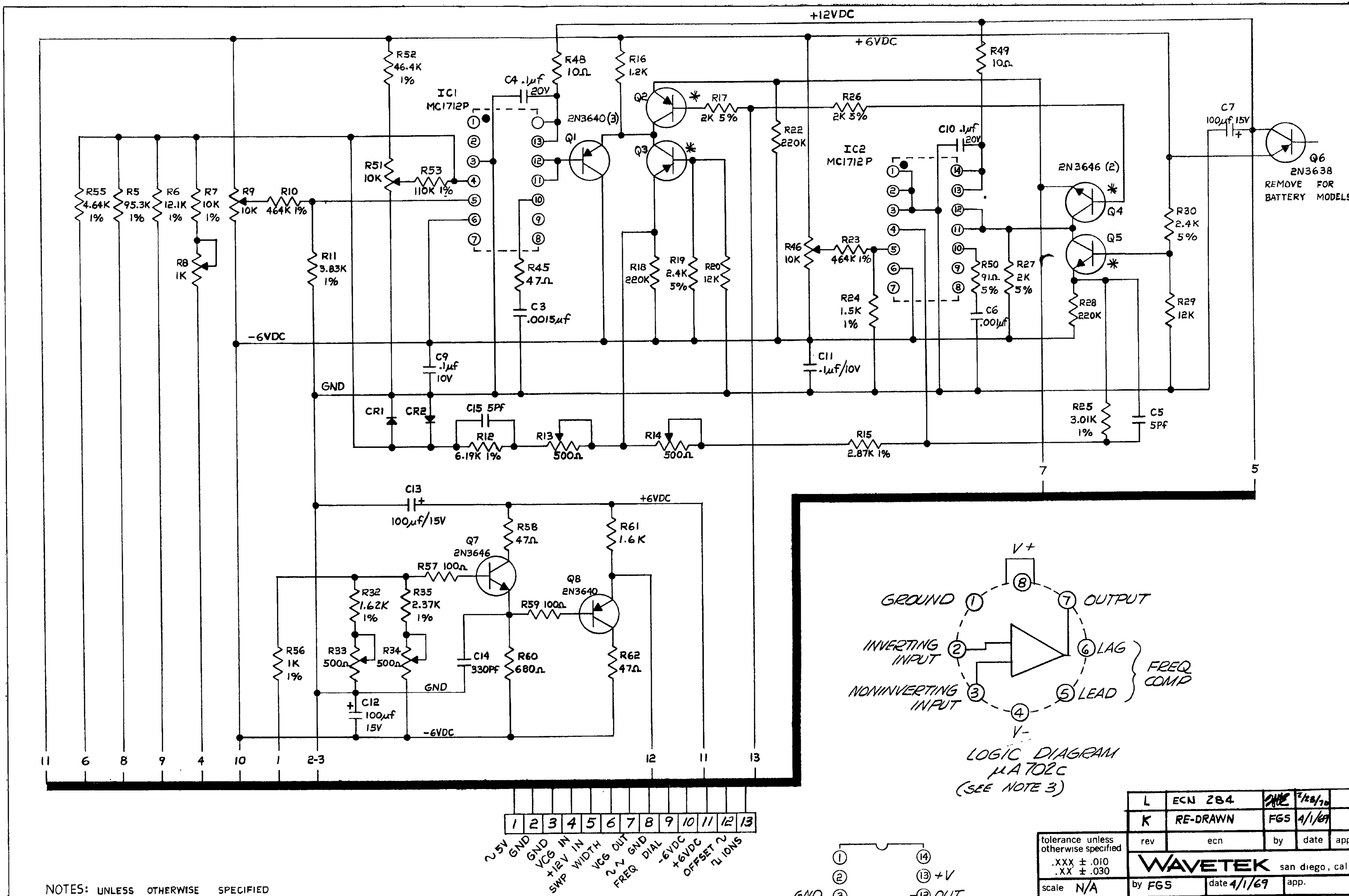
finish N/A

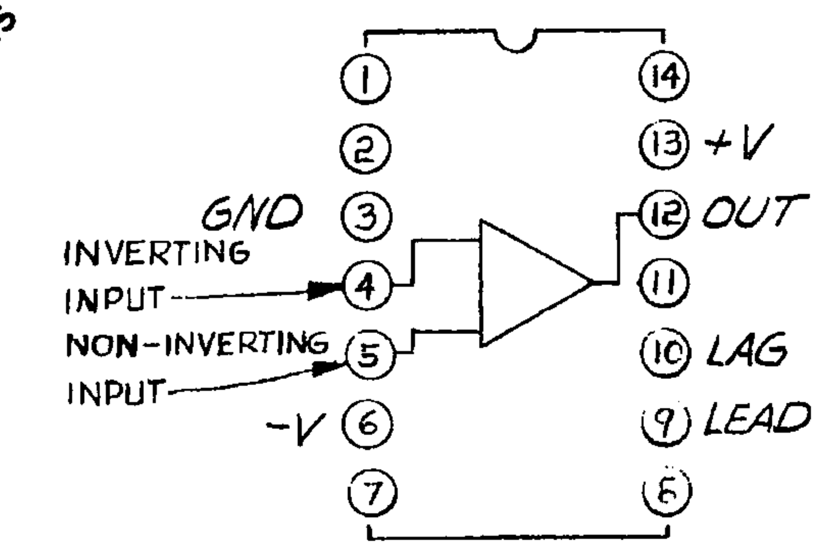
title: SCHEMATIC, TRIGGER BD

model no. 114 | dwg no. C114-221 | rev C



VCG Board Assembly (111-018)





LOGIC DIAGRAM MC1712P

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIODES ARE FD6666
2. * INDICATES MATCHED AS INVERTED SWITCHES
3. µA702C MAY BE USED AS AN ALTERNATE FOR MC1712P

rev	ecn	by	date	app.
L	ECN 284	[illegible]	7/28/70	
K	RE-DRAWN	FGS	4/1/69	

tolerance unless otherwise specified .XXX ± .010 .XX ± .030

scale N/A

material N/A

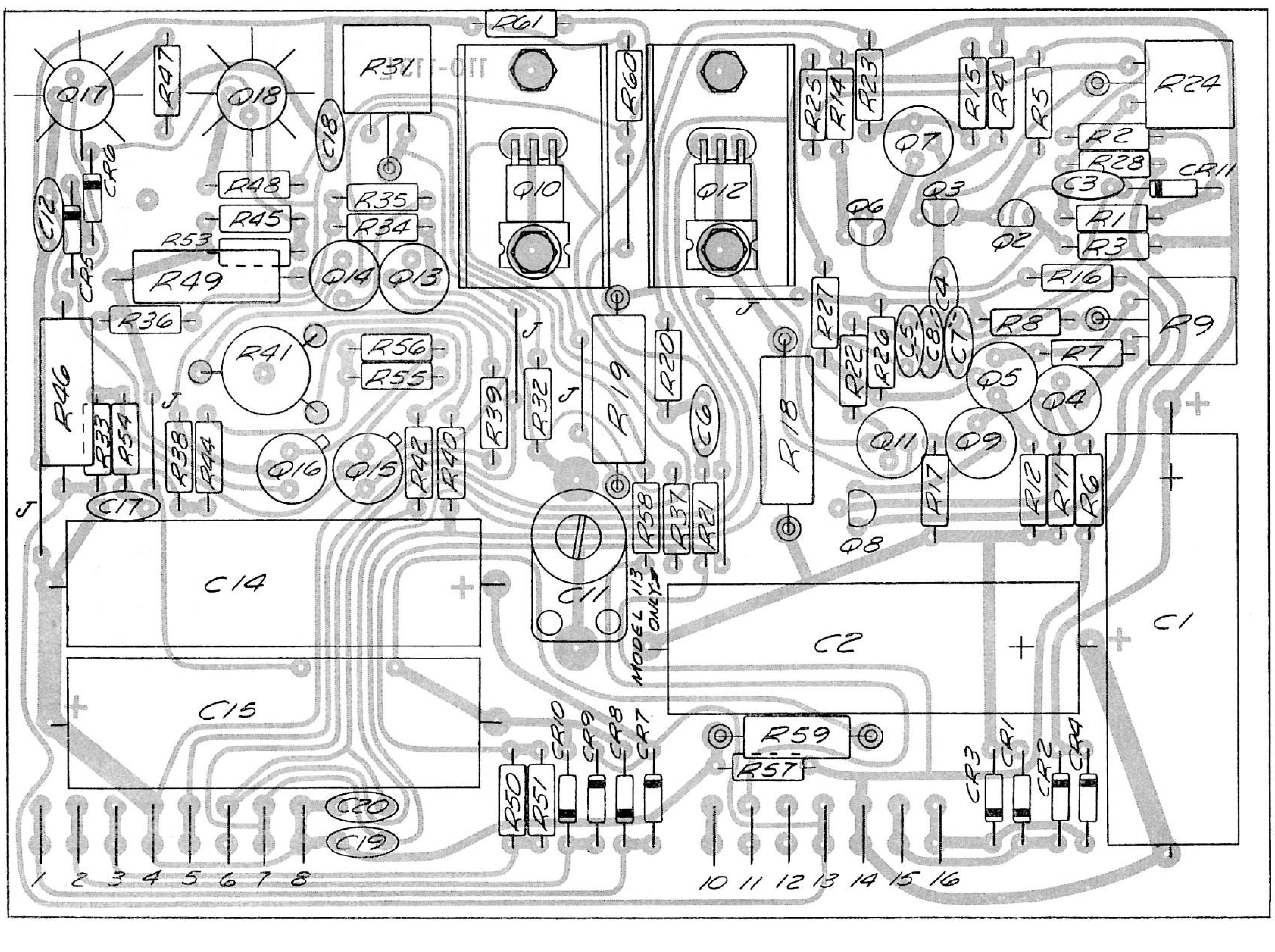
finish N/A

WAVETEK san diego, calif

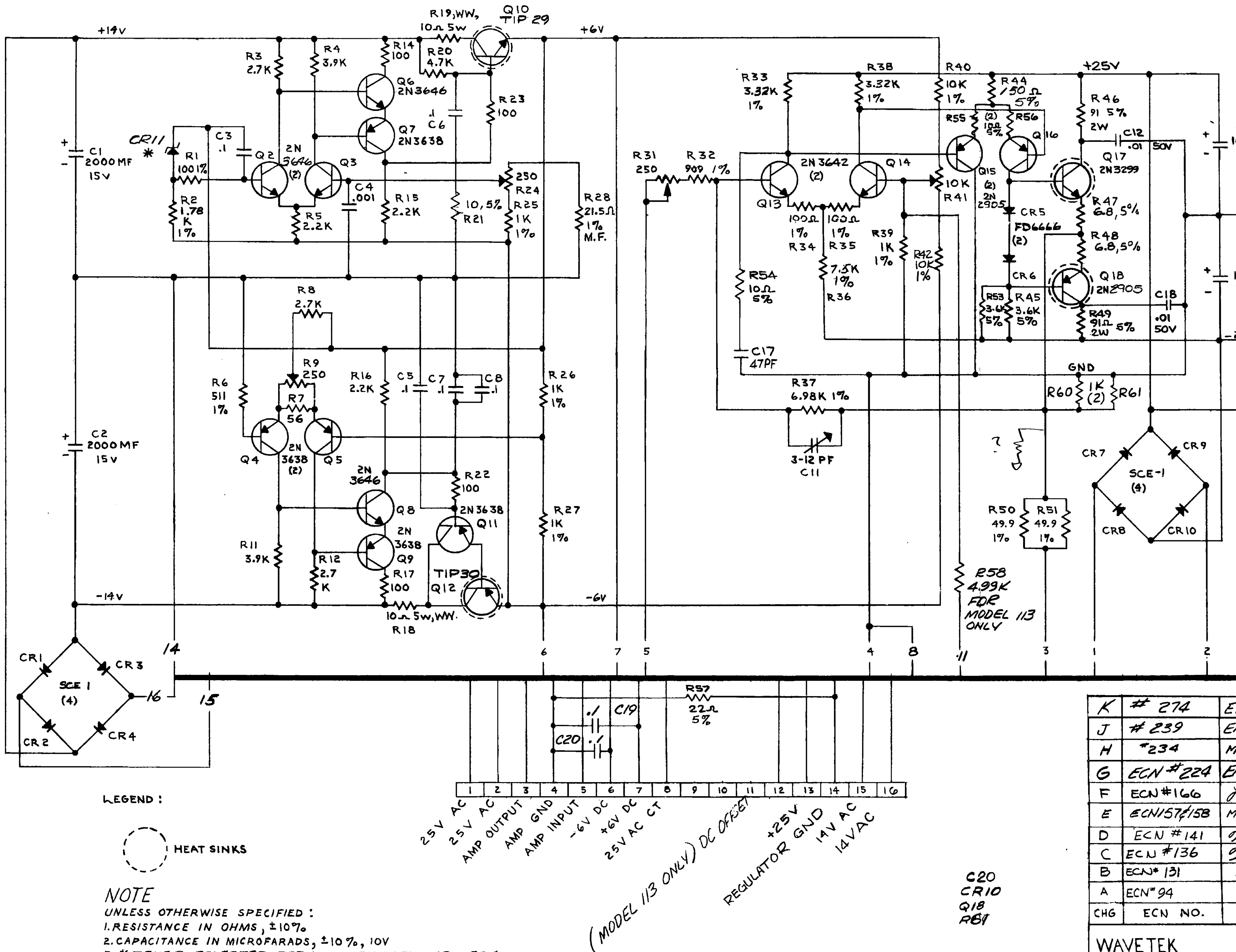
by FGS date 4/1/69 app.

title VCG SCHEMATIC

model no. 114 dwg no. 114-218 rev L



Power Supply and Output Amplifier Assembly (110-013)



C20
CR10
Q18
RET

NOTE
UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE IN OHMS, ±10%
2. CAPACITANCE IN MICROFARADS, ±10%, 10V
3. * ZENER SELECTED PER WAVETEK SPEC. 130-506
4. PINS ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD
5. ALL DIFFERENTIAL PAIRS MATCHED FOR 10% β MATCH

CHG	ECN NO.	BY	DATE	APP
K	# 274	ENH	1/27/69	T.O
J	# 239	ENH	4/29/68	T.O.
H	#234	MB	4/8/68	T.O.
G	ECN #224	ENH	3-8-68	T.O.
F	ECN #166	[illegible]	9/18/67	T.O
E	ECN157/158	MB	7/20/67	T.O.
D	ECN #141	[illegible]	5-18-67	[illegible]
C	ECN #136	[illegible]	5-1-67	[illegible]
B	ECN# 131	JW	3-31-67	[illegible]
A	ECN# 94	JW	12-12-66	[illegible]

CHG	ECN NO.	BY	DATE	APP
P	ECN 398	[illegible]	1/19/72	
N	ECN 339	TRQ	3/18/71	T.O
M	ECN 279	[illegible]	7/30/69	T.O
L	CORRECTED ERRORS	FGS	2/25/69	T.O

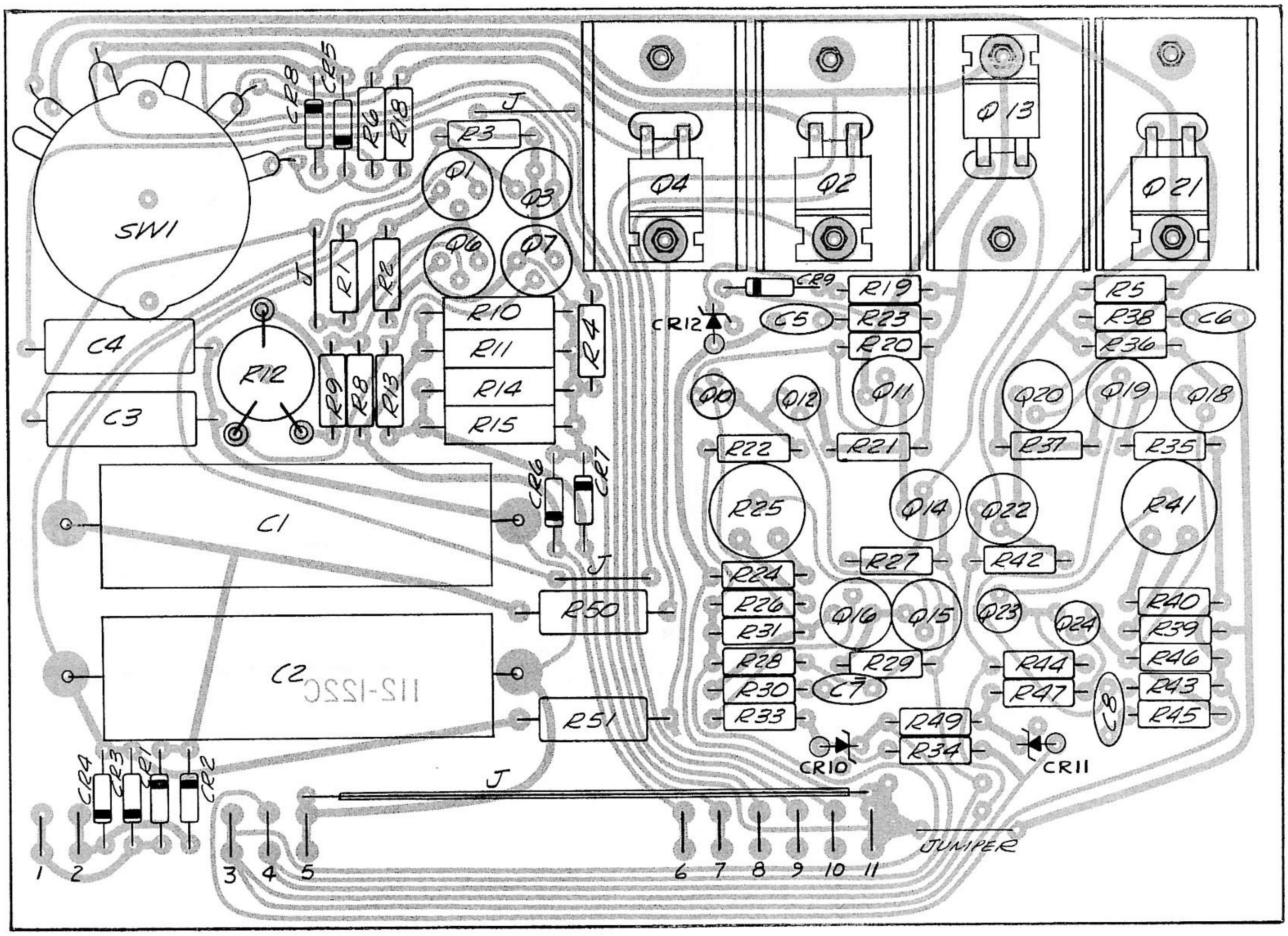
WAVETEK SAN DIEGO CALIF

DRN PA Marsh DATE 1-21-66 APP P. Marks

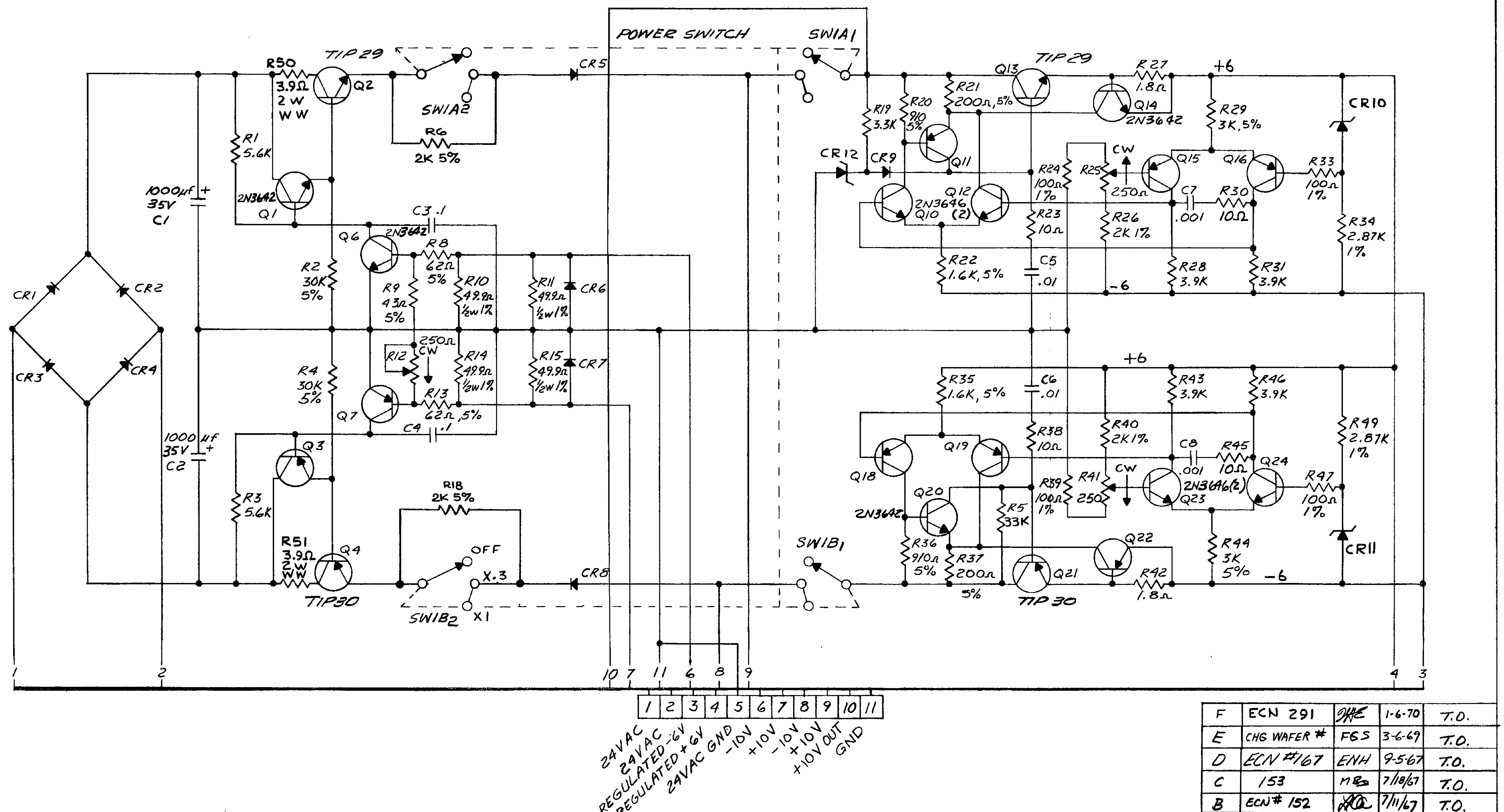
POWER SUPPLY AND OUTPUT AMP

MODEL 110 THRU 116

NO. C110-213 P



Battery Regulator Assembly (112-022)



NOTE: UNLESS OTHERWISE SPECIFIED

1. ALL TRANSISTORS ARE 2N3638
2. ALL RESISTANCE IN OHMS, 1/2W, 10%
3. CAPACITANCE IN MICROFARADS
4. DIODES ARE SCE-1's.
5. PINS NUMBERED LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF BOARD.
6. ALL DIFFERENTIAL PAIRS ARE MATCHED FOR β
7. ZENER DIODES SELECTED PER WAVETEK SPEC 130-506 (CR9, 10, 11)
8. TRANSISTORS 2N3740 AND 40250 ARE INTERCHANGABLE ALTERNATES WITH TIP 29 AND TIP30 RESPECTIVELY

LATEST COMP DESIGNATOR
R51
C8
CR12
Q25

CHANGE	ECN NO.	BY	DATE	APP'D
F	ECN 291	[illegible]	1-6-70	T.O.
E	CHG WAFER #	FGS	3-6-69	T.O.
D	ECN #167	ENH	9-5-67	T.O.
C	153	[illegible]	7/18/67	T.O.
B	ECN # 152	[illegible]	7/11/67	T.O.
A	94 (WAS DWG 112B-105)	JW	1-5-67	T.O.

WAVETEK SAN DIEGO, CALIF

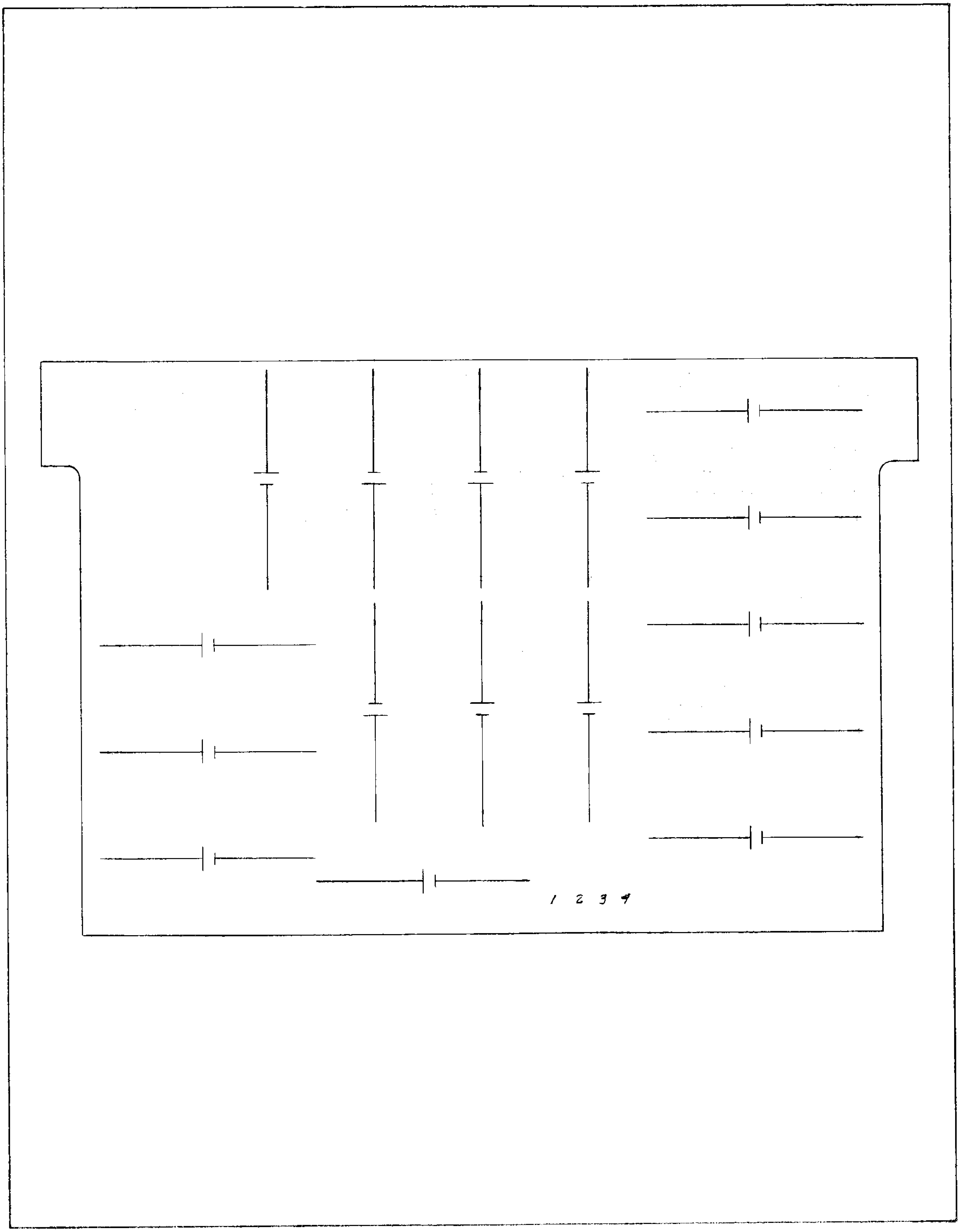
DRN PA Marsh DATE 7-21-66 APP P. Mackie

BATTERY REGULATOR BD

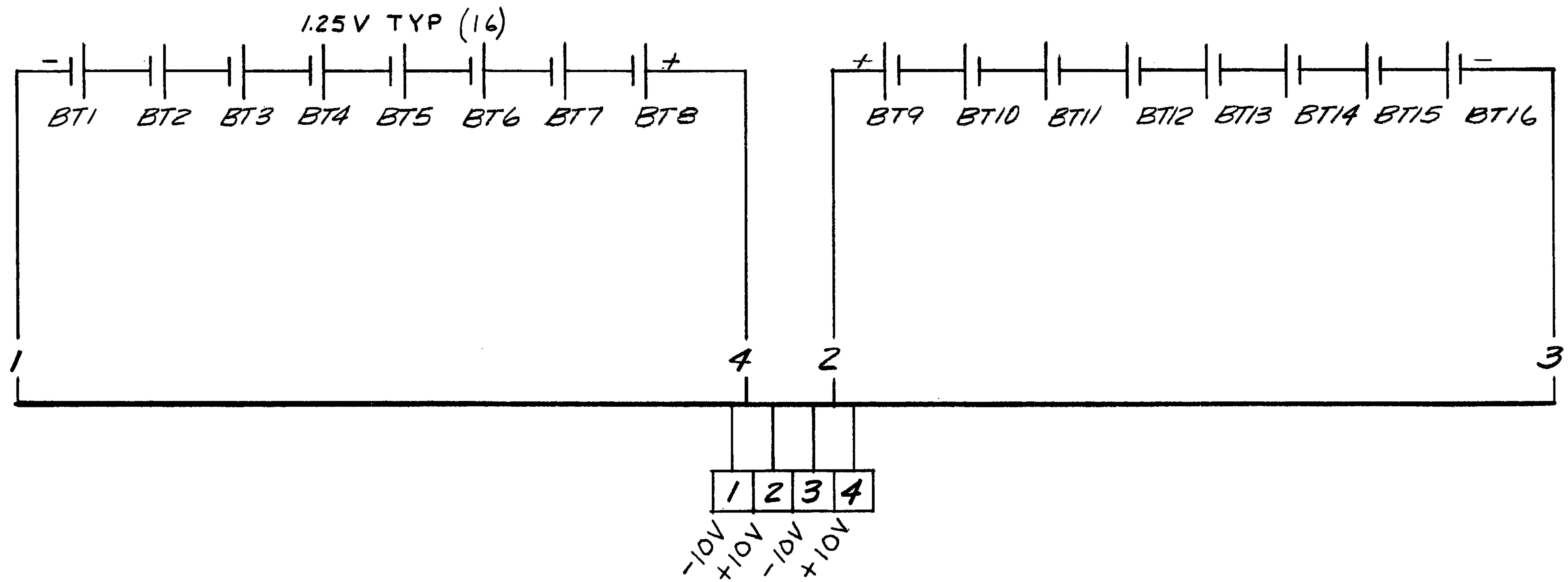
CHG	ECN NO.	BY	DATE	APP'D
H	ECN 428	[illegible]	5-3-72	
G	ECN 281	NG	12-16-70	T.O.

MODELS 110-116

NO C112-222H



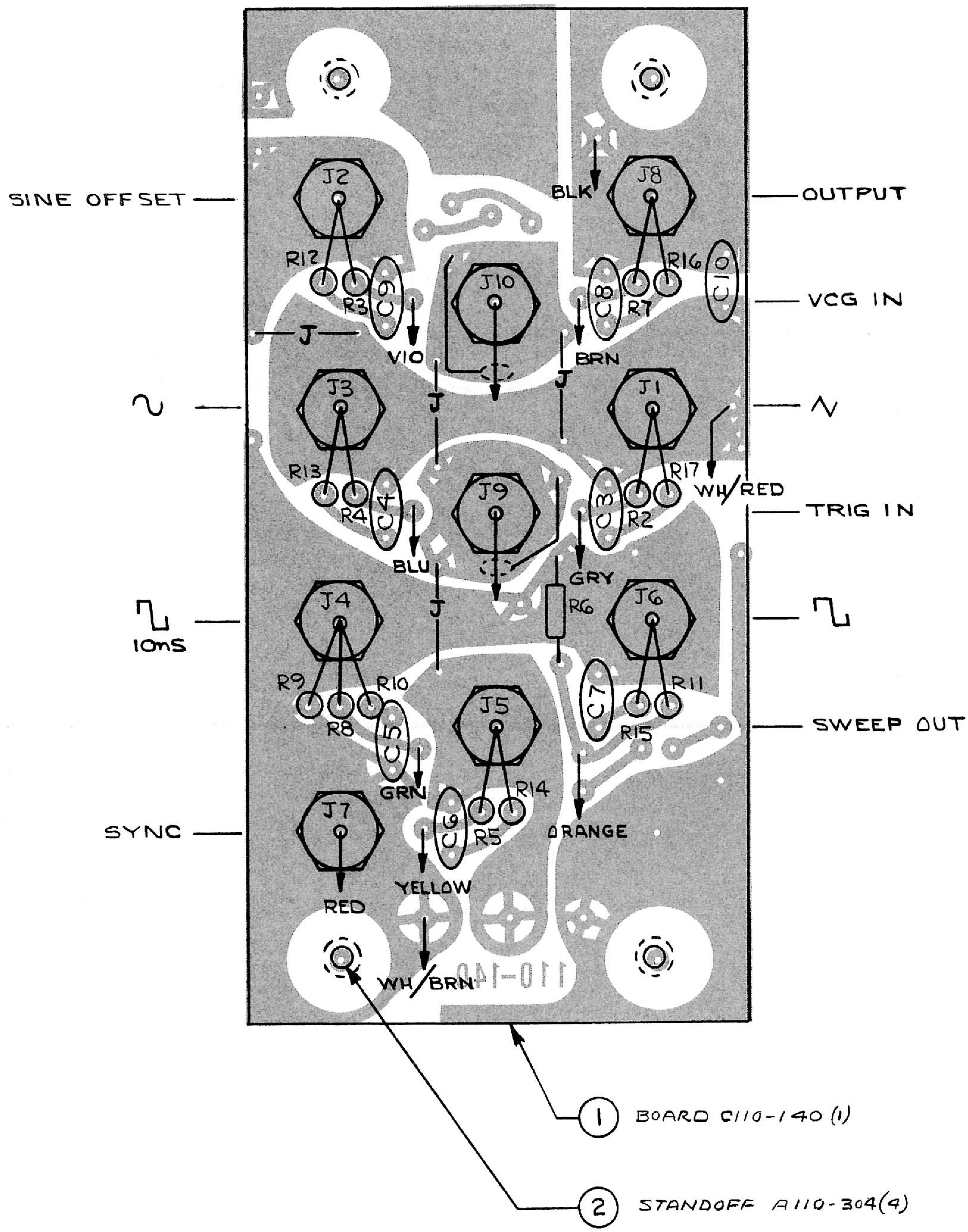
Battery Pack Assembly (112-023)



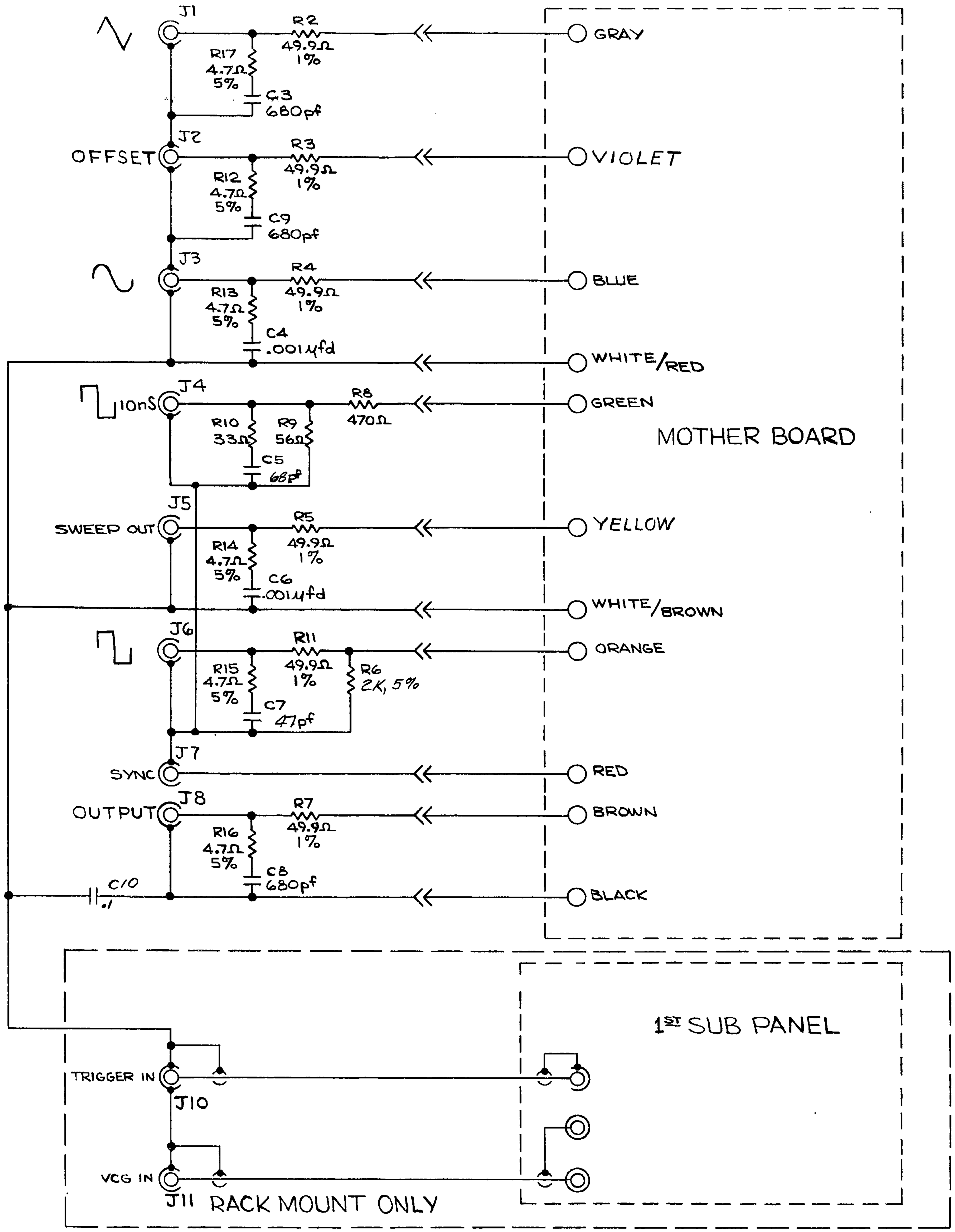
WAVETEK	SAN DIEGO, CALIF.
DWN: WHITELOCK DATE: 1-16-67	APP'D: P. Mackie

SCHEMATIC - BATTERY PACK

MODEL: 110-116 NO. B112-223



Rear Connector Board Assembly (114-040)



rev	ecn	by	date	app.

tolerance unless otherwise specified .XXX ± .010 .XX ± .030	WAVETEK san diego, calif
scale N/A	by L. ADAMSON date 9/7/67 app. [signature]
material N/A	title CONNECTOR MOUNTING BOARD (SCHEMATIC)
	model no. 114 dwg no. C114-240 rev
finish N/A	this document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, operation and maintenance without written authorization.

SECTION VI
PARTS LIST

GENERAL

This section contains a list of replaceable electronic parts and assemblies in the equipment; structural items and hardware such as screws and nuts are not included.

PARTS LIST ARRANGEMENT

The Parts List is arranged in the same sequence as the drawings in Section V.

LIST OF MANUFACTURERS

The following list of manufacturers should be used in conjunction with the "MFGR" column on the Parts List.

A/B	Allen Bradley, Milwaukee, Wisconsin
Accurate	Accurate Rubber, San Diego, Calif.
AMP	AMP Inc., Harrisburg, Penn.
A-R	American Radionics, Inc., Danbury, Conn.
ARCO	ARCO Electronics, Great Neck, L.I., N.Y.
CDE	Cornell Dubilier, Newark, New Jersey
Corning	Corning Glass Works, Bradford, Penn.
CRL	Centralab, Milwaukee, Wisconsin
ELCO	ELCO Corp., Willo Grove, Penn.
Erie	Erie Technological Products Inc., Erie, Penn.
Fair	Fairchild Semiconductor Corp., Palo Alto, Calif.
GE	General Electric Co., Semiconductor Products Div., Buffalo, N.Y.
Gould National	Gould Marathon Battery Co., St. Paul, Minnesota
H.H.S.	Herman H. Smith, Inc., Brooklyn, N.Y.
IMB	IMB Electronics Products, Santa Fe Springs, Calif.
IRC	International Resistance Co., Philadelphia, Penn.
Johnson	E.F. Johnson Co., Waseca, Minnesota
King	King Electronics Inc., Tuckahoe, N.Y.
Motorola	Motorola Semiconductor Products, Phoenix, Arizona
Semtech	Semtech Corp., Newbury Park, Calif.
Sprague	Sprague Electric Co., North Adams, Massachusetts
Stack	Stackpole Carbon Co., St. Mary's, Penn.
TI	Texas Instruments Inc., Dallas, Texas
USECO	USECO Div., Litton Industries, Van Nuys, Calif.
Wavetek	Wavetek, San Diego, Calif.

RECOMMENDED SPARE PARTS LIST

Information is provided to maintain the instrument on a board or component level. Price and delivery information should be obtained from the Wavetek representative in your area or directly from the factory.

DESCRIPTION	MFG	PART NO.	QTY
Capacitor 16 V, 100 μF	SPRAGUE	500D107G016DC7	1
Capacitor 35 V, 1000 μF	SPRAGUE	39D108G035GL4	1
Capacitor 15 V, 1900 μF	SPRAGUE	39D198G015GL4	1
Diode	GE	1N3716	1
Diode	FAIRCHILD	FD6666	1
Diode	SEMTECH	SCE-1	1
Diode, Zener (Selected for 6.6 V)	DICKSON	DDT710210	1
Fuse 1/4 A, Slow Blow, 3 AG	LITTELFUSE	313-250	2
Fuse 3/4 A, Fast, 3 AG	LITTELFUSE	313-750	1
Integrated Circuit	MOTOROLA	MC1712IC	1
Transistor	FAIRCHILD	2N2905	1
Transistor	FAIRCHILD	2N3299	1
Transistor	FAIRCHILD	2N3640	2
Transistor	FAIRCHILD	2N3646	2
Transistor	FAIRCHILD	2N5139	1
Transistor	GE	TD101	1
Transistor	TI	TIP29 (2N4025)	1
Transistor	TI	TIP30 (2N3740)	1
*Transistor (Matched Pair)	FAIRCHILD	2N2905	1
*Transistor (Matched Pair)	FAIRCHILD	2N3638	2
*Transistor (Matched Pair)	FAIRCHILD	2N3640	2
*Transistor (Matched Pair)	FAIRCHILD	2N3642	1
*Transistor (Matched Pair)	FAIRCHILD	2N3646	2
*Transistor (Reverse Switch)	FAIRCHILD	2N3640	1
*Transistor (Reverse Switch)	FAIRCHILD	2N3646	1

*Denotes special selected parts and should be ordered from Wavetek.

PARTS LIST
—For—
Model 114
Mother Board Assembly
Drawing No. 114-033

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
114	Mother Board	1	Wavetek	114-032
	CAPACITORS			
C1	Electrolytic 16 V, 100 μF	2	Sprague	500D107G016DC7
C2	Electrolytic 16 V, 100 μF		Sprague	500D107G016DC7
	RESISTORS			
R2	Carbon ½ W, 5%, 1.8Ω	1	Stack	RC20GF1R8J
R7	Carbon 1 W, 5%, 470Ω	1	Stack	RC32GF471J
	MISCELLANEOUS			
	Connector Pin	51	ELCO	013-5200
	Connector Pin	65	ELCO	113-3200
	AMP Pin	17	AMP	61182-2
	Nylon Bumper	7	Accurate	12592
	Spacer	2	Wavetek	110-320

PARTS LIST
—For—
Model 114
First Sub-Panel
Drawing No. 114-042

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
1	BOARD, FRONT SUB PANEL	WAVETEK	B114-127C	1	
2	CAPACITORS				
3	ELECTROLYTIC 16 V, 100µF	SPRAGUE	500D107G016DC7	2	C1,C2
4	DURA-MICA 500 V, 5%, 56 PF	ARCO	DM15-560J	1	C4
5	CERAMIC 1000 V, 10%, 10 PF	CRL	DD-100	1	C5
6	DURA-MICA, 1%, 910 PF	ARCO	DM15-911F	1	C6
7	POLYSTYRENE 100 V, 0.01µF	IMB	PA2B103F	1	C7
8	MYLAR 200 V, 1%, 1µF	CDE	210B1C105F	1	C8
9	DURA-MICA, 5%, 330 PF	ARCO	DM15-331J	1	C9
10	CERAMIC 1000 V, 0.0022µF	CRL	DD-222	1	C10
11	CERAMIC 10 V, 0.1µF	CRL	UK10-104	2	C11,C18
12	CERAMIC 50 V, 0.01µF	CRL	CK-103	5	△1
13	CERAMIC 1000 V, 10%, 470 PF	CRL	DD-471	1	C13
14	CERAMIC 1000 V, 10%, 330 PF	CRL	DD-331	1	C14
15	CERAMIC 1000 V, 10%, 220 PF	CRL	DD-221	1	C15
16	CERAMIC 1000 V, 10%, 47 PF	CRL	DD-470	2	C17, C21
17	CERAMIC 1000 V, 10%, 820 PF	CRL	DD-821	1	C26
18	DIODES				
19		FAIR	FD6666	4	△2
20		SOLOTRON	MS-7330	1	CR3
21	INTEGRATED CIRCUIT	RCA	CA3028A	1	IC1
22	RESISTORS				
23	CARBON 1/2W, 5%, 91Ω	STACK	RC20GF901J	1	R1
24	POTENTIOMETER		SEE SW3		R2
25	CARBON 1/2W, 5%, 150Ω	STACK	RC20GF151J	1	R3

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
26	CARBON 1/2W, 5%, 10Ω	STACK	RC20GF100J	4	△3
27	METAL FILM 1/4W, 1%, 12.1K	CORNING	RN60D	2	R6,R7
28	METAL FILM 1/4W, 1%, 30.1K	CORNING	RN60D	2	R8,R10
29	POTENTIOMETER 10K	A/B	FR-103M	1	R9
30	CARBON 1/2W, 10%,2.7K	STACK	RC20GF272K	2	R11,R14
31	METAL FILM 1/4W, 1%, 1.5K	CORNING	RN60D	1	R13
32	CARBON 1/2W, 10%, 220Ω	STACK	RC20GF221K	1	R15
33	CARBON 1/2W, 10%, 1.2K	STACK	RC20GF122K	1	R16
34	CARBON 1/2W, 5%, 15Ω	STACK	RC20GF150J	2	R17, R18
35	CARBON 1/2W, 5%, 1K	STACK	RC20GF102J	2	R19,R41
36	METAL FILM 1/4W, 1%, 2K	CORNING	RN60D	1	R20
37	METAL FILM 1/4W, 1%, 3.01K	CORNING	RN60D	3	R21, R26,R27
38	CARBON 1/2W, 5%, 22Ω	STACK	RC20GF220J	2	R22,R24
39	CARBON 1/2W, 5%, 200Ω	STACK	RC20GF201J	1	R23
40	METAL FILM 1/4W, 1%, 453Ω	CORNING	RN60D	1	R25
41	CARBON 1/2W, 10%, 8.2K	STACK	RC20GF822K	2	R28,R44
42	CARBON 1/2W, 5%, 4.7K	STACK	RC20GF472J	4	△4
43	METAL FILM 1/4W, 1%, 10K	CORNING	RN60D	1	R31
44	CARBON 1/2W, 10%, 3.9K	STACK	RC20GF392J	1	R33
45	CARBON 1/2W, 5%, 820Ω	STACK	RC20GF821J	1	R34
46	METAL FILM 1/4W, 1%, 237K	CORNING	RN60D	1	R37
47	DEPOSITED CARBON, 2%, 2.37M	IRC	MDA	1	R38
48	DEPOSITED CARBON, 2%, 23.7M	IRC	MDC	1	R39
49	POTENTIOMETER		SEE SW1		R42
50	POTENTIOMETER		SEE SW2		R45
51	CARBON 1/2W, 10%, 10K	STACK	RC20GF103K	1	R46
52	CARBON 1/2W, 10%, 470Ω	STACK	RC20GF471K	1	R47

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
53	CARBON 1/2W, 5%, 27Ω	STACK	RC20GF270J	1	R48
54	METAL FILM 1/4W, 1%, 12.4Ω	CORNING	RN60D	2	R49,R50
55	METAL FILM 1/4W, 1%, 8.25K	CORNING	RN60D	1	R51
56	FREQ DIAL POTENTIOMETER 1K	WAVETEK	A110-408	1	R52
57	CARBON 1/2W, 10%, 560Ω	STACK	RC20GF561K	1	R53
58	METAL FILM 1/4W, 1%, 49.9Ω	CORNING	RN60D	2	R54,R56
59	METAL FILM 1/4W, 1%, 23.7K	CORNING	RN60D	1	R57
60	METAL FILM 1/4W, 1%, 2.37K	CORNING	RN60D	1	R58
61	METAL FILM 1/4W, 1%, 2.87K	CORNING	RN60D	1	R62
62	CARBON 1/2W, 5%, 750Ω	STACK	RC20GF751J	1	R63
63	TRIM			1	R36
64	SWITCHES				
65	FUNCTION SW 7 ATTEN	WAVETEK	A112-409	1	SW1
66	SLOPE/LEVEL & TRIG	WAVETEK	A112-407	1	SW2
67	SWEEP RATE HZ & VARIABLE	WAVETEK	A114-407	1	SW3
68	MAN TRIG & SWEEP RESET	C & K	TG-3	1	SW4
69	TRANSISTORS				
70	THERMALLY CONNECTED MATCHED	TI	2N3819	1PR	Q1,Q2
71	MATCHED PAIR	FAIR	2N3640	2PR	△5
72		FAIR	2N3646	4	△6
73		FAIR	2N3640	1	Q6
74	MISCELLANEOUS				
75	BNC CONNECTOR	KING	UG657/U	1	
76	BINDING POST	JOHNSON	111-103	4	
77	STANDOFF	WAVETEK	A110-304	2	
78	STANDOFF	WAVETEK	A110-311	2	

PARTS LIST
—For—
Model 114
Second Sub-Panel
Drawing No. 141-043

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
1	SECOND SUB-PANEL BOARD	WAVETEK	B114-128D	1	
2	CAPACITORS				
3	ELECTROLYTIC 16V, 100μF	SPARGUE	16-375-10015T	2	C1,C5
4	CERAMIC 50V, 0.01μF	CRL	CK-103	3	C2,C4 C16
5	VARIABLE 15-60PF	ERIE	538-006-112F	2	C7,C11
6	DURA-MICA 500V, 5%, 68PF	ARCO	DM15-680J	1	C8
7	CURA-MICA, 1%, 910PF	ARCO	DM15-911F	1	C9
8	DURA-MICA 500V, 5%, 56PF	ARCO	DM15-560J	1	C10
9	POLYSTYRENE 100V, 1%, 0.1μF	A-R	PA2B104F	1	C12
10	MATCHED SET (5X2) 10μF	ELPAC	ZX-3022	1	C13
11	CERAMIC 1000V, 10%, 100PF	CRL	DD-101	1	C15
12	CERAMIC 1000V, 10%, 5PF	CRL	DD050	1	C18
13	CERAMIC 1000V, 10%, 560PF	CRL	DD-561	1	C21
14	CERAMIC 50V, 0.005μF	CRL	CK-502	1	C22
15	DIODES				
16		FAIR	FD6666	3	CR1,CR2 CR3
17	INTEGRATED CIRCUITS				
18		RCA	CA3028A	1	IC1
19	RESISTORS				
20	CARBON 1/2W, 5%, 10Ω	STACK	RC20GF100J	2	R1,R8
21	METAL FILM 1/4W, 1%, 3.01K	CORNING	RN60D	4	△1
22	CARBON 1/2W, 10%, 2.2K	STACK	RC20GF222K	2	R3,R55
23	METAL FILM 1/4W, 1%, 6.98K	CORNING	RN60D	3	R4,R22 R30
24	METAL FILM 1/4W, 1%, 4.99K	CORNING	RN60D	1	R5
25	CARBON 1/2W, 5%, 9.1K	STACK	RC20GF912J	2	R7,R10

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
26	CARBON, 12W, 10%, 3.3K	STACK	RC20GF332K	1	R9
27	SEE SW1				
28	CARBON 1/2W, 5%, 750Ω	STACK	RC20GF751J	1	R14
29	CARBON 1/2W, 5%, 100Ω	STACK	RC20GF100J	3	R15,R48 R52
30	METAL FILM 1/4W, 1%, 5.76K	CORNING	RN60D	2	R16,R17
31	POTENTIOMETER 1K	A/B	FR102M	1	R18
32	CARBON 1/2W, 10%, 220Ω	STACK	RC20GF221K	1	R19
33	METAL FILM 1/4W, 1%, 4.32K	CORNING	RN60D	1	R20
34	METAL FILM 1/4W, 1%, 69.8K	CORNING	RN60D	3	R26,R34 R42
35	METAL FILM 1/4W, 1%, 30.1K	CORNING	RN60D	3	R28, R36 R41
36	METAL FILM 1/4W, 1%, 698K	CORNING	RN60D	2	R38,R44
37	METAL FILM 1/4W, 1%, 301K	CORNING	RN60D	2	R40,R43
38	CARBON 1/2W, 5%, 3K	STACK	RC20GF302J	1	R45
39	CARBON 1/2W, 5%, 390Ω	STACK	RC20GF391J	1	R46
40	CARBON 1/2W, 5%, 1K	STACK	RC20GF102J	1	R47
41	CARBON 1/2W, 10%, 680Ω	STACK	RC20GF681K	1	R50
42	SEE SW3				R51
43	CARBON 1/2W, 10%, 6.8K	STACK	RC20GF682K	1	R56
44	CARBON 1/2W, 5%, 4.7K	STACK	RC20GF472K	1	R57
45	CARBON 1/2W, 10%, 3.9K	STACK	RC20GF392K	2	R58, R59
46	CARBON 1/2W, 10%, 560Ω	STACK	RC20GF561K	1	R60
47	TRIM			13	△2
48	SWITCHES				
49	FREQ HZ & SWEEP WIDTH	WAVETEK	A112-410	1	SW1
50	ON-OFF & X.3-X1	WAVETEK	A110-SW1-1	1	SW2

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
51	MODE & START/STOP POINT	WAVETEK	114-406	1	SW3
52	TRANSISTORS				
53	MATCHED PAIR	FAIR	2N3640	1PR	Q1,Q2
54	MATCHED PAIR	FAIR	2N3646	1PR	Q3,Q4
55		FAIR	2N3640	2	Q5,Q7
56		FAIR	2N3646	1	Q6
57	MISCELLANEOUS				
58	CONNECTOR PIN	ELCO	113-3200	25	
59	TERMINAL	USECO	2010-B1	1	

PARTS LIST
—For—
Model 110 - 116
Main Board
Drawing No. 110-012

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
110 - 116	Main Board	1	Wavetek	110-012
	CAPACITOR			
C1	Ceramic 1000 V, 10%, 100 pF	4	CRL	DD101
C2	Ceramic 1000 V, 10%, 100 pF		CRL	DD101
C3	Ceramic 1000 V, 10%, 390 pF	1	CRL	DD391
C4	Ceramic 1000 V, 10%, .001 mF	10	CRL	DD102
C5	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C6	Ceramic 10 V, 10%, .1 mF	6	CRL	UK10-104
C7	Ceramic 10 V, 10%, .1 mF		CRL	UK10-104
C8	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C9	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C10	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C11	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C12	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C13	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C14	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C15	Ceramic 1000 V, 10%, .001 mF		CRL	DD102
C16	Ceramic 1000 V, 10%, 100 pF 110-220 pF, 113-150 pF		CRL	DD101 110-DD221 113-DD151
C17	Ceramic 1000 V, 10%, 100 pF 110-220 pF, 113-150 pF		CRL	DD101, 110-DD221 113-DD151
C18	Ceramic 10 V, 10%, .1 mF		CRL	UK10-104
C19	Ceramic 10 V, 10%, .1 mF		CRL	UK10-104
C20	Ceramic 1000 V, 10%, 22 pF	3	CRL	DD220
C21	Ceramic 1000 V, 10%, 47 pF	3	CRL	DD470
C22	Ceramic 1000 V, 10%, 10 pF	1	CRL	DD100
C23	Ceramic 1000 V, 10%, 47 pF		CRL	DD470
C24	Ceramic 1000 V, 10%, 22 pF		CRL	DD220
C25	Ceramic 1000 V, 10%, 22 pF		CRL	DD220
C26	Ceramic 1000 V, 10%, 5 pF	1	CRL	DD050
C27	Ceramic 1000 V, 10%, 470 pF	3	CRL	DD471
C28	Ceramic 1000 V, 10%, 470 pF		CRL	DD471
C29	Ceramic 1000 V, 10%, 470 pF		CRL	DD471
C30	Ceramic 1000 V, 10%, 33 pF	1	CRL	DD330
C31	Ceramic 10 V, 10%, .1 mF		CRL	UK10-104
C32	Ceramic 10 V, 10%, .1 mF		CRL	UK10-104
C33	Ceramic 1000 V, 10%, 150 pF	1	CRL	DD151
C34	NOT USED			
C35	Ceramic 1000 V, 10%, 47 pF		CRL	DD470

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	DIODES			
All CR's		21	Fair	FD6666
	RESISTORS			
R1	Metal Film ¼w, 1%, 110K	3	Corning	RN60D
R2	Metal Film ¼w, 1%, 1K	6	Corning	RN60D
R3	Metal Film ¼w, 1%, 110K		Corning	RN60D
R4	Potentiometer, 500Ω	1	A/B	FR501M
R5	Metal Film ¼w, 1%, 46.4K	1	Corning	RN60D
R6	Metal Film ¼w, 1%, 1K		Corning	RN60D
R7	Metal Film ¼w, 1%, 100K		Corning	RN60D
R8	Potentiometer, 10K	3	A/B	FR103M
R9	Metal Film ¼w, 1%, 3.01K	3	Corning	RN60D
R10	Carbon ½w, 5%, 3K	1	Stack	RC20GF302J
R11	Metal Film ¼w, 1%, 100Ω	2	Corning	RN60D
R12	Metal Film ¼w, 1%, 100Ω		Corning	RN60D
R13	Metal Film ¼w, 1%, 3.83K	4	Corning	RN60D
R14	Metal Film ¼w, 1%, 3.83K		Corning	RN60D
R15	Metal Film ¼w, 1%, 1K		Corning	RN60D
R16	Carbon ½w, 5%, 130Ω	1	Stack	RC20GF131J
R17	Carbon ½w, 5%, 15Ω	2	Stack	RC20GF150J
R18	Carbon ½w, 5%, 15Ω		Stack	RC20GF150J
R19	Metal Film ¼w, 1%, 2.87K	2	Corning	RN60D
R20	Potentiometer, 250Ω	12	A/B	FR251M
R21	Metal Film ¼w, 1%, 4.64K	10	Corning	RN60D
R22	Metal Film ¼w, 1%, 1K		Corning	RN60D
R23	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R24	Potentiometer, 250Ω		A/B	FR251M
R25	Metal Film ¼w, 1%, 2.87K		Corning	RN60D
R26	Metal Film ¼w, 1%, 511Ω		Corning	RN60D
R27	Metal Film ¼w, 1%, 511Ω		Corning	RN60D
R28	NOT USED			
R29	Metal Film ¼w, 1%, 3.16K	2	Corning	RN60D
R30	Potentiometer, 250Ω		A/B	FR251M
R31	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R32	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R33	Potentiometer, 250Ω		A/B	FR251M
R34	Metal Film ¼w, 1%, 3.16K		Corning	RN60D
R35	Metal Film ¼w, 1%, 825Ω	5	Corning	RN60D
R36	NOT USED			
R37	Metal Film ¼w, 1%, 3.83K		Corning	RN60D
R38	Potentiometer, 250Ω		A/B	FR251M
R39	Metal Film ¼w, 1%, 4.75K	2	Corning	RN60D
R40	Metal Film ¼w, 1%, 4.75K		Corning	RN60D
R41	Potentiometer, 250Ω		A/B	FR251M
R42	Metal Film ¼w, 1%, 3.83K		Corning	RN60D

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R43	Metal Film ¼w, 1%, 2.49K	1	Corning	RN60D
R44	Metal Film ¼w, 1%, 10K	4	Corning	RN60D
R45	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R46	Potentiometer, 250Ω		A/B	FR251M
R47	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R48	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R49	Potentiometer, 250Ω		A/B	FR251M
R50	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R51	Metal Film ¼w, 1%, 2.37K	1	Corning	RN60D
R52	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R53	Metal Film ¼w, 1%, 4.64K		Corning	RN60D
R54	Metal Film ¼w, 1%, 1K		Corning	RN60D
R55	Carbon ½w, 10%, 150Ω	2	Stack	RC20GF151K
R56	Metal Film ¼w, 1%, 1K		Stack	RC20GF151K
R57	Metal Film ¼w, 1%, 6.98K		Stack	RC20GF151K
R58	Metal Film ¼w, 1%, 10K		Stack	RC20GF151K
R59	Metal Film ¼w, 1%, 825Ω		Stack	RC20GF151K
R60	Potentiometer, 250Ω		A/B	FR251M
R61	Metal Film ¼w, 1%, 825Ω		Corning	RN60D
R62	Carbon ½w, 5%, 4.7K	1	Stack	RC20GF472J
R63	NOT USED			
R64	Potentiometer, 10K		A/B	FR103M
R65	NOT USED			
R66	Metal Film ¼w, 1%, 10K		Corning	RN60D
R67	Carbon, ½w, 5%, 150Ω		Stack	RC20GF151J
R68	Carbon ½w, 5%, 1K	4	Stack	RC20GF102J
R69	Metal Film ¼w, 1%, 6.98K		Corning	RN60D
R70	Carbon ½w, 5%, 47Ω	4	Stack	RC20GF470J
R71	Carbon ½w, 5%, 4.7Ω	2	Stack	RC20GF4R7J
R72	Carbon ½w, 5%, 4.7Ω		Stack	RC20GF4R7J
R73	Carbon ½w, 5%, 4.7Ω		Stack	RC20GF470J
R74	Metal Film ¼w, 1%, 825Ω		Corning	RN60D
R75	Metal Film ¼w, 1%, 825Ω		Corning	RN60D
R76	Carbon ½w, 5%, 750Ω	2	Stack	RC20GF751J
R77	Potentiometer, 250Ω		A/B	FR251M
R78	Potentiometer, 250Ω		A/B	FR251M
R79	Carbon ½w, 5%, 750Ω		Stack	RC20GF751J
R80	Metal Film ¼w, 1%, 3.01K		Corning	RN60D
R81	Metal Film ¼w, 1%, 2K	3	Corning	RN60D
R82	Metal Film ¼w, 1%, 2K		Corning	RN60D
R83	Metal Film ¼w, 1%, 3.01K		Corning	RN60D
R84	Carbon ½w, 10%, 470Ω	2	Stack	RC20GF471K
R85	Carbon ½w, 10%, 4.7K	2	Stack	RC20GF472K
R86	Carbon ½w, 5%, 4.7K		Stack	RC20GF472J
R87	Carbon ½w, 10%, 470Ω		Stack	RC20GF471K

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R88	Carbon ½w, 5%, 1K		Stack	RC20GF102J
R89	Carbon ½w, 5%, 1K		Stack	RC20GF102J
R90	Carbon ½w, 10%, 560Ω		Stack	RC20GF561K
R91	Carbon ½w, 5%, 47Ω		Stack	RC20GF470J
R92	Carbon ½w, 5%, 62Ω		Stack	RC20GF620J
R93	Carbon ½w, 5%, 47Ω		Stack	RC20GF470J
R94	Carbon ½w, 10%, 560Ω		Stack	RC20GF561K
R95	Carbon ½w, 5%, 10Ω	2	Stack	RC20GF100J
R96	Carbon ½w, 10%, 2.2K	1	Stack	RC20GF222K
R97	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R98	Metal Film ¼w, 1%, 21.5K	1	Corning	RN60D
R99	Potentiometer, 10K		A/B	FR103M
R100	Metal Film ¼w, 1%, 2K		Corning	RN60D
R101	Carbon ½w, 5%, 1K		Stack	RC20GF102J
R102	Carbon ½w, 5%, 100Ω	3	Stack	RC20GF101J
R103	Metal Fil ¼w, 1%, 316Ω		Corning	RN60D
R104	Potentiometer, 250Ω		A/B	FR251M
R105	Metal Film ¼w, 1%, 511Ω		Corning	RN60D
R106	Carbon ½w, 5%, 100Ω		Corning	RC20GF101J
R107	Carbon ½w, 5%, 100Ω		Corning	RC20GF101J
R108	Carbon ½w, 10%, 1.2K	2	Corning	RC20GF122K
R109	Carbon ½w, 10%, 1.2K		Corning	RC20GF122K
R110	Carbon, ½w, 10%, 10K	1	Corning	RC20GF103K
R111	Metal Film ¼w, 1%, 10K		Corning	RN60D
R112	Carbon ½w, 10%, 270Ω	1	Stack	RC20GF271K
R113	Metal Film ¼w, 1%, 1.62K	2	Corning	RN60D
R114	Metal Film ¼w, 1%, 1.62K		Corning	RN60D
R115	Metal Film ¼w, 1%, 6.98K		Corning	RN60D
R116	Metal Film ¼w, 1%, 6.98K		Corning	RN60D
R117	NOT USED			
R118	NOT USED			
R119	Carbon ½w, 5%, 30Ω	1	Stack	RC20GF300J
	TRANSISTORS			
Q1	Dual Transistor ½ of Q1-Q4	2	GE	TD101
Q2	Dual Transistor ½ of Q2-Q3		GE	TD101
Q3	Dual Transistor ½ of Q2-Q3		GE	TD101
Q4	Dual Transistor ½ of Q1-Q4		GE	TD101
Q5	Match Pair Q5 & Q6		Fair	2N3640
Q6	Match Pair Q5 & Q6		Fair	2N3640
Q7	Match Pair Q7 & Q8		Fair	2N3646
Q8	Match Pair Q7 & Q8		Fair	2N3646
Q9		7	Fair	2N3646
Q10		8	Fair	2N3640

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	TRANSISTORS (Continued)			
Q11		4	Fair	2N3642
Q12		4	Fair	2N3638
Q13			Fair	2N3642
Q14			Fair	2N3638
Q15			Fair	2N3642
Q16			Fair	2N3638
Q17			Fair	2N3642
Q18			Fair	2N3638
Q19	Beta & Bve Match with Q20	1 pr	Fair	2N3642
Q20	Beta & Vbe Match with Q19		Fair	2N3642
Q21	Beta & Vbe Match with Q22	2 pr	Fair	2N3640
Q22	Beta & Vbe Match with Q21		Fair	2N3640
Q23			Fair	2N3646
Q24			Fair	2N3640
Q25			Fair	2N3640
Q26			Fair	2N3646
Q27			Fair	2N3646
Q28			Fair	2N3640
Q29			Fair	2N3640
Q30			Fair	2N3646
Q31	Switch Set Q31 & Q33		Fair	2N3640
Q32	Switch Set Q32 & Q34		Fair	2N3646
Q33	Switch Set Q31 & Q33		Fair	2N3640
Q34	Switch Set Q32 & Q34		Fair	2N3646
Q35	(Not used on 113)		Fair	2N3646
Q36			Fair	2N3646
Q37			Fair	2N3640
Q38			Fair	2N3640
Q39			Fair	2N3640
	MISCELLANEOUS			
	Transistor Sockets	4	ELCO	05-3303
	Connector Pins	13	ELCO	013-5200

PARTS LIST
—For—
Model 114
Trigger Board Assembly
Drawing No. 114-021

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
114	Trigger Board Assembly	1	Wavetek	114-021
	CAPACITORS			
C1	Electrolytic 16 V, 100 μF	2	Sprague	500D107G016DC7
C2	Electrolytic 16 V, 100 μF		Sprague	500D107G016DC7
C3	Ceramic 10 V, 0.1 μF	5	CRL	UK10-104
C4	Ceramic 1000 V, 10%, 22 pF	2	CRL	DD-220
C5	Ceramic 1000 V, 10%, 22 pF		CRL	DD-220
C6	Ceramic 1000 V, 10%, 47 pF	3	CRL	DD-470
C7	Ceramic 1000 V, 10%, 47 pF		CRL	DD-470
C8	Ceramic 1000 V, 10%, 47 pF		CRL	DD-470
C9	Ceramic 1000 V, 10%, 0.001 pF	1	CRL	DD-102
C10	Ceramic 1000 V, 10%, 5 pF	1	CRL	DD-050
C11	NOT USED			
C12	Ceramic 50 V, 20%, 0.01 μF	1	CRL	CK-103
C13	NOT USED			
C14	NOT USED			
C15	NOT USED			
C16	Ceramic 10 V, 0.1 μF		CRL	UK10-104
C17	Ceramic 10 V, 0.1 μF		CRL	UK10-104
C18	NOT USED			
C19	NOT USED			
C20	NOT USED			
C21	NOT USED			
C22	NOT USED			
C23	Ceramic 10 V, 0.1 μF		CRL	UK10-104
C24	Ceramic 10 V, 0.1 μF		CRL	UK10-104
C25	NOT USED			
C26	Ceramic 1000 V, 10%, 220 pF	1	CRL	DD-221
	DIODES			
CR1		9	Fair	FD6666
CR2	Tunnel TD3	2	GE	1N3716
CR3			Fair	FD6666
CR4	Tunnel TD3		GE	1N3716
CR5			Fair	FD6666
CR6			Fair	FD6666
CR7			Fair	FD6666
CR8			Fair	FD6666
CR9			Fair	FD6666
CR10			Fair	FD6666
CR11	NOT USED			
CR12	NOT USED			
CR13			Fair	FD6666

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS			
R1	Carbon ½ W, 5%, 10Ω	3	Stack	RC20GF100J
R2	Metal Film ¼ W, 1%, 2.87K	1	Corning	RN60D
R3	Carbon ½ W, 5%, 1K	2	Stack	RC20GF102J
R4	Metal Film ¼ W, 1%, 10K	3	Corning	RN60D
R5	Metal Film ¼ W, 1%, 2.37K	2	Corning	RN60D
R6	Metal Film ¼ W, 1%, 2.37K		Corning	RN60D
R7	Carbon ½ W, 5%, 10Ω		Stack	RC20GF100J
R8	Metal Film ¼ W, 1%, 511Ω	4	Corning	RN60D
R9	Carbon ½ W, 5%, 1K		Stack	RC20GF102J
R10	Carbon ½ W, 5%, 30K	1	Stack	RC20GF303J
R11	Carbon ½ W, 10%, 470Ω	2	Stack	RC20GF471K
R12	Carbon ½ W, 5%, 6.2K	2	Stack	RC20GF622J
R13	Carbon ½ W, 10%, 2.2K	1	Stack	RC20GF222K
R14	Carbon ½ W, 10%, 10K	2	Stack	RC20GF103K
R15	Carbon ½ W, 5%, 10Ω		Stack	RC20GF100J
R16	Carbon ½ W, 10%, 10K		Stack	RC20GF103K
R17	Metal Film ¼ W, 1%, 100Ω	1	Corning	RN60D
R18	Metal Film ¼ W, 1%, 316Ω	1	Corning	RN60D
R19	Metal Film ¼ W, 1%, 1.1K	1	Corning	RN60D
R20	Carbon ½ W, 10%, 1.5K	1	Stack	RC20GF152K
R21	Carbon ½ W, 10%, 560Ω	1	Stack	RC20GF561K
R22	Carbon ½ W, 5%, 82Ω	2	Stack	RC20GF820J
R23	Carbon ½ W, 5%, 4.7K	1	Stack	RC20GF472J
R24	Carbon ½ W, 10%, 150K	1	Stack	RC20GF154K
R25	Carbon ½ W, 10%, 10M	1	Stack	RC20GF106K
R26	Carbon ½ W, 5%, 6.2K		Stack	RC20GF622K
R27	Carbon ½ W, 5%, 47Ω	2	Stack	RC20GF470J
R28	Carbon ½ W, 5%, 47Ω		Stack	RC20GF470J
R29	Potentiometer 10K	2	A/B	FR103M
R30	Carbon ½ W, 10%, 15K	2	Stack	RC20GF153K
R31	Metal Film ¼ W, 1%, 3.01K	1	Corning	RN60D
R32	Metal Film ¼ W, 1%, 4.99K	1	Corning	RN60D
R33	Metal Film ¼ W, 1%, 1K	3	Corning	RN60D
R34	Metal Film ¼ W, 1%, 1K		Corning	RN60D
R35	Metal Film ¼ W, 1%, 23.7K	2	Corning	RN60D
R36	Metal Film ¼ W, 1%, 23.7K		Corning	RN60D
R37	Carbon ½ W, 10%, 220Ω	1	Stack	RC20GF221K
R38	Carbon ½ W, 5%, 390Ω	1	Stack	RC20GF391J
R39	Carbon ½ W, 10%, 1.2K	2	Stack	RC20GF122K
R40	Carbon ½ W, 5%, 15Ω	4	Stack	RC20GF150J
R41	Carbon ½ W, 5%, 15Ω		Stack	RC20GF150J
R42	Carbon ½ W, 10%, 470Ω		Stack	RC20GF471K
R43	Metal Film ¼ W, 1%, 1.21K	1	Corning	RN60D
R44	Carbon ½ W, 5%, 15Ω		Stack	RC20GF150J
R45	Carbon ½ W, 5%, 15Ω		Stack	RC20GF150J
R46	Carbon ½ W, 10%, 1.2K		Stack	RC20GF122K
R47	Carbon ½ W, 5%, 75Ω	3	Stack	RC20GF750J

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R48	Potentiometer 10K		A/B	FR103M
R49	Carbon ½ W, 10%, 15K		Stack	RC20GF153K
R50	NOT USED			
R51	Metal Film ¼ W, 1%, 511Ω		Corning	RN60D
R52	NOT USED			
R53	NOT USED			
R54	NOT USED			
R55	NOT USED			
R56	Metal Film ¼ W, 1%, 7.5K	1	Corning	RN60D
R57	Metal Film ¼ W, 1%, 511Ω		Corning	RN60D
R58	Metal Film ¼ W, 1%, 511Ω		Corning	RN60D
R59	Metal Film ¼ W, 1%, 10K		Corning	RN60D
R60	NOT USED			
R61	Metal Film ¼ W, 1%, 10K		Corning	RN60D
R62	Metal Film ¼ W, 1%, 1K		Corning	RN60D
R63	Potentiometer 250Ω	1	A/B	FR251M
R64	Metal Film ¼ W, 1%, 909Ω	1	Corning	RN60D
R65	NOT USED			
R66	NOT USED			
R67	NOT USED			
R68	NOT USED			
R69	NOT USED			
R70	NOT USED			
R71	NOT USED			
R72	NOT USED			
R73	NOT USED			
R74	NOT USED			
R75	NOT USED			
R76	NOT USED			
R77	NOT USED			
R78	NOT USED			
R79	NOT USED			
R80	NOT USED			
R81	NOT USED			
R82	Carbon ½ W, 5%, 620Ω	1	Stack	RC20GF621J
R83	NOT USED			
R84	Carbon ½ W, 5%, 75Ω		Stack	RC20GF750J
R85	Carbon ½ W, 5%, 82Ω		Stack	RC20GF820J
R86	NOT USED			
R87	NOT USED			
R88	Carbon ½ W, 10%, 680Ω	1	Stack	RC20GF681K
R89	Carbon ½ W, 5%, 51Ω	2	Stack	RC20GF510J
R90	Carbon ½ W, 5%, 51Ω		Stack	RC20GF510J

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	TRANSISTORS			
Q1	Matched Pair Q1 & Q2	3	Fair	2N3640
Q2	Matched Pair Q1 & Q2		Fair	2N3640
Q3		7	Fair	2N3640
Q4			Fair	2N3640
Q5		1	Fair	2N5139
Q6			Fair	2N3640
Q7			Fair	2N3640
Q8			Fair	2N3640
Q9		3	Fair	2N3646
Q10	Matched Pair Q10 & Q11	2	Fair	2N3646
Q11	Matched Pair Q10 & Q11		Fair	2N3646
Q12	Matched Pair Q12 & Q13		Fair	2N3640
Q13	Matched Pair Q12 & Q13		Fair	2N3640
Q14			Fair	2N3646
Q15			Fair	2N3640
Q16			Fair	2N3646
Q17			Fair	2N3640
Q18	Matched Pair Q18 & Q19		Fair	2N3640
Q19	Matched Pair Q18 & Q19		Fair	2N3640
Q20	Matched Pair Q20 & Q21		Fair	2N3646
Q21	Matched Pair Q20 & Q21		Fair	2N3646
	MISCELLANEOUS			
	Connector Pin	24	ELCO	57-5201-0213
	Terminal	3	USECO	2010B-1

PARTS LIST
—For—
VCG Board Assembly
Drawing No. 114-018

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
114	VCG Board Assembly	1	Wavetek	114-018
	CAPACITORS			
C1	NOT USED			
C2	NOT USED			
C3	Ceramic 1000 V, 10%, 0.0015 μF	1	CRL	DD-152
C4	Ceramic 20 V, 0.1 μF	2	CRL	UK20-104
C5	Ceramic 1000 V, 10%, 5 pF	2	CRL	DD-050
C6	Ceramic 1000 V, 10%, 0.001 μF	1	CRL	DD-102
C7	Electrolytic 16 V, 100 μF	3	Sprague	500D107G016DC7
C8	NOT USED			
C9	Ceramic 10 V, 0.1 μF	2	CRL	UK10-104
C10	Ceramic 20 V, 0.1 μF		CRL	UK20-104
C11	Ceramic 10 V, 0.1 μF		CRL	UK10-104
C12	Electrolytic 16 V, 100 μF		Sprague	500D107G016DC7
C13	Electrolytic 16 V, 100 μF		Sprague	500D107G016DC7
C14	Ceramic 1000 V, 10%, 330 pF	1	CRL	DD-331
C15	Ceramic 1000 V, 10%, 5 pF		CRL	DD-050
	DIODES			
CR1		2	Fair	FD6666
CR2			Fair	FD6666
	RESISTORS			
R1	NOT USED			
R2	NOT USED			
R3	NOT USED			
R4	NOT USED			
R5	Metal Film ¼ W, 1%, 95.3K	1	Corning	RN60D
R6	Metal Film ¼ W, 1%, 12.1K	1	Corning	RN60D
R7	Metal Film ¼ W, 1%, 10K	1	Corning	RN60D
R8	Potentiometer 1K	1	A/B	FR102M
R9	Potentiometer 10K	3	A/B	FR103M
R10	Metal Film ¼ W, 1%, 464K	2	Corning	RN60D
R11	Metal Film ¼ W, 1%, 3.83K	1	Corning	RN60D
R12	Metal Film ¼ W, 1%, 6.19K	1	Corning	RN60D
R13	Potentiometer 500Ω	4	A/B	FR501M
R14	Potentiometer 500Ω		A/B	FR501M
R15	Metal Film ¼ W, 1%, 2.87K	1	Corning	RN60D
R16	Carbon ½ W, 10%, 1.2K	1	Stack	RC20GF122K
R17	Carbon ½ W, 5%, 2K	3	Stack	RC20GF202J
R18	Carbon ½ W, 10%, 220K	3	Stack	RC20GF224K
R19	Carbon ½ W, 5%, 2.4K	2	Stack	RC20GF242J
R20	Carbon ½ W, 10%, 12K	2	Stack	RC20GF123K
R21	NOT USED			
R22	Carbon ½ W, 10%, 220K		Stack	RC20GF224K

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R23	Metal Film ¼ W, 1%, 464K		Corning	RN60D
R24	Metal Film ¼ W, 1%, 1.5K	1	Corning	RN60D
R25	Metal Film ¼ W, 1%, 3.01K	1	Corning	RN60D
R26	Carbon ½ W, 5%, 2K		Stack	RC20GF202J
R27	Carbon ½ W, 5%, 2K		Stack	RC20GF202J
R28	Carbon ½ W, 10%, 220K		Stack	RC20GF224K
R29	Carbon ½ W, 10%, 12K		Stack	RC20GF123K
R30	Carbon ½ W, 5%, 2.4K		Stack	RC20GF242J
R31	NOT USED			
R32	Metal Film ¼ W, 1%, 1.62K	1	Corning	RN60D
R33	Potentiometer 500Ω		A/B	FR501M
R34	Potentiometer 500Ω		A/B	FR501M
R35	Metal Film ¼ W, 1%, 2.37K	1	Corning	RN60D
R36	NOT USED			
R37	NOT USED			
R38	NOT USED			
R39	NOT USED			
R40	NOT USED			
R41	NOT USED			
R42	NOT USED			
R43	NOT USED			
R44	NOT USED			
R45	Carbon ½ W, 5%, 47Ω	3	Stack	RC20GF470J
R46	Potentiometer 10K		A/B	FR103M
R47	NOT USED			
R48	Carbon ½ W, 5%, 10Ω	2	Stack	RC20GF100J
R49	Carbon ½ W, 5%, 10Ω		Stack	RC20GF100J
R50	Carbon ½ W, 5%, 91Ω	1	Stack	RC20GF910J
R51	Potentiometer 10K		A/B	FR103M
R52	Metal Film ¼ W, 1%, 46.4K	1	Corning	RN60D
R53	Metal Film ¼ W, 1%, 110K	1	Corning	RN60D
R54	NOT USED			
R55	Metal Film ¼ W, 1%, 4.64K	1	Corning	RN60D
R56	Metal Film ¼ W, 1%, 1K	1	Corning	RN60D
R57	Carbon ½ W, 5%, 100Ω	2	Stack	RC20GF101J
R58	Carbon ½ W, 5%, 47Ω		Stack	RC20GF470J
R59	Carbon ½ W, 5%, 100Ω		Stack	RC20GF101J
R60	Carbon ½ W, 5%, 680Ω	1	Stack	RC20GF681J
R61	Carbon ½ W, 5%, 1.6K	1	Stack	RC20GF162J
R62	Carbon ½ W, 5%, 47Ω		Stack	RC20GF470J

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	TRANSISTORS			
Q1		2	Fair	2N3640
Q2	Matched Pair Q2 & Q3	1 pr	Fair	2N3640
Q3	Matched Pair Q2 & Q3		Fair	2N3640
Q4	Matched Pair Q4 & Q5	1 pr	Fair	2N3646
Q5	Matched Pair Q4 & Q5		Fair	2N3646
Q6		1	Fair	2N3638
Q7		1	Fair	2N3646
Q8			Fair	2N3640
	INTEGRATED CIRCUITS			
IC1		2	Motorola	MC1712CG
IC2			Motorola	MC1712CG
	MISCELLANEOUS			
	Transistor Sockets	2	ELCO	05-3303
	Connector Pin	13	ELCO	013-5200
	Terminal	8	USECO	2005-B

PARTS LIST
—For—
Model 110 - 116
Power Supply and Output Amp
Drawing No. 110-013

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
110-116	Power Supply and Output Amp	1	Wavetek	110-013
	CAPACITORS			
C1	Electrolytic 15 V, 1900μF	2	Sprague	39D198G015GL4
C2	Electrolytic 15 V, 1900μF		Sprague	39D198G015GL4
C3	Ceramic 10 V, .1μF	7	CRL	UK10-104
C4	Ceramic 1000 V, 10%, .001μF	1	CRL	DD102
C5	Ceramic 10 V, .1μF		CRL	UK10-104
C6	Ceramic 10 V, .1μF		CRL	UK10-104
C7	Ceramic 10 V, .1μF		CRL	UK10-104
C8	Ceramic 10 V, .1μF		CRL	UK10-104
C9	NOT USED			
C10	NOT USED			
C11	Variable 3 to 12 pF	1	Erie	505-001-17A
C12	Ceramic 50 V .01μF	2	CRL	CK103
C13	NOT USED			
C14	Electrolytic 35 V, 1000μF	2	Sprague	39D108G035GL4
C15	Electrolytic 35 V, 1000μF		Sprague	39D108G035GL4
C16	NOT USED			
C17	Ceramic 1000 V, 10%, 47 pF	1	CRL	DD470
C18	Ceramic 50 V, .01μF		CRL	CK103
C19	Ceramic 10 V .1μF		CRL	UK10-104
C20	Ceramic 10 V .1μF		CRL	UK10-104
	DIODES			
CR1		8	Semtech	SCE-1
CR2			Semtech	SCE-1
CR3			Semtech	SCE-1
CR4			Semtech	SCE-1
CR5		2	Fair	FD6666
CR6			Fair	FD6666
CR7			Semtech	SCE-1
CR8			Semtech	SCE-1
CR9			Semtech	SCE-1
CR10			Semtech	SCE-1
	RESISTORS			
R1	Metal Film ¼w, 1%, 100Ω	3	Corning	RN60D
R2	Metal Film ¼w, 1%, 1.78K	1	Corning	RN60D
R3	Carbon ½w, 10%, 2.7K	3	Stack	RC20GF272K
R4	Carbon ½w, 10%, 3.9K	2	Stack	RC20GF392K
R5	Carbon ½w, 10%, 2.2K	3	Stack	RC20GF222K

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R6	Metal Film ¼w, 1%, 511Ω	1	Corning	RN60D
R7	Carbon ½w, 5%, 56Ω	1	Stack	RC20GF560J
R8	Carbon ½w, 10%, 2.7K		Stack	RC20GF272K
R9	Potentiometer, 250Ω	3	A/B	FR251M
R10	NOT USED			
R11	Carbon ½w, 10%, 3.9K	2	Stack	RC20GF392K
R12	Carbon ½w, 10%, 2.7K		Stack	RC20GF272K
R13	NOT USED			
R14	Carbon ½w, 5%, 100Ω	4	Stack	RC20GF101J
R15	Carbon ½w, 10%, 2.2K		Stack	RC20GF222K
R16	Carbon ½w, 10%, 2.2K		Stack	RC20GF222K
R17	Carbon ½w, 5%, 100Ω		Stack	RC20GF101J
R18	Wirewound 5w, 10%, 10Ω	2	IRC	PW-5
R19	Wirewound 5w, 10%, 10Ω		IRC	PW-5
R20	Carbon ½W,5% 4.7K	1	Stack	RC20GF472J
R21	Carbon ½w, 5% 4.7K	1	Stack	RC20GF100J
R22	Carbon ½w, 5%, 100Ω		Stack	RC20GF101J
R23	Carbon ½w, 5%, 100Ω		Stack	RC20GF101J
R24	Potentiometer, 250Ω		A/B	FR251M
R25	Metal Film ¼w, 1%, 1K	4	Corning	RN60D
R26	Metal Film ¼w, 1%, 1K		Corning	RN60D
R27	Metal Film ¼w, 1%, 1K		Corning	RN60D
R28	Metal Film ¼w, 1%, 21.5Ω	1	Corning	RN60D
R29	NOT USED			
R30	NOT USED			
R31	Potentiometer, 250Ω		A/B	FR251M
R32	Metal Film ¼w, 1%, 909Ω	1	Corning	RN60D
R33	Metal Film ¼w, 1%, 3.32K	2	Corning	RN60D
R34	Metal Film ½w, 1%, 100Ω		Corning	RN60D
R35	Metal Film ¼w, 1%, 100Ω		Corning	RN60D
R36	Metal Film ¼w, 1%, 7.5K	1	Corning	RN60D
R37	Metal Film ¼w, 1%, 6.98K	1	Corning	RN60D
R38	Metal Film ¼w, 1%, 3.32K		Corning	RN60D
R39	Metal Film ¼w, 1%, 1K		Corning	RN60D
R40	Metal Film ¼w, 1%, 10K	2	Corning	RN60D
R41	Potentiometer 10K	1	A/B	FR103M
R42	Metal Film ¼w, 1%, 10K		Corning	RN60D
R43	NOT USED			
R44	Carbon ½w, 5%, 150Ω	1	Stack	RC20GF151J
R45	Carbon ½w, 5%, 3.6K	2	Stack	RC20GF362J
R46	Carbon 2w, 5%, 91Ω	2	Stack	RC42GF910J
R47	Carbon ½w, 5%, 6.8Ω	2	Stack	RC20GF6R8J
R48	Carbon ½w, 5%, 6.8Ω		Stack	RC20GF6R8J
R49	Carbon 2w, 5%, 91Ω		Stack	RC42GF910J
R50	Metal Film ¼w, 1%, 49.9	2	Corning	RN60D
R51	Metal Film ¼w, 1%, 49.9		Corning	RN60D

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R52	NOT USED			
R53	Carbon ½w, 5%, 3.6K		Stack	RC20GF362J
R54	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R55	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R56	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R57	Carbon ½w, 5%, 22Ω	1	Stack	RC20GF220J
R58	113 only Metal Film ¼w, 1%, 4.99K	1	Corning	RN60D
R59	Carbon 1w, 10%, 1K	1	Stack	RC32GF102K
R60	Carbon ½w, 5%, 1K	2	Stack	RC20GF102J
R61	Carbon ½w, 5%, 1K		Stack	RC20GF102J
	TRANSISTORS			
Q1	Selected for zener V. of 6.6 V ±.3 V	1	Wavetek	130-506
Q2	Match pair Q2 & Q3	1 pr	Fair	2N3646
Q3	Match pair Q2 & Q3		Fair	2N3646
Q4	Match pair Q4 & Q5	1 pr	Fair	2N3638
Q5	Match pair Q4 & Q5		Fair	2N3638
Q6		1	Fair	2N3646
Q7		4	Fair	2N3638
Q8			Fair	2N3638
Q9			Fair	2N3638
Q10		1	TI	TIP29
Q11			Fair	2N3638
Q12		1	TI	TIP30
Q13	Match pair Q13 & Q14	1 pr	Fair	2N3642
Q14	Match pair Q13 & Q14		Fair	2N3642
Q15	Match pair Q15 & Q16	1 pr	Fair	2N2905
Q16	Match pair Q15 & Q16		Fair	2N2905
Q17		1	Fair	2N3299
Q18		1	Fair	2N2905
	MISCELLANEOUS			
	Transipad	12		10123N
	Heatsink	2	Wakefield	NF207
	Connector Pin	15	ELCO	013-5200
	Terminal	17	USECO	2010B-1
	Terminal	3	USECO	2005-B
	Spacer	2	Wavetek	8480

PARTS LIST
—For—
Model 110 - 116
Battery Regulator Board
Drawing No. 112-022

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
110 - 116	Battery Regulator Board	1	Wavetek	112-022
	CAPACITORS			
C1	Electrolytic 35 V, 1000μF	2	Sprague	39D108G035GL4
C2	Electrolytic 35 V, 1000μF		Sprague	39D108G035GL4
C3	Mylar 100 V, 10%, .1μF	2	CDE	WMF 1P1
C4	Mylar 100 V, 10%, .1μF		CDE	WMF 1P1
C5	Ceramic 50 V, .01μF	2	CRL	CK-103
C6	Ceramic 50 V, .01μF		CRL	CK-103
C7	Ceramic 1000 V, 10%, .001μF	2	CRL	DD-102
C8	Ceramic 1000 V, 10%, .001μF		CRL	DD-102
	DIODES			
CR1		9	Semtech	SCE-1
CR2			Semtech	SCE-1
CR3			Semtech	SCE-1
CR4			Semtech	SCE-1
CR5			Semtech	SCE-1
CR6			Semtech	SCE-1
CR7			Semtech	SCE-1
CR8			Semtech	SCE-1
CR9			Semtech	SCE-1
	RESISTORS			
R1	Carbon ½w, 10% 5.6K	2	Stack	RC20GF562K
R2	Carbon ½w, 5% 30K	2	Stack	RC20GF303J
R3	Carbon ½w, 10%, 5.6K		Stack	RC20GF562K
R4	Carbon ½w, 5%, 30K		Stack	RC20GF303J
R5	Carbon ½w, 10%, 33K	1	Stack	RC20GF333K
R6	Carbon ½w, 5%, 2K	2	Stack	RC20GF202J
R7	NOT USED			
R8	Carbon ½w, 5%, 62Ω	2	Stack	RC20GF620J
R9	Carbon ½w, 5%, 43Ω	1	Stack	RC20GF430J
R10	Metal Film ¼w, 1%, 49.9Ω	4	Corning	RN65D
R11	Metal Film ½w, 1%, 49.9Ω		Corning	RN65D
R12	Potentiometer, 250Ω	3	A/B	FR251M
R13	Carbon ½w, 5%, 62Ω		Stack	RC20GF620J
R14	Metal Film ½w, 1%, 49.9Ω		Corning	RN65D
R15	Metal Film ½w, 1%, 49.9Ω		Corning	RN65D
R16	NOT USED			
R17	NOT USED			
R18	Carbon ½w, 5%, 2K		Stack	RC20GF202J
R19	Carbon ½w, 10%, 3.3K	1	Stack	RC20GF332K

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	RESISTORS (Continued)			
R20	Carbon ½w, 5%, 910Ω	1	Stack	RC20GF911J
R21	Carbon ½w, 5%, 200Ω	2	Stack	RC20GF201J
R22	Carbon ½w, 5%, 1.6K	2	Stack	RC20GF162J
R23	Carbon ½w, 5%, 10Ω	4	Stack	RC20GF100J
R24	Metal Film ¼w, 1%, 100Ω	4	Corning	RN60D
R25	Potentiometer, 250Ω		A/B	FR251M
R26	Metal Film ¼w, 1%, 2K	2	Corning	RN60D
R27	Carbon ½w, 5%, 1.8Ω	2	Stack	RC20GF1R8J
R28	Carbon ½w, 10%, 3.9K	4	Stack	RC20GF392K
R29	Carbon ½w, 5%, 3K	2	Stack	RC20GF302J
R30	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R31	Carbon ½w, 10%, 3.9K		Stack	RC20GF392K
R32	NOT USED			
R33	Metal Film ¼w, 1%, 100Ω		Corning	RN60D
R34	Metal Film ¼w, 1% 2.87K	2	Corning	RN60D
R35	Carbon ½w, 5%, 1.6K		Stack	RC20GF162J
R36	Carbon ½w, 5%, 910Ω		Stack	RC20GF911J
R37	Carbon ½w, 5%, 200Ω		Stack	RC20GF201J
R38	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R39	Metal Film ¼w, 1%, 100Ω		Corning	RN60D
R40	Metal Film ¼w, 1%, 2K		Corning	RN60D
R41	Potentiometer, 250Ω		A/B	FR251M
R42	Carbon ½w, 5%, 1.8Ω		Stack	RC20GF1R8J
R43	Carbon ½w, 10%, 3.9K		Stack	RC20GF392K
R44	Carbon ½w, 5%, 3K		Stack	RC20GF302J
R45	Carbon ½w, 5%, 10Ω		Stack	RC20GF100J
R46	Carbon ½w, 10%, 3.9K		Stack	RC20GF392K
R47	Metal Film ¼w, 1%, 100Ω		Corning	RN60D
R48	NOT USED			
R49	Metal Film ¼w, 1%, 2.87K		Corning	RN60D
R50	Carbon 1w, 10%, 3.9Ω	2	Stack	RC20GF3R9K
R51	Carbon 1w, 10%, 3.9Ω		Stack	RC20GF3R9K
	TRANSISTORS			
Q1			Fair	2N3642
Q2			TI	TIP 29
Q3			Fair	2N3638
Q4			TI	TIP 30
Q5	NOT USED			
Q6			Fair	2N3642
Q7			Fair	2N3638
Q8	NOT USED			
Q9	Selected zener V for 6.6 V ±.3 V			
Q10	Match pair Q10 & Q12		Fair	2N3646

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
	TRANSISTORS (Continued			
Q11			Fair	2N3638
Q12	Match pair Q10 & Q12		Fair	2N3646
Q13			TI	TIP 29
Q14			Fair	2N3642
Q15			Fair	2N3638
Q16			Fair	2N3638
Q17	Selected zener V for 6.6 V ±.3 V			
Q18			Fair	2N3638
Q19			Fair	2N3638
Q20			Fair	2N3642
Q21			TI	TIP 30
Q22				2N3638
Q23	Match pair Q23 & Q24	1 pr	Fair	2N3646
Q24	Match pair Q23 & Q24		Fair	2N3646
Q25	Selected zener V for 6.6 V ±.3 V			
	MISCELLANEOUS			
SW1	Power Switch wafer	2	Wavetek	110-SW1-2
	Transipad	15		10123N
	Heatsink	4		NR-150A
	Spacer	8	H.H.S.	8480
	Connector Pin	11	ELCO	013-5200
	Terminal	4	USECO	2010B-1
	Terminal	3	USECO	2005B

PARTS LIST
—For—
Model 110-116
Battery Pack Board
Drawing No. 112-023

REF DES	DESCRIPTION	TOTAL QTY	MFGR	MFGR NO.
110-116	Battery Pack Assembly	1	Wavetek	112-023
	P/C Board 112-123	1	Wavetek	112-123
	P/C Board 112-124	1	Wavetek	112-124
	Battery	16	Gould National	1.2 SCL
	Connector Pin	4	ELCO	013-5200
	Standoff	5	Wavetek	013-033-4

PARTS LIST
—For—
Model 114
Rear Connector
Drawing No. 114-040

LINE NO.	DESCRIPTION	MFGR	MFGR P/N	QTY	REF DES
1	CIRCUIT BOARD	WAVETEK	C110-540	1	
2	STANDOFF	WAVETEK	A110-304	4	
3	CAPACITORS				
4	CERAMIC 1000V, 47PF	CRL	DD470	1	C7
5	CERAMIC 1000V, 68PF	CRL	DD680	1	C5
6	CERAMIC 1000V, 680PF	CRL	DD681	3	C3,C8 C9
7	CERAMIC 1000V, .001μF	CRL	DD102	2	C4,C6
8	CERAMIC 10V, .1μF	CRL	UK10-104	1	C10
9					
10	RESISTORS				
11	CARBON 1/2W, 5%, 4.7Ω	STACKPOLE	RC20GF4R7J	6	R12,R13 R14,R15 R16,R17
12	CARBON 1/8W, 1%, 33.2Ω	CORNING	RN55D	1	R10
13	CARBON 1/8W, 1%, 56.2Ω	CORNING	RN55D	1	R9
14	CARBON 1/8W, 1%, 464Ω	CORNING	RN55D	1	R8
15	CARBON 1/8W, 1%, 2.0K	CORNING	RN55D	1	R6
16	METAL FILM, 1/4W, 1%, 49.9Ω	CORNING	RN60D	6	R2,R3, R4,R5 R7,R11
17	CONNECTOR BNC	KINGS	UG657/U	8	J1-J8
18					
19	WIRE CRIMPS	AMP	60598-1	11	
20	RACK MOUNT ONLY				
21	CONNECTOR BNC	KINGS	UG657/U	2	J9-J10