

Serial No. _____

INSTRUCTION MANUAL
MODEL 147
HF SWEEP GENERATOR

WAVETEK
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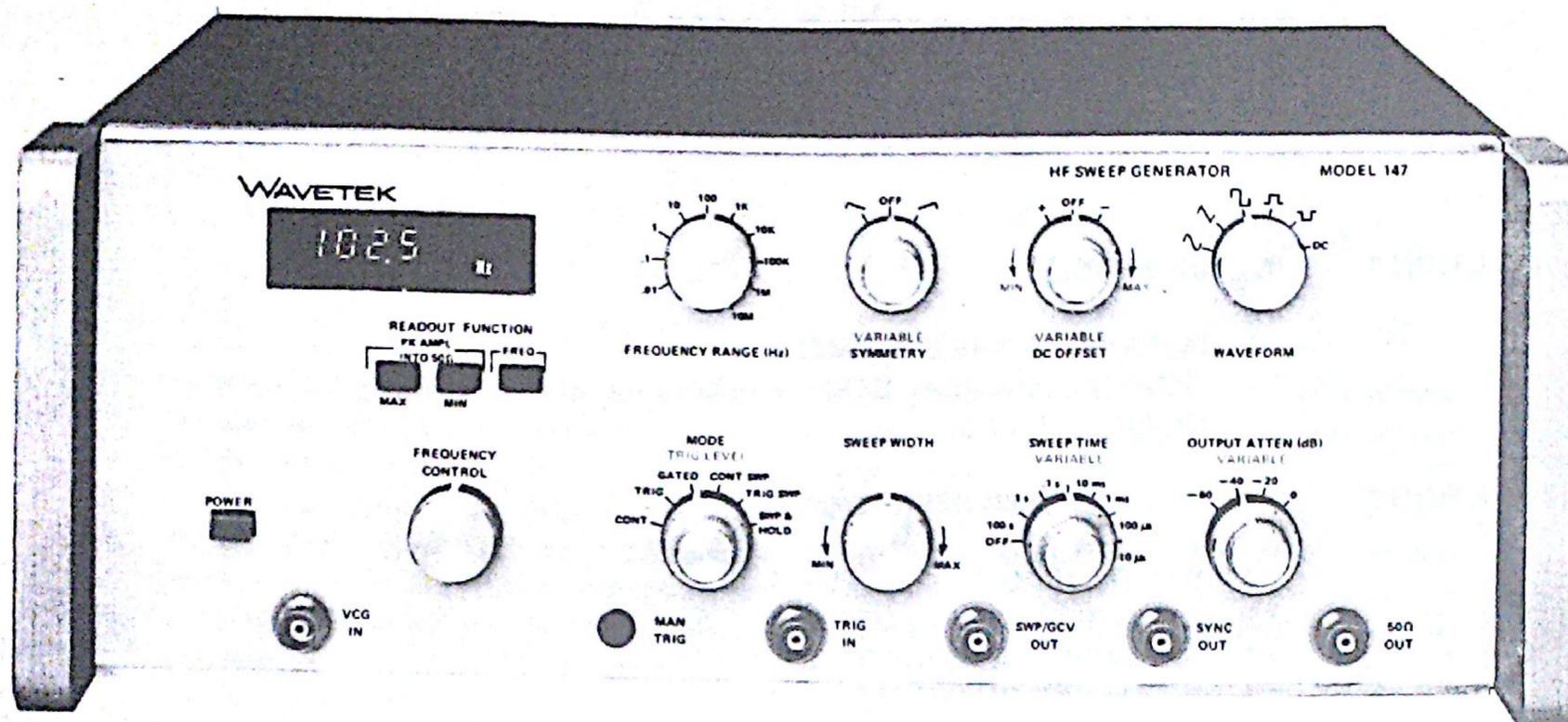


Figure i – Model 147 HF Sweep Generator

SCOPE OF THIS MANUAL

This manual provides descriptive material and instructions for the installation, operation, maintenance, and repair of this instrument. Wavetek's product improvement program ensures that the latest electronic developments are incorporated in all Wavetek instruments by the addition of circuit and component changes as rapidly as development and testing permit. Due to the time required to document and print instruction manuals, it is not always possible to incorporate the more recent changes in the released manual. In this case, data will be found on engineering change sheets at the rear of the manual. If no change sheets are included, the manual is correct as printed.

SECTION 1

INTRODUCTION

1.1 PURPOSE OF THE EQUIPMENT

The Model 147 HF Sweep Generator is a precision 0.0005 Hz to 10 MHz source of sine, triangle, square, positive pulse, and negative pulse waveforms, each with variable amplitude, dc offset, and symmetry. Frequency range selection is provided in 10 decades, with a 3½ digit LED readout and vernier control which permits accurate adjustment to the least significant digit of the readout. The 3½ digit readout is 3 digits plus a fourth (the most significant) digit of 0 or 1. DC voltage output is also selectable with an adjustable range of ± 10 Vdc into an open circuit (± 5 Vdc into 50Ω) with 150 mA short circuit current.

Maximum output amplitude is 30 V p-p into an open circuit (15 V p-p into 50Ω) with a 60 dB calibrated step attenuator and a 20 dB vernier attenuator (80 dB overall) allowing signal levels as low as 1.5 mV p-p. Both the output waveform and the dc offset are attenuated by the 60 dB calibrated step attenuator. Maximum and minimum output peak voltages are displayed on the 3½ digit LED readout and are accurate to the specification when the output has been properly terminated with 50Ω load.

The Model 147 has six operational modes (continuous, triggered, gated, continuous sweep, triggered sweep, and sweep and hold) plus tone burst capability. The main output can be internally swept over approximately a 1000:1 ratio at sweep times from 10 μ s to 100 s, or it can be frequency modulated, dc programmed, or externally swept over a greater than 1000:1 ratio by applying an external control signal to the front panel VCG IN connector. A single cycle of output, or one full sweep of the output, can be obtained by manual trigger or an external trigger signal applied to the front panel TRIG IN connector.

In addition to the 50Ω main output and sync output, the Model 147 also has sweep and generator control voltage (GCV) outputs. When the main output is not internally swept (i.e., operating in continuous, triggered, or gated modes without sweeping), the fixed amplitude sawtooth output of the internal sweep generator appears at the SWP/GCV OUT connector. When the main output is internally swept, an output voltage proportional to the instantaneous frequency of the main generator will appear at the SWP/GCV OUT connector. This GCV output can be used to

drive X-Y recorders or the vertical and horizontal deflection circuits of oscilloscopes, video monitors, etc.

Varying the triangle symmetry produces a sawtooth signal with a rise or fall time as fast as 50 ns at a recurring rate of up to 1 MHz. Pulse outputs as narrow as 50 ns (duty cycles from 19:1 to 1:19) with repetition rates as high as 1 MHz can be generated in either polarity. Even the sine wave symmetry may be varied over this 1:19 to 19:1 range if desired. When the output symmetry is not 1:1, the frequency range setting is divided by approximately 10; however, the actual output frequency is displayed on the LED readout.

With this instrument it is possible to internally or externally sweep the output frequency, select the output symmetry desired, and manually vary the dc offset. The output frequency, positive peak amplitude and negative peak amplitude are displayed on a digital readout. DC offset or dc output voltage can be set by digital readout. These capabilities coupled with the variety of waveforms available and precision output amplitude control make the Model 147 an extremely versatile instrument.

1.2 GENERAL PHYSICAL DESCRIPTION

The Model 147 weighs approximately 12 lb (5.45 kg) net and 16 lb (7.26 kg) when shipped. It is 14½ in. (368 mm) wide, 5¼ in. (133 mm) high, and 14¼ in. (362 mm) deep, and is housed in a compact, ruggedized, portable case. The Model 147 is normally shipped with a 10 foot, 3 wire, detachable line cord and one copy of this instruction manual.

1.3 SPECIFICATIONS

1.3.1 Waveforms

Waveforms that may be selected are sine , square , triangle , positive pulse  and negative pulse . DC voltage may also be selected. Symmetry of all outputs are continuously adjustable from 1:19 to 19:1. Varying the triangle symmetry produces sawtooth  or  output. The Model 147 has a SWP/GCV OUTput and a SYNC OUTput with variable symmetry as described below. Signal frequency and maximum and minimum peak signal voltages are indicated by a 3½ digit LED readout.

1.3.2 Operating Frequency Range

The FREQUENCY RANGE (Hz) switch selects from 0.0005 Hz to 10 MHz in the following ranges:

0.01	0.0005 Hz to 0.01 Hz
0.1	0.005 Hz to 0.1 Hz
1	0.05 Hz to 1 Hz
10	0.1 Hz to 10 Hz
100	1 Hz to 100 Hz
1K	10 Hz to 1 kHz
10K	100 Hz to 10 kHz
100K	1 kHz to 100 kHz
1M	10 kHz to 1 MHz
10M	100 kHz to 10 MHz

The FREQUENCY CONTROL adjusts the frequency to the least significant digit of the readout.

1.3.3 Main Output

The 50Ω OUT is the output for the selectable waveform and dc voltage output. Maximum output is 30 V p-p into an open circuit; 15 V p-p into 50Ω. There is a precision output attenuator calibrated in 20 dB steps to -60 dB with an overlapping vernier for an overall attenuation of -80 dB. Output impedance is 50Ω. Short circuit current is 150 mA.

1.3.4 Sync Output

The SYNC OUT connector provides TTL compatible output level sync signal. Rise and fall times are less than 50 ns. The sync signal is a square waveform for symmetrical outputs and rectangular for asymmetrical outputs. Sync pulse polarity is 180° out of phase with the selectable output square wave and 90° out of phase with the sine and triangle waveforms.

1.3.5 DC Offset and DC Output

DC offset and dc output are controlled manually by a front panel control. The adjustable range is ±10 Vdc into an open circuit (±5 Vdc into 50Ω) with peak signal and offset amplitude limited to ±15 Vdc into an open circuit (±7.5 Vdc into 50Ω). Display will flash when peak amplitude plus offset exceeds generator limits. DC offset and output waveform are attenuated proportionately by the 60 dB step output attenuator.

1.3.6 Sweep/GCV Output

Sweep output is a 0 to nominal +5 V sawtooth when in continuous, triggered or gated mode, and runs at a frequency determined by the SWEEP TIME control. GCV (Generator Control Voltage) output is a 0 to nominal +5 V signal pro-

portional to the instantaneous frequency output. This GCV signal is present when the Model 147 is in any of the sweep modes.

1.3.7 Operational Modes

Continuous (CONT)

The Model 147 operates as a standard VCG (Voltage Controlled Generator). Frequency at the 50Ω OUT connector is determined by front panel control settings in conjunction with the VCG input signal. Output of the internal sweep generator appears at the SWP/GCV OUT connector in this mode.

Triggered (TRIG)

Only one complete cycle of output appears at the 50Ω OUT connector for each pulse applied to the TRIG IN connector or push of the MAN TRIG control. The cycle begins and ends at zero phase angle, which is zero volt or the offset base line voltage level. At least 1 V peak (and up to 50 V peak) is required for the trigger signal. TRIG IN is 10 kΩ, dc coupled.

GATED

Gated mode is the same as triggered mode except that output oscillations continue for the duration of the gating signal applied to the TRIG IN connector or push of the manual trigger. The output will be an integral number of cycles beginning and ending at zero phase angle, which is approximately zero volt.

Continuous Sweep (CONT SWP)

In continuous sweep, the main generator is swept by the internal sweep generator so that the signal frequency at the 50Ω OUT connector is swept from a low frequency established by the front panel frequency controls to a high frequency determined by the SWEEP WIDTH control setting. Sweep width can be up to approximately 1000:1. Sweep rate, determined by the SWEEP TIME control, is 10 μs to 100 s. GCV appears at the SWP/GCV connector.

Triggered Sweep (TRIG SWP)

Triggered sweep is the same as continuous sweep mode except that the output is swept only once for each pulse applied to the TRIG IN connector. During the time between sweeps, the main generator oscillates at a low frequency determined by the FREQUENCY CONTROL settings.

Sweep and Hold (SWP & HOLD)

In this mode, a gate signal at the TRIG IN connector causes the Model 147 to begin a frequency sweep. After sweeping to the high frequency (set by the SWEEP WIDTH control), the output holds at the high frequency as long as the gate signal is present. When the gate signal drops, the output returns to the frequency set by the front panel frequency controls.

Tone Burst

A tone burst can be accomplished in the gated mode by connecting the ramp output of the SWP/GCV OUT to TRIG IN. Tone burst rate, frequency and duration can be independently controlled.

1.3.8 Voltage Controlled Generator

VCG Control Range

The generator frequency can be controlled by an external voltage; e.g., five volts can vary the frequency 1000:1. Restrictions for linear operation are: frequency range selection is the upper frequency and the lower frequency is 1000 times below the frequency range selection; the required external signal for full voltage control is ± 5 V. Either restriction may be exceeded for nonlinear operation, but operation is not specified. Input impedance is 5 k Ω .

VCG Input Frequency

VCG Bandwidth	100 kHz
VCG Slew Rate	2% of range per μ s

VCG Linearity

10 Hz to 100 kHz	$\pm 0.2\%$
0.001 Hz to 1 MHz	$\pm 0.5\%$

1.3.9 Horizontal Precision

Frequency Readout Accuracy

0.01 Hz to 10 kHz	$\pm(0.3\%$ of range ± 1 digit)
10 kHz to 10 MHz	$\pm(0.2\%$ of range ± 1 digit)

Time Symmetry

10 Hz to 100 kHz	$\pm 0.5\%$
0.01 Hz to 500 kHz	$\pm 1.0\%$

1.3.10 Vertical Precision

Amplitude Readout Accuracy

1 Hz to 100 kHz	$\pm(3\%$ of full output ± 1 digit)
100 kHz to 10 MHz	$\pm(5\%$ of full output ± 1 digit)

Sine Wave Frequency Response

Amplitude change with frequency is less than:

0.1 dB to 100 kHz
0.2 dB to 1 MHz
2.0 dB to 10 MHz

Step Attenuator Accuracy

± 0.25 dB per 20 dB step

Stability

Short Term	$\pm 0.05\%$ for 10 minutes
Long Term	$\pm 0.25\%$ for 24 hours

Percentages apply to amplitude, frequency, and dc offset.

Amplitude Symmetry

All waveforms (except pulse) are symmetrical about ground within $\pm 1\%$ of maximum peak to peak amplitude.

1.3.11 Purity

Sine Wave Distortion

10 Hz to 100 kHz	Less than 0.5% (typically 0.25%)
100 kHz to 1 MHz	Less than 1.0%
1 MHz to 10 MHz	All harmonics are at least 28 dB down

Triangle Linearity

0.0005 Hz to 100 kHz	Greater than 99%
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Square Wave Rise and Fall Time

Less than 30 ns when terminated in 50 Ω load.

Total Aberrations

Less than 5%.

1.3.12 Environmental

Temperature

All specifications listed, except for stability, are for 25 $^{\circ}$ C $\pm 5^{\circ}$ C. For operation from 0 $^{\circ}$ C to 55 $^{\circ}$ C, derate all specifications by a factor of 2.

1.3.13 Mechanical

Dimensions

14 $\frac{1}{2}$ in. (368 mm) wide; 5 $\frac{1}{4}$ in. (133 mm) high; 14 $\frac{1}{4}$ in. (362 mm) deep.

Weight

12 lb (5.45 kg) net; 16 lb (7.26 kg) shipping.

Power

90 to 110 V, 105 to 125 V, 180 to 220 V or 210 to 250 V;
50 to 400 Hz switchable; less than 50 watts.

SECTION 2

INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to knobs, connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

Connect the ac line cord to the mating connector at the rear of the unit.

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 105 - 125 Vac line supply and with 1/2 amp, 115 V line fuse.

Conversion for 90 to 110 V, 180 to 220 V or 210 to 250 V operation requires resetting two switches on the inside of the rear panel. To reset the switches, unscrew the four captive screws securing the rear panel, and remove the rear panel. Set the two switches and select the fuse for the ac line voltage according to the following table.

AC Line Voltage	Switch A	Switch B	Fuse (SB)
90 - 110	115	LO	½ amp
105 - 125	115	HI	½ amp
180 - 220	230	LO	¼ amp
210 - 250	230	HI	¼ amp

2.2.2 Signal Connections

Use 50Ω shielded cables equipped with female BNC connectors to distribute all signals when connecting this instrument to associated equipment.

2.3 OPERATING CONTROLS

The operating controls and electrical connections for the Model 147 are shown in Figure 2-1. The listing below discusses each control and its function.

1. **POWER Switch** – Power is on when this push button switch is in, and off when extended.
2. **READOUT FUNCTION FREQ Push Button** – When this push button is depressed, it causes the signal frequency at the 50Ω output to be displayed.
3. **READOUT FUNCTION PK AMPL, MAX/MIN Push Buttons** – MAX push button, when depressed, causes the maximum peak signal voltage to be displayed; MIN causes the minimum peak voltage to be displayed.
4. **Display and Readout Functions** – A fully automatic, direct reading display of the generator frequency and peak voltage outputs. When PK AMPL MAX or MIN push button is depressed, maximum or minimum peak voltage, respectively, is displayed. When the FREQ push button is depressed, the frequency is displayed. This is a 3½ digit display with sign, decimal point, and unit of measure. The decimal point is automatically positioned and the correct unit of measure automatically displayed. The three least significant digits each can be 0 through 9 while a fourth digit, the most significant, can be 0 or 1 only. The display is updated three times a second. The voltmeter is updated once every cycle.

NOTE

- A. *Display voltage is output voltage when the 50Ω output connector is properly terminated with a 50Ω load.*
- B. *For operation in the 0.01 Hz or 0.1 Hz range, amplitude display is instantaneous voltage value in a tracking mode rather than peak voltage. To set peak amplitudes, select a higher frequency range, set the peaks, then*

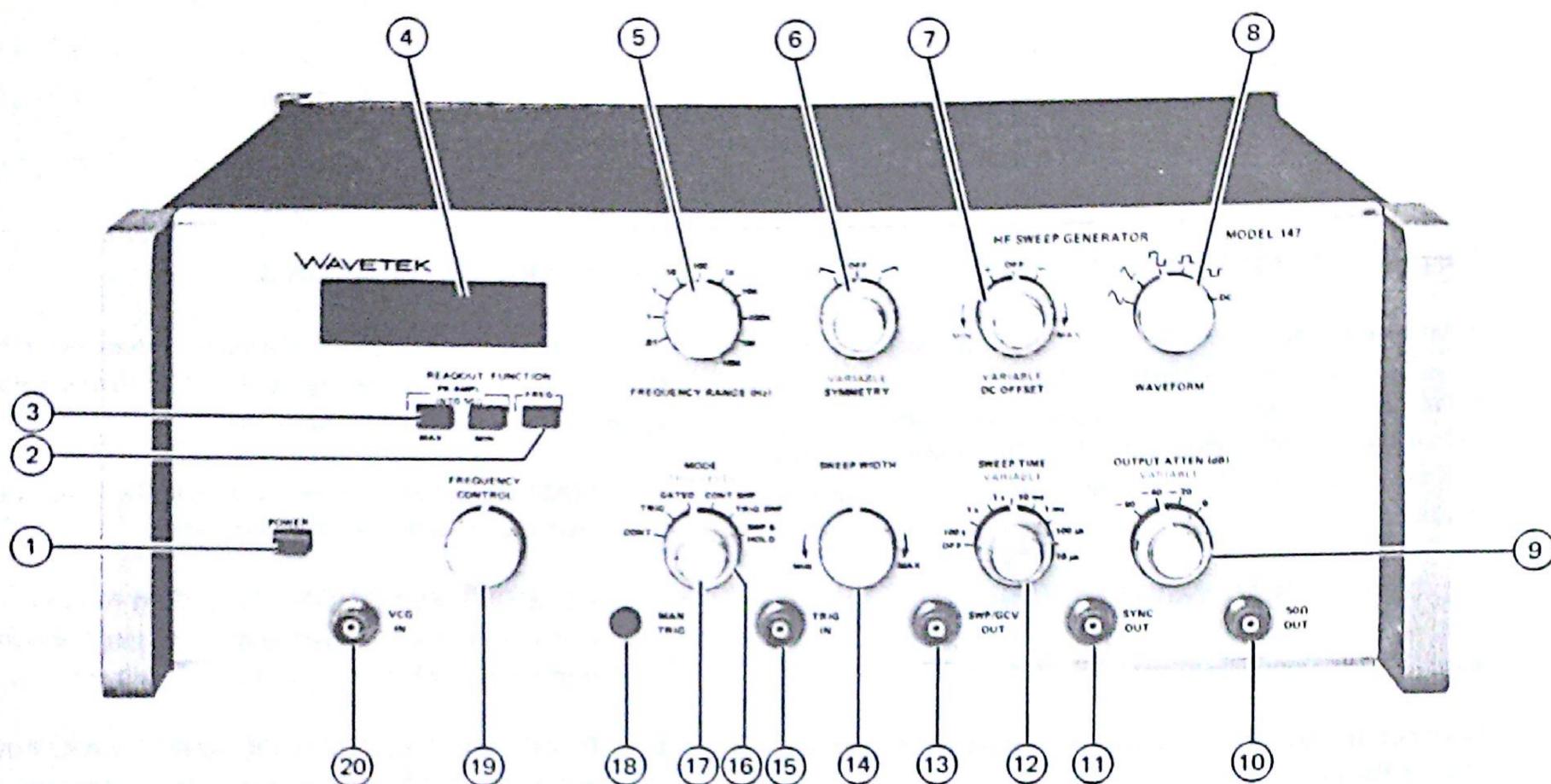


Figure 2-1. Operating Controls

return to the lower frequency range. In the 1 Hz through 10 MHz ranges, the amplitude display is updated once every cycle.

5. **FREQUENCY RANGE (Hz) Switch** – Selects one of the 10 frequency ranges. The range number represents the maximum frequency obtainable for the selected range. Some overranging exists.
6. **SYMMETRY Control** – The large knob selects a right-hand or left-hand waveform time-symmetry. The small VARIABLE knob varies the waveform time-symmetry up to 19:1 or 1:19. When these controls are used, the frequency range is divided by approximately ten; however, the readout shows actual output frequency.
7. **DC OFFSET Control** – Adjusts dc base line offset above (+) or below (–) signal ground; or, when DC is selected on the WAVEFORM switch, adjusts dc voltage at the 50Ω output. The large knob selects polarity, and the small VARIABLE knob adjusts voltage up to

±10 Vdc into an open circuit (±5 Vdc into 50Ω load).

Peak circuit output is limited to ±15 Vdc into an open circuit (±7.5 Vdc into a 50Ω load). (The OUTPUT ATTEN (dB) switch (9) affects dc offset as well as waveform amplitude.)

8. **WAVEFORM Selector** – This selects the waveform that appears at the 50Ω output. The waveforms are sine \sim , triangle ∇ , square \square , positive going pulse $\text{—} \uparrow \text{—}$, negative going pulse $\text{—} \downarrow \text{—}$, and DC voltage. See Figure 2-2 for phase and polarity relationships.
9. **OUTPUT ATTEN (dB) Control** – The large knob attenuates the 50Ω output from 0 dB (15 V p-p max into 50Ω load) to –60 dB (15 mV p-p into 50Ω) in 20 dB steps. The small VARIABLE knob may be used to continuously change the amplitude between the detented steps up to 40 dB. Maximum attenuation is –80 dB (1.5 mV p-p into 50Ω). The OUTPUT ATTEN (dB) VARIABLE control is inoperative when DC is selected on the WAVEFORM switch.

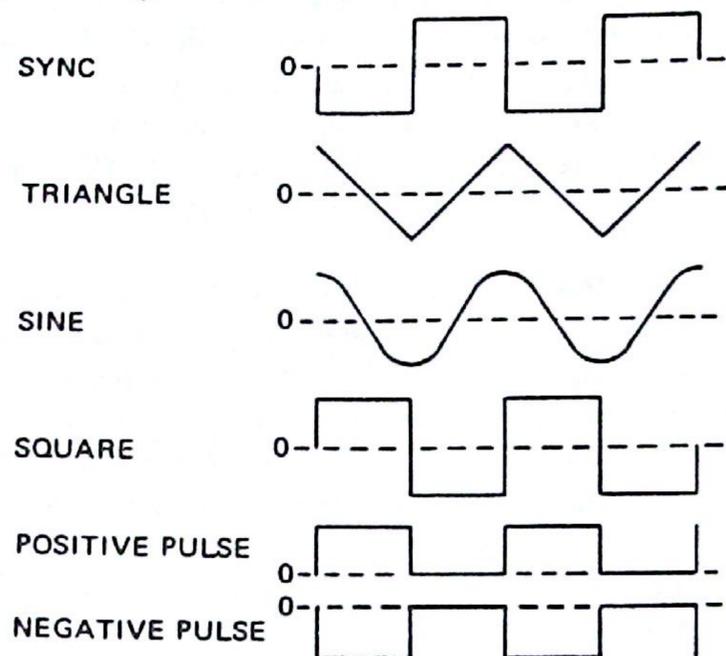


Figure 2-2.

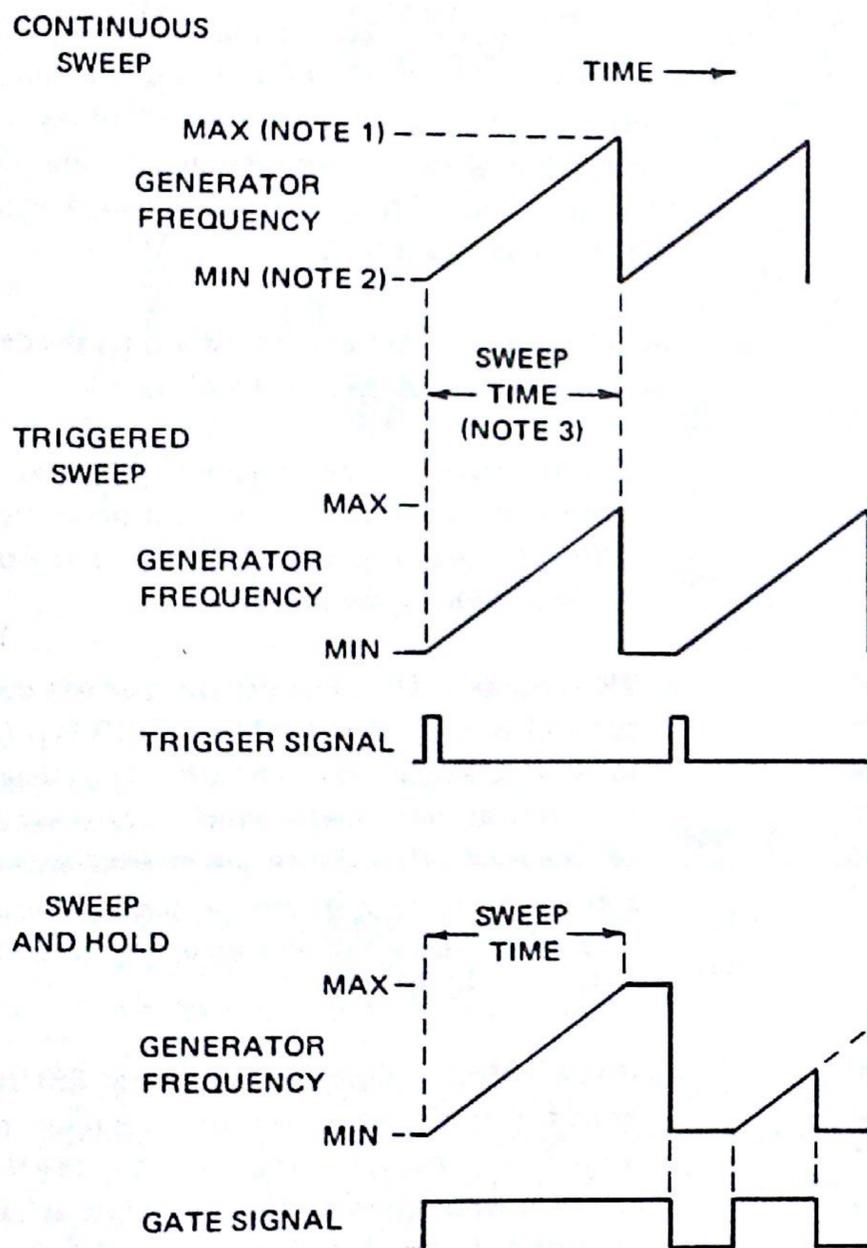
Selectable and Sync Signal Phase and Polarity Relationships

10. **50Ω OUT** – This is the selected waveform output for the main generator or a dc voltage. The Model 147 operating into an open circuit provides 30 V maximum, or into a 50Ω load provides a 15 V p-p output. The displayed amplitude is correct for the 50Ω termination.
11. **SYNC OUT** – This is a square wave (or rectangular if SYMMETRY control is in use) with the same frequency and opposite polarity of the selectable square wave at the 50Ω output. Amplitude into an open circuit is greater than 4 V p-p (2 V p-p into 50Ω). Rise and fall times are less than 50 ns. See Figure 2-2 for phase and polarity relationships.
12. **SWEEP TIME Control** – When in any of the sweep modes, this control determines the duration of the sweep cycle by controlling the frequency of the sweep generator, which is independent of the frequency of the main generator. The large knob selects the range, which is bounded by the time values printed on the panel on either side of the detent setting. The small VARIABLE knob varies the time throughout the range; when full cw, the sweep time is equal to the time printed to the right of the detent line; rotating the VARIABLE knob ccw increases the sweep time at least by 10:1 and up to 100:1. The full ccw position is not calibrated.
13. **SWP/GCV OUT** – When the generator is in CONT, TRIG, or GATED mode, this output provides a fixed 0 to nominal +5 V sawtooth. The frequency of this sawtooth is controlled by SWEEP TIME. When the generator is in CONT SWP, TRIG SWP, or SWP & HOLD mode, the output becomes the generator control voltage (GCV) that is proportional to main generator frequency.

This voltage may be used to drive the X-axis of an oscilloscope in the X-Y mode or the X-axis of an X-Y recorder, thus converting the recording device from the time to the frequency domain.
14. **SWEEP WIDTH Control** – Determines the amount of sweep when in one of the sweep modes by varying the amplitude of the sweep signal.
15. **TRIG IN** – A dc coupled input with 10 kΩ input impedance. The TRIG LEVEL control adjusts the sensitivity of the generator to this input signal. Sensitivity can be varied to accept signals greater than 1 V to greater than 7.5 V, positive or negative voltage. Maximum voltage is 50 V.
16. **MODE Switch** – Selects the operating mode of the main generator (50Ω OUT) as follows:
 - a. **CONT Mode** – The generator operates at the selected frequency and runs continuously. (The SWP/GCV output is a fixed 0 to 5 V ramp in this and the following two modes.)
 - b. **TRIG Mode** – The generator will give one complete cycle of output when the MAN TRIG is pressed or for each pulse applied to TRIG IN. The cycle begins and ends at zero phase, which is zero volts or dc voltage level offset. Since the internal sweep operates independently it can be used to provide a repetitive trigger signal by connecting the SWP/GCV OUT to TRIG IN.
 - c. **GATED Mode** – Operates the same as TRIG MODE except that the generator will continue to have output for the full time that the MAN TRIG switch is held down or the gate signal at TRIG IN exceeds the gating level set by the TRIG LEVEL control.
 - d. **CONT SWP Mode** – The main generator operates continuously and repetitively sweeps from the minimum to maximum frequency as determined by the sweep controls. See Figure 2-3. (In this mode as in the following two sweep modes, SWP/GCV OUT becomes the generator control voltage (GCV) which is proportional to the instantaneous frequency of the generator.)
 - e. **TRIG SWP Mode** – The main generator oscillates at the start or low frequency until a trigger signal

is applied. The frequency then sweeps to the maximum frequency as determined by SWEEP WIDTH and then returns to the low frequency until another trigger is applied. See Figure 2-3.

- f. **SWP & HOLD Mode** – When gated, the generator sweeps to the high frequency and remains at the high frequency for the duration of the gate signal. When the gate falls, the generator returns to the low frequency. See Figure 2-3.



NOTES

1. Set by *SWEEP WIDTH* control.
2. Set by *FREQUENCY* control.
3. Set by *SWEEP TIME* control.

Figure 2-3. Sweep Modes

17. **TRIG LEVEL Control** – Adjusts the sensitivity of the TRIG IN circuitry. When full ccw, approximately +7.5 V or greater voltage is required for triggering.

In the full cw position, approximately -7.5 V or greater voltage is required for triggering. By rotating the knob, it is possible to manually trigger the generator. In the GATED mode, the generator will begin to run continuously as the control is rotated cw past the midpoint. When using the MAN TRIG, this control must be ccw of the midpoint.

18. **MAN TRIG** – When in TRIG mode, pressing this switch causes one cycle of the selected waveform to appear at the 50Ω output. When in GATED mode, the waveform is continuous while the switch is pressed. The TRIG LEVEL control must be ccw from midpoint for proper MAN TRIG operation.
19. **FREQUENCY CONTROL** – A combination coarse and fine control used in conjunction with the FREQUENCY RANGE switch and the display to select the desired frequency. The fine or vernier portion of the FREQUENCY CONTROL covers approximately 30 degrees of knob rotation. After the knob has been rotated through the vernier range, further rotation is in the coarse control range. Reversing the direction of rotation immediately places the knob back in the 30 degrees of vernier range again. The usual procedure is to rotate the knob just past the desired frequency, reverse the direction of rotation, and use the fine control range to accurately select the desired frequency.
20. **VCG IN** – This connector allows external control of frequency. With 0 volt in, the generator frequency (50Ω OUT) is determined by the frequency range selected and the FREQUENCY CONTROL setting and is displayed on the LED readout. A positive VCG voltage will increase this frequency, and a negative voltage will decrease the frequency. Input impedance is 5 kΩ. Restrictions for linear operation are (1) FREQUENCY RANGE selection is the upper frequency and the lower frequency is 1000 times below the FREQUENCY RANGE selection and (2) 5 V is the maximum voltage input. Either restriction may be exceeded for nonlinear operation, but operation is not specified.

2.4 INSTALLATION CHECKS

The following procedures are used to determine that the instrument is operating properly. Field calibration and check-out instructions are given in Section 4 to ensure that the instrument complies with the specifications. If the instrument is not operating properly or within specifications, refer to the warranty on the back of the title page.

Use a Tektronix Model 454 oscilloscope or equivalent when performing these installation checks.

1. After connecting the line cord to the ac line, set the front panel controls and switches as follows:

POWER	In
FREQUENCY RANGE	1K
SYMMETRY	OFF
DC OFFSET	OFF
WAVEFORM	
OUTPUT ATTEN (dB)	0
OUTPUT ATTEN (dB) VARIABLE	Fully Clockwise
SWEEP TIME	OFF
MODE	CONT
READOUT FUNCTION FREQ	In
2. Connect the 50Ω OUT connector with a shielded cable terminated in a 50 ohm load to the oscilloscope and set FREQUENCY CONTROL to obtain a 1 kHz reading on the 147 display.
3. Press the PK AMPL MAX push button. Approximately +7.5 V should be displayed. Press MIN; approximately -7.5 V should be displayed. Observe the oscilloscope and verify the 1 kHz sine wave and peak voltages.
4. Set the OUTPUT ATTEN (dB) VARIABLE control full ccw. Approximately -0.7 V should be displayed. Compare with oscilloscope values.
5. Check minimum and maximum amplitudes of sine  and triangle  waveforms. They should be approximately plus and minus 7.5 V at 0 dB.
6. Check minimum and maximum amplitudes of positive and negative pulse waveforms  and . They should be approximately +7.5 V, 0 V and 0 V, -7.5 V, respectively at 0 dB.
7. Set the OUTPUT ATTEN (dB) VARIABLE control full clockwise and the WAVEFORM switch to  and press the FREQ push button. Adjust the FREQUENCY CONTROL for a 1 kHz readout.
8. Switch the FREQUENCY RANGE control to check range-to-range tracking accuracy. The 147 should read approximately the FREQUENCY RANGE value. Verify the frequencies with the oscilloscope.
9. Select the square waveform and rotate the SYMMETRY switch to  and the VARIABLE control full clockwise. Waveform asymmetry should be approximately 19:1. Rotate the VARIABLE control full ccw; the waveform should be symmetrical. Verify that the other switch position and VARIABLE control give approximately 1:19 waveform asymmetry.
10. Turn the SYMMETRY switch to OFF; press the PK AMPL MAX push button and select DC on the WAVEFORM switch.
11. Set the DC OFFSET switch to + and rotate the VARIABLE control full clockwise. The readout should be approximately +5 V. Verify the reading with the oscilloscope.
12. Set the DC OFFSET switch to -. Readout should be approximately -5 V. Verify the reading with the oscilloscope.
13. Rotate the OUTPUT ATTEN (dB) switch through each position. Verify the attenuation on the oscilloscope. (The VARIABLE control is inoperative for DC.)
14. Turn the DC OFFSET switch to OFF and connect the SWP/GCV OUT to the oscilloscope without a load. With the SWEEP TIME switch set to 10 ms/1 ms and the VARIABLE control set full clockwise (1 ms sweep), verify that the SWP/GCV OUT waveform is approximately a 1 kHz sawtooth. Set the VARIABLE control full ccw. The SWP/GCV OUT waveform should be approximately 100 Hz.
15. Check the SWP/GCV OUT frequency in all positions of the SWEEP TIME switch and at both the cw and ccw ends of the VARIABLE control.
16. Use a shielded cable equipped with BNC connectors to connect SWP/GCV OUT to TRIG IN and connect the oscilloscope to 50Ω OUT. Set the MODE switch to TRIG, the WAVEFORM switch to  and the SWEEP TIME to 1 s/0.1 s. Rotate the TRIG LEVEL control while observing the oscilloscope. One cycle of the waveform should be displayed each time the sweep output triggers the main generator.
17. Set the MODE switch to GATED and rotate the TRIG LEVEL control while observing the oscilloscope. The multiple cycles of the selected output waveform should appear when the TRIG LEVEL control is rotated full cw and disappear when the control is turned full ccw.
18. This step sets low and high frequencies of the sweep range. Disconnect the cable to TRIG IN. Set the MODE switch to SWP & HOLD, the SWEEP WIDTH control full clockwise, the TRIG LEVEL control to 9 o'clock and the FREQUENCY RANGE switch to 10K. Set the SWEEP TIME switch to 100 s/1 s and the SWEEP TIME VARIABLE control full clockwise. Set the output frequency to 0.1 kHz with the FREQUENCY CONTROL. Rotate the TRIG LEVEL control to 3 o'clock and set the SWEEP WIDTH control

for a 10 kHz readout. Repeat the low and high frequency settings because of interaction. Set the MODE switch to CONT SWP. Set the SWEEP TIME VARIABLE control full ccw. The displayed output should sweep from 100 Hz to 10 kHz.

19. Set the MODE switch to TRIG SWP and press the MAN TRIG switch while observing the oscilloscope. Displayed output should sweep once from 100 Hz to 10 kHz.
20. Connect the SWP/GCV OUT connector to the oscilloscope input without a load. Set the MODE switch to CONT, SWEEP TIME switch to 10 ms/1 ms and the SWEEP TIME VARIABLE control full clockwise. The oscilloscope should display approximately a 1 kHz sawtooth waveform.
21. Set the MODE switch to TRIG and then to GATED. The same 1 kHz sawtooth waveform should be present in these modes.
22. Set the MODE switch to CONT SWP, then TRIG SWP, then SWP & HOLD. The SWP/GCV OUT signal should be a GCV signal proportional to the instantaneous frequency of the main generator.

2.5 OPERATING PROCEDURE

No preparation for operation is required beyond the completion of the initial installation checks given in Paragraph 2.4. A one-half hour warm-up period should be allowed for the associated equipment to reach a stabilized operating temperature, and for the Model 147 to attain stated accuracies.

2.5.1 Operation as a Function Generator

1. Properly terminate the 50Ω OUT connector for accurate voltage readings.
2. Select desired output waveform using the WAVEFORM switch.
3. Set MODE switch to CONT.
4. Press the FREQ push button; set the FREQUENCY RANGE switch to the desired range, and set FREQUENCY CONTROL for the desired frequency. (For frequency readout press the READOUT FUNCTION FREQ push button.)
5. Set the OUTPUT ATTEN (dB) switch for the desired output level and amplitude. (For amplitude readout, press the READOUT FUNCTION AMPL MAX or MIN push button.) For reference, Table 2-1 gives the approximate output amplitude levels at attenuator

settings. The output levels of the positive and negative pulse waveforms are one half of these levels. The maximum amplitude voltage is ±7.5 volts.

Table 2-1

Attenuator Position	Peak to Peak Output into 50Ω Load	
	Maximum (variable full cw)	Minimum (variable full ccw)
0 dB	15 V	1.5 V
-20 dB	1.5 V	150 mV
-40 dB	150 mV	15 mV
-60 dB	15 mV	1.5 mV

6. With the DC OFFSET and SYMMETRY controls turned to OFF, the output waveform should be a symmetrical waveform oscillating around a zero dc reference point (except when a positive or negative pulse has been selected).
7. To add dc offset, first set the DC OFFSET control for the polarity of dc offset desired. Next, change the WAVEFORM switch to DC position and, using the readout display, adjust the DC OFFSET VARIABLE control until the desired amount is read on the display. Return the WAVEFORM switch to the selected waveform position. If an excessive amount of dc offset is used, waveform clipping may be observed and the display will flash. The sum of peak waveform voltage and the dc offset cannot exceed the maximum rated output of the generator. For example, on the 0 dB attenuator setting, the maximum output is 15 V peak-to-peak or 7.5 V peak above and below zero volt. Therefore, offset plus the peak voltage cannot exceed 7.5 V peak. See Figure 2-4.

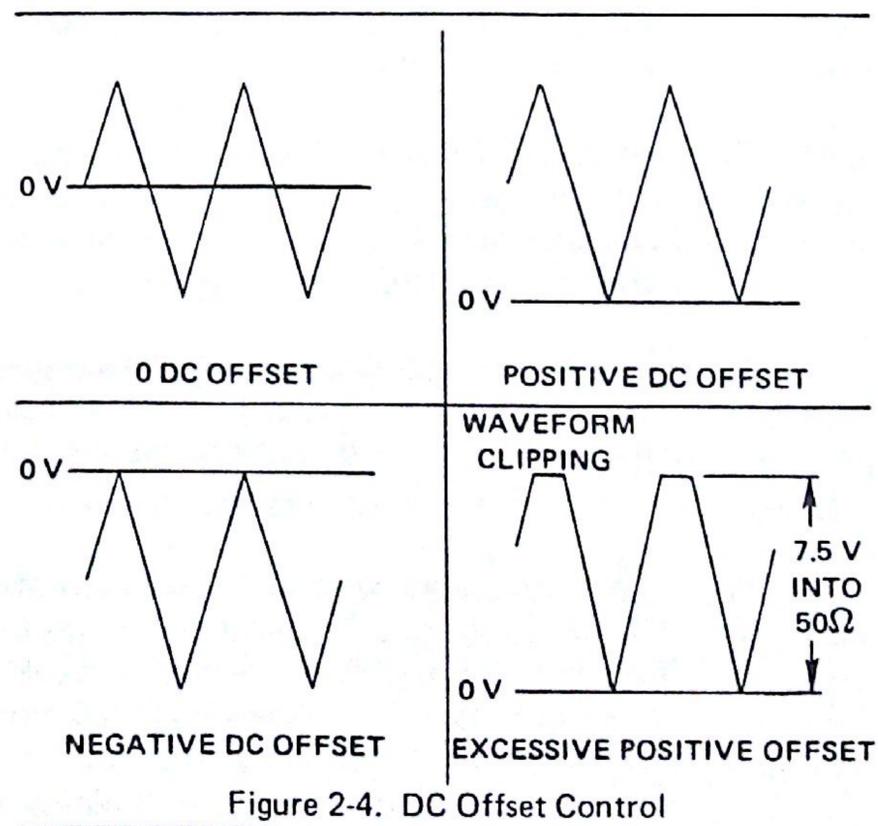


Figure 2-4. DC Offset Control

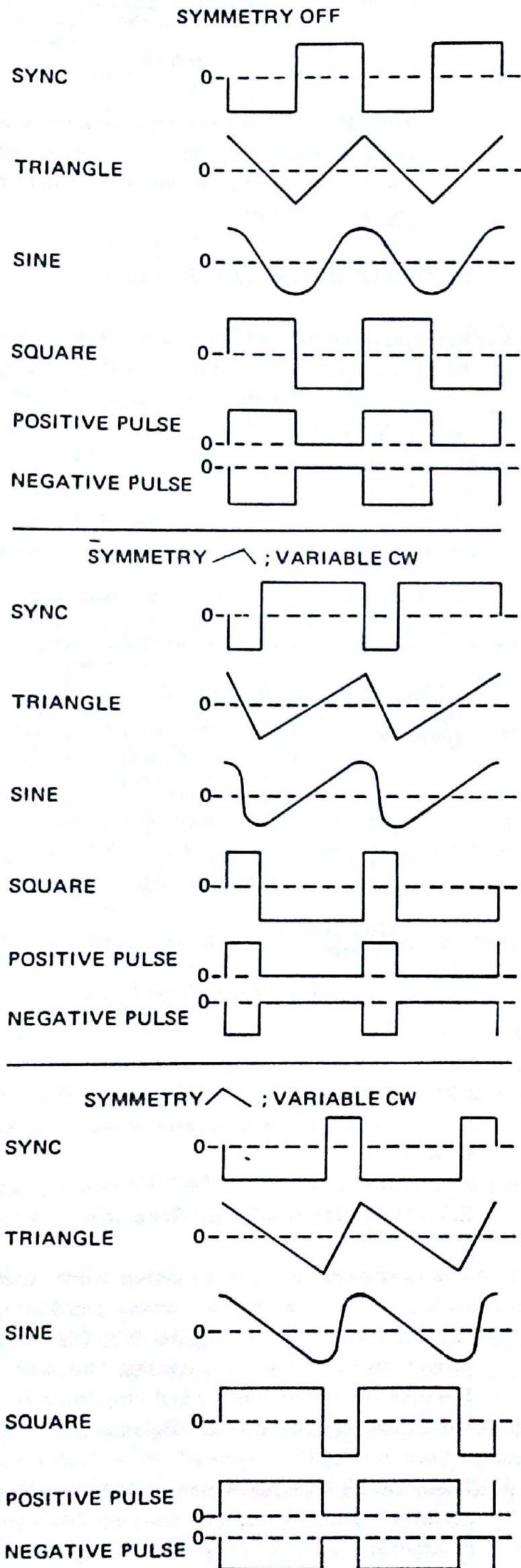


Figure 2-5. Waveform Phasing and Symmetry Control

8. Set SYMMETRY control for desired symmetry or asymmetry. The symmetry control can be used to develop ramp waveforms with variable rise/fall ratios and single or multiple pulses with variable duty cycles. By using the sine wave with asymmetry, controllable sine distortion can be developed. Figure 2-5 shows the effect of this control on output waveforms. The frequency of an asymmetrical waveform will be approximately a factor of 10 lower than the symmetrical waveform frequency output.

2.5.2 Operation as a Voltage Controlled Generator

The VCG input connector can be used to externally control the frequency of the generator. If a positive voltage is applied to the VCG input terminal, the frequency will increase from the FREQUENCY CONTROL setting. A negative voltage will cause the frequency to decrease from the FREQUENCY CONTROL setting.

A 5 V excursion in VCG voltage can vary the frequency up to 1000:1 in each range as follows:

Range	Limits for Linear Operation	
	Lower	Upper
0.01	0.01 mHz	0.01 Hz
0.1	0.1 mHz	0.1 Hz
1	1 mHz	1 Hz
10	10 mHz	10 Hz
100	100 mHz	100 Hz
1K	1 Hz	1 kHz
10K	10 Hz	10 kHz
100K	100 Hz	100 kHz
1M	1 kHz	1 MHz
10M	10 kHz	10 MHz

As shown, the range setting is the upper limit. This limit may be exceeded as there is a 10 to 20% overranging capability; however, overranging will be nonlinear and the operation is unspecified. Operation below the lower limit of any range setting is not recommended.

The nomograph of Figure 2-6 shows the characteristics of the VCG circuit. Column A gives a factor which is multiplied by the FREQUENCY RANGE to give the frequency shown in the readout. (Example: Column A X FREQUENCY RANGE = Readout Frequency or $0.3 \times 100 = 30.0$ Hz.) Column B is the voltage applied to the VCG IN. Column C (like A) is the factor which is multiplied by the FREQUENCY RANGE to give the frequency shown in the readout after the VCG voltage has been applied.

EXAMPLE:

Freq Range	Readout	Column A	Column B	Column C	Readout
100	30.0 Hz	0.3	+3.5 V	1	100 Hz
100	30.0 Hz	0.3	-1.5 V	0.001	0.1 Hz

NOTE

A further increase in VCG voltage will cause nonlinear operation as the range value will be exceeded.

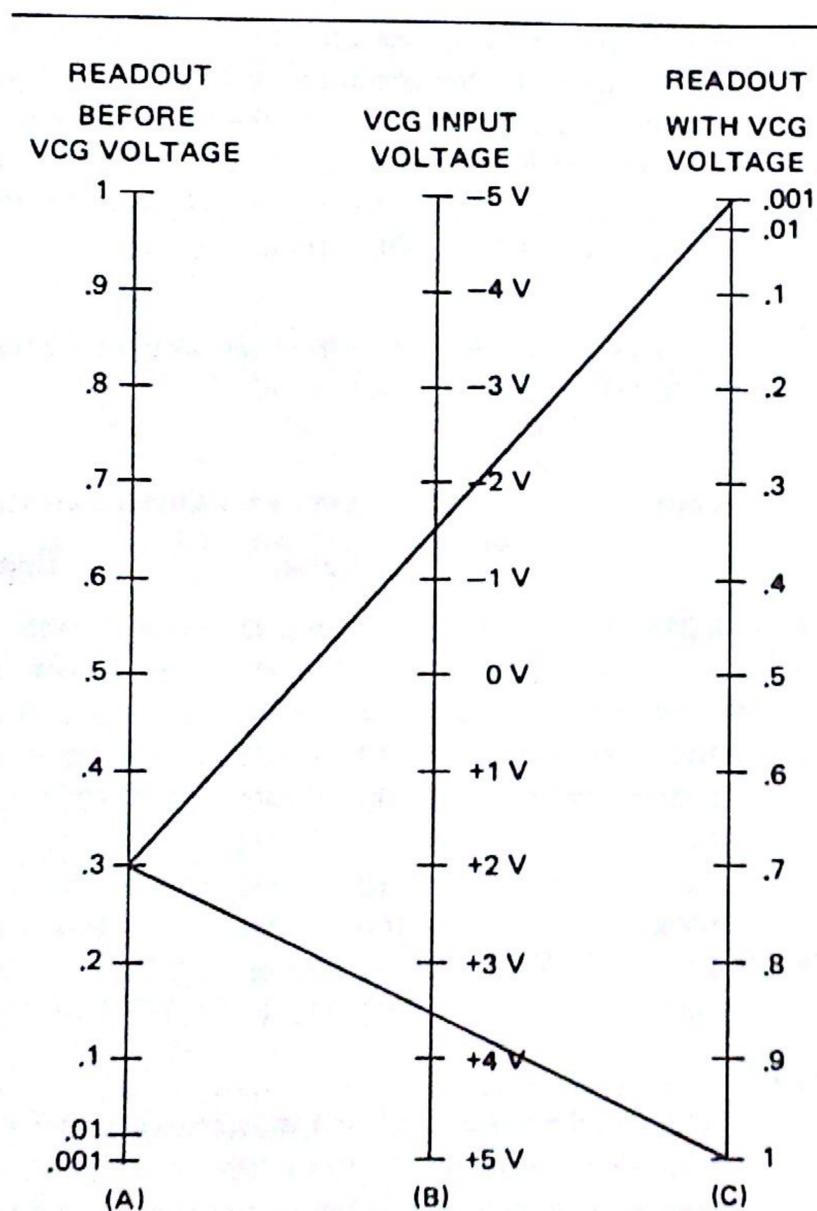


Figure 2-6. VCG Voltage-to-Frequency Nomograph

2.5.3 Operation as a Triggered Generator

1. Adjust the generator as for continuous operation (Paragraph 2.5.1); then set the MODE switch to TRIG.
2. If manual triggering is desired, set the TRIG LEVEL control (small knob) to the 11 o'clock position. For external triggering, set the TRIG LEVEL control to exclude undesirable trigger levels.

3. Operate the MAN TRIG switch or apply a 1 to 50 V signal to the TRIG IN connector.

NOTE

The SWP/GCV output may be used as a repetitive trigger source. In this case, the SWEEP TIME control determines the repetition rate of the triggered output signal.

2.5.4 Gated or Tone Burst Operation

With the generator adjusted as in trigger operation, change the MODE control to GATED position. The generator output will then be a burst of cycles. If the trigger is the SWP/GCV OUT sawtooth waveform, the duration of the burst is adjustable by the TRIG LEVEL control (see Figure 2-7). Notice that the last cycle gated is completed even if the gate signal is removed. In manual gating, the tone burst continues as long as the manual switch is pressed.

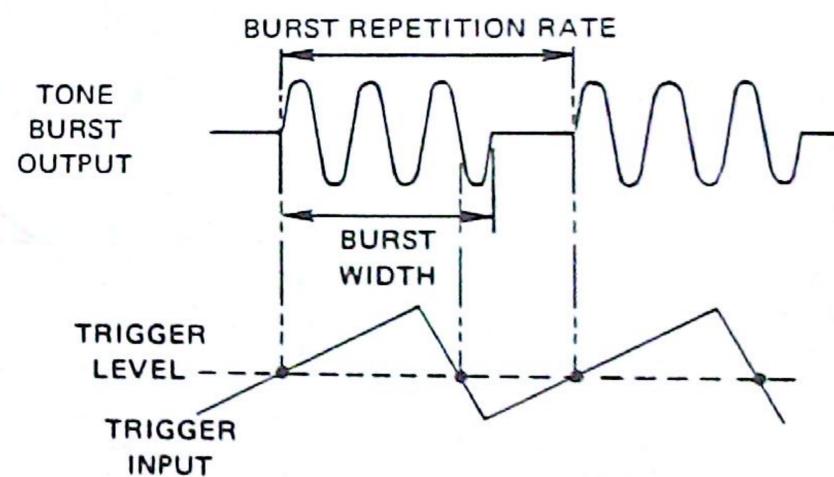


Figure 2-7. Gated Operation

The generator can be made to free run in this mode at certain settings of the trigger level control. By resetting the TRIG LEVEL control, normal gated operation can be re-established.

2.5.5 Operation as a Sweep Generator

The operation of the three sweep modes (continuous with sweep, triggered sweep, and sweep and hold) can be visualized by the graphs in Figure 2-3. Operation consists of proper terminations, and setting the low and high end frequencies, sweep time, signal amplitude and sweep mode. All are covered in the following example.

These modes together with the GCV output can be used to perform frequency response tests and drive an X-Y recorder or oscilloscope for display of the frequency response. As an example, Figure 2-8 shows a circuit under test which is to be swept and the frequency response of the circuit displayed

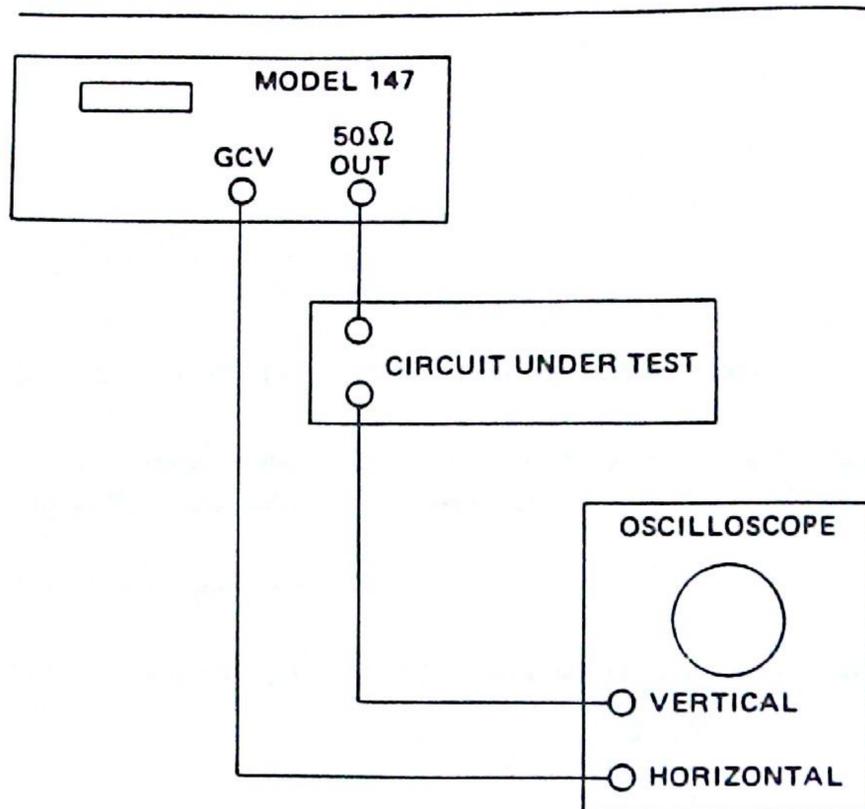


Figure 2-8. Frequency Response Test Using an Oscilloscope in the X-Y Mode

on the oscilloscope. Figure 2-9 shows a similar setup using an X-Y recorder. The following procedure is used to set up the Model 147 as a sweep generator.

1. Terminate the 50Ω output with 50Ω . Setup as in Figure 2-8 or 2-9 except bypass the circuit under test for this setup procedure.
2. Set the MODE switch to SWP & HOLD, the SWEEP TIME switch to OFF, and TRIG LEVEL to 9 o'clock.
3. Depress the READOUT FUNCTION FREQ push button and use the FREQUENCY RANGE switch and the FREQUENCY CONTROL switch to obtain the desired low frequency on the display.
4. Set the SWEEP TIME controls for the desired sweep time.
5. Rotate the TRIG LEVEL control to 3 o'clock. The frequency sweeps to the top and holds. Then rotate the SWEEP WIDTH control until the desired top frequency is displayed.
6. Rotate the TRIG LEVEL control back to 9 o'clock and reset the low frequency. Check the top frequency again and return the TRIG LEVEL control back to 9 o'clock.

7. Use the READOUT FUNCTION PK AMPL push buttons and the display and the OUTPUT ATTEN (dB) controls to obtain the desired signal amplitude.
8. With the circuit under test bypassed, and the oscilloscope, if used, in the external horizontal mode, adjust the horizontal position so that the trace is positioned on the left reticle on the screen or chart.
9. Rotate the TRIG LEVEL control to 3 o'clock and adjust the horizontal gain of the oscilloscope or recorder so that the waveform is positioned on the extreme right hand reticle, or any convenient reticle of the screen or chart for proper scaling.
10. Set the SWEEP TIME controls as desired for sweep duration. Sweep fast for the best oscilloscope presentation and sweep slow if the X-Y recorder is used.
11. For continuous sweep, rotate the MODE switch to TRIG. For triggered sweep or sweep and hold operation, adjust the TRIG LEVEL control to 9 o'clock for manual triggering or gating, or adjust as desired for external triggering or gating.
12. Insert the circuit to be tested as in Figures 2-8 or 2-9 and observe the frequency response characteristics shown on the oscilloscope or recorder.

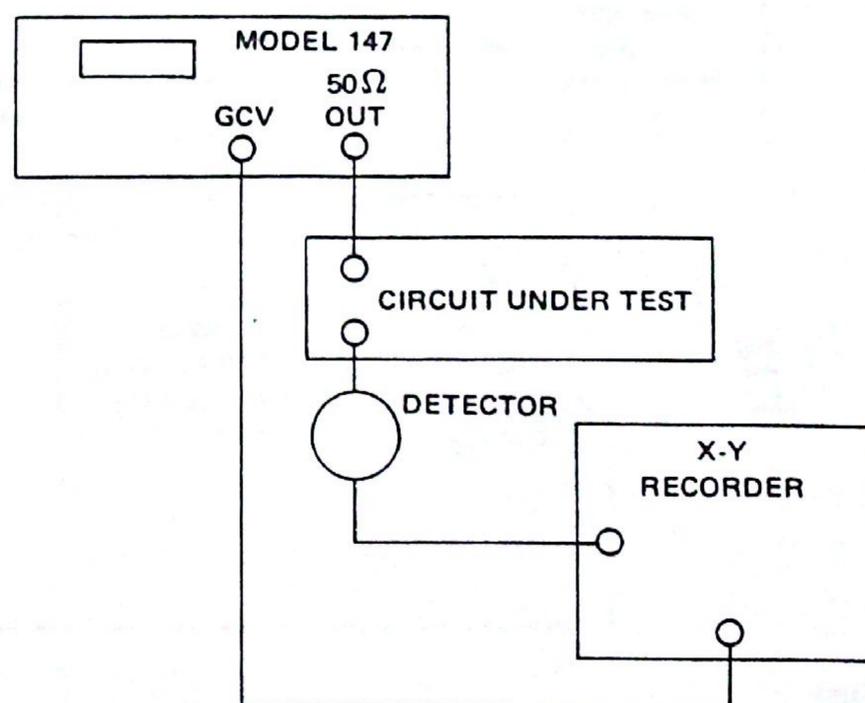


Figure 2-9. Frequency Response Test Using an X-Y Recorder

SECTION 3

CIRCUIT DESCRIPTION

3.1 SIMPLIFIED BLOCK DIAGRAM ANALYSIS

This paragraph describes, briefly, the major circuit elements and their relationship to one another.

3.1.1 Main Generator

Refer to Figures 3-1 and 3-2 when reading this description.

As shown in Figure 3-1, the VCG summing amplifier sums the currents from the FREQUENCY CONTROL, vernier, and VCG IN connector. The VCG summing amplifier is an inverting amplifier whose output voltage is used to control a positive current source and a negative current source. For symmetrical output waveforms, the currents from the two current sources are equal and directly proportional to the voltage of the VCG summing amplifier output. The diode

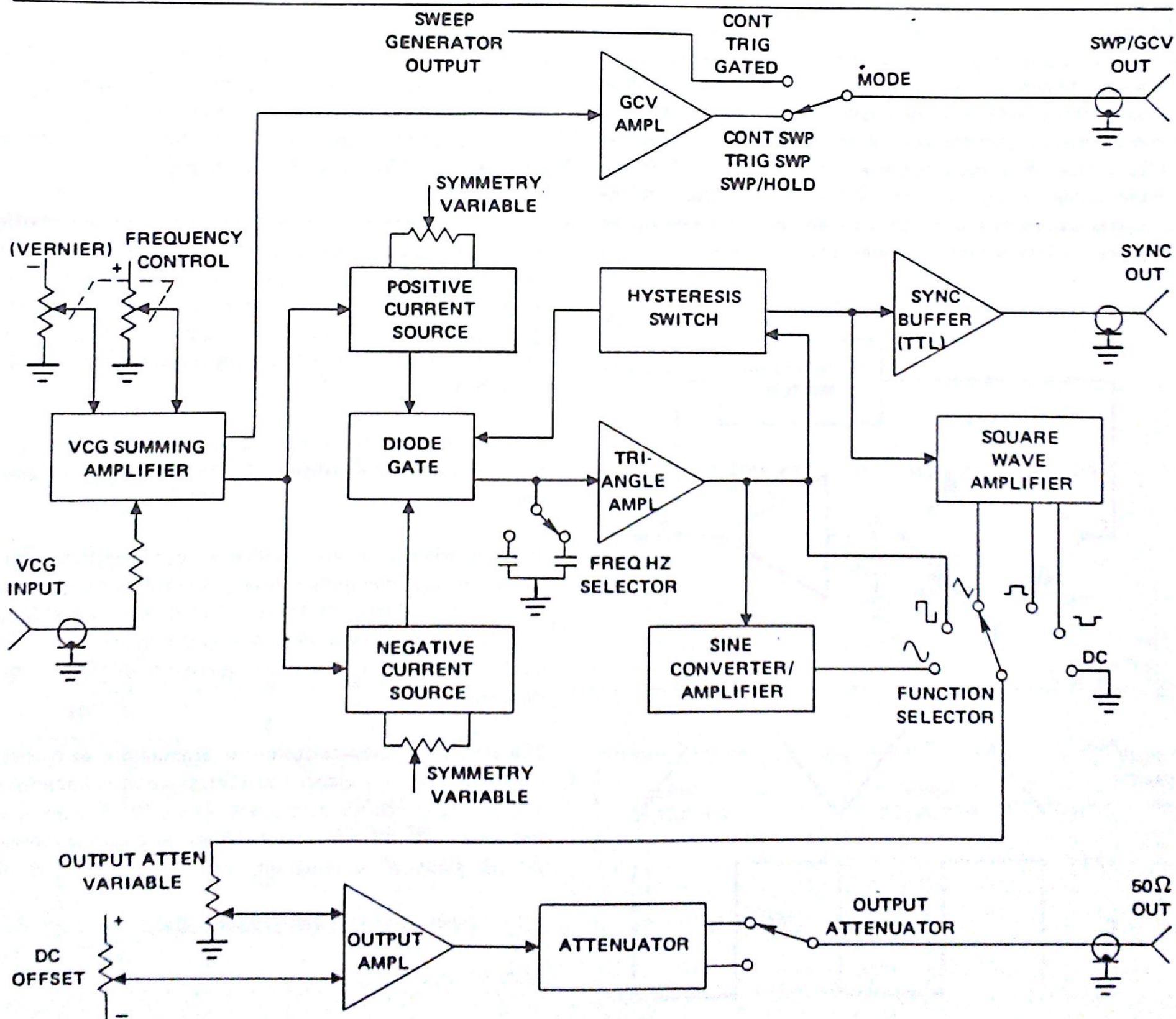


Figure 3-1. Main Generator Block Diagram

gate, which is controlled by the hysteresis switch, is used to switch the positive current or the negative current to the timing capacitor selected by the FREQUENCY RANGE (Hz) selector. If the positive current is switched into the timing capacitor, the voltage across the capacitor will rise linearly to generate the triangle rise transition. If the current is negative, the voltage across the timing capacitor will fall linearly to produce the fall transition.

The triangle amplifier is a unity gain amplifier whose output is fed to the hysteresis switch as well as to the sine converter. The hysteresis switch has two voltage limit points (+1.25 V and -1.25 V).

During the time the output voltage of the triangle amplifier is rising, the output voltage of the hysteresis switch is positive. But when the output voltage of the triangle amplifier reaches +1.25 V, it triggers the hysteresis switch causing the switch output to go negative. Once the control voltage into the diode gate becomes negative, it will switch the positive current out and switch the negative current in to the timing capacitor, so that the voltage across the capacitor will reverse, starting a linear decrease of the waveform. When the decreasing voltage reaches -1.25 V, the output of the hysteresis switch will switch back to positive, reversing the process. This action generates the triangle waveform as

shown in Figure 3-2. Since the output of the hysteresis switch is a square wave, the result is simultaneous generation of a square wave and a triangle wave at the same frequency.

The output frequency is determined by the magnitude of the capacitor selected by the FREQUENCY RANGE (Hz) selector and the magnitude of the positive and negative current sources. Since the current sources are linearly proportional to the control voltage of the VCG circuit, the output frequency will also be linearly proportional to the control voltage.

If the current of the negative current source is decreased by 19 times, the fall time of the triangle will be 19 times longer than the rise time of the triangle, resulting in an unsymmetrical waveform and a division of the frequency by a factor of 10. Gradually increasing the current from the negative current source and decreasing the current from the positive current source in such a way that the period for the triangle to complete one cycle remains constant, the symmetry of the output waveform can be continuously varied while the frequency is held constant.

The output of the hysteresis switch is fed to the sync buffer and also the square wave amplifier. The square wave amplifier consists of a shaping circuit which limits the output swing to ± 1.25 volts. For positive pulse outputs, it limits the output voltage swing from -1.25 V to 0 V; and for negative pulse outputs, it limits the output swing from 0 V to +1.25 V.

The output signal from the triangle amplifier is applied to the sine converter, consisting of a sine shaping circuit and a sine amplifier.

The sine, triangle, square, positive pulse, or negative pulse is fed to the output amplifier through the WAVEFORM selector switch and the OUTPUT ATTEN (dB) VARIABLE control. The output amplifier is an inverting amplifier whose output is fed into a step attenuator and then to the output BNC connector.

The attenuator consists of three pi attenuators, each having a 50 ohm input impedance and a 50 ohm output impedance. There is one -20 dB attenuator, one -40 dB attenuator, and one -60 dB attenuator. These attenuators provide 20 dB steps of attenuation, from 0 dB to -60 dB.

3.1.2 Sweep Generator and Trigger Logic

CONTINUOUS MODE

In this mode, both the main generator and the sweep generator operate independently. As shown in Figure 3-3,

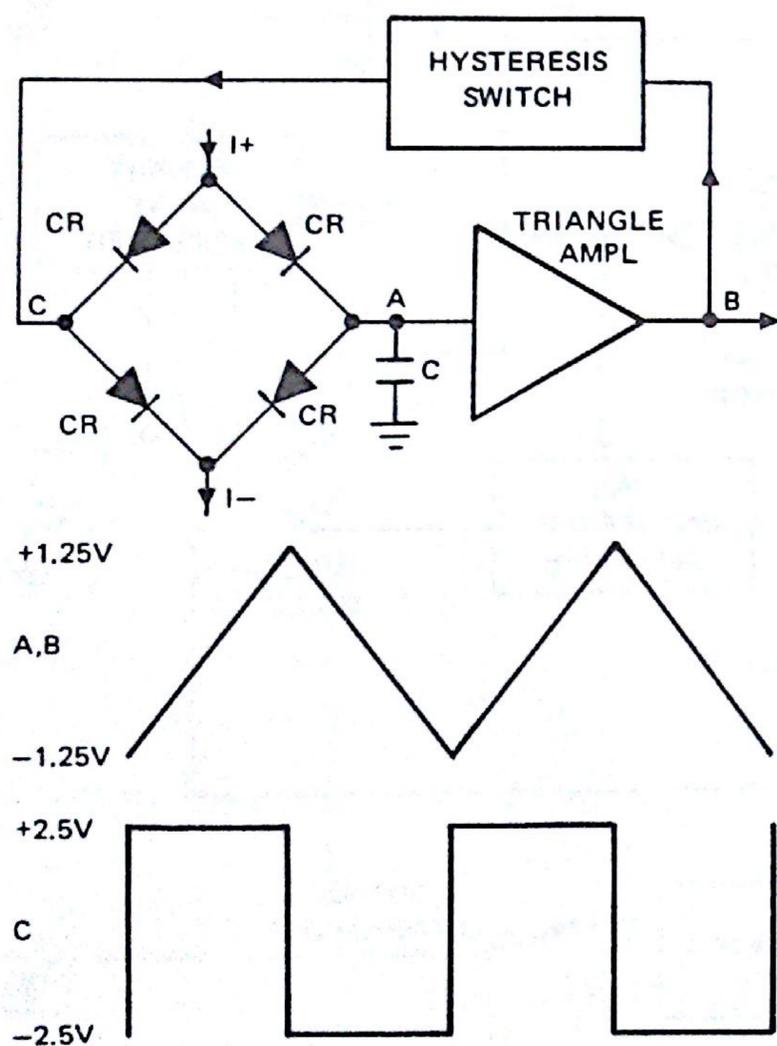


Figure 3-2. Basic Generator Timing Diagram

the sweep generator is a passive integrator with a voltage controlled current source. The output of the sawtooth amplifier changes the states of both the peak and zero detectors when either the peak or the zero limit is reached, thus switching on and off the current source output. The result of this charging and discharging of the timing capacitor is a continuous generation of a sawtooth waveform.

The charging and discharging rate of the timing capacitor, and also the repetition rate of the sawtooth waveform, are proportional to the amount of current fed into the capacitor and the size of the capacitor. The amount of current output is proportional to the controlling voltage and the current programming resistor. Thus, the repetition rate is controlled by the SWEEP TIME VARIABLE control and the SWEEP TIME range selector switch.

The current source switch provides a shunt path to signal ground for the timing capacitor when the sawtooth waveform is in the negative slope region. Switching action is activated by the peak detector and the zero detector outputs. The sawtooth amplifier is a non-inverting, high input impedance, high slew rate amplifier providing low output impedance and complete isolation for the passive integrator.

The peak and zero detectors accomplish detection of both extremes of the sawtooth waveform. The outputs of these two detectors, in conjunction with other transistor switches, cause the current source switch to place a shunt path across the timing capacitor or remove the shunt path. Thus, the operational loop is completed for the continuous mode operation of the sweep generator.

TRIGGERED OR GATED MODE

Refer to Figure 3-4. In both the triggered and the gated modes, the main generator and the sweep generator operate independently.

When this instrument is in the TRIG mode and ready, the main generator diode gate is switched off by the trigger gate control, and the timing capacitor is discharged through the shunt path. When a trigger signal arrives at the trigger gate control, the control flip-flop changes the state, opening the diode gate. Current flows into the timing capacitor, allowing the passive integrator to generate a triangle waveform. The control flip-flop is reset by the square wave from the sync amplifier when the proper phase triggers the flip-flop. The flip-flop output, in conjunction with the level-

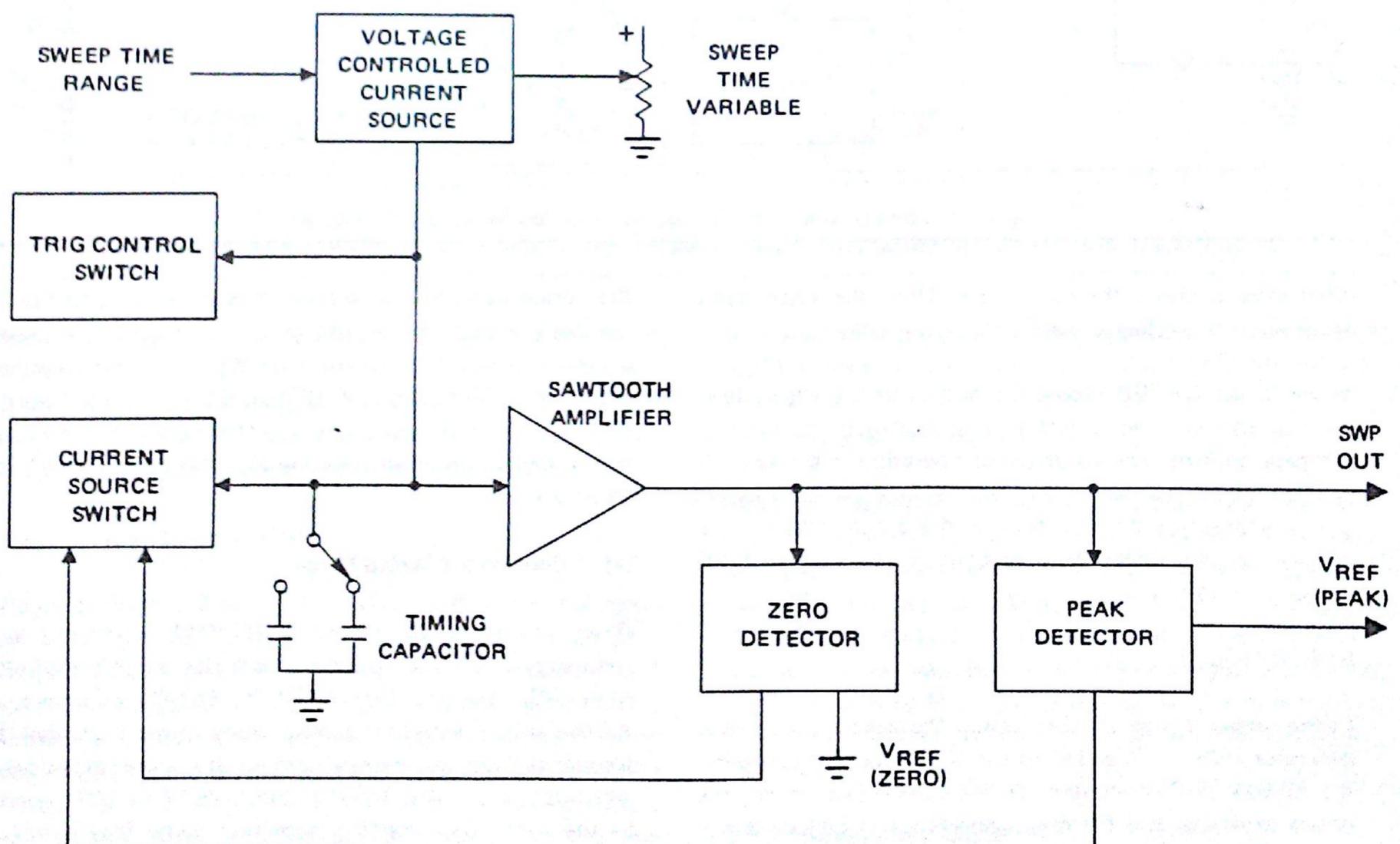


Figure 3-3. Sweep Generator Block Diagram

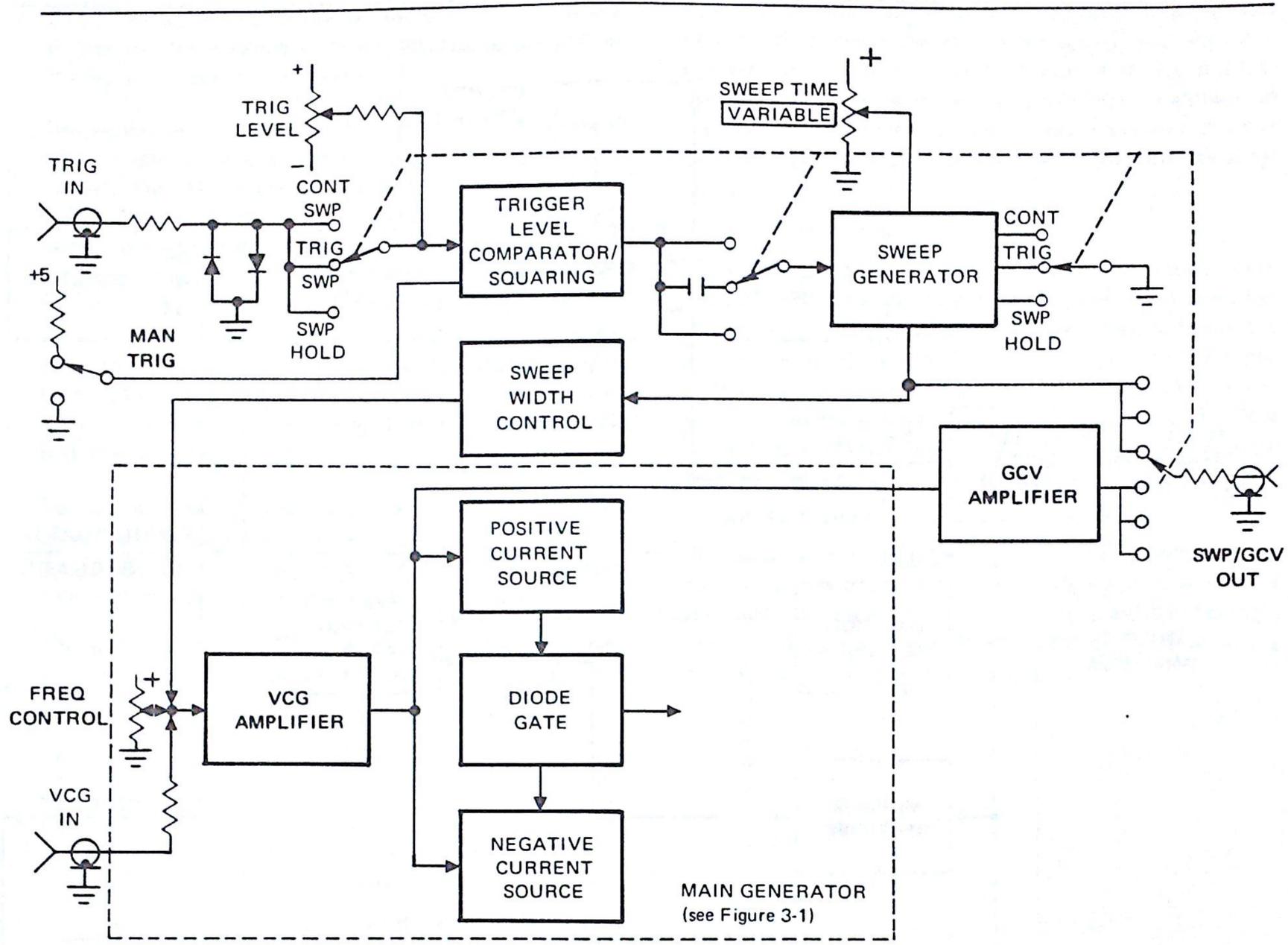


Figure 3-5. Sweep Generator Continuous Sweep, Triggered Sweep, and Sweep and Hold Mode Block Diagram

the basic frequency is set to less than 1/100 of the maximum frequency in the selected range. The swept output waveform repeats for as long as the MODE switch is set to CONT SWP. SWEEP TIME switch and SWEEP TIME VARIABLE control determine the sweep repetition rate.

(b) Triggered Sweep Mode

Refer to Figure 3-5. In the TRIG SWP mode, the main generator runs continuously at the minimum frequency set by the FREQUENCY CONTROL and the FREQUENCY RANGE (Hz) selector. The sweep generator is, initially, in a standby condition. When an input trigger signal is applied at the TRIG IN connector, or the MAN TRIG is depressed, the output of the trigger level comparator/squaring circuit changes the state of the trigger/gate control circuit. The output of the trigger level comparator/squaring circuit is coupled through a capacitor to release the sweep generator clamp for a single cycle. Thus, a single sweep of the main

generator is accomplished. The operation of the SWEEP WIDTH control is the same as in the CONT SWP mode.

(c) Sweep and Hold Mode

Refer to Figure 3-5. In the SWP HOLD mode, the main generator continuously generates the minimum frequency set by the FREQUENCY CONTROL and FREQUENCY RANGE (Hz) selector. When the TRIG IN is gated, or MAN TRIG depressed, the sweep generator will ramp up and hold at its maximum until the gate signal is removed from TRIG IN or MAN TRIG is released. The operation of the SWEEP WIDTH control is the same as in the CONT SWP mode.

3.1.3 Measurement Circuitry

Refer to Figure 3-6. The main board contains the necessary circuit for frequency counting and displays. The frequency

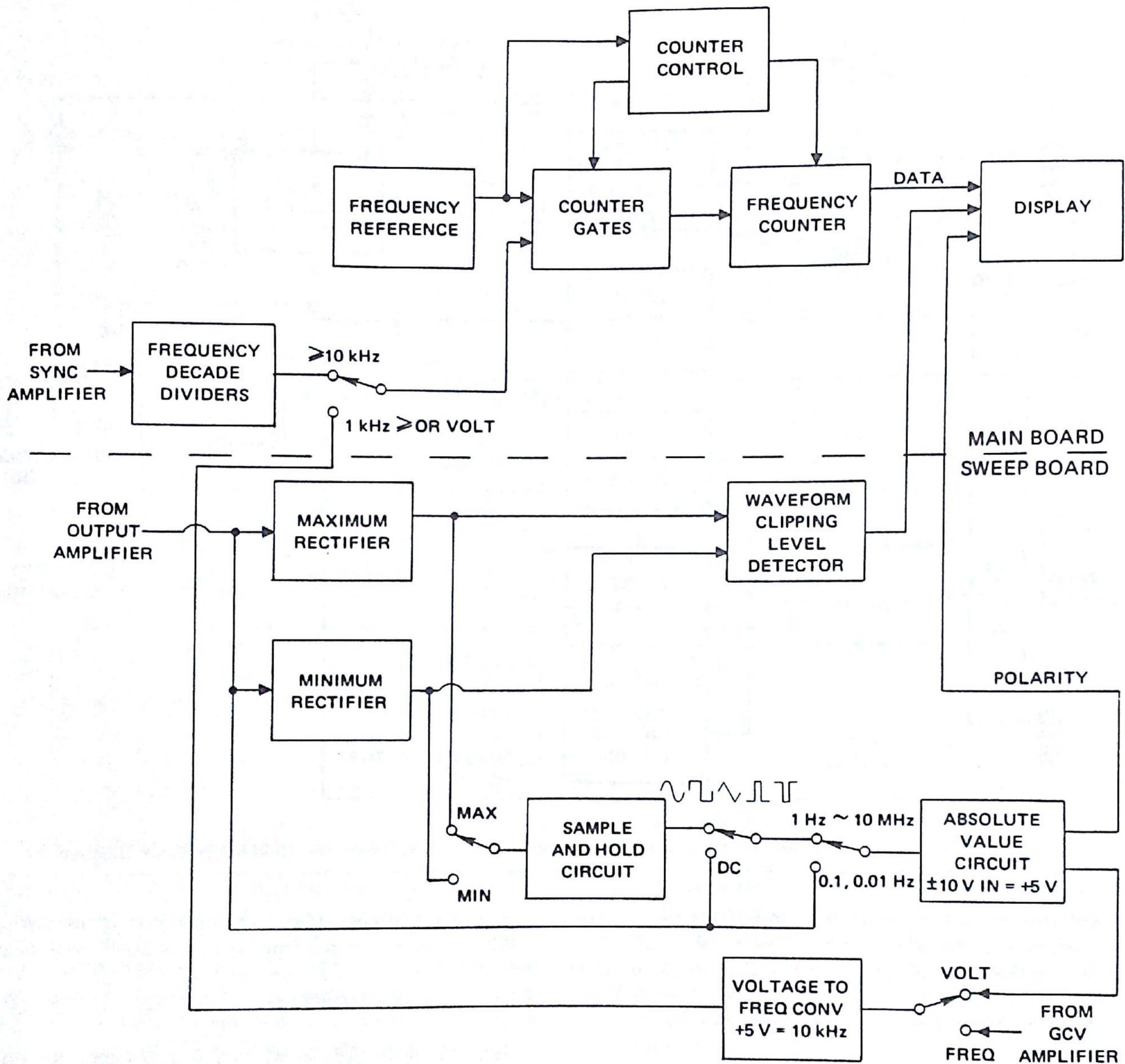


Figure 3-6. Measurement (Voltage and Frequency) Circuit Block Diagram

reference is a stable fixed frequency generator set precisely at 40 Hz.

The counter gate opens precisely for 200 ms and the frequency counter counts the number of pulses which went through the gate during the interval.

In order to normalize the maximum digits ($3\frac{1}{2}$ digits) displayed, the frequency decade dividers are provided in front of the counter gates. Thus, the counter gates receive

the full scale frequency of 10 kHz, whether 10 MHz or 10 kHz range measurements, by dividing the sync amplifier output by 1000 or none.

The sweep board contains the necessary circuits for peak reading and low frequency measurement (less than 1 kHz range).

The output of the output amplifier is fed to four circuits: the output attenuator network, the dc voltage divider, and two rectifiers.

The dc voltage divider is used in the 0.1 Hz, 0.01 Hz and dc modes. The amplifier voltage is divided in half and fed directly to the absolute value circuit.

The minimum and maximum rectifiers use a trim cap in their divider circuits to compensate for high frequency roll-off. The 741 operational amplifier is a gain of one buffer, compensating for the voltage drop on the rectifying diode. At higher frequencies, the output from the buffer is a flat dc; at lower frequencies, the output tries to follow the input, but the waveform peaks are rectified enabling the sample and hold circuit to sample accurately. For the extreme low frequency, the sampled data is stored in digital form until the next sampling signal occurs. Thus, the inaccuracy caused by the discharging of capacitor in the sample and hold circuit is eliminated.

Pressing the MIN or MAX switch will connect the corresponding rectifier to the sample and hold circuit. The FET gate is pulsed once a cycle at the peak of a selected waveform and the capacitor is charged to the peak value.

The sampling sync pulse is controlled by the sync logic circuitry on the main board.

The WAVEFORM switch and FREQUENCY RANGE (Hz) switch will connect the dc divider output (dc, 0.01 Hz, 0.1 Hz) or the sample and hold output to the absolute value circuit. This circuit will invert a negative voltage, so the output is positive voltage. It also generates the polarity indicator for the display logic circuit on the main board.

When the instrument is in the minimum or maximum position, the output of the absolute value circuit is connected to the voltage to frequency converter. The voltage to frequency circuit gives an output of 10 kHz for an input of +5.00 volts. In the frequency position, the output from the GCV amplifier is fed to the voltage to frequency converter. The GCV is scaled to give an output of +5.00 volts to the maximum frequency of the range, when adjusted.

The waveform clipping detector is a simple voltage limit detector whose input is set to approximately ± 7.6 volts. If the limit is exceeded, the signal is sent to the display logic and the display will indicate the condition by blinking the data readout (whatever is displayed).

SECTION 4

MAINTENANCE

4.1 ACCESS INSTRUCTIONS

The Model 147 is packaged so that it can be quickly disassembled to afford access to the majority of components within the unit, while allowing the instrument to be operated.

4.1.1 Removing the Dust Cover

To remove the dust cover (case) from the Model 147, the following procedure should be followed:

1. Unplug the ac line cord and unscrew the four captive screws on the rear panel.
2. Remove the rear panel and power supply.
3. Unplug power supply connector from power supply board. Slide dust cover off slowly.
4. At this time, the power supply can be remounted and the Model 147 may be operated normally.

4.1.2 Disassembly for Troubleshooting or Repair

1. Complete Steps 1 through 3 of Paragraph 4.1.1.
2. Remove the six screws which hold the main board in place.
3. Remove the top row of knobs off the front panel by pulling on them slowly.
4. To remove the main board, have the front panel facing you. Place your finger between the two boards at the connectors and lift the top connectors up until they come free of the pins. With the back of the board slightly raised, carefully slide the control shafts out of the front panel.

CAUTION

THE SWEEP BOARD (BOTTOM BOARD) MUST BE SUPPORTED WHILE PUSHING THE CONNECTOR ONTO THE PINS.

CAUTION

5. To put the main board in the maintenance position (see Figure 4-1), stand the main board up and slowly lower it onto the pin.

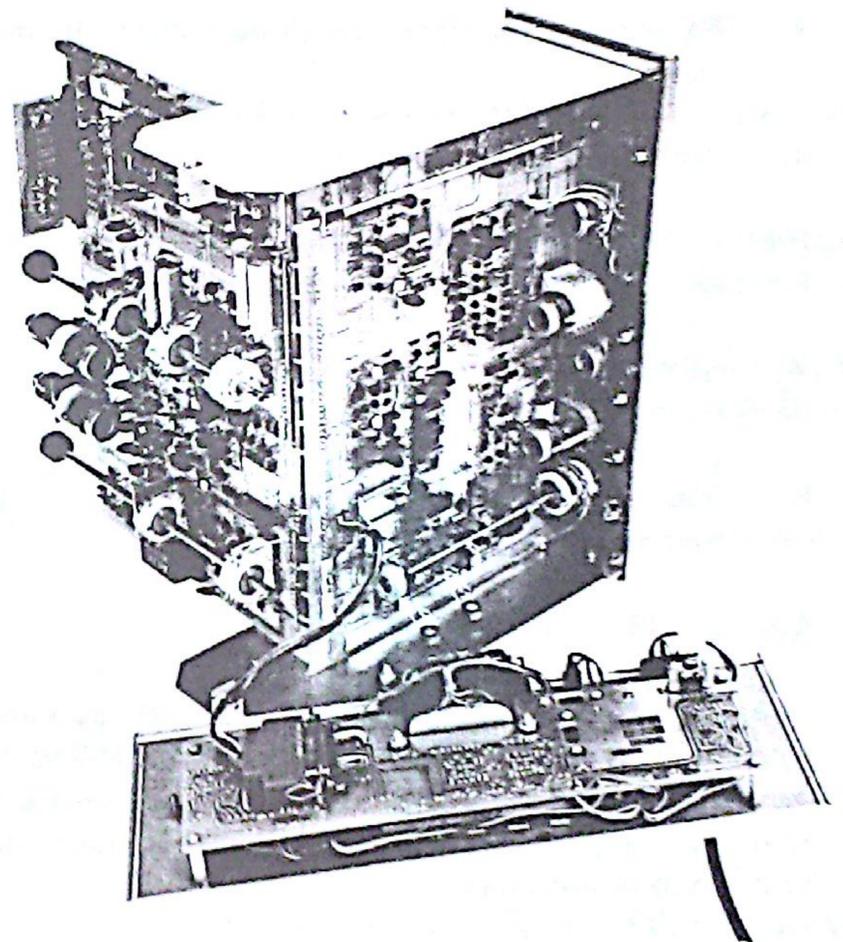


Figure 4-1. Model 147 in the Maintenance Position

6. Plug the power supply connector into the power supply board and plug in the ac line cord.
7. The power switch located on the power supply board will control the power to the instrument while in this configuration.

4.1.3 Reassembly Procedure

1. Turn off power switch on power supply board; unplug the ac line cord; and disconnect power connector from power supply.
2. Lift main board off connector pins.

3. With the back end of the main board slightly raised, guide the control shafts just into the front panel. Then lower the back and slide forward checking the three READOUT FUNCTION buttons. When they are through the front panel, raise the back and mate the pins and connector.

CAUTION

**THE SWEEP BOARD (BOTTOM BOARD)
MUST BE SUPPORTED WHILE PUSHING THE
CONNECTOR ONTO THE PINS.**

CAUTION

4. Replace the six screws which hold down the main board.
5. Replace knobs on front panel.
6. Slide the dust cover on slowly, making sure it is seated into the groove on the front panel.
7. Reconnect the power supply connector to the power supply board.
8. Replace the rear panel and power supply; tighten the four captive screws.

4.2 CALIBRATION INSTRUCTIONS

This paragraph provides complete sequential calibration instructions for this instrument. The instructions are concise and are written for the experienced electronics technician or field engineer having a working knowledge of this type of instrument.

WAVETEK maintains a factory repair department for those customers not possessing the necessary test equipment or personnel to maintain this type of instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached. This will hasten turnaround time.

4.2.1 Preliminary Procedures

1. Complete precalibration checkout procedure as necessary.
2. Perform the following front panel settings:

FREQUENCY CONTROL	fully cw
READOUT FUNCTION	FREQ
FREQUENCY RANGE (Hz)	1K
SYMMETRY	OFF

SYMMETRY VARIABLE	fully ccw
DC OFFSET	OFF
DC OFFSET VARIABLE	fully ccw
WAVEFORM	\wedge
MODE	CONT
TRIG LEVEL	fully ccw
SWEEP WIDTH	fully ccw
SWEEP TIME	OFF
SWEEP TIME VARIABLE	fully ccw
OUTPUT ATTEN (dB)	0
OUTPUT ATTEN (dB) VARIABLE	fully cw
POWER	depressed (ON)

3. Install the unit in the cover and allow 30 minutes warm-up time.

4.2.2 Power Supply Board

POWER SUPPLY REGULATION

1. Connect ac power to the instrument and connect the voltmeter leads to TP1 (common) and TP2 (+15 V) on the main board.
2. Adjust R10 (power supply board) for a reading of +15 Vdc \pm 20 mV on the voltmeter.
3. Check the voltage at TP3 for -15 Vdc \pm 50 mV, at TP4 for +24 Vdc \pm 400 mV, at TP5 for -24 Vdc \pm 400 mV, and at TP6 for +5 Vdc \pm 200 mV.

4.2.3 Main Board

TRIANGLE AMPLITUDE ADJUSTMENT

NOTE

Fold out Page 4-7 for calibration adjustment and test point locations.

1. Connect the oscilloscope probe (a peak reading plug-in module should be used with the scope) to (\wedge) TP7 (WAVEFORM selector wafer, yellow wire).
2. Adjust the triangle amplitude to \pm 1.25 V \pm 5 mV using R90 and R100.
R89

FREQUENCY AND TIME SYMMETRY CALIBRATION

1. Set FREQUENCY RANGE (Hz) to 100K, WAVEFORM selector to \square , FREQUENCY CONTROL fully ccw; and adjust R10 for approximately 1/1250 of full scale (80 Hz) and R22 for time symmetry within 1%.

- Turn FREQUENCY CONTROL to 1/100 of full scale (1 kHz) and adjust R12 for minimum frequency shift while opening and shorting the VCG IN.

NOTE

If Step 2 cannot be accomplished, center R12 and repeat Step 1.

- Turn FREQUENCY CONTROL fully cw, and adjust time symmetry within 0.1% with R23.
- Repeat Steps 1 and 3 as necessary for accurate time symmetry at full scale to 1/1000 of full scale.
- Turn FREQUENCY CONTROL fully cw, FREQUENCY RANGE (Hz) to 100K, and adjust R4 to obtain 105.0 kHz.
- Set FREQUENCY RANGE (Hz) to 10M and adjust C17 to obtain an output frequency of 10.50 MHz.
- Set FREQUENCY RANGE (Hz) to 1M and adjust C26 to obtain 1.050 MHz at the output.
- Set FREQUENCY RANGE (Hz) to 10K and adjust R5 to obtain 10.50 kHz.

NOTE

1.050 in frequency equals 0.952381 in time.

- Set FREQUENCY RANGE (Hz) to 1K and adjust R6 to obtain 1.050 kHz.
- Set FREQUENCY RANGE (Hz) to 100 and adjust R7 to obtain 105.0 Hz.
- Set FREQUENCY RANGE (Hz) to 10 and adjust R39 to obtain 10.50 Hz. (95.0ms)
- Adjust R66 for 0.1% time symmetry.
- Readjust R39 for optimum frequency on 10, 1, 0.1, and 0.01 of FREQUENCY RANGE (Hz) selector.
- Set FREQUENCY RANGE (Hz) to 10K, FREQUENCY CONTROL fully cw; and connect counter to SYNC OUT.
- Adjust R235 to read same frequency on the readout as the counter (10.50 kHz). Note: R11 Adjusts lower Range Readout
- Connect DVM to pin 12; set FREQUENCY RANGE (Hz) to 1K; adjust FREQUENCY CONTROL for

Adjust For Nominal 5V and 1000 on Readout
1.000 on counter; adjust R47 for 5.00 V on DVM; adjust FREQUENCY CONTROL for 50 Hz on counter; adjust R45 for 0.25 V on DVM; and recheck for 5.00 V at 1.000 kHz. R43

SINE DISTORTION AND AMPLIFIER ADJUSTMENTS

- Set FREQUENCY RANGE (Hz) to 1K, FREQUENCY CONTROL fully cw, and WAVEFORM selector to \sim .
- Connect oscilloscope probes to (\sim) TP7 (WAVEFORM selector wafer).
- Adjust R149 so that the dc offset of the sine amplifier is zero.
- Adjust R143, R139 and R140 for minimum sine wave distortion.
- Set FREQUENCY RANGE (Hz) to 10K and readjust R143, R139 and R140 for optimum sine distortion.
- Alternately perform Steps 4 and 5 until the least amount of sine wave distortion is obtained on both ranges (typically 0.14%).
- Adjust R167 for a 2.5 V p-p ± 5 mV sine wave.
- Readjust R149 so that the dc offset of the sine wave amplifier is 0 V ± 5 mV.

SQUARE WAVE AMPLITUDE ADJUSTMENT

- Set WAVEFORM selector to \square .
- Adjust the square wave amplitude to ± 1.25 V ± 5 mV using R184 and R175.

4.2.4 Sweep Board

OUTPUT AMPLIFIER ADJUSTMENT

NOTE

Fold out Page 4-9 for calibration adjustment and test point locations.

- With the 50 Ω OUT connected to the oscilloscope using a 50 Ω $\pm 1\%$ termination, set FREQUENCY RANGE (Hz) to 1K, FREQUENCY CONTROL fully cw, WAVEFORM selector to \sim , OUTPUT ATTEN (dB) to 0, and OUTPUT ATTEN (dB) VARIABLE fully ccw.

2. Adjust R132 for amplitude symmetry about ground.
3. Set OUTPUT ATTEN (dB) VARIABLE fully cw and adjust R134 for 15 V p-p ± 25 mV output amplitude.

HIGH FREQUENCY RESPONSE ADJUSTMENT

1. Set FREQUENCY RANGE (Hz) to 10M, FREQUENCY CONTROL to read 1 MHz and WAVEFORM selector to \square .
2. Adjust C81 for best square wave, without peaking, at full amplitude with 50Ω load.
3. Set WAVEFORM selector to \sim and FREQUENCY CONTROL fully cw.
4. Adjust C53 (main board) to obtain approximately 15 V p-p output amplitude at full amplitude with 50Ω load.
5. If clipping occurs as waveforms are varied from 1M to 10M, readjust C53 to correct this occurrence.

VOLTAGE TO FREQUENCY CONVERTER ADJUSTMENTS

1. Connect counter to SYNC OUT; set FREQUENCY RANGE (Hz) to 1K; set FREQUENCY CONTROL fully cw.
2. Adjust R111 to match counter on 147 readout.

SAMPLE AND HOLD CIRCUIT ZERO

1. Set READOUT FUNCTION to PK AMPL MAX.
2. Ground the input (pin 27); connect a DVM to sample and hold output (pin 28).
3. Set R191 for 0.000 volt. *Bottom Board*

ABSOLUTE VALUE CIRCUIT

1. Adjust R237 for 0.00 volt at summing node of absolute value circuit (TP1).
2. Adjust R230 for 0.00 volt at output of absolute value circuit (pin 6).
3. Remove ground jumper on pin 27; set WAVEFORM selector to DC.
4. Connect 50Ω OUT to a 50Ω load and a DVM.

5. Use - DC OFFSET control to set 5.50 V to 6.00 V on the DVM; set the readout to match the DVM with R227.
6. Switch to + DC OFFSET; set the readout to match the DVM with R224.
7. Repeat Steps 5 and 6 until both + and - readings match the DVM.

RECTIFIER CALIBRATION

1. Set WAVEFORM selector to \sim , DC OFFSET to OFF, FREQUENCY RANGE (Hz) to 100K.
2. Connect 50Ω OUT (loaded with 50Ω) to scope.
3. Use OUTPUT ATTEN (dB) VARIABLE to set a 14.00 V peak-to-peak waveform.
4. Select PK AMPL MAX; set the + peak waveform to exactly +7.00 V on the scope using a peak comparator; and set the readout to +7.00 V with R217.
5. Select PK AMPL MIN; set the - peak waveform to exactly -7.00 V on the scope using a peak comparator; and set the readout to -7.00 V with R206.
6. Set FREQUENCY RANGE (Hz) to 10M.
7. Set the - peak waveform to exactly -7.00 V on the scope; and set the readout to -7.00 V with C70.
8. Select PK AMPL MAX; set the + peak waveform to exactly +7.00 V on the scope; set the readout to +7.00 V with C74.
9. Repeat Steps 4 through 8 if necessary.

NOTE

The peak comparator should not be used to check voltmeter settings above 100 kHz.

SWEEP/GCV ADJUSTMENTS

1. Set FREQUENCY RANGE (Hz) to 1K and connect oscilloscope to the sweep output (TP13).
2. Adjust R21 to set the output to 0 ± 5 mV.
3. Set SWEEP TIME selector to 0.1 s/10 ms and the SWEEP TIME VARIABLE fully cw.

4. Adjust R46 to set the lower peak of the sawtooth wave for 0 V (+0, -5 mV) and R238 to set the upper peak of the sawtooth wave for +5 V \pm 20 mV at the SWP/GCV OUT connector (unloaded).
5. Reset R46 to assure at least 1000:1 operation in the SWP/HOLD MODE.

TRIGGER BASELINE ADJUSTMENT

1. Set MODE selector to TRIG, FREQUENCY RANGE (Hz) to 10K, FREQUENCY CONTROL fully cw, DC OFFSET to OFF, WAVEFORM selector to $\wedge \vee$, OUTPUT ATTEN (dB) to 0, and OUTPUT ATTEN (dB) VARIABLE fully cw.
2. Adjust R84 for 0 V \pm 20 mV and 50 Ω OUT (loaded with 50 Ω).
3. Set FREQUENCY CONTROL fully ccw and adjust R60 to set baseline to 0 V \pm 20 mV.
4. Check that the baseline remains within \pm 50 mV at all frequency settings.

SYMMETRY ADJUSTMENT

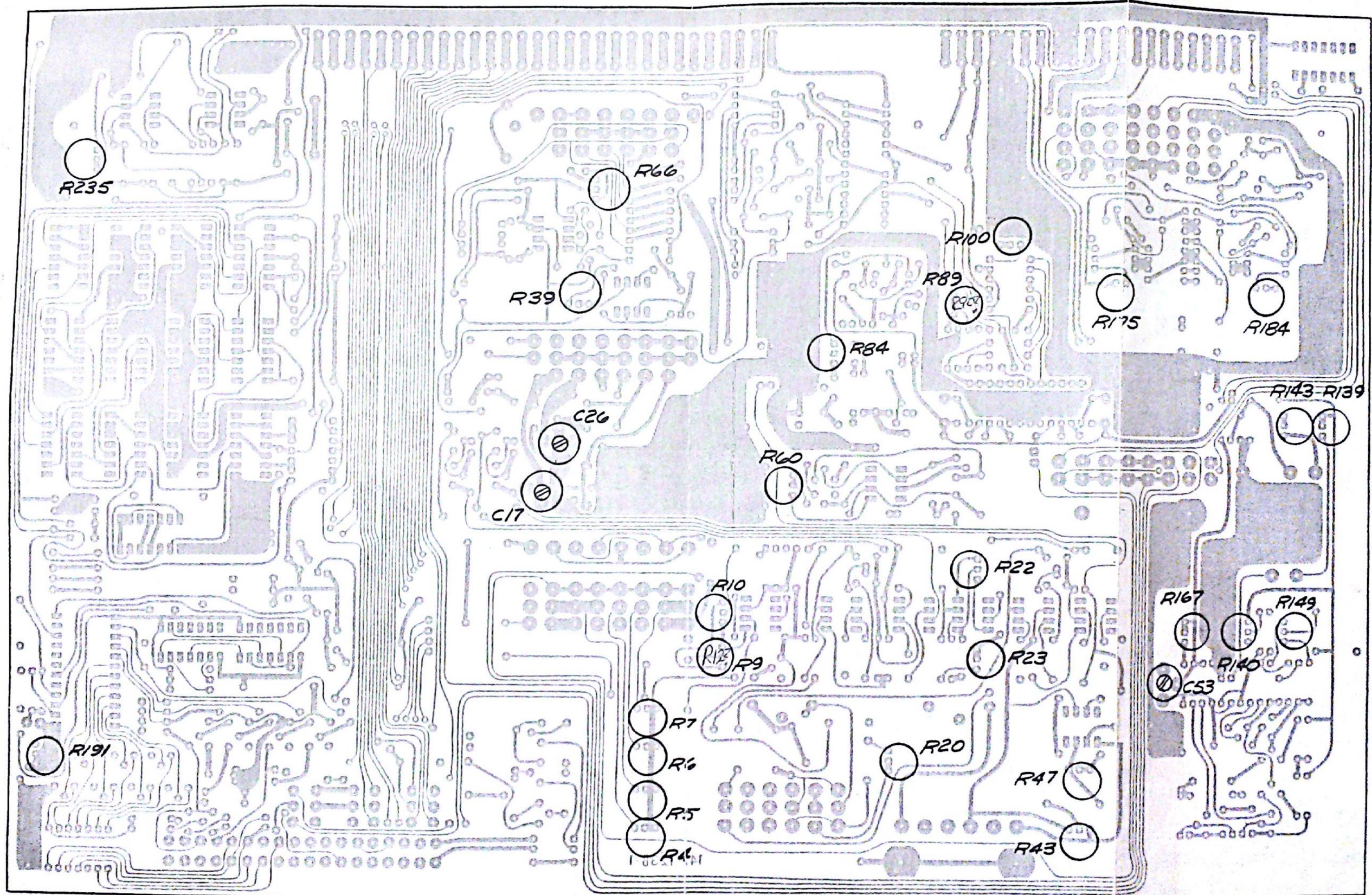
1. Set FREQUENCY RANGE (Hz) to 1K, MODE to CONT, FREQUENCY CONTROL fully cw.
2. Adjust R20 for 1/10 of reading from SYMMETRY switch OFF to SYMMETRY switch \wedge or \wedge .

READOUT ZERO FLICKER ADJUSTMENT

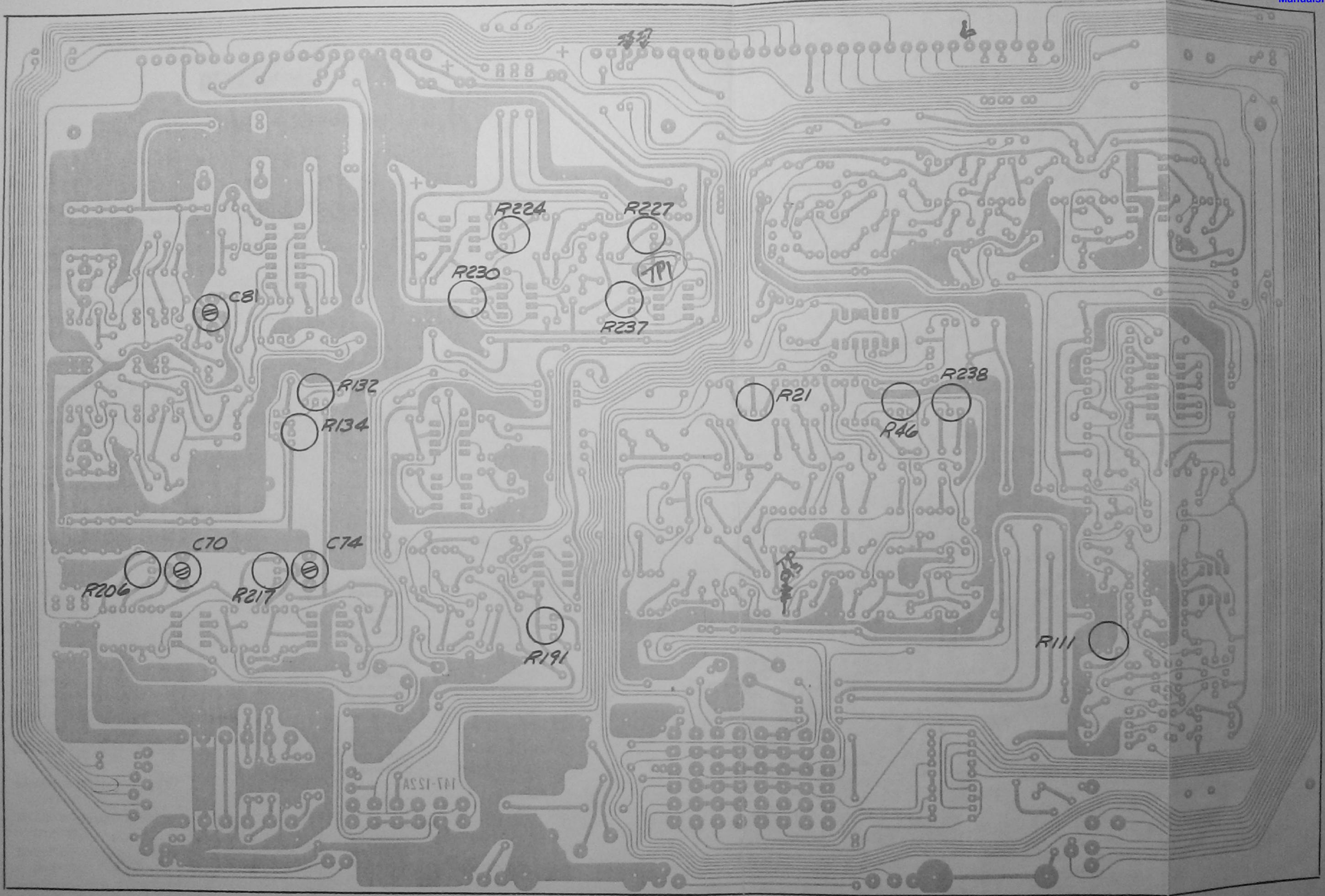
1. Set SYMMETRY switch to OFF, FREQUENCY CONTROL fully ccw.
2. Adjust R191 until no flicker is seen in the blanked out decimal points and zeros. *TOP BOARD*

4.2.5 Post Operational Checkout

1. Check the MODE switch, SYMMETRY switch and SYMMETRY VARIABLE, WAVEFORM switch, SWEEP WIDTH potentiometer, SWEEP TIME switch and SWEEP TIME VARIABLE, and OUTPUT ATTEN (dB) switch and OUTPUT ATTEN (dB) VARIABLE for proper operation.
2. Verify that the readout functions properly in all functions of the READOUT FUNCTION controls at all frequency ranges.



147-010 MAIN BOARD CALIBRATION POINTS.



SECTION 5

DIAGRAMS ADDENDUMS AND PARTS LISTS

5.1 DIAGRAMS

The schematic diagrams within this manual are, wherever possible, arranged in the sequence followed in the circuit description. Whenever assembly drawings are included, they are positioned adjacent to the schematics for maximum information presentation and minimum page flipping. Additional voltage or waveform information, beyond that given in the circuit description, may be shown on the schematic diagrams, at test points and key locations throughout the instrument.

5.2 ADDENDUMS

Under WAVETEK's product improvement program, the latest electronic designs and circuits are incorporated into each WAVETEK instrument as quickly as development and

testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made under a WAVETEK Engineering Change Notice (ECN) and these ECN pages are inserted immediately inside the rear cover. If no such pages exist, the manual should be correct as printed.

5.3 PARTS LISTS

Whenever possible, an assembly drawing and the associated parts list are kept to one piece of paper or are positioned for maximum information presentation. When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and if applicable, the function performed.

DRAWINGS

The following assembly drawings (with parts lists) and schematics will be included at the rear of this manual, in the arrangement shown below:

LEFT PAGE	RIGHT PAGE
CHASSIS ASSEMBLY D147-000 1 of 2	CHASSIS ASSEMBLY D147-000 2 of 2
CHASSIS SCHEMATIC D147-200	REAR PANEL ASSEMBLY D147-001
MAIN BOARD ASSEMBLY D147-023 1 of 4	MAIN BOARD ASSEMBLY D147-023 2 of 4
MAIN BOARD ASSEMBLY D147-023 3 of 4	MAIN BOARD ASSEMBLY D147-023 4 of 4
MAIN BOARD SCHEMATIC D147-223 1 of 4	MAIN BOARD SCHEMATIC D147-223 2 of 4
MAIN BOARD SCHEMATIC D147-223 3 of 4	MAIN BOARD SCHEMATIC D147-223 4 of 4
READOUT BOARD ASSEMBLY D147-021	READOUT BOARD SCHEMATIC D147-221
SWEEP BOARD ASSEMBLY D147-022 1 of 4	SWEEP BOARD ASSEMBLY D147-022 2 of 4
SWEEP BOARD ASSEMBLY D147-022 3 of 4	SWEEP BOARD ASSEMBLY D147-022 4 of 4
SWEEP BOARD SCHEMATIC D147-222 1 of 2	SWEEP BOARD SCHEMATIC D147-222 2 of 2
POWER SUPPLY BOARD ASSEMBLY D147-020 1 of 2	POWER SUPPLY BOARD ASSEMBLY D147-020 2 of 2
POWER SUPPLY BOARD SCHEMATIC D147-220	

5.4 RECOMMENDED SPARE PARTS LIST

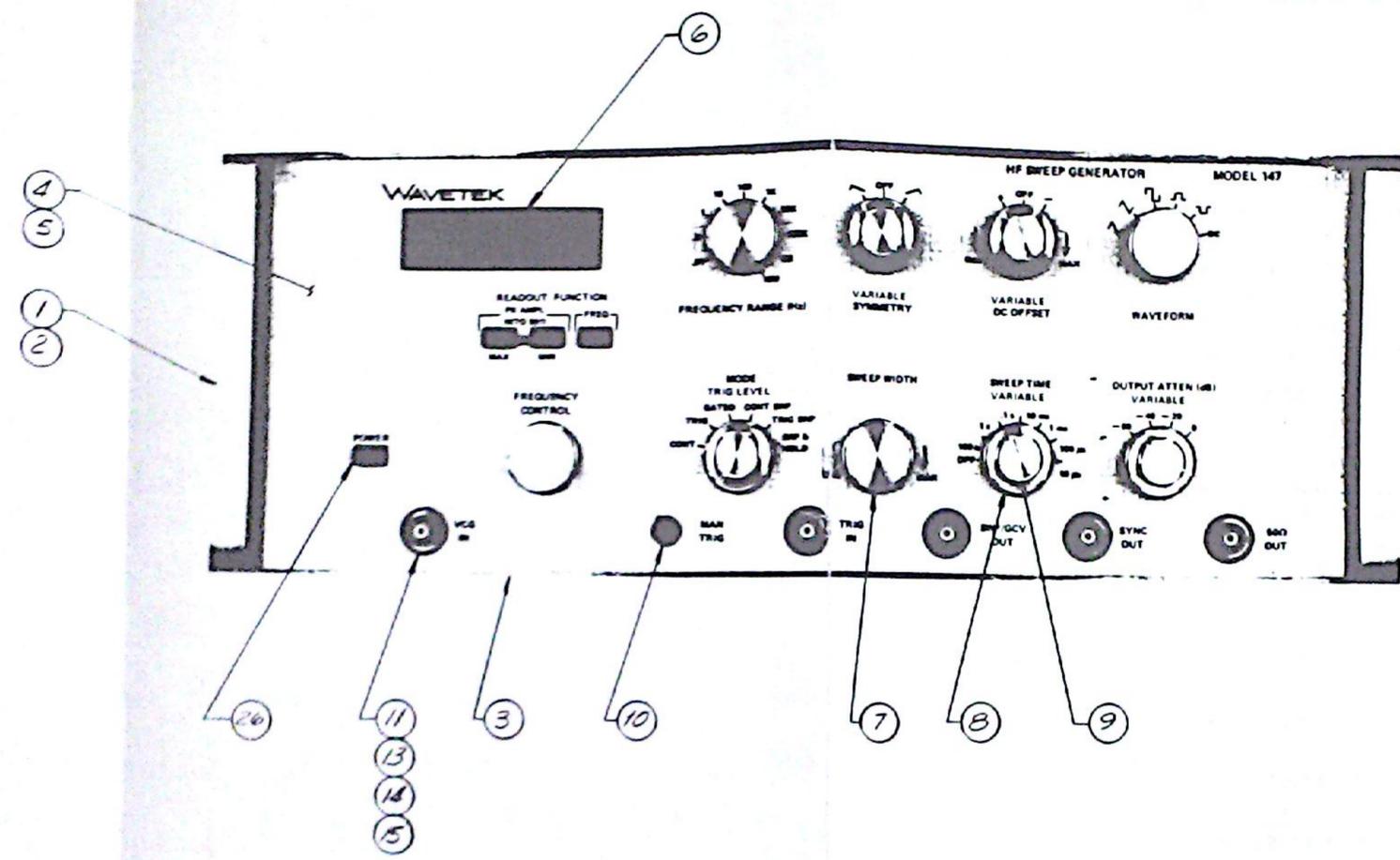
Information is provided to maintain the instrument on a board or component level. Price and delivery information should be obtained from the Wavetek representative in your area or directly from the factory.

DESCRIPTION	MFG	PART NO.	QTY
BOARD LEVEL			
COMPLETE REAR PANEL ASSEMBLY	WAVETEK	147-001	1
READOUT BOARD	WAVETEK	147-021	1
SWEEP BOARD	WAVETEK	147-022	1
MAIN BOARD	WAVETEK	147-023	1
COMPONENT LEVEL			
DIODE TUNNEL	GE	1N3716	1
DIODE	SEMTECH	SCE-1	2
DIODE	FAIRCHILD	FD777	5
*DIODE SET	WAVETEK	142-501-58	1
DIODE	HEWLETT-PACKARD	HP-2811	3
DIODE	FAIRCHILD	FD666	5
DIODE ZENER	WAVETEK	130-506	2
FUSE 1/2A 115 V	LITTELFUSE	313-500	2
FUSE 1/2A 230 V	LITTELFUSE	313-250	2
INTEGRATED CIRCUIT	FAIRCHILD	7805	1
INTEGRATED CIRCUIT	FAIRCHILD	μM741C	5
INTEGRATED CIRCUIT	NAT SEMI-CONDUCTOR	LM-301	1
INTEGRATED CIRCUIT	RCA	CA3028A	1
INTEGRATED CIRCUIT	RCA	CA3030	1
INTEGRATED CIRCUIT	RCA	CA3049	1
INTEGRATED CIRCUIT	MOTOROLA	MC-3050	1
INTEGRATED CIRCUIT	RCA	CA3054	1
INTEGRATED CIRCUIT	RCA	CA3080	2
INTEGRATED CIRCUIT	MOSTEK	5005 P	1
LED	OPCOA	OSL-6L-1	2
LED READOUT	FAIRCHILD	FND 70	1
LED READOUT	FAIRCHILD	FND 71	1
*TRANSISTOR SET	WAVETEK	142-501-52	1
*TRANSISTOR SET	WAVETEK	142-501-53	1
*TRANSISTOR SELECTED	WAVETEK	142-501-55	2
TRANSISTOR	MOTOROLA	2N2219A	2
TRANSISTOR	FAIRCHILD	2N2905A	2
TRANSISTOR	FAIRCHILD	2N3563	1
TRANSISTOR	FAIRCHILD	2N3565	5
TRANSISTOR	FAIRCHILD	2N3638	1
TRANSISTOR	FAIRCHILD	2N3638A	5
TRANSISTOR	FAIRCHILD	2N3640	5
TRANSISTOR	FAIRCHILD	2N3642	1
TRANSISTOR	FAIRCHILD	2N3646	10
TRANSISTOR	FAIRCHILD	2N4248	1
TRANSISTOR	FAIRCHILD	2N5139	5
TRANSISTOR	MOTOROLA	2N5485	1
TRANSISTOR	FAIRCHILD	2N4047	1
TRANSISTOR	FAIRCHILD	2N5160	1
TRANSISTOR	MOTOROLA	MPS L08	2
TRANSISTOR	TECH PROD	TD308	1
TRANSISTOR	TECH PROD	TD401	1
TRANSISTOR	SILICONIX	U233	1
TRANSISTOR	NATIONAL	NF-510	1
TRANSISTOR	TEXAS INST	TIP 29	2
TRANSISTOR	TEXAS INST	TIP 30	2

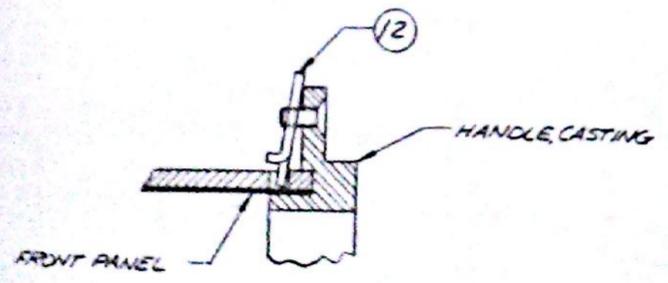
*Denotes special selected parts and should be ordered from Wavetek.

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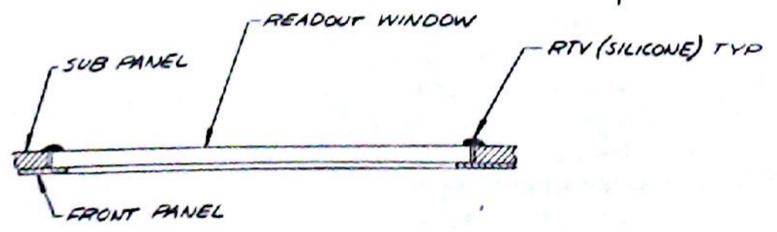


PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR PIN	QTY
1	HANDLE TRIM (MAKE FROM 847-333)	WAVETEK	23338	B147-345	2
2	HANDLE (MAKE FROM C147-315)	WAVETEK	23338	C147-342	2
3	TRIM (MAKE FROM 847-313)	WAVETEK	23338	B147-317	2
4	SUB PANEL	WAVETEK	23338	C147-301	1
5	FRONT PANEL	WAVETEK	23338	C147-300	1
6	READOUT WINDOW	WAVETEK	23338	B147-350	1
7	KNOB	WAVETEK	23338	B130-314	4
8	KNOB, COAX	WAVETEK	23338	B130-309	5
9	KNOB, SMALL	WAVETEK	23338	B130-354	5
10	SWITCH (MOMENTARY)	C + K	09353	7108 PDCN	1
11	BNC CONNECTOR	KING	9836	KC7946	5
12	CLAMP (MAKE FROM 147-314)	WAVETEK	23338	A147-354	4
13	SHOULDER WASHER	H H SMITH	83330	2668	5
14	FLAT WASHER	H H SMITH	83330	2264	5
15	SOLDER LUG	H H SMITH	83330	1497	5
16	SWEEP BD	WAVETEK	23338	D147-022	1
17	MAIN BD	WAVETEK	23338	D147-023	1
18	READOUT BD	WAVETEK	23338	D147-021	1
19	SIDE PLATE	WAVETEK	23338	D147-355	2
20	SUPPORT BAR	WAVETEK	23338	B147-347	1
21	SWAGE NUTS	SOUTHCO	94222	78-11-20-13	4
22	REAR PANEL (POWER SUPPLY)	WAVETEK	23338	D147-001	1
* 23	COVER	WAVETEK	23338	C147-307	1
* 24	BAIL KIT (WITH FEET)	WAVETEK	23338	B147-505	1
* 25	COVER SUPPORT (MAKE FROM 147-314)	WAVETEK	23338	B147-365	1
26	PUSH BUTTON (RED)	CRL	71590	J52305 RED	1
27	CHASSIS BLOCKS	USECO	88245	15918-11	4
28	MYLAR	H H SMITH	83330	4L2FF	9
29	SHOULDER WASHER	H H SMITH	83330	2661	2
30					
31					
32					
33					
34					
35					



NOTE: BEFORE CLAMPING HANDLE CASTING (2) IN PLACE THE TRIM (TOP & BOTTOM) & PANELS MUST BE IN PLACE

HANDLE DETAILS



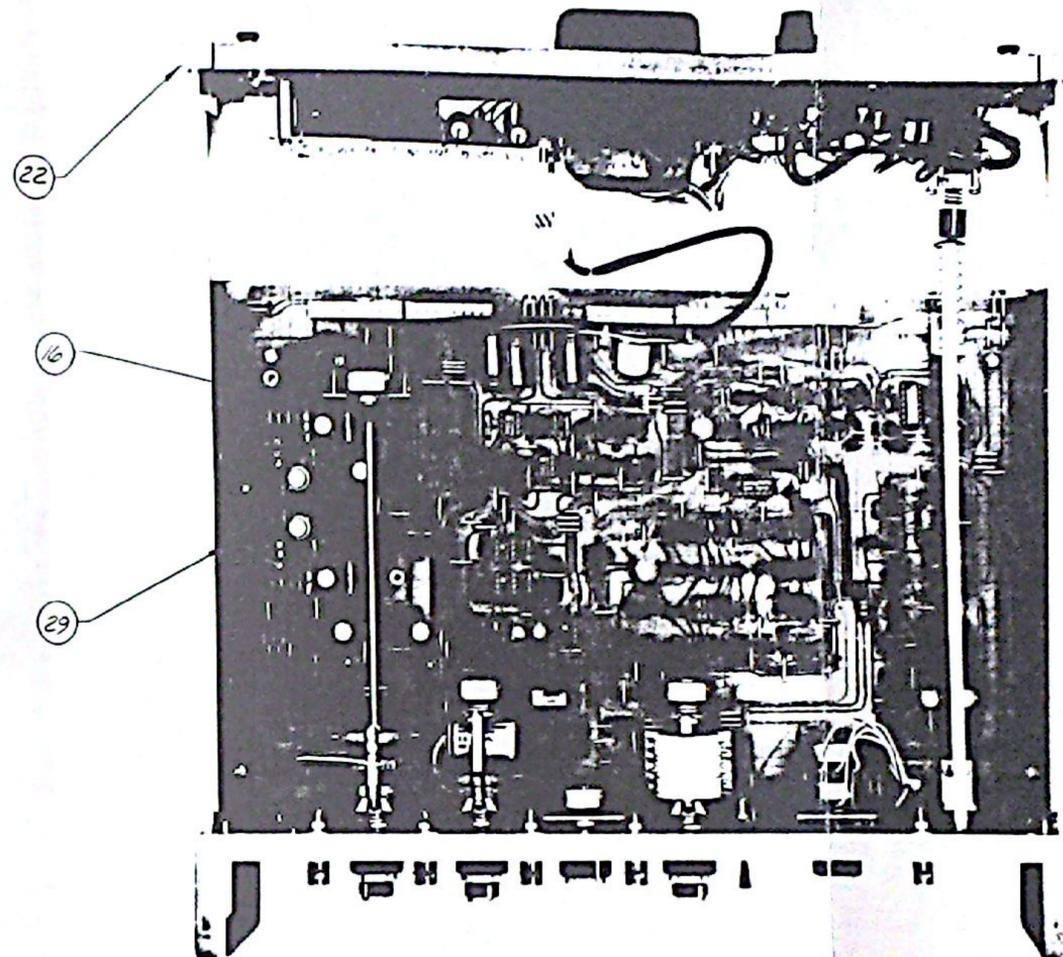
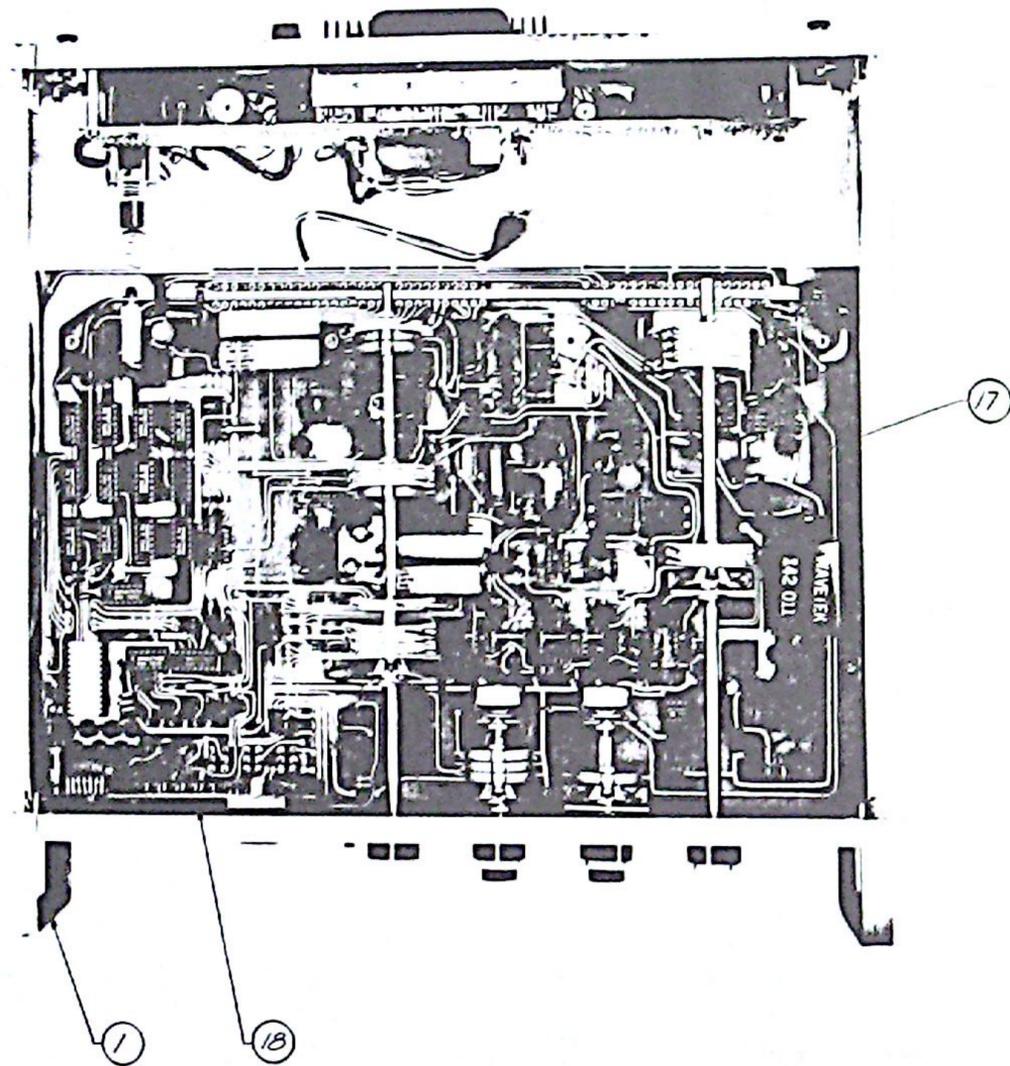
READOUT WINDOW DETAIL

* # INDICATES ITEMS NOT SHOWN
 NOTE: UNLESS OTHERWISE SPECIFIED

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MATERIAL	DESIGNED BY BOCHICCHIO	
FINISH WAVETEK PROCESS	RELEASED BY [Signature] 9-28-74	TOLERANCES UNLESS OTHERWISE SPECIFIED X.X .010 ANGLES 1 X.X .030 DO NOT SCALE DWG SCALE
	MODEL NO 147	MODEL NO D147-000 REV A CODE 23338 SHEET 1 OF 2

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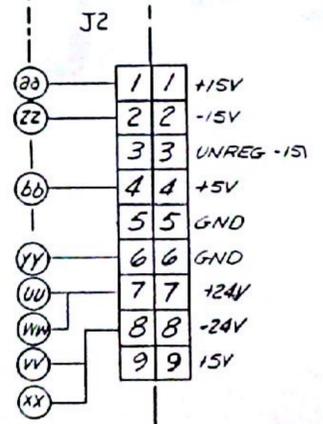
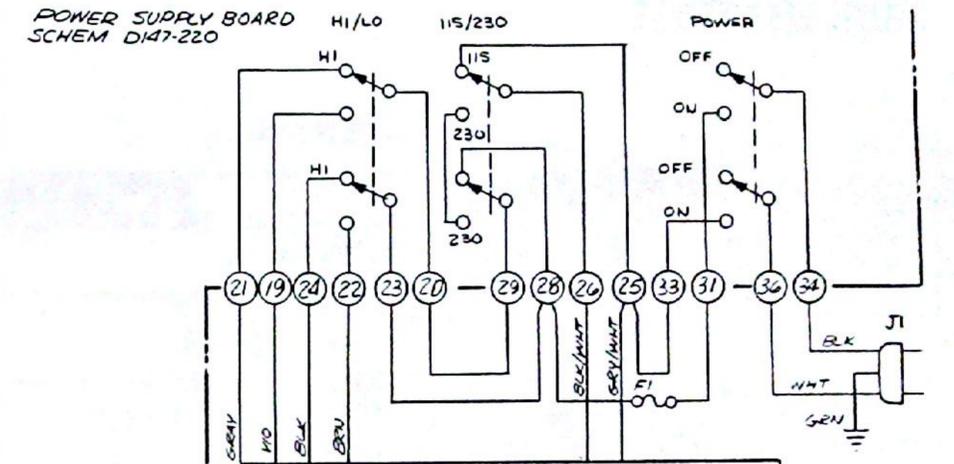
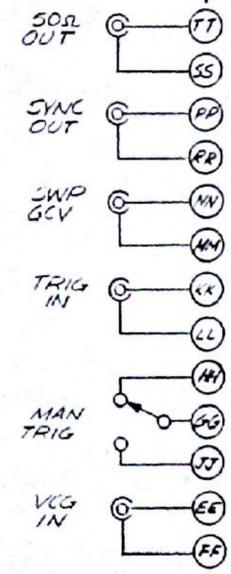
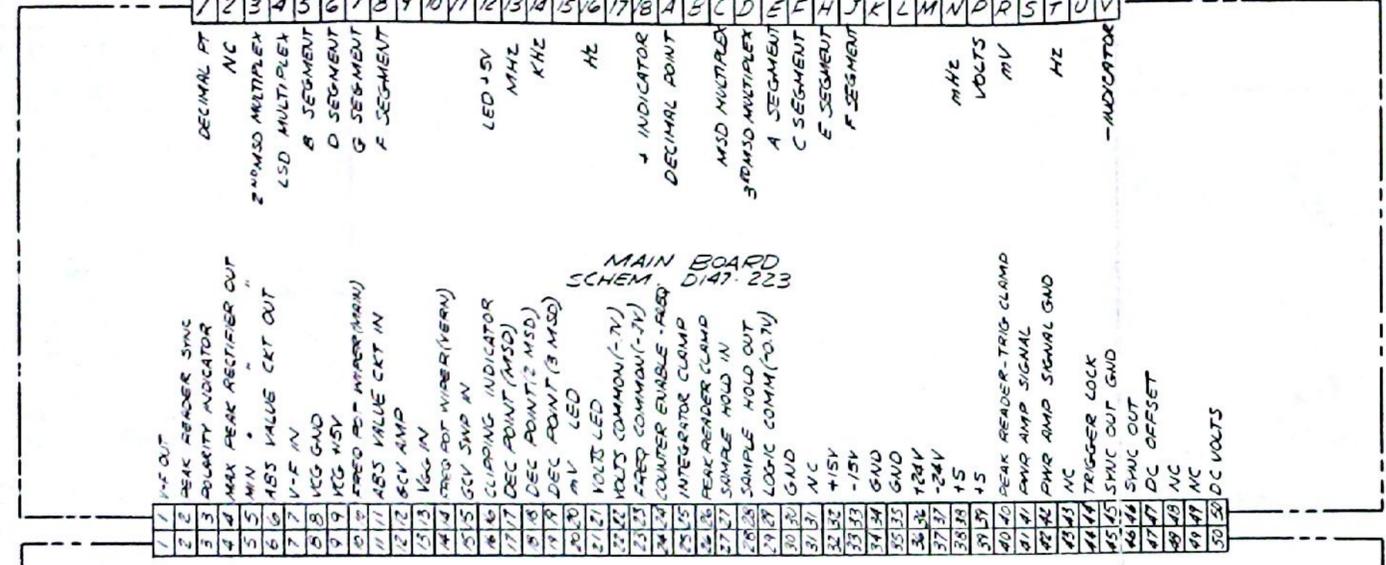
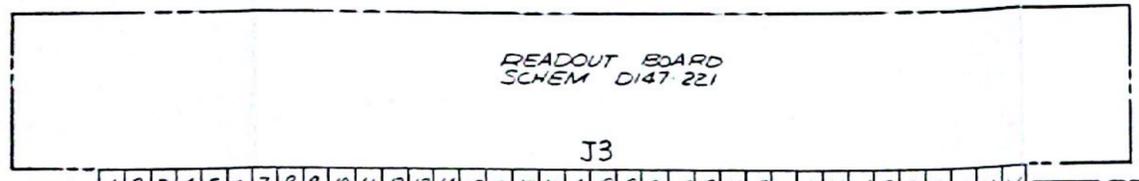


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BOONK/MO			ASSEMBLY CHASSIS	
MATERIAL			MODEL NO	
3030			147	
FINISH			REV	
WAVETEK PROCESS			D147-000 A	
SCALE			SHEET 2 OF 2	
			23330	

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MATERIAL	PROJENR		
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DO NOT SCALE DWG	SCALE	MODEL NO: 147	DWG NO: D147-200
		REV: A	REV: A
		23338	SHEET 1 OF 1

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REV ECH BY DATE APP

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
1	CAPACITORS				
2	CERAMIC DISC 50V .01uF	CRL	71590	CK103	4
3	CERAMIC DISC 20V .1uF	CRL	71590	UK20-104	7
4	CERAMIC DISC 50V .1uF	CRL	71590	CK104	2
5	ELECTROLYTIC 50V 50uF	SPRAGUE	56289	500506G0500D7	2
6	ELECTROLYTIC 16V 250uF	SPRAGUE	56289	500257G0160F7	3
7	ELECTROLYTIC 50V 500uF	SPRAGUE	56289	590507G0500GL4	2
8	ELECTROLYTIC 35V 1000uF	SPRAGUE	56289	390108G035GL4	2
9	ELECTROLYTIC 15V 1900uF	SPRAGUE	56289	390198G015GL4	1
10	CERAMIC DISC 33PF	CRL	71590	CD-330	1
11					
12	DIODES SCE-1	SEMTECH	14099	SCE-1	10
13	ZENER	WAVETEK	23338	A130-506	1
14					
15					
16					
17	INTEGRATED CIRCUITS 741	FAIRCHILD	33888	uM741C	4
18	INTEGRATED CIRCUITS 7805	FAIRCHILD	33888	7805393	1
19					
20					
21	TRANSISTORS 2N3642	FAIRCHILD	33888	2N3642	6
22	TRANSISTORS 2N4248	FAIRCHILD	33888	2N4248	6
23	TRANSISTORS TIP-29	TEXAS INST.	01295	TIP-29	2
24	TRANSISTORS TIP-30	TEXAS INST.	01295	TIP-30	2
25					
26					
27					
28					
29					
30					
31					
32					

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
33	RESISTORS				
34	CARBON 1/2W 5% 3.9Q	STACKPOLE	29604	RC20GF3R9J	2
35	CARBON 1/2W 5% 4.7Q	STACKPOLE	29604	RC20GF4R7J	2
36	METALFILM 1/8W 1% 464Q	CORNING	16299	RN550	2
37	METALFILM 1/8W 1% 681Q	CORNING	16299	RN550	2
38	METALFILM 1/8W 1% 825Q	CORNING	16299	RN550	2
39	METALFILM 1/8W 1% 2.21K	CORNING	16299	RN550	4
40	METALFILM 1/8W 1% 2.74K	CORNING	16299	RN550	2
41	METALFILM 1/8W 1% 2.87K	CORNING	16299	RN550	1
42	METALFILM 1/8W 1% 3.92K	CORNING	16299	RN550	1
43	METALFILM 1/8W 1% 4.75K	CORNING	16299	RN550	7
44	METALFILM 1/8W 1% 5.76K	CORNING	16299	RN550	2
45	METALFILM 1/8W 1% 6.19K	CORNING	16299	RN550	1
46	METALFILM 1/8W 1% 8.25K	CORNING	16299	RN550	1
47	METALFILM 1/8W 1% 9.09K	CORNING	16299	RN550	2
48	METALFILM 1/8W 1% 9.53K	CORNING	16299	RN550	2
49	METALFILM 1/8W 1% 10K (-64)	CORNING	16299	RN550	2
50	METALFILM 1/8W 1% 18.2K	CORNING	16299	RN550	2
51	METALFILM 1/8W 1% 38.3K	CORNING	16299	RN550	2
52	POTENTIOMETER 1K	BECKMAN	80740	91AR1K	1
53					
54	PUSH BUTTON (RED)	CRL	71590	J52315(RED)	1
55	STANDOFFS	WAVETEK	23338	013-005-1	2
56	POWER SWITCH	WAVETEK	23338	157-422	1
57	CONNECTOR BLOCK	MOLEX		03-06-1091	1
58	CONNECTOR PINS	MOLEX		02-06-1152	9
59	SWITCH (115-230)	SWITCHCRAFT	82389	46256LF	1
60	SWITCH (HI - LO)	SWITCHCRAFT	82389	5M422-FT-HK	1
61	TRANSISTORS	MILTON ROSS	07047	10123N	8
62	BOARD	WAVETEK	23338	147-120	1
63	SOLDER GUARD	SWITCHCRAFT	82389	46256LF-50	2
64					

LINE ITEM REFERENCE LIST

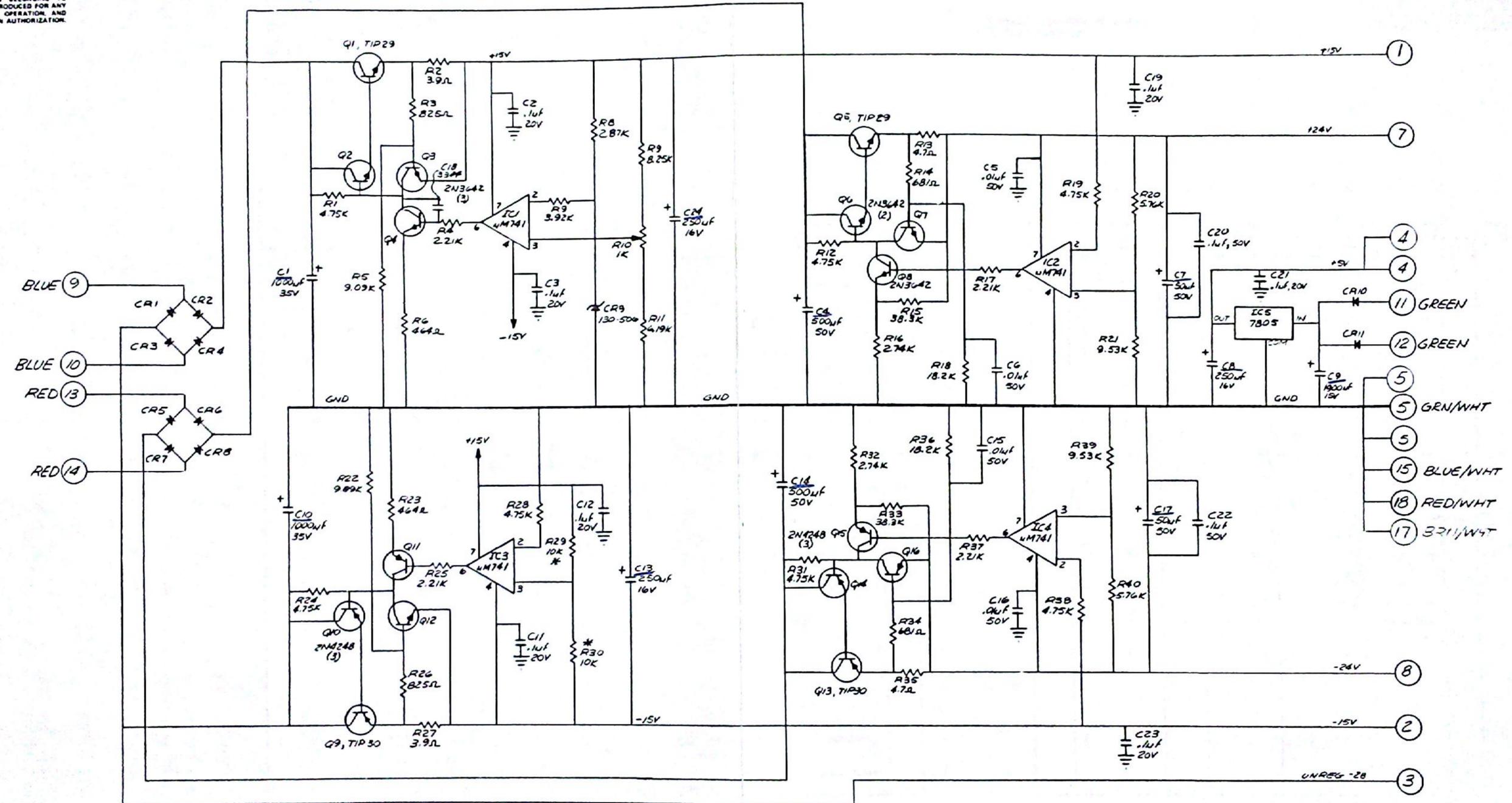
Ref. Desig	F/L Line	Ref. Desig	F/L Line	Ref. Desig	F/L Line
C1	8	IC1	17	R12	43
C2	3	IC2	17	R13	35
C3	3	IC3	17	R14	37
C4	7	IC4	17	R15	51
C5	2	IC5	18	R16	40
C6	2			R17	39
C7	5			R18	50
C8	5			R19	43
C9	9	Q1	23	R20	44
C10	8	Q2	21	R21	48
C11	5	Q3	21	R22	47
C12	5	Q4	21	R23	36
C13	6	Q5	23	R24	43
C14	7	Q6	21	R25	39
C15	2	Q7	21	R26	38
C16	2	Q8	21	R27	34
C17	5	Q9	24	R28	43
C18	10	Q10	22	R29	49
C19	3	Q11	22	R30	49
C20	4	Q12	22	R31	43
C21	3	Q13	24	R32	40
C22	4	Q14	22	R33	51
C23	3	Q15	22	R34	37
C24	6	Q16	22	R35	35
				R36	50
				R37	39
				R38	43
				R39	48
				R40	44
CR1	12				
CR2	12				
CR3					
CR4	12	R1	43		
CR5	12	R2	34		
CR6	12	R3	38		
CR7	12	R4	39		
CR8	12	R5	47		
CR9	15	R6	36		
CR10	12	R7	42		
CR11	12	R8	41		
		R9	46		
		R10	52		
		R11	45		

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE 10/19/79	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ. NO. 23338	TITLE ASSEMBLY POWER SUPPLY
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XX.X - .010 XX.X - .020	DO NOT SCALE DIMS
SCALE	MODEL NO. 147	REV. D147-020 D
	SHEET NO. 23338	SHEET 2 OF 2

REV	ECN	BY	DATE	APP
B	761		9/79	

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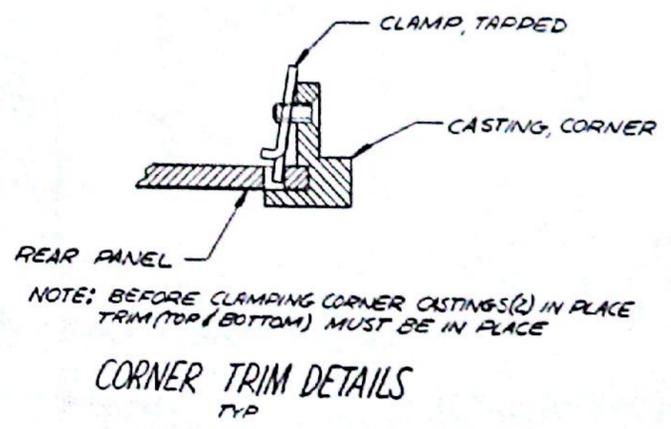
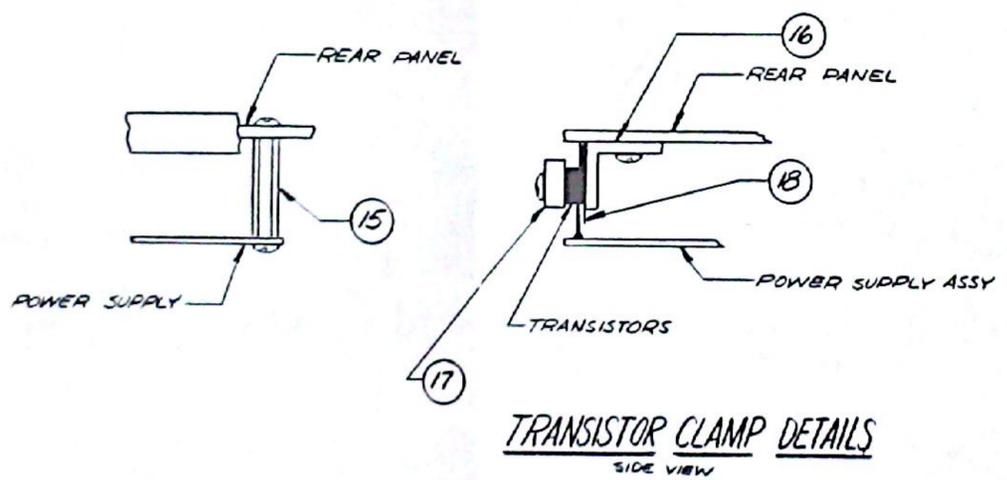
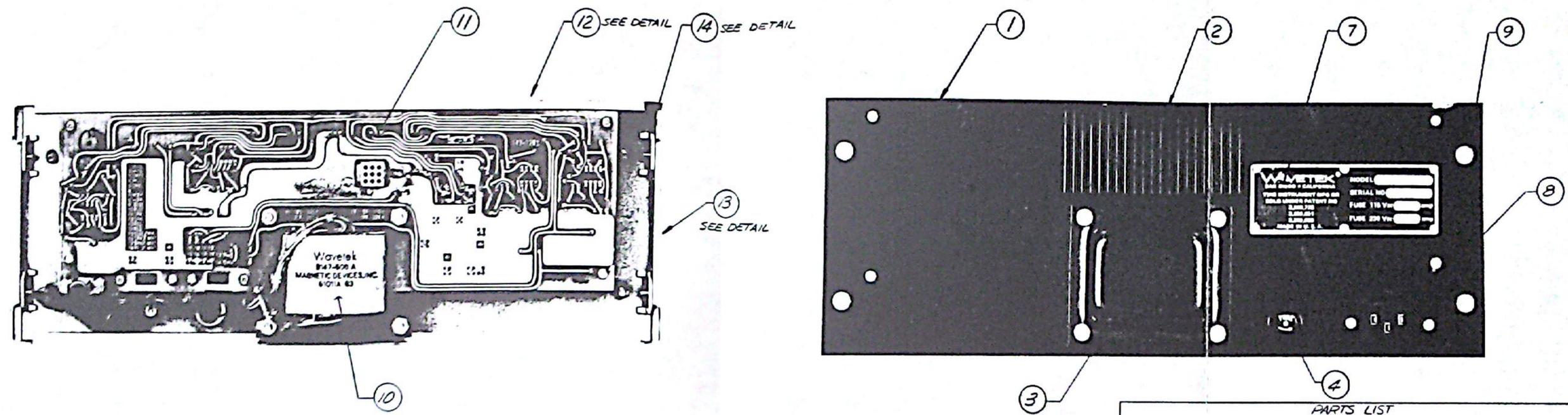
1) COLORED CALLOUTS INDICATE TRANSFORMER LEADS
 2) SEE CHASSIS SCHEMATIC D147-200 FOR INTERWIRING
 3) DIODES ARE SCE-11
 4) * INDICATES MATCHED PAIR (R29, R30)
 NOTE UNLESS OTHERWISE SPECIFIED

LAST DESIGNATORS USED	NOT USED
CAPACITOR C24	
DIODE CR11	
INTEGRATED CIRCUIT IC5	
TRANSISTOR Q10	
RESISTOR R40	

REMOVE ALL BURRS AND BREAK SHARP EDGES	DESIGN BORMING	DATE 9/79	WAVETEK SAN DIEGO - CALIFORNIA
MATERIAL	PROJECT	TITLE	
FINISH WAVETEK PROCESS	RELEASE APPROV. 9.5.79	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX - 010 ANGLES - 1 XX - 030	SCHEMATIC POWER SUPPLY BOARD
SCALE	DO NOT SCALE DWG	MODEL NO. 147	
		DWG NO. D147-220	REV. B
		23338	SHEET 1 OF 1

REV	ECN	BY	DATE	APP
A	ECN 765	Bo	7/74	

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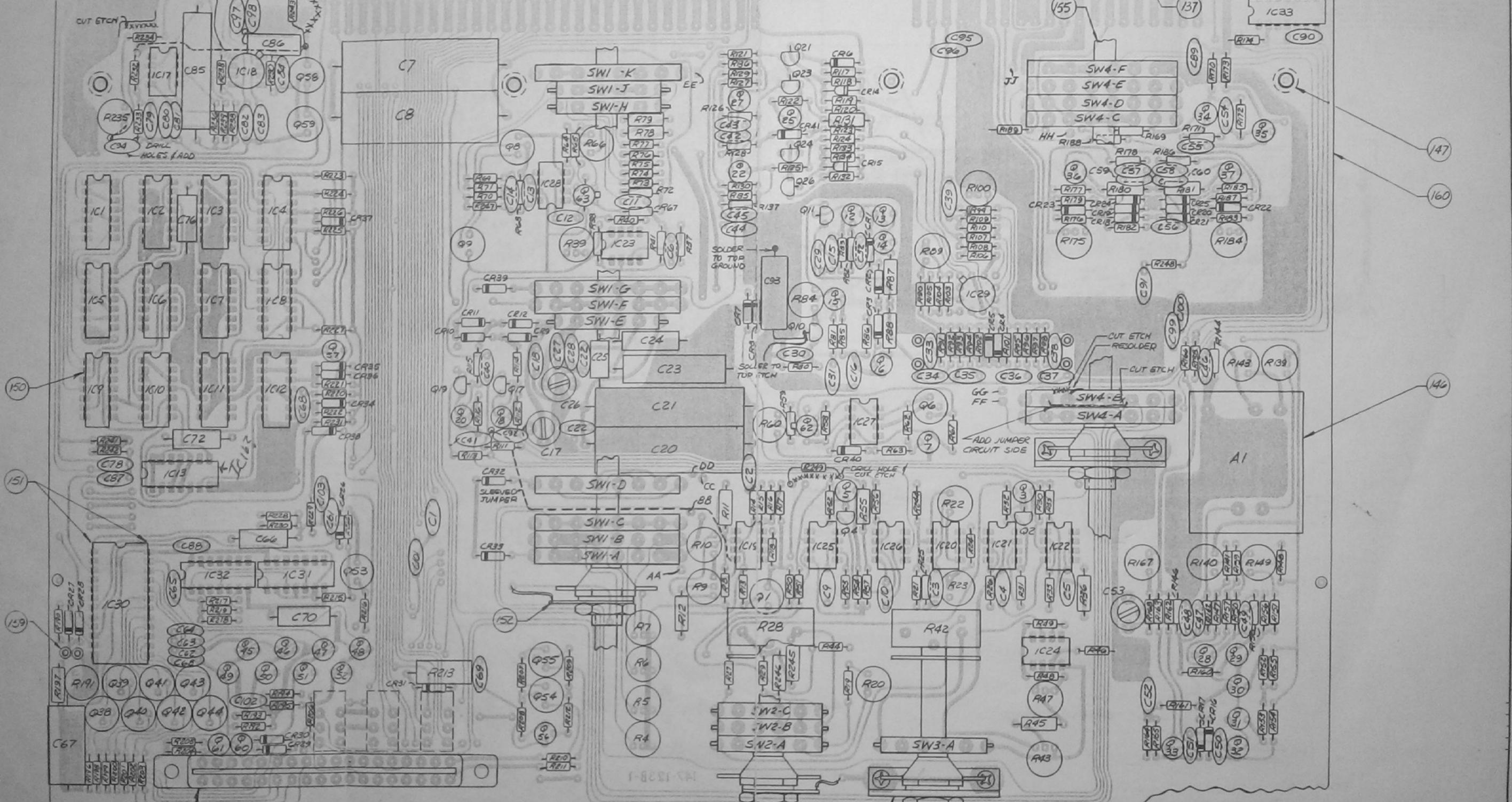
PARTS LIST

LINE NO	DESCRIPTION	MFGR	FSCM	MFGR PIN	QTY
1	REAR PANEL	WAVETEK	23338	C147-302	1
2	HEATSINK	WAVETEK	23338	B147-312	1
3	TRANSFORMER END BELL	WAVETEK	23338	A147-352	1
4	FUSE HOLDER	LITTELFUSE	75915	342012	1
5	FUSE 1/2 AMP (115V)	LITTELFUSE	75915	313.500	1
6	FUSE 1/2 AMP (230V)	LITTELFUSE	75915	313.250	1
7	NAMETAG (SERIAL NO)	WAVETEK	23338	B147-334	1
8	POWER CONNECTOR	SMITHCRAFT	82389	EAC-301	1
9	CAPTIVE SCREWS	DEUTSCH	-	DKN7900-10-C-2	4
10	TRANSFORMER	WAVETEK	23338	B147-500	1
11	POWER SUPPLY BO ASSY	WAVETEK	23338	D147-020	1
12	TRIM (MADE FROM 807-513)	WAVETEK	23338	B147-317	2
13	CORNER CASTING (MADE FROM CM7-340)	WAVETEK	23338	C147-341	2
14	CLAMPS TAPPED (MADE FROM AM7-810)	WAVETEK	23338	A147-354	4
15	STANDOFFS	WAVETEK	23338	A201-333	4
16	BRACKET, POWER TRANS.	WAVETEK	23338	B147-351	1
17	CLAMPING BAR	WAVETEK	23338	B147-303	1
18	INSULATOR (TRANSISTOR)	WAVETEK	23338	B154-314	1
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					

1) FOR CHASSIS WIRING SEE CHASSIS SCHEMATIC D147-200
NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DESIGN: BOCHKENIG, M	DATE: 7-26-73	WAVETEK SAN DIEGO, CALIFORNIA	
MATERIAL:	PAINTING:		TITLE: ASSEMBLY, REAR PANEL (POWER SUPPLY)	
FINISH: WAVETEK PROCESS	SCALE: DO NOT SCALE DWG	MODEL NO: 147	DWG NO: D147-001	REV: A
		CODE: 23338	SHEET 1 OF 1	

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NOTE: UNLESS OTHERWISE SPECIFIED:

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE	3/18/78	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJECT		
FINISH WAVETEK PROCESS	RELEASE APPROV	J. M. [Signature]	TITLE
	TOLERANCE UNLESS OTHERWISE SPECIFIED	XXX ± 0.10 ANGLES 11°	ASSEMBLY MAIN BOARD
SCALE	DO NOT SCALE DWG	MODEL NO	REV
		147	D147-023 B
LOOK UP	23338	SHEET 1 OF 4	

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PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
1	CAPACITOR				
2	CERAMIC DISC 1000V 15PF	CRL	71590	00150	1
3	CERAMIC DISC 1000V 22PF	CRL	71590	00220	1
4	SILVER MICA 500V 5A 30PF	ELMENCO	72136	DM15-300J	3
5	CERAMIC DISC 1000V 47PF	CRL	71590	00470	1
6	SILVER MICA 500V 68PF	ELMENCO	72136	DM15-680J	2
7	CERAMIC DISC 500V 91PF	CRL	71590	DM-15-910	2
8	SILVER MICA 500V 100PF	ELMENCO	72136	DM15-101J	2
9	SILVER MICA 500V 150PF	ELMENCO	72136	DM15-151J	4
10	CERAMIC DISC 1000V 220PF	CRL	71590	00221	1
11	CERAMIC DISC 1000V 330PF	CRL	71590	00331	2
12	SILVER MICA 470PF	ELMENCO	72136	DM15-471J	1
13	SILVER MICA 820PF	ELMENCO	72136	DM15-821J	1
14	CERAMIC DISC 50V .005uE	CRL	71590	CK502	5
15	CERAMIC DISC 1000V .001uE	CRL	71590	DD102	3
16	CERAMIC DISC 50V .01uE	CRL	71590	CK105	20
17	CERAMIC DISC 20V .1uE	CRL	71590	UK20-104	28
18	POLYSTYRENE 200V 1A 1uE	ELECTROCUBE		21001C105F	1
19	MYLAR 100V 5uE	WAVETEK	23338	B146-505	1SET
20	TANTALIUM 10V 33uE	SPRAGUE	56289	1500356X901002	5
21	ELECTROLYTIC 50V 50uE	SPRAGUE	56289	5000506G0500D7	1
22	ELECTROLYTIC 16V 100uE	SPRAGUE	56289	5000107G0100C7	1
23	MATCHED SET 5uE	WAVETEK	23338	B146-504	1SET
24	MATCHED SET 1uE				REF
25	MATCHED SET 2uE				REF
26	MATCHED SET 0.1uE				REF
27	VARIABLE 7/35PF	STETNER		75-TRIKO-02-77E	3
28	Ceramic Disc 1000V 470PF	CRL	71590	00471	3
29					
30					
31					

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
32					
33	DIODE FD777	FAIRCHILD	33888	FD777	8
34	DIODE MATCHED FD777	WAVETEK	23338	142-501-58	1PR
35	DIODE MATCHED FD6666	FAIRCHILD	33888	FD6666	23
36	DIODE MATCHED 1N3716			1N3716	2
37	DIODE MATCHED HP2811	GENERAL ELECTRIC HEWLETT PACKARD		HP-2811	2
38	DIODE MATCHED ZENER	WAVETEK	23338	A130-506	3
39					
40					
41					
42	INTEGRATED CIRCUIT uA709	WAVETEK	23338	130-501-14	1
43	INTEGRATED CIRCUIT uM741	FAIRCHILD	33888	uM741C	11
44	INTEGRATED CIRCUIT CA3049	RCA	86684	CA3049	1
45	INTEGRATED CIRCUIT MK5005P	FAIRCHILD	33888	MK5005P	1
46	INTEGRATED CIRCUIT 7400	FAIRCHILD	33888	7400	2
47	INTEGRATED CIRCUIT 7402	FAIRCHILD	33888	7402	3
48	INTEGRATED CIRCUIT 7403	FAIRCHILD	33888	7403	1
49	INTEGRATED CIRCUIT 7404	FAIRCHILD	33888	7404	2
50	INTEGRATED CIRCUIT 7405	FAIRCHILD	33888	7405	1
51	INTEGRATED CIRCUIT 7474	FAIRCHILD	33888	7474	3
52	INTEGRATED CIRCUIT 7490	FAIRCHILD	33888	7490	4
53					
54					
55					
56					
57	TRANSISTORS LDB	MOTOROLA	04713	MPSL08	4
58	TRANSISTORS TP308	TECHNICAL PRODUCTS		TP308	2
59	TRANSISTORS 2N3563	FAIRCHILD	33888	2N3563	1
60	TRANSISTORS (MATCHED) 2N3563	WAVETEK	23338	142-501-52	1PR
61	TRANSISTORS 2N3565	FAIRCHILD	33888	2N3565	9
62	TRANSISTORS 2N3638	FAIRCHILD	33888	2N3638	3

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
63	TRANSISTORS 2N3638A	FAIRCHILD	33888	2N3638A	10
64	TRANSISTORS 2N3642	FAIRCHILD	33888	2N3642	3
65	TRANSISTORS 2N3646	FAIRCHILD	33888	2N3646	10
66	TRANSISTORS 2N4248	FAIRCHILD	33888	2N4248	1
67	TRANSISTORS 2N5139	FAIRCHILD	33888	2N5139	12
68	TRANSISTORS 2N5462	WAVETEK	23338	142-501-55	2
69	TRANSISTORS 2N5485	MOTOROLA	04713	2N5485	2
70	TRANSISTORS (MATCHED) 2N5485	WAVETEK	23338	142-501-55	1PR
71					
72					
73					
74					
75	RESISTORS				
76	CARBON 1/2W 5% 4.7k	STACKPOLE	29604	RC20GF4R7J	2
77	CARBON 1/2W 5% 8.2k	STACKPOLE	29604	RC20GF8R2J	4
78	METALFILM 1/8W 1% 100	CORNING	16299	RN550	4
79	METALFILM 1/8W 1% 21.50	CORNING	16299	RN550	6
80	METALFILM 1/8W 1% 33.20	CORNING	16299	RN550	5
81	METALFILM 1/8W 1% 46.40	CORNING	16299	RN550	6
82	METALFILM 1/8W 1% 56.20	CORNING	16299	RN550	3
83	METALFILM 1/8W 1% 82.50	CORNING	16299	RN550	2
84	METALFILM 1/8W 1% 90.90	CORNING	16299	RN550	2
85	METALFILM 1/8W 1% 1000	CORNING	16299	RN550	8
86	METALFILM 1/8W 1% 1240	CORNING	16299	RN550	11
87	METALFILM 1/8W 1% 1500	CORNING	16299	RN550	1
88	METALFILM 1/8W 1% 1960	CORNING	16299	RN600	1
89	METALFILM 1/8W 1% 1490	CORNING	16299	RN550	4
90	METALFILM 1/8W 1% 2740	CORNING	16299	RN550	2
91	METALFILM 1/8W 1% 1160	CORNING	16299	RN550	5
92	METALFILM 1/8W 1% 1320	CORNING	16299	RN550	3
93	METALFILM 1/8W 1% 1640	CORNING	16299	RN550	1

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE: 7/20/64	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL:	DESIGNER: BOCHICHO	TITLE: ASSEMBLY MAIN BOARD	
FINISH: WAVETEK PROCESS	RELEASE APPROV:	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX - .010 ANGLES 1:1 XX - .030	
SCALE:	DO NOT SCALE DWG	WORKING NO: 147	TRNG NO: D147-023 REV: B
		23338	SHEET 2 OF 4

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PARTS LIST					
LINE NO	DESCRIPTION	MFG#	FSC#	MFG P/N	QTY
94	CARBON 1W 5K 4700	STACKPOLE	29604	RC32GF	1
95	METALFILM 1/8W 1K 4990	CORNING	16299	RN55D	4
96	METALFILM 1/8W 1K 5110	CORNING	16299	RN55D	4
97	METALFILM 1/8W 1K 7500	CORNING	16299	RN55D	1
98	METALFILM 1/8W 1K 8250	CORNING	16299	RN55D	2
99	METALFILM 1/8W 1K 1K	CORNING	16299	RN55D	19
100	METALFILM 1/8W 1K 1.1K	CORNING	16299	RN55D	3
101	METALFILM 1/8W 1K 1.21K	CORNING	16299	RN55D	4
102	METALFILM 1/8W 1K 1.5K	CORNING	16299	RN55D	9
103	METALFILM 1/8W 1K 1.62K	CORNING	16299	RN55D	3
104	METALFILM 1/8W 1K 1.78K	CORNING	16299	RN55D	2
105	METALFILM 1/8W 1K 2.21K	CORNING	16299	RN55D	1
106	METALFILM 1/8W 1K 2.37K	CORNING	16299	RN55D	3
107	METALFILM 1/8W 1K 2.49K	CORNING	16299	RN55D	8
108	METALFILM 1/8W 1K 3.32K	CORNING	16299	RN55D	3
109	METALFILM 1/8W 1K 3.65K	CORNING	16299	RN55D	2
110	METALFILM 1/8W 1K 3.92K	CORNING	16299	RN55D	1
111	METALFILM 1/8W 1K 4.32K	CORNING	16299	RN55D	1
112	METALFILM 1/8W 1K 4.75K	CORNING	16299	RN55D	4
113	METALFILM 1/8W 1K 4.99K	CORNING	16299	RN55D	15
114	METALFILM 1/8W 1K 6.19K	CORNING	16299	RN55D	2
115	METALFILM 1/8W 1K 7.5K	CORNING	16299	RN55D	2
116	METALFILM 1/8W 1K 8.25K	CORNING	16299	RN55D	2
117	METALFILM 1/8W 1K 9.09K	CORNING	16299	RN55D	2
118	METALFILM 1/8W 1K 10K	CORNING	16299	RN55D	21
119	METALFILM 1/8W 1K 12.1K	CORNING	16299	RN55D	1
120	METALFILM 1/8W 1K 15K	CORNING	16299	RN55D	2
121	METALFILM 1/8W 1K 16.5K	CORNING	16299	RN55D	1
122	METALFILM 1/8W 1K 18.2K	CORNING	16299	RN55D	3
123	METALFILM 1/8W 1K 19.1K	CORNING	16299	RN55D	2
124	METALFILM 1/8W 1K 27.4K	CORNING	16299	RN55D	1

PARTS LIST					
LINE NO	DESCRIPTION	MFG#	FSC#	MFG P/N	QTY
125	METALFILM 1/8W 1K 69.8K	CORNING	16299	RN55D	1
126	METALFILM 1/8W 1K 100K	CORNING	16299	RN55D	1
127	METALFILM 1/4W 1K 464K	CORNING	16299	RN60D	1
128	METALFILM 1/4W 1K 1M	CORNING	16299	RN60D	2
129	CARBON 1/2W 5K 4.7M	STACKPOLE	29604	RC20GF475K	1
130	CARBON 1/2W 5K 6.8M	STACKPOLE	29604	RC20GF685K	2
131	MATCHED SET 1M	WAVETEK	23338	142-501-50	1SET
132	MATCHED SET 100K				REF
133	MATCHED SET 10K				REF
134	MATCHED SET 1K				REF
135					
136					
137	CONNECTOR	MCLEX		09523101	5
138	POTENTIOMETER 1000	BECKMAN	80740	91AR100	2
139	POTENTIOMETER 2000	BECKMAN	80740	91AR200	1
140	POTENTIOMETER 5000	BECKMAN	80740	91AR500	8
141	POTENTIOMETER 1K	BECKMAN	80740	91AR1K	4
142	POTENTIOMETER 2K	BECKMAN	80740	91AR2K	5
143	POTENTIOMETER 10K	BECKMAN	80740	91AR10K	2
144	POTENTIOMETER 100K	BECKMAN	80740	91AR100K	4
145	POTENTIOMETER 10K	WAVETEK	23338	146-R1	2
146	SINE MODULE	WAVETEK	23338	142-011	1
147	STANDOFFS (SWAGE)	LYNTRON		6311-4-2-C	4
148	CONNECTOR	MCLEX		09-52-3101	5
149	CONNECTOR (CARD EDGE)	CINCH JONES	71785	252-18-30-160	1
150	SOCKET (14 PIN)	CINCH JONES	71785	14-D1P	15
151	SOCKET (12 PIN)	CINCH JONES	71785	CSA-2300-12	2
152	SWITCH ASSY SW1	WAVETEK	23338	0147-005	1
153	SWITCH ASSY SW2	WAVETEK	23338	0147-008	1
154	SWITCH ASSY SW3	WAVETEK	23338	0147-014	1
155	SWITCH ASSY SW4	WAVETEK	23338	0147-015	1

PARTS LIST					
LINE NO	DESCRIPTION	MFG#	FSC#	MFG P/N	QTY
156	SWITCH ASSY SWS-SW7	WAVETEK	23338	132-401	1
157	TRANSIPADS	MILTON ROSS	07047	10123N	16
158	SWITCH BRACKET	WAVETEK	23338	133-305	7
159	TERMINALS	USECO	88245	20108-1	2
160	CIRCUIT BOARD	WAVETEK	23338	147-123	1

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE 9/25/81	WAVETEK SAN DIEGO - CALIFORNIA
MATERIAL	ENGINEER S. J. WILSON	TITLE ASSEMBLY MAIN BOARD
FINISH WAVETEK PROCESS	RELEASE APPROV	DO NOT SCALE DWG
	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX - 010 ANGLES - 1/2 XX - 020	MODEL NO 147
	SCALE	DWG NO 0147-023
		REV B
		CODE 23338
		SHEET 3 OF 4

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LINE ITEM REFERENCE LIST

Ref. Desig.	F/L Line	Ref. Desig.	F/L Line	Ref. Desig.	F/L Line
C1	17	C92	17	Q1	62
C2	17	C93	21	Q2	69
C3	17	C94	12	Q3	65
C4	17	C95	21	Q4	68
C5	16	C96	17	Q5	67
C6	10	C97	17	Q6	64
C7	19	C98	17	Q7	66
C8	19	C99	17	Q8	64
C9	17	C100	17	Q9	62
C10	16	C101	17	Q10	70
C11	16	C102	16	Q11	70
C12	12	C103	16	Q12	67
C13	28			Q13	59
C14	16			Q14	65
C15	17			Q15	65
C16	17			Q16	67
C17	27			Q17	68
C18	2	CR1	38	Q18	67
C19		CR2	35	Q19	69
C20	23	CR3	35	Q20	65
C21	23	CR4	35	Q21	57
C22	16	CR5	35	Q22	67
C23	24	CR6	38	Q23	57
C24	25	CR7	34	Q24	57
C25	26	CR8	34	Q25	67
C26	27	CR9	33	Q26	57
C27	13	CR10	33	Q27	67
C28	6	CR11	33	Q28	60
C29	16	CP12	33	Q29	60
C30	4	CP13		Q30	67
C31	16	CP14	36	Q31	67
C32	16	CR15	36	Q32	65
C33	7	CR16	35	Q33	67
C34	15	CR17	35	Q34	67
C35	9	CR18	33	Q35	65
C36	9	CR19	33	Q36	65
C37	15	CR20	33	Q37	67
C38	7	CR21	33	Q38	63
C39	17	CR22	37	Q39	63
C40	11	CR23	37	Q40	63
C41	11	CR24	35	Q41	63
C42	16	CR25	35	Q42	63
C43	16	CR26	38	Q43	63
C44	17	CR27	35	Q44	63
C45	17	CR28	35	Q45	61
C46	8	CR29	35	Q46	61
C47	8	CR30	35	Q47	61
C48	9	CR31	35	Q48	61
C49	4	CR32	35	Q49	61
C50	16	CR33	35	Q50	61
C51	16	CR34	35	Q51	61
C52	17	CR35	35	Q52	61
C53	27	CR36	35	Q53	63
C54	5	CR37	35	Q54	63
C55	17	CR38	35	Q55	63
C56	3	CR39	35	Q56	61
C57	16	CR40	35	Q57	65
C58	16	CR41	35	Q58	64
C59	16	IC1	51	Q59	62
C60	16	IC2	52	Q60	65
C61	17	IC3	52	Q61	65
C62	14	IC4	39	Q62	58
C63	14	IC5	46	Q63	58
C64	14	IC6	51		
C65	14	IC7	52		
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C67	22	IC9	46		
C68	28	IC10	47		
C69	16	IC11	52		
C70	20	IC12	47		
C71		IC13	51		
C72	20	IC14			
C73	6	IC15			
C74		IC16			
C75		IC17	43	R1	
C76	20	IC18	42	R2	
C77		IC19	43	R3	
C78	16	IC20	43	P4	142
C79	17	IC21	43	R5	142
C80	17	IC22	43	R6	142
C81	17	IC23	43	R7	142
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C84	9	IC26	43	R10	144
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C87	28	IC29	44	R13	113
C88	14	IC30	45	R14	125
C89	17	IC31	50	R15	112
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LINE ITEM REFERENCE LIST

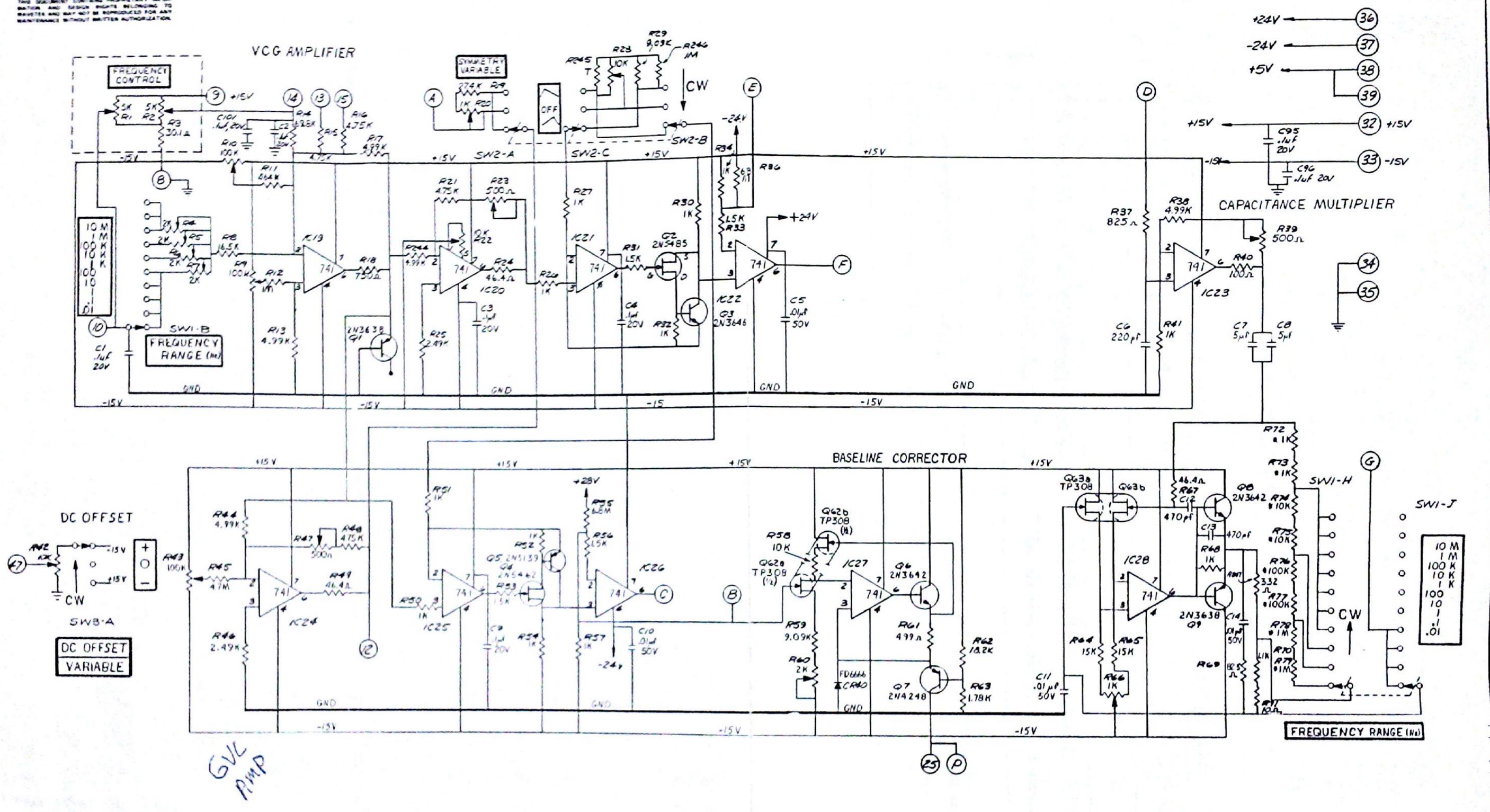
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R42	145	R133	85	R224	118
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R46	107	R137	107	R228	118
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R64	120	R155	93	R246	128
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R66	141	R157	81	R248	92
R67	81	R158	81	R249	102
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R70	100	R161	108		
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R72	134	R163	78		
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R74	133	R165	80		
R75	133	R166	79		
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R77	132	R168	95		
R78	131	R169	85		
R79	131	R170	104		
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R81	101	R172	99		
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R90	109	R181	77		
R91	79	R182	91		
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R93	115	R184	141		
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R95	91	R186	102		
R96	115	R187	122		
R97	118	R188	78		
R98	79	R189	92		
R99	109	R190	107		
R100	140	R191	144		
R101	91	R192	118		
R102	91	R193	118		
R103	101	R194	118		
R104	114	R195	118		
R105	103	R196	86		
R106	79	R197	76		
R107	114	R198	86		
R108	101	R199	86		
R109	79	R200	86		
R110	103	R201	86		

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	
	PROJENGA	PLAT	
FINISH WAVETER PROCESS	RELEASE APPROV	TITLE	ASSEMBLY MAIN BOARD
	TOLERANCE UNLESS OTHERWISE SPECIFIED	SCALE	1:1
DO NOT SCALE DWG	MODEL NO	DWG NO	REV
SCALE	147	D147-023	B
	23338		SHEET 4 OF 2

REV	ECN	BY	DATE	APP
A	ECN 764		7/76	

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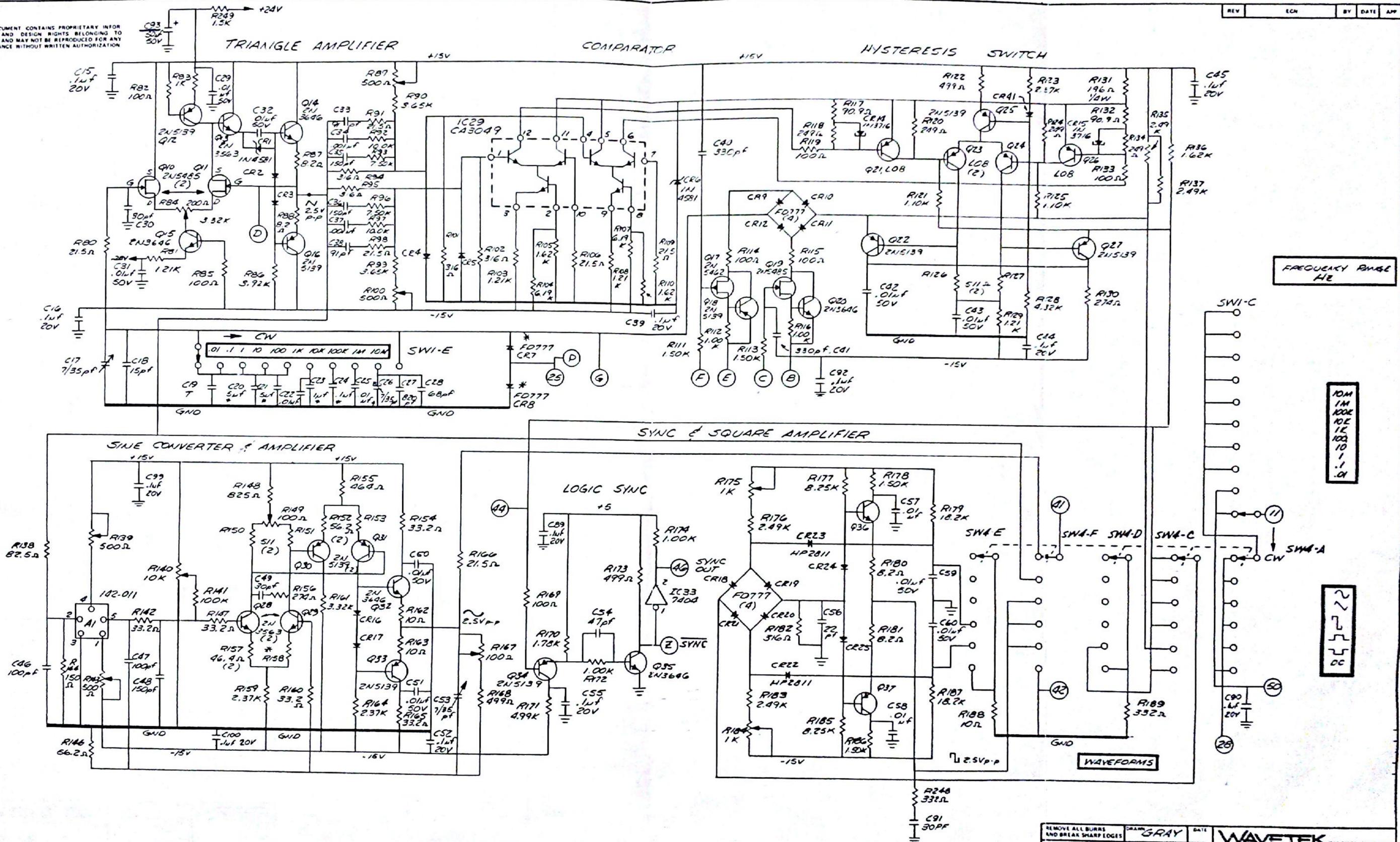
GVL AMP

LAST DESIGNATOR USED
 R250
 C102
 Q63
 CR39
 IC53

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN COSHOW	DATE 5/30/73	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	DESIGNED BY	TITLE SCHEMATIC MAIN BOARD	
FINISH WAVETEK PROCESS	RELEASE APPROVAL 7/16/73	TOLERANCE UNLESS OTHERWISE SPECIFIED RES ± 1% ANGLES 45°	MODEL NO. 147
SCALE	DO NOT SCALE DWG	DO NOT SCALE DWG	DWG NO. D147-223
			REV. A
			LOG # 23338
			SHEET 1 OF 4

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FREQUENCY RANGE Hz

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1M
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1K
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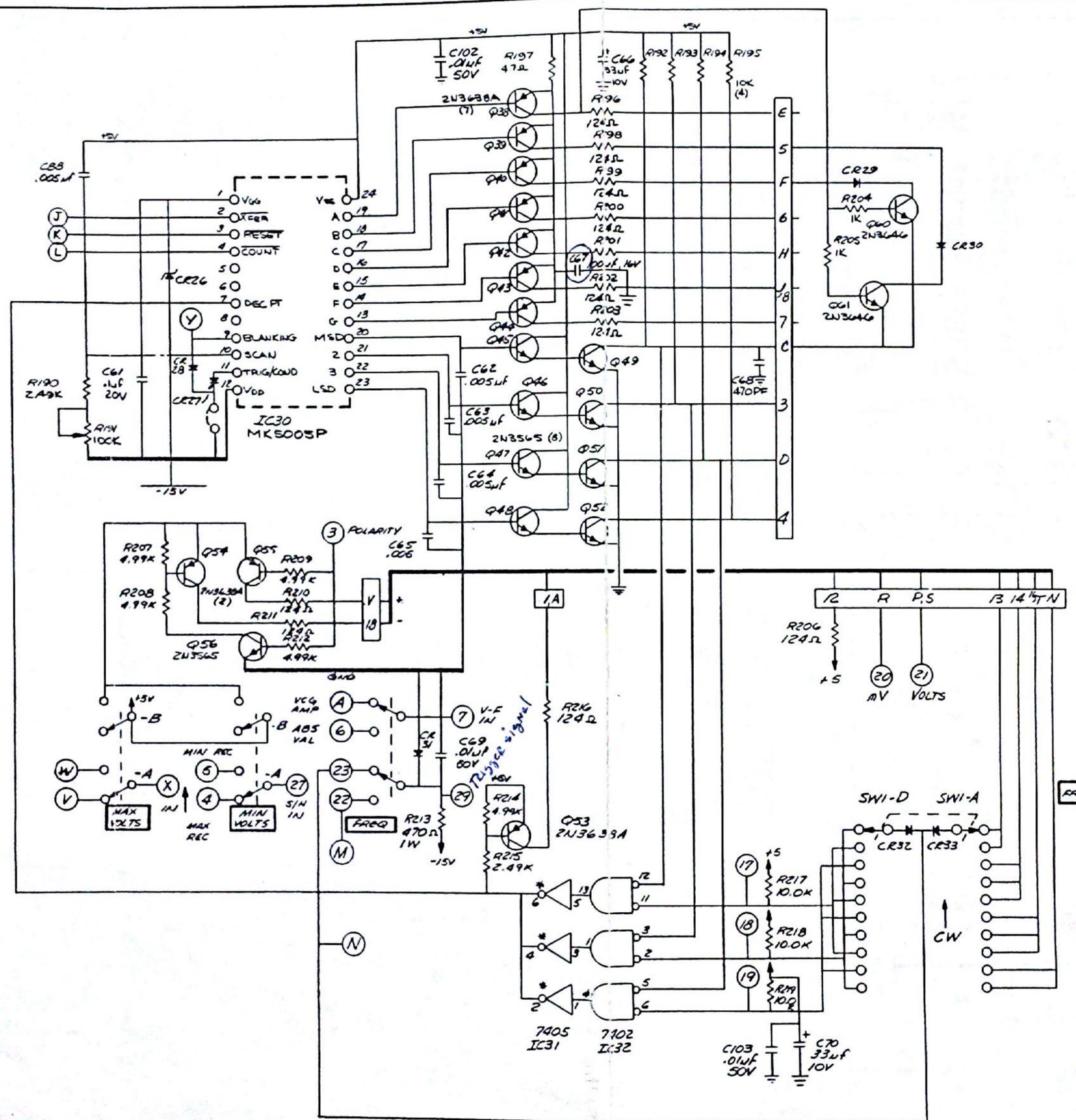
DC
2
3
4
5

WAVEFORMS

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES		DATE	WAVETEK	
MATERIAL	PROLIFER	1/10/77	TITLE	
FINISH	WAVETEK PROCESS	1/10/77	SCHEMATIC MAIN BOARD	
TOLERANCE UNLESS OTHERWISE SPECIFIED		DO NOT SCALE DWG	MODEL NO	REV
XX - 0.10 ANGLES 1:1		SCALE	147	D47-223 A
COSH		23338	SHEET 2 OF 4	

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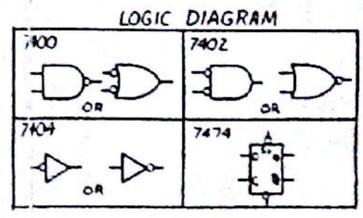
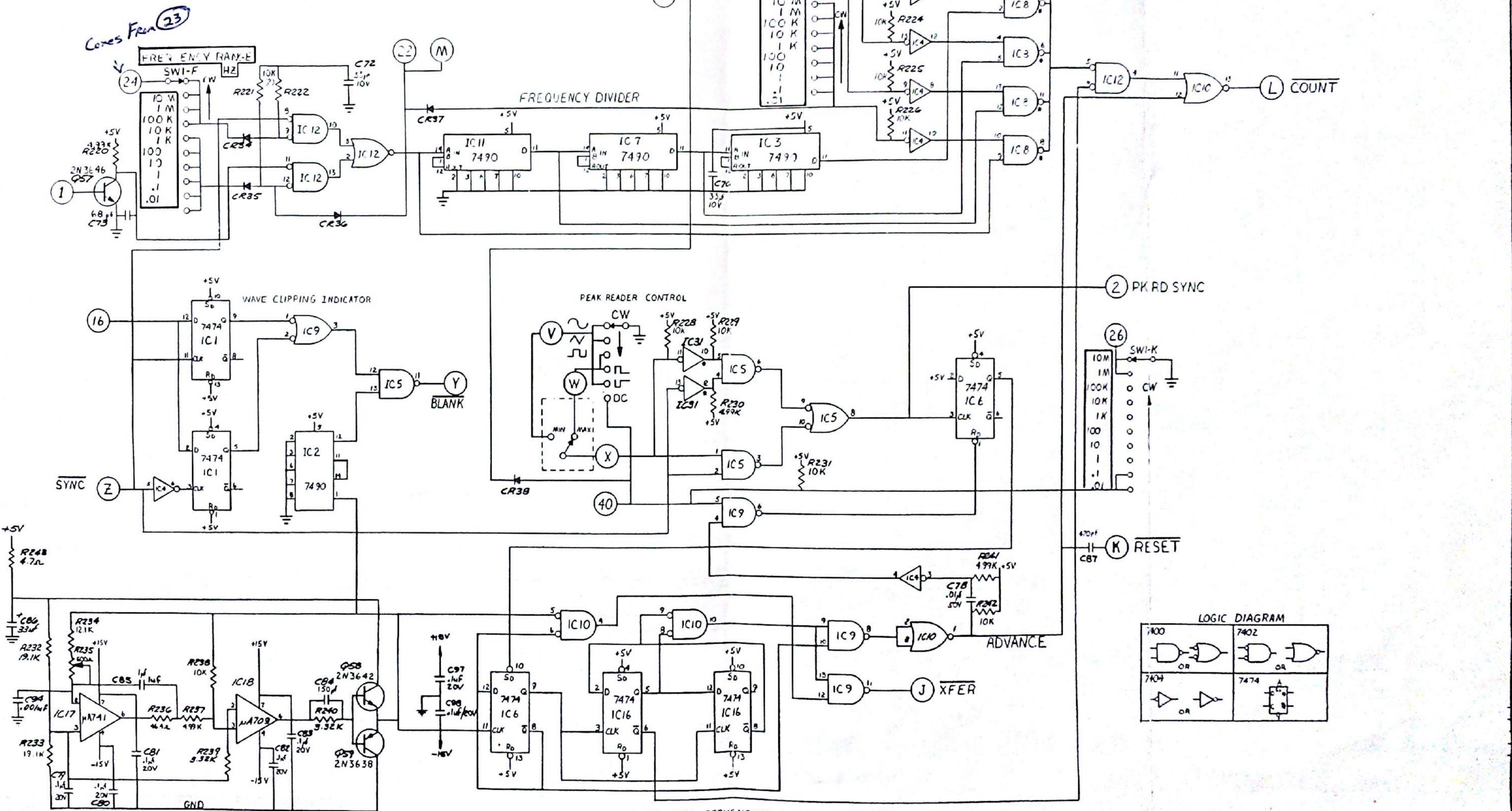
FREQUENCY RANGE NE

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1M
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0.1

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL	PROJ. NO.	TITLE	
	RELEASE APPROV. <i>[Signature]</i>	SCHEMATIC MAIN BOARD	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED: XX ± 0.10 ANGLES 11°	MODEL NO.	DWG NO. D147-223
	DO NOT SCALE DWG	SCALE	REV A
		COGN. ONLY	23338 SHEET 3 OF 4

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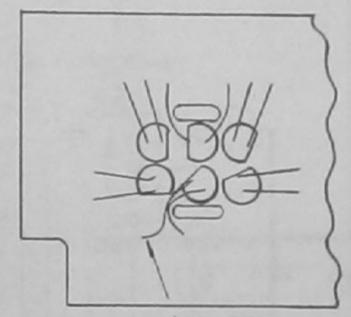
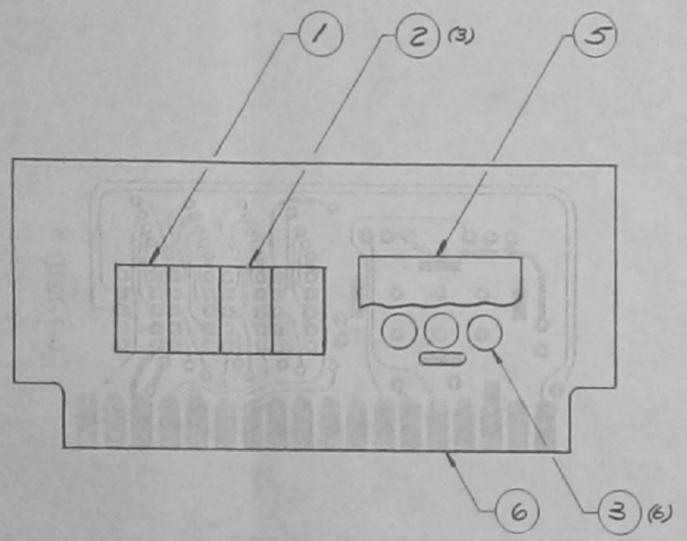


1. ALL DIODES ARE FD666 UNLESS OTHERWISE SPECIFIED

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DESIGNER COSHOW	DATE 10-73	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	REV. ENG.		
FINISH WAVETEK PROCESS	REL. ENG. 10-73	TOLERANCES UNLESS OTHERWISE SPECIFIED: XXX ± 0.00 ANGLES 11° EX ± 0.02	TITLE SCHEMATIC MAIN BOARD
DO NOT SCALE DRAWING	SCALE	147	147 D147-223 A
		23338	SHEET 4 OF 4

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PARTS LIST

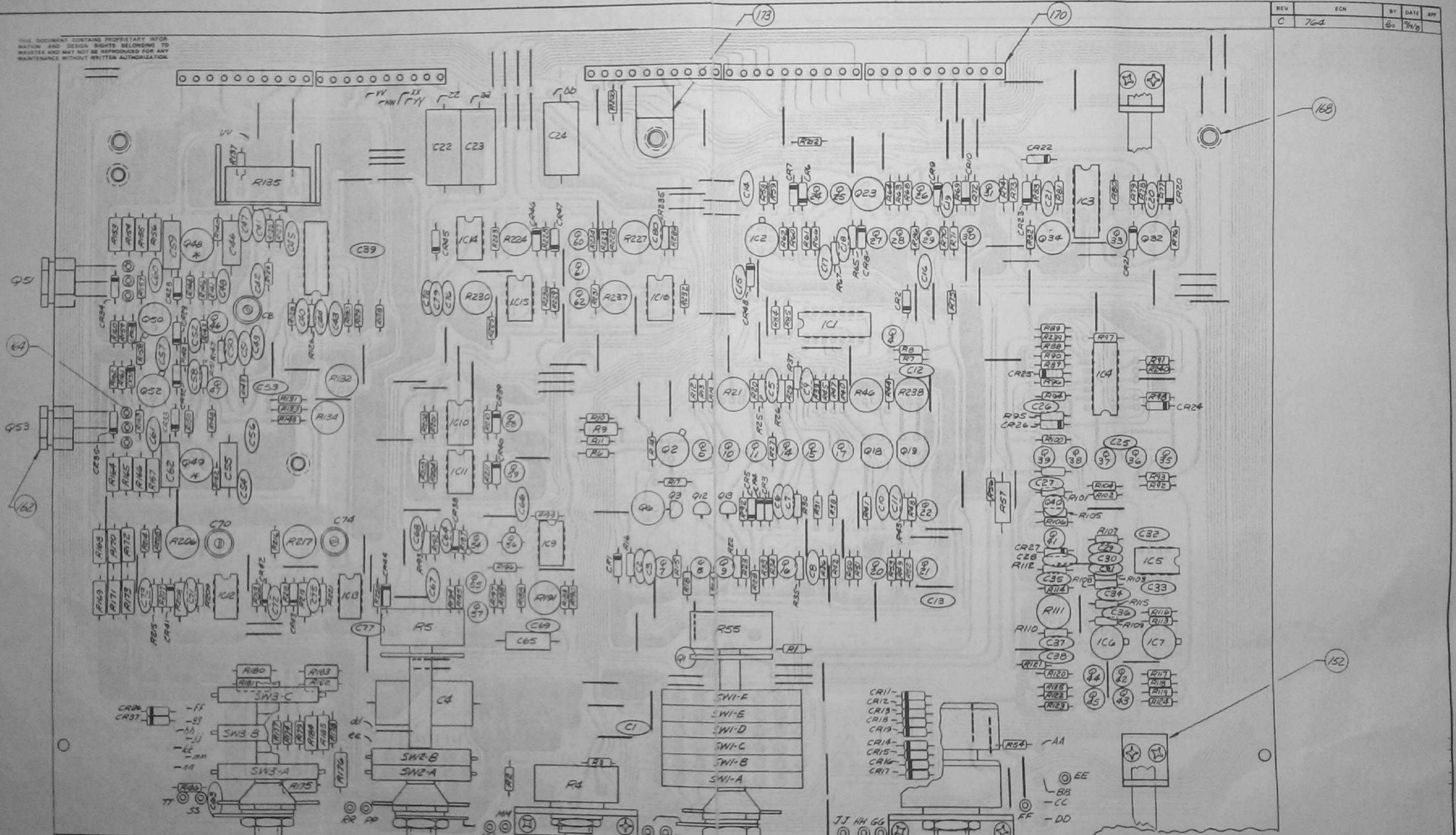
ITEM	DESCRIPTION	MEGR	FSCM	MFGR P/N	QTY
1	READOUT +/-	FAIRCHILD	33888	FND-71	1
2	DIGIT	FAIRCHILD	33888	FND-70	3
3	LED	OPCOA		OSL-6L-1	6
4					
5	DISPLAY CAP	WAVETEK	23338	B147-507	1
6	CIRCUIT BOARD	WAVETEK	23338	147-121	1
7					
8					

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN WAVETEK	DATE 8-28-73	WAVETEK SAN DIEGO • CALIFORNIA		
MATERIAL	PROJ ENGR				TITLE ASSEMBLY READOUT BD
FINISH WAVETEK PROCESS	RELEASE AUTH 9-28-73	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES 1:1 XX ± .030	MODEL NO. 147	DWG NO. D147-021	REV
	DO NOT SCALE DWG	SCALE	CODE IDENT 23338	SHEET / OF /	

REV	ECN	BY	DATE	APP
C	764	Bo	7/4/78	

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1- INSTALL HEAT-SINK ITEM 163

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN Bochichio	DATE 8/1/78	WAVETEK SAN DIEGO - CALIFORNIA
MATERIAL	PROJ ENGR	TITLE	
FINISH WAVEK PROCESS	RELEASE APPROV. 8/1/78	9-18-78	ASSEMBLY SWEEP BD
DO NOT SCALE DWG	SCALE	MODEL NO. 147	DWG NO. D147-022 C
		CODE 23338	SHEET 1 OF 4

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LINE ITEM REFERENCE LIST

Ref. Desig.	F/L Line	Ref. Desig.	F/L Line	Ref. Desig.	F/L Line
C1	14	C46	20	CR1	31
C2	4	C47	15	CR2	30
C3	4	C48	15	CR3	31
C4	19	C49	15	CR4	30
C5	9	C50	10	CR5	30
C6	15	C51	13	CR6	30
C7	15	C52	17	CR7	30
C8	18	C53	15	CR8	30
C9	9	C54	15	CR9	30
C10	10	C55	20	CR10	30
C11	6	C56	15	CR11	30
C12	18	C57	15	CR12	30
C13	18	C58	17	CR13	30
C14	18	C59	20	CR14	30
C15	18	C60	15	CR15	30
C16	18	C61	15	CR16	30
C17	15	C62	20	CR17	30
C18	11	C63	7	CR18	30
C19	8	C64	12	CR19	30
C20	11	C65	16	CR20	30
C21	11	C66	18	CR21	30
C22	21	C67	18	CR22	28
C23	21	C68	3	CR23	28
C24	21	C69	18	CR24	31
C25	11	C70	24	CR25	31
C26	18	C71	2	CR26	31
C27	13	C72	15	CR27	30
C28	13	C73	18	CR28	30
C29	18	C74	24	CR29	30
C30	18	C75	2	CR30	30
C31	18	C76	18	CR31	30
C32	7	C77	15	CR32	30
C33	4	C78	18	CR33	30
C34	5	C79	18	CR34	30
C35	18	C80	15	CR35	30
C36	18	C81	24	CR36	30
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C38	18			CR38	30
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C40	18			CR40	30
C41	12			CR41	29
C42	12			CR42	29
C43	12			CR43	29
C44	18			CR44	29
C45	12			CR45	30

LINE ITEM REFERENCE LIST

Ref. Desig.	F/L Line	Ref. Desig.	F/L Line	Ref. Desig.	F/L Line
CR46	30	Q13	56	Q58	53
CR47	30	Q14	53	Q59	53
CR48	31	Q15	57	Q60	53
		Q16	51	Q61	51
		Q17	53	Q62	53
		Q18	59		
		Q19	59		
		Q20	53		
		Q21	53		
		Q22	53		
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IC2	37	Q24	51	R2	85
IC3	39	Q25	51	R3	85
IC4	40	Q26	53	R4	149
IC5	35	Q27	53	R5	144
IC6	41	Q28	53	R6	87
IC7	41	Q29	53	R7	109
IC8	38	Q30	53	R8	109
IC9	34	Q31	53	R9	130
IC10	34	Q32	50	R10	126
IC11	34	Q33	53	R11	112
IC12	34	Q34	50	R12	119
IC13	34	Q35	51	R13	126
IC14	34	Q36	51	R14	91
IC15	34	Q37	51	R15	76
IC16	34	Q38	53	R16	68
		Q39	53	R17	94
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Q5	51	Q50	46	R28	106
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Q9	53	Q54	61	R32	94
Q10	51	Q55	54	R33	66
Q11	51	Q56	60	R34	94
Q12	56	Q57	53	R35	76
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LINE ITEM REFERENCE LIST

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R39	110	R85	109	R130	100
R40	104	R86	109	R131	125
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R42	81	R88	99	R133	104
R43	94	R89	120	R134	138
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R47	98	R93	99	R138	109
R48	94	R94	116	R139	86
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R67	101	R113	88	R158	89
R68	100	R114	116	R159	66
R69	116	R115	99	R160	67
R70	116	R116	116	R161	66
R71	129	R117	128	R162	67
R72	96	R118	108	R163	72
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R75	116	R121	111	R166	71
R76	119	R122	75	R167	71
R77	110	R123	94	R168	74
R78	100	R124	118	R169	74
R79	96	R125	94	R170	74
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R82	119				

LINE ITEM REFERENCE LIST

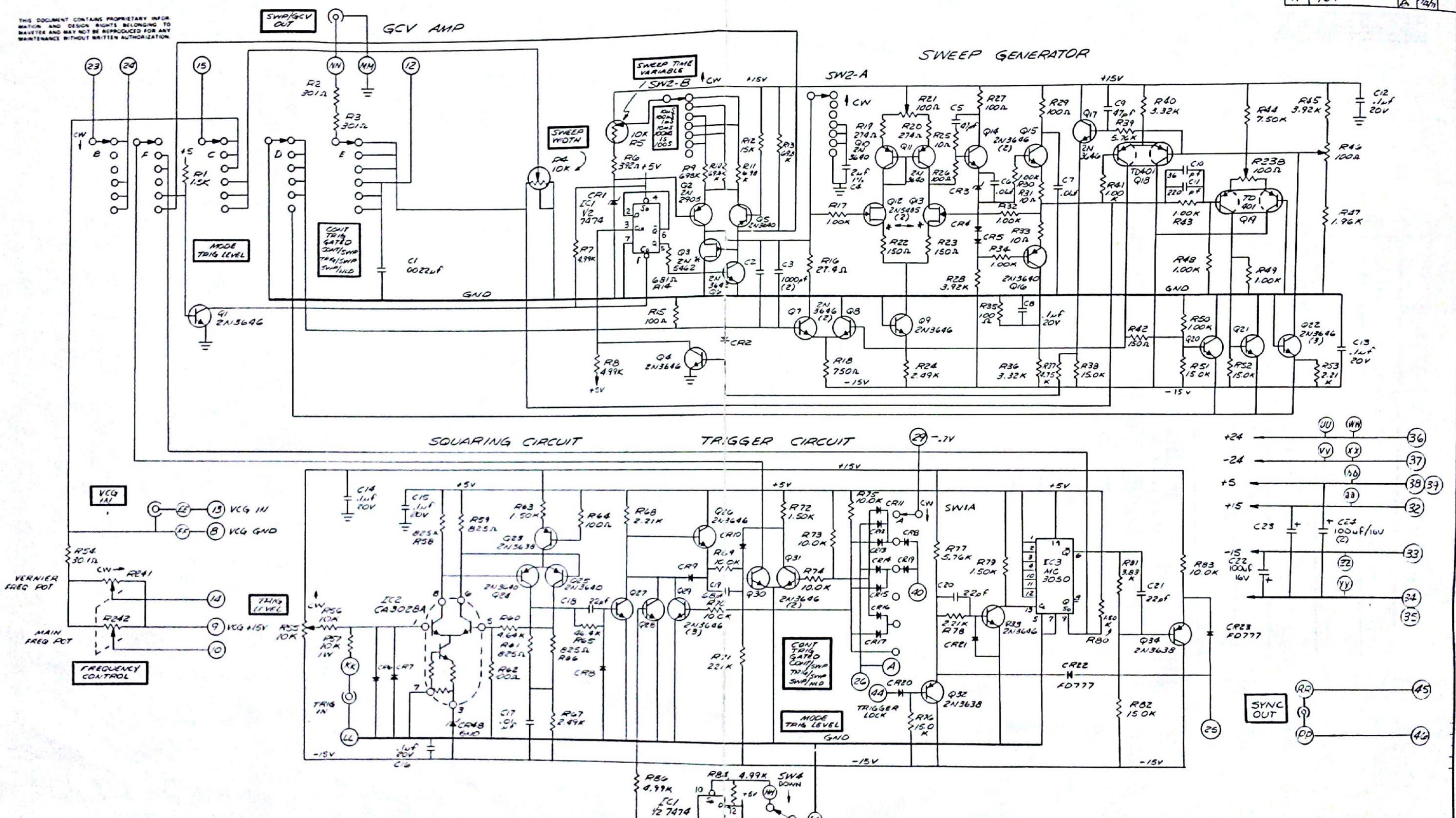
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R176	71	R221	128		
R177	85	R222	115		
R178	172	R223	116		
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R180	76	R225	102		
R181	80	R226	110		
R182	77	R227	138		
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R209	121				
R210	114				
R211	114				
R212	101				
R213	70				
R214	114				
R215	114				
R216	94				
R217	134				

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN BOGNER	DATE 7/27/77	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL	PROCESSOR	TITLE	ASSEMBLY SWEEP BOARD	
	WILLIAM APPROV			
		TOLERANCE UNLESS OTHERWISE SPECIFIED X.X - 0.00 ANGLES - 1		
FINISH WAVETEK PROCESS	DO NOT SCALE DWG	MODEL NO 147	DWG NO D147-022	REV C
	SCALE	PLATE NO 23338	SHEET 2 OF 2	

REV	ECN	BY	DATE	APP
A	764		1/14/73	

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- 5) RESISTORS ARE 1/8W, 1%, METAL FILM
 - 6) DIODES ARE FD6666
 - 3) LETTERS IN ○ DENOTE INTERCONNECTIONS BETWEEN SHEETS OF THIS SCHEMATIC
 - 2) NUMBERS IN ○ DENOTE PIN NOS ON REAR CONNECTOR (BETWEEN BOARDS)
 - 1) DESCRIPTIONS IN □ DENOTE FRONT PANEL NOMENCLATURE
- NOTE: UNLESS OTHERWISE SPECIFIED

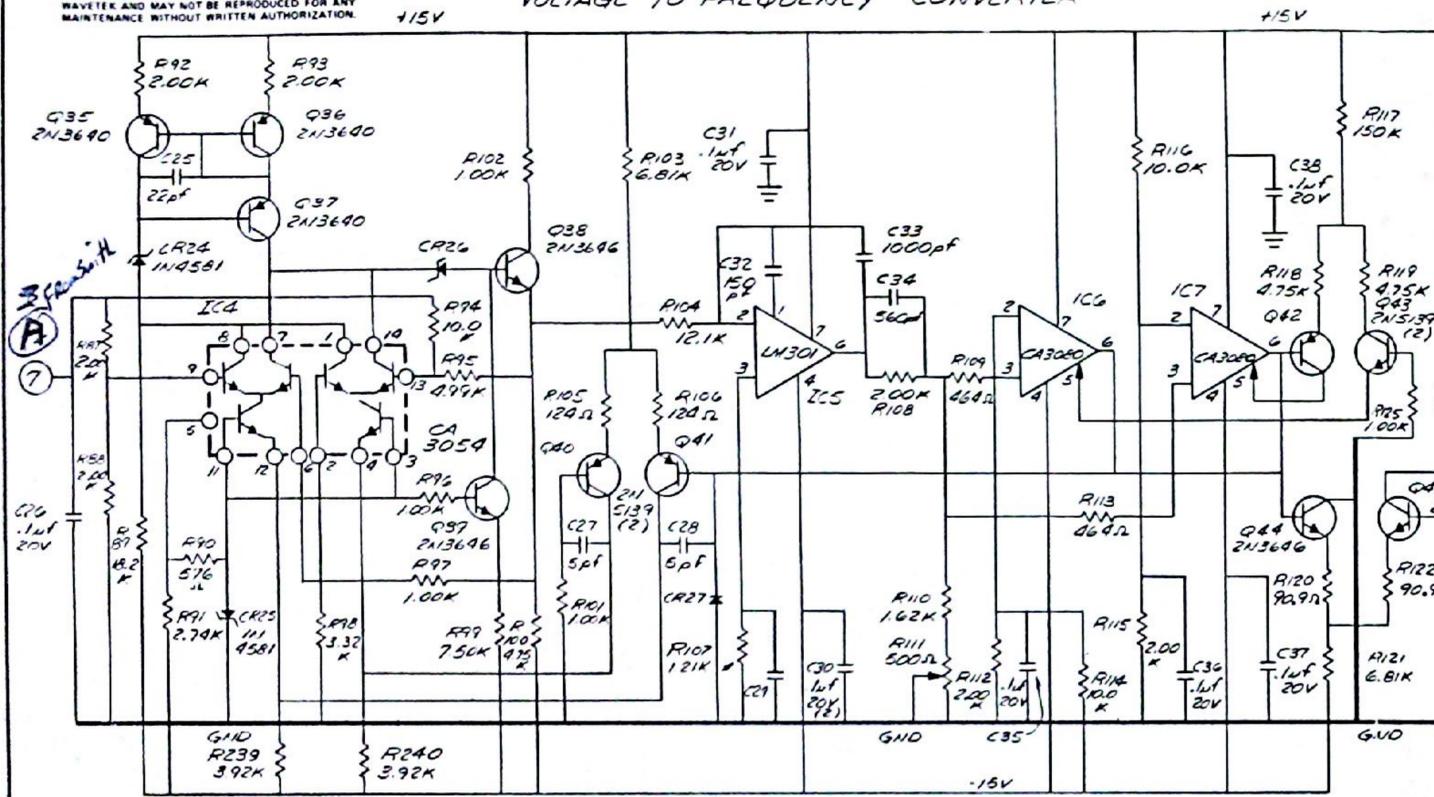
LAST DESIGNATOR USED
 R242
 Q62
 C81
 CR4B
 IC16

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN GRAY	DATE	WAVETEK 648 BRIDGE CALIFORNIA TITLE SCHEMATIC, SWEEP BOARD
MATERIAL	PROJECTOR		
FINISH WAVETEK PROCESS	RELEASE APPROV 9-28-73	SCALE	MODEL NO 147 PART NO D147-222 A
DO NOT SCALE DWG	SCALE	CODE IDENT	REV A SHEET 1 OF 2

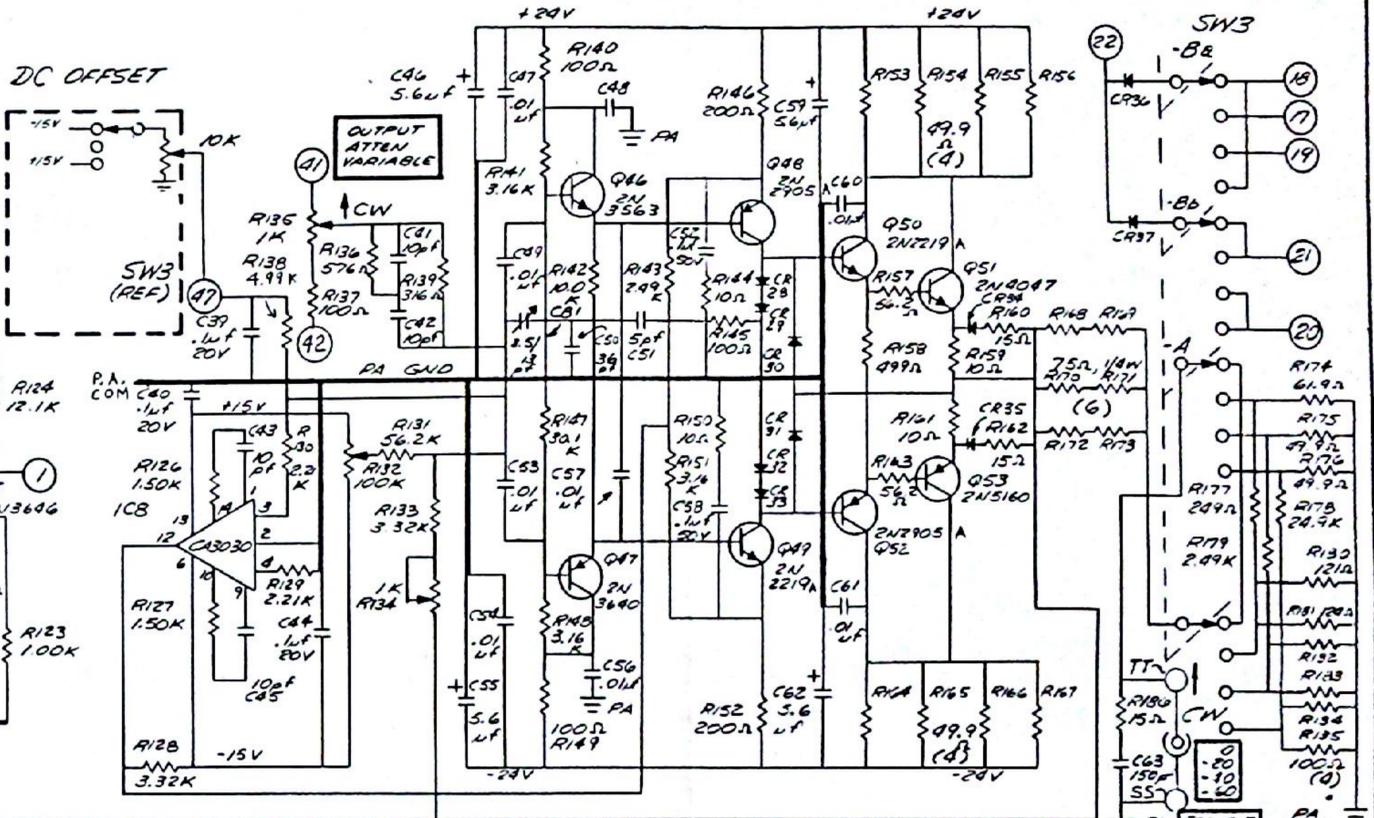
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REV ECH BY DATE APP

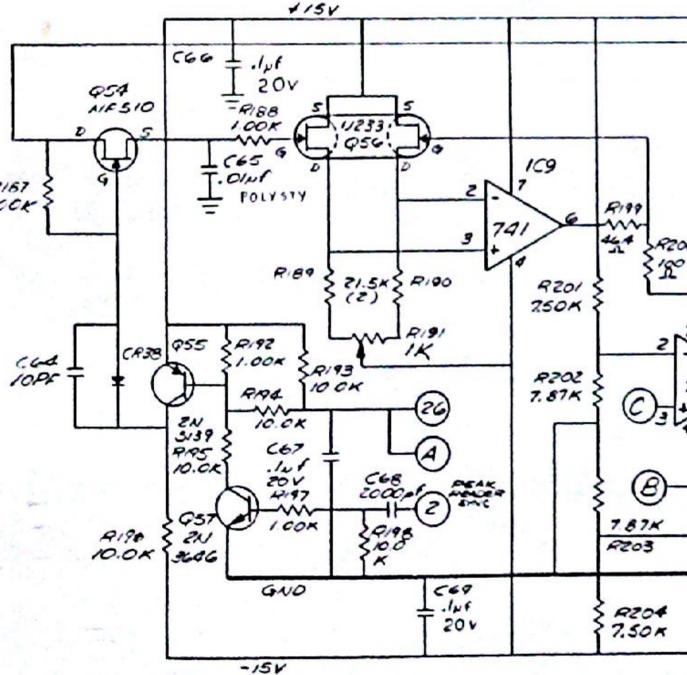
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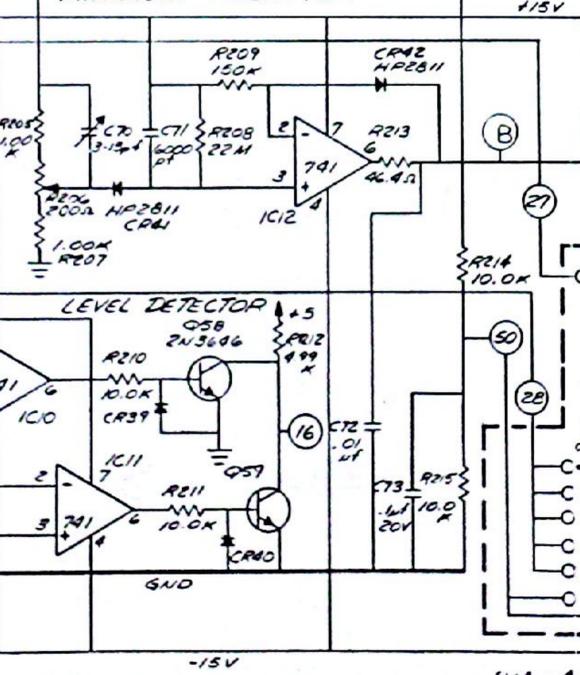
OUTPUT AMPLIFIER



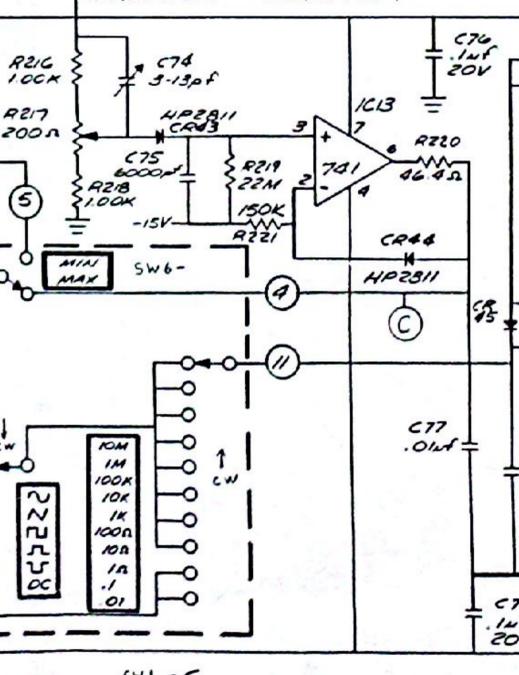
SAMPLE & HOLD CIRCUIT



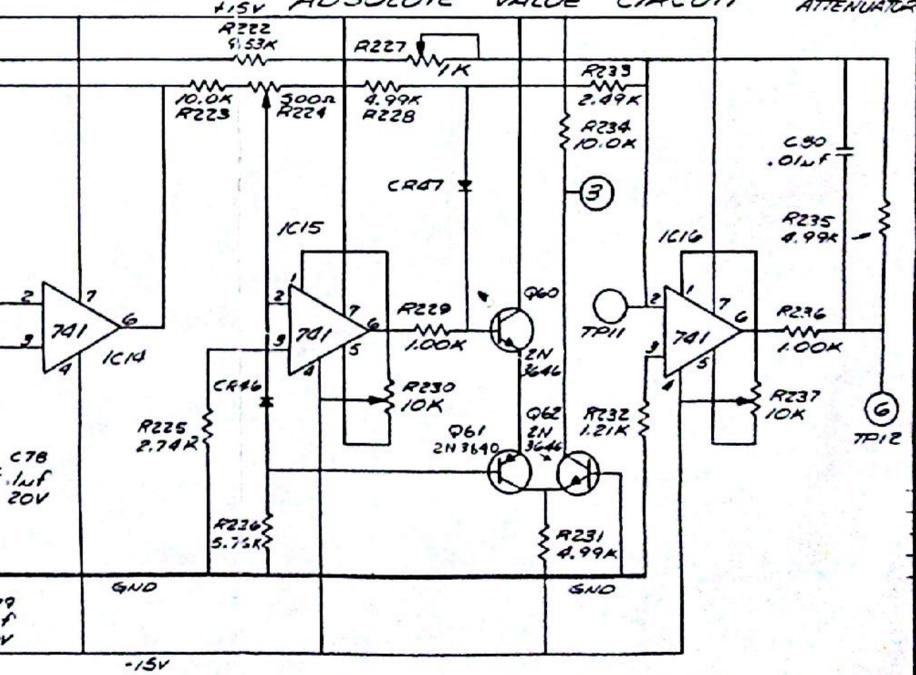
MINIMUM RECTIFIER



MAXIMUM RECTIFIER



ABSOLUTE VALUE CIRCUIT

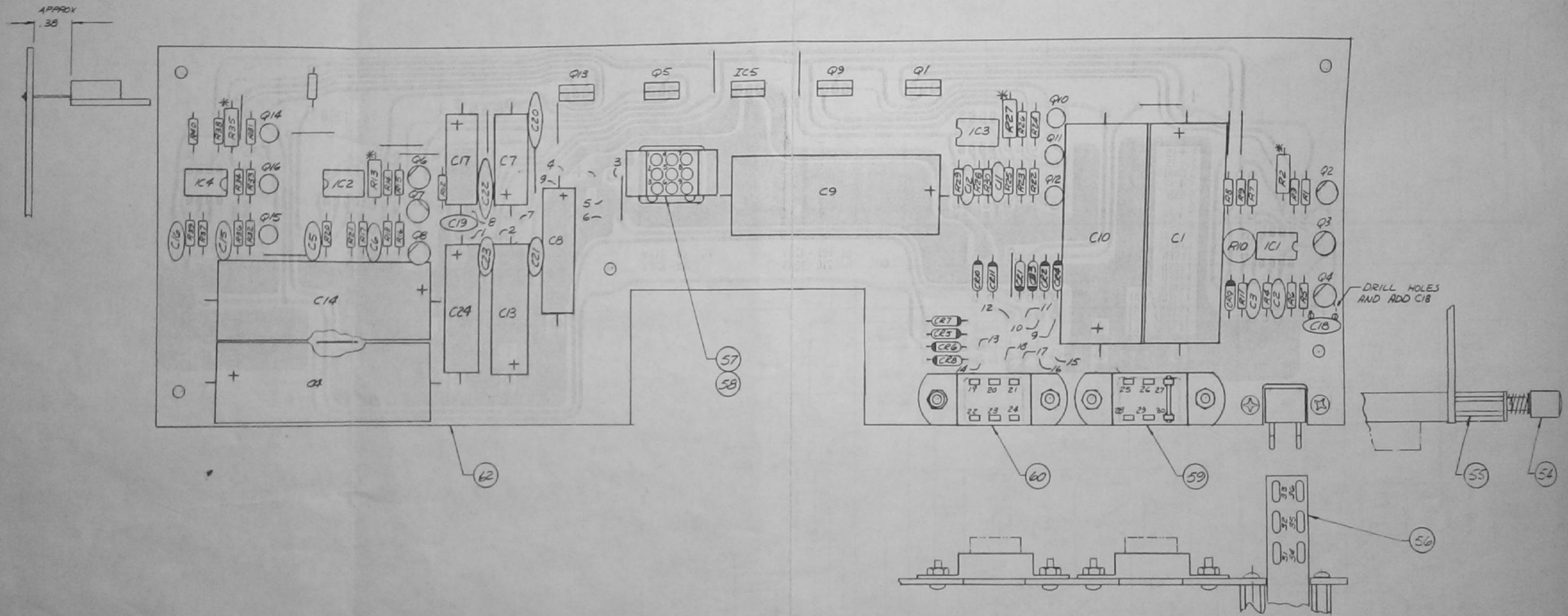


NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DESIGN GRAY	DATE 8/15/72	WAVETEK SAN DIEGO - CALIFORNIA
MATERIAL	PROJ ENGR	RELEASE APR 27 1972	
FINISH WAVETEK PROCESS	TOLERANCES UNLESS OTHERWISE SPECIFIED XXX ± 0.10 ANGLES 11° XX ± 0.20		TITLE SCHEMATIC, SWEEP BOARD
SCALE	DO NOT SCALE DWG	MODEL NO 147	DWG NO D147-222
		CODE 23338	SHEET 2 OF 2

REV	ECN	BY	DATE	APP
D	764	B	1/19	

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3 * INDICATES RESISTORS MOUNTED OFFBOARD
 2 NUMBERS INDICATE CHASSIS WIRING SEE CHASSIS SCHEMATIC D147-200
 1

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE 1/19/70	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL	PROJ ENGR	TITLE ASSEMBLY POWER SUPPLY	
FINISH WAVETEK PROCESS	RELEASE APPR 7/1/70 P-38-23	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX : 010 ANGLES 1:1 XX : 030	
	DO NOT SCALE DWG	MODEL NO 147	DWG NO D147-020 D
	SCALE	CDD 23338	SHEET 1 OF 2

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PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
1	CAPACITOR				
2	SILVER MICA 500V 5% 6000 pf	ELMENDO	72136	DM19-622J	2
3	SILVER MICA 500V 5% 2000 pf	ELMENDO	72136	DM19-202J	1
4	SILVER MICA 500V 1% 1000 pf	ELMENDO	72136	DM19-102F	3
5	SILVER MICA 500V 5% 560 pf	ELMENDO	72136	DM15-561J	1
6	SILVER MICA 500V 5% 220pf	ELMENDO	72136	DM15-221J	1
7	CERAMIC DISC 1000V 150 pf	CRL	71590	DD151	2
8	CERAMIC DISC 1000V 68 pf	CRL	71590	DD680	1
9	CERAMIC DISC 1000V 47 pf	CRL	71590	DD470	2
10	SILVER MICA 500V 5% 36pf	ELMENDO	72136	DM15-360J	2
11	CERAMIC DISC 1000V27pf	CRL	71590	DD220	4
12	CERAMIC DISC 1000V10pf	CRL	71590	DD100	5
13	CERAMIC DISC 1000V5pf	CRL	71590	DD050	3
14	CERAMIC DISC 1000V .0022uF	CRL	71590	DD222	1
15	CERAMIC DISC 50V .01uF	CRL	71590	CK103	15
16	POLYSTYRENE 100V .01uF	IMB	30874	PA28103F	1
17	CERAMIC DISC 50V .1uF	CRL	71590	CK104	2
18	CERAMIC DISC 20V .1uF	CRL	71590	UK20-104	24
19	MYLAR 10% 200V 2uF	AMERICAN RADIONICS	07994	2MF2205K	1
20	TANT 35V 5 uF	SPRAGUE	56289	1500565X9035R2	4
21	ELECTROLYTIC 16V 100uF	SPRAGUE	56289	500D107G016DC7	3
22					
23					
24	VARIABLE 3.5 -15pf	STETNER		75-TRIK0-02	3
25					
26					
27					
28	DIODE FD777	FAIRCHILD	33888	FD777	2
29	DIODE HP2811	HEWLETT PACKARD		HP-2811	4
30	DIODE FD6666	FAIRCHILD	33888	FD6666	36
31	DIODE ZENER	WAVETEK	23338	A130-506	6
32					

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
33	INTEGRATED CIRCUIT				
34	INTEGRATED CIRCUIT LM741	FAIRCHILD	33888	LM741C	8
35	INTEGRATED CIRCUIT LM301	NATIONAL	27014	LM301AN	1
36	INTEGRATED CIRCUIT 7474	MOTOROLA	04713	7474	1
37	INTEGRATED CIRCUIT CA3028A	RCA	86684	CA3028A	1
38	INTEGRATED CIRCUIT CA3030	RCA	86684	CA3030	1
39	INTEGRATED CIRCUIT MC1050	MOTOROLA	04713	MC-3050	1
40	INTEGRATED CIRCUIT CA3054	RCA	86684	CA3054	1
41	INTEGRATED CIRCUIT CA3080	RCA	86684	CA3080	2
42					
43					
44					
45					
46	TRANSISTOR 2N2219A	MOTOROLA	04713	2N2219A	2
47	TRANSISTOR 2N2905	FAIRCHILD	33888	2N2905	1
48	TRANSISTOR 2N2905A	FAIRCHILD	33888	2N2905A	2
49	TRANSISTOR 2N3563	FAIRCHILD	33888	2N3563	1
50	TRANSISTOR 2N3638	FAIRCHILD	33888	2N3638	3
51	TRANSISTOR 2N3640	FAIRCHILD	33888	2N3640	11
52	TRANSISTOR 2N3642	FAIRCHILD	33888	2N3642	1
53	TRANSISTOR 2N3646	FAIRCHILD	33888	2N3646	27
54	TRANSISTOR 2N5139	FAIRCHILD	33888	2N5139	5
55	TRANSISTOR (-55) 2N5462	MOTOROLA	04713	2N5462	1
56	TRANSISTOR (-55) 2N5485	MOTOROLA	04713	2N5485	2
57	TRANSISTOR 2N4047	FAIRCHILD	33888	2N4047	1
58	TRANSISTOR 2N5160	FAIRCHILD	33888	2N5160	1
59	TRANSISTOR TD401	TECH PRODUCT		TD401	2
60	TRANSISTOR U253	SILICONIX		U253	1
61	TRANSISTOR NF-510	NATIONAL	27014	NF-510	1
62					
63					
64					

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
65	RESISTORS				
66	METALFILM 1/8W 1% 100	CORNING	16299	RN550	7
67	METALFILM 1/8W 1% 150	CORNING	16299	RN550	3
68	METALFILM 1/8W 1% 27.40	CORNING	16299	RN550	1
69	METALFILM 1/8W 1% 30.10	CORNING	16299	RN550	1
70	METALFILM 1/8W 1% 46.40	CORNING	16299	RN550	3
71	METALFILM 1/4W 1% 49.90	CORNING	16299	RN600	10
72	METALFILM 1/8W 1% 56.20	CORNING	16299	RN550	2
73	METALFILM 1/8W 1% 61.90	CORNING	16299	RN550	1
74	METALFILM 1/4W 1% 750	CORNING	16299	RN600	6
75	METALFILM 1/8W 1% 90.90	CORNING	16299	RN550	2
76	METALFILM 1/8W 1% 100	CORNING	16299	RN550	12
77	METALFILM 1/4W 1% 100	CORNING	16299	RN600	4
78	METALFILM 1/4W 1% 1210	CORNING	16299	RN600	1
79	METALFILM 1/8W 1% 1240	CORNING	16299	RN550	2
80	METALFILM 1/4W 1% 1240	CORNING	16299	RN600	1
81	METALFILM 1/8W 1% 1500	CORNING	16299	RN550	3
82	METALFILM 1/8W 1% 2000	CORNING	16299	RN550	2
83	METALFILM 1/8W 1% 2450	CORNING	16299	RN550	1
84	METALFILM 1/8W 1% 2740	CORNING	16299	RN550	2
85	METALFILM 1/8W 1% 3010	CORNING	16299	RN550	2
86	METALFILM 1/8W 1% 3160	CORNING	16299	RN550	1
87	METALFILM 1/8W 1% 3900	CORNING	16299	RN550	1
88	METALFILM 1/8W 1% 4640	CORNING	16299	RN550	2
89	METALFILM 1/8W 1% 4990	CORNING	16299	RN550	1
90	METALFILM 1/8W 1% 5760	CORNING	16299	RN550	2
91	METALFILM 1/8W 1% 6810	CORNING	16299	RN550	1
92	METALFILM 1/8W 1% 7500	CORNING	16299	RN550	1
93	METALFILM 1/8W 1% 8250	CORNING	16299	RN550	4
94	METALFILM 1/8W 1% 1K	CORNING	16299	RN550	24
95	METALFILM 1/8W 1% 1.21K	CORNING	16299	RN550	2
96	METALFILM 1/8W 1% 1.5K	CORNING	16299	RN550	7

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE 8/27/77	WAVETEK SAN DIEGO - CALIFORNIA
MATERIAL	RELEASE APPROVAL	TITLE ASSEMBLY SWEEP BOARD
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX - .010 ANGLES - 1 XX - .030	MODEL NO 147
SCALE	DO NOT SCALE DWG	DWG NO 0147-022C
		CONTROL NO 23338
		SHEET 2 OF 2

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REV	ECN	BY	DATE	APP
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PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
97	METALFILM 1/8W 1% 1.62K	CORNING	16299	RN55D	1
98	METALFILM 1/8W 1% 1.96K	CORNING	16299	RN55D	1
99	METALFILM 1/8W 1% 2K	CORNING	16299	RN55D	7
100	METALFILM 1/8W 1% 2.21K	CORNING	16299	RN55D	5
101	METALFILM 1/8W 1% 2.49K	CORNING	16299	RN55D	5
102	METALFILM 1/8W 1% 2.74K	CORNING	16299	RN55D	2
103	METALFILM 1/8W 1% 3.16K	CORNING	16299	RN55D	3
104	METALFILM 1/8W 1% 3.32K	CORNING	16299	RN55D	5
105	METALFILM 1/8W 1% 3.83K	CORNING	16299	RN55D	1
106	METALFILM 1/8W 1% 3.92K	CORNING	16299	RN55D	4
107	METALFILM 1/8W 1% 4.64K	CORNING	16299	RN55D	1
108	METALFILM 1/8W 1% 4.75K	CORNING	16299	RN55D	4
109	METALFILM 1/8W 1% 4.99K	CORNING	16299	RN55D	11
110	METALFILM 1/8W 1% 5.76K	CORNING	16299	RN55D	3
111	METALFILM 1/8W 1% 6.81K	CORNING	16299	RN55D	2
112	METALFILM 1/8W 1% 6.98K	CORNING	16299	RN55D	1
113	METALFILM 1/8W 1% 7.5K	CORNING	16299	RN55D	4
114	METALFILM 1/8W 1% 7.87K	CORNING	16299	RN55D	2
115	METALFILM 1/8W 1% 9.53K	CORNING	16299	RN55D	1
116	METALFILM 1/8W 1% 10K	CORNING	16299	RN55D	22
117	CARBON 1W 5% 10K	STACKPOLE	29604	RC32GF	1
118	METALFILM 1/8W 1% 12.1K	CORNING	16299	RN55D	2
119	METALFILM 1/8W 1% 15K	CORNING	16299	RN55D	6
120	METALFILM 1/8W 1% 18.2K	CORNING	16299	RN55D	1
121	METALFILM 1/8W 1% 21.5K	CORNING	16299	RN55D	2
122	METALFILM 1/8W 1% 24.9K	CORNING	16299	RN55D	1
123	METALFILM 1/8W 1% 30.1K	CORNING	16299	RN55D	1
124	METALFILM 1/8W 1% 46.4K	CORNING	16299	RN55D	1
125	METALFILM 1/8W 1% 56.2K	CORNING	16299	RN55D	1
126	METALFILM 1/8W 1% 69.8K	CORNING	16299	RN55D	2
127	METALFILM 1/8W 1% 100K	CORNING	16299	RN55D	1

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
128	METALFILM 1/8W 1% 150K	CORNING	16299	RN55D	3
129	METALFILM 1/8W 1% 221K	CORNING	16299	RN55D	1
130	METALFILM 1/4W 1% 698K	CORNING	16299	RN60D	1
131	CARBON 1/2W 5% 22M	STACKPOLE	29604	RC20GF225J	2
132					
133					
134					
135	POTENTIOMETER 100Ω	BECKMAN	80740	91AR100	3
136	POTENTIOMETER 200Ω	BECKMAN	80740	91AR200	2
137	POTENTIOMETER 500Ω	BECKMAN	80740	91AR500	2
138	POTENTIOMETER 1K	BECKMAN	80740	91AR1K	3
139	POTENTIOMETER 10K	BECKMAN	80740	91AR10K	2
140	POTENTIOMETER 100K	BECKMAN	80740	91AR100K	1
141					
142					
143	SWITCH ASSEMBLY (ATTN)	WAVETEK	23338	D147-004	1
144	SWITCH ASSEMBLY (SWEEP TIME)	WAVETEK	23338	D147-007	1
145	SWITCH ASSEMBLY (MODE)	WAVETEK	23338	D147-006	1
146					
147					
148	POTENTIOMETER	WAVETEK	23338	A147-401	1
149	POTENTIOMETER	WAVETEK	23338	136-R1A	1
150	POTENTIOMETER DUAL	WAVETEK	23338	A147-501	1
151					
152	POWER ROD ASSY	WAVETEK	23338	D147-003	1
153					
154	D-WASHER (RETAINER)	WAVESSR	-	D-191	1
155					
156					
157					
158					

PARTS LIST					
LINE NO	DESCRIPTION	MFR	FSCM	MFR P/N	QTY
159					
160					
161	SWITCH BRACKET	WAVETEK	23338	B133-305	2
162	HEATSINK	THERMOLLY	13103	1103A	2
163	HEATSINK	WAKEFIELD	05820	NF-207	2
164	THERMinals (TALL BIF)	USECO	88245	2005B-1	6
165	TRANSIDADS	MILTON ROSS	07047	10123W	7
166	TRANSIDADS (TALL)	MILTON ROSS	07047	10160	2
167	AMP PINS	AMP	00779	61182-2	13
168	STANDOFFS (SWAGE)	LYNTRON		6311-4-2	5
169	SHIELD	WAVETEK	23338	B147-357	1
170	CONNECTOR PINS	MOLEX		09-64-2101	5
171	CONNECTOR PINS	MOLEX		02-06-2132	9
172	CONNECTOR RECEPTACLE	MOLEX		03-06-2091	1
173	CABLE CLAMP	H.H. SMITH	83330	832	1
174	CIRCUIT BOARD	WAVETEK	23338	147-122	1
175					
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189					

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE 1/24/79	WAVETEK SAN DIEGO • CALIFORNIA	
MATERIAL	DESIGNER BENJAMIN	TITLE ASSEMBLY SWEEP BOARD	
FINISH WAVETEK PROCESS	RELEASE APPROV	TOLERANCE UNLESS OTHERWISE SPECIFIED XX - 0.10 ANGLES - 1 XX - 0.30	MODEL NO 147
		DO NOT SCALE DWG	DWG NO D147-022
		SCALE	CODE IDENT 23338
			SHEET 3 OF 8