

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Visit our website - *Click HERE*

INSTRUCTION MANUAL

MODEL 110

FUNCTION GENERATOR

and

MODEL 111

VOLTAGE CONTROLLED GENERATOR

WAVETEK ®

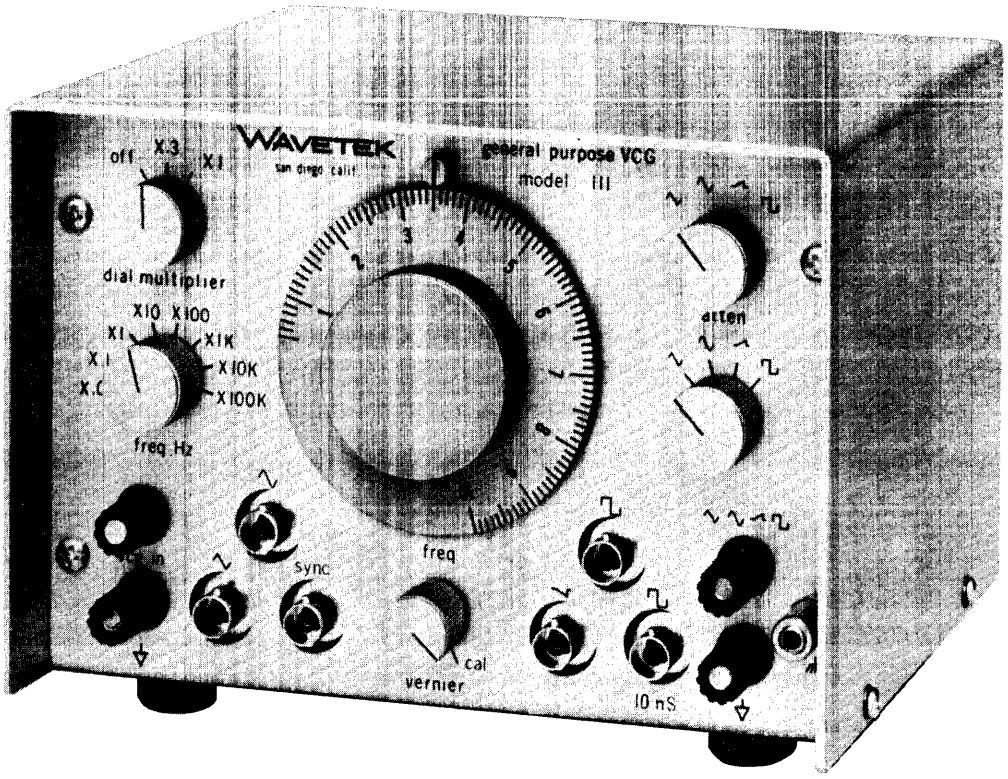
8159 ENGINEER ROAD, SAN DIEGO, CALIFORNIA

© - 1966

Revised 1-67



Model 110 and 110B Function Generator



Model 111, VGG Voltage Controlled Generator

TABLE OF CONTENTS

Section		Page
I	GENERAL DESCRIPTION AND OPERATION	
	General	1-1
	Model 111	1-1
	Models 110 and 111; Models 110B and 111B	1-2
	Models 110 and 110B; Controls and Terminals	1-3
	Power Switch	1-3
	Frequency Range Switch	1-4
	Frequency Dial	1-4
	Selector Switch, Output Attenuator, and D-C Zero Control	1-5
	The 5 Volt Triangle, 5 Volt Sine and 5 Volt Square Outputs (Model 110)	1-5
	The 10 Nsec. Square Output	1-5
	Models 111 and 111B; Controls and Terminals	1-5
	Power/Dial Multiplier Switch	1-5
	Frequency Range Switch	1-6
	Frequency Dial and Frequency Vernier	1-6
	The VCG Input	1-6
	The 5 Volt Triangle, 5 Volt Sine and 5 Volt Square Outputs (Model 111)	1-6
	Model 111B; Main Output	1-7
II	SPECIFICATIONS AND TEST PROCEDURES	
	Specifications	2-1
	Test Procedures	2-12
	General Information	2-12
	Testing Information	2-12
	Other Kinds of Tests	2-12
III	THEORY OF OPERATION	
	Model 110	3-1
	Model 111	3-2
	Circuit Description	3-3
IV	CALIBRATION	
	Model 110; Calibration Procedure	4-1
	Equipment Required	4-1
	Power Supply Board	4-1
	Power Amplifier	4-2

TABLE OF CONTENTS

Section		Page
IV	CALIBRATION (Continued)	
	Main Board	4-2
	Sine Waveform Adjustments	4-2
	Check Ranges	4-3
	Model 111	4-3
	Equipment Required	4-3
	Power Supply Board	4-3
	Power Amplifier	4-4
	Main Board	4-4
	Sine Waveform Adjustments	4-5
	VCG Board Frequency	4-5
	Ramp Adjustment	4-6
	Check Ranges	4-6
V	PARTS LIST	
	General	5-1
	Parts List Arrangement	5-1
	List of Manufacturers	5-1
	Matched or Paired Parts	5-2
VI	SCHEMATIC DIAGRAMS	

LIST OF ILLUSTRATIONS

Figure No.		Page
5-1	Chassis Assembly	5-3
5-2	Front Panel Assembly (Model 110)	5-5
5-3	Front Panel Assembly (Model 111)	5-8
5-4	Main Board Assembly	5-12
5-5	VCG Board Assembly	5-17
5-6	Power Supply and Output Amplifier Assembly	5-21
5-7	Battery Power Supply Assembly	5-23

WARRANTY

WAVETEK warrants instruments manufactured by it to have met WAVETEK's published specifications at the time of shipment of such instruments, and agrees to repair within one year of shipment, such instruments or their components (excluding batteries), which under normal use are found to be defective as a result of our manufacturing. Our obligation under this warranty is limited solely to repairing any such instrument which in our sole opinion proves to be defective when returned to our factory. Transportation to the factory is to be prepaid by the purchaser. Instruments returned to the factory will be accepted only when prior authorization has been given by a representative of WAVETEK.

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

WAVETEK assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. WAVETEK assumes no liability for secondary charges or consequential damages, and in any event, WAVETEK's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and as to which a claim is made.

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

SECTION I
GENERAL DESCRIPTION AND OPERATION

GENERAL

The WAVETEK Model 110 Function Generator and Model 111 Voltage Controlled Generator (VCG) are semi-precision sources of waveforms from servo to video frequencies. These units are extremely rugged, completely transistorized portable packages. They feature complete plug-in printed circuit board construction with interchangeable individually calibrated printed circuit boards utilizing silicon semiconductors throughout. The extremely clean and stable waveform signal from 0.005 Hz to 1 MHz (Model 110) and 0.0015 Hz to 1 MHz (Model 111) make these generators highly versatile general purpose pieces of equipment for the laboratory or the field.

The Models 110 and 111 are identical in size and performance except that the Model 111 offers VCG and the additional ramp function. Both Models feature a main output with function selector switch and amplitude attenuator. In addition, they offer simultaneous 5 volt peak to peak 50Ω outputs of sine, square and triangle waveforms; 1 volt, 10 nsec. rise and fall time square wave; and, -10 volt sync pulse. Frequency is controlled by an eight position range switch at 20:1 range, thus providing good overlap.

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

MODEL 111

The Model 111 features VCG voltage control of frequency by the internal frequency dial operating in parallel with the VCG input terminals. The generated frequency is the resultant sum of the VCG input voltage and the dial setting. Without an externally applied voltage, the dial governs and the generator operates like a Model 110. By adding a positive voltage to the input terminals, the frequency is increased; by adding a negative voltage to the input terminals, the frequency is decreased. The applied voltage may be either a d-c programming voltage or an a-c frequency modulating voltage. The modulation band width is 100 KHz (it is possible to have a higher modulation frequency than carrier frequency, with a resulting triangle wave that may look like a staircase).

The frequency dial is a continuously variable quality composition potentiometer. An electronic frequency vernier is incorporated for extremely precise frequency adjustment. The vernier covers one minor dial division for one vernier rotation.

In addition to sine, square and triangle, the Model 111 also offers ramp functions. The base line of this ramp signal is zero volts and the ramp duty cycle is 50 per cent. The ramp on the binding post is a positive ramp; the ramp on the BNC connector is a negative ramp.

MODELS 110 and 111; MODELS 110B and 111B

The Models 110 and 111 incorporate a power amplifier which offers a maximum of 32.5 volts peak to peak (+16.25 volts ramp) at the binding post output. An attenuator is included on the input of this output amplifier. The amplifier will supply 30 volts peak to peak (15 volts ramp) into a 600Ω load at maximum output setting. Ten volts peak to peak (5 volts ramp) may be driven into a 50Ω load with undistorted waveforms by rotating the output attenuator counterclockwise until clipping stops.

NOTE

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

The output amplifier inverts the signals appearing at the BNC connectors. Thus there will be a 180 degree phase shift between the sine, square or triangle output appearing on the binding posts and those on the BNC's. The ramp on the binding post will be simultaneous in time with the ramp on the BNC; however, it is a positive ramp while the BNC is a negative ramp. Both have a base line very near zero volts.

The Models 110B and 111B incorporate an internal battery charger in place of the power amplifier. These units will operate continuously for eight hours (Model 110B) or six hours (Model 111B) from the internal batteries. Both may be charged completely in 16 hours. The charge is designed so that charging occurs while the unit is in operation. A screwdriver adjustment enables the operator to set the desired charge rate. In maximum clockwise position, charge time from discharge to charge is 14 hours. Frequent operation with the instrument plugged into a-c power with the charge rate set this high would result in damage to the batteries. Maximum counterclockwise position of the rear control sets the charge rate to maintain the

batteries at full charge without overcharge. The units are wired so that when plugged into a-c power but turned OFF, a trickle charge maintains the batteries at full charge setting.

The power amplifier used in the Models 110 and 111 is not utilized in the Models 110B and 111B, and is thus bypassed. The signal appearing on the binding post is now a maximum 5 volts peak to peak (-2.5 volts ramp) at approximately 600Ω output impedance. Because no inverting amplifier is used, output signals on the binding post are directly in phase with those on the BNC's.

MODELS 110 and 110B; CONTROLS AND TERMINALS

Controls and outputs for the Models 110 and 110B are identical except for output impedances and voltage levels at the binding posts. For the Model 110, these are 50Ω and 0 to 32.5 volts peak to peak (or, by removal of one jumper, an impedance of 600Ω is obtained). Output impedance of the Model 110B is 600Ω at voltage levels of 0 to 5 volts peak to peak. No zero adjustment is provided for this output on the Model 110B, but internal controls permit setting the balance of each function independently.

Power Switch

The power switch on the Model 110 connects the instrument to either 115 VAC or 230 VAC line power through a 3/4 ampere fuse mounted on the rear panel. (See drawing in Schematic Section of this manual for 115 VAC and 230 VAC connections.)

For the Model 110B, when the power switch is OFF, the batteries are disconnected from the instrument but connected to the charger. The charger is set for a trickle-charge of approximately 3 ma if it is plugged into the power line. In the ON position, the batteries are connected to the instrument for normal operation. If the instrument is not connected to line power, the batteries are discharging; but, if connected, the charger supplies sufficient current to operate the instrument and charge the batteries. The amount of charge current is dependent upon the potentiometer available through the rear panel. In maximum clockwise rotation the charge current is approximately 50 ma. In maximum counter-clockwise rotation the charge current is approximately 15 ma. The 15 ma charge current is recommended for optimum battery life unless a greater charge rate is required by duty use cycle.

CAUTION

If the batteries are allowed to completely discharge, the instrument power supply cannot provide adequate power to simultaneously operate and charge. If this condition exists, the

instrument should be allowed to recharge for at least one hour before it is used in the a-c mode.

Frequency Range Switch

An eight position switch which selects the appropriate timing resistor and capacitor for proper frequency range and selects appropriate compensating resistors for constant dial potentiometer loading, and balanced integrator source resistances.

Frequency Dial

A continuously variable high quality composition potentiometer which allows precise frequency adjustment. The generated frequency is the product of the dial setting and the frequency range switch multiplier; for instance, if the dial setting is 3 and 1/2, and the "Freq Hz" dial is at X100, the frequency generated is 350 Hz.

Selector Switch, Output Attenuator, and D-C Zero Control (rear-mounted screwdriver adjustment)

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

The output attenuator covers a 30 db range. For output voltages less than 20 db below maximum output, it is recommended that an external attenuator using a pair of resistors be used and the internal attenuator be used for fine control. For a 10:1 attenuator, use a 470Ω resistor in series in a 56Ω shunt with the load. For a 100:1 attenuator, use 1K in series and 10Ω in shunt, or 4.7K in series and 51Ω in shunt (these values are indicative and not critical). The attenuator is located in the input/output amplifier. As a result, the zero adjust will be most critical at minimum setting. The rear-mounted d-c adjustment control should be adjusted with the attenuator in maximum counter-clockwise position.

NOTE

Zero adjust control is a high resolution Zero Adjust Potentiometer not a d-c offset control.

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

The 5 Volt Triangle, 5 Volt Sine and 5 Volt Square Outputs

These outputs are accurate 5 volt, 50Ω sources balanced about ground. They will drive 2.5 volts peak to peak into a 50Ω load, and supply ±50 ma peak into a short circuit.

The 10 Nsec Square Output

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

Sync Output

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

NOTE

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

MODELS 111 AND 111B; CONTROLS AND TERMINALS

Power/Dial Multiplier Switch

This switch incorporates two ON positions, X.3 and X1. This switch, in conjunction with the frequency range switch and the frequency dial, determines the generated frequency. For example, the dial is set a 3 and 1/2, the frequency range switch setting is X100, and the dial multiplier switch at X1, the frequency generated is 350 Hz. With the dial multiplier switch at X.3, the frequency is 105 Hz.

In the Model 111B, when the switch is in the OFF position, the batteries are disconnected from the instrument but connected to the charger. The charger is set for a trickle-charge of approximately 3 ma when the instrument is connected to line power. In the ON position, the batteries are connected to the instrument for normal operation. If the instrument is not connected to the line power, the batteries are discharging; if connected, the charger supplies sufficient current to operate the instrument and charge the batteries. The amount of charge current available is variable through the potentiometer at the rear panel. In maximum counter-clockwise rotation the charge current is approximately 15 ma. The 15 ma charge current is recommended for optimum battery life unless the maximum charge rate is required.

CAUTION

If the batteries are allowed to completely discharge, the instrument power supply cannot provide adequate power to simultaneously operate and charge. If this condition exists, the instrument should be allowed to recharge for at least one hour before it is used in the a-c mode.

Frequency Range Switch

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

Frequency Dial and Frequency Vernier

The frequency dial is a high quality composition potentiometer providing continuous frequency control. In addition, an electronic vernier control is provided for precise frequency setting. Complete rotation of the vernier changes the frequency approximately one minor dial division for all settings of the dial. The frequency vernier should be in extreme clockwise position (cal) for maximum dial accuracy.

The VCG Input

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

The 5 Volt Triangle, 5 Volt Sine and 5 Volt Square Outputs

These outputs are accurate 5 volt, 50Ω sources that are balanced about ground. They will drive 2.5 volts peak to peak into a 50Ω load, and supply ±50 ma peak into a short circuit. The ramp output is 2.5 volts. Fixed ramp output is identical with fixed sine, square, and triangle output except that the base line is at zero volt ±25 mv (5 mv typical). Open circuit voltage is a 2.5 volt negative going ramp. Ramp duty cycle is 50%. Negative ramp coincides in time with the negative going portion of the triangle wave and the positive half of the square wave. The ramp signal passing through the output amplifier is amplified and inverted so that the resultant ramp appearing at the binding posts runs from zero to a positive voltage.

Model 111B; Main Output

Because no inverting amplifier is utilized, output waveforms in the switch-selected output are in phase with fixed outputs. Maximum output is 5 volts peak to peak with 600Ω output impedance and -2.5 volts ramp.

SECTION II
SPECIFICATIONS AND TEST PROCEDURES

This section contains specifications for the WAVETEK instruments discussed in this manual and procedures for testing their accuracy. Table 2-1 provides specifications for the Models 110 and 110B Function Generators, and Table 2-2 provides specifications for the Models 111 and 111B Voltage Controlled Generators.

NOTE

Specifications apply 10% to 100% of maximum amplitude setting.

VERSATILITY

Waveforms

Sine ∿, square ⊓, triangle △ and sync pulse.

Dynamic Frequency

0.005 Hz to 1 MHz (3.3 min. to 1 μsec).

NOTE: Dial is a high quality composition potentiometer allowing true continuously variable frequency control.

Ranges

X.01 = 0.005 Hz to 0.1 Hz.

X0.1 = 0.05 Hz to 1 Hz.

X1.0 = 0.5 Hz to 10 Hz.

X10 = 5 Hz to 100 Hz.

X100 = 50 Hz to 1 KHz.

X1K = 500 Hz to 10 KHz.

X10K = 5 KHz to 100 KHz.

X100K = 50 KHz to 1 MHz.

Table 2-1. Models 110 and 110B Specifications
Sheet 1 of 5

Six Simultaneous Outputs:

1) ∿, ⊓ or ∿ selectable.

   Amplitude adjustable over at least a 50:1 range.

   Output impedance 50Ω (600Ω output impedance available by removing one jumper wire).

   At least 30 volts peak to peak into an open circuit.

   At least 10 volts peak to peak into a 50Ω load (the attenuator should be adjusted counter-clockwise until clipping stops).

   Short circuit current ±100 ma.

   Model 110B: A maximum of 5 volts peak to peak at 600Ω output impedance.

2) 50Ω ⊓ 0.5 volt peak to peak, 10 nsec. risetime into 50Ω.

3) 50Ω ⊓ 5 volts peak to peak, 15 nsec. risetime.

4) 50Ω ∿ 5 volts peak to peak.

5) 50Ω ∿ 5 volts peak to peak.

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

NOTE: All outputs may be shorted to signal ground without damage to the instrument.

HORIZONTAL PRECISION

Dial Accuracy

±1% of full scale 0.005 Hz to 100 KHz.

±2% of full scale 100KHz to 1 MHz.

Frequency Stability

Short term: Drift less than ±0.05% of setting for 10 minutes.

Table 2-1. Models 110 and 110B Specifications
Sheet 2 of 5

Long term: Drift less than ±0.25% of setting for 24 hours.

No critical components requiring internal oven.

Jitter

±0.025% cycle to cycle stability.

VERTICAL PRECISION

Frequency Response

Amplitude change with frequency less than 0.1 db 0.005 Hz to 10 KHz, 0.2 db 10 KHz to 100 KHz, 0.5 db 100 KHz to 1 MHz.

Peak to Peak Voltage Accuracy

±1% for 5-volt outputs.

±1% for 30-volt output into a 600Ω load at maximum gain.

±10% for 0.5-volt output into 50Ω.

Amplitude Stability

Short term: ±0.05% of maximum peak to peak values for 10 minutes.

Long term: ±0.25% of maximum peak to peak values for 24 hours.

Symmetry

All waveforms are symmetrical about ground within ±1% of maximum peak to peak amplitude (external zero adjust rear-panel control provided for output number 1).

D-C Offset Stability

Short term: ±0.05% of maximum peak to peak amplitude for 10 minutes.

Long term: ±0.25% of maximum peak to peak amplitude for 24 hours.

PURITY

Sine Wave Distortion

Less than:	0.5%	0.005 Hz to 10 KHz.
	1.0%	10 KHz to 100 KHz.
	2.0%	100 KHz to 1 MHz.

Triangle Linearity

Greater than:	99%	0.005 Hz to 100 KHz.
	95%	100 KHz to 1 MHz.

Square Wave Rise and Fall Time

0.5-volt output less than 10 nsec. into 50Ω termination.

5-volt output less than 15 nsec.

30-volt output less than 100 nsec.

5-volt adjustable (Model 110B) less than 100 nsec.

Total Aberrations

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

Tilt

Less than 0.5%.

Time Symmetry

All waveforms:	99%	0.005 Hz to 100 KHz.
	98%	100 KHz to 1 MHz.

ENVIRONMENTAL

Temperature

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

Table 2-1. Models 110 and 110B Specifications
Sheet 4 of 5

For operation from $0^{o}C$ to $55^{o}C$, derate all specifications by a factor of 2.

MECHANICAL

Dimensions

7 and 3/4 inches wide, 5 and 1/4 inches high, 7 and 1/2 inches deep.

Weight

7 pounds net, 10 pounds shipping.

Color

Clear anodized aluminum.

Controls

ON-OFF power switch, frequency range switch, frequency dial, function selector switch, amplitude attenuator, d-c zero adjustment (rear). All-silicon semiconductors, modular plug-in construction.

Power

Model 110: 105 volts to 125 volts or 200 volts to 250 volts, 50 Hz to 400 Hz. Less than 10 watts.

Model 110B: D-C rechargeable ni-cad batteries provided with built-in charger. Eight hours of operation on batteries for every 16 hours of charge; simultaneous operation and charge.

105 volts to 125 volts or 200 volts to 250 v lts, 50 Hz to 400 Hz. Less than 10 watts.

Table 2-1. Models 110 and 110B Specifications
Sheet 5 of 5

VERSATILITY

Waveforms

Sine , square , triangle , ramp  and sync pulse.

Dynamic Frequency

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

Ranges

X.01 = 0.005 Hz to 0.1 Hz.

X0.1 = 0.05 Hz to 1 Hz.

X1.0 = 0.5 Hz to 10 Hz.

X10 = 5 Hz to 100 Hz.

X100 = 50 Hz to 1 KHz.

X1K = 500 Hz to 10 KHz.

X10K = 5 KHz to 100 KHz.

X100K = 50 KHz to 1 MHz.

X.003 = 0.0015 Hz to 0.03 Hz.

X.03 = 0.015 Hz to 0.3 Hz.

X.3 = 0.15 Hz to 3 Hz.

X3.0 = 1.5 Hz to 30 Hz.

X30 = 15 Hz to 300 Hz.

X300 = 150 Hz to 3 KHz.

X3K = 1.5 KHz to 30 KHz.

X30K = 15 KHz to 300 KHz.

Table 2-2. Models 111 and 111B Specifications
Sheet 1 of 6

Seven Simultaneous Outputs:

1) ∿ , ⊓ , ∿ or ◢ selectable.

Amplitude adjustable over at least a 50:1 range.

Output impedance 50Ω (600Ω output impedance available by removing one jumper wire).

At least 30 volts peak to peak (15 volts ramp) into an open circuit.

At least 10 volts peak to peak (5 volts ramp) into a 50Ω load (the attenuator should be adjusted counter-clockwise until clipping stops).

Short circuit current ±100 ma.

Model 111B: A maximum of 5 volts peak to peak at 600Ω output impedance (2.5 volts ramp).

2) 50Ω ⊓ 0.5 volt peak to peak, 10 nsec. risetime into 50Ω.

3) 50Ω ⊓ 5 volts peak to peak, 15 nsec. risetime.

4) 50Ω ∿ 5 volts peak to peak.

5) 50Ω ∿ 5 volts peak to peak.

6) 50Ω ◥ 0 volts to -2.5 volts ramp; 50% duty cycle.

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

NOTE: All outputs may be shorted to signal ground without damage to the instrument.

VCG - Voltage Controlled Generator

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

Table 2-2. Models 111 and 111B Specifications
Sheet 2 of 6

HORIZONTAL PRECISION

Dial Accuracy

±1% of full scale 0.0015 Hz to 100 KHz.

±2% of full scale 100 KHz to 1 MHz.

NOTE: Dial is a high quality composition potentiometer allowing true continuously variable frequency control.

Electronic Frequency Vernier

One turn for approximately one minor dial division.

VCG Linearity

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

VCG Bandwidth

100 KHz.

Frequency Stability

Short term: Drift less than ±0.05% of setting for 10 minutes.

Long term: Drift less than ±0.25% of setting for 24 hours.

No critical components requiring internal oven.

Jitter

±0.025% cycle to cycle stability.

VERTICAL PRECISION

Frequency Response

Amplitude change with frequency less than 0.1 db 0.0015 Hz to 10 KHz, 0.2 db 10 KHz to 100 KHz, 0.5 db 100 KHz to 1 MHz.

Table 2-2. Models 111 and 111B Specifications
Sheet 3 of 6

Peak to Peak Voltage Accuracy

±1% for 5-volt and 2.5-volt outputs.

±1% for 30-volt output into a 600Ω load at maximum gain.

±10% for 0.5-volt output.

Amplitude Stability

Short term: ±0.05% of maximum peak to peak values for 10 minutes.

Long term: ±0.25% of maximum peak to peak values for 24 hours.

Symmetry

All waveforms, except ramp, are symmetrical about ground within ±1% of maximum peak to peak amplitude (external zero adjust rear-panel control provided for output number 1).

D-C Offset Stability

Short term: ±0.05% of maximum peak to peak amplitude for 10 minutes.

Long term: ±0.25% of maximum peak to peak amplitude for 24 hours.

PURITY

Sine Wave Distortion

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

Triangle and Ramp Linearity

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

Table 2-2. Models 111 and 111B Specifications
Sheet 4 of 6

Ramp Fall Time

Less than 200 nsec.

Square Wave Rise and Fall Time

0.5-volt output less than 10 nsec into 50Ω termination.

5-volt output less than 15 nsec.

30-volt output less than 100 nsec.

5-volt adjustable (Model 111B) less than 100 nsec.

Total Aberrations

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

Tilt

Less than 0.5%

Time Symmetry

All Waveforms:	99%	0.0015 Hz to 100 KHz.
	98%	100 KHz to 1 MHz.

ENVIRONMENTAL

Temperature

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

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

MECHANICAL

Dimensions

7 and 3/4 inches wide, 5 and 1/4 inches high, 7 and 1/2 inches deep.

Table 2-2. Models 111 and 111B Specifications
Sheet 5 of 6

Weight

7 pounds net, 10 pounds shipping.

Color

Clear anodized aluminum.

Controls

OFF X.3-X1 power/dial multiplier switch, frequency range switch, frequency dial, frequency vernier, function selector switch, amplitude attenuator, d-c zero adjustment (rear).

All-silicon semiconductors, modular plug-in construction.

Power

Model 111: 105 volts to 125 volts or 200 volts to 250 volts, 50 Hz to 400 Hz. Less than 10 watts.

Model 111B: D-C rechargeable ni-cad batteries provided with built-in charger. Six hours of operation on batteries for every 16 hours of charge; simultaneous operation and charge. 105 volts to 125 volts or 200 volts to 250 volts, 50 Hz to 400 Hz. Less than 10 watts.

Table 2-2. Models 111 and 111B Specifications
Sheet 6 of 6

TEST PROCEDURES

GENERAL INFORMATION

Specifications apply only when the dial setting is between 0.5 and 10. Instruments should be within specifications within 30 minutes' warm-up time. All specifications are for 25°C ± 5°C and 105 to 125 volts a-c, 50 Hz to 400 Hz. All measurements must be made as described herein. Frequency stability specifications refer to constant temperature, line voltage, panel setting, and loads; testing must be made after one hour warm-up at defined conditions.

TESTING INFORMATION

All frequency measurements should be made with the function selector switch on sine ∿, output attenuator set in the maximum counter-clockwise most position, all outputs unconnected (and VCG input, Model 111) except the 10 nsec. square wave output which should be connected to a counter through a 50Ω cable using 50Ω termination at the counter. The frequency vernier (Model 111) should be at maximum clockwise position (cal). The generated frequency should be within specifications for all combinations of the range switch and frequency dial.

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

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

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

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

OTHER KINDS OF TESTS

All voltage measurements should be made with an accurate wide band peak measuring device. It is strongly suggested that a Tektronix type W, or type Z plug-in with an appropriate oscilloscope be used for making these voltage measurements. The measuring device should have at least 50KΩ input impedance and sufficient band width so that waveform peaks are accurately

measurable. The measurements should be made individually with no loads connected to the instrument.

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

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

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

When measuring the selectable output amplitude of the Models 110B and 111B, the measuring device should have at least 500K input impedance. It should be terminated into 600Ω for high frequency measurements. Sine distortion, triangle and ramp linearity, rise and fall time, total aberrations and tilt specifications should be made independently connecting only one output to the appropriate measuring device at a time.

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

GENERAL NOTE

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

SECTION III
THEORY OF OPERATION

MODEL 110. Refer to the block diagram of the Model 110 Function Generator in Section VI. An understanding of the Model 111 is best accomplished by first studying the Model 110.

A square wave is generated into an integrator composed of a wide band differential d-c amplifier and integrating resistor R with integrating capacitor C. The output of the integrator is fed into the Hysteresis and output switch. The Hysteresis and output switch function like a Schmitt trigger with the limit points set wide apart. As a result they fire when the triangle wave reaches +2.5 volts and -2.5 volts. The firing of the Hysteresis and the output switches reverses the square wave fed into the integrator and the triangle wave reverses direction. The result is simultaneous generation of a square wave and triangle wave of the same frequency with the positive half cycle of the square wave coincident with the negative going portion of the triangle wave.

The frequency of oscillation is determined by the R and C selected by the frequency range switch and by the amplitude of the square wave fed into the integrating resistor R. The ±5 volt square wave is fed to the frequency dial potentiometer. Setting the potentiometer at the top of the dial results in maximum voltage and thus maximum integrating current is generated resulting in maximum frequency. Frequency is directly proportional to the square wave amplitude appearing on the arm of the frequency dial potentiometer.

The sine wave is produced by shaping the triangle wave. The triangle wave is fed into a shaping network composed of resistors and diodes with transistor emitter followers biasing circuitry. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus slope is maximum. As the triangle wave voltage increases successively, diodes with current limiting resistors conduct causing the slope of the output to be less. The resultant waveform resembles a sine wave but is pointed at the top. The diodes are biased by transistor emitter followers whose base emitter junctions are opposite in polarity from the diodes. This provides a first order compensation for drifts due to temperature variations.

The increase in diode current at the peak of the triangle wave causes a pointed voltage pattern on the collectors of the emitter followers. This pointed waveform is combined out of phase with the somewhat pointed sine wave. The resultant waveform is an almost pure sine wave. The circuitry is completely symmetrical about ground using PNP transistors on one side and NPN transistors on the other. The sine wave produced by shaping is considerably less in amplitude than the triangle wave input and is thus amplified to be equal to the triangle wave.

The triangle wave output of the integrator, the sine wave output, and the square wave coupled through an associated amplifier are fed to the function selector switch and also to the simultaneous BNC outputs. The switch is coupled to the attenuator which in turn drives the output power amplifier. In the Model 110B and the Model 111B, this power amplifier is replaced by a 560Ω resistor.

The entire instrument except the power amplifier, runs off a current regulated +6 volts and -6 volts. The power amplifier runs off of an unregulated ±25 volts.

MODEL 111. Refer to the block diagram of the Model 111 Voltage Controlled Generator in Section VI. In the Model 111, unique circuitry is provided whereby the amplitude of the square wave fed to the integrator is controlled by an analog voltage. The integrating resistor R is connected to a PNP and NPN transistor switch which is connected in an inverted configuration. The bases of these transistor switches are driven from the output square wave. Negative square waves cause conduction of the PNP transistor, and positive square waves cause conduction of the NPN. These transistors connected in inverted configuration when in the conduction mode, have in the vicinity of 10 mv drop between their emitter and collector.

The VCG input and the frequency dial both drive an operational amplifier whose output is proportional to, but inverted from, the sum of the input voltages. The first operational amplifier drives the second operational amplifier which is designed for unity gain, but inversion about ground. As a result, a positive voltage appearing on the input causes a negative voltage at the output of the first amplifier and a positive voltage at the output of the second amplifier. A negative square wave thus causes integrating resistor R to be shorted to the negative voltage output of the first amplifier. A positive square voltage causes resistor R to be shorted to the positive voltage output of the second amplifier.

The circuit would be complete and work accurately except for the small drop across the switching transistors. This drop is compensated for by inserting a matching transistor in the feedback loop of the operational amplifiers. The base drive to the compensating transistor is designed to equal the base drive to the switching transistors. The switching transistors and the operational amplifiers must have good high frequency characteristics since square waves up to 1 MHz must be controlled. As a result, the basic circuitry is also capable of a wide band frequency modulation.

The ramp is formed by offsetting the triangle wave so that the positive peaks are at zero d-c. This resultant waveform is shorted to ground by transistor switches during the positive going half cycle. A two-stage clipping circuit is used in order to provide a very flat base line near zero volts. The excellent linearity of the triangle wave is preserved. The high quality ramp signal

is fed through an associated amplifier to the BNC connector and the function selector switch.

CIRCUIT DESCRIPTION

Refer to the Model 110 and 111 Main Board schematic diagrams.

INTEGRATOR, MAIN BOARD

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

Q1 and Q2 are a Darlington input pair for the minus input; Q14 and Q15 are a Darlington pair in the plus input. Transistors Q1 through Q4 are low current, high gain, wide band transistors which allow the inputs to operate with less than 40 nano amps of source current. The collectors of Q2 and Q3 work into a complex load made up of R1, R3, R4, C3, and the input impedance of Q5 and Q6. Q5 and Q6 form a differential amplifier stage driving the differential stage made up of Q7 and Q8. The output is taken off single ended at the collector of Q7 through the push-pull emitter follower, Q9 and Q10. CR1 and CR2 provide the bias voltage for Q9 and Q10 to prevent crossover distortion. R8 allows the d-c levels in the two sides of the amplifier to be balanced throughout. The triangle output is connected to pin 1. It is also fed through R22 to the sine converter and to the Hysteresis switch made up of Q25 through Q30.

HYSTERESIS AND OUTPUT SWITCH, MAIN BOARD

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

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

SINE CONVERTER AND AMPLIFIER, MAIN BOARD

Transistors Q11 through Q18 are emitter followers in the sine converter that bias and temperature compensate the clipping diodes, CR3 through CR10. Diodes CR3, CR5, CR7, and CR9 clip the positive portion of the triangle at points set by the pots in the base of their associated emitter follower transistors. Diodes CR4, CR7, CR8, and CR10 clip the negative portion of the triangle. Therefore, the input to the sine amplifier is a sine wave with small peaks at the top and bottom. The sine wave is fed to the plus input of the sine amplifier through R64. The sine amplifier is a d-c wide band operational amplifier connected in a potentiometric configuration. R69 is the feedback resistor. The peaks on the sine wave are also seen at the collectors of the emitter followers in the sine converter. These peaks are coupled through R54 and R56 to the minus input of the sine amplifier and peak cancellation occurs in the amplifier giving a clean sine wave at the output. The sine wave is coupled to pin 9. R60 adjusts the sine wave symmetry about ground and R64 adjusts the sine wave amplitude.

POWER SUPPLY AND OUTPUT AMPLIFIER BOARD

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

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

OUTPUT AMPLIFIER

Q13 through Q18 form an operational output amplifier with a gain of approximately -6 set by feedback resistor R37 and the input resistor made up of R31 and R32. Transistors Q13 and Q14 are a differential input stage driving a second differential stage of Q15 and Q16. The output is taken off single ended at the collector of Q16 and coupled to the push-pull emitter follower, Q17 and Q18. Diodes CR5 and CR6 provide bias for the push-pull emitter follower to prevent crossover distortion. The output is coupled through R50 and R51 to pin 3. The input is selected on the front panel and comes in on pin 3. C10 and C11 allow the amplifier to be high frequency compensated and are adjusted to give the best Gaussian response when a 1 MHz square wave is applied. A-c is coupled from the transformer to pins 1 and 2 and drives the bridge rectifier made up of diodes CR7 through CR10. The outputs of the bridge rectifier are filered by C14 and C15 providing the supply voltages for the output amplifier. R41 is the d-c balance control allowing the output to be adjusted for symmetry about ground. R41 is a screwdriver adjustment available from the rear panel. D-C OFFSET MODIFICATION: To convert the d-c Balance control, R41, to a d-c Offset control, remove R40 and R42, 10K 1% and replace with 2K 5% carbon resistors. R41 will now serve as a d-c offset control allowing the power amplifier output to be offset approximately ±5 vdc. It should be remembered that using an offset control limits the available peak output signal. The output will deliver 100 ma into a short circuit and 32.5 volts peak to peak into an open circuit. When terminated in 600Ω, the amplifier will deliver 30 volts peak to peak. When terminated in 50Ω, the amplifier will deliver 10 volts peak to peak. When offset +5 vdc, the output when terminated in 600Ω is only capable of swinging +10 volts peak. When offset +5 vdc and terminated in 50Ω, the output is at its positive going limit point.

BATTER POWER SUPPLY BOARD

The battery power supply delivers plus and minus 6 volts d-c to a Model 110 or Model 111 from two 7-cell, 500 ma/hr rechargeable Ni-Cad batteries. The regulator circuits are similar to the regulators in the standard power supply board. Q3 is connected as a zener diode reference. The two regulators have differential amplifiers driving pass transistors. Since the on/off wafer may not be in the OFF position when the battery supply is removed from the instrument, switch S2 is provided to allow the batteries to be disconnected to prevent discharge.

The remaining circuitry makes up the charging circuit. The batteries are always being charged as long as S2 is on and the line cord is plugged into an a-c source. The transformer delivers a-c to pins 1 and 2. The a-c is rectified by the bridge rectifier, filtered by C1 and supplied to the charging network. Q1 is a zener diode connected transistor serving as a reference for the charge circuit. When the instrument is turned OFF and the line cord

plugged in, the level set by R4 on the base of the pass transistor Q2 sets a trickle charge. R4 is available from the rear panel so that the charge rate can be adjusted. When the instrument is turned ON, $S1_C$ places R6 in parallel with R3 to increase the charge rate to compensate for instrument current drain. Since the currents are different in a Model 110 and a Model 111, R6 is different when the battery supply is used in a Model 110 or a Model 111.

Since there is no power amplifier in the battery version of a Model 110 or Model 111, the power amplifier input and output pins (pins 3 and 4) are shorted together and the front panel attenuator delivers the selected waveform directly to the front panel connector. The jumper across the 560Ω resistor on the front panel is removed providing a 600Ω output resistance.

MODEL 110, FRONT PANEL

The Model 110 front panel board has the frequency ranging capacitors and resistors with their associated switch, the frequency dial potentiometer, the output amplifier function selector switch and attenuator potentiometer, the five fixed output connectors, and the power amplifier output connectors.

The output of the power amplifier is available on pin 19 and is coupled through R28 to the front panel. C13 attenuates those frequencies beyond the band pass of the power amplifier to insure clean waveforms. R30 is normally jumpered. The parallel resistance of R28 and R29 in series with the parallel resistance of two 49.9Ω resistors on the power supply and output amplifier board make up the parallel resistance of the power amplifier. The jumper around R30 is removed when a 600Ω output resistance is desired. The fixed amplitude triangle, sine, sync, and the two square wave outputs are fed to BNC connectors. Resistors R17, R18, and R21 set the output resistance of the sine, triangle and 5 volt square wave outputs. R25 and R23 attenuate and establish the output resistance of the 10 nsec. square wave output. C8, C9, C11, C12, and R24 are high frequency roll-off components to insure clean waveforms. The 10 volt peak to peak square wave is also fed to the top of the frequency dial potentiometer. The frequency dial potentiometer attenuates the square wave and drives the selected integrating resistor. R16 insures that a square wave is delivered to the integrator when the frequency dial is turned fully clockwise. R20 provides an initial offset current to start the Model 110 when the unit is first turned ON.

Wafers 1 and 2 of the frequency hertz switch select the appropriate integrating capacitors and resistors for the different frequency ranges. Wafer 3 selects resistors to ground from the center arm of the frequency dial potentiometer so that the dial potentiometer has the same resistive loading when different integrating resistors are selected. Wafer 4 selects resistors for the plus input of the integrator when different integrating resistors are used

so that the source current in the plus and minus inputs of the integrator flow in the same resistances and do not develop an offset voltage.

MODEL 111, FRONT PANEL

The Model 111 front panel is similar to the Model 110 front panel with the addition of the VCG input connectors, the frequency vernier control, the X.3-X1 switch and the ramp output connector. In addition, the dial rather than attenuating the square wave and driving the integrator, attenuates the +6 volt supply voltage and provides an input to the first VCG amplifier. The frequency vernier is returned through R30 to -6 volts. The center arm of the vernier potentiometer provides a second input to the first VCG amplifier. In the "cal" position, the vernier potentiometer is fully clockwise and there is no vernier input to the VCG. In the CCW position of the vernier, a negative voltage is applied to the VCG and the frequency is reduced by approximately one minor dial division. The frequency hertz switch selects the appropriate integrating capacitors and resistors like the Model 110; however, the added X.3-X1 switch allows an added resistor to be placed in series with the selected integrating resistor when this switch is in the X.3 position. The added resistor is of such a value as to reduce the frequency to 0.3 of its X1 value.

MODEL 111, VCG BOARD

Refer to the VCG schematic. The two VCG amplifiers are similar operational inverting amplifier configurations. The basic operational amplifier is a μA702C integrated circuit. IC1 is the first inverting operational VCG amplifier, and serves as the main frequency control. The dial voltage from the front panel is available on pin 9 and applied through the 12.1K to the summing node of the operational amplifier.

The voltage from the vernier potentiometer on the front panel is available on pin 8 and applied through the 95.3K to the summing node of the operational amplifier. Any voltage applied to the front panel VCG input connector is applied to pin 4 through the 10K potentiometer and the 7.5K resistor to the summing node of the operational amplifier. The resultant output is the sum of the input voltages.

In the case of the more complex Models 115 and 116, a phase lock voltage is present on pin 6, and coupled through the filter network made up of R1, R2, R3, C1 and C2 to the summing node of the operational amplifier. The components are not added in a Model 111 or a Model 114. In the case of the Model 114, a sweep signal voltage is present on pin 6 in the sweep modes and coupled through R4 to the summing node of the operational amplifier.

R4 is not included on the VCG board in the other models. R8 allows a calibration of the effect of a VCG voltage applied on the front panel to the output frequency of the instrument. CR1 and CR2 provide protection in case of an overvoltage applied at the VCG input terminal.

R9, R10, and R11 provide a zero adjust network for the non-inverting input to the operational amplifier. R12 and R13 are the feedback resistors in the first operational amplifier. R13 is adjusted for frequency calibration at the high end of the dial, while R9 is adjusted for frequency calibration at the low end of the dial.

Pin 7 is the output point of the operational amplifier and Q1 serves an emitter follower to provide added current swing in the negative direction at the output of the first VCG amplifier. The output at the emitter of Q1 is coupled through saturated transistor Q3 to the feedback resistor R13 and also to the input resistors of the second VCG amplifier made up of R14 and R15.

The square wave output from the output switch on the Main Board is available on pin 13, and applied through R17 to the base of Q2. When the square wave is negative Q2 is turned on and saturated and the output of the first VCG amplifier is coupled through Q2 to pin 7, the VCG out terminal.

When the square wave is positive, Q2 is turned off. Q2 and Q3 serve as inverted switches. Q2, operating as an inverted switch, has a very low saturation voltage; however, to compensate for this voltage, Q3 is placed in the feedback loop of the first operational amplifier. This also temperature compensates the first VCG amplifier.

The first operational amplifier has a gain of approximately 3/5 with respect to the dial input, while the second operational amplifier has a gain of unity. The output of the first VCG amplifier is coupled through R14 and R15 to the summing node of the first operational amplifier.

R25 serves as a feedback resistor in the second operational amplifier. Q4 and Q5 serve the same purpose in the second operational amplifier as Q2 and Q3 in the first. However, the output of the second operational amplifier is moving positive, therefore, NPN transistors are used.

When the square wave from pin 13 is positive, Q4 is turned on and saturated coupling the output of the second VCG amplifier to pin 7, the VCG out terminal. Therefore, the signal on pin 7 is a square wave whose frequency is determined by the switching rate of the output switch set on the Main Board and whose amplitude is dependent on the levels at the output of the two VCG amplifiers.

Since the second VCG amplifier has a unity gain, it will provide an output of opposite polarity but of the same magnitude as the output of the first VCG

amplifier. The square wave on pin 7 is that square wave applied to the input of the integrator on the Main Board and in turn determines the frequency of the generator.

R46 and R24 serve as the zero adjust control for the second VCG amplifier. R14 allows adjustment of the symmetry at the high end of the dial, while R46 allows adjustment of the output frequency symmetry at the low end of the dial.

IC1 and IC2, the two integrated circuits, require a +12 volt supply at pin 8. The positive high voltage supply from the power amplifier on the power supply and power amplifier board is coupled to pin 5 of the VCG board, on to the collector of Q6 and in turn, to pin 8 of both the integrated circuits.

Q6 is a transistor connected and operated as a 6 volt zener diode. The emitter of Q6 is returned to +6 volts; therefore, its collector will be 6 volts above this level or +12 volts with respect to ground. Q6 thus serves as the +12 volt regulating element for the supply for the integrated circuits. When properly calibrated the system is so well balanced that it cannot start when the machine is first turned on. The square wave output from the VCG clamp transistors on pin 5 drives the input to the integrator.

R22 is added to provide an initial unbalance to allow the integrator to start. Once the machine is running, resistors R18 and R28 offset this unbalance introduced by R22 and the system is once again balanced.

MODEL 111, RAMP CIRCUIT

The triangle wave is available on pin 1 and is offset and attenuated by resistors R31, R32, R33, R34, and R35 so that its most positive excursion is 0 volts d-c and its most negative excursion is -2.5 volts. Transistors Q7 and Q8 are turned on and saturated by the negative going portion of the square wave applied to their bases through R37 and R38. When turned on, Q7 and Q8 chop the positive going portion of the offset triangle to ground. The result is the negative going 2.5 volt ramp in phase with the negative going portion of the triangle output. The ramp is delivered to pin 12 through the two emitter followers Q15 and Q16. The two opposing base to emitter voltages insure that the ramp starts at ground and that the emitter followers temperature compensate each other.

SECTION IV
CALIBRATION

MODEL 110; CALIBRATION PROCEDURE

EQUIPMENT REQUIRED

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

*2. Oscilloscope, Tektronix 530 series or equivalent.

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

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

5. Frequency counter, 5 digit resolution.

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

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

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

Remove cover from instrument.

POWER SUPPLY BOARD (REAR ETCHED CIRCUIT BOARD)

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

There is no adjustment in the +24 and -24 volt supplies.

Typical 120 cycle ripple in the ±6 volt supplies is 250 μv.

Typical 120 cycle ripple in the ±24 volt supplies is 250 mv.

POWER AMPLIFIER (REAR ETCHED CIRCUIT BOARD)

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

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

MAIN BOARD (SECOND ETCHED CIRCUIT BOARD FROM FRONT PANEL)

1. Rotate the dial to the extreme clockwise position. Connect a lead between the center arm of the dial potentiometer and circuit ground. Install a 100 K resistor between pin 1 and pin 3 of the main board. Observe integrator output with the appropriate indicating device at the junction of R17 and R18. Adjust R8 for zero volts at X100, extreme bottom of the dial. Remove jumper wire and 100 K resistor.

2. Using Tektronix scope and type W plug-in, observe triangle at front panel connector, open circuit. Adjust R78 in the switch set for the triangle break  at exactly -2.50 volts. Use comparison voltage on the type W plug-in and adjust R77 for the triangle break  at exactly +2.50 volts. To compensate for effects of interaction, repeat the adjustments.

3. Observe the 15 nsec. square wave for leading edge spikes with a 50Ω cable terminated into 50Ω. Adjust R104 for plus and minus 2.5 volts ±1 mv. Adjust R99 for symmetry about ground. Tolerance on spikes is 5% of the total peak to peak amplitude. Set the range switch X100, rotate the dial, measuring the frequency at the 10 nsec. BNC connector with a 50Ω cable and 50Ω termination and counter. Set the dial reading to 10 (1000 Hz) and tighten the setscrew. Set the dial at 1 and adjust R8 for time symmetry.

4. Observe the 10 nsec. square wave output on an oscilloscope to be free of excessive leading edge spikes, X100K top of the frequency dial, using a 50Ω cable terminated in 50Ω.

SINE WAVEFORM ADJUSTMENTS (SECOND ETCHED BOARD FROM THE FRONT PANEL)

Place the main board on extended cable. Observe the sine wave at the BNC connector, open circuited. Using a Tektronix scope and type W plug-in, set the frequency dial at 10, range X100.

Adjust R64 for sine out of ±2.5 volts. Adjust R60 for sine symmetry about ground. Using distortion analyzer, adjust R20, R24, R30, R33, R38, R41, R46 and R49 for minimum harmonic distortion. Readjust R64 and R60 for amplitude and symmetry about ground.

CHECK RANGES

Check all fixed ranges for frequency tracking. Trim resistors have been installed on individual ranges for tracking. Adjust C5 for proper tracking on X10K range. A trim resistor has been installed between position 3 and position 5 on wafer 1 of the range switch for proper tracking on X1K range. Adjust C1 for proper tracking on X100K range.

MODEL 111; CALIBRATION PROCEDURE

EQUIPMENT REQUIRED

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

*2. Oscilloscope, Tektronix 530 series or equivalent.

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

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

5. Frequency counter, 5 digit resolution.

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

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

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

Remove cover from the instrument.

POWER SUPPLY BOARD (REAR ETCHED CIRCUIT BOARD)

Two 100 μf bypass capacitors are located in the bottom of the instrument which are filter capacitors for the +6 volts and -6 volts power supplies. The capacitor toward the rear of the instrument is in the +6 volt supply, and the other is in the -6 volt supply. The capacitor leads are convenient voltage test points. Connect an appropriate measuring device between the end marked plus (+) of the rear 100 μf capacitor and circuit ground. Adjust R24 for +6.00 volts ±1 mv. Move the measuring device to the other capacitor

between the end marked minus (-) and circuit ground. Adjust R9 for -6.00 volts ±1 mv. To compensate for the effects of interaction, repeat these adjustments.

There is no adjustment in the +24 and -24 volt supplies.

Typical 120 cycle ripple, ±6 volt supplies is 250 μv.

Typical 120 cycle ripple, ±24 volt supplies is 250 mv.

POWER AMPLIFIER (REAR ETCHED CIRCUIT BOARD)

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

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

MAIN BOARD (SECOND ETCHED CIRCUIT BOARD FROM FRONT PANEL)

1. Set the generator at X100, the extreme bottom of the frequency dial. Use a jumper to short pin 5, VCG board to circuit ground. Install a 100 K resistor between pin 1 and pin 3 of the main board. Observe the integrator output with an appropriate indicating device at the junction of R17 and R18. Adjust R8 for zero volts. Remove the jumper wire and the 100 K resistor.

2. Using Tektronix scope and a type W plug-in, observe the triangle at the front panel connector, open circuit. Adjust R78 in the switch set for the triangle break  at exactly -2.50 volts (use comparison voltage on the type W plug-in). Adjust R77 for the triangle break  at exactly +2.50 volts. To compensate for the effects of interaction, repeat the adjustments.

3. Observe the 15 nsec. square wave for leading edge spikes with a 50Ω cable terminated into 50Ω. Adjust R104 for + and -2.5 volts ±1 mv. Adjust R99 for symmetry about ground. Tolerance on spikes is 5% of the total peak to peak amplitude.

4. Observe the 10 nsec. square wave output on an oscilloscope to be free of excessive leading edge spikes (X100K top of the frequency dial, using 50Ω cable terminated into 50Ω).

SINE WAVEFORM ADJUSTMENTS (SECOND ETCHED BOARD FROM FRONT PANEL)

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

Adjust R64 for sine wave out of ±2.5 volt ±1 mv. Adjust R60 for sine symmetry about ground. Using a distortion analyzer, adjust R20, R24, R30, R33, R38, R41, R46, and R49 for minimum harmonic distortion. Readjust R64 and R60 for amplitude and symmetry about ground.

VCG BOARD FREQUENCY (THIRD ETCHED BOARD FROM FRONT PANEL)

1. Set the dial to the extreme clockwise position. Using a jumper, short the VCG dial input (pin 9, VCG board) to signal ground (insure that the vernier is fully clockwise). Observe the output of the first VCG amplifier at the junction of Q2 and Q3, the inverted switch and adjust R9 for zero volts. Observe the second VCG amplifier at the junction of Q4 and Q5 and adjust R46 for zero volts. This adjustment insures that the amplifiers can be balanced and sets an approximate balance for adjusting the top of the dial. Remove the jumpers.

2. Observe pin 9 (VCG board). Using a digital voltmeter, set the dial for +5.75 volts ±2 mv. Tighten the setscrew in the dial with the dial reading 10. Set the range switch at X100, dial at 10. Adjust R13 for 1000 Hz, adjust R14 for time symmetry (0.5 ms). To compensate for the effects of interaction, repeat the adjustments. Do not reset the symmetry in the integrator. Set the dial at 1. Readjust R9 and R46 for time symmetry and 100 Hz. It may be necessary to move back and forth from the top to the bottom of the dial several times until optimum settings are obtained.

Monitor voltage at the center arm of the dial potentiometer and insure that VCG is tracking. Use the following chart:

X100 Range

Dial Pot - Center Arm	Frequency
+5.750 volts	1000 Hz
5.175 volts	900 Hz
4.600 volts	800 Hz
4.025 volts	700 Hz
3.450 volts	600 Hz
2.875 volts	500 Hz
2.300 volts	400 Hz
1.725 volts	300 Hz
1.150 volts	200 Hz
0.575 volts	100 Hz

Tolerance, normal dial accuracy. If the VCG tracks, check the dial for proper tracking.

To adjust the VCG in, set the dial at 5 and monitor frequency, range switch at X100, frequency 500 Hz. Apply +1.00 volt to VCG in on the front panel and adjust R8 for an output frequency of 700 Hz.

Rotate the vernier fully counter-clockwise and observe that the frequency decreases approximately one minor dial division. Return the vernier fully clockwise.

RAMP ADJUSTMENT

Observe the ramp output at the BNC connector with 50Ω cable terminated into 50Ω load. Adjust R34 so that the signal is neither nor , but is .

Adjust R33 for -2.5 volts peak ramp output into an open circuit.

CHECK RANGES

Check all fixed ranges for frequency tracking. Trim resistors have been installed on individual ranges for tracking. Adjust C5 for proper tracking on X10K range. A trim resistor has been installed between position 3 and position 5 on wafer 1 of the range switch for proper tracking on the X1K range. Adjust C1 for proper tracking on X100K range.

SECTION V
PARTS LIST

GENERAL

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

PARTS LIST ARRANGEMENT

The parts list starts with the chassis assembly, figure 5-1, followed by a list of components found on the chassis as well as the major modular components.

LIST OF MANUFACTURERS

The MANUFACTURER (MFR) column of the parts list uses brief descriptions; the names are given in full below.

Allen Bradley	Allen Bradley, Milwaukee, Wisconsin
ARCO	Arco Electronics, Great Neck, L.I., New York
CDE	Cornell-Dubilier Electronics Division, Federal Pacifid Electric Company, Newark, New Jersey
Continental	Continental-Wirt Electronics Corporation, Philadelphia, Pennsylvania
Corning	Corning Glass Works, Bradford, Pennsylvania
CRL	Centralab, Division of Globe-Union, Milwaukee, Wisconsin
CTS	Chicago Telephone Systems, Los Angeles, California
Elpac	Elpac Incorporated, Fullerton, California
Erie	Erie Technological Products Incorporated, Erie, Pennsylvania
Eveready	Eveready Batteries, Union Carbide Corporation, Los Angeles, California
Fairchild	Fairchild Semiconductor Corporation, Palo Alto, California

G. E.	General Electric, Semiconductor Products Division, Buffalo, New York
Johnson	E. F. Johnson Company, Waseca, Minnesota
Kings	Kings Electronics Company Incorporated, Tuckahoe, New York
Littelfuse	Littelfuse Incorporated, Des Plaines, Illinois
Motorola	Motorola Semiconductor Products, Phoenix, Arizona
Nashville	Nashville Electronics Incorporated, Nashville, Tennessee
Ohmite	Ohmite Manufacturing Company, Skokie, Illinois
RCA	RCA Semiconductor Division, Somerville, New Jersey
Richey	Richey Electronics, Nashville, Tennessee
Semtech	Semtech Corporation, Newbury Park, California
Smith	H. H. Smith Incorporated, Brooklyn, New York
SEC	Southern Electronics Corporation, Burbank, California
Sprague	Sprague Electric Company, North Adams, Massachusetts
Stackpole	Stackpole Carbon Company, St. Marys, Pennsylvania
TRW	TRW Electronics, Incorporated, El Segundo, California
USECO	USECO Incorporated, Mt. Vernon, New York
Wakefield	Wakefield Engineering Incorporated, Wakefield, Massachusetts

MATCHED OR PAIRED PARTS

Prior to ordering or replacing electronic components in the equipment, refer to the notes regarding matched or paired parts on the schematic diagrams in Section VI.

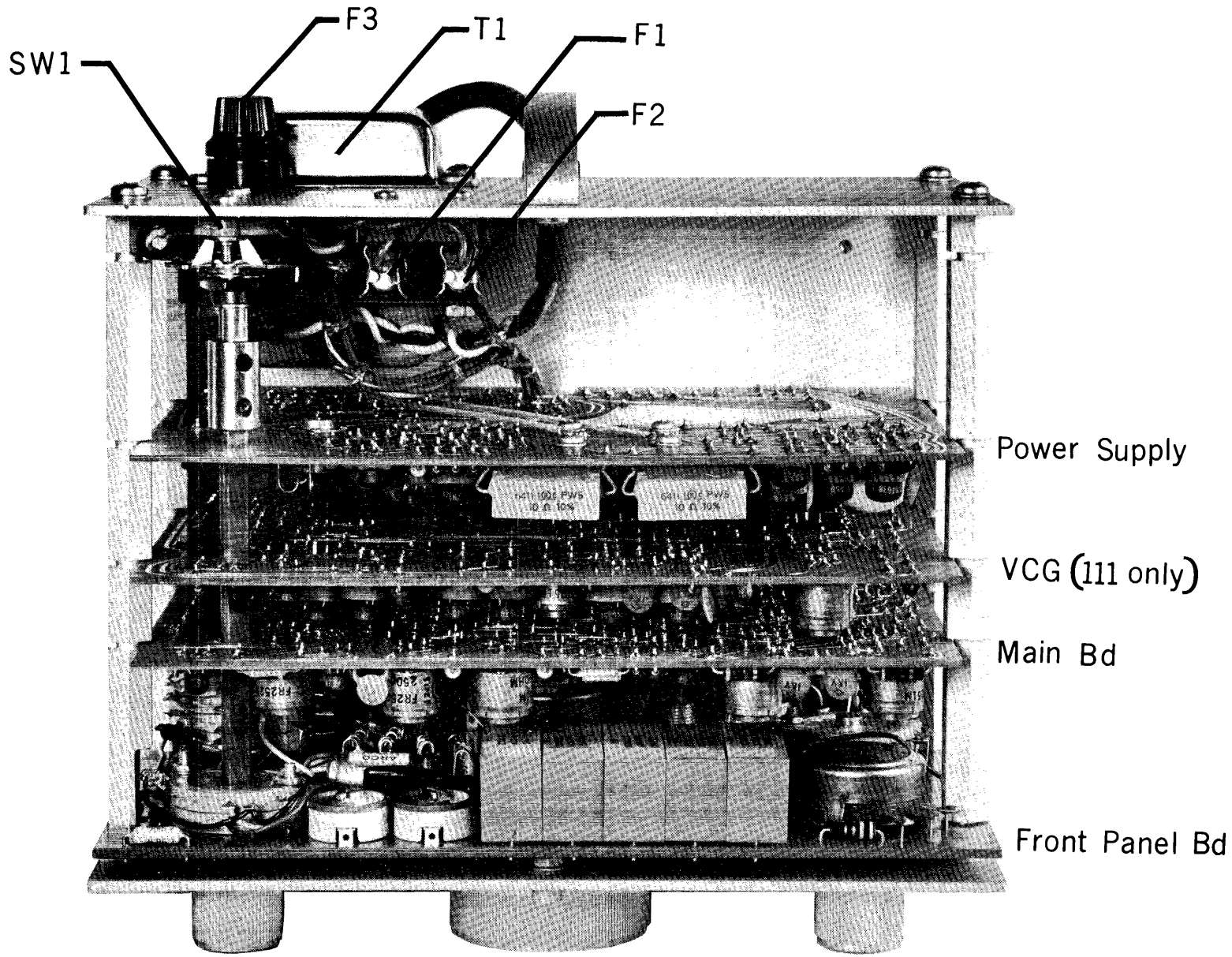


Figure 5-1. Chassis Assembly.

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R1		RESISTOR, Carbon, 1 w, 10% 470Ω	1	Stackpole
C1, C2*	TL1135	CAPACITOR, Electrolytic, 12 v, 100 mfd	2	Sprague
	013-5200	CONNECTOR PIN	20	Elco
	5201-0213	CONNECTOR PIN	40	Elco
F1, F2		FUSE, 1/4 amp, Slo-Blo	2	Littelfuse
F3		FUSE, 3/4 amp, Slo-Blo	1	Littelfuse
SW1	110SW2	SWITCH	1	Wavetek
T1	110-500	TRANSFORMER	1	Wavetek
	110-110	MOTHER BOARD	1	Wavetek
		CHASSIS ASSY.	1	Wavetek
	110-012	MAIN BOARD ASSY.	1	Wavetek
	110-011	FRONT PANEL ASSY. (Model 110)	1	Wavetek
	111-017	FRONT PANEL ASSY. (Model 111)	1	Wavetek
	*110-014	BATTERY POWER ASSY.	1	Wavetek
	110-013	POWER SUPPLY and OUTPUT AMPLIFIER ASSY.	1	Wavetek
	111-018	VCG BOARD ASSY.	1	Wavetek

*Not visible on the illustration.

Chassis Assembly Parts List

(Sheet 1 of 1)

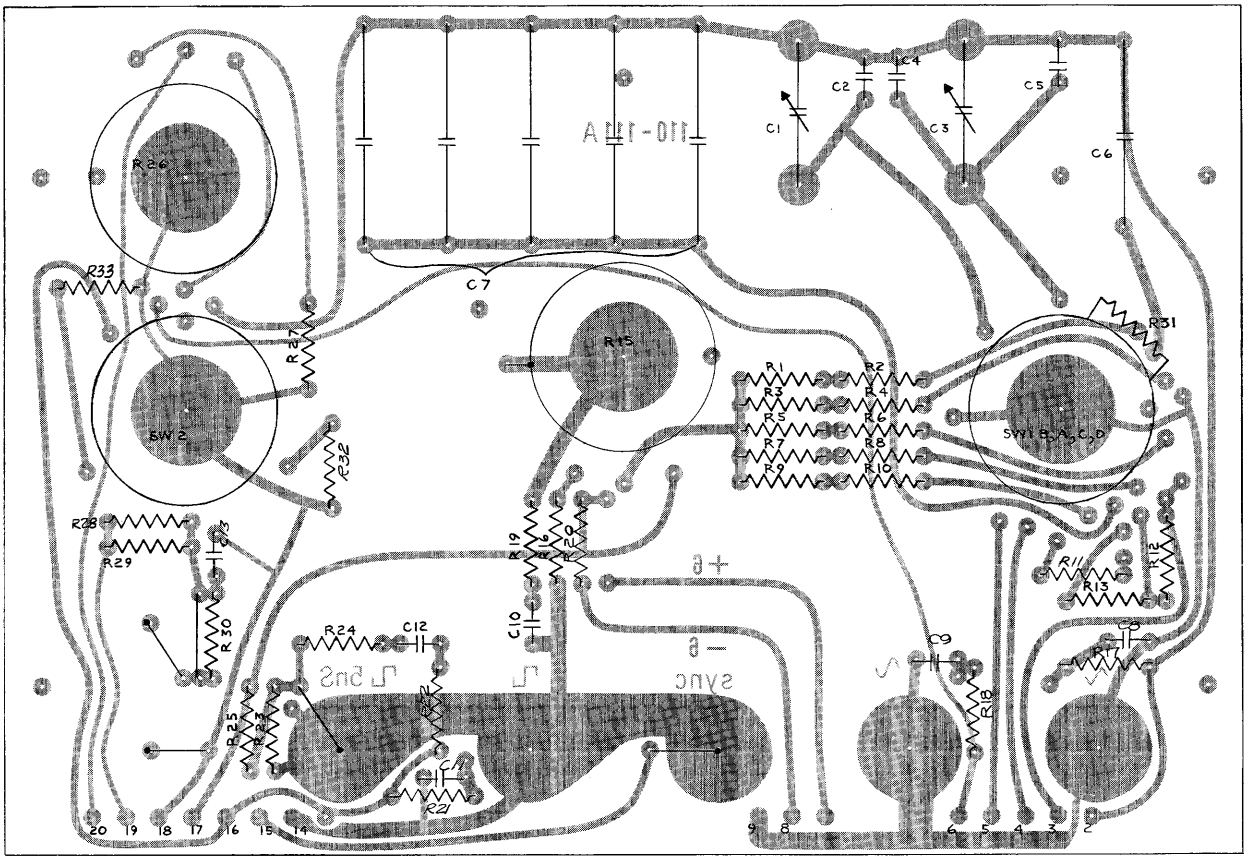


Figure 5-2.

Front Panel Assembly (110-011)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R27	RC20GF4R7J	RESISTOR, Carbon, 1/2w, 5% 4.7Ω	1	Stackpole
R19	RC20GF270K	RESISTOR, Carbon, 1/2w, 10% 27Ω	1	Stackpole
R24	RC20GF430K	RESISTOR, Carbon, 1/2w, 10% 43Ω	1	Stackpole
R23	RC20GF560K	RESISTOR, Carbon, 1/2w, 10% 56Ω	1	Stackpole
R11, R25	RC20GF471K	RESISTOR, Carbon, 1/2w, 10% 470Ω	2	Stackpole
R32, R33	RC20GF511K	RESISTOR, Carbon, 1/2w, 10% 510Ω	2	Stackpole
R30	RC20GF561K	RESISTOR, Carbon, 1/2w, 10% 560Ω	1	Stackpole
R22	RC20GF103K	RESISTOR, Carbon, 1/2w, 10% 10,000Ω	1	Stackpole
R20	RC20GF123K	RESISTOR, Carbon, 1/2w, 10% 12,000Ω	1	Stackpole
R16	RN60D	RESISTOR, Metal Film, 1/4w, 1% 21.5Ω	1	Corning
R17, R18, R21, R28, R29	RN60D	RESISTOR, Metal Film, 1/4w, 1% 49.9Ω	5	Corning
R2, R6	RN60D	RESISTOR, Metal Film, 1/4w, 1% 4640Ω	2	Corning
R12	RN60D	RESISTOR, Metal Film, 1/4w, 1% 42,200Ω	1	Corning
R4, R8	RN60D	RESISTOR, Metal Film, 1/4w, 1% 46,400Ω	2	Corning
R13	RN60D	RESISTOR, Metal Film, 1/4w, 1% 422,000Ω	1	Corning
R10	RN60D	RESISTOR, Metal Film, 1/4w, 1% 464,000Ω	1	Corning
R26	111-R2	POTENTIOMETER, 500Ω	1	Allen-Bradley

Front Panel Assembly Parts List (110-011)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R15	JAIN104P-102UA	POTENTIOMETER, 1000Ω	1	Allen-Bradley
C12	DD680	CAPACITOR, Ceramic Disc, 68 pf	1	CRL
C11, C13	DD221	CAPACITOR, Ceramic Disc, 220 pf	2	CRL
C10	DD331	CAPACITOR, Ceramic Disc, 330 pf	1	CRL
C8	DD681	CAPACITOR, Ceramic Disc, 680 pf	1	CRL
C9	DD102	CAPACITOR, Ceramic Disc, 1000 pf	1	CRL
C7	ZX-3022	CAPACITOR, Mylar, 5 x 2 mfd	1	Elpac
C6	PO104G1	CAPACITOR, Polystyrene, 0.1 mfd	1	SEC
C4	DM15-680J	CAPACITOR, Silver Mica, 68 pf	1	Arco
C2	DM15-820J	CAPACITOR, Silver Mica, 82 pf	1	Arco
C5	DM15-911J	CAPACITOR, Silver Mica, 910 pf	1	Arco
C1, C3	503-001-COPO-37R	CAPACITOR, Variohm, 4.5 to 25 pf	2	Erie
SW1	110-SW1	SWITCH	1	Wavetek
SW2	110-SW2	SWITCH with T107 Wafer	1	Wavetek
	110-111	BOARD, Printed Circuit	1	Wavetek

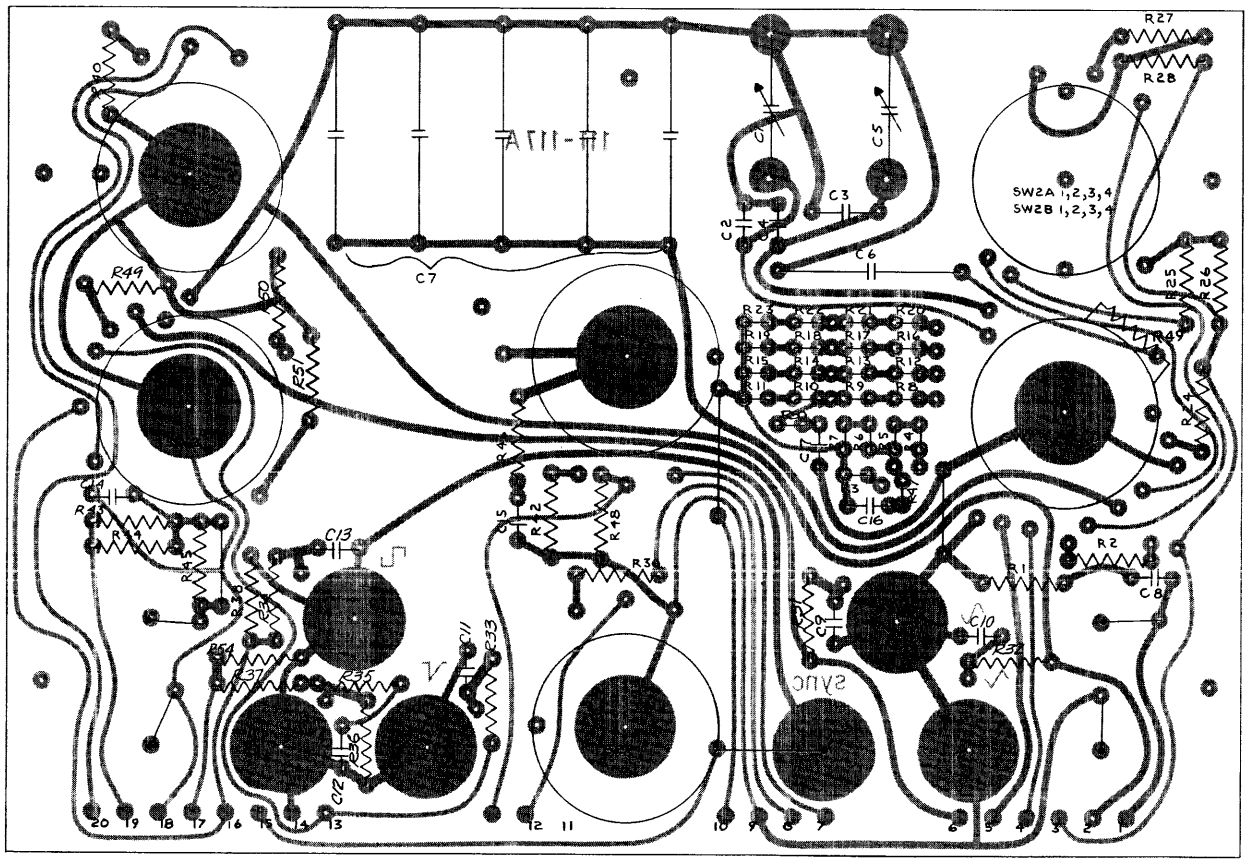


Figure 5-3.

Front Panel Assembly (111-017)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R40	RC20GF4R7J	RESISTOR, Carbon, 1/2w, 5% 4.7Ω	1	Stackpole
R35, R46	RC20GF270K	RESISTOR, Carbon, 1/2w, 10% 27Ω	2	Stackpole
R36	RC20GF560K	RESISTOR, Carbon, 1/2w, 10% 56Ω	1	Stackpole
R51, R52, R53	RC20GF511K	RESISTOR, Carbon, 1/2w, 10% 510Ω	3	Stackpole
R45	RC20GF561K	RESISTOR, Carbon, 1/2w, 10% 560Ω	1	Stackpole
R54	RC20GF122K	RESISTOR, Carbon, 1/2w, 10% 1200Ω	1	Stackpole
R24	RC20GF302K	RESISTOR, Carbon, 1/2w, 10% 3000Ω	1	Stackpole
R30	RC20GF562K	RESISTOR, Carbon, 1/2w, 10% 5600Ω	1	Stackpole
R38	RC20GF103K	RESISTOR, Carbon, 1/2w, 10% 10,000Ω	1	Stackpole
R2	RC20GF221K	RESISTOR, Carbon, 1/2w, 10% 220Ω	1	Stackpole
R1, R37	RC20GF471K	RESISTOR, Carbon, 1/2w, 10% 470Ω	2	Stackpole
R42	RN60D	RESISTOR, Metal Film, 1/4w, 1% 21.5Ω	1	Corning
R31, R32, R33, R34, R43, R44	RN60D	RESISTOR, Metal Film, 1/4w, 1% 49.9Ω	6	Corning
R15, R7	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3010Ω	2	Corning
R3	RN60D	RESISTOR, Metal Film, 1/4w, 1% 4320Ω	1	Corning
R5, R13	RN60D	RESISTOR, Metal Film, 1/4w, 1% 6980Ω	2	Corning
R48	RN60D	RESISTOR, Metal Film, 1/4w, 1% 8250Ω	1	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R11, R19, R26	RN60D	RESISTOR, Metal Film, 1/4w, 1% 30, 100Ω	3	Corning
R9, R17, R25	RN60D	RESISTOR, Metal Film, 1/4w, 1% 69, 800Ω	3	Corning
R23, R28	RN60D	RESISTOR, Metal Film, 1/4w, 1% 301, 000Ω	2	Corning
R21, R27	RN60D	RESISTOR, Metal Film, 1/4w, 1% 698, 000Ω	2	Corning
R29, R39	111-R2	POTENTIOMETER, Single Turn, 500Ω	2	Allen-Bradley
R41	JAIN104P-102UA	POTENTIOMETER, Single Turn, 1000Ω	1	Allen-Bradley
C12	DD680	CAPACITOR, Ceramic Disc, 1000v 68 pf	1	CRL
C13, C14	DD221	CAPACITOR, Ceramic Disc, 1000v 220 pf	2	CRL
C15	DD331	CAPACITOR, Ceramic Disc, 1000v 330 pf	1	CRL
C8	DD471	CAPACITOR, Ceramic Disc, 1000v 470 pf	1	CRL
C10, C11	DD681	CAPACITOR, Ceramic Disc, 1000v 680 pf	2	CRL
C9	DD102	CAPACITOR, Ceramic Disc, 1000v 1000 pf	1	CRL
C7	ZX-3022	CAPACITOR, Mylar, 5 x 2.0 mfd	1	Elpac
C6	PO104G1	CAPACITOR, Polystyrene, 100v 0.1 mfd	1	Arco
C2	DM15-820J	CAPACITOR, Silver Mica, 15v, 82 pf, 5%	1	Arco
C4	DM15-680J	CAPACITOR, Silver Mica, 15v, 68 pf, 5%	1	Arco
C3	DM15-911F	CAPACITOR, Silver Mica, 15v, 910 pf, 1%	1	Arco

Front Panel Assembly Parts List (111-017)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C1, C5	503-001 COPO-37R	CAPACITOR, Variohm, 4.5 to 25 pf	2	Erie
SW1	110-SW1	SWITCH	1	Wavetek
SW2A, SW2B		WAFER, From 104-SW3	2	Wavetek
SW3	110-SW2	SWITCH	1	Wavetek
	UG657/U	CONNECTOR, BNC	6	Kings
	114-3200	CONNECTOR, Pin	20	Elco
	111-103	BINDING POST	4	Johnson
	1414-8	SOLDER LUG	1	Smith
	111-117	BOARD, Printed Circuit	1	Wavetek

Front Panel Assembly Parts List (111-017)

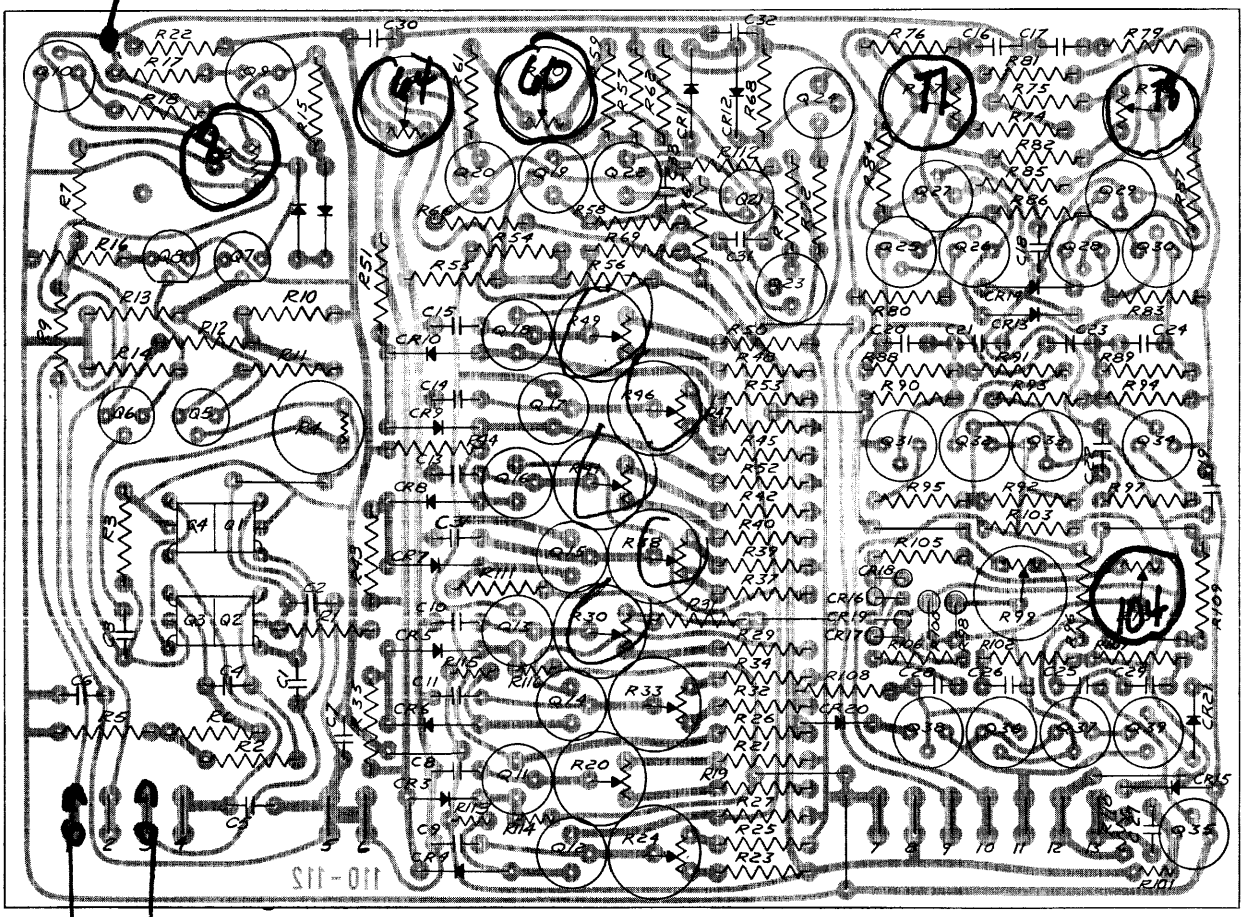


Figure 5-4.

Main Board Assembly (110-012)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R76, R79	RC20GF751J	RESISTOR, Carbon, 1/2 w, 5% 750Ω	2	Stackpole
R10	RC20GF302J	RESISTOR, Carbon, 1/2 w, 5% 3000Ω	1	Stackpole
R62	RC20GF472J	RESISTOR, Carbon, 1/2 w, 5% 4700Ω	1	Stackpole
R95, R97	RC20GF100K	RESISTOR, Carbon, 1/2 w, 10% 10Ω	2	Stackpole
R17, R18, R71, R72	RC20GF150K	RESISTOR, Carbon, 1/2 w, 10% 15Ω	4	Stackpole
R91, R93	RC20GF470K	RESISTOR, Carbon, 1/2 w, 10% 47Ω	2	Stackpole
R92	RC20GF620K	RESISTOR, Carbon, 1/2 w, 10% 62Ω	1	Stackpole
R16, R102, R106, R107	RC20GF101K	RESISTOR, Carbon, 1/2 w, 10% 100Ω	4	Stackpole
R67	RC20GF151K	RESISTOR, Carbon, 1/2 w, 10% 150Ω	1	Stackpole
R112	RC20GF271K	RESISTOR, Carbon, 1/2 w, 10% 270Ω	1	Stackpole
R84, R87	RC20GF471K	RESISTOR, Carbon, 1/2 w, 10% 470Ω	2	Stackpole
R90, R94	RC20GF561K	RESISTOR, Carbon, 1/2 w, 10% 560Ω	2	Stackpole
R88, R89	RC20GF102K	RESISTOR, Carbon, 1/2 w, 10% 1000Ω	2	Stackpole
R108, R109	RC20GF122K	RESISTOR, Carbon, 1/2 w, 10% 1200Ω	2	Stackpole
R96	RC20GF222K	RESISTOR, Carbon, 1/2 w, 10% 2200Ω	1	Stackpole
R85, R86	RC20GF472K	RESISTOR, Carbon, 1/2 w, 10% 4700Ω	2	Stackpole
R110	RC20GF103K	RESISTOR, Carbon, 1/2 w, 10% 10,000Ω	1	Stackpole

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R11, R12	RN60D	RESISTOR, Metal Film, 1/4w, 1% 100Ω	2	Corning
R103	RN60D	RESISTOR, Metal Film, 1/4w, 1% 316Ω	1	Corning
R26, R27, R105	RN60D	RESISTOR, Metal Film, 1/4w, 1% 511Ω	3	Corning
R35, R59, R61, R74, R75	RN60D	RESISTOR, Metal Film, 1/4w, 1% 825Ω	5	Corning
R2, R6, R15, R22, R54, R56	RN60D	RESISTOR, Metal Film, 1/4w, 1% 1000Ω	6	Corning
R113, R114	RN60D	RESISTOR, Metal Film, 1/4w, 1% 1620Ω	2	Corning
R65, R81, R82, R100	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2000Ω	4	Corning
R51	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2370Ω	1	Corning
R43	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2490Ω	1	Corning
R19, R25	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2870Ω	2	Corning
R9, R80, R83	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3010Ω	3	Corning
R29, R34	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3160Ω	2	Corning
R13, R14, R37, R42	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3830Ω	4	Corning
R21, R23, R31, R32, R39, R40, R45, R47, R48, R50, R52, R53	RN60D	RESISTOR, Metal Film, 1/4w, 1% 4640Ω	12	Corning
R57, R69, R115, R116	RN60D	RESISTOR, Metal Film, 1/4w, 1% 6980Ω	4	Corning
R44, R58, R66, R111	RN60D	RESISTOR, Metal Film, 1/4w, 1% 10,000Ω	4	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R98	RN60D	RESISTOR, Metal Film, 1/4w, 1% 21,500Ω	1	Corning
R5	RN60D	RESISTOR, Metal Film, 1/4w, 1% 46,400Ω	1	Corning
R1, R3, R7	RN60D	RESISTOR, Metal Film, 1/4w, 1% 110,000Ω	3	Corning
R55	RN60D	RESISTOR, Metal Film, 1/4w, 1% 150Ω	1	Corning
R20, R24, R30, R33, R38, R41, R46, R49, R60, R77, R78, R104	FR251M	POTENTIOMETER, Single Turn, 250Ω	12	Allen-Bradley
R4	FR501M	POTENTIOMETER, Single Turn, 500Ω	1	Allen-Bradley
R8, R64, R99	FR103M	POTENTIOMETER, Single Turn, 10,000Ω	3	Allen-Bradley
C6, C7, C18, C19, C31, C32	UK10-104	CAPACITOR, 10v, 0.1 mfd	6	CRL
C5	CK103	CAPACITOR, 50v, 0.01 mfd	1	CRL
C26	DD050	CAPACITOR, 1000v, 5 pf	1	CRL
C22	DD100	CAPACITOR, 1000v, 10 pf	1	CRL
C20, C24, C25	DD220	CAPACITOR, 1000v, 22 pf	3	CRL
C30	DD330	CAPACITOR, 1000v, 33 pf	1	CRL
C21, C23, C33	DD470	CAPACITOR, 1000v, 47 pf	3	CRL
C1	DD101	CAPACITOR, 1000v, 100 pf	1	CRL
C16, C17	DD221	CAPACITOR, 1000v, 220 pf	2	CRL

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C2	DD331	CAPACITOR, 1000v, 330 pf	1	CRL
C27, C28, C29	DD471	CAPACITOR, 1000v, 470 pf	3	CRL
C3, C4, C8, C9, C10, C11, C12, C13, C14, C15	DD102	CAPACITOR, 1000v, 1000 pf	10	CRL
CR1 thru CR21	FD6666	DIODE	21	Fairchild
Q1, Q2, Q3, Q4	2N3856	TRANSISTOR	4	G. E.
Q5, Q6, Q10, Q21, Q22, Q24, Q25, Q28, Q29, Q31, Q33, Q37, Q38	2N3640	TRANSISTOR	13	Fairchild
Q9, Q23, Q26, Q27, Q30, Q32, Q34, Q35, Q36, Q39	2N3646	TRANSISTOR	10	Fairchild
Q7, Q8	MPS6521	TRANSISTOR	2	Motorola
Q12, Q14, Q16, Q18	2N3638	TRANSISTOR	4	Fairchild
Q11, Q13, Q15, Q17, Q19, Q20	2N3642	TRANSISTOR	6	Fairchild
	05-3303	SOCKET, Transistor	4	Elco
	110-112	BOARD, Printed Circuit	1	Wavetek

The following transistors are matched pairs:

Q1 & Q4, Q2 & Q3, Q5 & Q6, Q7 & Q8,
Q19 & Q20, Q21 & Q22.

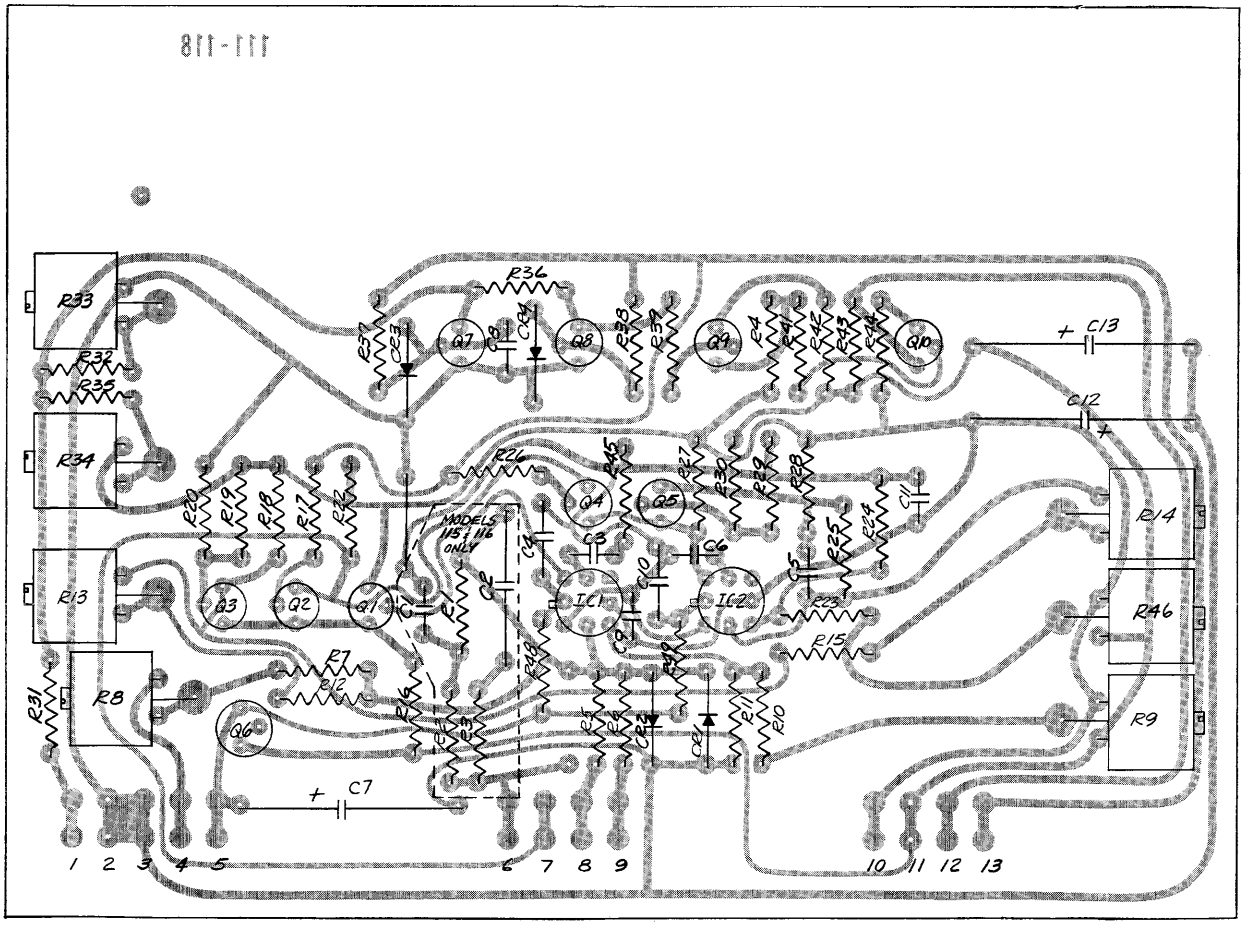


Figure 5-5.

VCG Board Assembly (111-018)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R48, R49	RC20GF100K	RESISTOR, Carbon, 1/2w, 10% 10Ω	2	Stackpole
R42, R44	RC20GF470K	RESISTOR, Carbon, 1/2w, 10% 47Ω	2	Stackpole
R45	RC20GF820K	RESISTOR, Carbon, 1/2w, 10% 82Ω	1	Stackpole
R39, R41	RC20GF101K	RESISTOR, Carbon, 1/2w, 10% 100Ω	2	Stackpole
R3	RC20GF561K	RESISTOR, Carbon, 1/2w, 10% 560Ω	1	Stackpole
R40	RC20GF821K	RESISTOR, Carbon, 1/2w, 10% 820Ω	1	Stackpole
R43	RC20GF102K	RESISTOR, Carbon, 1/2w, 10% 1000Ω	1	Stackpole
R16	RC20GF152K	RESISTOR, Carbon, 1/2w, 10% 1500Ω	1	Stackpole
R36	RC20GF182K	RESISTOR, Carbon, 1/2w, 10% 1800Ω	1	Stackpole
R27	RC20GF222K	RESISTOR, Carbon, 1/2w. 10% 2200Ω	1	Stackpole
R1, R2	RC20GF242K	RESISTOR, Carbon, 1/2w, 10% 2400Ω	2	Stackpole
R17, R19, R26, R30, R37, R38	RC20GF472K	RESISTOR, Carbon, 1/2w, 10% 4700Ω	6	Stackpole
R20, R29	RC20GF243K	RESISTOR, Carbon, 1/2w. 10% 24,000Ω	2	Stackpole
R18, R22, R28	RC20GF224K	RESISTOR, Carbon, 1/2w, 10% 220,000Ω	3	Stackpole
R31	RN60D	RESISTOR, Metal Film, 1/4w, 1% 909Ω	1	Corning
R24	RN60D	RESISTOR, Metal Film, 1/4w, 1% 1500Ω	1	Corning
R32	RN60D	RESISTOR, Metal Film, 1/4w, 1% 1780Ω	1	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R35	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2370Ω	1	Corning
R15	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2870Ω	1	Corning
R25	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3010Ω	1	Corning
R11	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3830Ω	1	Corning
R23	RN60D	RESISTOR, Metal Film, 1/4w, 1% 4640Ω	1	Corning
R12	RN60D	RESISTOR, Metal Film, 1/4w, 1% 6340Ω	1	Corning
R7	RN60D	RESISTOR, Metal Film, 1/4w, 1% 7500Ω	1	Corning
R6	RN60D	RESISTOR, Metal Film, 1/4w, 1% 12,100Ω	1	Corning
R5	RN60D	RESISTOR, Metal Film, 1/4w, 1% 95,300Ω	1	Corning
R10	RN60D	RESISTOR, Metal Film, 1/4w, 1% 464,000Ω	1	Corning
R13, R14, R33, R34	FR501M	RESISTOR, Variable, Single Turn, 500Ω	4	Allen-Bradley
R8, R9, R46	FR103M	RESISTOR, Variable, Single Turn, 10,000Ω	3	Allen-Bradley
C3, C6, C9, C11	UK10-104	CAPACITOR, Ceramic, 10v, 0.1 μf	4	CRL
C4, C10	UK20-104	CAPACITOR, Ceramic, 20v, 0.1 μf	2	CRL
C1	CK103	CAPACITOR, Ceramic, 50v, 0.01 μf	1	CRL
C5	DD50	CAPACITOR, Ceramic, 1000v, 5 pf	1	CRL
C8	DD101	CAPACITOR, Ceramic, 1000v, 100 pf	1	CRL

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C12, C13	TL1135	CAPACITOR, Electrolytic, 12v, 100 µf	2	Sprague
C7	12-250-100-15T	CAPACITOR, Electrolytic, 15v, 100 µf	1	Richey
C2	WMF1S33	CAPACITOR, Mylar, 100v, 0.033 µf	1	CDE
CR1 thru CR4	FD6666	DIODE	4	Fairchild
Q9	2N3646	TRANSISTOR	1	Fairchild
Q1, Q2, Q3, Q7, Q8, Q10	2N3640	TRANSISTOR	6	Fairchild
Q4, Q5	2N3903	TRANSISTOR	2	Fairchild
Q6	2N3638	TRANSISTOR	1	Fairchild
IC1, IC2	µA702C	CIRCUIT, Integrated	2	Fairchild
	05-3303	SOCKET, Transistor	2	Elco
	111-118	BOARD, Printed Circuit	1	Wavetek

VCG Board Assembly Parts List (111-018)

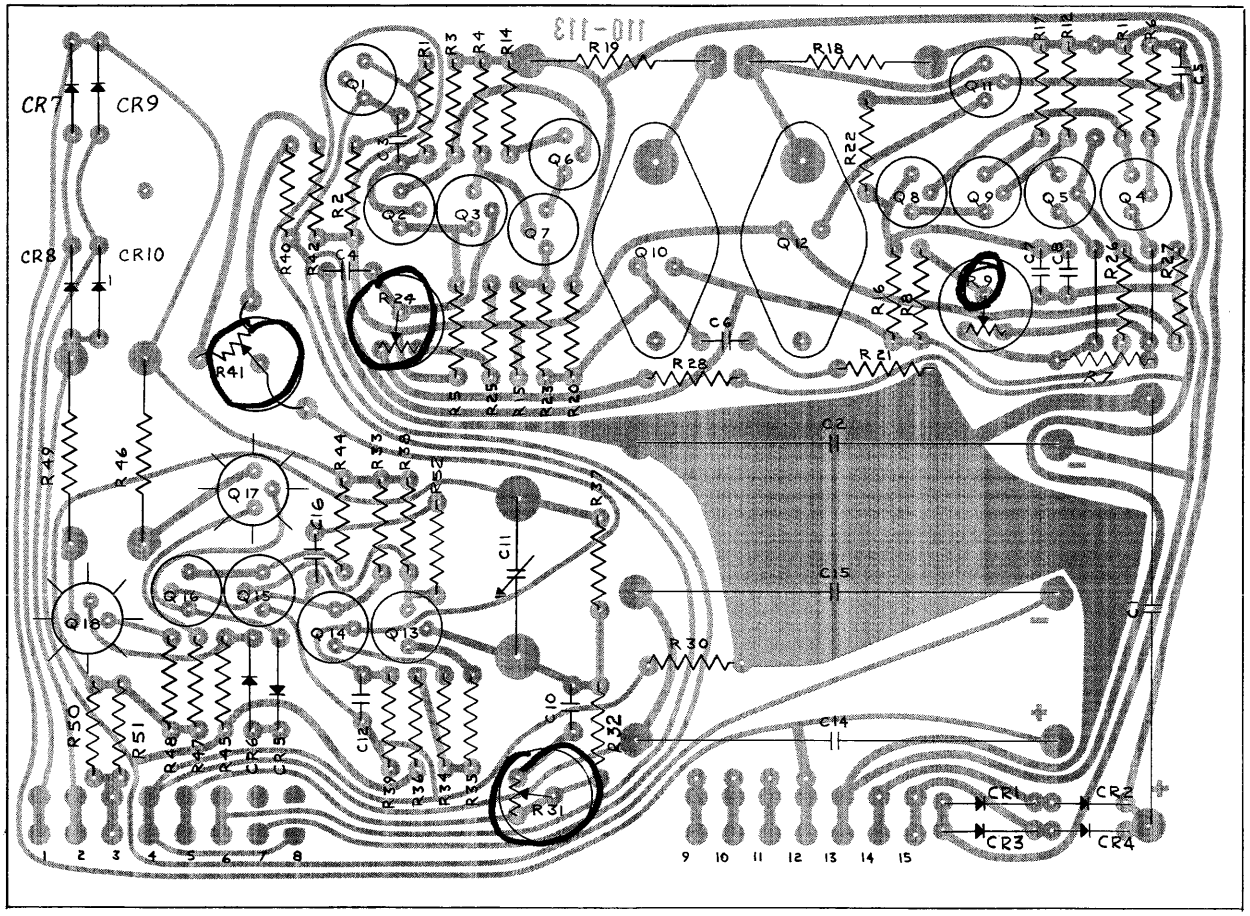


Figure 5-6.

Power Supply and Output Amplifier Assembly (110-013)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R46, R49	RC42GF910J	RESISTOR, Carbon, 2w, 5% 91Ω	2	Stackpole
R52	RC20GF201J	RESISTOR, Carbon, 1/2w, 5% 200Ω	1	Stackpole
R36	RC20GF622J	RESISTOR, Carbon, 1/2w, 5% 6200Ω	1	Stackpole
R21	RC20GF100K	RESISTOR, Carbon, 1/2w, 10% 10Ω	1	Stackpole
R30	RC20GF220K	RESISTOR, Carbon, 1/2w, 10% 22Ω	1	Stackpole
R7	RC20GF560K	RESISTOR, Carbon, 1/2w, 10% 56Ω	1	Stackpole
R14, R17, R22, R23	RC20GF101K	RESISTOR, Carbon, 1/2w, 10% 100Ω	4	Stackpole
R29	RC20GF151K	RESISTOR, Carbon, 1/2w, 10% 150Ω	1	Stackpole
R44	RC20GF221K	RESISTOR, Carbon, 1/2w, 10% 220Ω	1	Stackpole
R45	RC20GF182K	RESISTOR, Carbon, 1/2w, 10% 1800Ω	1	Stackpole
R5, R15, R16	RC20GF222K	RESISTOR, Carbon, 1/2w, 10% 2200Ω	3	Stackpole
R3, R8, R12	RC20GF272K	RESISTOR, Carbon, 1/2w, 10% 2700Ω	3	Stackpole
R4, R11	RC20GF392K	RESISTOR, Carbon, 1/2w, 10% 3900Ω	2	Stackpole
R20	RC20GF472K	RESISTOR, Carbon, 1/2w, 10% 4700Ω	1	Stackpole
R47, R48	RC20GF150K	RESISTOR, Carbon, 1/2w, 10% 15Ω	2	Stackpole
R50, R51	RN60D	RESISTOR, Metal Film, 1/4w, 1% 49.9Ω	2	Corning
R1, R28, R34, R35	RN60D	RESISTOR, Metal Film, 1/4w, 1% 100Ω	4	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R6	RN60D	RESISTOR, Metal Film, 1/4w, 1% 511Ω	1	Corning
R32	RN60D	RESISTOR, Metal Film, 1/4w, 1% 909Ω	1	Corning
R25, R26, R27, R39	RN60D	RESISTOR, Metal Film, 1/4w, 1% 1000Ω	4	Corning
R2	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2870Ω	1	Corning
R33, R38	RN60D	RESISTOR, Metal Film, 1/4w, 1% 3830Ω	2	Corning
R37	RN60D	RESISTOR, Metal Film, 1/4w, 1% 6980Ω	1	Corning
R40, R42	RN60D	RESISTOR, Metal Film, 1/4w, 1% 10,000Ω	2	Corning
R18, R19	PW-10	RESISTOR, Wirewound, 5w, 10% 10Ω	2	IRC
R9, R24, R31	FR251M	POTENTIOMETER, Single Turn, 250Ω	3	Allen Bradley
R41	FR103M	POTENTIOMETER, Single Turn, 10,000Ω	1	Allen Bradley
C3, C5, C6, C7, C8, C12	UK10-104	CAPACITOR, Ceramic, 10v, 0.1 mfd	6	Sprague
C10	DD220	CAPACITOR, Ceramic, 1000v, 22 pf	1	CRL
C16	DD330	CAPACITOR, Ceramic, 1000v, 33 pf	1	CRL
C4	DD102	CAPACITOR, Ceramic, 1000v, 1000 pf	1	CRL
C1, C2	34-750BP 2000	CAPACITOR, Electrolytic, 15v, 2000 mfd	2	Richey
C14, C15	34-750BP 1000	CAPACITOR, Electrolytic, 25v, 1000 mfd	2	Richey
C11	503-001 COPO-37R	CAPACITOR, Variohm, 3.0 to 12 pf	1	Erie

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
CR1, CR2, CR3, CR4, CR7, CR8, CR9, CR10	SCE-1	DIODE	8	Semtech
CR5, CR6	FD6666	DIODE	2	Fairchild
Q15* & Q16*	2N3645	TRANSISTOR	2	Fairchild
Q4* & Q5* Q1, Q7, Q9, Q11	2N3638	TRANSISTOR	6	Fairchild
Q2* & Q3*, Q6, Q8	2N3646	TRANSISTOR	4	Fairchild
Q13*, Q14*	2N3642	TRANSISTOR	2	Fairchild
Q10	40250	TRANSISTOR	1	RCA
Q12	2N3740	TRANSISTOR	1	Motorola
Q17	2N3299	TRANSISTOR	1	Fairchild
Q18	2N3502	TRANSISTOR	1	Fairchild
	013-5200	CONNECTOR, Pin	14	Elco
	NF207	HEATSINK	2	Wakefield
	2010B-1	TERMINAL	11	USECO
	110-113	BOARD, Printed Circuit	1	Wavetek

*Indicates transistors which are matched pairs.

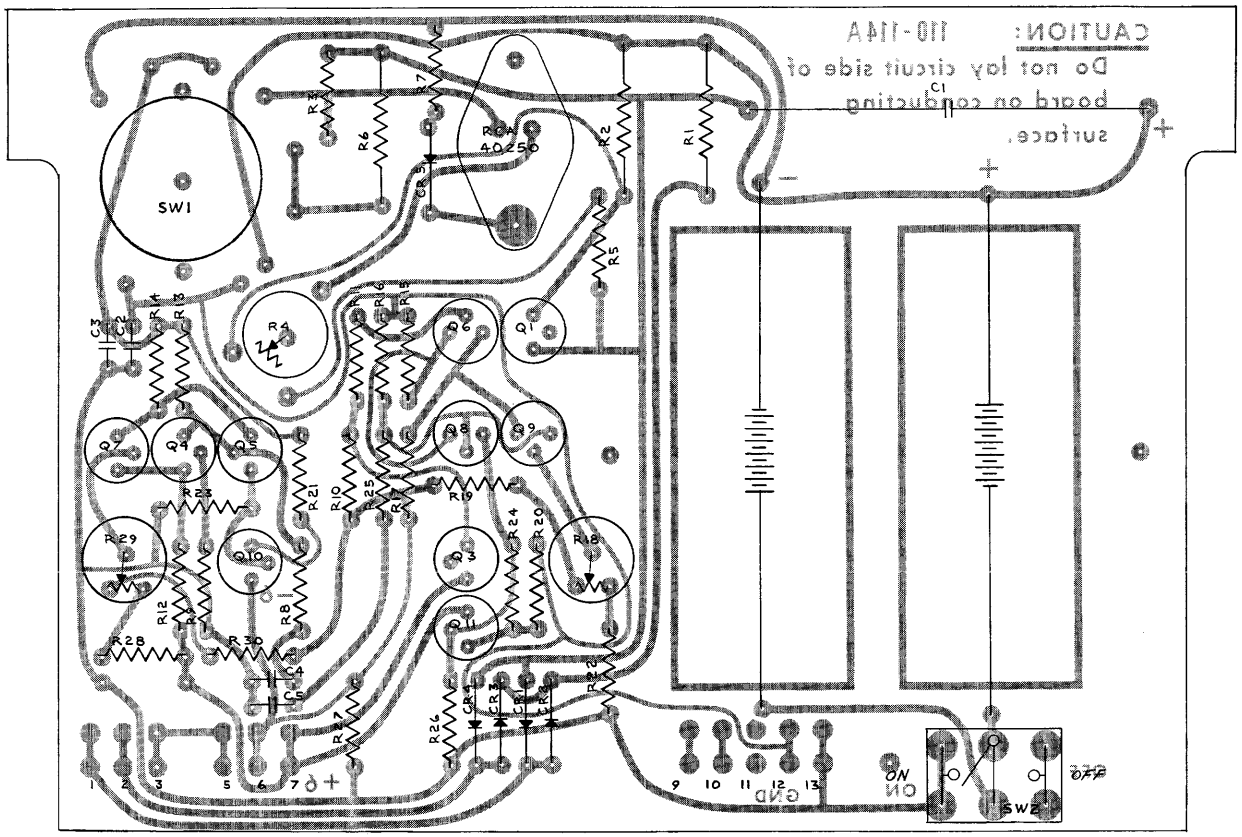


Figure 5-7.

Battery Power Supply Assembly (110-014)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R7, R20, R21	RC07GF100J	RESISTOR, Carbon, 1/4w, 5% 10Ω	3	Stackpole
R6	RC42GF390J	*RESISTOR, Carbon, 2w, 5% 39Ω	1	Stackpole
R6	RC42GF470J	**RESISTOR, Carbon, 2w, 5% 47Ω	1	Stackpole
R27	RC20GF561J	RESISTOR, Carbon, 1/2w, 5% 560Ω	1	Stackpole
R2	RC42GF122J	RESISTOR, Carbon, 2w, 5% 1200Ω	1	Stackpole
R5	RC20GF132J	RESISTOR, Carbon, 1/2w, 5% 1300Ω	1	Stackpole
R8, R14, R15, R25	RC20GF101K	RESISTOR, Carbon, 1/2w, 10% 100Ω	4	Stackpole
R13, R16	RC20GF821K	RESISTOR, Carbon, 1/2w, 10% 820Ω	2	Stackpole
R3	RC20GF102K	RESISTOR, Carbon, 1/2w, 10% 1000Ω	1	Stackpole
R17, R24	RC20GF302K	RESISTOR, Carbon, 1/2w, 10% 3000Ω	2	Stackpole
R12	RC20GF332K	RESISTOR, Carbon, 1/2w, 10% 3300Ω	1	Stackpole
R23, R26	RC20GF123K	RESISTOR, Carbon, 1/2w, 10% 12,000Ω	2	Stackpole
R11, R22	RN60D	RESISTOR, Metal Film, 1/4w, 1% 100Ω	2	Corning
R19	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2000Ω	1	Corning
R9	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2370Ω	1	Corning

* Model 111 only.
** Model 110 only.

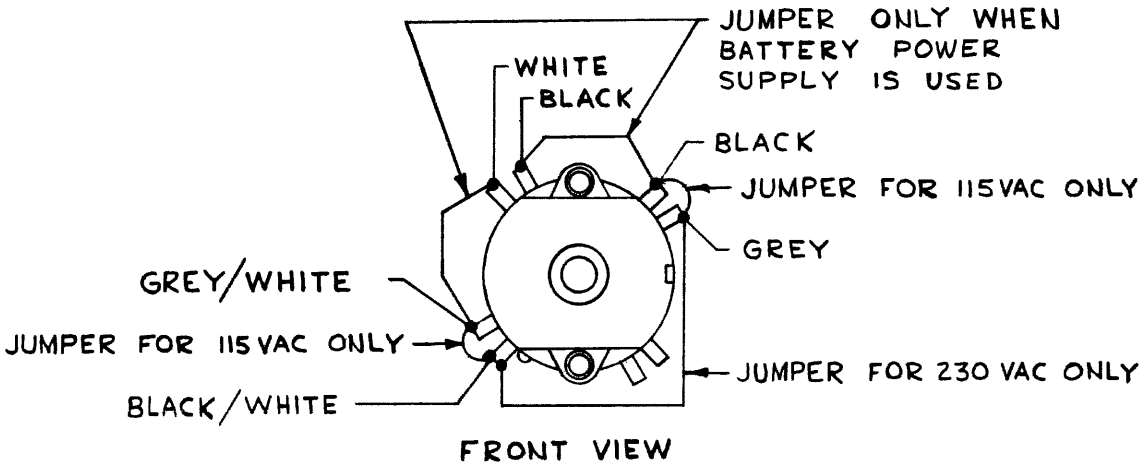
Battery Power Supply Assembly Parts List (110-014)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R10	RN60D	RESISTOR, Metal Film, 1/4w, 1% 2870Ω	1	Corning
R28, R30	RN60D	RESISTOR, Metal Film, 1/4w, 1% 4640Ω	2	Corning
R1	4576	RESISTOR, Wirewound, 5w, 5% 39Ω	1	Ohmite
R4, R18, R29	FR251M	POTENTIOMETER, Single Turn, 250Ω	3	Allen-
C2, C3	UK10-104	CAPACITOR, Ceramic, 10v, 0.1 mfd	2	CRL
C4, C5	DD331	CAPACITOR, Ceramic, 1000v, 330 pf	2	CRL
C1	34-750-500-50T	CAPACITOR, Electrolytic, 50v, 500 mfd	1	Richey
CR1 thru CR5	SCE-1	DIODE	5	Semtech
Q1, Q3, Q4, Q7, Q8, Q10	2N3638	TRANSISTOR	6	Fairchild
Q2	40250	TRANSISTOR	1	RCA
Q5, Q6, Q9	2N3646	TRANSISTOR	3	Fairchild
Q11	2N3567	TRANSISTOR	1	Fairchild
B1, B2	7/BH500-Y5652	BATTERY, Rechargeable ni-cad	2	Eveready
SW1		SWITCH, 3 pole	1	CTS
SW2		SWITCH, DPDT	1	Continental
	110-114	BOARD, Printed Circuit	1	Wavetek

The following transistors are matched pairs:

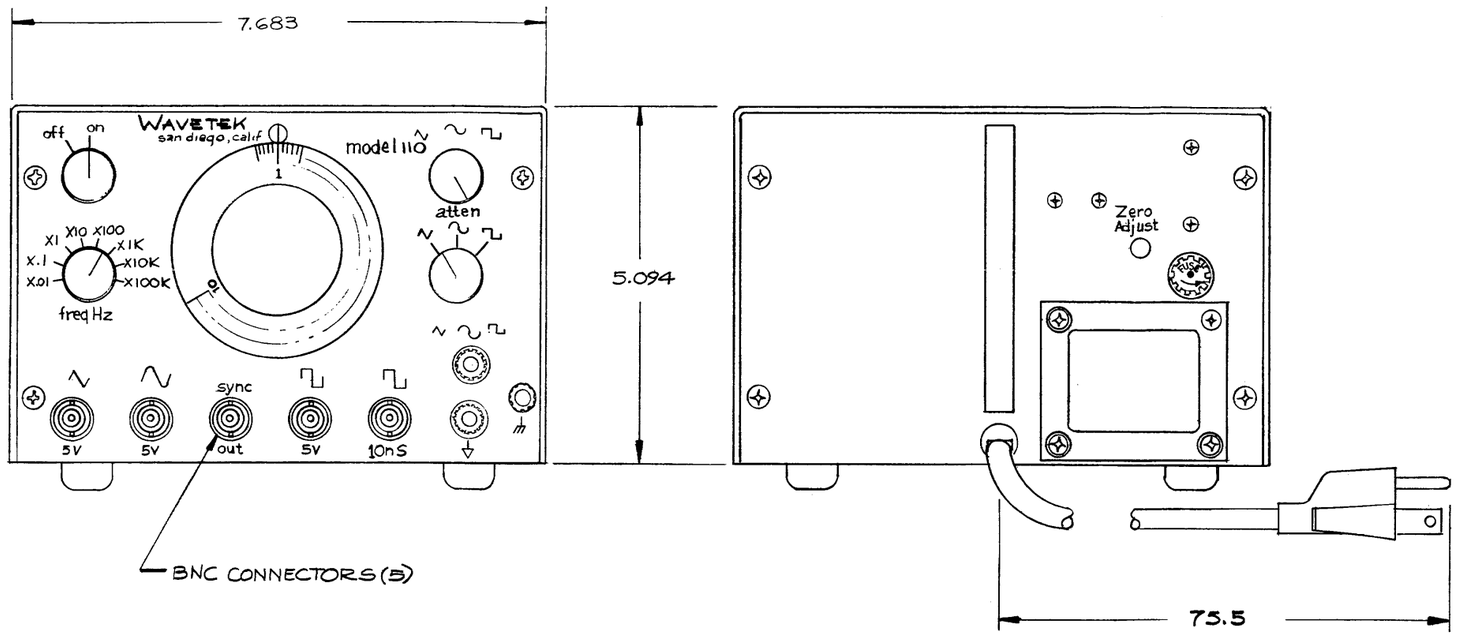
Q6 & Q9, Q4 & Q7.

SECTION VI
SCHEMATIC DIAGRAMS

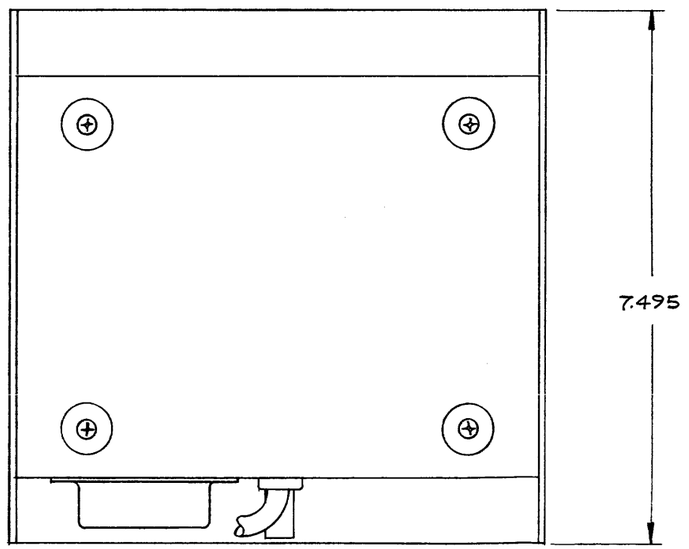


115/230V SWITCH WIRING

115/230 VAC Switch Wiring Schematic Diagram



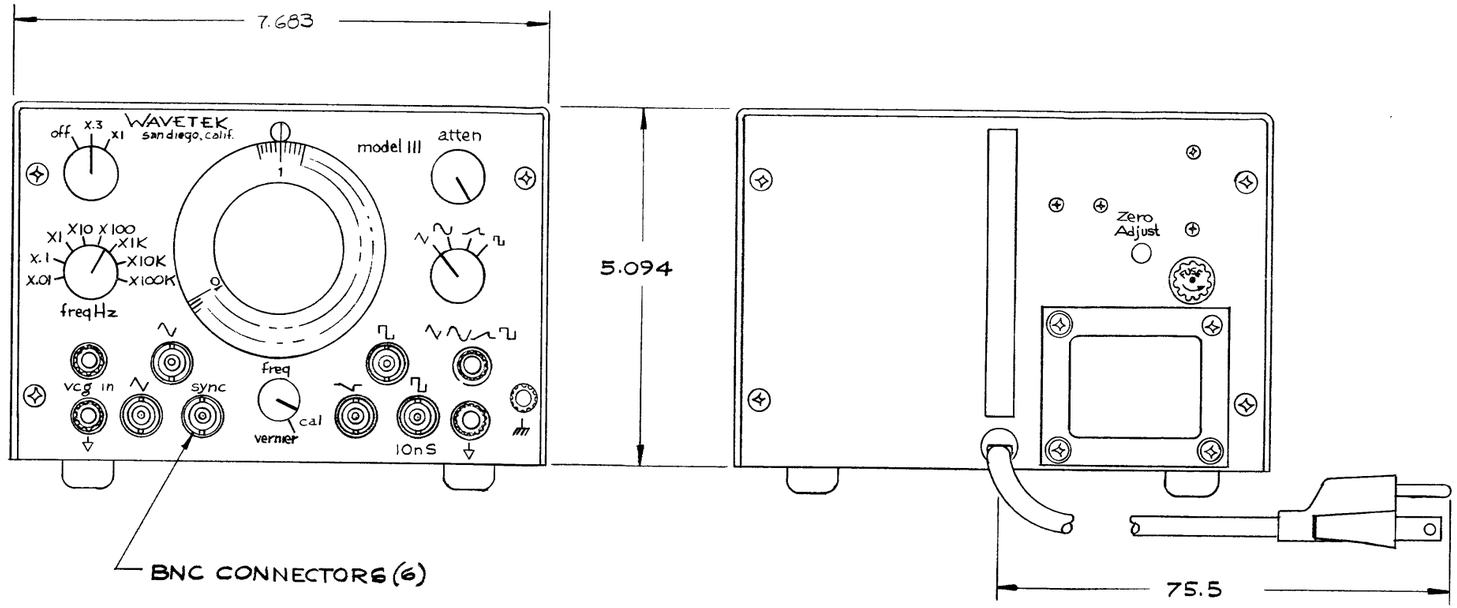
REAR VIEW



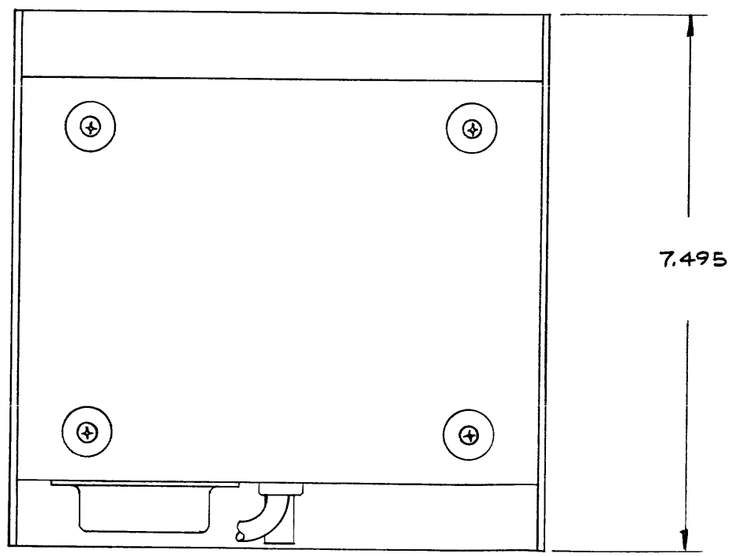
WAVETEK	8159 ENGINEER RD SAN DIEGO, CALIF
DWN: J. WHITELOCK DATE: 3-14-6	APPD: D. L. Peinetti

OUTLINE DRAWING

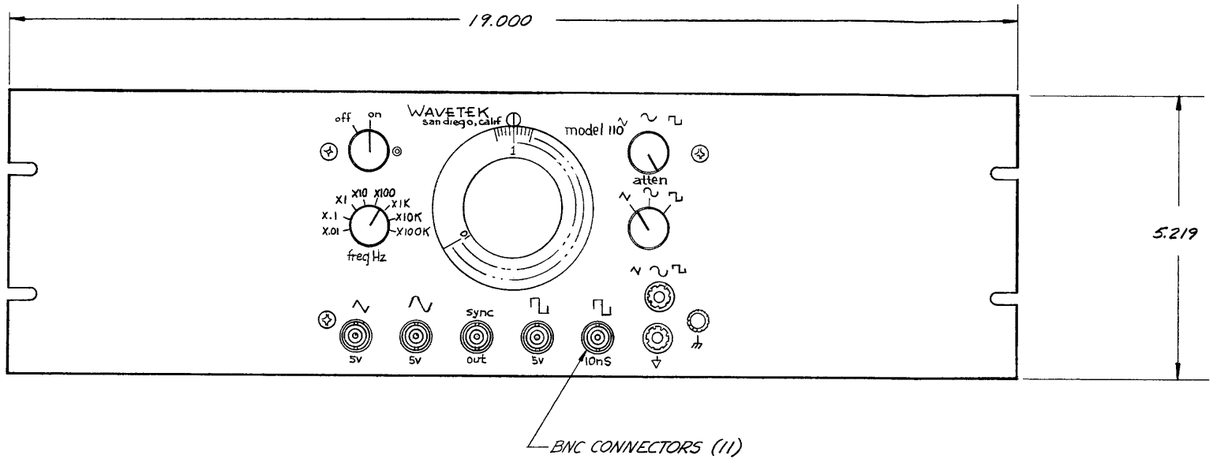
MODEL: 110, 110B	NO: 110-600

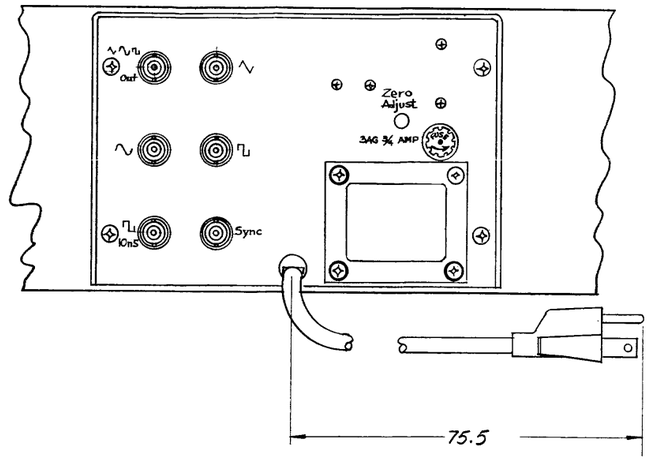


REAR VIEW

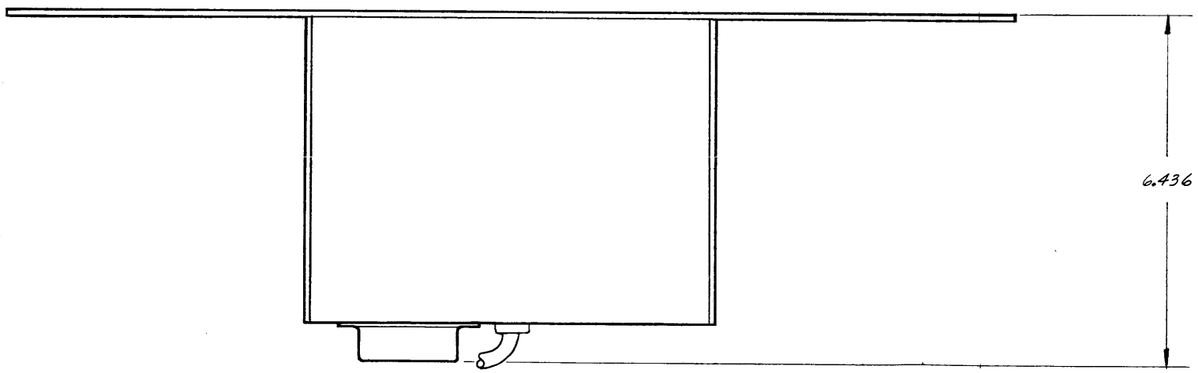


WAVETEK	8159 ENGINEER RD SAN DIEGO, CALIF.	
DWN: J. WHITELOCK	DATE: 3-14-6	APP'D: D. L. Reinetti
OUTLINE DRAWING		
MODEL: 111, 111B	NO: 111-600	

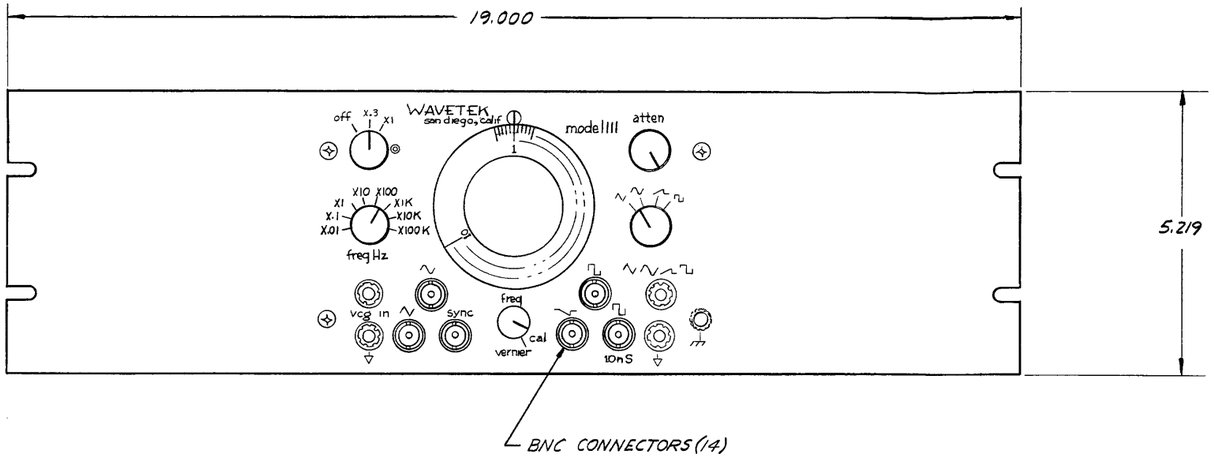


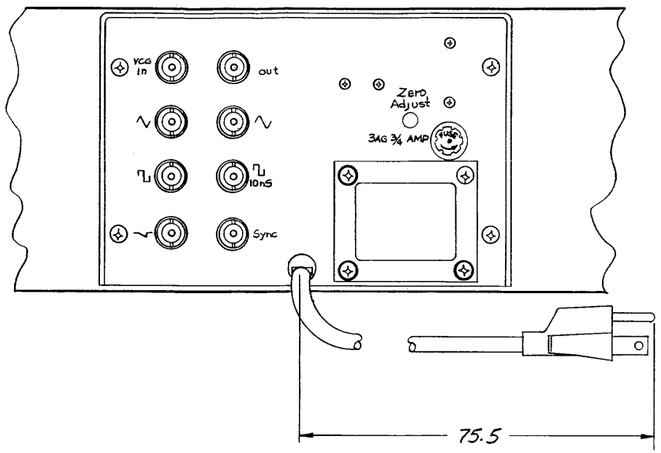


REAR VIEW

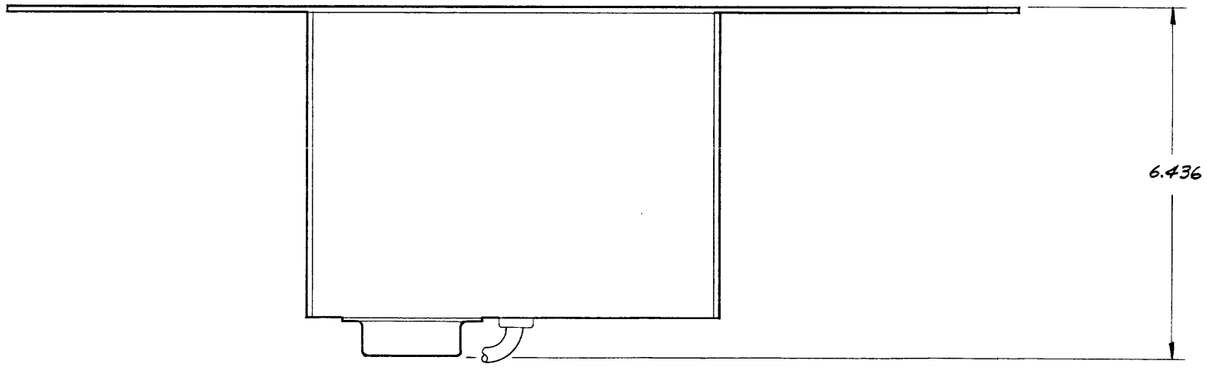


WAVETEK 8159 ENGINEER RD SAN DIEGO, CALIF	
DWN: WAVETEK DATE: 4-14-6	APP'D: R.L. Painetti
OUTLINE DWG. - RACK MOUNT	
MODEL: 110,110B	NO: 110-601

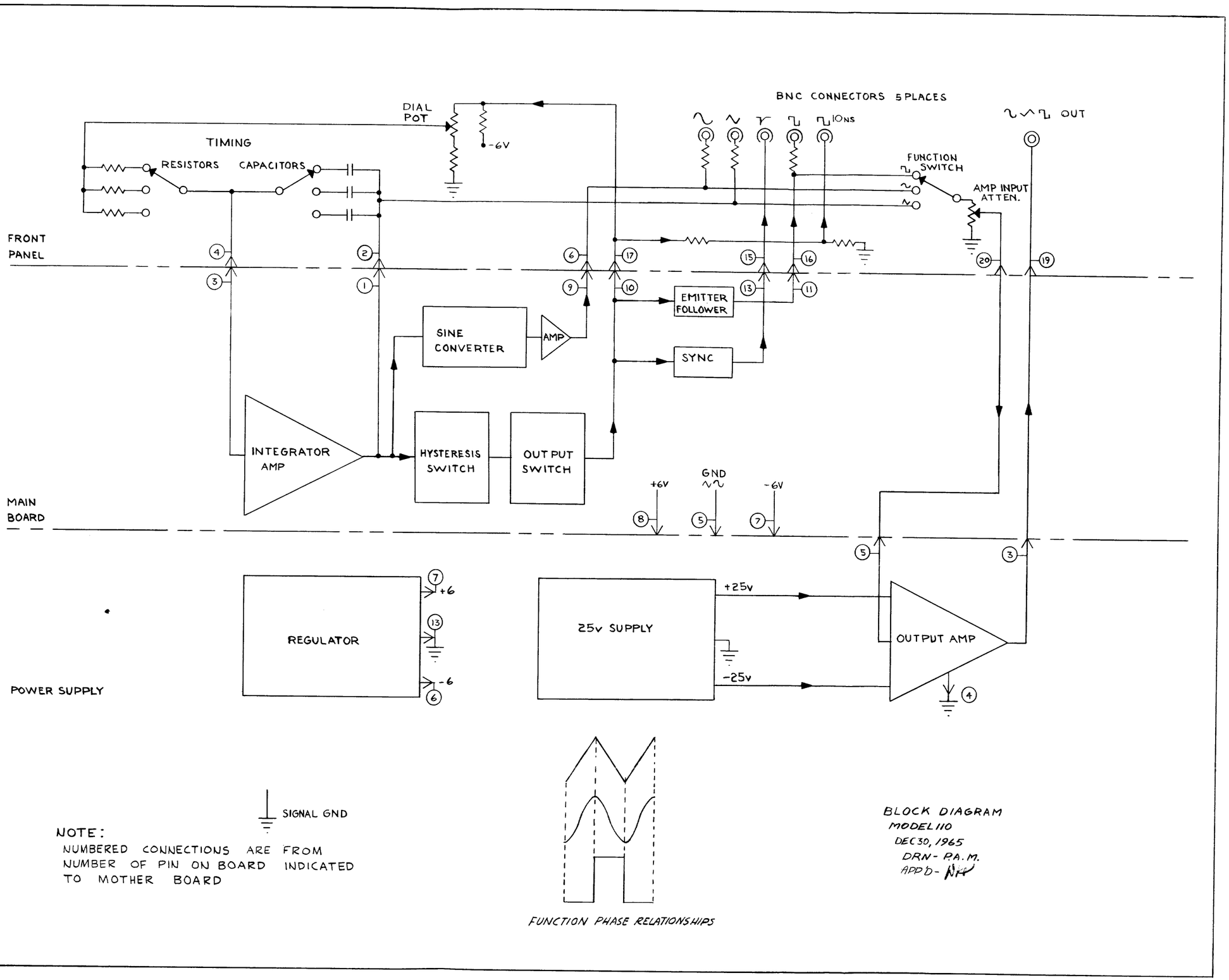




REAR VIEW



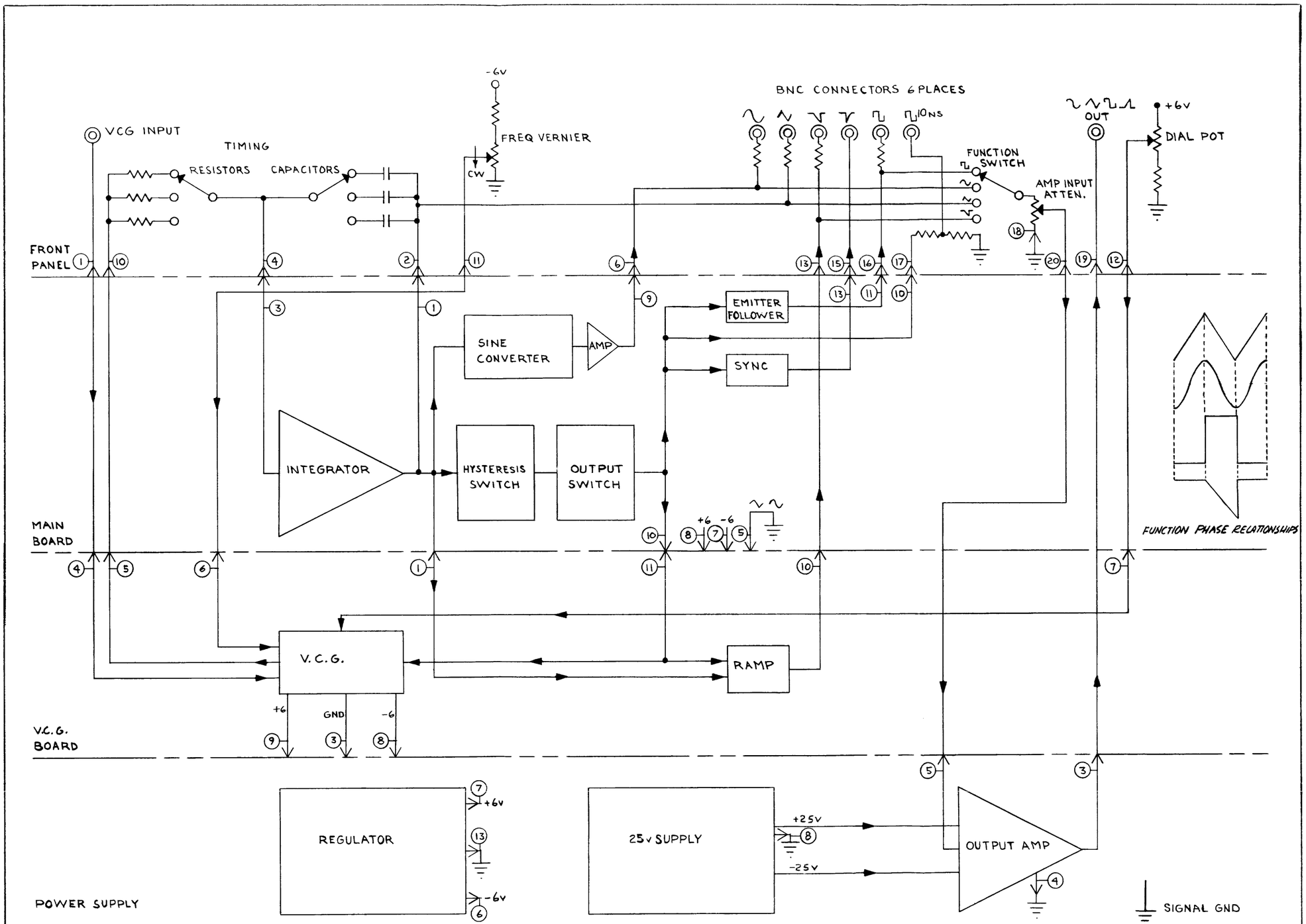
WAVETEK	8159 ENGINEER RD. SAN DIEGO, CALIF.
DWN: WHITELOCK DATE: 4-14-6	APP'D:
OUTLINE DWG.- RACK MOUNT	
MODEL: 111, 111B	NO: 111-601



NOTE:
NUMBERED CONNECTIONS ARE FROM NUMBER OF PIN ON BOARD INDICATED TO MOTHER BOARD

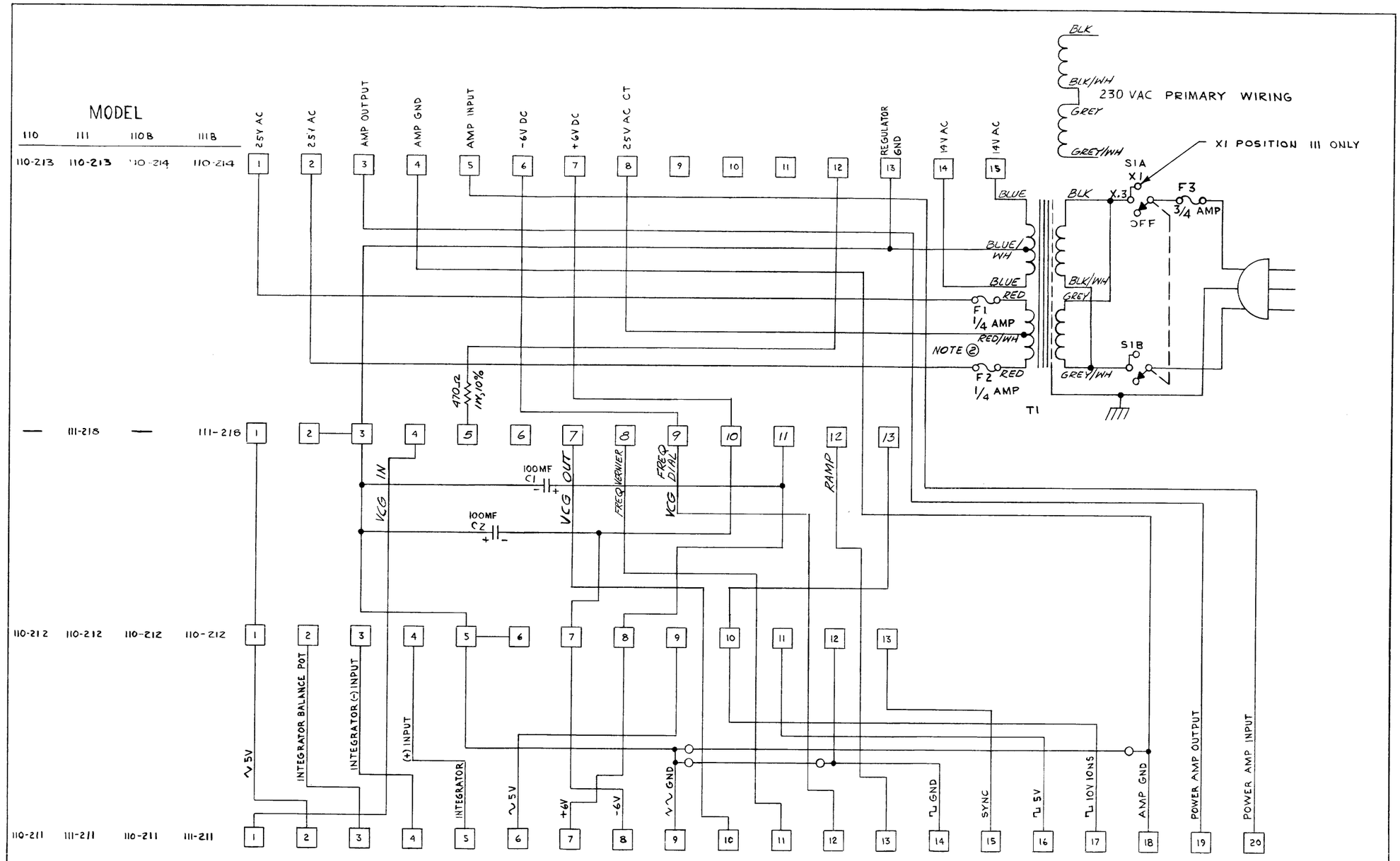
FUNCTION PHASE RELATIONSHIPS

BLOCK DIAGRAM
MODEL 110
DEC 30, 1965
DRN - P.A.M.
APP'D - NH



NOTE:
NUMBERED CONNECTIONS ARE FROM NUMBER OF PIN ON BOARD INDICATED TO MOTHER BOARD

BLOCK DIAGRAM
MODEL III
DEC 30, 1965
DRN - P.A.M. APP'D - [illegible]



FRONT

NOTE

1. PINS ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD.
2. FOR "B" MODELS, USE 1/2 AMP 3AG FAST BLOW FOR F1 AND F2.

CHG	ECN NO	BY	DATE	APP
A	ECN #94 (WAS DWG # 110-200B)	JW	12-12-66	

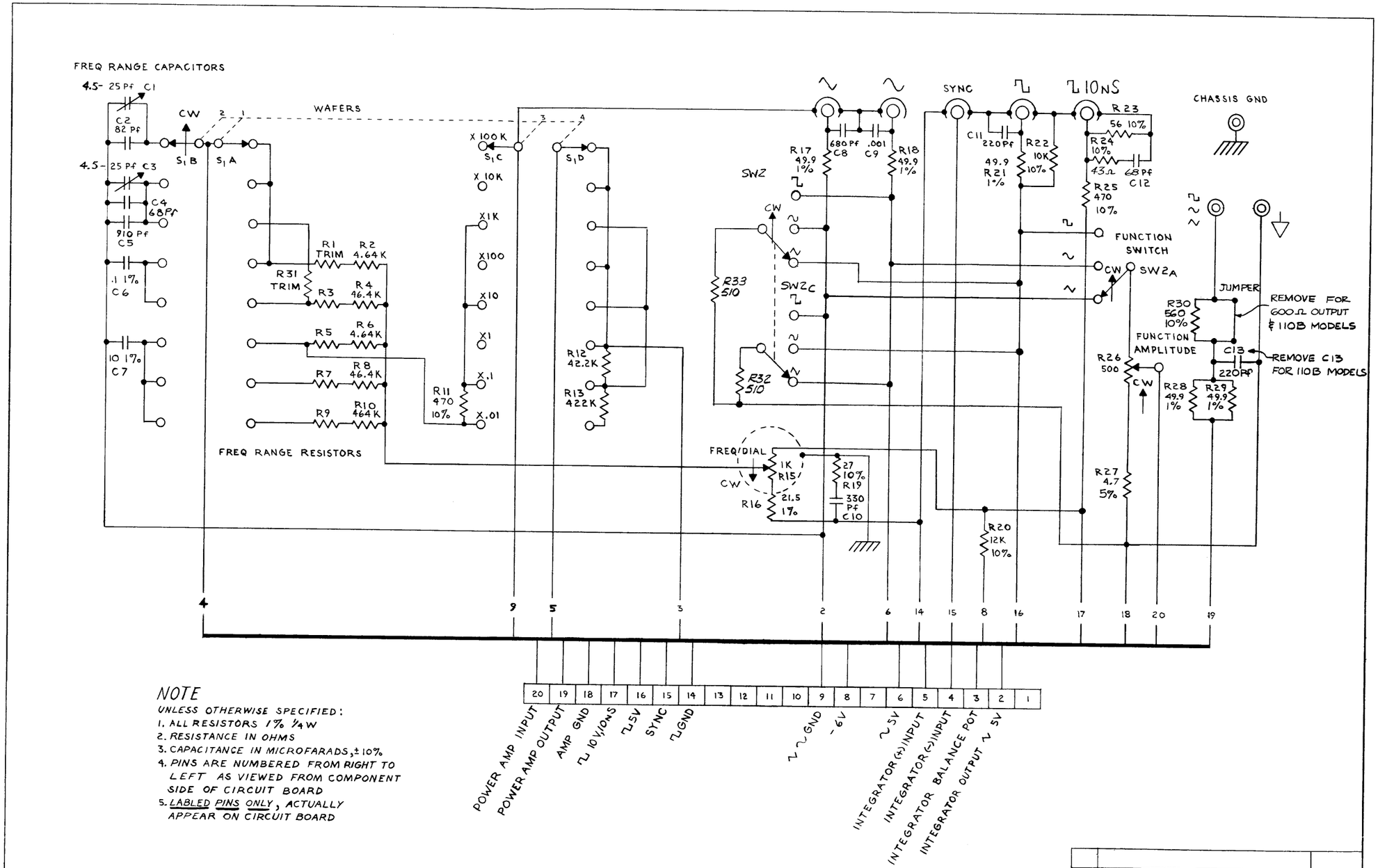
WAVETEK
8159 ENGINEER RD
SAN DIEGO, CALIF

DRN PA Marsh DATE 1-20-66 APP D. L. Finietti

MOTHER BOARD

MODEL 110 - 111 - 110B - 111B

NO. 110-210



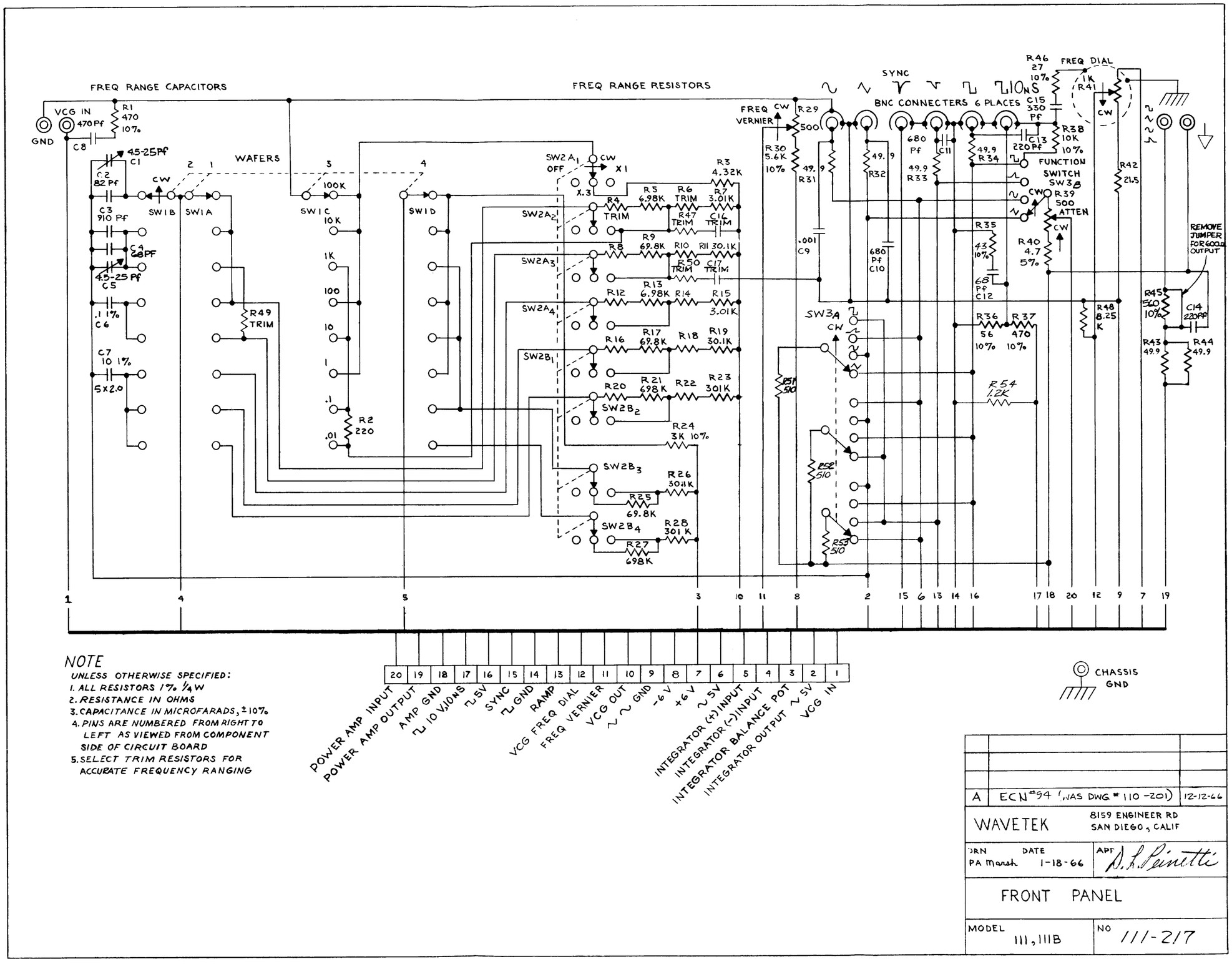
NOTE

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS 1% ¼W
2. RESISTANCE IN OHMS
3. CAPACITANCE IN MICROFARADS, ± 10%
4. PINS ARE NUMBERED FROM RIGHT TO LEFT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD
5. LABLED PINS ONLY, ACTUALLY APPEAR ON CIRCUIT BOARD

A	ECN #94 (WAS DWG # 110-201C)	12-9-66

WAVETEK	8159 ENGINEER RD SAN DIEGO, CALIF
DRN PA Marsh DATE 1-19-66	APP D. L. Peinetti
FRONT PANEL	
MODEL 110, 110B	NO 110-211



NOTE

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS 1% ¼W
2. RESISTANCE IN OHMS
3. CAPACITANCE IN MICROFARADS, ±10%
4. PINS ARE NUMBERED FROM RIGHT TO LEFT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD
5. SELECT TRIM RESISTORS FOR ACCURATE FREQUENCY RANGING

CHASSIS GND

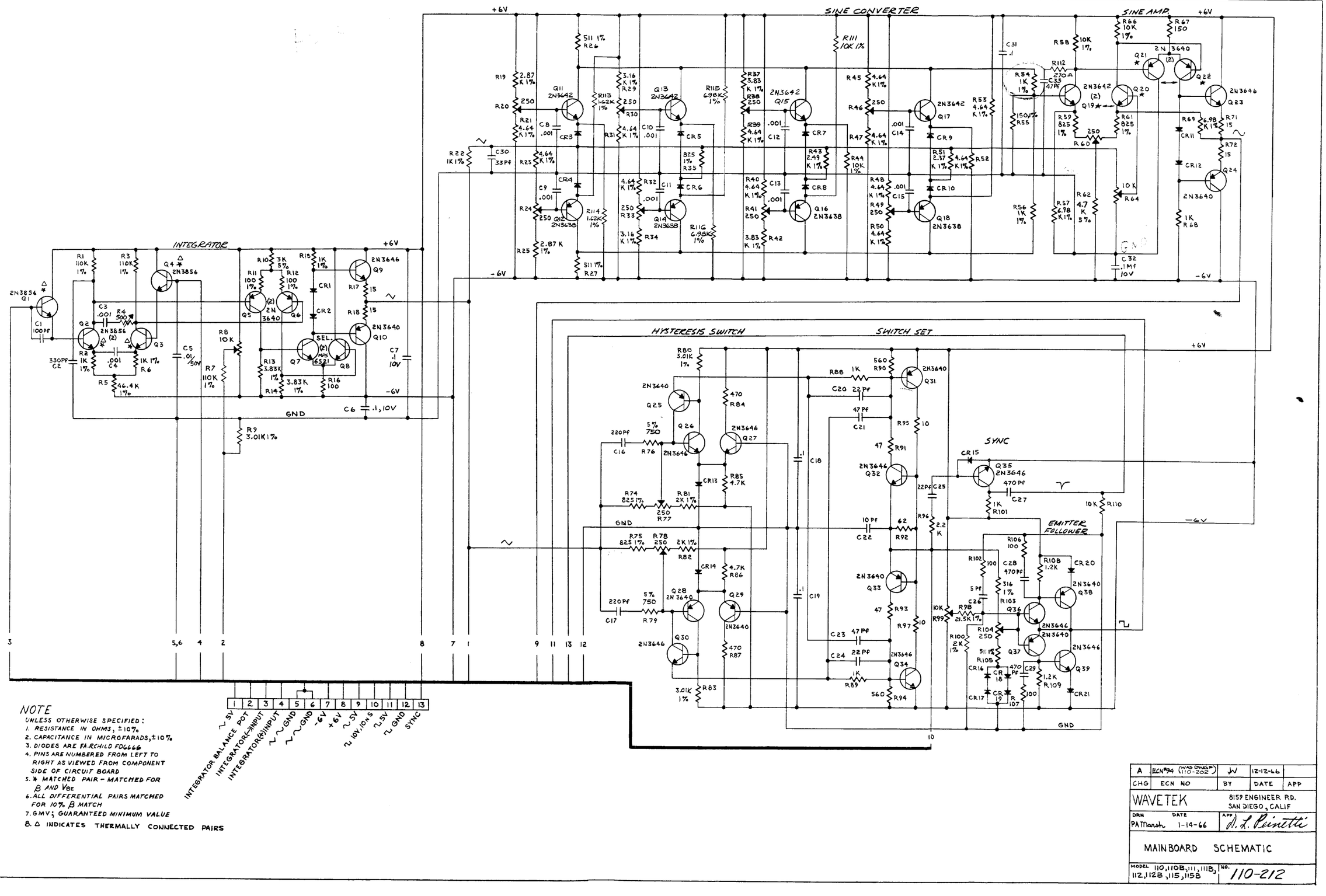
A	ECN #94 (WAS DWG # 110-201)	12-12-66

WAVETEK — 8159 ENGINEER RD, SAN DIEGO, CALIF

DRN PA Marsh — DATE 1-18-66 — APP D. L. Reinetti

FRONT PANEL

MODEL 111, 111B — NO 111-217



NOTE

UNLESS OTHERWISE SPECIFIED:

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

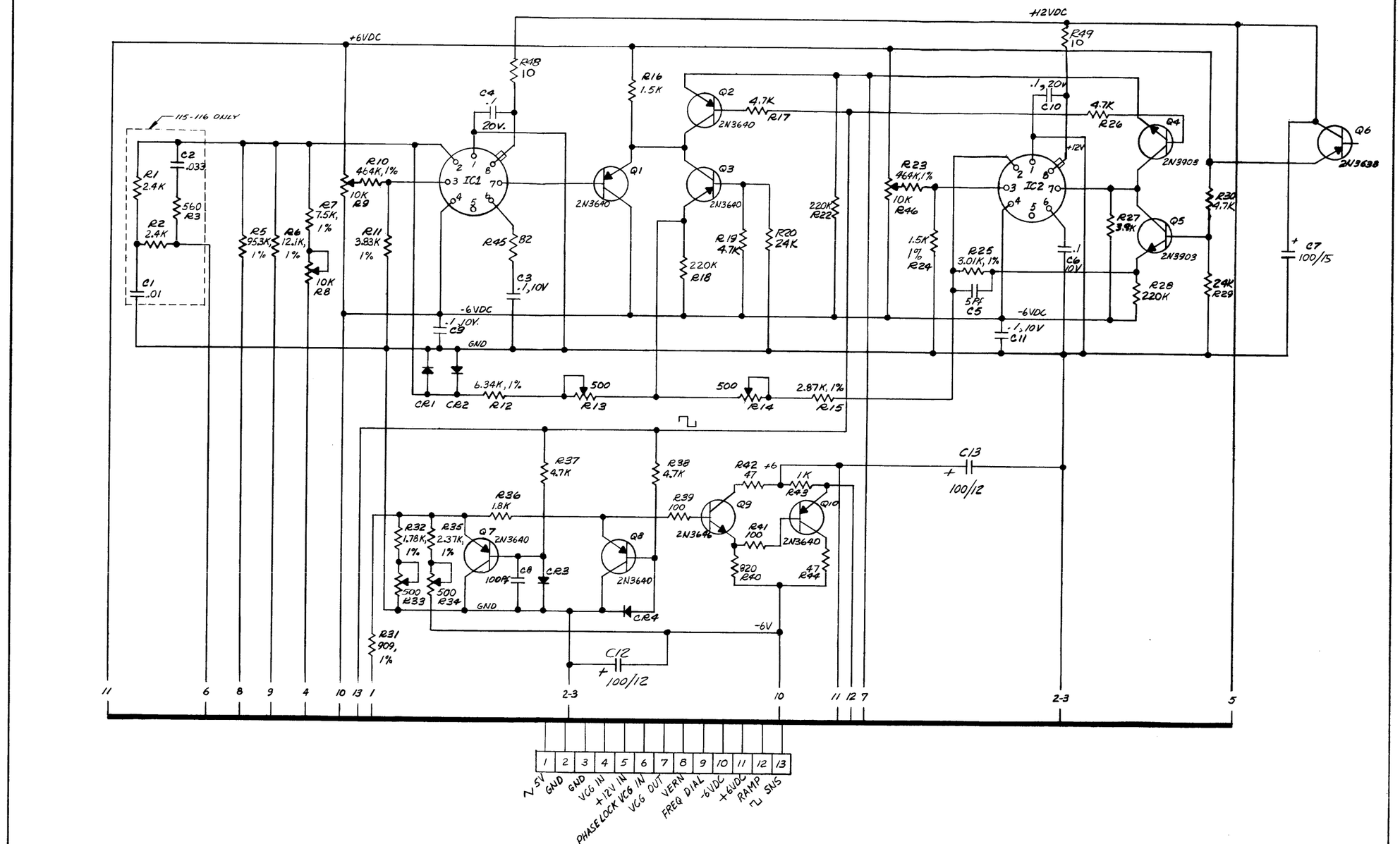
CHG	ECN NO	BY	DATE	APP
A	ECN#94 (WAS ECN#S 110-202)	JW	12-12-66	

WAVETEK, 8159 ENGINEER RD., SAN DIEGO, CALIF

DRN P.A. Marsh DATE 1-14-66 APP A. L. Reinetti

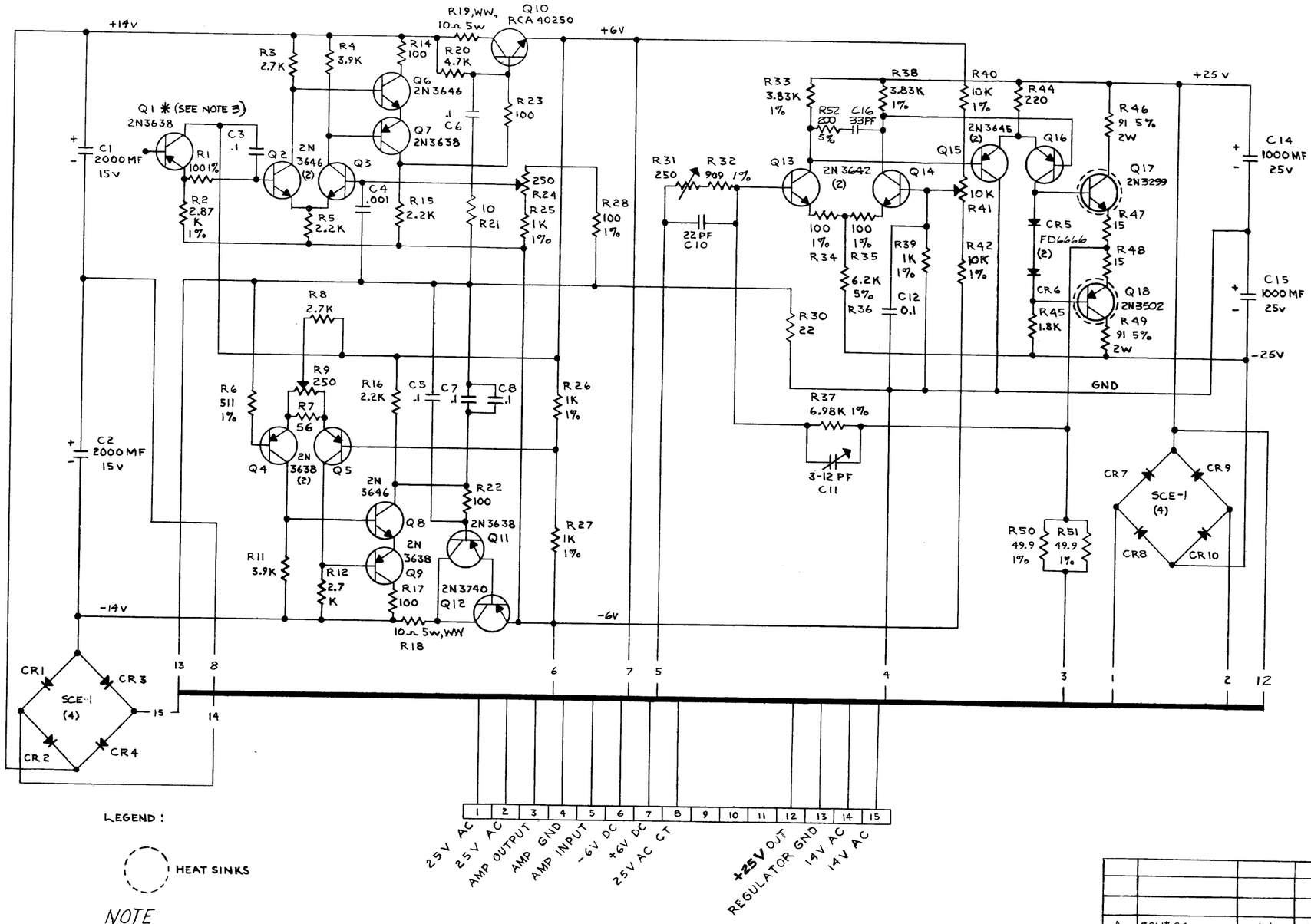
MAIN BOARD SCHEMATIC

MODEL 110, 110B, 111, 111B, 112, 112B, 115, 115B NO. 110-212



NOTES
UNLESS OTHERWISE SPECIFIED
1. RESISTANCE IN OHMS, 1/2 W, 10%, CARBON
2. CAPACITANCE IN MICROFARADS
3. DIODES ARE FAIRCHILD FD6666
4. INTEGRATED CIRCUITS ARE FAIRCHILD μA702C

WAVETEK	8159 ENGINEER ROAD SAN DIEGO, CALIF.
DRN S.L.B. DATE 11-4-66	APP D. L. Reinetti
VCG SCHEMATIC	
MODEL: 111, 112, 114, 115, 116	NO. 111-218



LEGEND :

HEAT SINKS

NOTE

UNLESS OTHERWISE SPECIFIED :

1. RESISTANCE IN OHMS, ±10%
2. CAPACITANCE IN MICROFARADS, ±10%
3. *Q1 PRE-SELECTED FOR ZENER VOLTAGE OF 6.6V ± .3V.
4. PINS ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD
5. ALL DIFFERENTIAL PAIRS MATCHED FOR 10% β MATCH

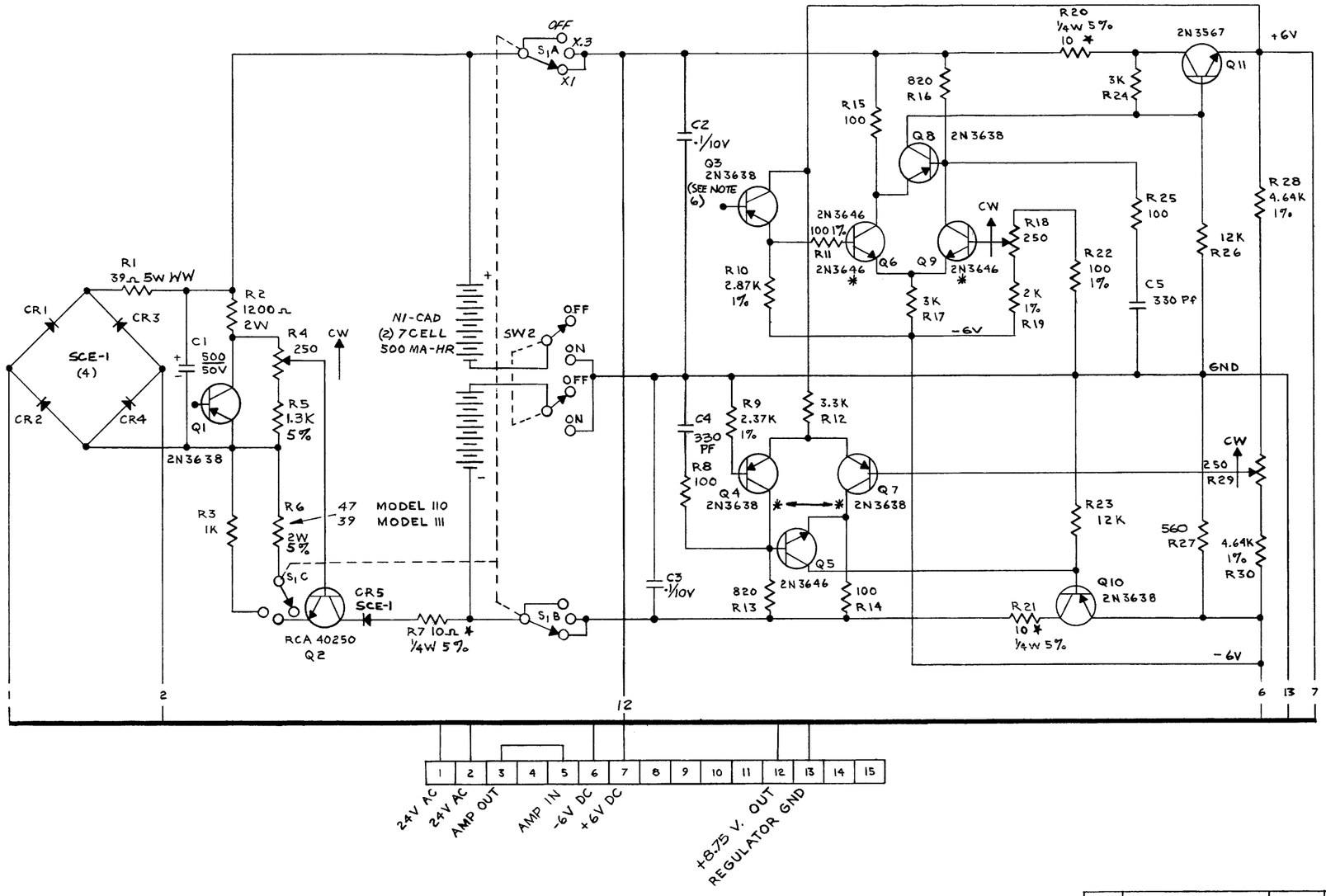
A	ECN# 94	JW	12-12-66	
CHG	ECN NO.	BY	DATE	APP

WAVETEK 8159 ENGINEER RD SAN DIEGO, CALIF

DRN PA Marsh DATE 1-21-66 APP D. L. Peinetti

POWER SUPPLY AND OUTPUT AMP

MODEL 110, 111, 112, 115 NO 110-213



NOTE

UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE IN OHMS
2. CAPACITANCE IN MICROFARADS
3. PINS ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM COMPONENT SIDE OF CIRCUIT BOARD
4. * MOUNT 1/4 INCH OFF BOARD (FUSE RESISTORS)
5. LABELED PINS ONLY, ACTUALLY APPEAR ON CIRCUIT BOARD
6. Q3 PRE-SELECTED FOR ZENER VOLTAGE OF 6.6V ± .3V.
7. (*) INDICATES PAIRS MATCHED FOR β

CHG	ECN NO.	BY	DATE	APP
A	ECN #34 (WAS DWG 110B-204)	JW	12-12-66	

WAVETEK
8159 ENGINEER RD
SAN DIEGO, CALIF

DRN PA Marsh DATE 1-27-66 APP. D. L. Rinaldi

BATTERY POWER SUPPLY

MODEL 110B-111B NO 110-214

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP