INSTRUCTION MANUAL

MODEL 157

PROGRAMMABLE WAVEFORM SYNTHESIZER

WAVETEK

9045 BALBOA AVENUE, SAN DIEGO, CALIFORNIA

WARRANTY

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

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Product Improvement Notice

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

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

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

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

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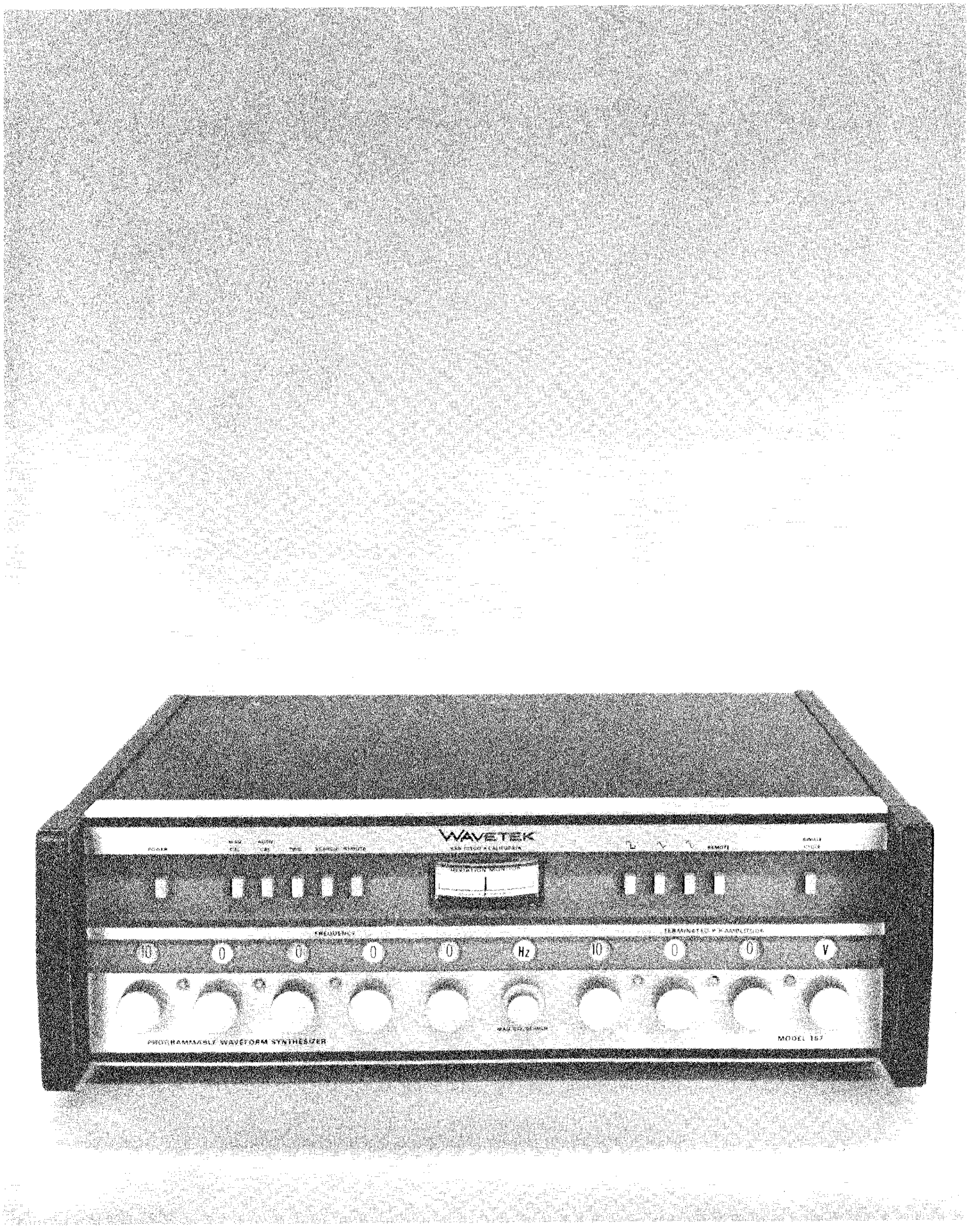
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PROGRAMMABLE WAVEFORM SYNTHESIZER

SECTION 1
GENERAL DESCRIPTION

SCOPE OF MANUAL

This manual provides instructions for operating, testing, and maintaining the Wavetek Programmable Waveform Synthesizer. Sections 1 through 5 include the necessary information for the basic Model 157. Section 6 consists of **Difference Data** that describe specific differences, if any, from the basic model.

SCOPE OF EQUIPMENT

The Model 157 is a precision source of selectable sine, square, or triangle waveforms that are generated from 100 μHz (2¾ hours per cycle) to 1 MHz in 10 ranges. Output amplitudes are selectable from 1 millivolt to 10 volts, peak-to-peak, into a 50-ohm load. This instrument incorporates a voltage-controlled generator that may be swept over a 1000:1 frequency ratio with a 0-volt to 5-volt analog input for frequency modulation of the selected output frequency.

Four modes of operation can be programmed with the front-panel controls. Three modes of operation are programmable from a remote source by static logic levels or contact closures. Frequency, amplitude, and function also are programmable from either the front-panel controls or a remote source.

The instrument is packaged for mounting in a standard 19-inch rack or for operating on a test bench.

MODES OF OPERATION

Front-panel pushbutton operation provides the following operational modes:

1. VCG with manual calibration.
2. Automatic calibration.
3. Trigger.
4. Search.

Remote logic-level or contact-closure programming provides the following operational modes:

1. Automatic calibration.
2. Trigger.
3. VCG without manual calibration.

VCG With Manual Calibration Mode

This mode is selected at the front panel for accurately calibrating the output frequency. After calibration, the Model 157 may be swept about the calibrated center frequency with a VCG input.

Automatic Calibration Mode

This mode is selected at the front panel or programmed from the remote source to provide an accurate fixed-frequency output by closed-loop operation.

Trigger Mode

This mode is selected at the front panel or programmed from the remote source to place the Model 157 in a standby state until a positive pulse is applied through a connector on the rear panel. The standby state for the sine and triangle waveforms is 0-volts dc. For the square wave, the standby state is the positive peak value of the programmed amplitude. A tone-burst output starts at the positive-going edge of the input pulse and continues, at the programmed frequency, for the duration of the pulse plus the time required for the generator to complete the last cycle. Another front-panel pushbuttom permits a single cycle of the programmed frequency to be generated without an external pulse input. The same function can be accomplished remotely by injecting an input pulse having less duration than a single cycle of the programmed frequency.

Search Mode

This mode is selected at the front panel for sweeping the entire selected frequency range to find a specific frequency. In this mode, digital programming of frequency is disabled and the generator functions in open-loop operation.

VCG Without Manual Calibration Mode

This mode is obtained in remote-control operation when none of the preceding functions are programmed. In this mode, the generator is in the open-loop operation and the output frequency is determined by the digitally-programmed frequency and a VCG input signal. If the input signal is dc, the generator output frequency will be the digitally-programmed frequency proportionally modified by the level of the input signal. A positive input level increases the generator output frequency, and a negative level decreases the output frequency. If the input signal is ac, the output frequency will be frequency modulated over a band that is proportional to the signal amplitude at a rate that is equal to the signal frequency.

REMOTE CONTROL OPERATIONS

Transfer of control to a remote source is accomplished by depressing the REMOTE pushbuttons and turning the rotary switches to their R positions. Control of generator mode, function, and each rotary switch may be transferred to the REMOTE connector collectively or independently. (Refer to **Operations** section.) Any or all of these controls may then be programmed in BCD/binary format at the 50-pin REMOTE connector on the rear panel. Synchronizing, trigger, and VCG input signals are connected to the Model 157 through separate BNC connectors on the rear panel for either local or remote-program applications. Programming an automatic calibration command simultaneously with a synchronizing, trigger, or VCG input signal is a *not-allowed* operation.

FUNCTIONAL DESCRIPTIONS

Programming

Operation by contact closure (local/remote) or by automatic data processing (ADP) is controlled by binary states. The coding format is modified BCD, BCD, or binary. The coded program controls numerical frequency, frequency range, numerical amplitude, amplitude range, function selection, and generator mode selection. Circuit functions are implemented by reed-relay contact closures and digital-to-analog converters (DAC).

In the simplified block diagram of Figure 1-1, all switch symbols represent a switching function that can be commanded either remotely or locally. The binary code is converted by the frequency DAC into an analog voltage which is applied to an inverter and error-sensing circuit. The outputs of these circuits establish the operating state for the voltage-controlled generator (VCG).

Error Loop Operation

The inverter input to the VCG is disconnected in the search mode (represented by S_1 in Figure 1-1) so that the frequency range may be manually swept with a front-panel control. The frequency error-sensing circuit is disconnected in search, trigger, and VCG modes. In automatic calibration, this circuit operates in closed loop and corrects for frequency drift.

The error-sensing circuit operates between 100 Hz to 1 kHz. Therefore, when the programmed frequency is greater than 1 kHz, the divider circuit is automatically switched between the output of the hysteresis switch and the error-circuit input (represented by S_3).

The divider circuit consists of three cascaded divide-by-ten counters that are progressively engaged as the frequency is increased. With all three circuits engaged, the divider output is 0.001 of the input frequency which reduces the top frequency range of the generator to within the error-circuit band.

High-Frequency Range

Frequences from 100 Hz to 1 MHz are produced by conventional function-generator techniques. The integrator output is a triangle wave and the hysteresis switch output is a square wave, each being interdependent with the other. The frequency program establishes the charging slope for the integrator and selects the proper integrating capacitance for the specific frequency range. In the trigger mode, a square-wave output from the hysteresis switch is coupled through S_2 to enable the trigger circuit.

The triangle wave is coupled through S_6 to the sine converter which transforms the input waveform into a sinusoidal wave at its output. The programmed function at S_7 (triangle, square, or sine) is then given the necessary gain by the output amplifier before being applied to the attenuation network.

The output level program then selects the required attenuation network to provide the desired output amplitude for the selected waveform over the 100 Hz to 1 MHz range.

Low-Frequency Range

Waveforms with frequencies from 100 Hz down to 100 μHz are synthesized from the basic generator square-wave output by the counter and waveform DAC. The counter circuit counts the input pulses to produce square waves at 0.001 of the input frequency. One output is applied through S_2 to enable the trigger circuit in the low-frequency range when this mode is selected. Another counter output pulse is applied through S_5 to the function-selection circuit S_7. All pulses from the counter are coupled to the waveform DAC that transforms the binary bits into a

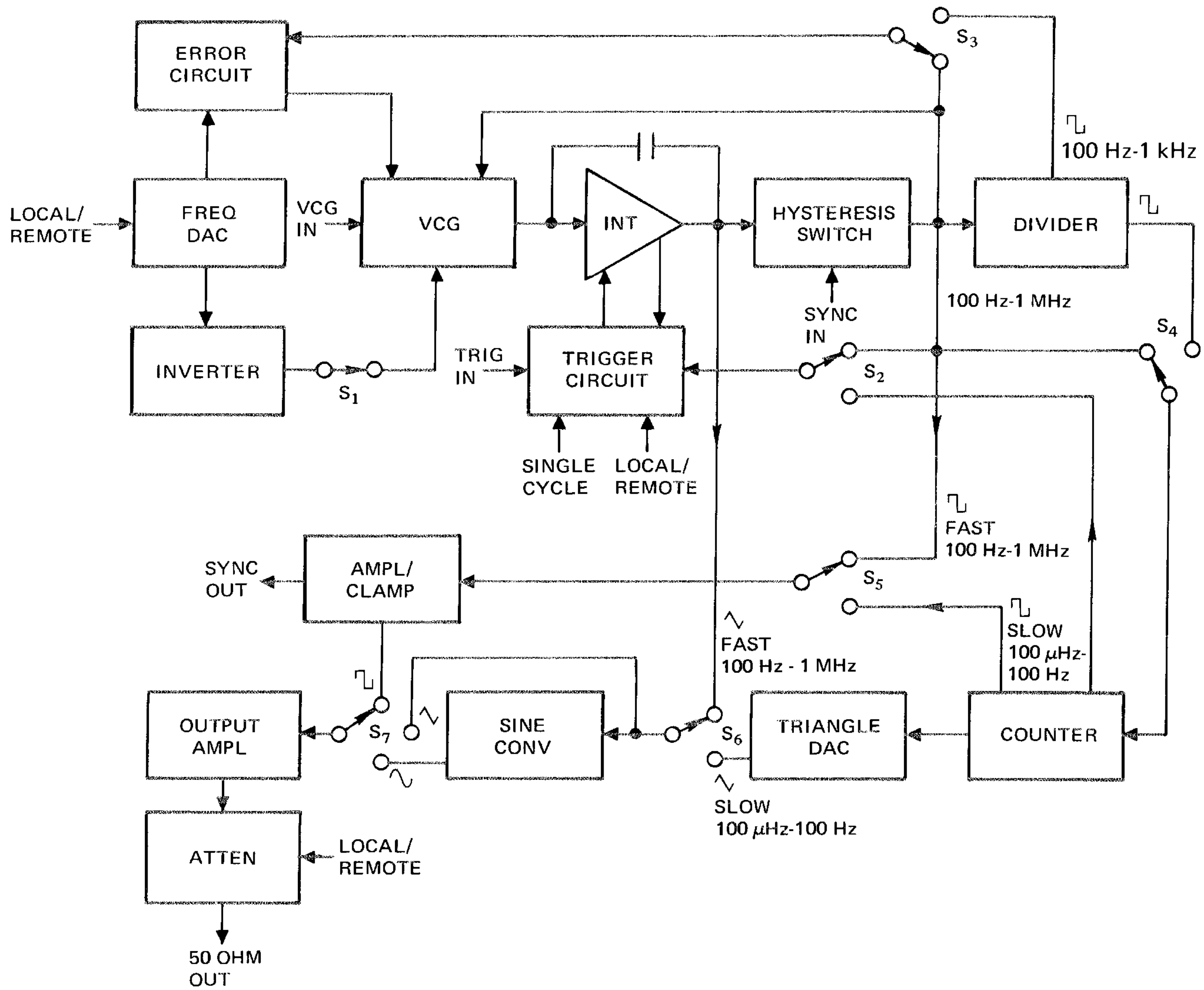


Figure 1-1. Simplified Block Diagram

triangle waveform at 0.001 of the generator frequency over the range of 100 μHz to 100 Hz.

For frequencies from 100 Hz down to 100 μHz, the divider is progressively switched into the counter input through S_4 as described previously for the error-sensing circuit.

Sine conversion, function selection, amplification, and output attenuation are executed in the same manner as described for the high-frequency range.

SPECIFICATIONS

VERSATILITY

Waveforms

Sine ∿ , square ⊓⊔ , and triangle ⋀ .

Dynamic Frequency

100 μHz (2.77 hr) to 1 MHz (1 μsec) in 10 ranges.

Outputs

∿ , ⊓⊔ , ∧ selectable and digitally variable from 0.001 to 10 V p-p into a 50-ohm load in 4 ranges with 3-digit resolution (0.002 to 20 V p-p open circuit).

NOTE

Output may be shorted without damage to instrument.

VCG—Voltage-Controlled Generator

Over 1000:1 frequency ratio with 0-volt to 5-volt input signal. Input impedance is 10 kΩ.

OPERATIONAL MODES

Trigger Mode

Generator may be triggered to produce single cycles on command or gated to produce any discrete number of cycles by applying a + gate signal to trigger input for the length of the desired burst.
Input impedance is 10 k.
Plus gate required is +5 volts to +50 volts.

Auto Cal Mode

Generator has an automatic control loop to maintain the ouput frequency for high accuracy and stability.

Manual Cal Mode

Generator is manually calibrated using the control loop but is then returned to the open-loop condition when momentary switch is released so that it may be swept or triggered.

Search Mode

Generator frequency control within the selected range is transferred from the digital controls to a single turn analog control for convenient manual sweeping of the entire range.

Sync In

Within the upper 4 ranges, the instrument may be frequency synchronized to an external signal of approximately 1 V p-p that is within 1% of the free-running frequency. The induced sine distortion will be less than 1%.

Sync Out

A fixed amplitude square wave is brought out at 1 k impedance for syncing scopes or other equipment.

HORIZONTAL PRECISION

Auto Cal Mode

Frequency accuracy from programmed input or front-panel selector switches is ±(0.01% of programmed frequency, plus 1 digit). Closed-loop stability is within ±0.005% of programmed frequency at constant temperature for a 24-hour period.
Loop will settle to within the accuracy specified within 1 msec minimum and 3 sec maximum, depending on frequency and range.

Manual Cal Mode

Instrument can be calibrated to an accuracy of ±0.02% of programmed frequency and triggered or frequency modulated about this accurate center frequency.
Open-loop stability is within 0.05% of setting for 8-hour period at constant temperature.

VCG Bandwidth

1 MHz.
Slew rate 100% of range per μsec.

VCG Linearity

Frequency vs input voltage—best straight-line method.
±0.1% 100 μHz-10 kHz.
±1% 10 kHz-100 kHz.
±3% 100 kHz-1MHz

VERTICAL PRECISION

Amplitude change with frequency is less than 0.1 db to 100 kHz and 0.5 db to 1 MHz.

Peak-to-Peak Voltage Accuracy % of Program

1 V to 10 V range ±(0.1% + 5 mV).
0.1 V to 1 V range ±(1% + 1 mV).
10 mV to 100 mV range ±(1% + 0.1 mV).
1 mV to 10 mV range ±(1% + 0.1 mV).

Amplitude Symmetry

All waveforms are symmetrical about ground ±1% of full range.
Trigger start-stop point will be 0 V ±0.5% of output amplitude program.

PURITY

Sine Wave Distortion

Less than:
- 0.5% 100 μHz to 10 kHz
- 1% 10 kHz to 100 kHz
- 3% 100 kHz to 1 MHz

Triangle Linearity

Greater than:
- 99% 1 Hz to 100 kHz
- 95% 100 kHz to 1 MHz

Square Wave Rise and Fall Time
Less than 100 nsec.

ISOLATION

Output signal can be raised above ground up to 250 V. Caution must be taken as all exposed BNC connectors are at raised potential.

ENVIRONMENTAL

Temperature
Specifications apply at 25°C ±5°C.
Operating temperature range 0°C to 50°C.

REMOTE CONTROL SPECIFICATIONS

Configuration A (Standard)
True or Logic "1" = 0 volt ±1 volt.
Note: 0 volt sinks approximately 1.5 mA.
False or Logic "0" = +2 volts to +10 volts.
Note: Open circuit voltage is approximately +2 volts.

Configuration B
True or Logic "1" = 0 volt ±1 volt.
Note: 0 volt sinks approximately 1.5 mA.
False or Logic "0" = −2 volts to −10 volts.
Note: Open circuit voltage is approximately −2 volts.

Configuration C
True or Logic "1" = −2 volts to −10 volts.
Note: −2 volts sinks approximately 1.5 mA.
False or Logic "0" = 0 volt to −1 volt.
Note: Open circuit voltage approximately +0.7 volts.

Configuration D
True or Logic "1" = +2 volts to +10 volts.
Note: +2 volts sinks approximately 1.5 mA.
False or Logic "0" = 0 volt to +1 volt.
Note: Open circuit voltage approximately −0.7 volts.

Program Transition Time
1 msec.

MECHANICAL

Weight
24 lb, 34 lb shipping.

Power
105 Vac to 125 Vac or 210 Vac to 250 Vac, 50 Hz to 400 Hz.
50 watts of power required.

NOTE

Precision specifications apply over 10% to 100% of selected range.

SECTION 2
OPERATING INSTRUCTIONS

INSTALLATION

Conversion for 230-Volt Line Power

The Model 157 is shipped from the factory with the power transformer connected for 115-volt line power, unless otherwise specified. To convert the transformer primary for 230-volt operation, remove the bottom cover and place the conversion switch (located on the underside of the Mother Board) in the 230 position. The 1-ampere fuse (rear panel) should be replaced with a ½-ampere fuse after conversion. (Refer to **Replacement of Circuit Boards** in Section 4 for information on removing the bottom cover.)

Rack Mounting

The Model 157 is equipped with four rubber feet when ordered for bench use and with rail-attaching hardware when ordered for use in a standard 19-inch rack. If rack mounting of a bench model is desired, two rack mount adapters, Wavetek part No. 210-367, can be used as follows:

1. Remove the six flathead machine screws that retain the left and right side rails to the left and right handles, respectively.
2. Install one rack mount adapter on each side of the Chassis Assembly with the six roundhead screws supplied with the adapters, using the tapped holes previously occupied by the flathead screws.
3. Secure the Model 157 in the desired rack position with standard rack mounting hardware.

INSPECTION

The following procedures should be performed to assure the user that the instrument has arrived at its destination in proper operating condition. Complete calibration and checkout instructions are provided in Section 4 for determining if the instrument is within electrical specifications.

Visual Inspection

After carefully unpacking the instrument, visually inspect the external parts for damage to knobs, dials, indicators, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the instrument.

Operating Inspection

NOTE

Refer to **Installation** paragraph for 115-volt or 230-volt line power instructions.

The procedural steps in this paragraph provide a quick checkout of instrument operation. If electrical deficiencies exist, refer to the *Warranty* in the front of the manual. The following test equipment, or equivalent, is recommended for performing the electrical inspection. (Refer to Table 2-1 and Figure 2-1 for operating control descriptions.)

Name	Manufacturer	Model
Oscilloscope	Tektronix	454

1. Depress POWER pushbutton.
2. Connect oscilloscope through 50-ohm terminator to 50Ω OUTPUT connector.
3. Depress AUTO CAL pushbutton.
4. Depress ⊓⊔ pushbutton.
5. Set FREQUENCY dials for 1000.00 Hz.
6. Set TERMINATED P-P AMPLITUDE dials for 10.00 V.
7. Observe oscilloscope display to determine the general correctness of the signal output for Steps 8 through 16.
8. Depress the TRIG pushbutton and observe that the output is +5 Vdc.
9. Press SINGLE CYCLE pushbutton several times. Output should go to −5 Vdc for 0.5 milliseconds and back to +5 Vdc each time the pushbutton is pressed.
10. Depress the SEARCH pushbutton and rotate the MAN CAL/SEARCH control from maximum counterclockwise to maximum clockwise positions. Output should respond to frequency control from less than 100 Hz to more than 1 kHz over the control range.
11. Depress the AUTO CAL pushbutton. Depress the ⊓⊔ , ⋀⋁ , and ∿ , in turn. Output should respond with indicated waveform.
12. Step the most-significant-decade FREQUENCY dial from 10 through 1. Output should change frequency in 100 Hz increments from 1 kHz to 100 Hz.

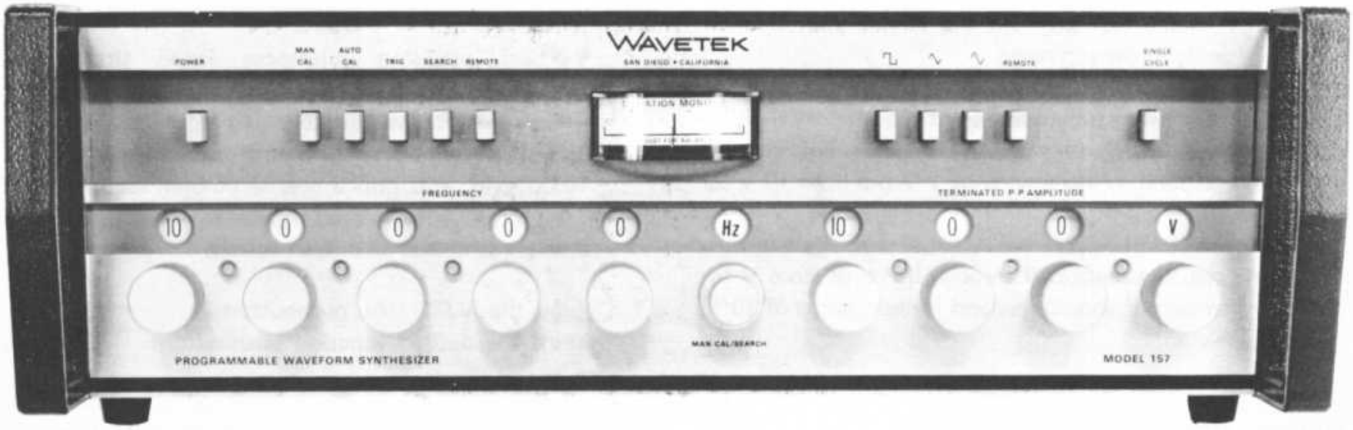
Table 2-1. CONDENSED OPERATING DATA

Name	Description
CONTROLS	
POWER pushbutton	Applies power to unit when depressed.
MAN CAL pushbutton*	Closes frequency-error loop so that **MAN CAL/SEARCH** control and nullmeter can be used to calibrate frequency output for VCG operation (momentary engage, opens loop when released).
AUTO CAL pushbutton*	Closes frequency-error loop for fixed-frequency operation.
TRIG pushbutton*	Opens frequency-error loop and enables trigger circuit for pulsed operation.
SEARCH pushbutton*	Opens frequency-error loop so that **MAN CAL/SEARCH** control can be used to sweep selected frequency range. Disconnects digital frequency control.
REMOTE pushbutton*	Transfers automatic calibration and trigger control to remote connector.
⊓⊔ pushbutton**	Selects square-wave output.
⋀⋁ pushbutton**	Selects triangle-wave output.
∿ pushbutton**	Selects sine-wave output.
REMOTE pushbutton**	Transfers function control to remote connector.
SINGLE CYCLE pushbutton	Provides one-cycle of the selected output when the **TRIG** pushbutton is depressed (momentary engage).
FREQUENCY dials	Programs decimal frequency selection.
Most-Significant Decade	Numbered decimally from 1 through 10 with **R** being the remote-control transfer, or a logical "0" if not remotely programmed.
Next Four Decades	Numbered decimally from 0 through 9 with **R** being the remote-control transfer, or a logical "0" if not remotely programmed.
Range Dial	Lettered from μHz (one position), mHz (three positions), Hz (three positions), through kHz (three positions, and **R** for remote.

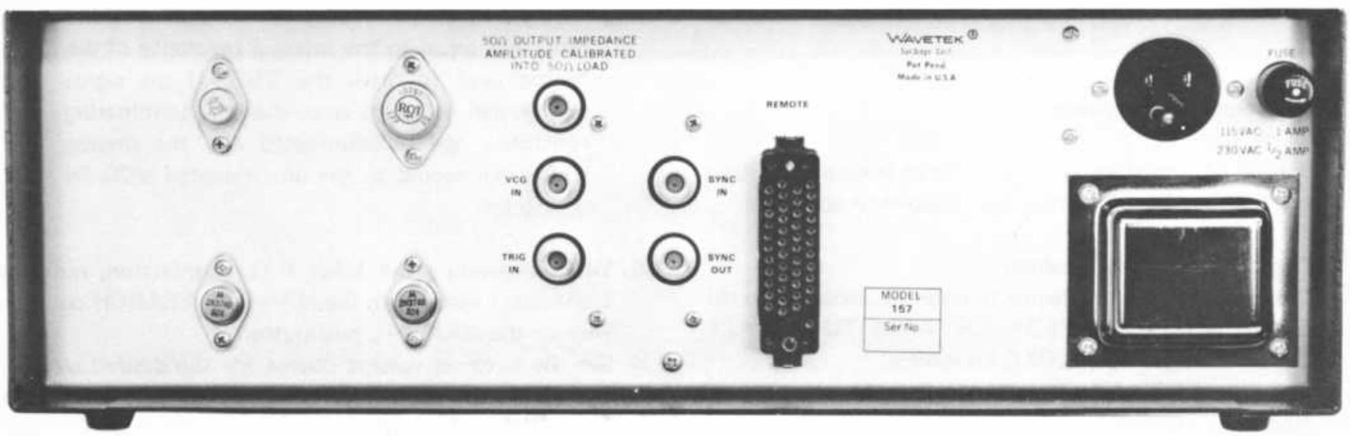
Table 2-1 CONT.

Name	Description
TERMINATED P-P AMPLITUDE dials	Programs decimal amplitude selection.
Most-Significant Decade	Numbered decimally 1 through 10 with **R** being the remote--control transfer, or a logical "0" if not remotely programmed.
Next Two Decades	Numbered decimally from 0 through 9 with **R** being the remote-control transfer, or a logical "0" if not remotely programmed.
Range Dial	Lettered from mV (three positions) to V (one position) and **R** for remote.
INDICATORS	
Nullmeter	Operates in conjunction with **MAN CAL** and **SEARCH** pushbutton and during **Checkout and Calibration**.
FREQUENCY decimal-point lamps	Illuminate to indicate position of decimal point during manual operation—pilot light only if range dial is in **R** position.
TERMINATED P-P AMPLITUDE	Illuminate to indicate position of decimal during manual operation—pilot light only if range dial is in **R** position.
CONNECTORS	
50Ω OUTPUT IMPEDANCE AMPLITUDE CALIBRATED INTO 50Ω LOAD	Output for selected function/amplitude waveform.
VCG IN	Analog input for frequency modulation of programmed frequency.
TRIG IN	Input for pulse to produce tone bursts of desired duration.
SYNC IN	Input for synchronizing output frequency with external signal.
SYNC OUT	Output for sychronizing external device with synthesizer.
REMOTE	Input for contact-closure or logic level programming from remote source.

NOTE: Pushbutton switches marked * or ** are mechanically linked. Depressing any one in a set releases any other previously depressed pushbutton in the same set.



Front View



Rear View

Figure 2-1. Operating controls, indicators, and connectors.

SECTION 3
CIRCUIT DESCRIPTION

INTRODUCTION

This section presents theory of operation as an aid to the user in understanding and maintaining the Model 157 Programmable Waveform Synthesizer. The block diagram in Section 5 graphically illustrates the functional features of the Model 157 and should be referenced when reading the theoretical discussion. In addition to the block diagram, references are made throughout the text to specific board schematic diagrams in Section 5 and simplified diagrams are used in this section to supplement the text for more complicated circuits. The theory in Section 3 is divided into six discussional parts:

1. Programming the various generator characteristics.
2. The 100 Hz to 1 MHz generation.
3. The 100 μHz to 100 Hz generation.
4. Sine conversion.
5. Tone-burst generation.
6. Power-supply characteristics.

PROGRAM SELECTION

Generator Mode Selection

The generator-mode selection circuit is graphically shown in the block diagram and detailed on sheet 1 of the Chassis Assembly schematic diagram and also the VCG/Integrator Board schematic diagram. When one of the pushbuttons in the generator mode row is depressed, the following circuit functions occur.

REMOTE switching disables the MAN CAL/SEARCH voltage input to the first VCG amplifier and transfers control of error amplifier output relay K5 to a remote connector pin so that either closed-loop or open-loop mode can be programmed.

AUTO CAL switching disconnects the MAN CAL/SEARCH voltage input to the first VCG amplifier and connects the error amplifier output to this amplifier so that the basic generator operates in closed-loop.

MAN CAL switching (momentary) connects the nullmeter across the error amplifier output and the output into the first VCG amplifier input so that the generator frequency may be accurately set with the MAN CAL/SEARCH control prior to analog control operation.

SEARCH switching connects the nullmeter between the inverter output and the manual calibration/search input to the first VCG amplifier. Also, the error amplifier output is disconnected from the first VCG amplifier input, which enables the VCG to sweep the basic generator over any single frequency range with one turn of the MAN CAL/SEARCH control.

TRIG switching turns on driver Q8 on the VCG/Integrator Board which energizes relay K6. The normally-open contact of K6 closes, causing emitter follower Q9 to turn off, and the generator subsequently enters the standby condition. (Refer to the description of tone-burst generation for additional details.)

Function Selection

The function-mode selection circuit is graphically shown in the block diagram and detailed on sheet 1 of the Chassis Assembly schematic diagram and the Function Board schematic diagram. When a specific pushbutton in this row is depressed, the following circuit functions occur:

REMOTE switching disconnects the front-panel function pushbuttons and connects the pins on the remote connector to the sine, square, and triangle relay drivers on the Function Board.

⊓⊔ switching energizes relay K3 on the Function Board to provide the square waveform to the Output Amplifier Board.

∧∨ switching energizes relay K2 on the Function Board to provide the triangle waveform to the Output Amplifier Board.

∿ switching energizes relay K1 on the Function Board to provide the sine waveform to the Output Amplifier Board.

Frequency Selection

The frequency-selection circuit is shown in the block diagram as the first-decade driver/ladder through the fifth-decade driver/ladder, the range capacitors, the range switch, and the range matrix. The digital switch details are shown on sheet 1 of the Chassis Assembly Board schematic diagram; the first and second decade of the frequency digital-to-analog converter (DAC) in the Error Amplifier Board schematic diagram; the third through fifth decade of the frequency DAC in the Crystal One-Shot Board schematic diagram; the range capacitor/relay switching circuit in the VCG/Integrator Board schematic diagram; and the frequency-range diode matrix on the Range Matrix Board schematic diagram.

Frequency number selection of the first decade switch is converted from binary logic to an analog voltage that is proportional to the BCD coding by the first decade DAC shown on the Error Amplifier Board schematic diagram. The BCD code, in this case, is modified by a "1*" that has a binary weight of 2^0. All of the other frequency decade DACs have an unmodified BCD input. Figure 3-1 is a simplified diagram of a single binary input for one of the decades--all others function similarly.

Driver Q_1 is biased *off* by the +6-volt dc connection and relay K_1 is in its normally-open state, resulting in zero volts across R_1 and R_2 and zero contribution to the current in the summing nodes of the inverter and error amplifiers. When a logical "1" appears at the binary input to Q_1, the driver is turned *on* and the relay is energized. This connects 12 volts across R_1 and R_3 and the correct contribution to the summing nodes. Resistances R_1 and R_3 represent the network associated with the Q_1 driver, but R_2, R_4, R_5, and R_6 represent all of the other resistance in the frequency DAC. Similarly, relays K_2 and K_3 represent their associated circuits with driver/relay stages. Thus any parallel combination of resistance can be achieved by programming to provide an analog current input to the VCG that is proportional to the selected frequency.

The frequency range selector output is converted from binary logic to relay-closure functions by the diode matrix shown in the Range Matrix schematic diagram. The 8421 BCD coding from the FREQUENCY range selector switch, or remote programming, is decoded into decimal format shown at the right of the schematic diagram. Table 3-1 shows the correlation between these decimal numbers and the resulting relay closures.

Relays K4 through K6 on the Function Board perform the fast-slow switching function. Relays K5, K6, K7, and K8 on the Range Matrix Board are paralled by relays K4, K3, K2,

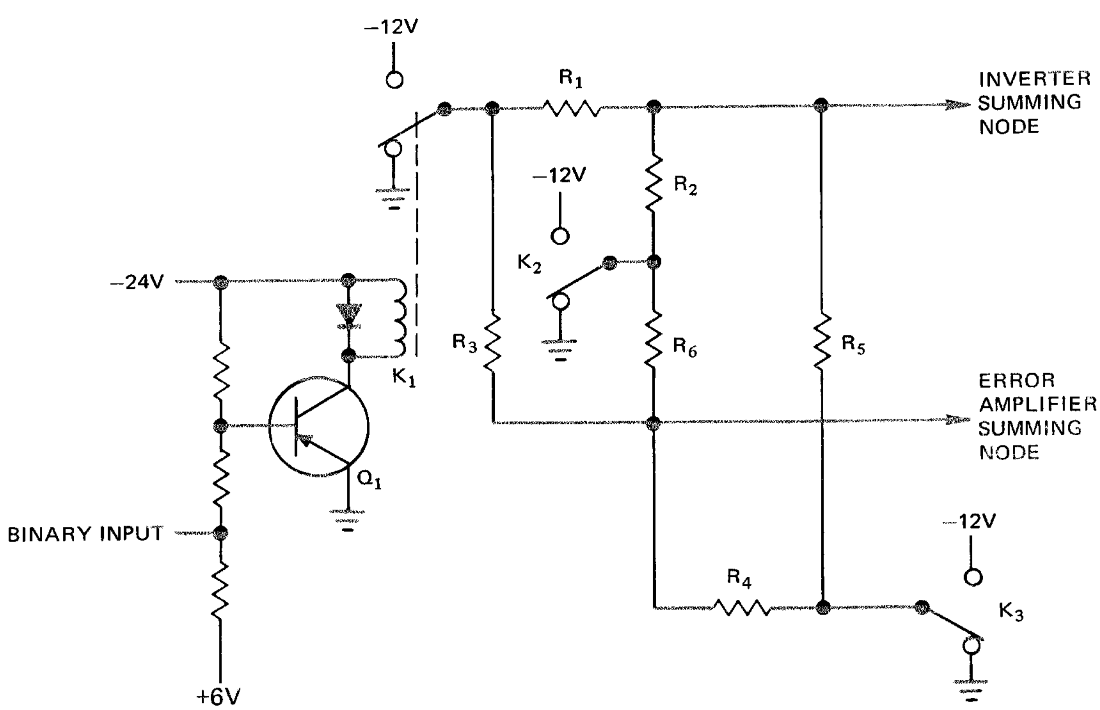


Figure 3-1. Frequency Selection, Simplified Diagram

Table 3-1. FREQUENCY RANGE CODING

Board Desig	Relay Desig	Digital Program 0	1	2	3	4	5	6	7	8	9
A11	K1	1	0	0	0	0	0	0	0	0	0
A11	K2	0	1	0	0	0	0	0	0	0	0
A11	K3	0	0	1	0	0	0	0	0	0	0
A11	K4	0	0	0	1	1	1	0	0	0	0
A11	K5	1	1	1	1	0	0	1	0	0	0
A11	K6	0	0	0	0	1	0	0	1	0	0
A11	K7	0	0	0	0	0	1	0	0	1	0
A11	K8	0	0	0	0	0	0	0	0	0	1
A10	K4	1	1	1	1	0	0	1	0	0	0
A10	K3	0	0	0	0	1	0	0	1	0	0
A10	K2	0	0	0	0	0	1	0	0	1	0
A10	K1	0	0	0	0	0	0	0	0	0	1
A9	K4-6	0	0	0	0	0	0	1	1	1	1

and K1 on the VCG/Integrator Board, respectively, which switch in the correct capacitance for the programmed range. (Refer to description of basic generator for additional details.) The relays on the Range Matrix Board also provide circuit switching for the divider flip-flops that connect to the crystal one-shot circuit and to the low-frequency generator. (Refer to the descriptions of the closed-loop basic generator and the low-frequency generator for additional details.)

The frequency range selector (SW6) also applies power to the proper decimal-place indication lamp (L1, L2, or L3) as shown on sheet 1 of the Chassis Assembly schematic diagram.

Amplitude Selection

The amplitude-selection circuit is shown in the block diagram as the signal attenuator and the range attenuator. The digital switch details are shown on sheet 1 of the Chassis Assembly schematic diagram; the three decades of the amplitude attenuation on the Output Amplifier Board schematic diagram; and the range/attenuation circuit (A5) on sheet 2 of the Chassis Assembly schematic diagram.

The amplitude-number selection circuitry is similar to the frequency-number DAC circuit previously described.

The amplitude-range selection circuit, contained on the Output Attenuator Board, consists of a 20-db attenuator and a 40-db attenuator, either or both of which are switched into the path of the output waveform by the binary program. Table 3-2 is a truth table of the binary code expanded to list associated circuit functions.

Table 3-2. ATTENUATOR RANGE CODING

A5-6	A5-7	Range (max)	20-db	40-db
0	0	10 mV	X	X
1	0	100 mV		X
0	1	1000 mV	X	
1	1	10 V		

NOTE: X denotes attenuator in circuit.

BASIC GENERATOR

The basic generator is shown in block diagram as the first and second voltage-controlled generator amplifiers, the integrator, and the hysteresis switch. This generator produces both triangle and square waveforms over a 100 Hz to 1 MHz range in open-loop operation. For closed-loop operation, the divide-by-ten stages, the one-shot stage, the frequency-converter circuit, and the error amplifier are connected between the output of the hysteresis switch and the input of the first VCG.

Open-Loop Operation

When power is applied, the high-gain characteristic of the integrator causes this device to produce an output voltage that is equal to one of the threshold levels of the hysteresis switch. The switch assumes one of its binary states and regeneration proceeds in the following manner.

If the bistable output of the hysteresis switch is negative, the diode connecting the second VCG amplifier to the integrator (D_2 in Figure 3-2) is zero biased by the diode connecting the second VCG amplifier to the hysteresis switch (D_3). With this condition, current proportional to the frequency program flows from the integrator summing node to the first VCG amplifier and the positive slope of the triangle is formed at the integrator output. When the output level reaches +2.5 volts, the hysteresis switch reverses state to provide a positive output. This zero biases diode D_3 to permit current to flow from the second VCG amplifier into the integrator summing node. This current is precisely twice the value of the current flowing into the first VCG amplifier; therefore, a net current flows that is equal in value, but in the opposite direction, to the current produced by the negative output of the hysteresis switch. The net current causes the integrator to produce the negative slope of the triangle at its output. When the integrator output reaches −2.5 volts, the hysteresis switch again reverses states and the cycle is repeated.

The output voltages of the two VCG amplifiers are always equal in value, but opposite in polarity, and directly

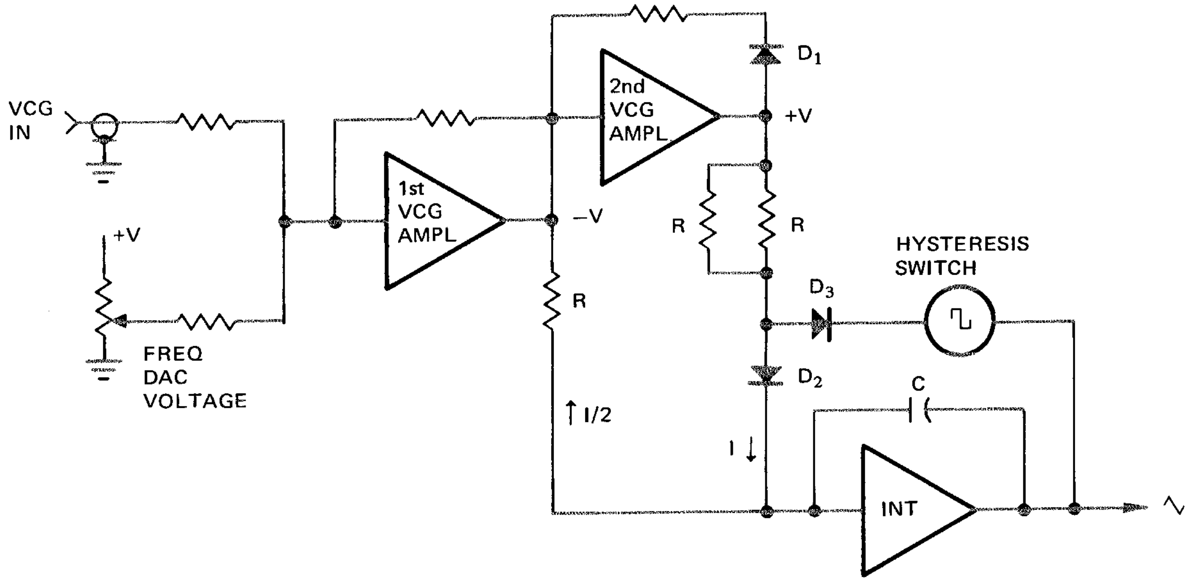


Figure 3-2. Open-Loop Operation, Simplified Diagram

proportional to the frequency program.

If an external voltage is applied to the VCG IN connector, the voltage levels at the outputs of the VCG amplifiers will change proportionally, thereby providing frequency modification or modulation.

On the VCG/Integrator schematic diagram, the first VCG amplifier is the Q1/IC1 stage; the second VCG amplifier, the Q3/IC3 stage; the diode switch, the IC2 stage; and the integrator, the Q14/IC4 stage. The hysteresis switch, on the Function Board schematic diagram, consists of a complementary Schmitt trigger coupled to a bistable switch. Stage Q22/Q23/Q24 form one half of the Schmitt trigger, and stage Q25/Q26/Q27 form the other half. Similarly, Q28/Q29 are one half of the bistable switch and Q30/Q31 the other half. The single-ended 1 volt peak-to-peak square-wave output of the bistable switch is the VCG diode switching voltage.

Closed-Loop Operation

Frequency accuracy of 0.01 percent is obtained by connecting an error-sensing circuit into a feedback loop around the basic generator. With either the AUTO CAL or MAN CAL pushbutton depressed, the output of the error amplifier is connected to the input of the first VCG amplifier through the relay closure shown in the block diagram.

The error-sensing circuit consists of the three cascaded divide-by-ten stages; the one-shot stage; the pulse-repetition frequency (PRF) switching circuit (consisting of the common-collector/common-base stage and the diode-resistor switching matrix); the +6-volt offset source; and the error amplifier.

The crystal one-shot circuit operates over a 10:1 frequency range from 1 kHz to 100 Hz. The frequency dividing stages are switched between the hysteresis switch output and the one-shot input for the range from 1 kHz to 1 MHz by the range matrix (previously discussed). Since the three divide-by-ten stages are cascaded, a total of 0.001 F is available which, of course, is sufficient to reduce the basic generator top range of 1 MHz to the one-shot top range of 1 kHz.

The output of each divide-by-ten stage, shown in the Range Matrix Board schematic diagram, is coupled to the error-sensing circuit and to the low-frequency generator. This discussion will be limited to the error-sensing circuit; the low-frequency generator will be discussed later.

Dual flip-flop stages IC1/IC2, IC3/IC4, or IC5/IC6 are logically connected so that each paired dual flip-flop provides a divide-by-ten output. When relay K5 is digitally programmed, the output to the one-shot circuit is the frequency of the basic generator; closure of K6 contacts, 0.1 F; closure of K7 contacts, 0.01 F; and closure of K8 contacts, 0.001 F.

The crystal one-shot circuitry is shown in the upper half of that schematic diagram in Section 5. A free-running crystal-controlled oscillator (Y1/Q1) produces an accurate 4 MHz sinusoidal output. Potentiometric amplifier Q2-Q4 provides buffering for the oscillator. The buffered output is applied to the trigger input of a JKT flip-flop which is configured logically with thirteen other flip-flops to produce an accurate 400-microsecond rectangular output 400 microseconds after a square-wave input is received from the divide-by-ten circuits.

The Q5/Q6 input stage couples the incoming signal into a differentiator (C8/R12). The differentiated pulse presets the upper flip-flop (IC7A) in the IC7 stage. The set output of this flip-flop enables the IC1A flip-flop. The count begins with the first oscillator cycle and, after 400 microseconds. IC7B is set, producing a high state at pin 9 (see Figure 3-3 for PRF timing). After 400 microseconds IC7B is reset, which sets IC7A to disable the trigger input to IC1A.

This cycling is repeated for each square-wave input. Thus, the output of the one-shot circuit is a rectangular waveform, having a duty cycle proportional to the pulse reoccurrence time and, hence, the frequency of the basic generator.

The offset +6-volt regulator (IC2), the PRF switching circuit (Q1/Q2/IC3), and the error amplifier subassembly are shown in the upper half of the Error Amplifier Board schematic diagram. Figure 3-4 is a simplified diagram of this same circuit.

The one-shot output appears at the base of Q1. During the pulse period that the base is low, Q1 is turned on and Q2 is turned off. This causes the collector of Q2 to be approximately −1.4 volts dc due to the D_1/D_2 connection of ground. Thus, the D_2 cathode is approximately −0.7 volts dc that forward biases D_3 and zero biases D_4. Current (I_{off}) then flows from the +6-volt offset source to the −12 V source through R18 and none to the summing node.

Conversely, the high state turns Q1 off and Q2 on so that the collector of Q2 is approximately zero volts, resulting in the D_2 cathode being approximately +0.7-volts dc. This positive potential zero biases D_3 and forward biases D_4, which causes the +6-volt offset current (I_{on}) to flow into the error amplifier summing node.

Comparison of the average current from the PRF switching circuit and the current from the programmed frequency DAC is made at the summing node of the error amplifier. If

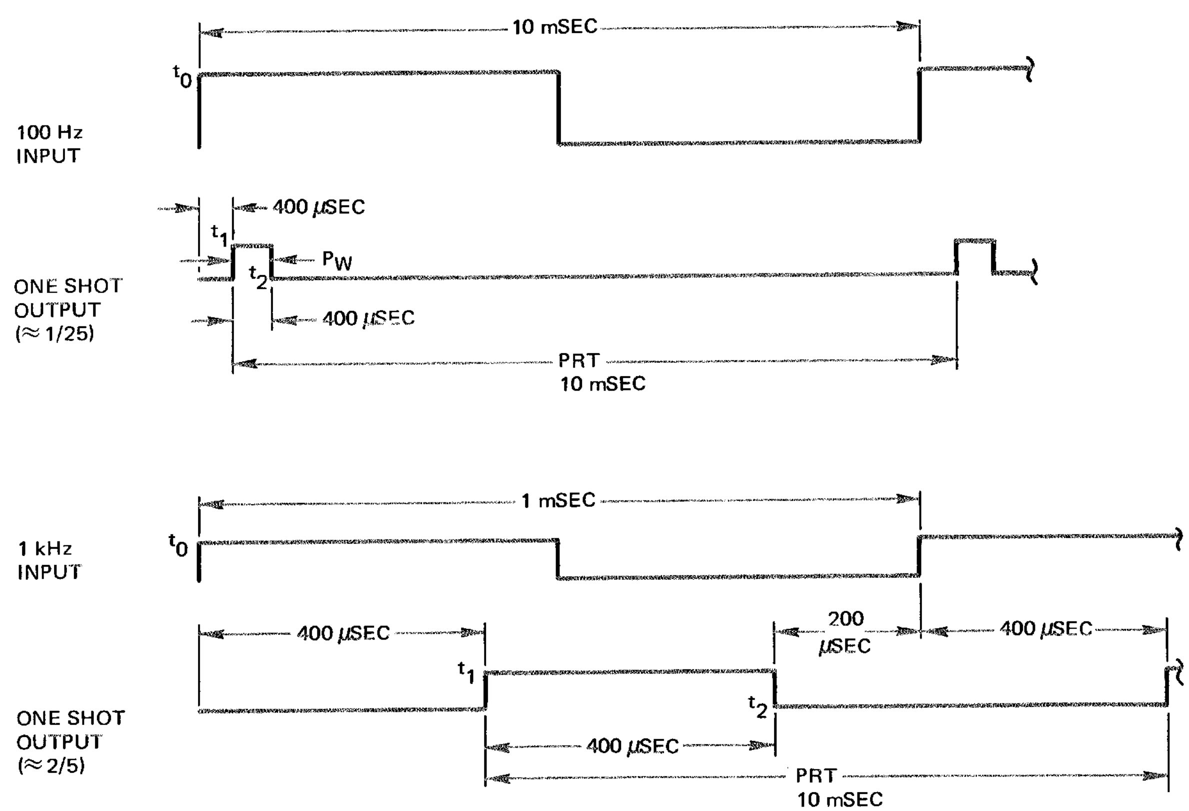


Figure 3-3. One-Shot Pulse Period Ratios for Minimum and Maximum Frequencies

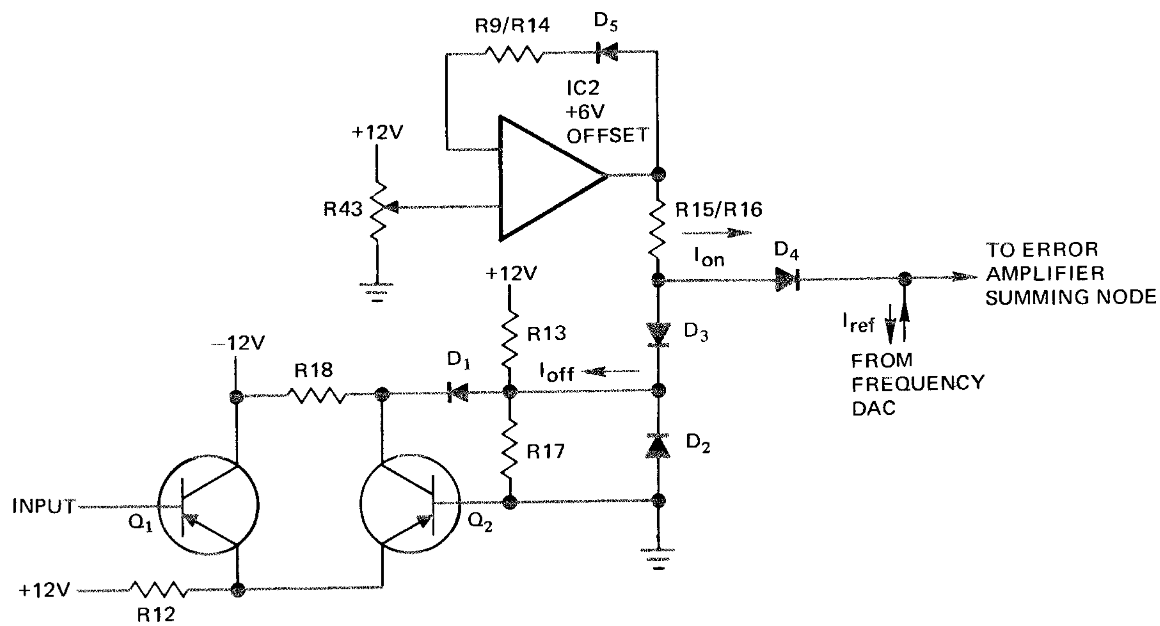


Figure 3-4. PRF Switching Circuit, Simplified Diagram

the magnitudes and polarities of these currents are not equal and opposite, an error current will result at the node to cause an error-voltage output from the error amplifier.

The error amplifier has considerable forward gain for both ac and dc. Since the PRF current has a large ac component, capacitor C8 provides negative feedback to prevent amplifier saturation. The output of the error amplifier is applied to the MAN CAL switch (sheet 1 of Chassis Assembly schematic diagram) and to the VCG/Integrator Board. As shown on the latter schematic diagram, an additional two-pole filter (R5, R6, R7, C28, C25) is inserted in the error signal path to further reduce the ripple voltage and to provide proper loop damping.

The error signal that is applied to the VCG summing node causes a change in the VCG output voltage that, in turn, modifies the output frequency of the basic generator in the direction (either frequency increase or decrease) to cause the error current at the error amplifier summing node to be equal in amplitude and opposite in polarity to the analog current from the digitally-programmed frequency DAC. In this manner, the error-sensing circuit holds the output frequency of the basic generator to the value that is programmed in spite of component value drifts.

LOW-FREQUENCY GENERATOR

Triangle and square waveforms are digitally generated in the frequency ranges covering the band from 100 μHz to 100 Hz. This circuitry consists of the divide-by-ten stages, cyclic counter, and triangle DAC shown in the block diagram.

Slow Square-Wave Generation

The cyclic counter is logically configured to count from 6 to 506 and then back down to 6 again to produce square-wave outputs that are 0.001 F of the input frequency from the basic generator. The divide-by-ten states are progressively switched between the output of the basic generator and the input to the cyclic counter so that the low-frequency range (100 Hz) of the basic generator may be extended down to the 100 μHz low-frequency range of the instrument. This operation is essentially the same as previously described for providing the correct frequency input to the error-sensing circuit.

The simplified logic diagram for the counter appears in Section 5. The parallel trigger inputs to each flip-flop are not shown, but enter directly without being gated. All other inputs to the flip-flops are controlled by NOR gates which require *all* inputs to be false to produce a true output. When a true output from a NOR gate occurs, both the set and reset inputs are enabled and the flip-flop will change state with the next clock pulse into its trigger input terminal.

When the last flip-flop in the counter is set at the No. 506 clock-pulse input, the logic gating causes the next clock-pulse input to begin sequentially resetting the flip-flops, starting with the highest order flip-flop. Thus after No. 506, the counter output steps down until No. 6 is reached and the cycle is repeated.

Two binary (square-wave) outputs are taken from the cyclic counter as square waveforms and connected to other boards. The No. 256 count is coupled to the trigger circuit on the VCG/Integrator Board (described later in the tone-burst generator theory), and the No. 506 count is sent to the square-wave amplifier/clamp on the Function Board.

As shown in the Function Board schematic diagram, the *slow* ⊓⊔ is applied to the amplifier/clamp circuit that provides the 5-volt peak-to-peak square-wave output. Stages Q5/Q6 and Q9/Q10 consist of a differential amplifier driving a compound configuration to provide the collector supply for the positive excursion of the square-wave output. Stages Q7/Q8 and Q11/Q12 are the complementary equivalent of the circuitry just described and provide the negative-excursion of the square-wave output.

Slow Triangle Wave Generation

The triangle DAC, shown in the block diagram as the 9-bit digital-to-analog converter, produces the digitally-generated *slow* triangle waveform over the 100 μHz to 100 Hz frequency ranges of the instrument.

The triangle DAC consists of the nine diode-bridge switching circuits (IC25 through IC33), the +6-volt regulator (IC22), the −6-volt regulator (IC23), and the summing amplifier (IC24/Q3/Q4) shown on the Counter Board schematic diagram. The counter and DAC are capable of binary outputs up to 2^9 (512_{10}), but are logically configurated to provide a count of 500.

Figure 3-5 is a simplified diagram of the triangle DAC. The binary inputs from the counter cause the nine diode-bridges to switch on in their logical binary sequence. Since all of these bridges are connected in parallel, the resulting output from the summing amplifier is a triangle waveform at 0.001 F of the basic generator frequency.

The slow triangle output is connected to the slow/fast relay switching circuit for application to the sine converter (discussed later) and the function-selection relay-switching circuits (discussed previously).

SINE CONVERSION

The selected, slow or fast, triangle waveform is transformed into a sine waveform by the sine convertor shown in the block diagram. In the Function Board schematic diagram, this circuitry is shown as a clipper (IC1), the diode-shaping network (IC3 through IC6), and a potentiometric amplifier (IC2/Q1-Q4). Figure 3-6 simplifies this circuitry for clarity.

The triangle input is applied to clipper IC1 which transforms the triangle into a trapezoidal waveform by clipping the top and bottom peaks. Potentiometers R6 and R15 adjust the positive and negative amplitudes.

Conversion of the trapezoidal wave into the sine wave is accomplished by four temperature-compensated, diode-resistor networks which are biased to operate at the knee of the diode curve. Only one such network is shown in the simplified diagram of Figure 3-6; the other three are parallel-connected and biased to operate at different levels of both positive and negative excursions of the trapezoidal wave so that shape and amplitude symmetry of the sine wave is obtained.

Due to the losses inherent in the sine-shaping process, the amplitude of the shaped sine wave requires amplification before application to the Output Amplifier Board. Stages IC2/Q1-Q4 form a potentiometric amplifier that provides the required gain.

TONE BURST GENERATION

When the TRIG pushbutton is depressed, or a logical "1" is programmed during remote operation, driver Q8 on the VCG/Integrator Board draws current through the coil of relay K6, causing the normally-open contact of this relay to close (Figure 3-7).

Prior to the closing of the K6 contact, emitter follower Q9 is turned on by the +12-volt path through CR5 and associated resistors, and flip-flop IC6 is clamped in the set state by approximately +3 volts at the preset input. The set state of IC6 disables the standby circuit and the integrator provides its programmed output.

Turn off of Q9, however, removes the set state clamp from the flip-flop, and the next square-wave clock input causes the flip-flop to assume the reset state. The set output, "Q", is now a positive voltage sufficient to turn on grounded-base amplifier Q12 which, in turn, enables emitter follower Q11. The feedback path around the integrator is now a short circuit around the programmed range capacitance through the Q13/Q11 path and the integrator is in the "standby state"—no output.

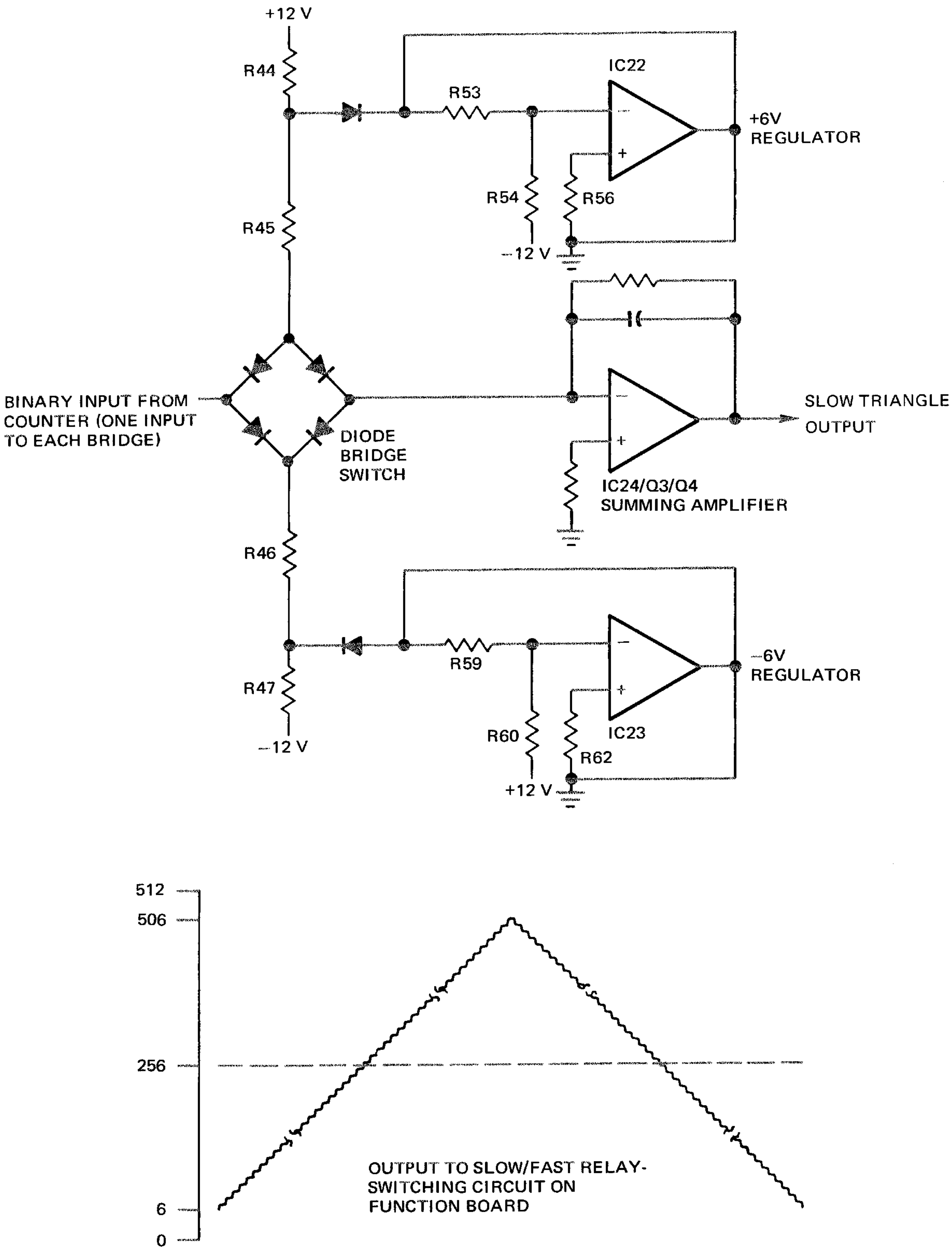


Figure 3-5. Slow-Triangle Digital-to-Analog Converter, Simplified Diagram

SECTION 4
MAINTENANCE

INTRODUCTION

This section provides instructions for testing, adjusting, calibrating, and troubleshooting the Model 157. The instructions are concise and directed to the experienced electronics technician or field engineer. Wavetek maintains a factory-repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If the instrument is returned to the factory for repair, a detailed description of the specific problem should be attached to facilitate the turnaround time.

NOTE

The Model 157 requires one-hour warmup for stabilization before output parameters are within specified tolerances. Prepare for this in advance of any planned checkout, calibration, or troubleshooting programs. For amplitude checks, use a precise 50-ohm load. A 0.1-percent error in load resistance will cause a 0.05-percent error in the output voltage level.

RECOMMENDED TEST EQUIPMENT

The following table contains a list of recommended test equipment. Any test equipment having equal accuracies may be substituted for those listed.

Name	Manufacturer	Model
Oscilloscope	Tektronix	543B
Plug-In Unit	Tektronix	W or 1A7
Electronic Counter	Computer Measurements	727D
Dialamatic Voltmeter	Wavetek	201
Extender Board*	Wavetek	157-111
Distortion Analyzer	Hewlett-Packard	332A

*For troubleshooting.

CHECKOUT AND CALIBRATION

The following subparagraphs provide complete sequential calibration procedures for the Model 157. Instrument checkout procedures are indicated by a checkmark √, following the procedure title. A quick checkout of the instrument can be performed by observing these indicated parameters and applying the tolerance factors given in the **Electrical Specifications** of Section 1. Circuit board test-point and adjustment locations are shown on the board-layout diagrams in Section 5.

NOTE

The entire calibration procedure *must* be read first to determine initial control settings and test equipment connections before attempting checkout.

Preliminary Procedure √

1. Set generator mode for REMOTE.
2. Press the POWER pushbutton.
3. Wait 1 hour for warmup.

NOTE

Setting any rotary digital switch to R is the same as setting it to 0.

Power Supply Regulation

1. Connect the voltmeter high input to TP2 and the low input to TP1 on the power supply board. Adjust R7 for +12 volts dc ±10 mV.
2. Move voltmeter high input to TP3 and check for −12 volts dc ±10 mV.
3. Move voltmeter high input to TP4 and check logic V_{CC} for +2.8 volts dc ±200 mV.
4. Move voltmeter high input to TP5 and check logic common for −0.7 volts dc ±100 mV.
5. Connect the voltmeter high input to TP7 and the low input to TP6. Adjust R50 for −24 volts dc ±50 mV.
6. Move voltmeter connection to TP8 and check for +6 volts dc ±200 mV.

Square Wave Offset and Amplitude

1. Connect the voltmeter with precise 50-ohm terminator to the 50Ω OUTPUT connector on rear panel.

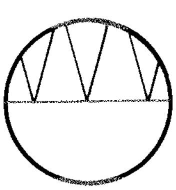
NOTE

Terminator resistance must be ±0.1 percent of 50 ohms.

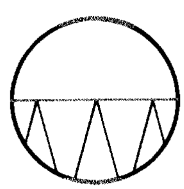
2. Set TERMINATED P-P AMPLITUDE dials for 10.0 V, generator mode for AUTO CAL, FREQUENCY dials for 10.000 mHz, and output function for REMOTE. Adjust R5 on the Output Amplifier Board for 0 volts ±2 mV.
3. Set output function to ⊓⊔ .
4. With voltmeter set to measure negative half-cycle of square wave, adjust R34 on the Function Board for −5 volts ±10 mV.
5. With voltmeter set to measure positive half-cycle of square wave, adjust R51 for +5 volts ±10 mV.

Fast Triangle Amplitude √

1. Connect the oscilloscope with precise 50-ohm terminator to the 50Ω OUTPUT connector with controls set for voltage-comparison measurement of 10-volt peak-to-peak range and 10 mV/cm sensitivity.
2. Set the FREQUENCY dials for 100.00 Hz and output function for ⊓⊔ .
3. Display the negative half-cycle of the square wave with the peak at a convenient reference line on the graticule.
4. Set the output function to ⋀⋁ , and adjust R111 on the Function Board until the triangle peak is within 5 mV of the square wave peak.
5. Set the output function at ⊓⊔ and display the positive half-cycle of the square wave peak at the reference line.
6. Set the output function to ⋀⋁ and adjust R104 so that the triangle peak is within 5 mV of the square wave peak.



NEGATIVE PEAK



POSITIVE PEAK

Time Symmetry and VCG Null

1. Set output function for ⊓⊔ .
2. Set FREQUENCY dials for R1.000 kHz and generator mode for REMOTE.
3. Connect 50Ω OUTPUT connector through precise 50-ohm terminator and T-connector to both channels of oscilloscope (internal trigger).
4. Set oscilloscope for 100 μsec/cm and invert one channel. Position the two bipolar displayed square waves with the axis crossings about midpoint on the graticule. Use the horizontal expansion, up to X100, for more accurate observation.
5. Momentarily short test point TP9 (ground) on the VCG/Integrator Board to TP10 (first VCG summing node) and observe the display. Adjust R16 until connecting and disconnecting the short results in minimum change in display.
6. Set FREQUENCY dials for R01.00 kHz and output function for ⋀⋁ . Adjust R46 for straight slopes on the triangle waveform.

NOTE

Adjust low-frequency potentiometer R1, as required, to observe time symmetry when performing Steps 7 through 10.

7. Set the FREQUENCY dials for 1000.00 Hz and output function for ⊓⊔ . Adjust R19 for time symmetry of the square wave at 100 percent of frequency range.
8. Set the FREQUENCY dials for 1.000 kHz and observe the time symmetry of the square wave at 10 percent of frequency range.
9. Set the FREQUENCY dials for R1.000 kHz and adjust R79 for time symmetry of the square wave at 1 percent of frequency range.
10. Set the FREQUENCY dials for R01.00 kHz and adjust R80 for time symmetry of the square wave at 0.1 percent of frequency range.
11. Repeat Steps 7 through 10 until optimum adjustment is obtained.

Closed-Loop Frequency (Nullmeter) Adjustment √

1. Connect the electronic counter to the 50Ω OUTPUT connector with a 50-ohm terminator connector. Set the counter to read period.
2. Set the generator mode for AUTO CAL.
3. Set the FREQUENCY dials for 1000.00 Hz and adjust R43 on the Error Amplifier/First and Second Decade Board for 1000.0 μsec on the counter.
4. Set the FREQUENCY dials for 100.00 Hz and adjust R20 for 10000 μsec on the counter.
5. Repeat Steps 3 and 4 until optimum adjustment is obtained.

NOTE:

If frequencies cannot be adjusted within specification, perform the following **Frequency Alignment** and then repeat both the **Closed-Loop Frequency Adjustment** and the **Frequency Alignment** again.

Frequency Alignment

NOTE

Do not refer to the electronic counter display during the following procedures.

1. Perform Steps 2 through 8 below by making the specified frequency selection, *simultaneously holding the* MAN CAL *and* AUTO CAL *pushbuttons depressed,* and adjusting the indicated potentiometer.
2. Set the FREQUENCY dials for 1000.00 Hz and adjust R21 on the VCG/Integrator Board for a null indication on the front-panel meter.
3. Set the FREQUENCY dials for 100.00 Hz and adjust R1 for a null indication.
4. Repeat Steps 2 and 3 until optimum adjustment is obtained.
5. Set the FREQUENCY dials to 10.0000 kHz and check for a close-to-null indication on the front-panel meter.

NOTE

Trim capacitors across C31 are a factory adjustment.

6. Set the FREQUENCY dials to 100.000 kHz and adjust C3 for a null indication.

NOTE

Trim capacitors across C3 are a factory adjustment.

7. Set the FREQUENCY dials for 1000.00 kHz and adjust C4 for smallest deviation from null as frequency is stepped through its range.

NOTE

Meter indication normally will vary widely over this range, but should not peg.

8. Set FREQUENCY dials to 1000.00 Hz and adjust R99 on the Error Amplifier Board for minimum meter deviation as dials are changed to 990.00 Hz and back to 1000.00 Hz.

Sine Conversion and Slow Triangle

1. With the generator mode in AUTO CAL and the output function in ∿ , connect the distortion analyzer and oscilloscope to the synthesizer as shown in Figure 4-1.
2. Set the FREQUENCY dials for 100.00 Hz and adjust R68, R93, R15, and R6 on the Function Board for minimum distortion of the sine wave.
3. Set the FREQUENCY dials for 100.000 Hz and adjust R65 and R70 on the Counter Board for minimum distortion (approximately 0.1 percent).

NOTE

If readjustment of distortion analyzer frequency or balance controls are required for this step, perform the **Closed-Loop Frequency Adjustment.**

4. Set the oscilloscope controls for voltage-comparison measurement of 10-volts peak-to-peak range and 10 mV/cm sensitivity.
5. Set the FREQUENCY dials for 100.00 Hz with output function at ⊓⊔ .
6. Display the negative half-cycle of the square wave with the peak at a convenient reference line on the graticule.
7. Set output function at ∿ , and adjust R20 on the Function Board until sine peak is at reference line.
8. Set the output function at ⊓⊔ , and display the positive half-cycle of the square wave peak at the reference line.

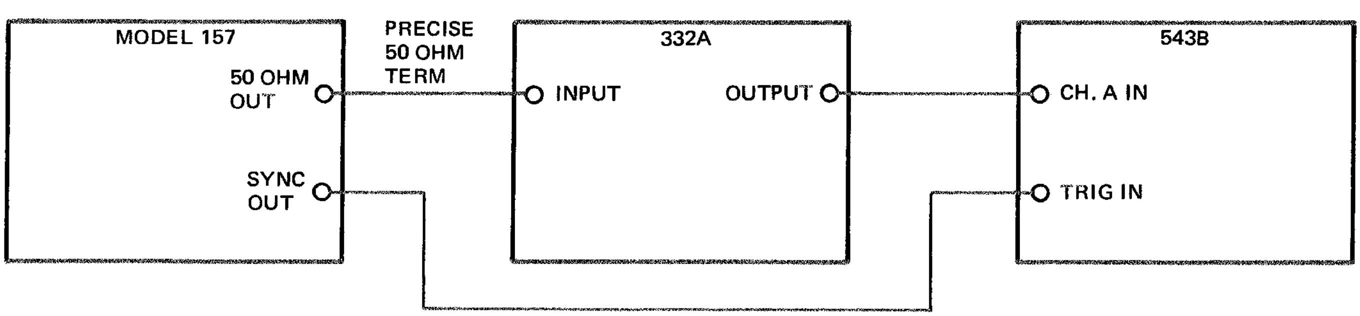


Figure 4-1. Distortion Analyzer Test Setup

9. Set the output function at ∿ and adjust R17 until the sine peak is halfway between its original position and the reference.
10. Repeat Steps 5 through 8 until the peak values of the sine half-cycles are within 0.1 percent (±5 mV) of the square half-cycle peaks.
11. Repeat Steps 2 through 9 until the optimum adjustment is obtained.

Trigger

1. Connect the voltmeter to the 50Ω OUTPUT with the 50-ohm termination connector.
2. Set the Model 157 controls as follows:
   a. Generator mode in TRIG.
   b. Output function in ∿ .
   c. FREQUENCY dials to 1000.00 Hz.
   d. TERMINATED P-P AMPLITUDE dials at 10.0 V.
3. Adjust R74 on the VCG/Integrator Board for minimum peak dc voltage change as the FREQUENCY dials are stepped down through the range to 100.00 Hz.

NOTE

Approximately 5 mV change is normal.

Frequency Loop Final Calibration √

1. Connect the electronic counter to the 50Ω OUTPUT with the 50-ohm termination connector. Set the counter to measure period.
2. With generator mode in AUTO CAL and output function in ⊓ , set the FREQUENCY dials to 1000.00 Hz. Carefully adjust R43 on the Error Amplifier/First and Second Decade Board for 1000.0 μsec on the counter.
3. Set FREQUENCY dials to R90.00 Hz and carefully adjust R119 for 11111.1 μsec.
4. Set FREQUENCY dials to R99.00 Hz and carefully adjust R20 for 10101.0 μsec,
5. Repeat Steps 3 and 4 until optimum setting is obtained.
6. Repeat Steps 2 and 4 until optimum setting is obtained.
7. Now repeat the **Closed-Loop Frequency Adjustment.**

VCG Input Sensitivity

1. Set generator mode in REMOTE and FREQUENCY dials to R00.00 Hz.
2. Connect the precision dc voltage source to the VCG IN connector on the rear panel with +5.000-volts dc applied.
3. Adjust R69 on the VCG/Integrator Board for 1000.0 μsec (1 kHz) on the time interval counter.
4. Reduce the applied dc voltage in 0.5-volt decrements, and check the frequency-vs-voltage linearity, using the best-straight-line method.

Volts, dc	Time Interval, μsec	Frequency, Hz
+5.000	1000.0	1000
+4.500	1111.1	900
+4.000	1250.0	800
+3.500	1428.6	700
+3.000	1006.7	600
+2.500	2000.0	500
+2.000	2500.0	400
+1.500	3333.3	300
+1.000	5000.0	200
+0.500	10000.0	100
+0.050	100.00 msec	10
+0.005	1000.0 msec	1
0	∞	0

TROUBLESHOOTING

Basic Techniques

Troubleshooting the Model 157 requires no special techniques. The following are a few reminders of basic electronics fault isolation.

1. Check control settings carefully: many times an incorrect control setting, or a knob that has loosened on its shaft, will cause a false indication of a malfunction.
2. Check associated equipment connections: make sure that all connections are properly connected to the correct connector.
3. Perform the checkout procedures: many out-of-specification indications can be corrected by recalibrating the instrument.
4. Visually check the interior of the instrument. Look for such indications as broken wires, charred components, loose leads, etc.

Troubleshooting Chart

Table 4-2 provides a list of some of the more probable symptoms of malfunctions and their remedies. Locate the indicated symptom listed in Column 1 of the chart and follow the corresponding procedures. When a fault has been localized to a specific stage by checking the parameters given for the major test points, check the dc operating voltages at solid-state device junction/pins. Check associated passive elements with an ohmmeter (power off) before replacing a suspected semiconductor element.

Table 4-2. TROUBLESHOOTING CHART

Symptom	Probable Cause	Board
Automatic calibration is less accurate than open loop.	Damaged crystal or logic failure in crystal, one shot.	Crystal One Shot
	Damaged error amplifier	Error Amplifier
Automatic calibration less accurate than open loop on some ranges only.	Logic failure in range-divider stages.	Range Matrix
Generator operates on some ranges only.	Damaged range matrix or relay.	Range Matrix
No or output on upper four ranges.	Failure in triangle-wave buffer stage.	VCG/Integrator
Poor time symmetry or open-loop accuracy.	Miscalibration or failure in VCG circuitry.	VCG/Integrator
Problems on lower six or upper four ranges only.	Failure in slow-fast relay stages.	VCG/Integrator
No output on lower six ranges only.	Failure in counter logic or clock buffer.	Counter
⊓⊔ output on lower six ranges only or distorted ⋀⋁ and ∿ on lower six ranges only.	Failure in waveform DAC.	Counter
No output.	Failure in power supply .	Power Supply
No ∿ output.	Defective function relay stage.	Function
No ⋀⋁ output.	Defective function relay stage.	Function
No ⊓⊔ output.	Defective function relay stage.	Function
Asymmetrical ⊓⊔ amplitude.	Square-wave clamp faulty.	Function
Distorted or no ∿ signal to sine function relay.	Failure in sine converter.	Function
⋀⋁ and ∿ produce 0 Vdc output.	Trigger circuit failure.	VCG/Integrator
Positive or negative half cycles of output waveform only.	Output amplifier at fault.	Output Amplifier
Incorrect output waveform amplitude.	Failure in output attenuator.	Output amplifier
Output amplitude incorrect by one or more decades.	Failure in final attenuator.	Attenuator

REPLACEMENT OF CIRCUIT BOARDS

Refer to the Chassis Assembly illustration in Section 5 as a visual aid to the following procedural instructions.

Replacing Plug-In Boards

Plug-in boards in the Model 157 are color-coded from front to rear relative to the last digit of the part number:

PN Digit	Color	Board
1	Brown	Extender
2	Red	Output Amplifier
3	Orange	Function
4	Yellow	VCG/Integrator
5	Green	Range Matrix
6	Blue	Error Amplifier
7	Violet	One-shot
8	Gray	Power Supply
9	White	Counter

To remove any of these boards, proceed as follows:

1. Remove the three machine screws holding the top cover at the rear of the unit and slide the top cover out of the front retaining lip.
2. Remove the four machine screws holding the calibration shield over the plug-in boards and remove the shield.
3. Pull straight up on the plug-in board that you wish to remove.
4. If the board is to be checked operationally with the unit, remove the extender board and put it in the position of the board to be checked. Then plug this board into the top connectors of the extender board.

Replacing Left Switch Board

To replace the Left Switch Board, proceed as follows:

1. Remove top cover.
2. Remove the two machine screws retaining the POWER pushbutton switch to the subpanel.
3. Remove the one machine screw holding this switch to the Left Switch Board.
4. Disconnect the 18 Amphenol pin connections.
5. Remove the four machine screws that secure the Left Switch Board to the subpanel and lift out the Left Switch Board.
6. Replacement is essentially the reverse of removal.

Replacing Right Switch Board

To replace the Right Switch Board, proceed as follows:

1. Remove top cover.
2. Disconnect the 11 Amphenol pin connections.
3. Remove the four machine screws that secure the Right Switch Board to the subpanel and lift out the Right Switch Board.
4. Replacement is essentially the reverse of removal.

Replacing Attenuator Board

To replace the Attenuator Board, proceed as follows:

1. Remove top cover.
2. Remove all plug-in boards.
3. Unsolder the BNC connections (three leads), the two coaxial connections (four leads), and the five single-conductor leads at the bottom of the board.
4. Remove the four machine screws retaining the Attenuator Board to the rear panel and remove the board.
5. Replacement is essentially the reverse of removal.

REPLACEMENT OF ROTARY SWITCHES, DIALS, OR DECIMAL LAMPS

The decimal lamps in the Model 157 are operated at one-half of the manufacturer's voltage rating. The rated MTBF for this lamp, continuously operated in this mode, is 20 million hours which precludes normal lamp failure during the life of the instrument. However, if a lamp or rotary switch item is inadvertently damaged, proceed as follows to replace the defective item:

1. Remove top and bottom covers.
2. Spring out bail from bottom of chassis.
3. Remove all front-panel knobs by loosening their set screws.
4. Remove the three hex nuts, lockwashers, and flat washers that hold the Mother Board to each side rail.
5. Remove the six machine screws from each side rail.
6. Disconnect the eight Amphenol pin connectors at the front edges of the Mother Board.
7. Pull off the side rails, starting at the top edge.
8. Remove the two No. 6 machine screws on each handle.
9. Loosen all machine screws on the top and bottom of the handles.
10. Pull the extrusion off, being careful to guide the Amphenol pin leads through their slots at the bottom left and right ends of the subpanel.
11. Lamps can now be removed by unsoldering two leads and pulling the lamp out from the rear.
12. Rotary switches can now be removed since access for unsoldering leads from top (Left or Right Switch Board removed, as required) and bottom of switch wafers is now available. Access to the switch-shaft locking nut is obtained by pulling off the switch dial.
13. Replacement is essentially the reverse of removal.

SECTION 5
DATA PACKAGES

INTRODUCTION

This section contains data packages for the Model 157 Programmable Waveform Synthesizer. Each data package is a quick-access document that contains maintenance data arranged for the user's convenience in simultaneously viewing the schematic diagram and supporting data. Each data package includes a part-location illustration; replaceable parts list; voltage, waveform, and logic data; and a schematic diagram. The voltage, waveform, and logic data are numerically coded to correspond with numbers on the schematic diagram and part-location illustration. Also included in this section are block diagrams, logic diagrams, and mechanical drawings that are helpful in understanding and maintaining the equipment.

ARRANGEMENT

Figures 5-1 through 5-8 of this section locate test points and internal adjustments used during calibration and test procedures.

Drawings and data packages are arranged in this section in the following order:

Title	Drawing No.
Model 157 Outline Drawing	157-603
Model 157 Block Diagram	157-600
Counter Logic Diagram	157-602
Chassis Assembly (A1-A7) Data Package	157-000/200
Mother Board	157-010
Extender Board	157-011
Output Amplifier A8 Data Package	157-012/212
Function Board A9 Data Package	157-013/213
VCG/Integrator A10 Data Package	157-014/214
Range Matrix A11 Data Package	157-015/215
Error Amplifier A12 Data Package	157-016/216
Crystal One Shot A13 Data Package	157-017/217
Power Supply A14 Data Package	157-018/218
Counter Board A15 Data Pacakge	157-019/219
Left Switch Board	157-020
Right Switch Board	157-021
Attenuator Board	157-024

LIST OF MANUFACTURERS

The manufacturers listed below make the replaceable electrical parts listed in the following data packages. (Bulk items, such as wire, insulation, etc. are not listed.) All electrical parts can be obtained from the listed manufacturer or from Wavetek. However, many of the standard electronic component parts can be purchased locally in less time than is required to order from the manufacturer. When ordering parts locally, make sure that the replacement part ratings agree with the values, tolerances, and descriptions in the parts lists. The size of the replacement part is not only critical as an installation requirement, but may effect circuit performance at higher frequencies.

A/B	Allen Bradley Milwaukee, Wisconsin
Amelco	Teledyne Amelco Semiconductor Co. Mountain View, California
Amp	Amphenol Corp. Broadview, Illinois
ARCO	Arco Electronics Great Neck, L. I., New York
CDE	Cornel Dublier Electronics Division Federal Pacific Electronic Co. Newark, New Jersey
C/J	Cinch Mfg. Company Elk Grove Village, Illinois
Corning	Corning Glass Works Bradford, Pennsylvania
CRL	Centralab Division of Globe-Union Milwaukee, Wisconsin
CTS	CTS Electronics, Inc. South Pasadena, California
Elec/C	Electro Cube Inc. San Gabriel, California
Erie	Erie Technological Products, Inc. Erie, Pennsylvania
Fair	Fairchild Semiconductor Corp. Palo Alto, California
IRC	IRC, Division of TRW Inc. Philadelphia, Pennsylvania
King	King Electronics Inc. Pasadena, California

Littelfuse . . . . Littelfuse Incorporated
Des Plaines, Illinois

Mektron . . . . . . .California General Corporation, Inc.
Mektron Division
Chula Vista, California

Motorola . . . . .Motorola Semiconductor Products
Phoenix, Arizona

Mura . . . . Mura Corporation
Great Neck, L. I., New York

Nexus . . . . Nexus Research Lab, Inc.
Canton, Massachusetts

Phipps . . . . Phipps Precision Products
Van Nuys, California

RCA . . . . RCA Semiconductor Division
Somerville, New Jersey

Richey . . . . Richey Electronics
Nashville, Tennessee

Semtech . . . . Semtech Corporation
Newbury Park, California

Sprague . . . . Sprague Electronic Company
North Adams, Massachusetts

Stack . . . . Stackpole Carbon Company
St. Marys, Pennsylvania

TRW . . . . .TRW Electronic Components Division
Camden, New Jersey

USECO . . . . USECO Inc.
Mt. Vernon, New York

Wakefield . . . . Wakefield Engineering, Inc.
Wakefield, Massachusetts

Wavetek . . . . Wavetek
San Diego, California

Winchester . . . . .Litton Industries
Winchester Electronic Division
Oakville, Connecticut

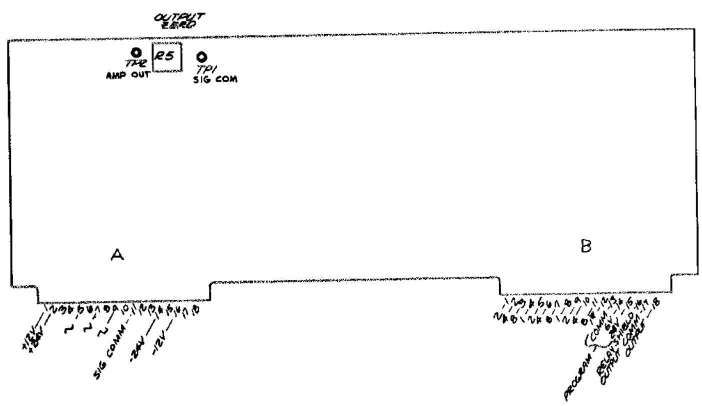


Figure 5-1. Output Amplifier

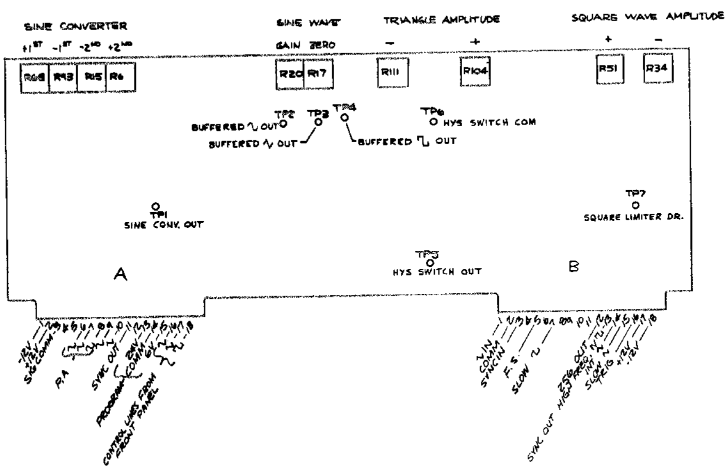


Figure 5-2. Function Board

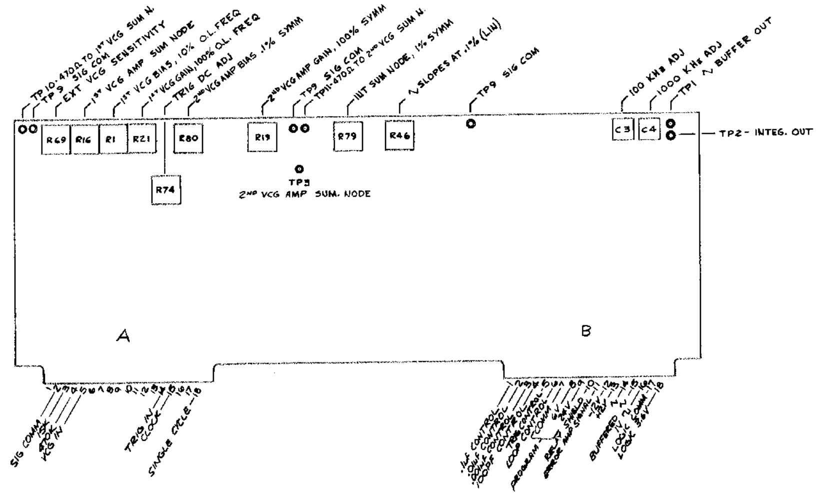


Figure 5-3. VCG/Integrator

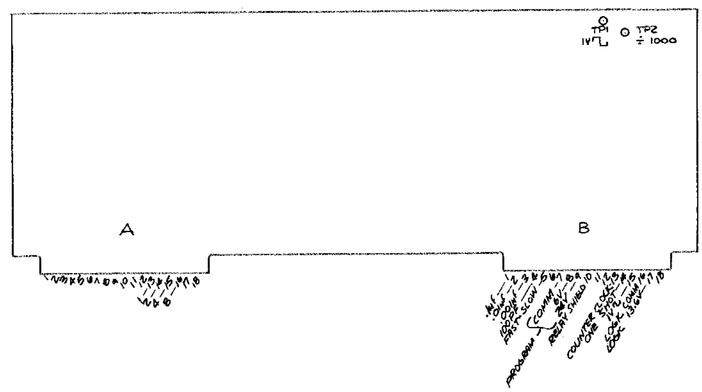


Figure 5-4. Range Matrix

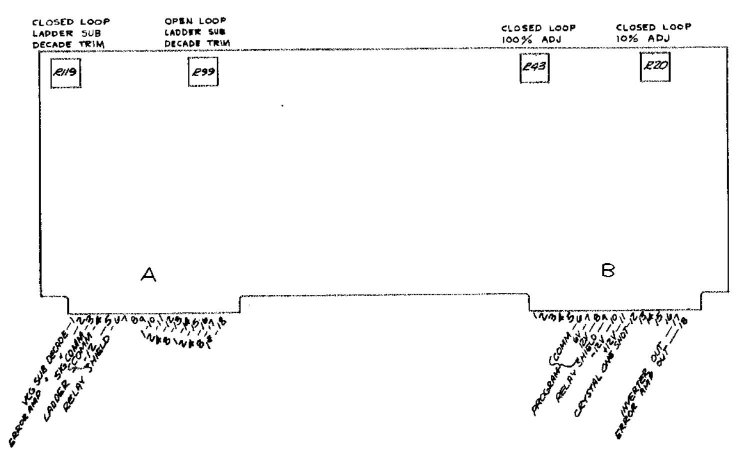


Figure 5-5. Error Amplifier

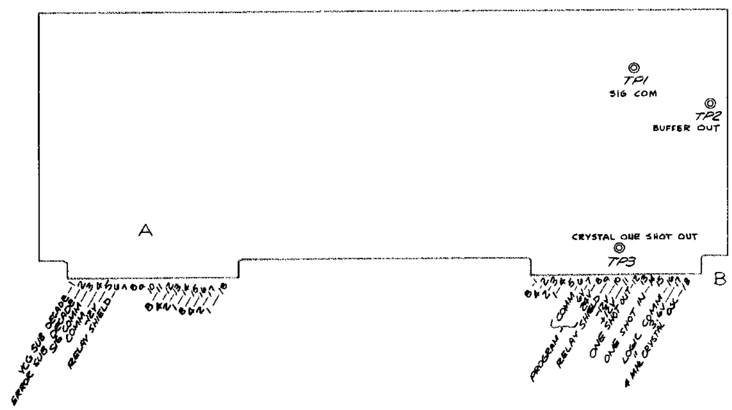


Figure 5-6. Crystal One Shot

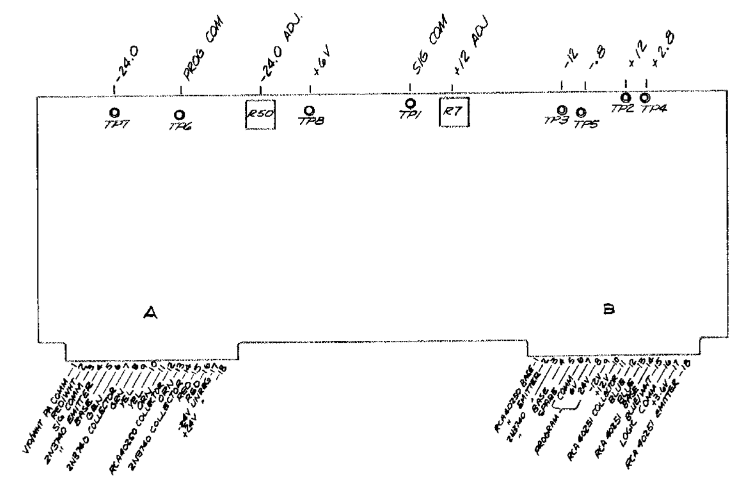


Figure 5-7. Power Supply

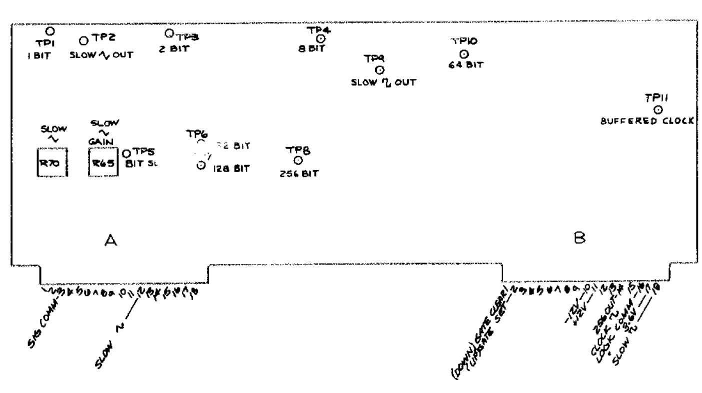
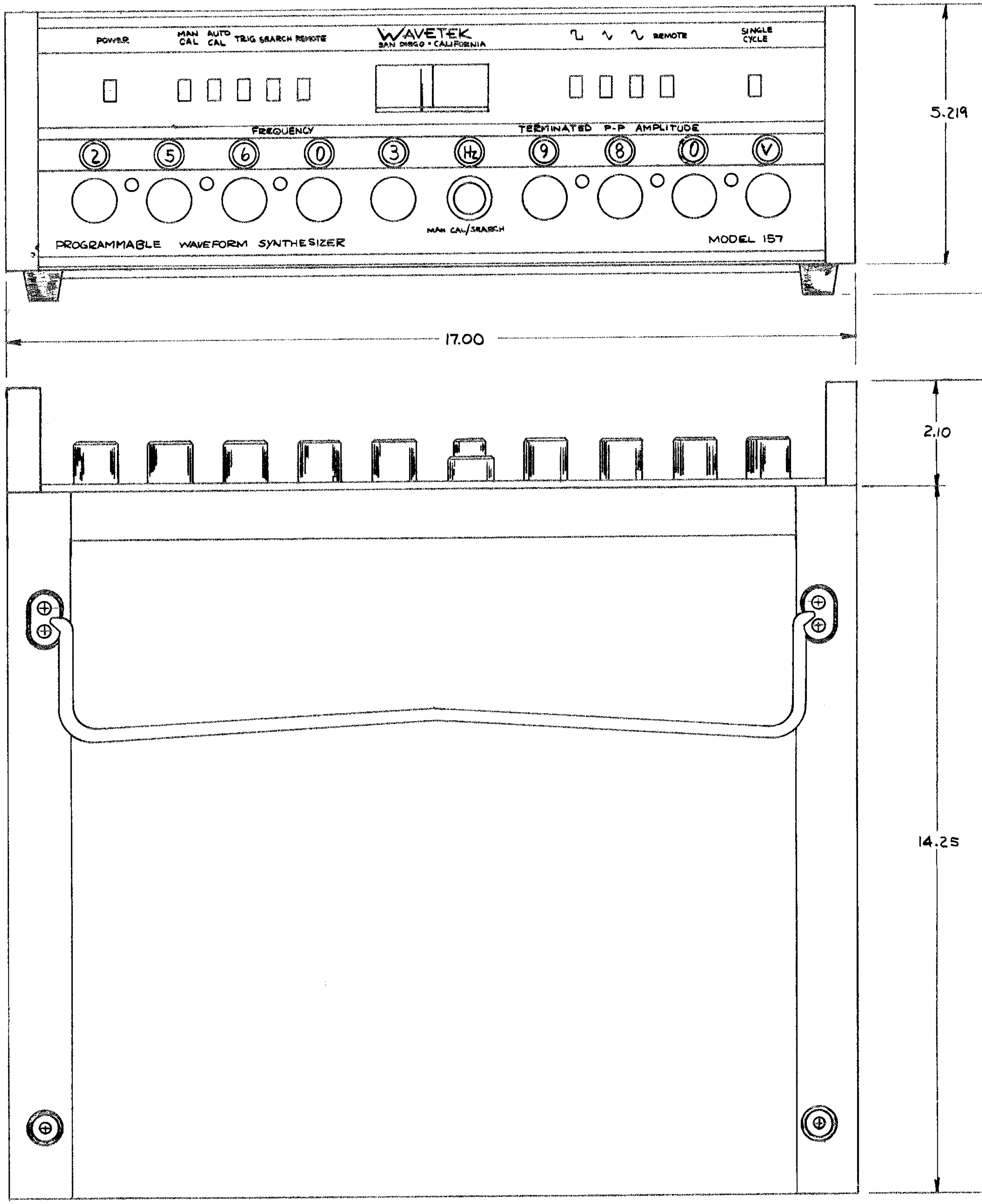
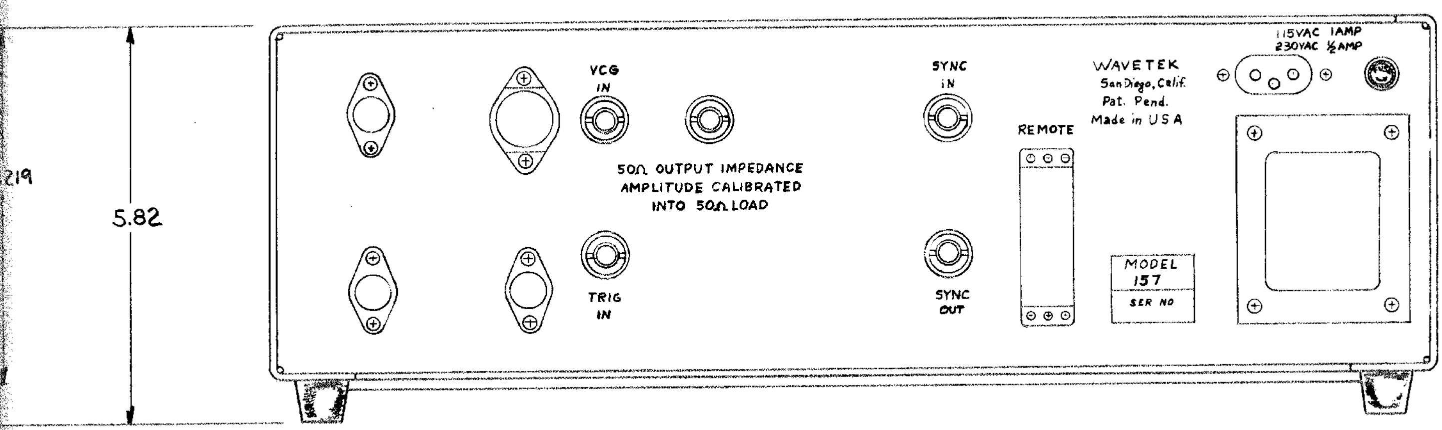


Figure 5.8. Counter Board


POWER
MAN CAL
AUTO CAL
TRIG
SEARCH
REMOTE
WAVETEK
SAN DIEGO • CALIFORNIA
REMOTE
SINGLE CYCLE
FREQUENCY
TERMINATED P-P AMPLITUDE
2
5
6
0
3
Hz
9
8
0
V
MAN CAL/SEARCH
PROGRAMMABLE WAVEFORM SYNTHESIZER
MODEL 157
5.219
17.00
2.10
14.25



rev	ecn	by	date	app.
A	Re-draw Rear Panel	FGS	12-13-68	

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

scale 3/4

material N/A

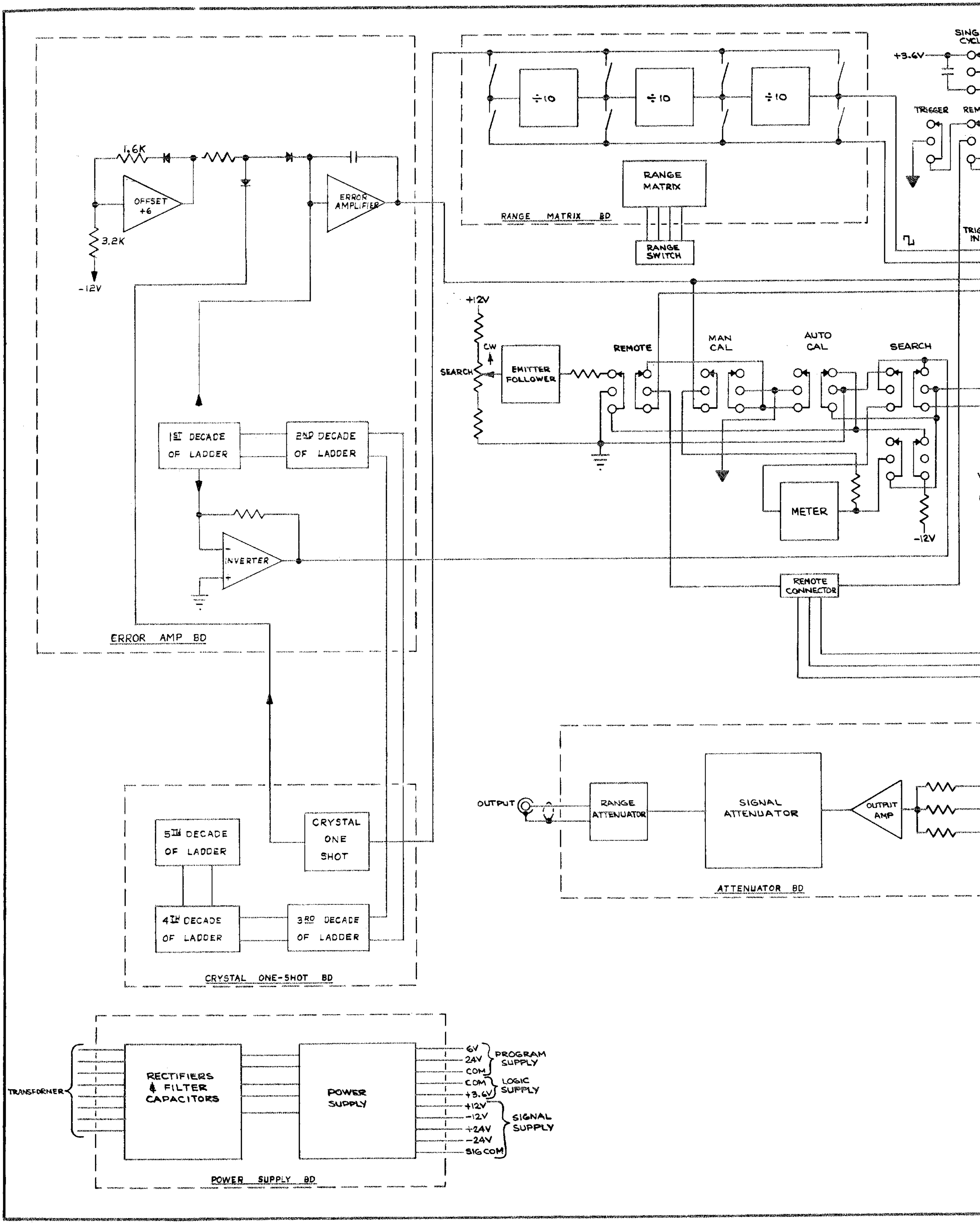
finish N/A

WAVETEK san diego, calif

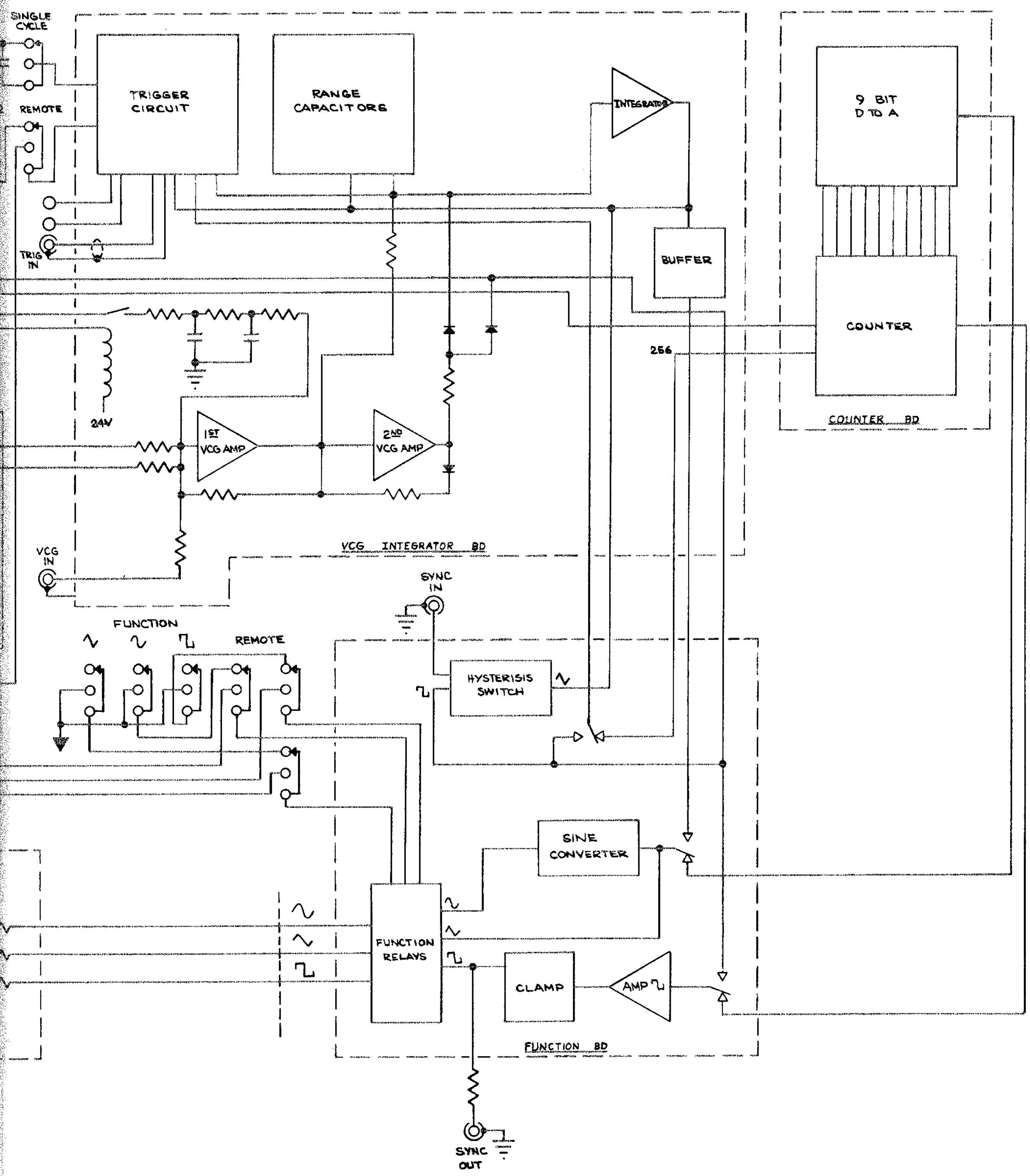
by BOCCHICHIO | date 11/8/68 | app.

title: OUTLINE DRAWING

model no.	dwg no.	rev
157	157-603	A



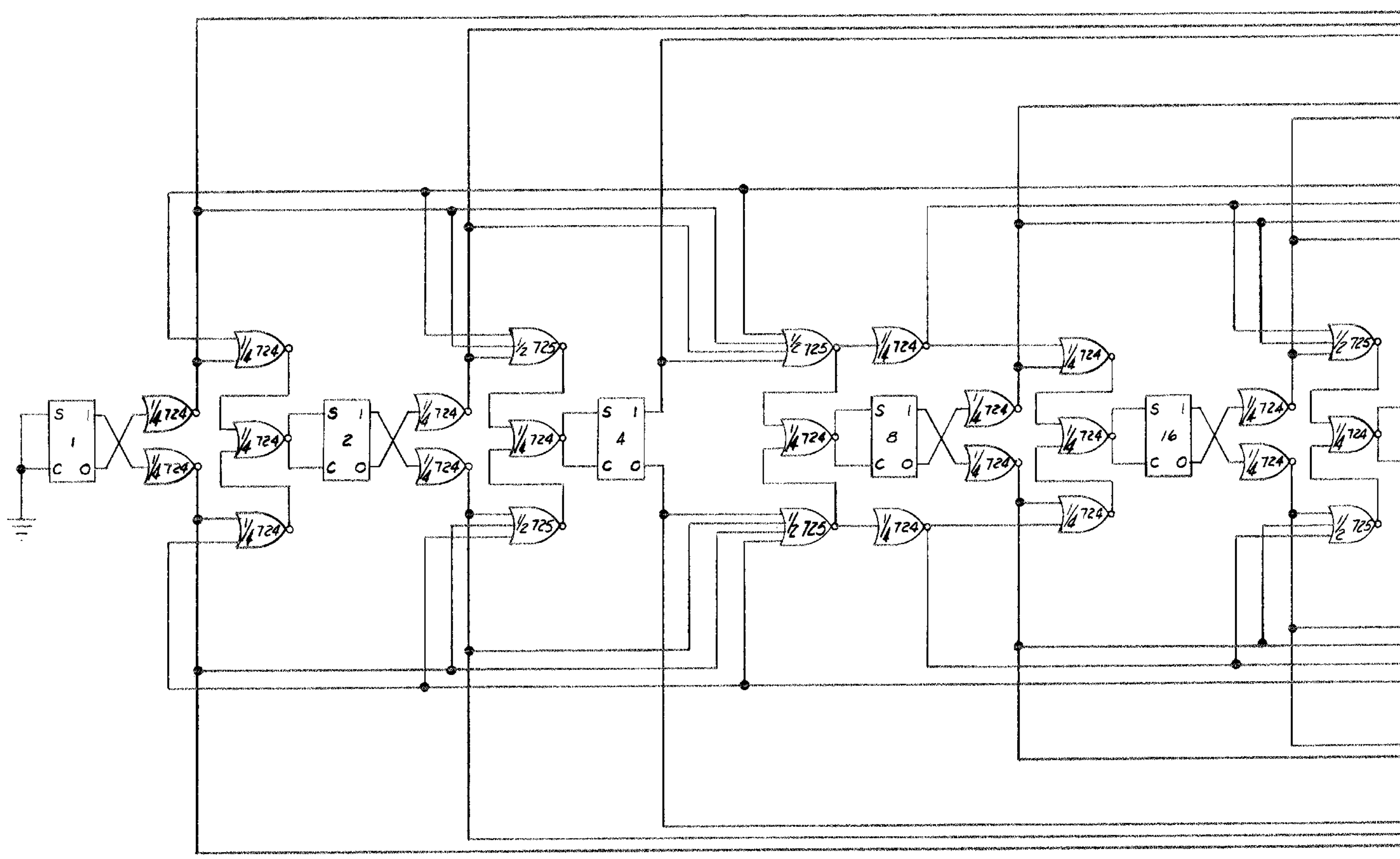
1.6K
3.2K
-12V
OFFSET +6
ERROR AMPLIFIER
1ST DECADE OF LADDER
2ND DECADE OF LADDER
INVERTER
ERROR AMP BD
÷10
÷10
÷10
RANGE MATRIX
RANGE MATRIX BD
RANGE SWITCH
+3.6V
TRIGGER
+12V
CW
SEARCH
EMITTER FOLLOWER
REMOTE
MAN CAL
AUTO CAL
SEARCH
METER
-12V
REMOTE CONNECTOR
5TH DECADE OF LADDER
4TH DECADE OF LADDER
CRYSTAL ONE SHOT
3RD DECADE OF LADDER
CRYSTAL ONE-SHOT BD
OUTPUT
RANGE ATTENUATOR
SIGNAL ATTENUATOR
OUTPUT AMP
ATTENUATOR BD
TRANSFORMER
RECTIFIERS & FILTER CAPACITORS
POWER SUPPLY
6V
24V
COM
PROGRAM SUPPLY
COM
+3.6V
LOGIC SUPPLY
+12V
-12V
+24V
-24V
SIG COM
SIGNAL SUPPLY
POWER SUPPLY BD

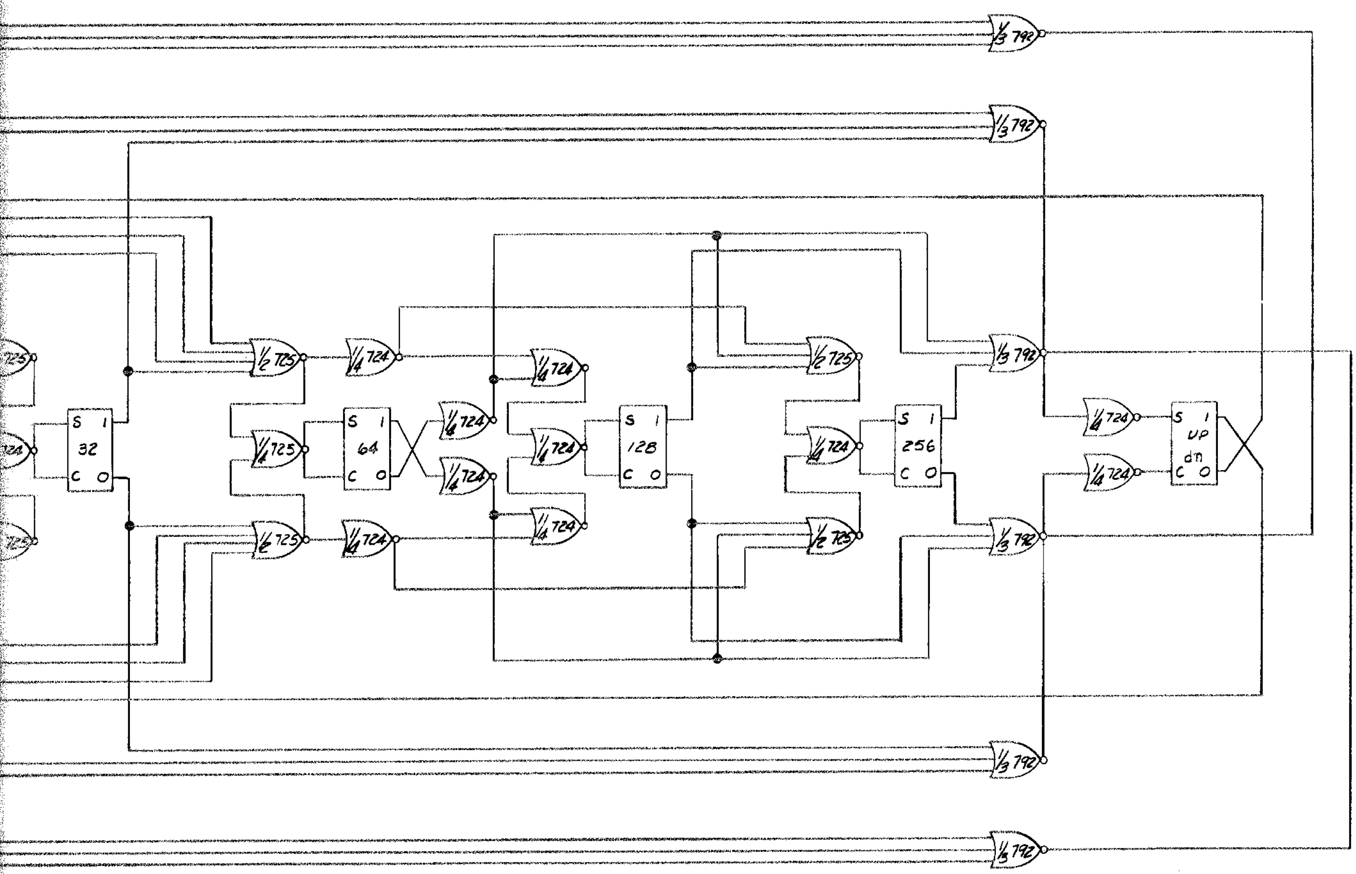


— INDICATES SIGNAL COMMON

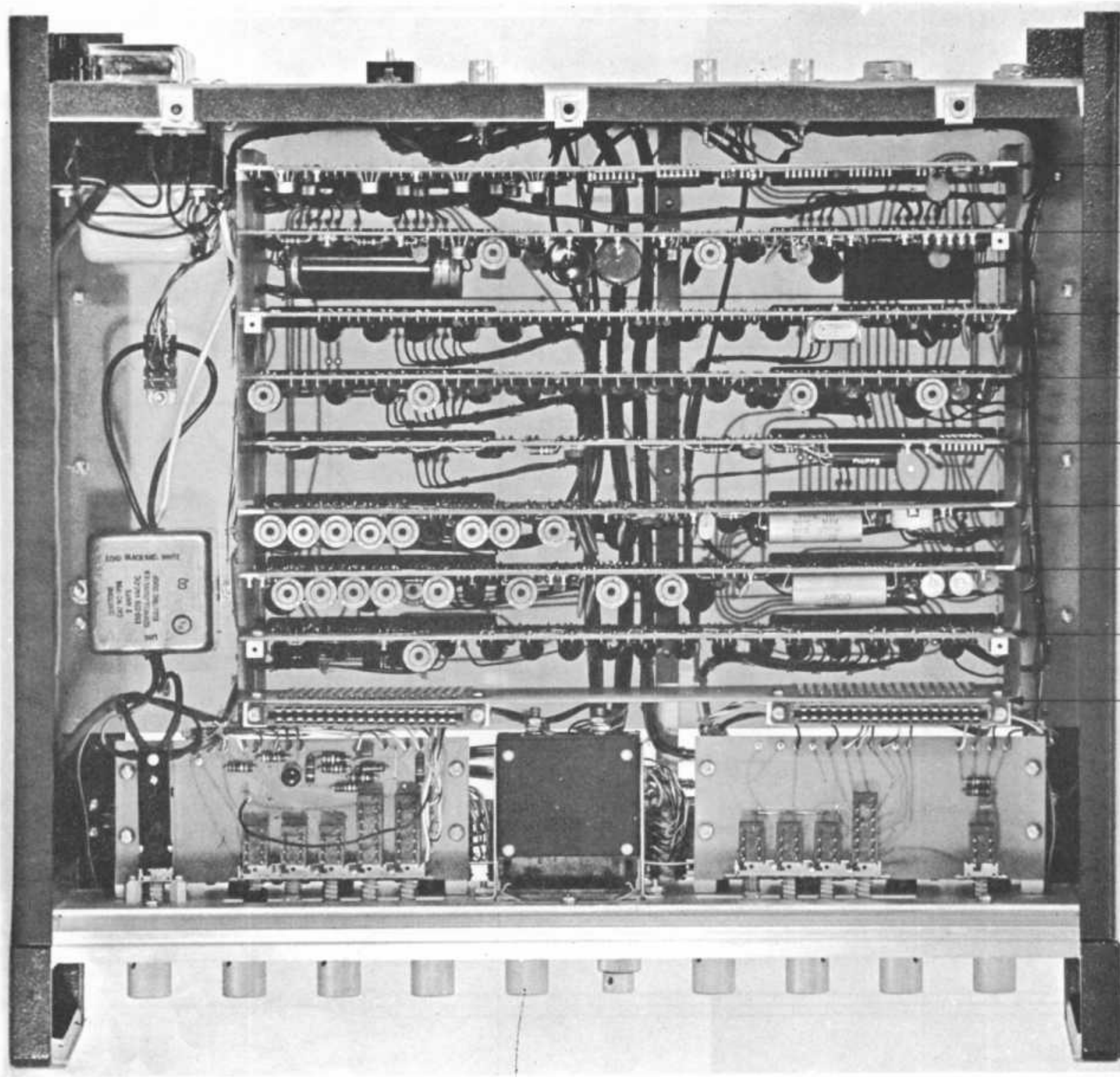
— INDICATES PROGRAM COMMON

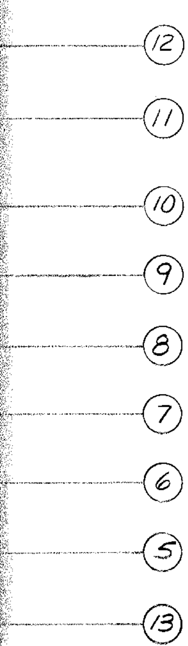
tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
scale	WAVETEK san diego, calif				
material N/A	by L. ADAMSON	date 9/12/68	app		
	title: BLOCK DIAGRAM				
finish N/A	model no. 157	dwg no. 157-600	rev		


S 1
1
C O
S 1
2
C O
S 1
4
C O
S 1
8
C O
S 1
16
C O
1/4 724
1/2 725



tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
scale N/A	WAVETEK san diego, calif				
material N/A	by E HOLAWAY	date 10/22/68	app.		
	title COUNTER LOGIC DIAGRAM				
finish N/A	model no. 157	dwg no. 157-602			rev
	this document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, operation and maintenance without written authorization.				





PARTS LIST

ITEM NO	DESCRIPTION	MFGR	MFGR NO	QTY
1	TOP COVER	WAVETEK	211-311B	1
2	BOTTOM COVER	WAVETEK	211-312A	1
3	CALIBRATION SHIELD	WAVETEK	157-125	1
4				
5	OUTPUT AMPL BD ASSY	WAVETEK	157-012	1
6	FUNCTION BD ASSY	WAVETEK	157-013	1
7	VCG, INTEGRATOR BD ASSY	WAVETEK	157-014	1
8	RANGE MATRIX BD ASSY	WAVETEK	157-015	1
9	ERROR AMPL BD ASSY	WAVETEK	157-016	1
10	ONE SHOT BD ASSY	WAVETEK	157-017	1
11	POWER SUPPLY BD ASSY	WAVETEK	157-018	1
12	COUNTER BD ASSY	WAVETEK	157-019	1
13	EXTENDER BD ASSY	WAVETEK	157-011	1
14	POWER CORD	BELDEN	17258-S	1
15				
16				1
17				
18				
19				
20				
21				
22				
23				
24				
25				

rev	ecn	by	date	app.
G	ECN 680	Bo	6/21/73	
F	ECN 562	Shel	1/3/73	S
E	ECN 440	Shel	9/2/72	
D	ECN 412	S	7/27/72	S
C	295	N.G.	1/30/70	
B	289	NG	12/5/69	
A	285	Bo	12-10-69	

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

scale N/A

material N/A

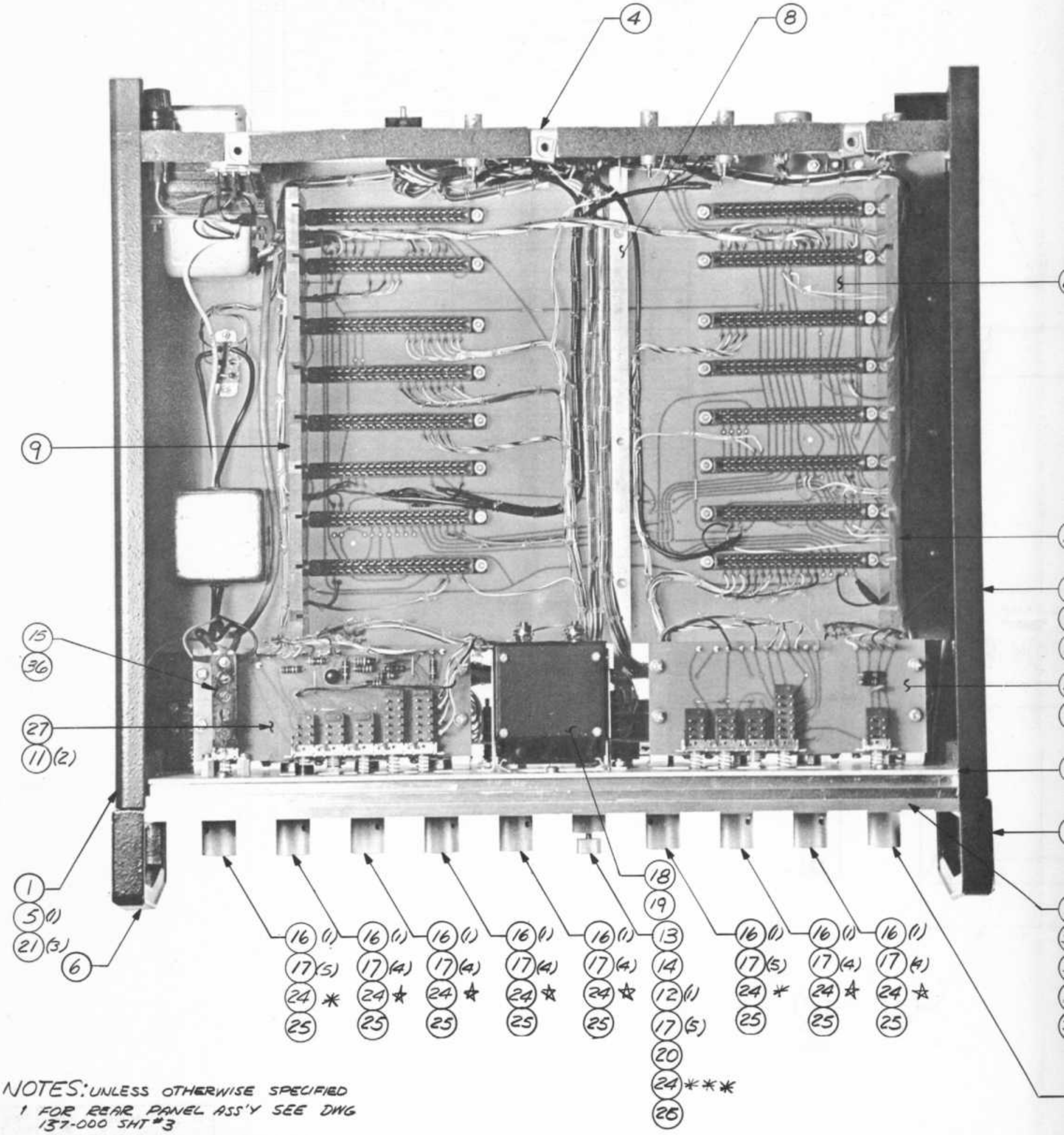
finish N/A

WAVETEK san diego, calif

by BOCHICHIO date 7-8-69 app.

title CHASSIS ASSY (TOP)

model no. 157 | dwg no. SHEET 1 OF 3 D157-000 | rev G

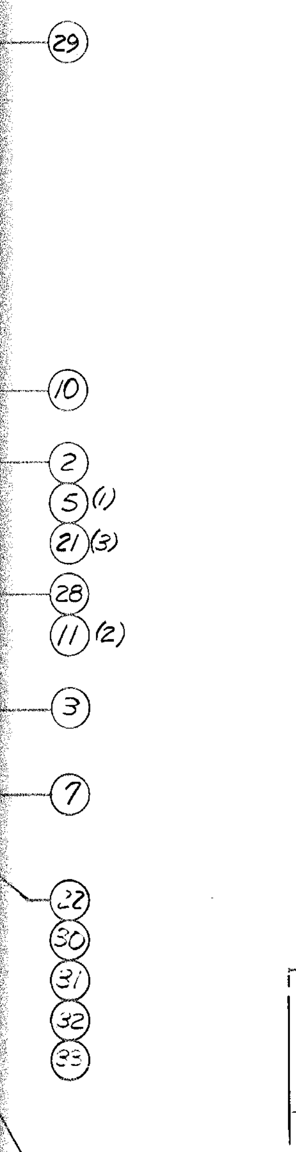


NOTES: UNLESS OTHERWISE SPECIFIED

1 FOR REAR PANEL ASS'Y SEE DWG 137-000 SHT #3

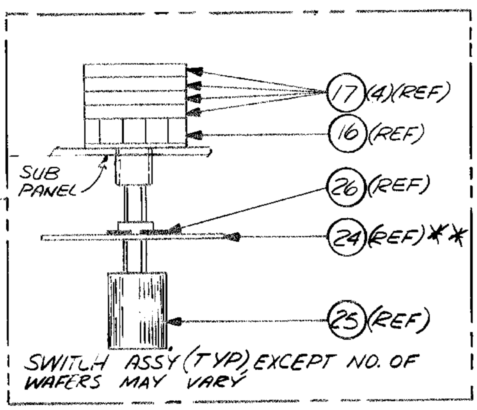
2 ITEM 24 IS BLANK DISC FOR SCREENING USE

- * 157-306B
- ☆ 157-307B
- ** 157-308C
- *** 157-309C



PARTS LIST

ITEM NO	DESCRIPTION	MFGR	MFGR NO	QTY
1	LEFT SIDE RAIL	WAVETEK	210-341D	1
2	RIGHT SIDE RAIL		210-342D	1
3	SUB PANEL		157-302 F	1
4	REAR PANEL ASS'Y		SEE NOTE 1	1
5	BOARD SPACER		157-324A	2
6	HANDLE LEFT		157-3[illegible]C-1	1
7	RIGHT		[illegible]-32[illegible]C-2	1
8	SUPPORT BAR		157-313	1
9	BOARD GUIDE LEFT		157-312A-1	1
10	RIGHT		157-312A-2	1
11	SWITCH BOARD BRACE		157-304B	4
12	DETENT		A157-327	1
13	KNOB, COAXIAL, LARGE		157-317C	1
14	SMALL		157-316B	1
15	LINE SWITCH ASSY		157-422A	1
16	DETENT	CTS	157-SW1	9
17	WAFER	CTS	T-105	42
18	METER, BRACKET	GE	4149K16778	1
19	, MODIFIED	GE	50-185112EMEM	
20	POTENTIOMETER 10K	CTS	30600	1
21	FASTENER #6-32	BOOTS AIRCRAFT	T81D070	6
22	FRONT PANEL	WAVETEK	157-300C	1
23				
◇2 24	READ OUT DISC		157-329	10
25	KNOB		201-339C	9
26				
27	SWITCH BD ASS'Y, LEFT	WAVETEK	157-020	1
28	, RIGHT		157-021	1
29	MOTHER BD ASSY		157-010	1
30	DECIMAL LENS		210-356	6
31	LEFT LIGHT BD		157-122	1
32	RIGHT		157-123	1
33	LIGHT BULB	LAMPS	20MS-24367	6
34	STANDOFF	WAVETEK	8480	1
35	BAIL ASS'Y 15½"	BUCKEYE		1
36	STANDOFF 5/16	WAVETEK	013-003-2	2
37				
38				
39				
40				



rev	ecn	by	date	app.
G	ECN 680	Bo	4/13/73	B
F	ECN 562	[illegible]	1/3/73	S

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

WAVETEK san diego, calif

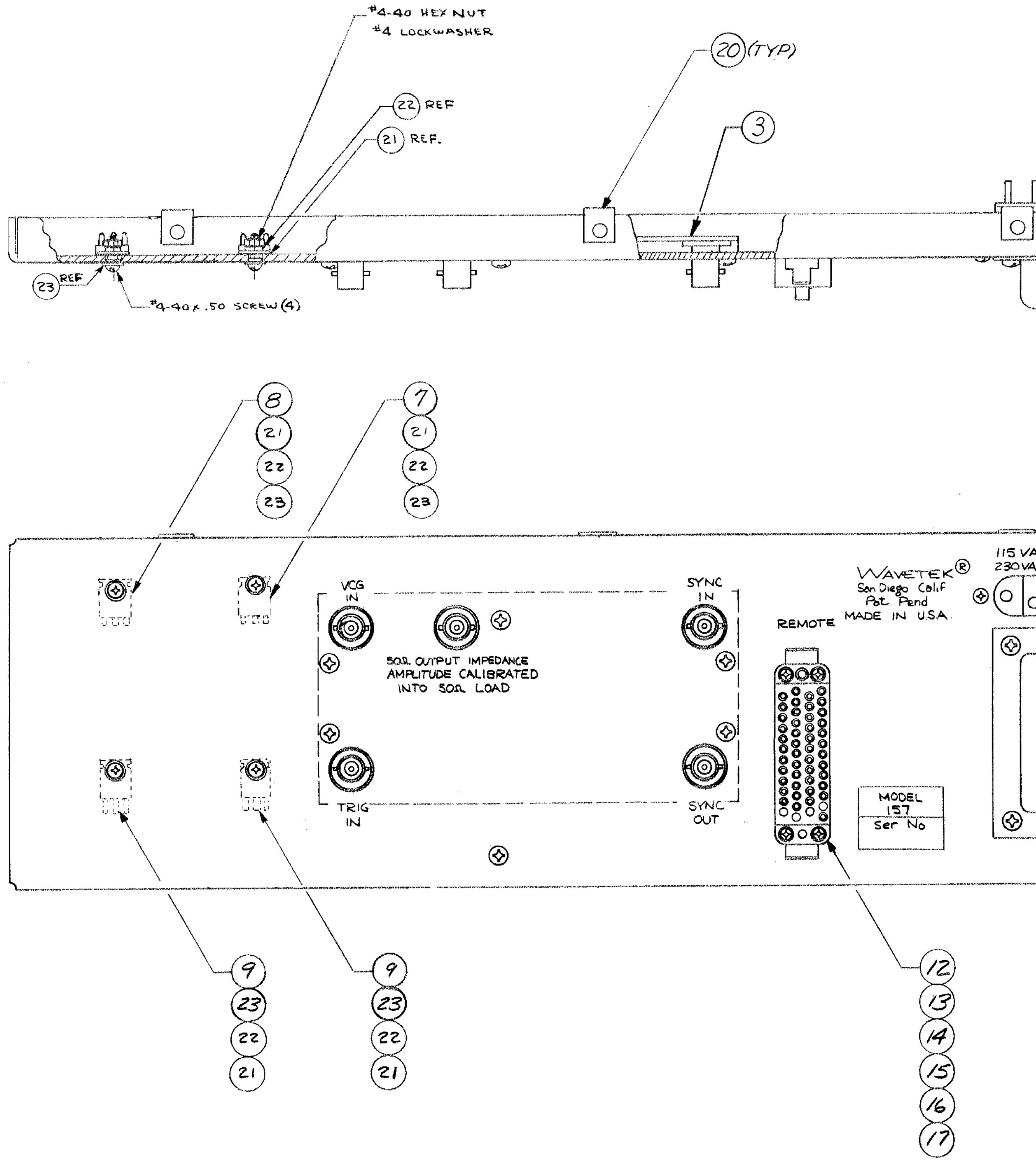
scale N/A | by BOCHICHIO | date 7-8-69 | app [illegible]

material N/A

title CHASSIS ASS'Y

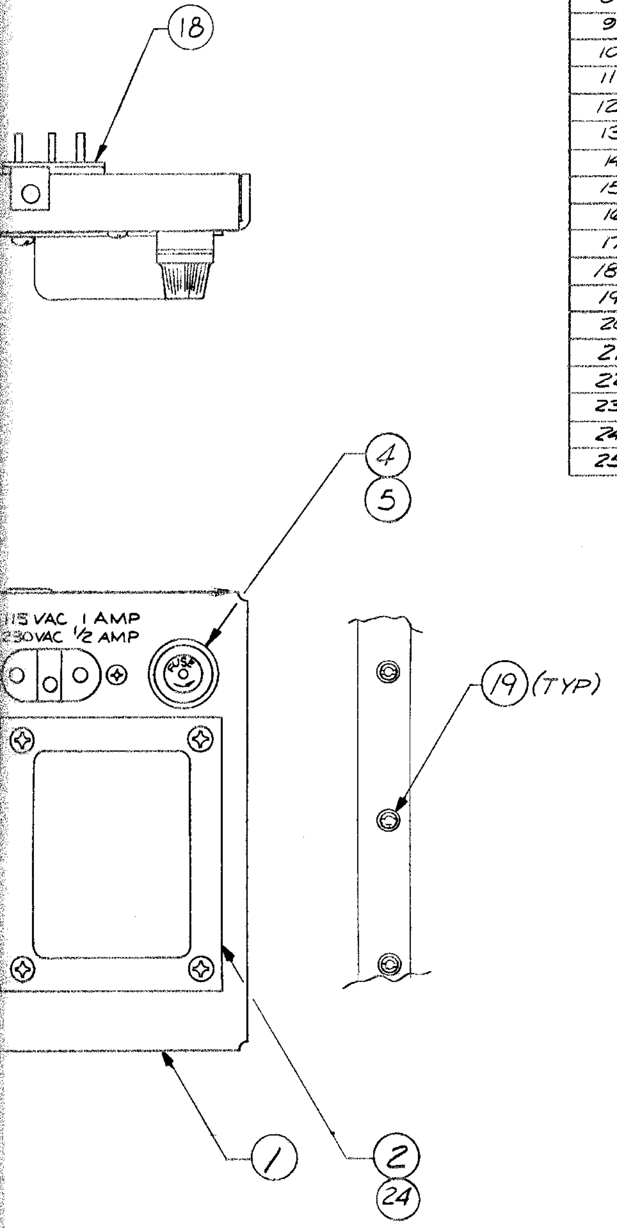
model no. 157 | dwg no. SHEET 2 OF 3 D157-000 | rev G

finish N/A


#4-40 HEX NUT
#4 LOCKWASHER
20 (TYP)
22 REF
21 REF.
3
23 REF
#4-40 x .50 SCREW (4)
8
21
22
23
7
21
22
23
VCG IN
SYNC IN
50Ω OUTPUT IMPEDANCE
AMPLITUDE CALIBRATED
INTO 50Ω LOAD
TRIG IN
SYNC OUT
REMOTE
WAVETEK®
San Diego Calif
Pat Pend
MADE IN U.S.A.
115 VA
230 VA
MODEL
157
Ser No
9
23
22
21
9
23
22
21
12
13
14
15
16
17

PARTS LIST

ITEM NO	DESCRIPTION	MFGR	MFGR NO	QTY
1	REAR PANEL	WAVETEK	157-301G	1
2	TRANSFORMER		157-500B	1
3	ATTENUATOR BD ASSY		157-024	1
4	FUSE HOLDER	LITTELFUSE	342012	1
5	1 AMP		312001	1
6				
7	TRANSISTOR TIP33	TI	TIP 33	1
8	TIP29	TI	TIP 29	1
9	TIP30	TI	TIP 30	2
10				
11				
12	CONNECTOR BLOCK	AMP	200277-2	1
13	50 PIN		7-202663-9	1
14	GUIDE PIN, FEMALE		200390-4	1
15	MALE		200389-4	1
16	LOCK SPRING		201926-1	2
17	SOCKETS		42985-4	46
18	AC CONNECTOR	SWITCHCRAFT	LAC3-G	1
19	FASTENER #6-32	BOOTS AIRCRAFT	T81D070	6
20	CLIP NUT	SUR-LOK	SL210-062-2	3
21	INSULATOR, MICA	WVTK	A142-311	4
22	INSULATOR, NYLON	AMATOM	2675-1415GN115	4
23	SHOULDER WASHER #6	H.H. SMITH	2660	4
24	END COVER	ELECTRO MAGNETICS		1
25				



rev	ecn	by	date	app.
G	ECN 680		4/24/75	
F	ECN 562		1/5/73	S

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

scale FULL

material N/A

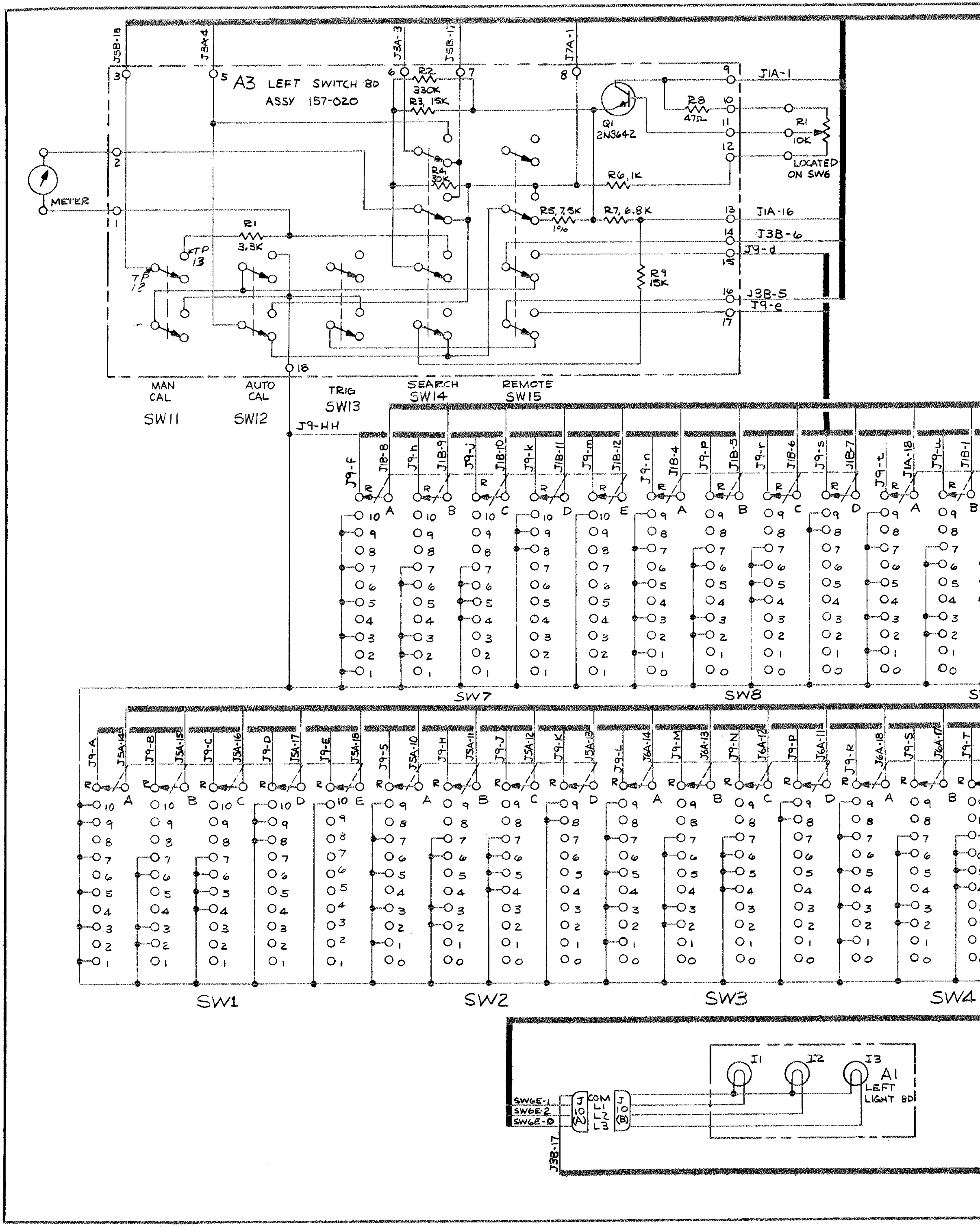
finish N/A

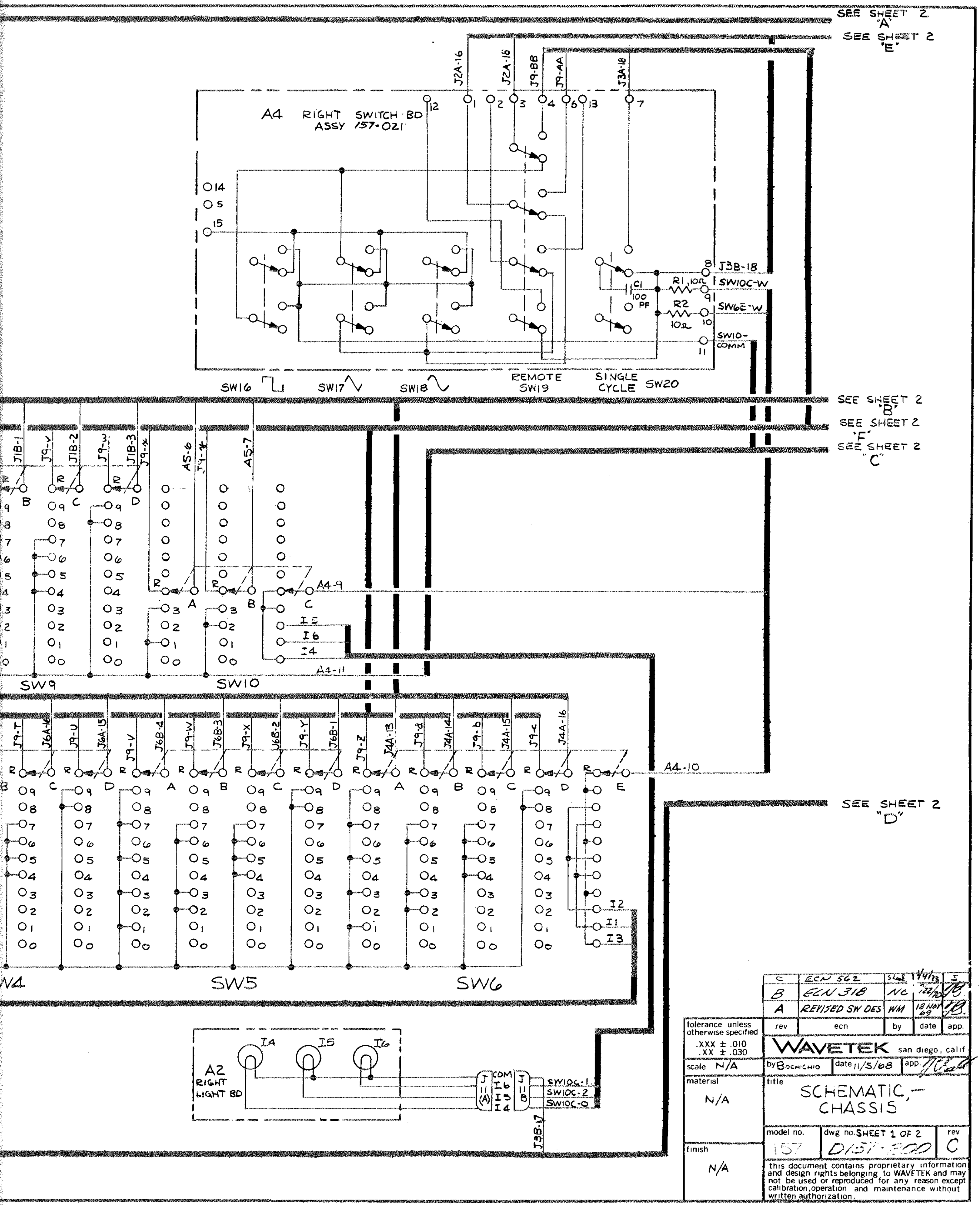
WAVETEK san diego, calif

by BOCHICHIO date 6-24-69 app

title ASS'Y REAR PANEL

model no. 157 dwg no. SHT 3 OF 3 D157-000 rev G


A3 LEFT SWITCH BD
ASSY 157-020
METER
R1 3.3K
R2 330K
R3, 15K
R4 30K
R5, 7.5K 1%
R6, 1K
R7, 6.8K
R8 47Ω
R9 15K
Q1 2N3642
R1 10K
LOCATED ON SW6
TP 12
TP 13
J1A-1
J1A-16
J3B-6
J9-d
J3B-5
J9-e
J9-HH
MAN CAL
SW11
AUTO CAL
SW12
TRIG
SW13
SEARCH
SW14
REMOTE
SW15
SW7
SW8
SW1
SW2
SW3
SW4
I1
I2
I3
A1 LEFT LIGHT BD
SW6E-1
SW6E-2
SW6E-0
J10 (A)
J10 (B)
COM
L1
L2
L3
J3B-17



rev	ecn	by	date	app.
C	ECN 562			
B	ECN 318	NC		
A	REVISED SW DES	WM	18 NOV 69	

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

WAVETEK san diego, calif

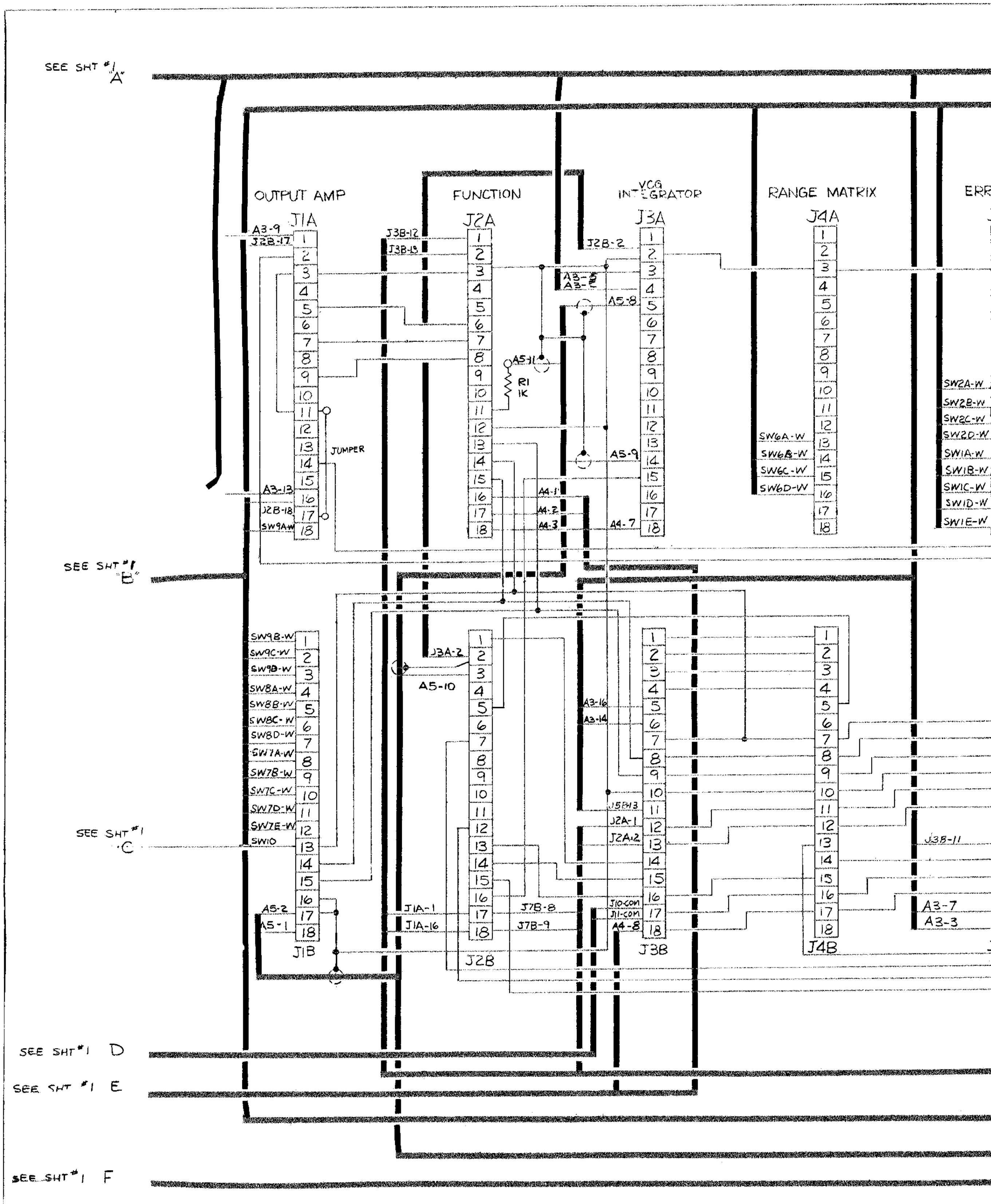
scale N/A — by BOCHICHIO — date 11/5/68 — app.

material N/A

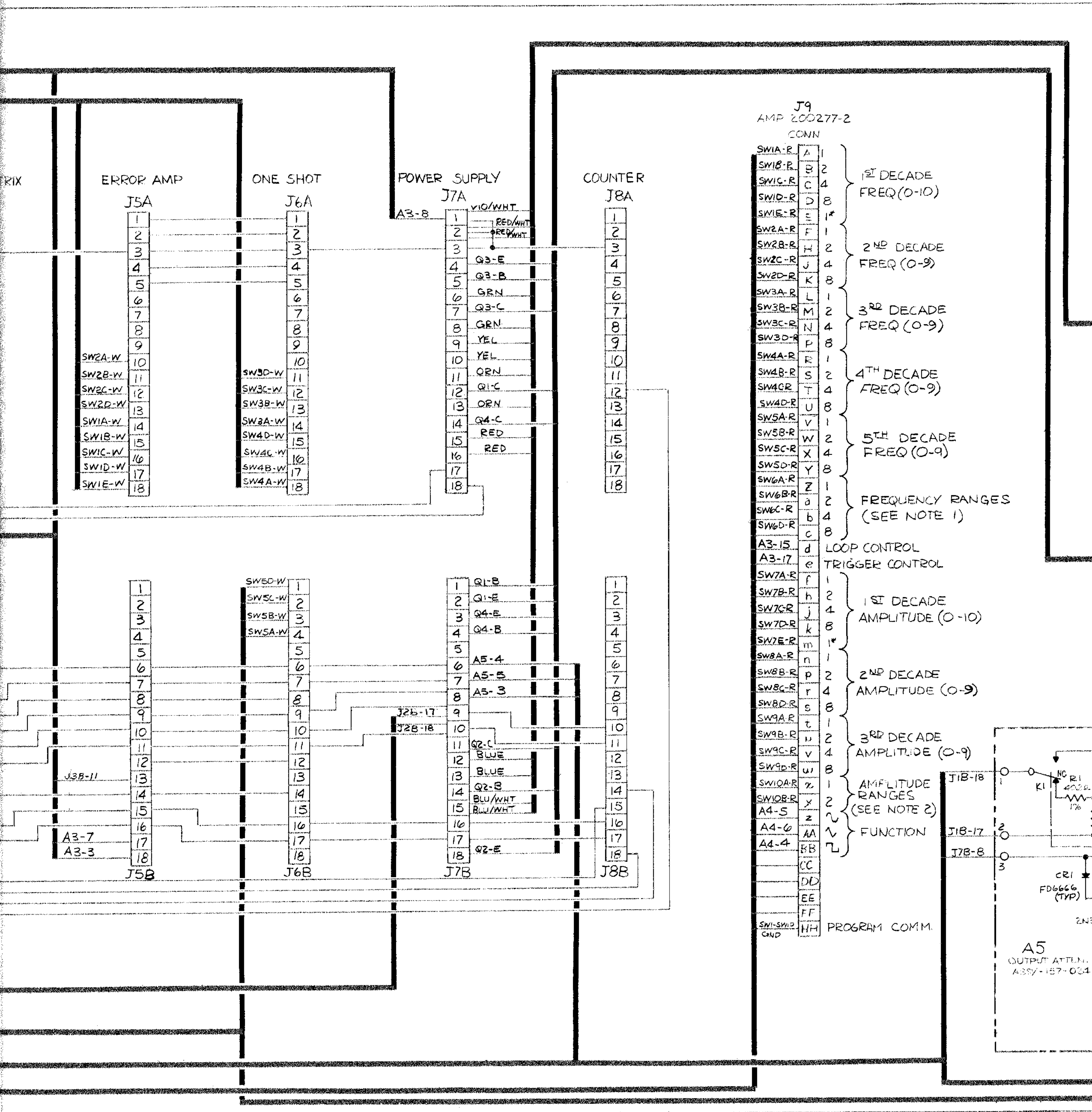
title SCHEMATIC, — CHASSIS

model no. 157 — dwg no. SHEET 1 OF 2 D157-200 — rev C

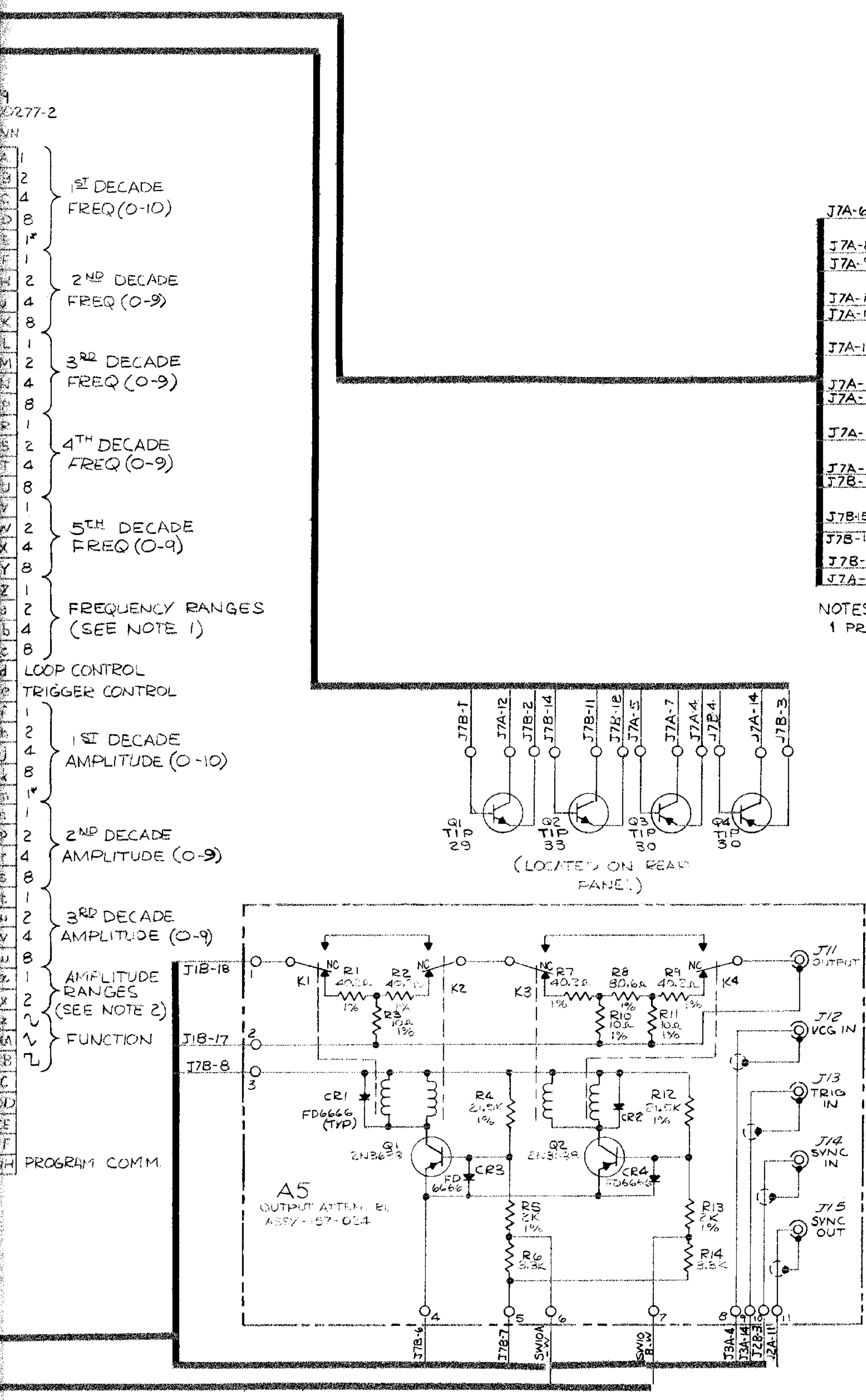
finish N/A

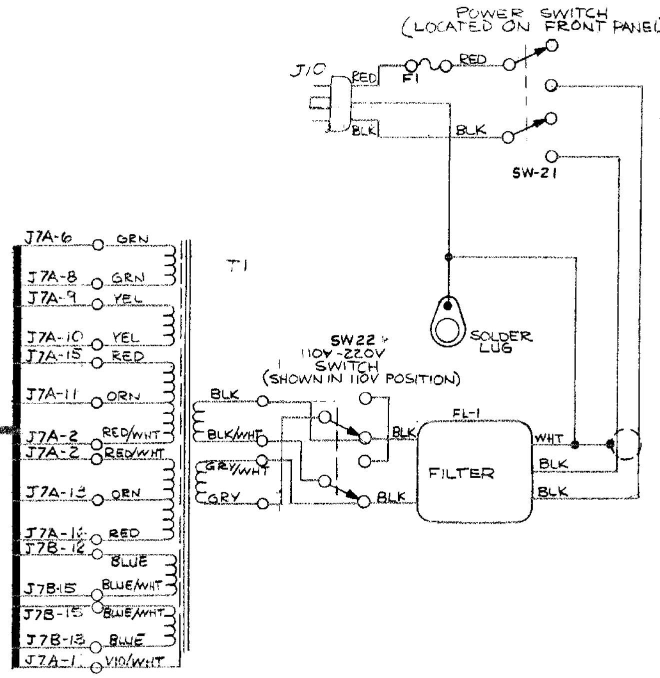


SEE SHT #1 "A"
OUTPUT AMP
J1A
FUNCTION
J2A
VCG INTEGRATOR
J3A
RANGE MATRIX
J4A
SEE SHT #1 "B"
JUMPER
R1 1K
J1B
J2B
J3B
J4B
SEE SHT #1 "C"
SEE SHT #1 D
SEE SHT #1 E
SEE SHT #1 F



ERROR AMP
J5A
ONE SHOT
J6A
POWER SUPPLY
J7A
COUNTER
J8A
J9
AMP 200277-2
CONN
1ST DECADE FREQ (0-10)
2ND DECADE FREQ (0-9)
3RD DECADE FREQ (0-9)
4TH DECADE FREQ (0-9)
5TH DECADE FREQ (0-9)
FREQUENCY RANGES (SEE NOTE 1)
LOOP CONTROL
TRIGGER CONTROL
1ST DECADE AMPLITUDE (0-10)
2ND DECADE AMPLITUDE (0-9)
3RD DECADE AMPLITUDE (0-9)
AMPLITUDE RANGES (SEE NOTE 2)
FUNCTION
PROGRAM COMM.
J5B
J6B
J7B
J8B
A5





NOTES: UNLESS OTHERWISE SPECIFIED

1 PROGRAM FREQ R.

PROGRAM	FREQ R.
0	1000 µHz
1	10 mHz
2	100 mHz
3	1000 m Hz
4	10 Hz
5	100 Hz
6	1000 Hz
7	10 KHz
8	100 KHz
9	1000 KHz

2 PROGRAM AMP R.

PROGRAM	AMP R.
0	10 mV
1	100 mV
2	1000 mV
3	10 V

TO PROGRAM "10" ON FREQ & AMP 1ST DECADES THE CODE IS 8,1,+1*

3. PROGRAM VOLTAGE INFORMATION
TRUE OR LOGIC "1" = 0V ± 1V
NOTE: 0V. SINKS ~ 1mA
FALSE OR LOGIC "0" = +2V TO +10V
NOTE: OPEN CIRCUIT VOLTAGE IS ~ +2V
FRONT PANEL OVERIDES ALL PROGRAMMED INFORMATION

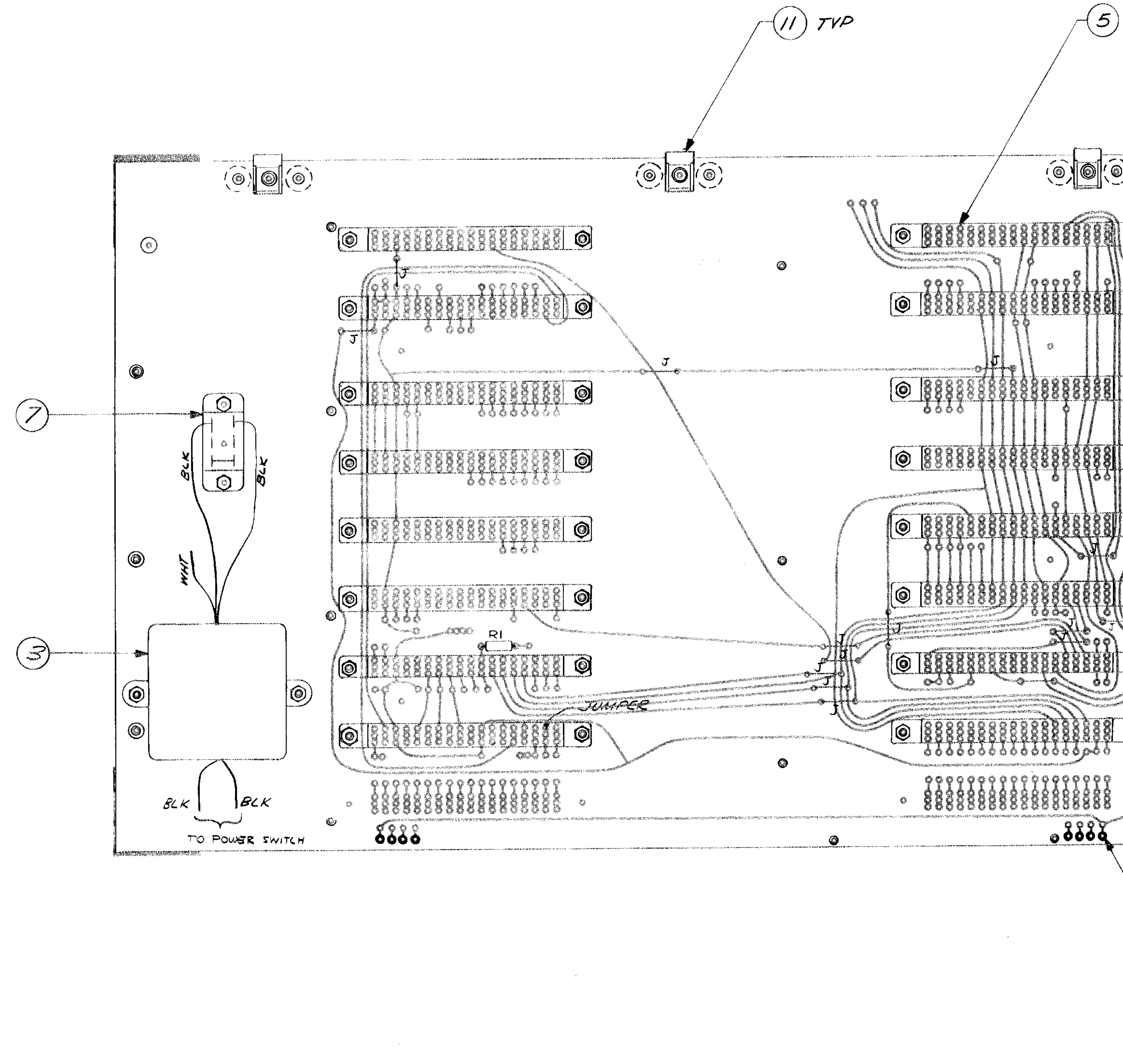
REV	ECN	BY	DATE	APPD
C	ECN 562		1/4/73	S
B	REFER SH. 1	NG	10/22/70	
A	REFER SH 1	WM	18 NOV 69	

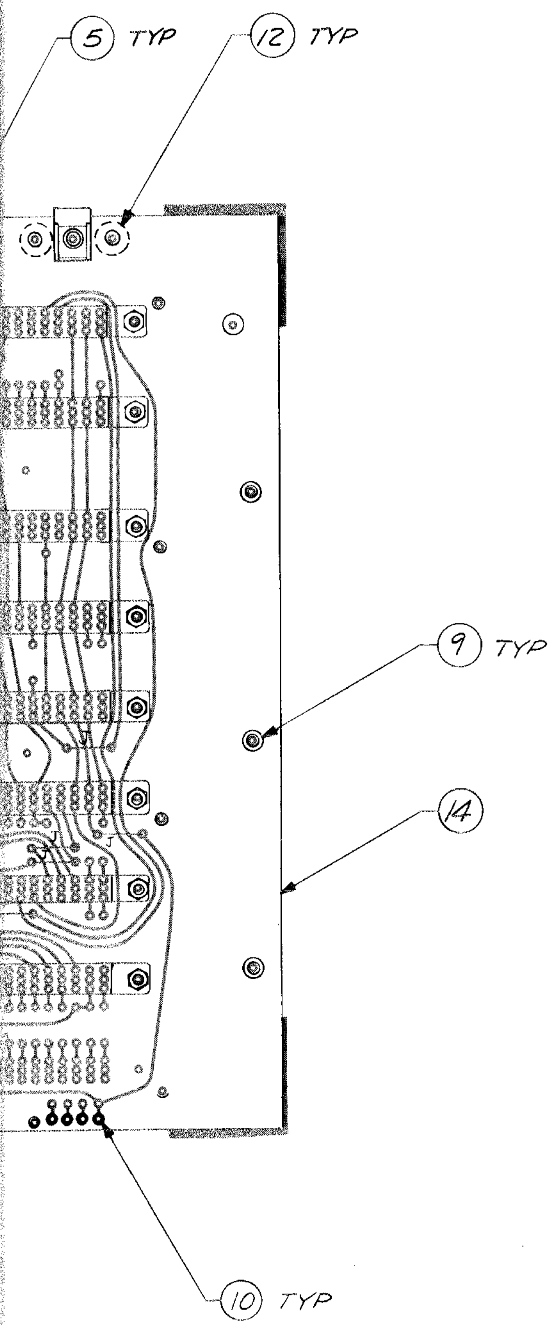
WAVETEK SAN DIEGO, CALIF

BY BOCHICHIO DATE 11/11 APPD

TITLE SCHEMATIC – CHASSIS

MODEL 157 DWG NO 157-200 SHT 2 OF 2 REV C


11 TYP
5
7
BLK
BLK
WHT
3
R1
J
JUMPER
BLK
BLK
TO POWER SWITCH



PARTS LIST

ITEM NO	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
1	R1	RESISTOR, CAR., ½W, 10% 1K	STACKPOLE	RC20GF102K	1
2					
3		LINE FILTER	CDE	1F54	1
4					
5		CONNECTOR	CINCH JONES	252-18-30-160	16
6					
7		SWITCH	SWITCHCRAFT	46256LF SOLDER GUARD	1
8					
9		FASTENERS #6-32	BOOTS AIRCRAFT	T810070	6
10		TERMINAL	AMP	60599-1	8
11		CLIP NUT	SUR-LOK	SL210-062-2	3
12		STANDOFF	WAVETEK	A110-320	6
13					
14		CIRCUIT BOARD	WAVETEK	157-110	1
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

rev	ecn	by	date	app.
B	COP 29	NG	[illegible]	[illegible]
A				[illegible]

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

scale N/A

material N/A

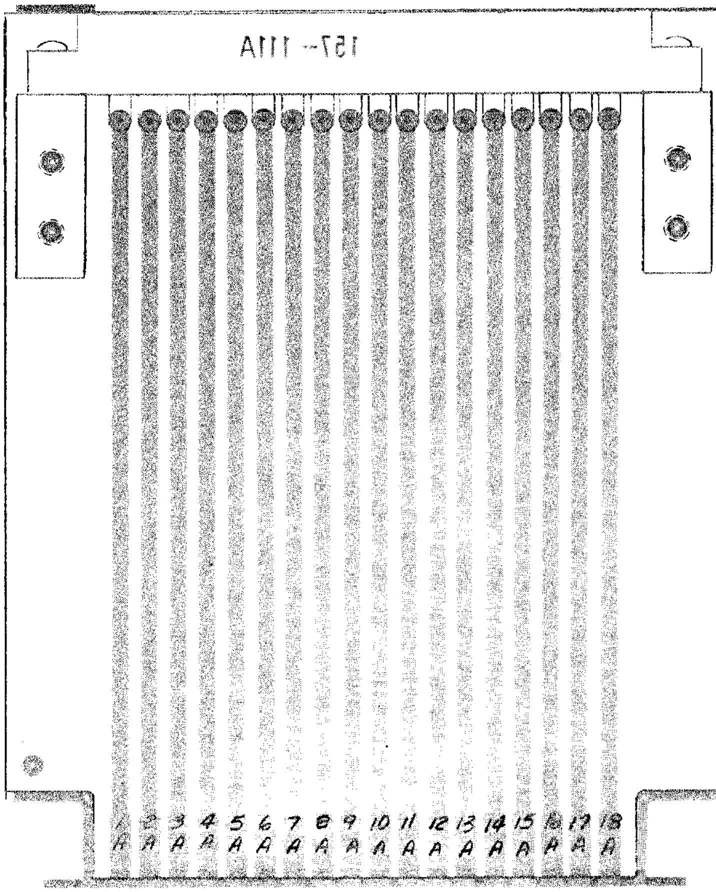
finish N/A

WAVETEK san diego, calif

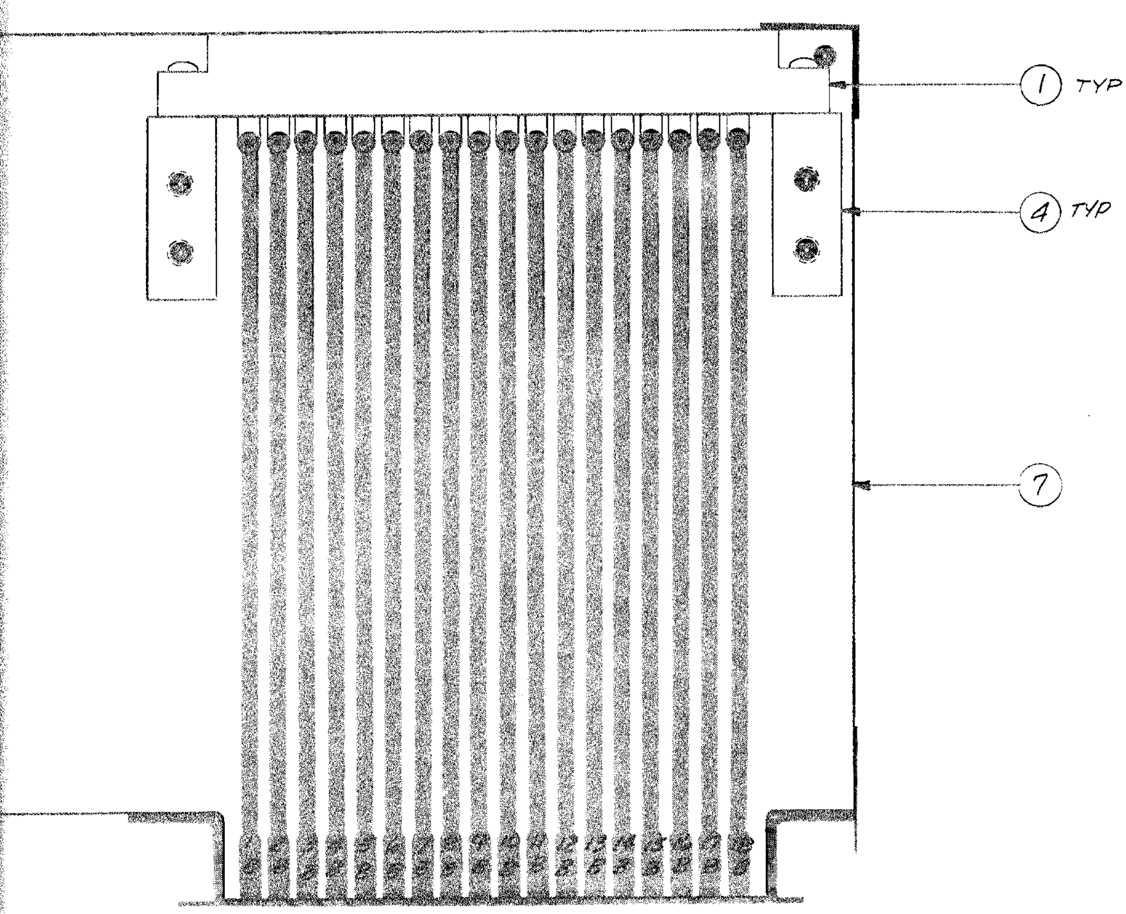
by BOCHICHIO date 7-12-69 app. [illegible]

title ASS'Y MOTHER B'D

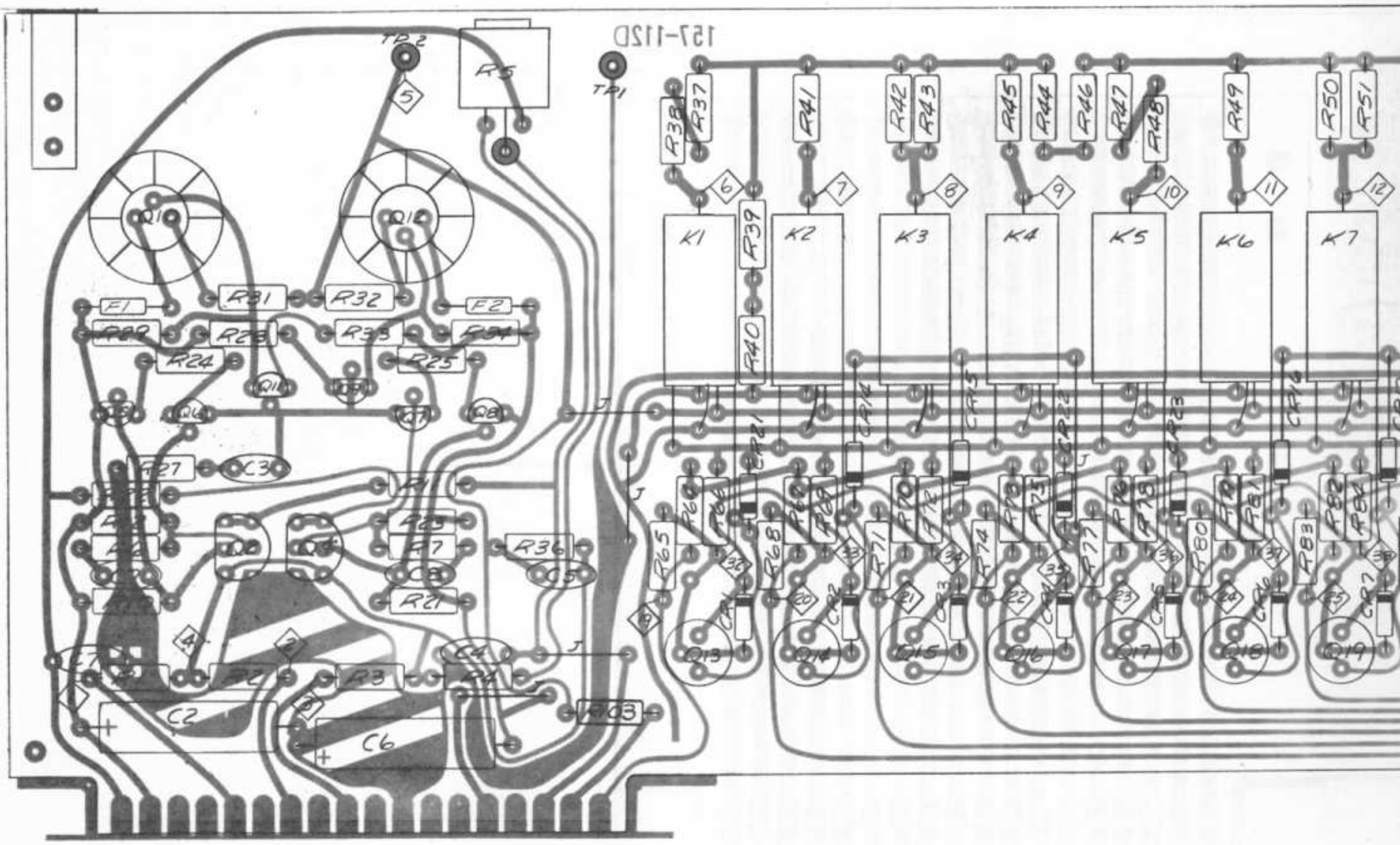
model no. 157 dwg no. D157-010 rev B



PARTS LIST				
ITEM NO	DESCRIPTION	MFGR	MFGR NO.	QTY
1	CONNECTOR	CINCH JONES	252-18-30-160	2
2				
3				
4	CONNECTOR BRACKET	WAVETEK	157-314	4
5				
6				
7	CIRCUIT BOARD	WAVETEK	157-111A	1



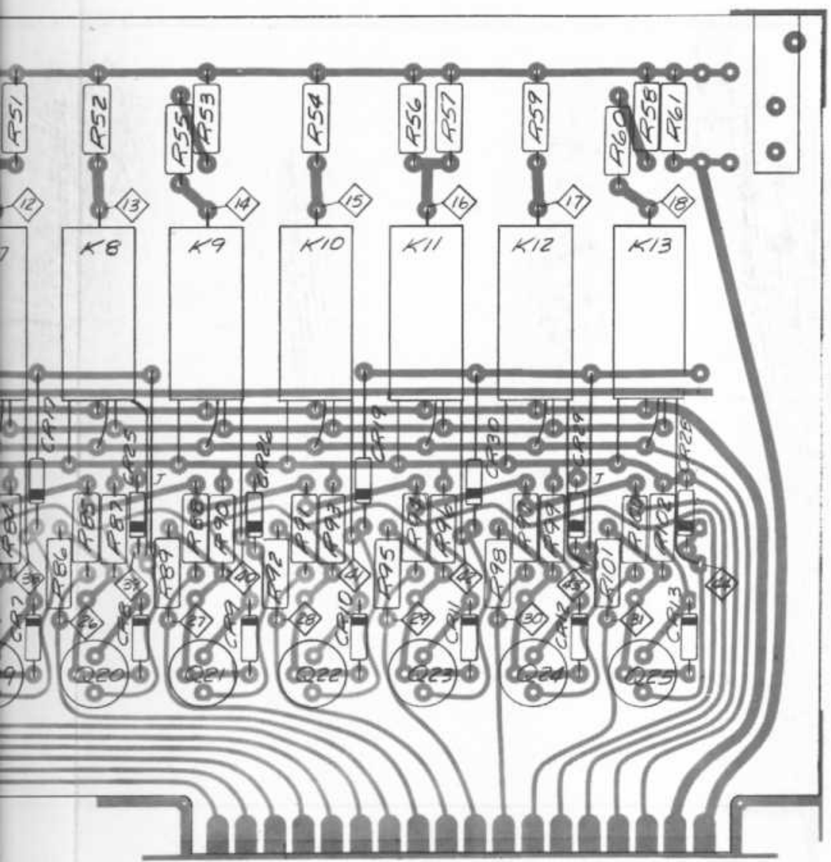
	A	REDRAWN	EH	6/6/69	
tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale 2/1	by E. HOLAWAY	date 6/6/69	app		
material N/A	title ASS'Y EXTENDER BOARD				
	model no. 157	dwg no. 157-011	rev A		
finish N/A	this document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, operation and maintenance without written authorization.				



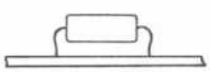
PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	CAPACITORS			
C5	CERAMIC 1000V 5PF	CRL	DD050	1
C3	10PF		DD100	1
C7, C8	68PF		DD680	2
C1, C4	20V .1µf		UK20-104	2
C2, C6	ELECTROLYTIC 50V 50µf	SPRAGUE	500D506G050DD7	2
	DIODES			
CR1-CR17 CR19 CR21-CR23 CR25, CR26 CR28-CR30	FD6666	FAIRCHILD	FD6666	26
K1-K13	RELAY (FORM C)	PHIPPS	PS-865	13
	TRANSISTORS			
Q12	2N2905A	MOTOROLA	2N2905A	1
Q10	2N2219A	FAIRCHILD	2N2219A	1
Q13-Q15 Q17-Q19 Q21-Q23, Q25	2N3638		2N3638	10
Q16, Q20, Q24	2N3638A		2N3638A	3
Q5, Q7, Q9	2N3903		2N3903	3
Q6, Q8, Q11	2N3905		2N3905	3
Q2	TD101	SPRAGUE	TD101	1
Q4	TD401		TD401	1

PARTS LIST				
REF. DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	RESISTORS			
R31, R32	CARBON ½w, 5% 10Ω	STACKPOLE	RC20GF100J	2
R27	100Ω		101J	1
R24, R25	200Ω		201J	2
R6, R7	300Ω		301J	2
R28, R33	10% 820Ω		821K	2
R29, R34	5% 3K		302K	2
R64, R67, R70 R73, R76 R79, R82 R85, R88 R91, R94 R97, R100	10% 3.3K		332K	13
R11, R22	5% 7.5K		752J	2
R10, R21	10% 8.2K		822K	2
R12, R23	15K		153K	2
R4	1M		105K	1
R103	470Ω		471K	1
R61	METAL FILM ¼w, 1% 14Ω	CORNING	RN60D	1
R1, R2, R3	1.1K			3
R44	1.21K			1
R37-R43 R45, R65 R68, R71 R74, R77 R80, R83 R86, R89 R92, R95 R98, R101	2K			21
R46	2.37K			1
R36	4.99K			1

P...	
REF DES	DESCRI...
R63, R66, R72 R75, R78 R81, R84 R87, R90 R93, R96 R99, R102	METAL FILM ...
R47-R52	(MATCHED SET...
R53-R60	
	POTENTIOM...
R5	
	HEAT SINK...
	BRACKET
◎	TERMINAL...
	CIRCUIT B...
F1, F2	AXIAL LEA...



PARTS LIST			
...SCRIPTION	MFGR	MFGR NO.	QTY
...FILM 1/4W, 1% 21.5K	CORNING	RN60D	13
...D SET) 2K(-20)			6
2000Ω(-19)			8
...TIOMETER			
100K	A/B	FR104M	1
... SINK	WAKEFIELD	NF-207	2
...KET	WAVETEK	8157-315	2
...INALS	USECO	20108-1	3
...IT BOARD	WAVETEK	157-112D	1
... LEAD FUSE	LITTELFUSE	GFA 1/4A	2



TYP FOR:
R24, R25, R28,
R29, R31, R32
R33, R34

rev	ecn	by	date	app.
K	ECN 490	SLJ	6/1/72	
J	ECN 368	NG	10-28-71	
H	COP # 16	NG	11/15/70	
G	COP # 38	NG	8/31/70	
F	ECN # 303	NG	8/31/70	
E	REDRAWN	EH	5/29/69	

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

WAVETEK san diego, calif

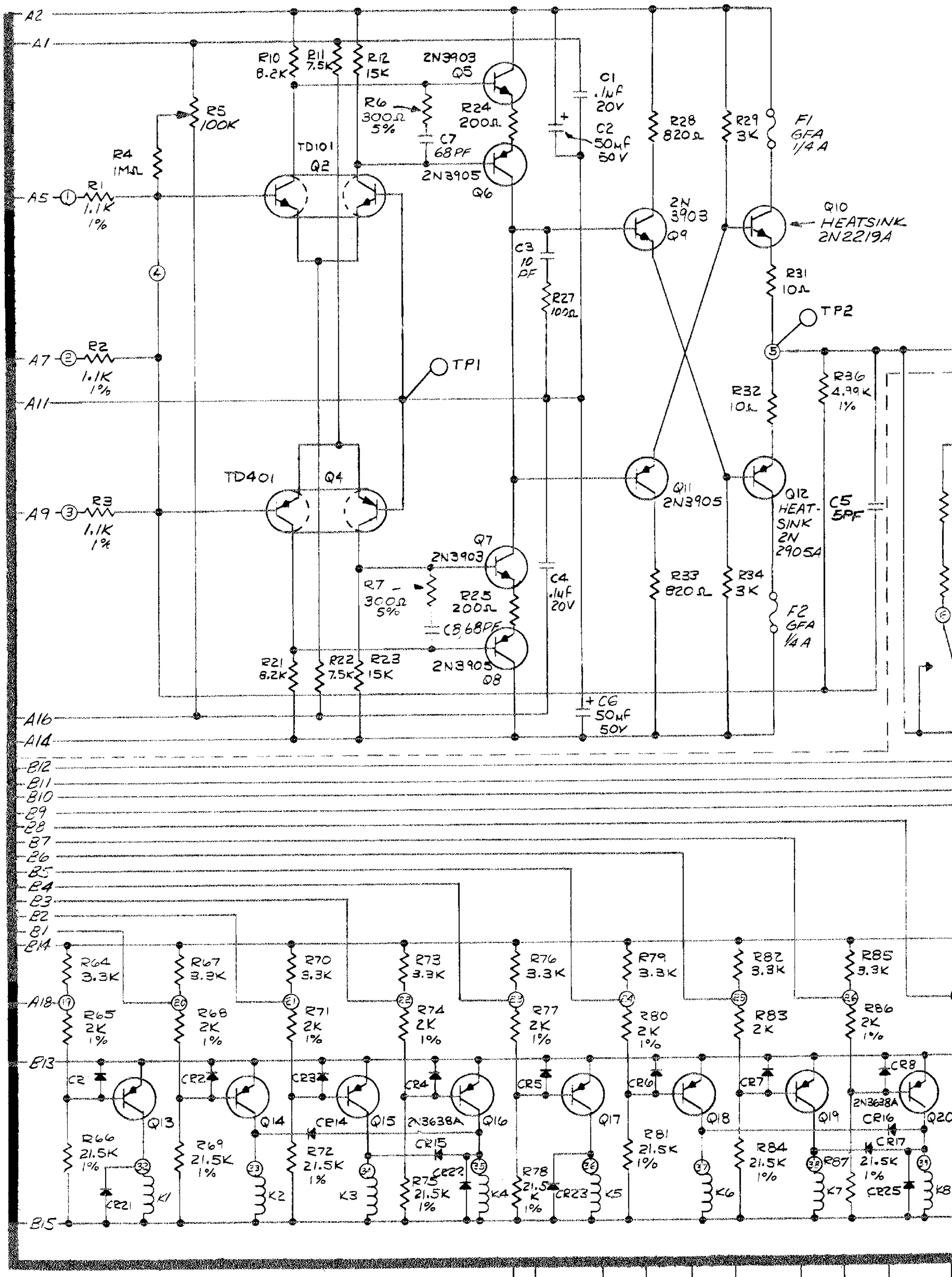
scale 2/1 | by E. HOLAWAY | date 5/29/69 | app.

material N/A

title ASS'Y OUTPUT AMPLIFIER

finish N/A

model no. 157 | dwg no. D157-012 | rev K



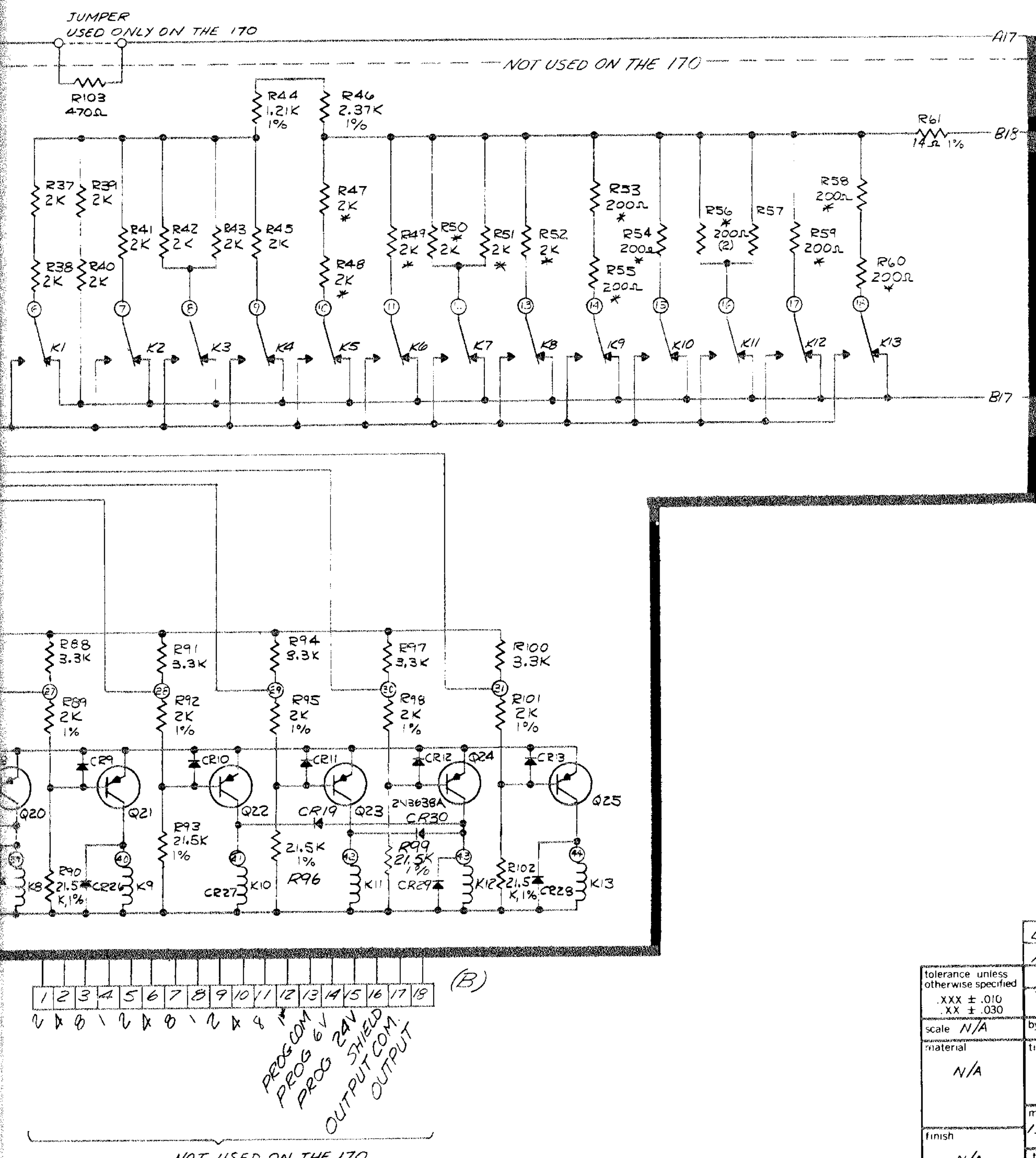
(A)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

+12V +24V ~ ~ ~ SIG COMM -24V -12V OUTPUT (170 ONLY)

NOTES UNLESS OTHERWISE SPECIFIED

1. RESISTORS ARE 1/2W, 10% CARBON
2. TRANSISTORS ARE 2N3638
3. * MATCHED SET OF 6 — 2K, 1% TO .1%
   MATCHED SET OF 8 - 200Ω, 1% TO .1%



B	ECN 303 & COP38	NG	8/31/70	
A				
rev	ecn	by	date	app.

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

WAVETEK san diego, calif

scale N/A

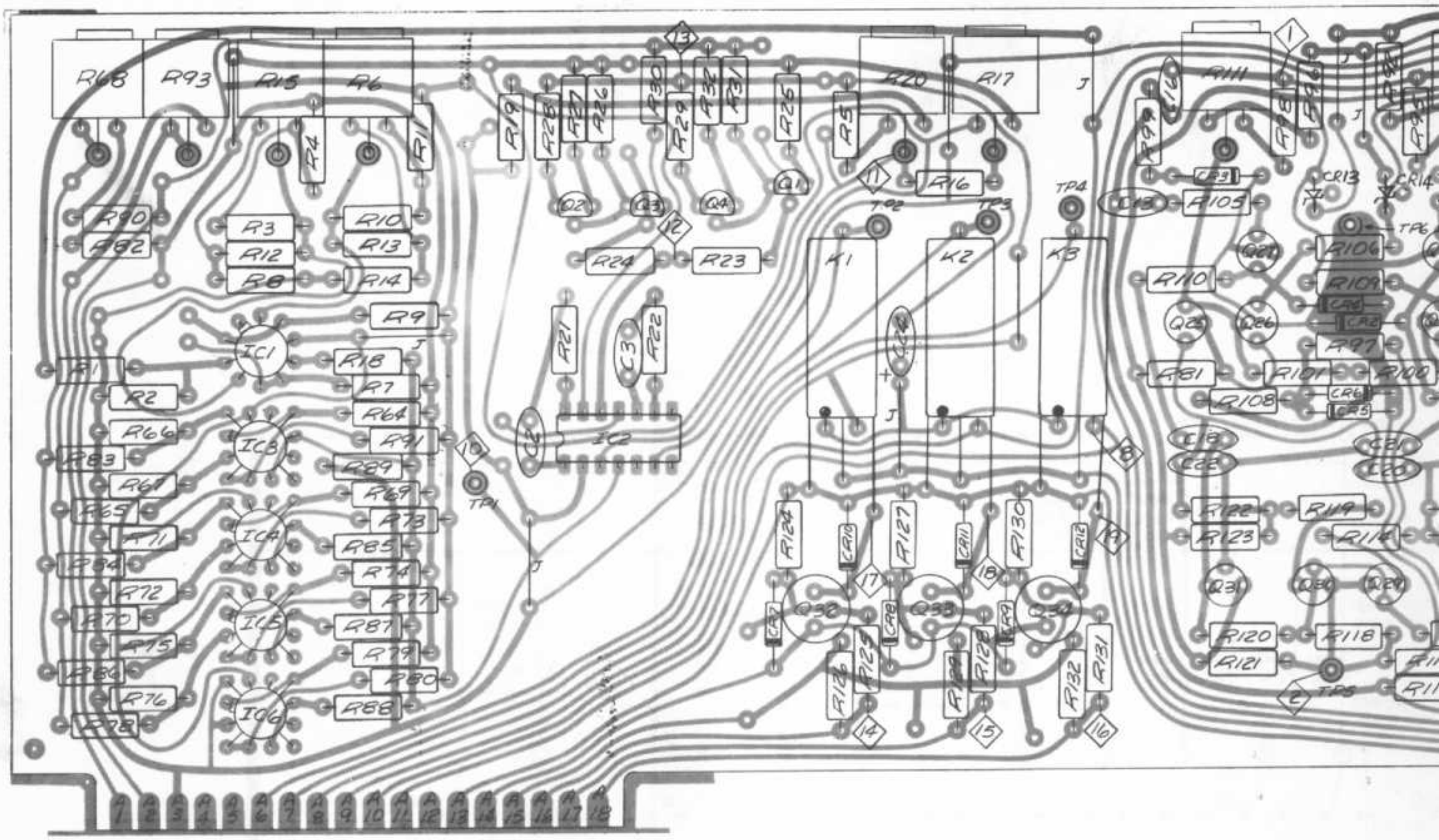
by M BOCHICHIO — date 9-30-68 — app.

material N/A

title: SCHEMATIC OUTPUT AMPLIFIER A CONFIGURATION

model no. 157 & 170 — dwg no. SHT 1 OF 4 157-212 — rev B

finish N/A



PARTS LIST

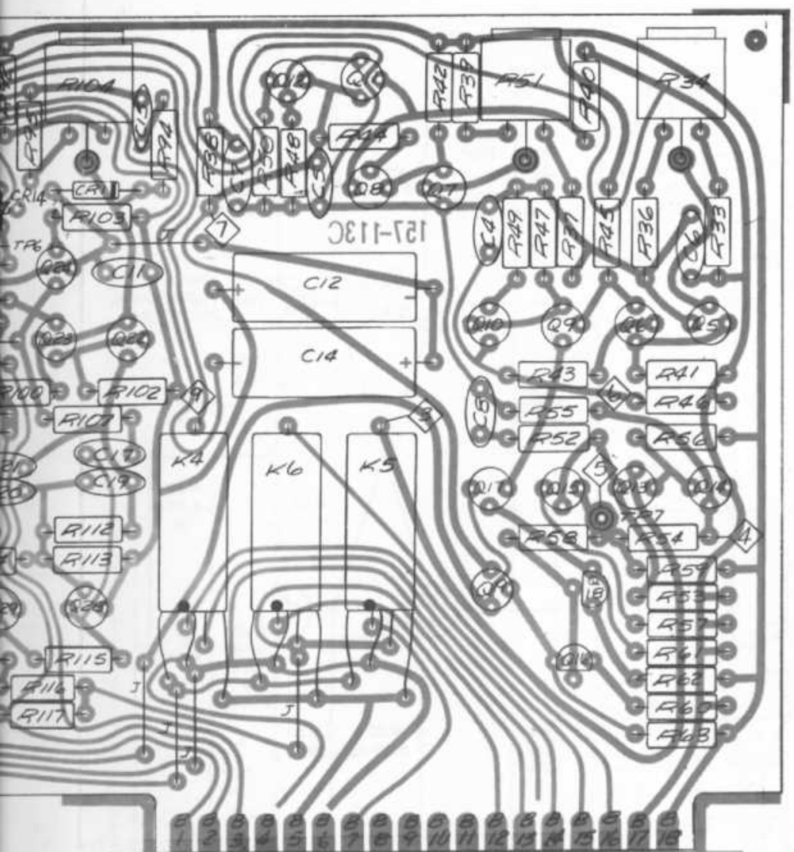
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	CAPACITORS			
C8	CERAMIC 1000V 5pF	CRL	DD050	1
C2, C3	15PF		DD150	2
C19-C22	47PF		DD470	4
C15, C16	SILVER MICA 68PF	ARCO	DM15-680J	2
C17, C18	CERAMIC 1000V 680PF	CRL	DD681	2
C11, C13	10V .1µf		UK10-104	2
C6, C7	20V .1µf		UK20-104	2
C4, C5, C24	TANTALUM 15V 22µf	SPRAGUE	196D226X9015KA	3
C12, C14	ELECTROLYTIC 15V 100µf	RICHEY	16-375-100-15T	2
	DIODES			
CR1-CR12	FD6666	FAIRCHILD	FD6666	12
CR13, 14	DIODE, ZENER	WVTK	A130-506	2
	INTEGRATED CIRCUITS			
IC1		RCA	CA3019	1
IC2			CA3030	1
IC3-IC6	(-18)		CA3039	4
	RELAY			
K1-K6		PHIPPS	PS-865	6
	TRANSISTORS			
Q7, Q8, Q10, Q11, Q13, Q14	2N3563	FAIRCHILD	2N3563	6
Q5, Q6, Q9, Q12, Q15, Q19, Q22, Q26, Q27, Q28, Q30	2N3640		2N3640	11
Q32, Q33, Q34	2N3638		2N3638	3

PARTS LIST

REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	TRANSISTORS			
Q17, Q23, Q24, Q25, Q29, Q31	2N3646	FAIRCHILD		6
Q1, Q2, Q16	2N3903	MOTOROLA	2N3903	3
Q3, Q4, Q18	2N3905		2N3905	3
	RESISTORS			
R58	CARBON ½W 5% 10Ω	STACKPOLE	RC20GF100J	1
R28, R29	15Ω		150J	2
R117	39Ω		390J	1
R47, R48, R49, R50, R114, R119	47Ω		470J	6
R118	62Ω		620J	1
R23, R24, R27, R32, R57	100Ω		101J	5
R94, R99	10% 150Ω		151K	2
R116	5% 160Ω		161J	1
R25, R30	10% 270Ω		271K	2
R38, R46	330Ω		331K	2
R52, R103, R105, R55	470Ω		471K	4
R60, R62, R97	560Ω		561K	3
R59	5% 750Ω		751J	1
R0, R22	10% 1K		102K	2
R26, R31	1.8K		182K	2
R43, R44	5% 2K		202J	2
R107, R110	10% 2.2K		222K	2
R53, R61, R63, R126, R129, R132	3.3K		332K	6
R41, R42, R106, R109	4.7K		472K	4
R56	5% 6.2K		622J	1
R54	9.1K		912J	1

PA[RTS LIST]

REF DES	DESCRI[PTION]
	RESISTOR[S]
R40, R45, R64, R69, R73, R74, R77, R79, R80, R91	CARBON ½W
R121	
R16	
R115, R120	METAL FILM ¼
R2	
R75, R76	
R1, R3, R8, R10, R12, R13, R14	
R71, R72	
R66, R67, R108	
R19, R113, R123	
R82, R90	
R95, R98	
R100, R101, R112, R122	
R4, R11, R18, R85, R87, R88	
R65, R70, R78, R83, R84, R86, R125, R128, R131	
R81, R102	
R5	
R89, R92, R96	
R7, R9	
R124, R127, R130	
R33, R39	



PARTS LIST				
SCRIPTION		MFGR	MFGR NO	QTY
STORS				
W ½W 10%	15K	STACKPOLE	RC20GF153K	10
	22K		223K	1
	1M		105K	1
FILM ¼W, 1%	10Ω	CORNING	RN60D	2
	30.1Ω			1
	42.2Ω			2
	49.9Ω			7
	56.2Ω			2
	124Ω			3
	316Ω			3
	750Ω			2
	825Ω			6
	1.1K			4
	1.78K			2
	2K			9
	3.01K			2
	3.83K			1
	4.32K			3
	7.5K			2
	21.5K			3
	6.19K			2

PARTS LIST					
REF DES	DESCRIPTION		MFGR	MFGR NO	QTY
R36, 37	METAL FILM, ¼W, 1%, 1.50K		CORNING	RN60D	2
	POTENTIOMETER				
R6, R15, R20		100Ω	A/B	FR101M	3
R34, R51, R68, R93, R104, R111		250Ω		FR251M	6
R17		100K		FR104M	1
◎	TERMINAL		USECO	20108-1	17
	CIRCUIT BOARD		WAVETEK	157-113C	1

rev	ecn	by	date	app.
K	ECN 440		5/1/72	
J	364	NG	9-30-71	
H	ECN 355	NG	9-23-71	
G	ECN 304	NG	10/6/70	
F	REDRAWN	EH	5/23/69	

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

scale 2/1

material N/A

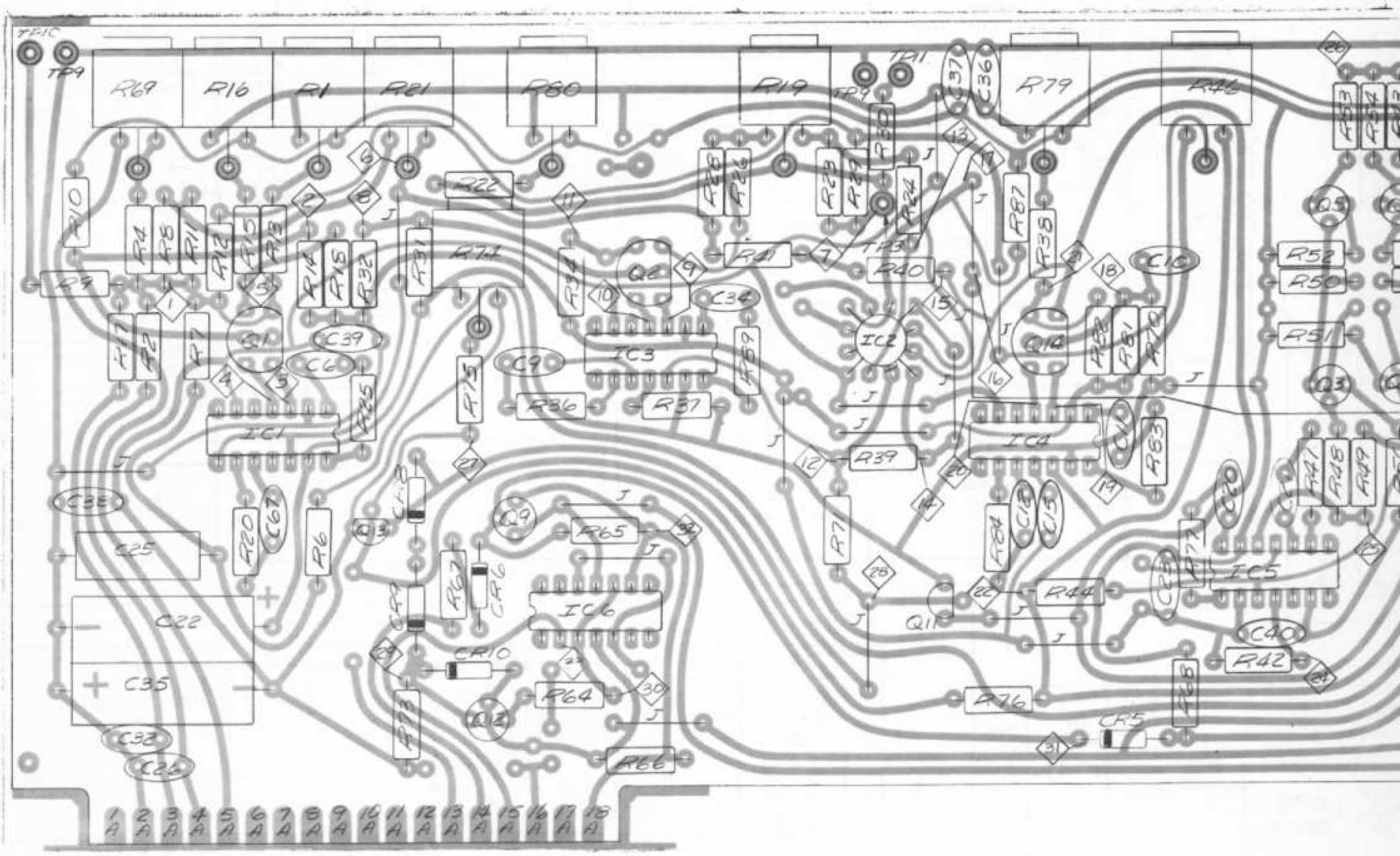
finish N/A

WAVETEK san diego, calif

by E. HOLMAN date 5/23/69 app.

title FUNCTION BOARD

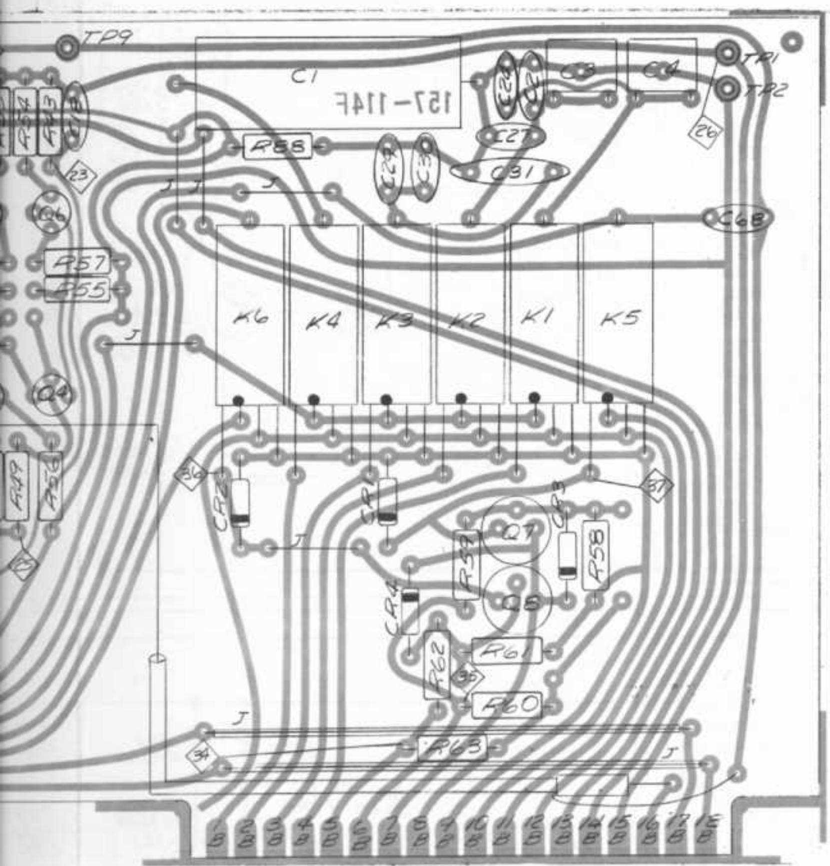
model no. 157 dwg no. D157-013 rev K



PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	CAPACITORS			
C15, C18	CERAMIC 1000V 5PF	CRL	DD050	2
C11, C12, C20, C21	15PF		DD150	4
C6, C9, C34, C67	22PF		DD220	4
C24	SILVER MICA 5% 82PF	ARCO	DM15-820J	1
C2	910PF		DM15-911J	1
C31	1% 9100PF		DM20-912F	1
C68	CERAMIC 1000V .0022µF	CENTRAL LAB	DD222	1
C25	MYLAR .33µF	TRW	X663F	1
C10, C26, C32	CERAMIC 10V .1µF	CRL	UK10-104	3
C23, C36, C37, C38, C37, C40	20V ..1µF		UK20-104	6
C1	POLYSTYRENE 100V .1µF	ARCO	H-1281	1
C4	VARIABLE 2-8PF	ERIE	538-006-89A	1
C3	5.5-18PF		538-006-92R	1
C27, C29, C30	SELECTED VALUE			3
C22, C35	ELECTROLYTIC 15V, 100µF	RICHEY	16-375-100-15T	2
CR1-CR9	DIODES	FAIRCHILD	FD6666	9
IC5	INTEGRATED CIRCUIT	RCA	CA3030	1
IC2	LOW LEAKAGE (-18)		CA3039	1
IC6		MOTOROLA	MC816P	1
IC1, 3 & 4	-15	RCA	CA3030	3
K1-K6	RELAYS	PHIPPS	PS-864	6

PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	TRANSISTORS			
Q4, Q5	2N3563	FAIRCHILD	2N3563	2
Q7, Q8	2N3638		2N3638	2
Q3, Q6, Q12	2N3640		2N3640	3
Q9	2N3646		2N3646	1
Q11	2N3903		2N3903	1
Q13	2N3905		2N3905	1
Q1, Q2, Q14	TD101		TD101	3
	RESISTORS			
R53, R54	CARBON 1/2W, 5% 15Ω	STACKPOLE	RC20GF150J	2
R23, R26	47Ω		470J	2
R64	68Ω		680J	1
R48, R49, R52, R57, R76	100Ω		101J	5
R51, R56	10% 270Ω		271K	2
R9, R30	470Ω		471K	2
R14, R32, R81, R85, R66	1K		102K	5
R42, R47, R77, R83, R84	1.5K		152K	5
R20, R25, R34, R36, R50, R55, R89	1.8K		182K	7
R60, R63	3.3K		332K	2
R82, R87	5.6K		562K	2
R18, R73	6.2K		622K	2
R65, R67, R68	10K		103K	3
R10, R31, R70	5% 11K		113J	3

REF DES	DESCR…
	RESISTO…
R71	CARBON 1/2W…
R37	
R75	
R6, R7	
R2	
R29	
R12	
R13, R15, R22, R38	
R11	SELECTED
R59, R62	METAL FILM…
R44	
R24, R88, R39, R40, R41, R43	
R4	
R8	
R58, R61	
R17	
	POTENTIOM…
R19	
R21	
R69	
R1, R16, R46, R74, R79, R80	



PARTS LIST			
ESCRIPTION	MFGR	MFGR NO.	QTY
ISTORS			
N ½W, 10% 12K	STACKPOLE	RC20GF123K	1
22K		223K	1
33K		333K	1
110K		114K	2
470K		474K	1
1M		105K	1
5% 8.2M		825J	1
10% 10M		106K	4
CTED VALUE			1
FILM ⅛W, 1% 2K	CORNING	RN60D	2
2.87K			1
3.01K			6
9.53K			1
12.1K			1
21.5K			2
15K			1
NTIOMETERS			
100Ω	A/B	FR101M	1
250Ω		FR251M	1
1K		FR102M	1
100K		FR104M	6

PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
◎	TERMINAL	USECO	20108-1	16
	CIRCUIT BOARD	WAVETEK	157-114F	1

rev	ecn	by	date	app.
H	ECN 676	Bo		
G	ECN 440	[illegible]	6/1/72	
F	REDRAWN	EH	6/11/69	

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

scale 2/1

material N/A

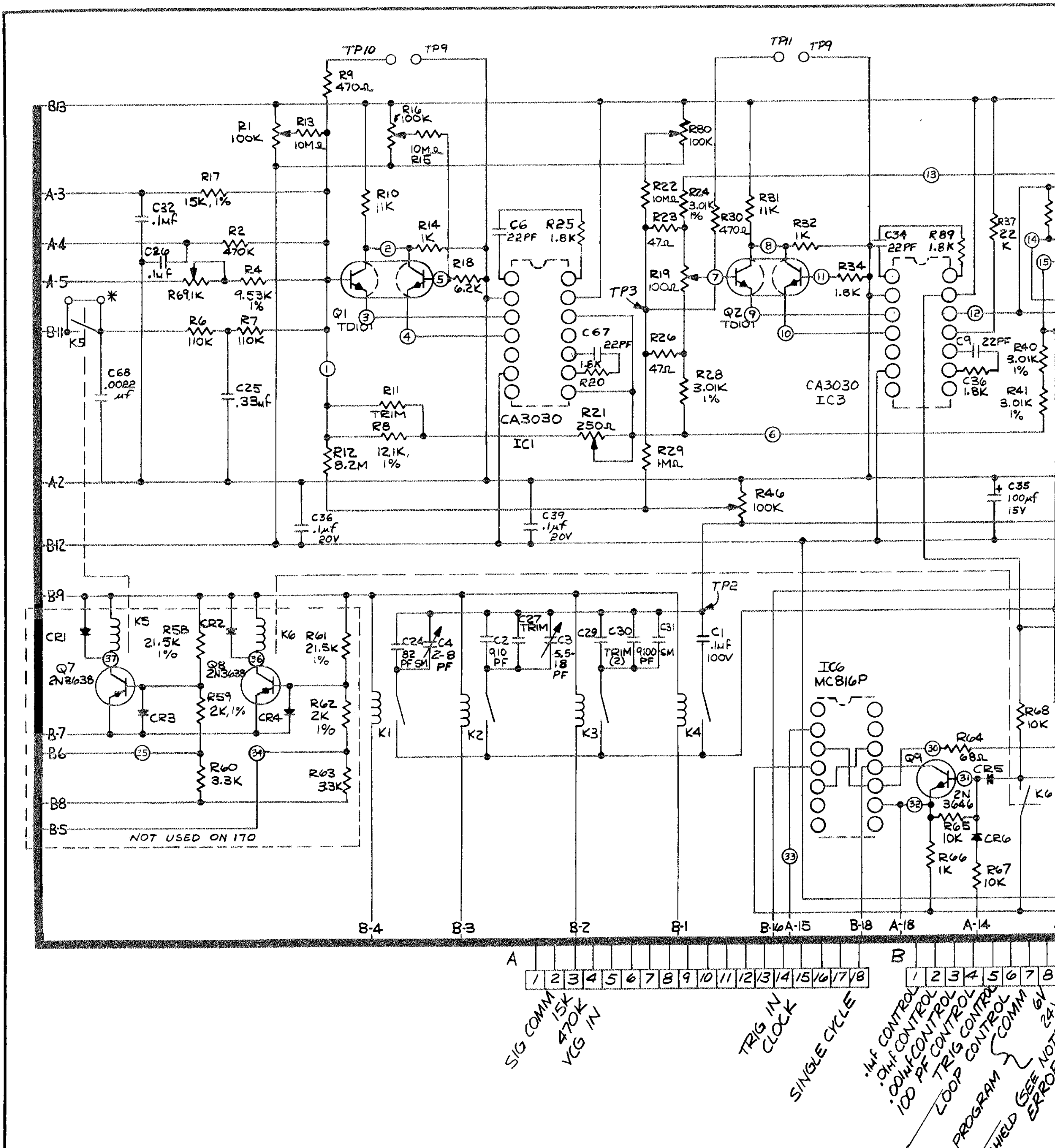
finish N/A

WAVETEK san diego, calif

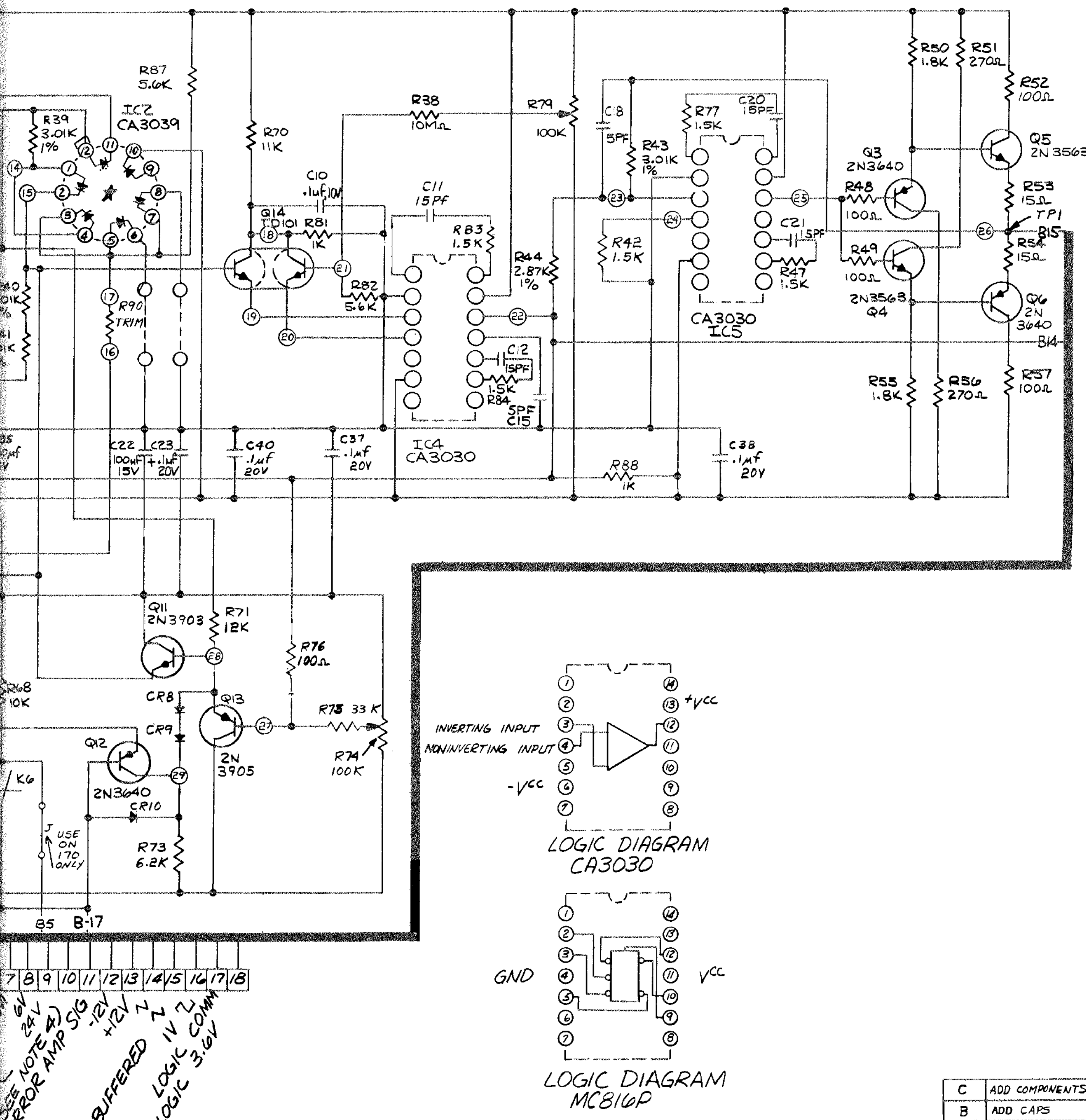
by E. HOLAWAY date 6/11/69 app. [illegible]

title ASS'Y VCG BOARD

model no. 157 dwg no. D157-014 rev H



NOTES UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE 1/2W, 10% CARBON
2. DIODES ARE FD6666
3. RELAY SHIELD IS B10
4. RELAYS ARE PHIPPS - PS-864
5. FOR MODEL 170 REMOVE K5 AND ADD JUMPER
6. ★ - CA3039 SELECTED FOR LOW LEAKAGE



rev	ecn	by	date	app.
C	ADD COMPONENTS	FGS	4-23-69	
B	ADD CAPS	FGS	2-24-69	
A	ADD 170 OPTION	EH		

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

scale N/A

material N/A

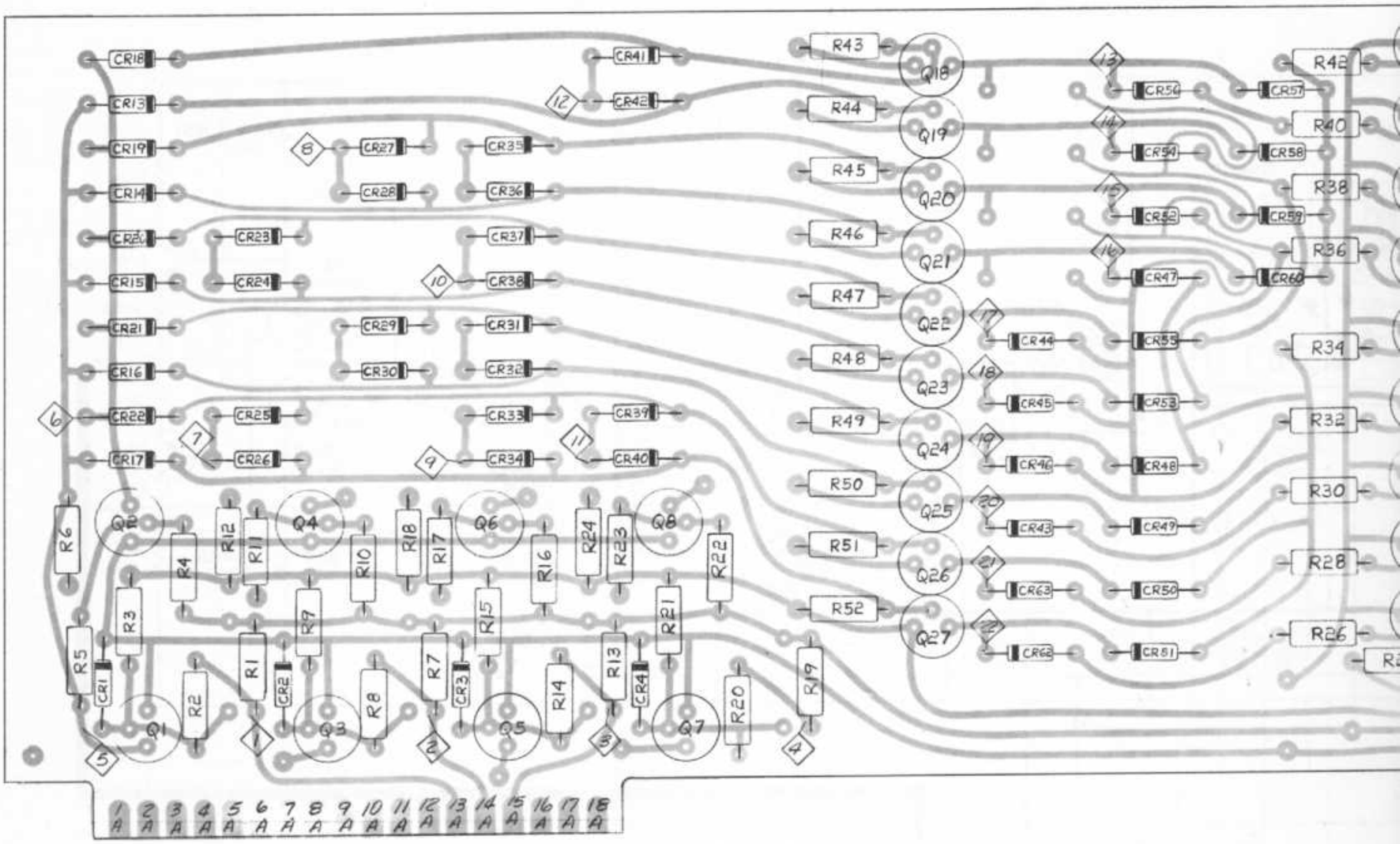
finish N/A

WAVETEK san diego, calif

by M Bocchicchio date 1-9-69 app.

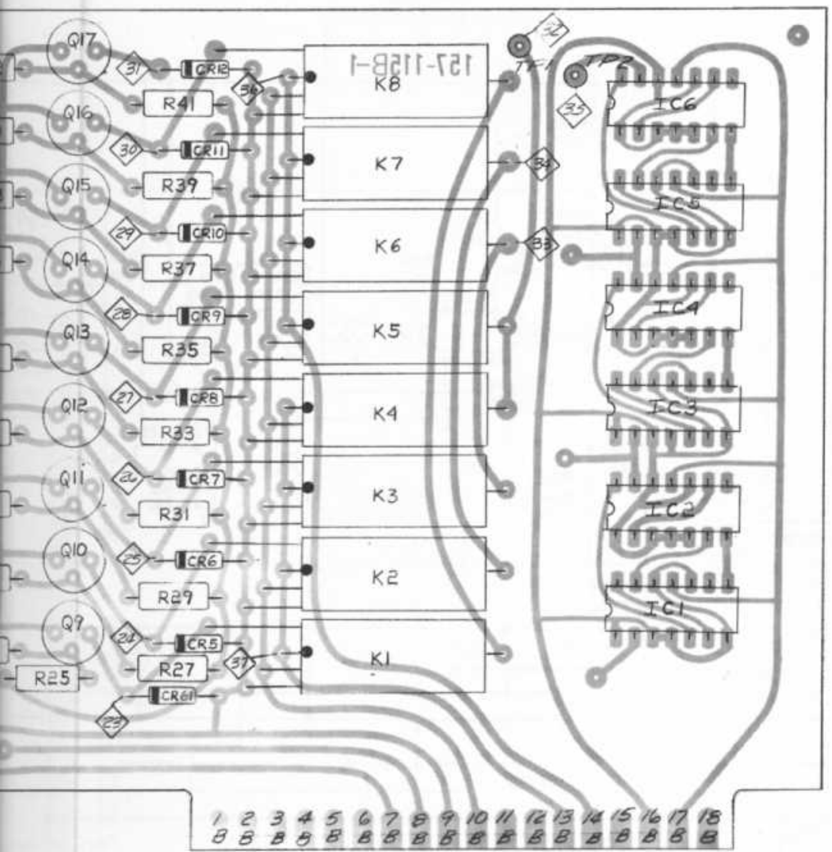
title SCHEMATIC – VCG, INTEGRATOR A CONFIGURATION

model no. 157 & 170 dwg no. 157-214 rev C



PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	DIODES			
CR1-CR63	FD6666	FAIRCHILD	FD6666	63
	INTEGRATED CIRCUIT			
IC1-IC6	MC890P	MOTOROLA	MC890P	6
K1-K8	RELAYS	PHIPPS	PS-864	8
	TRANSISTORS			
Q1-Q9 Q10-Q12 Q18-Q27	2N3638	FAIRCHILD	2N3638	22
Q13, Q14 Q15, Q16 Q17	2N3638A		2N3638A	5
	RESISTORS			
R1, R7 R13, R19	CARBON 1/2W, 10% 3.3K	STACKPOLE	RC20GF332K	4
R6, R12 R18, R24	12K		123K	4
R26, R28 R30, R32 R34, R36 R38, R40 R42	18K		183K	9
R5, R11 R17, R23	47K		473K	4
R4, R10, R16 R22, R25, R27 R43 - R52 R29, R31, R33 R35, R37 R39, R41	100K		104K	23

PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
R2, R8 R14, R20	METAL FILM 1/4W, 1% 2K	CORNING	RN60D	4
R3, R9 R15, R21	21.5K			4
◎	TERMINALS	USECO	20108-1	2
	CIRCUIT BOARD	WAVETEK	157-115B	1



	ECN 440		6/1/72	
C	REDRAWN	EH	6/4/69	
rev	ecn	by	date	app.

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

WAVETEK san diego, calif

by E. HOLAWAY date 6/4/68

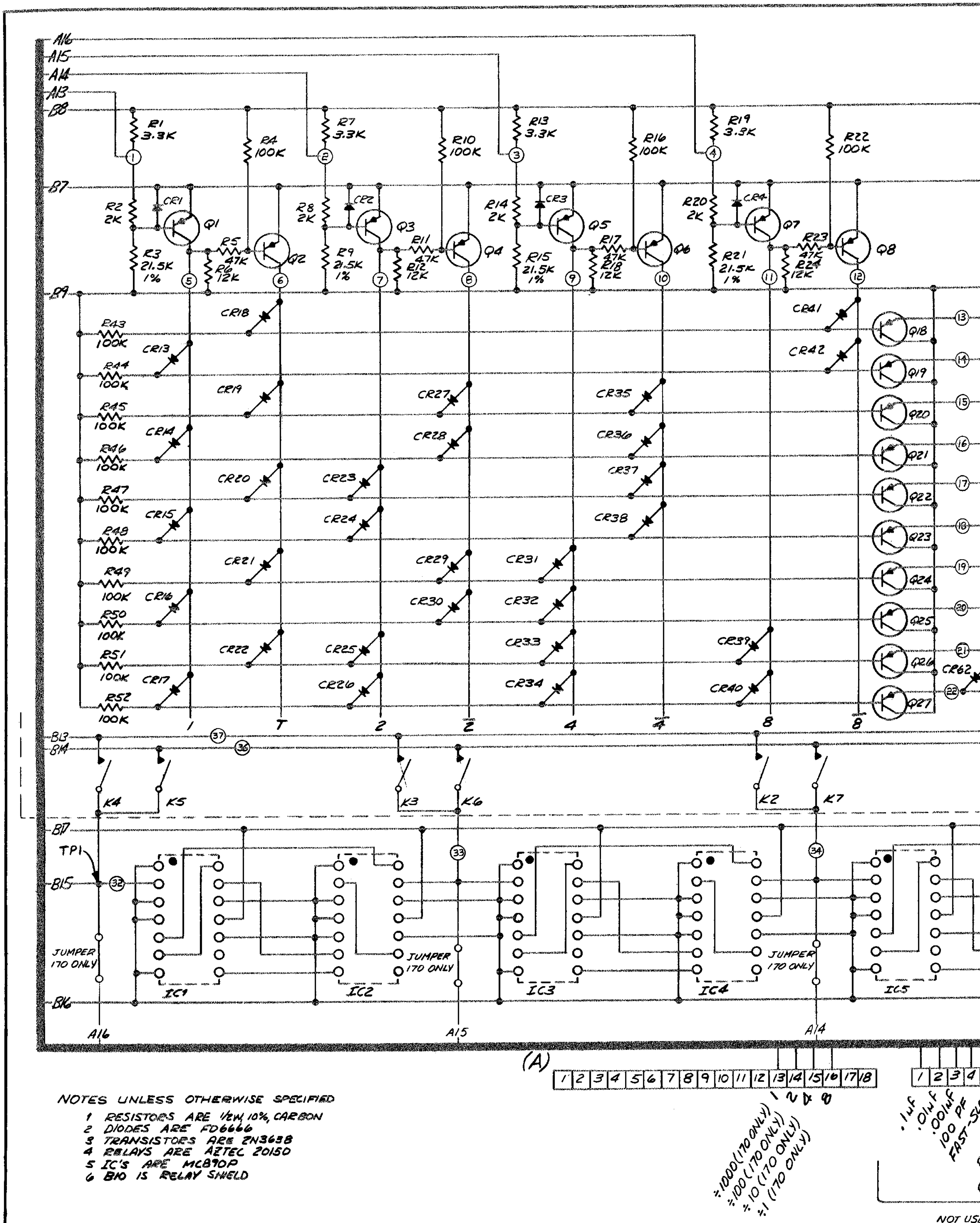
scale 2/1

material N/A

title ASS'Y RANGE MATRIX

model no. 157 dwg no. D157-015 rev D

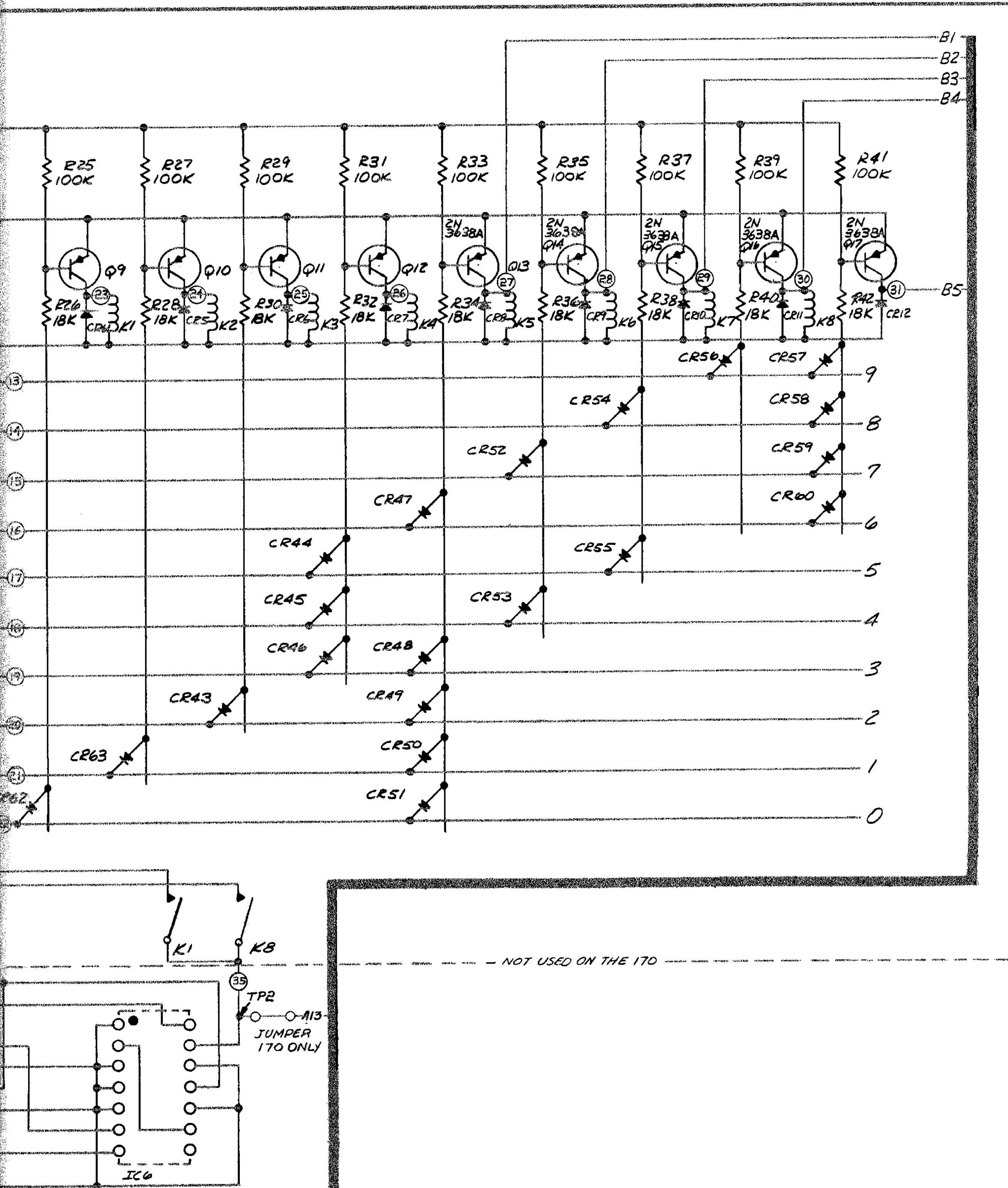
finish N/A

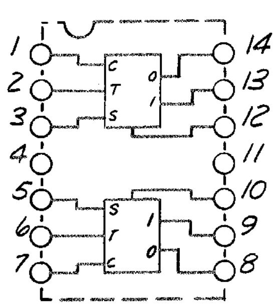


NOTES UNLESS OTHERWISE SPECIFIED

1. RESISTORS ARE 1/2W, 10%, CARBON
2. DIODES ARE FD6666
3. TRANSISTORS ARE 2N3638
4. RELAYS ARE AZTEC 2015D
5. IC'S ARE MC890P
6. B10 IS RELAY SHIELD

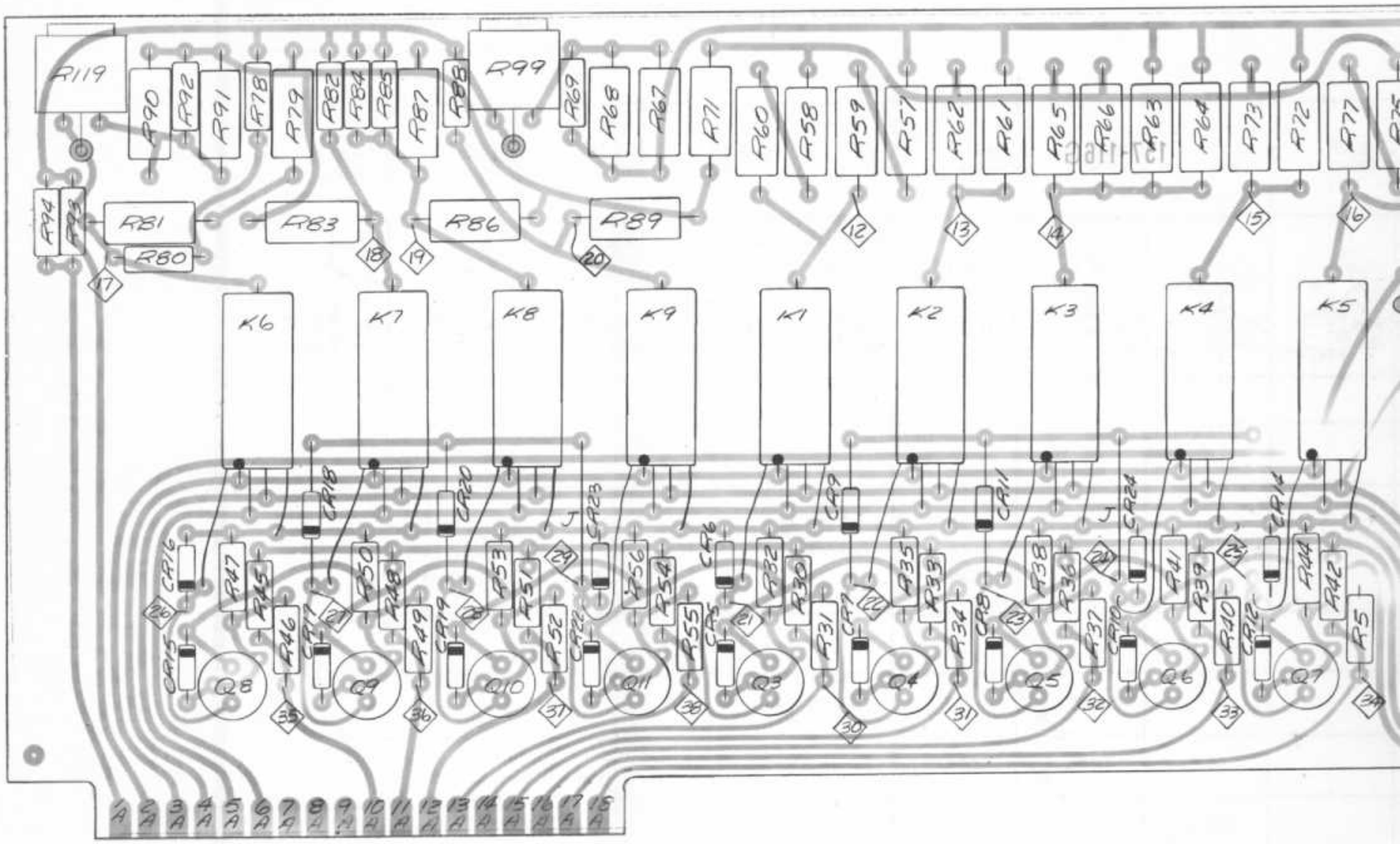
CR63, IC6, K8, Q27, R52





LOGIC DIAGRAM
MC 890P

tolerance unless otherwise specified	rev	ecn	by	date	app.
.XXX ± .010 .XX ± .030	WAVETEK san diego, calif				
scale N/A	by Bocchichio	date 9/25/68	app.		
material N/A	title SCHEMATIC RANGE MATRIX A CONFIGURATION				
	model no. 157 & 170	dwg no. SHT 1 OF 4 157-215	rev		
finish N/A					



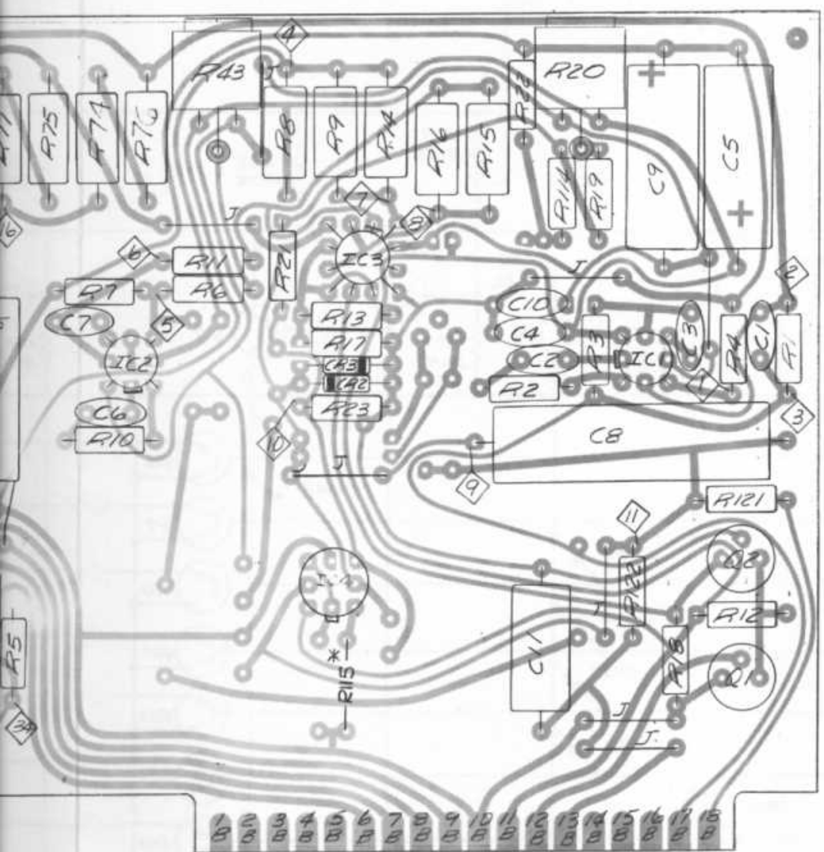
PARTS LIST

REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY	ECN
	CAPACITORS				
C1, C3, C7	CERAMIC 1000V 220PF	CRL	DD221	3	
C11	MYLAR 200V .33µf	TRW	X663F	1	
C2, C6	CERAMIC 50V .01µf	CRL	CK-103	2	
C4, C10	20V .1µf		UK20-104	2	
C8	MYLAR 200V 1% 1µf	ELECTRO CUBE	2108IC105F	1	
C5, C9	ELECTROLYTIC, 15V, 100µf	RICHEY	16-375-100-15T	2	
CR2,3, CR14-23	DIODE FD6666	FAIRCHILD	FD6666	20	
K1-K9	RELAYS FORM C	PHIPPS	PS 865	9	
IC1, IC2	INTEGRATED CIRCUIT µA709	FAIRCHILD	µA709	2	
IC3	LOW LEAKAGE (-18)	RCA	CA3039	1	
IC4	MC1456	MOTOROLA	MC1456	1	
	TRANSISTORS				
Q6, Q11	2N3638A		2N3638A	2	
Q1, Q2	2N3905	MOTOROLA	2N3905	2	
Q3-Q5, Q7, Q8-Q10	2N3638	FAIRCHILD	2N3638	7	
R99, R119	POTENTIOMETER 1K	A/B	FR102M	2	
R20, R43	100K	A/B	FR104M	2	

PARTS LIST

REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
	RESISTOR			
R3, R11	CARBON 1/2W, 5%, 47Ω	STACKPOLE	RC20GF470J	2
R22	100Ω		101J	1
R12	10%, 820Ω		821K	1
R18, R121	1K		102K	2
R2, R10, R17	1.5K		152K	3
R4	5%, 3K		302J	1
R30, R33, R36, R39, R42, R45, R48, R51, R54	10%, 3.3K		332K	9
R23	5%, 5.1K		512J	1
R114	10%, 10K		103K	1
R13	22K		223K	1
R122	110K		114K	1
R19, R21	1MΩ		105K	2
R93	5%, 24MΩ		245J	1
R6	10%, 2.2MΩ		225K	1
R5, R31, R34, R37, R40, R46, R49, R52, R55	METALFILM, 1/4W, 1% 2K	CORNING	RN60D	9
R1	4.99K			1
R32, R35, R38, R41, R44, R47, R50, R53, R56	21.5K			9
R94	698K			1
R69, R92	METALFILM, 1/8W, 1%, 499K	CORNING	RN55D	2

REF DES	
	R
R78, R80, R82, R84, R85, R88	ME M
R7	
R8, R9	W
R14-R16	¼
R67, R68	W
R90, R91	¼
R79, R81, R83, R86, R87, R89	W ¼ M
R58, R60, R62, R65, R66, R73, R75, R77	W ¼ M
R57, R59, R61, R63, R64, R72, R74, R76	W ¼ M
R71	W
◎	
	C
R115	S



...ES	DESCRIPTION	MFGR	MFGR NO	QTY
	PARTS LIST			
	RESISTORS			
...80 ...84 ...88	METALFILM 1/4W, 1% 301K MATCHED SET (-26)	CORNING	RN60D	6
	1.1K	|	|	1
...7 ...6	WIREWOUND 1/4W .025% 3.2K	MEKTRON	MK-3	5
...58 ...91	WIREWOUND 1/4W 1% 40K	|	|	4
...81 ...86 ...89	WIREWOUND 1/4W, .1% 40K MATCHED SET (-23)	|	|	6
...60 ...65 ...73 ...77	WIREWOUND 1/4W .01% 40K MATCHED SET (-23)	|	|	8
...59 ...63 ...72 ...76	WIREWOUND 1/4W, .025% 40K MATCHED SET (-23)	|	|	8
	WIREWOUND, 1/4W, .01%, 72K	|	|	1
	TERMINALS	USECO	20108-1	4
	CIRCUIT BD	WAVETEK	157-116G	1
	SELECTED IN CALIB			

* TO EITHER PIN 1 OR PIN 5 IN CALIBRATION

rev	ecn	by	date	app.
F	ECN 627		5-3-73	
E	ECN 560		1/4/73	S
D	ECN 440		6/7/72	
C	COP 33		9/18/70	
B	ECN 295	N.G	2/4/70	

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

WAVETEK san diego, calif

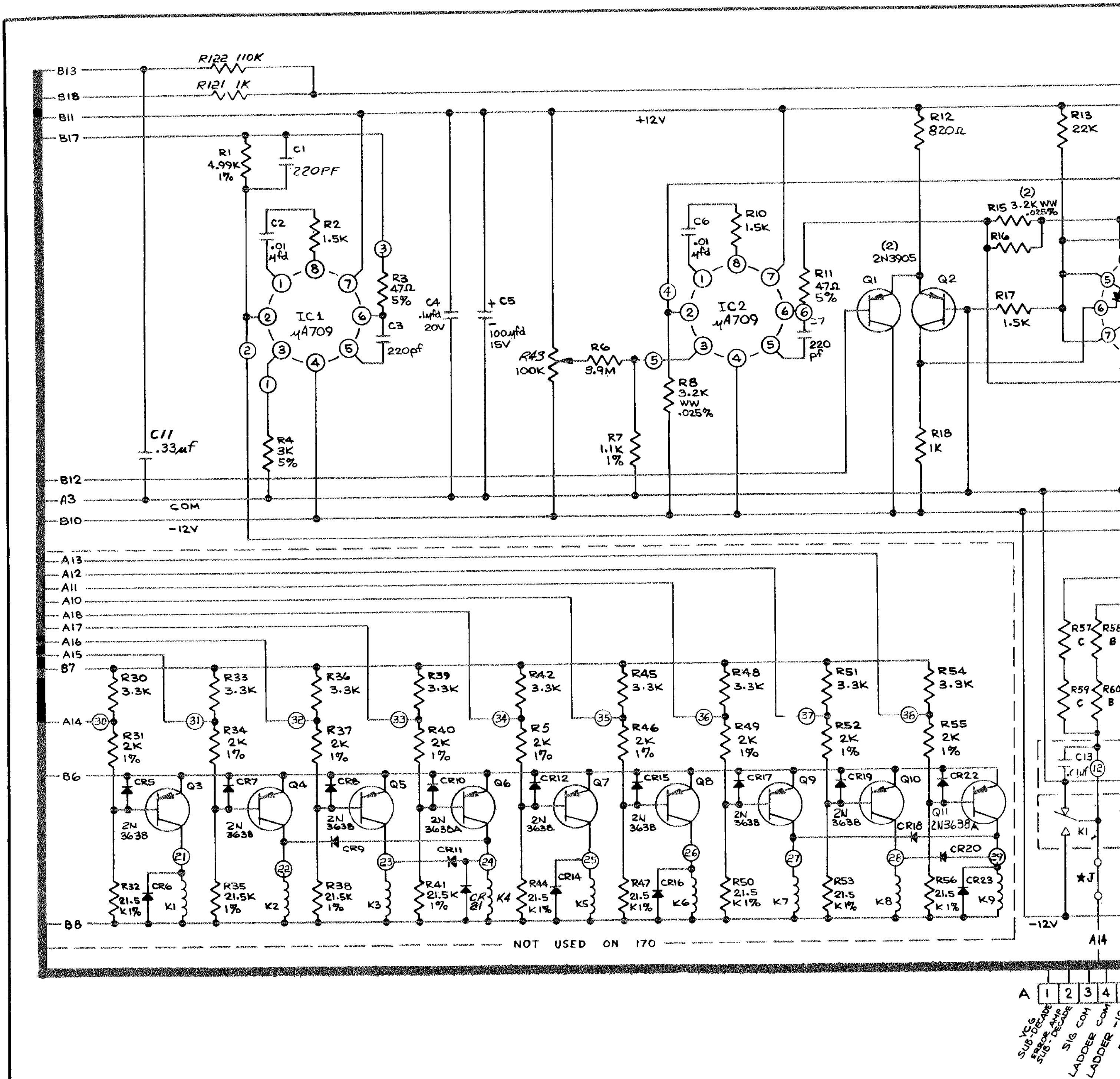
scale N/A | by BOCHICHIO | date 7-7-69 | app.

material N/A

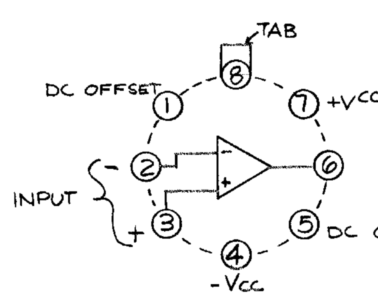
title ASS'Y ERROR AMPLIFIER

model no. 157 | dwg no. D157-016 | rev F

finish N/A

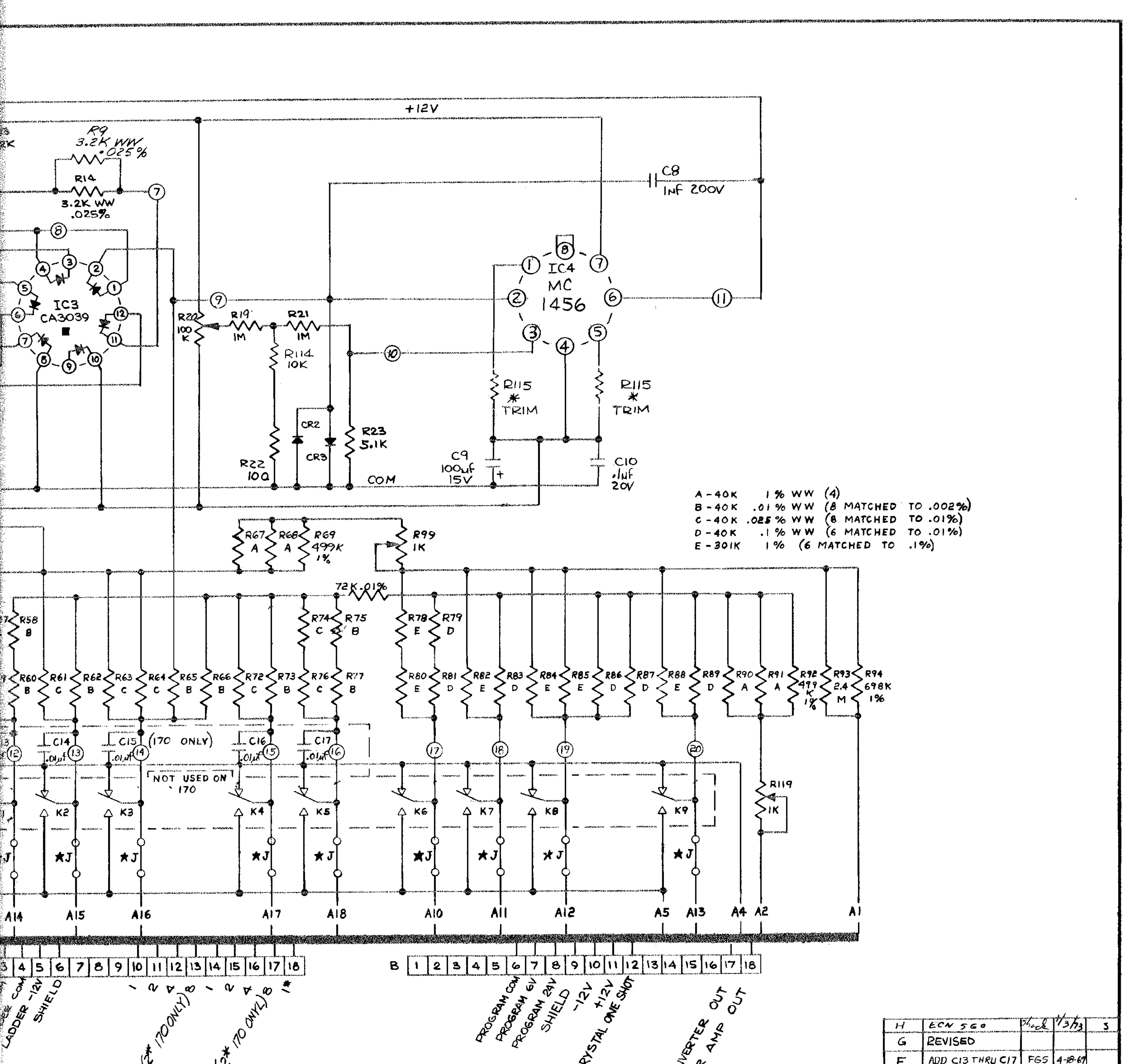


Notes - U
1. ALL R
2. ALL 1
3. ALL D
4. SHIEL
AG
5✱ R115
PIN 1 C
6.★ JUM
7. C13 TH
8. ■ CA3

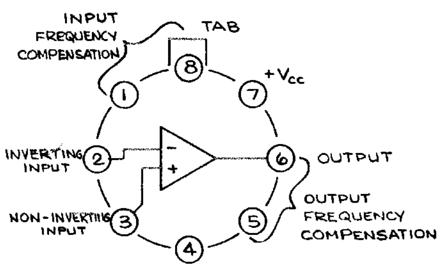


LOGIC DIAGRAM

MC1456



S – UNLESS OTHERWISE SPECIFIED
LL RESISTORS ½W 10% CARBON.
LL 1% RESISTORS ARE ¼WATT.
LL DIODES FD6666
SHIELDS OF RELAYS GO TO
A6 & B9
R115 TO BE CONNECTED TO
N 1 OR 5 IN CALIBRATION
JUMPERS USED ON 170 ONLY
13 THRU C17 USED ON 170 ONLY
CA3039 SELECTED FOR LOW LEAKAGE



(PIN 4 CONNECTED TO CASE)

LOGIC DIAGRAM
FOR μA709
& 801B

LATEST COMPONENT DESIGNATOR USED

IC4	R120
CR25	Q12
C12	K9

rev	ecn	by	date	app.
H	ECN 560	Shack	1/3/73	S
G	REVISED			
F	ADD C13 THRU C17	FGS	4-18-69	
E	ADD C11-R121-R122	FGS	3-13-69	
D	ADD 47Ω	FGS	2-24-69	
C	ADD AMP ASS'Y	FGS	2-13-69	
B	ADD 170 OPTION	FGS	1-30-69	
A	REDRAW LOGIC			

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

scale NONE

material N/A

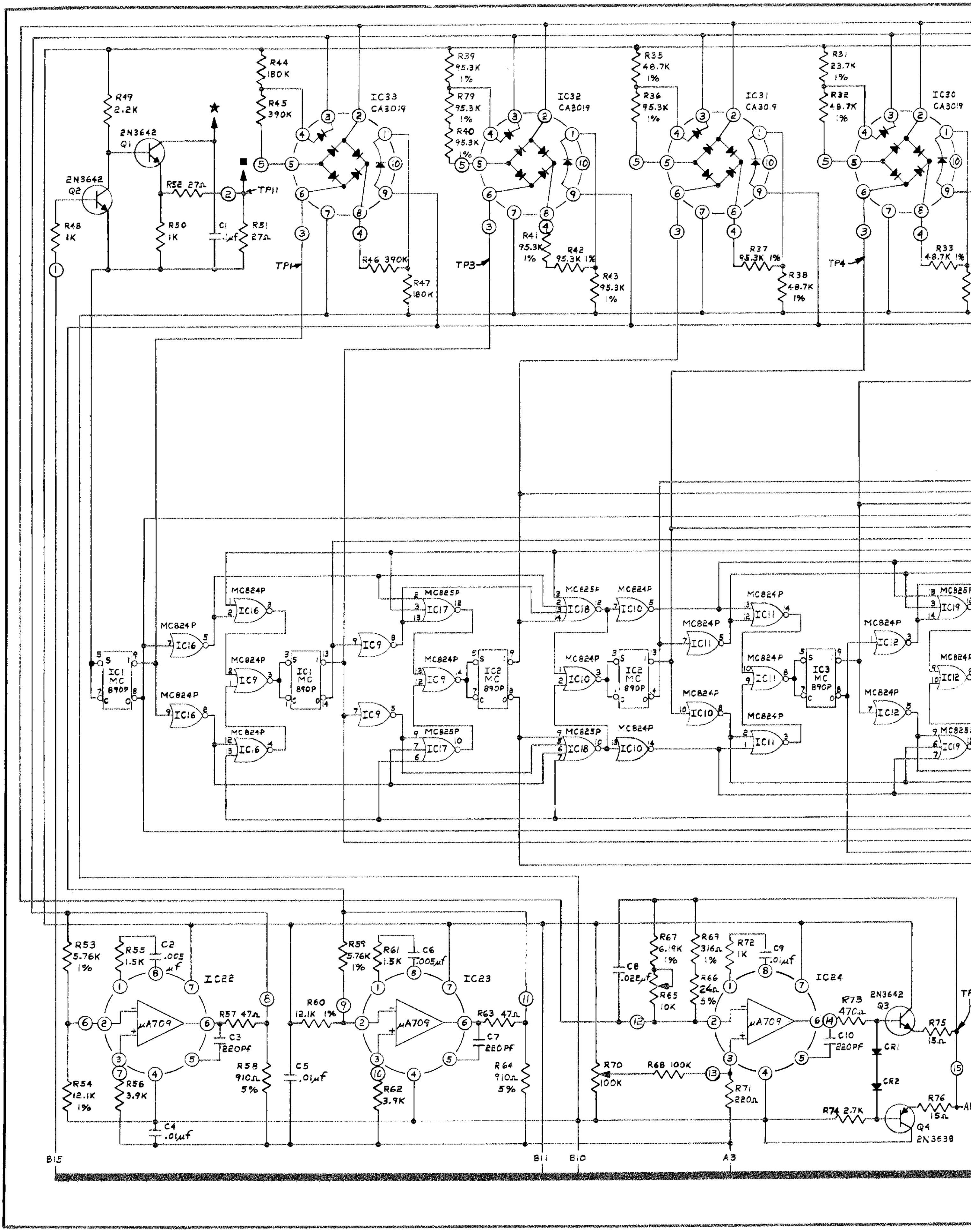
finish N/A

WAVETEK san diego, calif

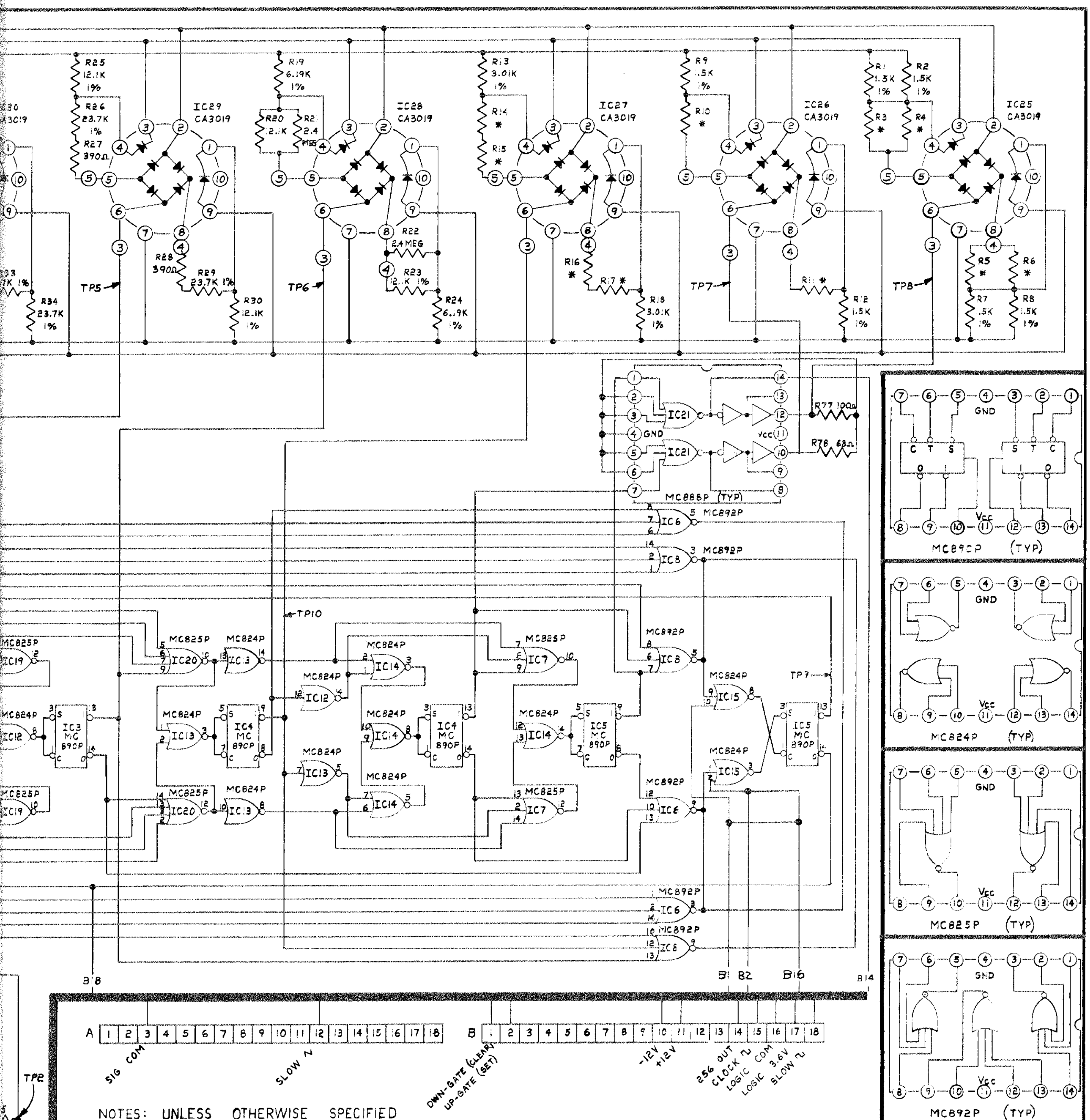
by L. ADAMSON date 9/17/68 app. [signature]

title A CONFIGURATION ERROR AMPLIFIER & 1ST & 2ND FREQUENCY DECADE SCHEM.

model no. 157 | dwg no. D157-216 | rev H



R49 2.2K
2N3642 Q1
2N3642 Q2
R48 1K
R52 27Ω
R50 1K
C1 .1μf
R51 27Ω
TP11
TP1
R44 180K
R45 390K
IC33 CA3019
R46 390K
R47 180K
R39 95.3K 1%
R79 95.3K 1%
R40 95.3K 1%
IC32 CA3019
R41 95.3K 1%
R42 95.3K 1%
R43 95.3K 1%
TP3
R35 48.7K 1%
R36 95.3K 1%
IC31 CA3019
R37 95.3K 1%
R38 48.7K 1%
R31 23.7K 1%
R32 48.7K 1%
IC30 CA3019
R33 48.7K 1%
TP4
MC824P
MC825P
MC890P
IC1 MC 890P
IC2 MC 890P
IC3 MC 890P
IC9
IC10
IC11
IC12
IC16
IC17
IC18
IC19
R53 5.76K 1%
R55 1.5K
C2 .005 μf
IC22
μA709
R57 47Ω
C3 220PF
R58 910Ω 5%
R54 12.1K 1%
R56 3.9K
C4 .01μf
C5 .01μf
R60 12.1K 1%
R59 5.76K 1%
R61 1.5K
C6 .005μf
IC23
R63 47Ω
C7 220PF
R64 910Ω 5%
R62 3.9K
C8 .022μf
R67 6.19K 1%
R65 10K
R69 316Ω 1%
R66 24Ω 5%
R72 1K
C9 .01μf
IC24
R73 470Ω
2N3642 Q3
R75 15Ω
C10 220PF
CR1
CR2
R70 100K
R68 100K
R71 220Ω
R74 2.7K
R76 15Ω
Q4 2N3638
B15
B11
B10
A3

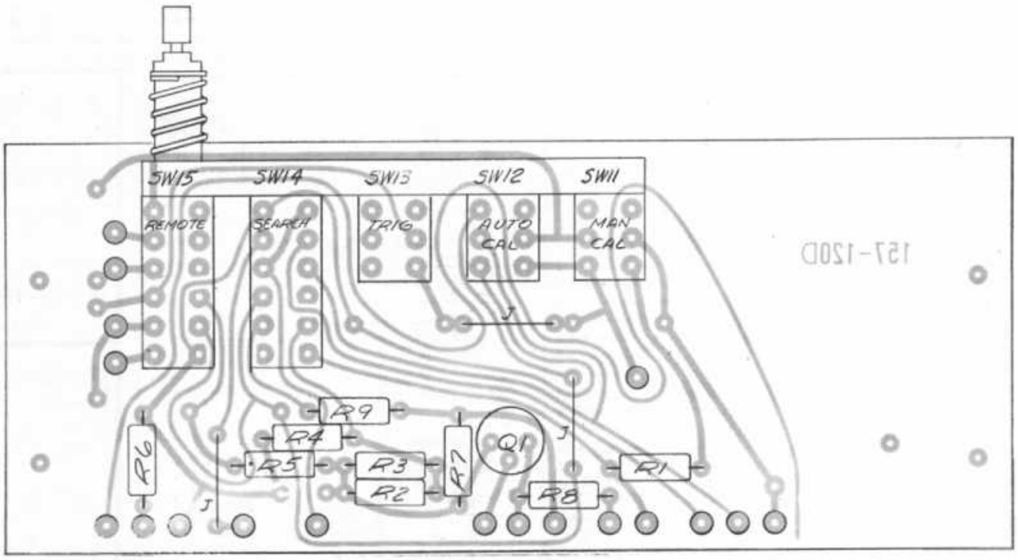


NOTES: UNLESS OTHERWISE SPECIFIED

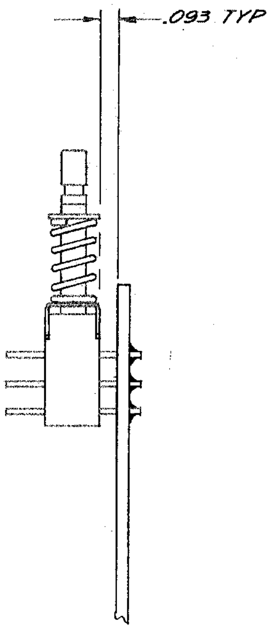
1. ★ LOGIC 3.6V FROM B17 TO PIN 11 IC1 THRU IC22
2. ■ TO PINS 2 & 6 IC1 THRU IC5
3. ✱ (10) MATCHED RESISTORS 3.01K MATCHED TO ±.05% & WITHIN .2% OF 3.01K
4. B16 LOGIC COMMON CONNECTS TO THE FOLLOWING PINS (4 IC6-8-14-18-20) (4-6 IC11) (4-10-12 IC2-3-4-5) (3-4-5 IC7) (4-6-10IC9-14,IC16) (2-6-13 IC12) (4 IC15) (4-5-14 IC17) (2-4-5 IC19) (4-6-9-12 IC10-13) (2-3-4-5-6 IC21) (4-5-7-10-12 IC1)

REV	ECN	BY	DATE	APP
C	ADD SYNC OPTION	FGS	5-27-69	
B	RE-DRAWN	FGS	2-15-69	

tolerance unless otherwise specified .XXX ± .010 .XX ± .030	WAVETEK san diego, calif
scale N/A	by FGS · date 3-4-68 · app.
material N/A	title SCHEMATIC DIAGRAM COUNTER
	model no. 157 · dwg no. 157-219 · rev C
finish N/A	this document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, operation and maintenance without written authorization.



PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	CAPACITOR			
Q1	TRANSISTOR	FAIRCHILD	2N3642	1
	RESISTOR			
R8	CARBON 1/2W, 5% 47Ω	STACKPOLE	RC20GF470J	1
R6	10% 1K		102K	1
R1	3.3K		332K	1
R7	6.8K		682K	1
R3, R9	15K		153K	2
R4	5% 30K		303J	1
R2	10% 330K		334K	1
R5	METAL FILM 1/4W, 1% 7.5K	CORNING	RN60D	1
	AMP PINS	AMP	60597-1	17
SW11, SW12 SW13, SW14, SW15	SWITCH ASSY	WAVETEK	8157-421	1
	CIRCUIT BOARD		157-120D	1



rev	ecn	by	date	app.
B	ECN 318	NG	10/22/70	
A	REDRAWN	EH	9/5/69	

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

scale 2/1

material N/A

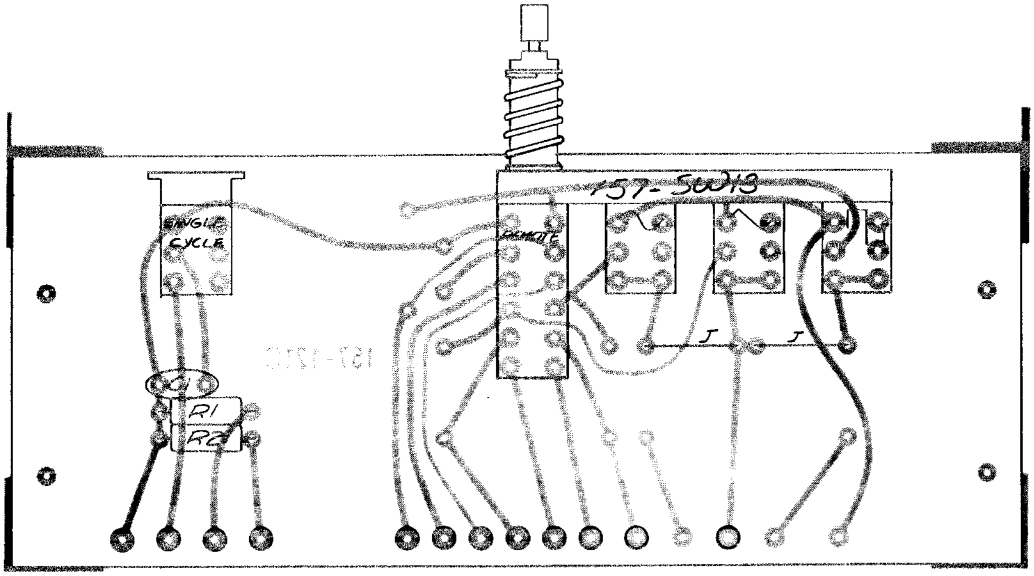
finish N/A

WAVETEK san diego, calif

by E. HOLAWAY date 6/5/69 app

title ASS'Y LEFT SWITCH BD.

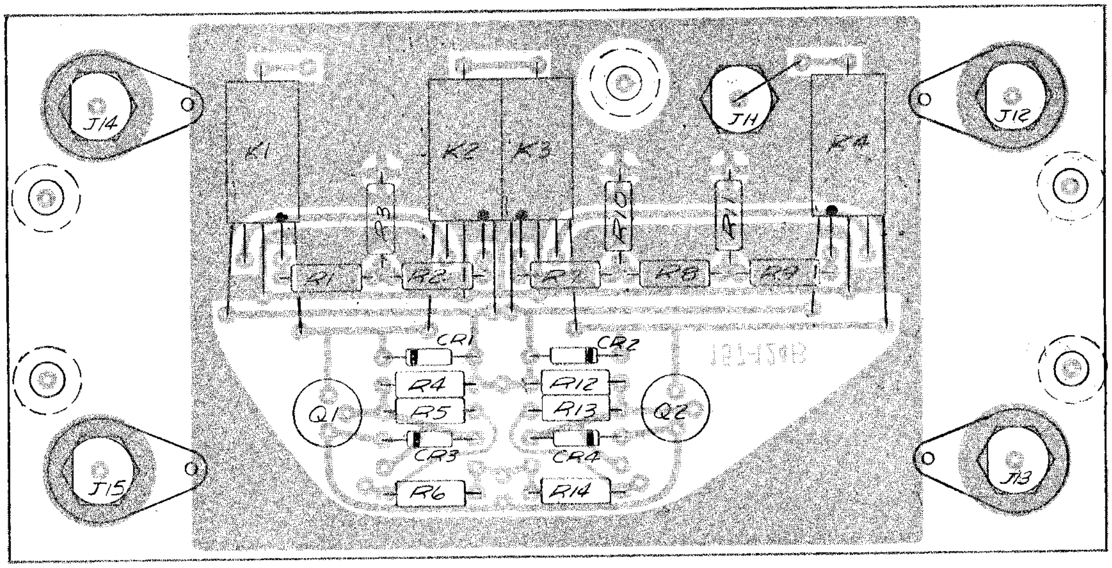
model no.	dwg no.	rev
157	D157-020	B



PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	CAPACITOR			
C1	CERAMIC 1000V 100PF	CRL	DD101	1
	RESISTOR			
R1, R2	CARBON 1/2W, 5% 10Ω	STACKPOLE	RC20GF100J	2
○	AMP PINS	AMP	60599-1	11
	SWITCHES	WAVETEK	157-SW13	1
	CIRCUIT BOARD		157-121C	1

rev	ecn	by	date	app.
A	REDRAWN	EH	6/6/69	

tolerance unless otherwise specified .XXX ± .010 .XX ± .030	WAVETEK san diego, calif		
scale 2/1	by E. HOLAWAY	date 6/6/69	app.
material N/A	title ASS'Y RIGHT SWITCH BD		
finish N/A	model no. 157	dwg no. 157-021	rev A



PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO.	QTY
	DIODES			
CR1-CR4		FAIRCHILD	FD6666	4
J11-J15	BNC CONNECTOR	KING	UG657/U	5
K1-K4	RELAYS (FORM C)	PHIPPS	PS-865	4
Q1, Q2	TRANSISTOR	FAIRCHILD	2N3638	2
	SOLDER LUG	H. SMITH	1497	4
	RESISTORS			
R6, R14	CARBON 1/2W, 10% 3.3K	STACKPOLE	RC20GF332K	2
R3, R10, R11	METAL FILM 1/4W, 1% 10Ω	CORNING	RN60D	3
R1, R2 R7, R9	40.2Ω			4
R8	60.6Ω			1
R5, R13	2K			2
R4, R12	21.5K			2
	STANDOFF	WAVETEK	A110-311A	5
	CIRCUIT BOARD		157-124B	1

rev	ecn	by	date	app.
D	ECN. 295	NG	1/30/70	
C	REDRAWN	EH	9/6/69	

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

scale 2/1

material N/A

finish N/A

WAVETEK san diego, calif

by E. HOLAWAY date 6/6/69 app

title ASS'Y ATTENUATOR BOARD

model no.	dwg no.	rev
157	D157-024	D