

INSTRUCTION MANUAL

MODEL 131A VCG GENERATOR



WAVETEK

WAVETEK CORPORATION, 11000 W. CENTRAL EXPRESSWAY, DALLAS, TEXAS 75243

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.

WARRANTY

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

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

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

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

CONTENTS

Section		Page No.
1	SPECIFICATIONS	
	Versatility	1
	Horizontal Precision	1
	Vertical Precision	1
	Purity	2
	Environmental	2
	Mechanical	2
2	OPERATION	
	Inspection	3
	Operating Controls	4
	Operation	5
3	CIRCUIT DESCRIPTION	
	General Description	8
4	MAINTENANCE	
	Introduction	10
	Recommended Test Equipment	10
	Checkout and Calibration	10
	Troubleshooting	12
	Removal of Dust Covers and Panels	14
	Replacement of Switch Wafers and Potentiometers	14
	Replacement of Sine Converter	15
5	DATA PACKAGE	
	Introduction	16
	List of Manufacturers	16

SCOPE OF MANUAL

This manual contains instructions for operating, testing, and maintaining the Wavetek Model 131 and the 131A VCG Generator. The 131A is identical to the 131 with the addition of a step attenuator and a output impedance selector switch. The Wavetek product-improvement program ensures that the latest electronic developments are incorporated into the Wavetek instruments by the addition of circuit and component changes as rapidly as development and testing permit. Due to the time required to document and print these Instruction Manuals, it is not always possible to get these changes incorporated into the

manual. In this case, data will be found on engineering change sheets at the back of the manual. If there are no change sheets, the manual is correct as printed.

SCOPE OF EQUIPMENT

The Model 131A is a precision source of sine, square, and triangle waveforms, with selectable and variable outputs over a dynamic frequency range of 0.2 Hz to 2 MHz. It can be manually operated with easy-to-use, front-panel controls and also offers frequency control by external voltage for either dc programming of wideband ac FM applications.

SECTION 1

SPECIFICATIONS

VERSATILITY

Waveforms

Sine , square , and triangle 

Dynamic Frequency Range

50 Ω OUT	0.2 Hz to 2 MHz
600 Ω BAL OUT	0.2 Hz to 20 kHz
600 Ω BAL OUT	Usable to 2 MHz

Ranges

X10	0.2 Hz to 20 Hz
X100	2 Hz to 200 Hz
X1K	20 Hz to 2 kHz
X10K	200 Hz to 20 kHz
X100K	2 kHz to 200 kHz
X1M	20 kHz to 2 MHz

Outputs

Sine , square , and triangle , selectable; output is controlled with 60 dB step attenuator in 10 dB steps with overlapping vernier control. 50 Ω output impedance, 20 V p-p into open circuit and 10 V p-p into 50 Ω load from 50 Ω source impedance. 600 Ω output impedance balanced with center tap; 20 V p-p into open circuit and 10 V p-p into 600 Ω balanced load from 600 Ω balanced source impedance. Short circuit current is ± 100 milliamperes.

NOTE

When 600 Ω BAL OUT is used as a balanced output, the instrument signal common may not be tied to any external signal common unless the common is completely floating and no dc path exists to the 131A common (BNC shell).

Sync Output

Greater than 1 V p-p square wave into open circuit at 600 Ω output impedance.

DC Offset

± 5 V offset (± 2.5 V offset into 50 Ω load or 600 Ω balanced load) controlled from rear panel; peak amplitude limited by the dynamic range of the amplifier output. DC offset voltage as well as waveform is proportionally attenuated by the step attenuator.

VCG—Voltage Controlled Generator

Frequency of generator may be dc-programmed or ac-modulated by external 0 to 5 V signal. Voltage control circuitry is capable of 1000:1 deviation of the output frequency. The VCG amplifier has a 100 kHz bandwidth and a slew rate of 0.1 V/ μ sec. The instantaneous frequency is the result of the sum of the dial setting and the externally applied voltage.

Stability

Short term $\pm 0.05\%$ for 10 minutes
 Long term $\pm 0.25\%$ for 24 hours
 Percentages apply to amplitude, frequency, and dc offset.

HORIZONTAL PRECISION

Dial Accuracy

$\pm 2\%$ of full scale, 1 Hz to 2 MHz.

Electronic Frequency Vernier

One turn for approximately 1% of full scale change.

Time Symmetry

$\pm 1\%$ through X100K range.

VERTICAL PRECISION

Sine Wave Frequency Response

Amplitude change with frequency less than:

0.1 dB from 0.2 Hz to 200 kHz

0.5 dB from 0.2 Hz to 2 MHz

Step Attenuator Accuracy

± 0.25 dB/10 dB.

PURITY**Sine Wave Distortion**

Less than:

- 0.5% on X10, X100, X1K, X10K ranges
- 1.0% on X100K range
- 2.0% on X1M range

Square Wave Rise and Fall Time

Less than 50 ns.

ENVIRONMENTAL**Temperature**

All specifications listed, except stability, are for 25°C ±5°C. The generator will operate from 0°C to 55°C.

MECHANICAL**Dimensions**

8½ in./21.6 cm wide, 5¼ in./13.3 cm high, 11½ in./29.2 cm deep.

Weight

8 lb/3.6 kg net, 11 lb/4.99 kg shipping.

Power

105 V to 125 V or 200 V to 250 V, 50 Hz to 400 Hz.
Less than 15 watts

NOTES

All specifications apply for frequencies obtained when dial is between 0.1 and 2 and at 10 V p-p into a 50Ω load.

It is possible to stop the generator from oscillating by applying a negative voltage when the dial is already set at minimum frequency. Inputs up to 30 V will not permanently damage the instrument, however.

SECTION 2 OPERATION

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. If your instrument is a 131, disregard any instructions pertaining to the 600Ω balanced output or the step attenuator.

Checking Visually

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. Retain the shipping container and packing material for use in case reshipment is required.

Checking Electrically

NOTE

Instruments are normally shipped connected for 115 V power unless 230 V power is ordered. Refer to the end of this section for conversion instructions.

The steps in this paragraph provide a quick checkout of instrument operation. If electrical deficiencies exist, refer to the *Warranty* in the front of this manual. The following test equipment, or equivalent, is recommended for performing this electrical inspection. (Refer to Page 4 and Figure 2-2 for operating control descriptions.)

Name	Manufacturer	Model
Oscilloscope	Tektronix	544
Oscilloscope Plug In	Tektronix	1A5
Counter-Timer	Monsanto	101A

1. Turn FREQ HZ selector to the X1K position. (This connects ac power to the unit and establishes the frequency multiplier).

2. Connect oscilloscope to the 50Ω OUT connector with a 50-ohm terminator and set the 50/600Ω selector to 50Ω.
3. Set frequency dial to the 1.0 mark and the frequency vernier to CAL position.
4. Set function selector to \sim .
5. Rotate 20 V P-P MAX control to its maximum clockwise position, with the attenuator in the 0 dB setting.
6. Check for 1-kHz sine wave with greater than 10 V p-p amplitude on oscilloscope.
7. Select \square and \wedge with function selector and check for 10 V p-p amplitude on oscilloscope.
8. Turn frequency dial from maximum counterclockwise to maximum clockwise positions and check for frequency change.
9. Step the output attenuator through its range and verify attenuation at each step.
10. Rotate 20 V P-P MAX control from maximum clockwise to maximum counterclockwise positions and check for decreasing amplitude.
11. Rotate VERNIER control and check for frequency change.
12. Set VERNIER control at maximum cw and frequency dial at .02. Set frequency to 20 Hz with counter. Connect a 0 to +5 Vdc input to the VCG IN connector. Slowly increase voltage input from 0 to maximum and check that frequency of output waveform increases from approximately 20 Hz to 2 kHz.
13. Connect the 600Ω balanced output connectors to a differential input oscilloscope (Tektronix 1A5 plug-in or equivalent) as shown in Figure 2-1.
14. Set 50/600Ω selector to 600Ω.
15. Repeat steps 5 through 10.

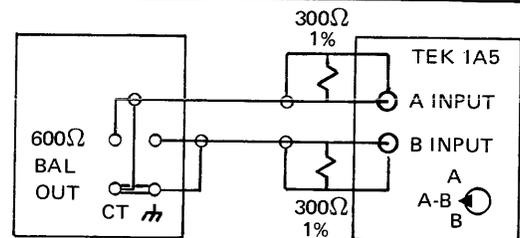


Figure 2-1. Test Set-up for 600Ω BAL

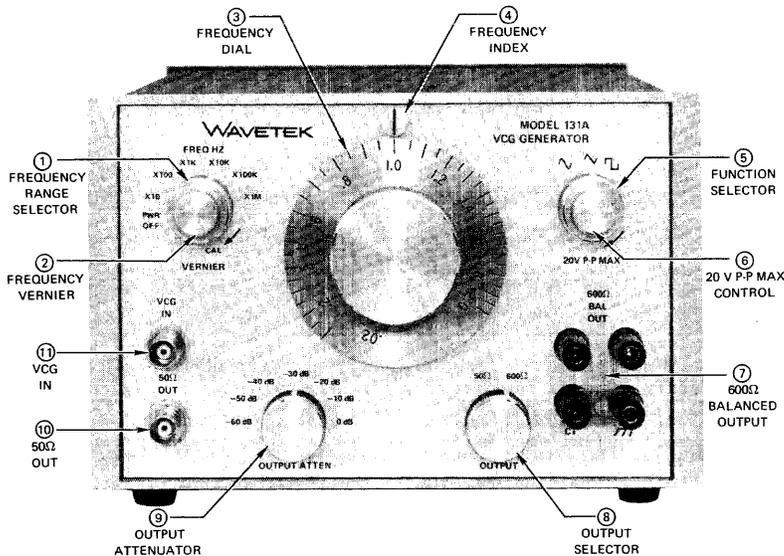


Figure 2-2. Operating Controls

OPERATING CONTROLS

The operating controls and electrical connections for the Model 131A are shown in Figure 2-2. The listing below discusses each control and its function.

1. **FREQ HZ/Power Switch** — This 7-position switch selects the generator frequency range. The extreme counter-clockwise position is the power off position.
2. **Frequency VERNIER** — This control allows precision control over the output frequency. A full turn of this control is approximately equal to one minor division of the frequency dial. When in the full clockwise position (CAL), the settings on the main dial will be calibrated.
3. **Frequency Dial** — The setting on this dial multiplied by the frequency range setting equals the output frequency of the generator. The frequency VERNIER also affects the generator frequency.
4. **Frequency Index** — The scribe line indicates the frequency dial setting. The index is illuminated when the unit is on.
5. **Function Selector** — This selects the waveform that appears at the 50Ω OUT connector. The waveforms are sine \sim , triangle \wedge , or square \square .
6. **20 V P-P Max Control** — A vernier control of the output amplitude. Maximum clockwise position gives the full output amplitude of 20 V peak-to-peak into an open circuit or 10 V p-p into a 50Ω load, for 50Ω OUT and 10 V p-p into 600 balanced load. Counter-clockwise rotation will continuously reduce the output amplitude. The control gives a minimum of 40 dB variation (100:1), and operates in conjunction with the OUTPUT ATTEN (9). For maximum amplitude output this vernier must be full clockwise, and the output attenuator in the "0 dB" position.
7. **600Ω BAL OUT** — This connector provides the selected generator output function when the 600Ω output is selected. The generator may operate into an open circuit providing 20 V peak to peak maximum or into a 600Ω balanced load providing a 10 V peak to peak output.
8. **OUTPUT Selector** — Selects the output impedance of the generator, either 50Ω floating or 600Ω balanced.

9. **Output Attenuator** — This control attenuates the output amplitude according to the following table:

Attenuator Position	Output peak to peak into 50Ω or 600Ω Balanced Load	
	Maximum Vernier full cw	Minimum Vernier*
0 dB	10 V	1 V
-10 dB	3 V	300 mV
-20 dB	1 V	100 mV
-30 dB	300 mV	30 mV
-40 dB	100 mV	10 mV
-50 dB	30 mV	3 mV
-60 dB	10 mV	1 mV

*The values in this table are approximate. The 20 V p-p max attenuator will reduce the output nearly 40 dB in all cases. This table shows only a 20 dB reduction for simplicity.

10. **50Ω OUT** — This connector provides the selected generator output function when the 50Ω output is selected. The generator may operate into an open circuit providing 20 V peak-to-peak maximum, or into a 50Ω load providing a 10 V peak-to-peak output.
11. **VCG IN** — This connector allows external control of frequency. With 0 volts in, the generator output frequency is determined by the frequency range selected and the frequency dial setting. A positive VCG voltage will increase this frequency, and a negative voltage will decrease the frequency. Input impedance is 5 kΩ.

DC OFFSET — This rear panel control adjusts the amount of DC or baseline offset above or below signal ground. The detent position gives normal vertical symmetry.

SYNC OUT — This rear panel output provides a synchronizing wave output at the same frequency of the main generator. The output amplitude is greater than 1 V p-p into open circuit at 600Ω output impedance.

OPERATION

NOTE

One-half hour warmup is required for generator to stabilize at specified accuracies.

Operating as a Function Generator

1. Select output impedance by using 50Ω/600Ω selector.
2. Properly terminate the output connector in use.

NOTE

A proper termination results in 10 V p-p maximum output level. Open-circuit termination gives 20 V p-p.

3. Set the function selector to \sim , \square , or \wedge .
4. Set FREQ HZ range selector to desired multiplier.
5. Set desired frequency dial mark under illuminated index.

NOTE

The frequency VERNIER control must be in fully clockwise position for calibrated frequency operation.

6. Set OUTPUT ATTENUATOR for desired setting.
7. Set 20 V p-p max control for desired output level.

Operating as a VCG Generator

1. Set 50Ω/600Ω selector to desired output impedance.
2. Properly terminate the output signal. (50Ω or 600Ω).
3. Set function selector to \sim , \square , or \wedge as required.
4. Set FREQ HZ selector to desired multiplier.
5. Connect external voltage source (dc programming or wideband ac signal) to VCG IN connector. When using the 600Ω OUTPUT the VCG IN BNC shell must not be connected to 600Ω CT or ground. See Figure 2-5.

NOTE

VCG input requires 0 to ±5 volts for operation over full-scale range, but can withstand many times maximum input.

6. Set frequency dial as follows:
 - a. For frequency modulation with ac input, set dial for center frequency.
 - b. For increasing frequency sweep with positive dc input, set dial to lower frequency limit.

- c. For decreasing frequency sweep with negative dc input, set dial to upper frequency limit.
- 7. To sweep the audio range from 20 Hz to 20 kHz, set the controls to 20 Hz as follows:
 - a. Set the main dial at .02.
 - b. Set the frequency vernier at the full counter-clockwise position.
 - c. Introduce a 0 to +5 V ramp into the VCG input connector.
- 8. The nomograph in Figure 2-3 shows the characteristics of the VCG circuit. Column A gives the frequency dial setting; column B, the VCG input voltage; and column C, the approximate resultant dial frequency. Column C must be multiplied by the frequency range multiplier for the actual output frequency.

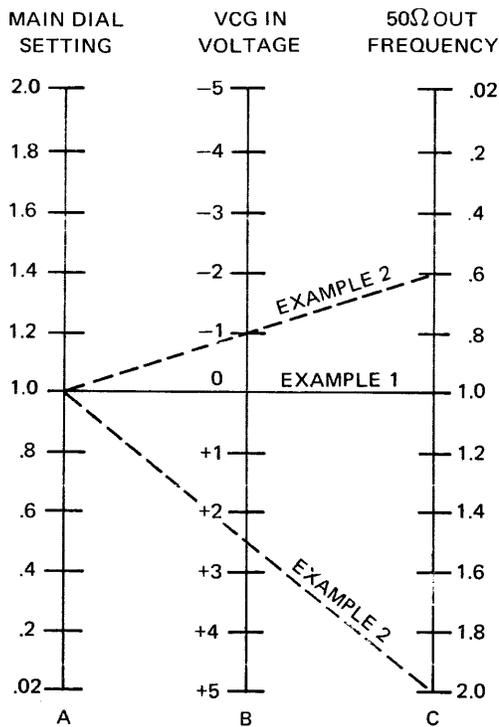


Figure 2-3 - VCG Voltage-to-Frequency Nomograph

In example 1, the dial is set at 1, and 0 volts is applied to the VCG input. Extend a straight line

from 1 (dial setting) through 0 volts (VCG voltage) and obtain a dial frequency of 1. For the total output frequency multiply the range by 1 with the same dial setting, example 2 shows the results of using a ramp from -1 volts to +2.5 volts for the VCG voltage. This results in a swept output from .6 to 2.0 on the dial. Remember to multiply the dial times the range.

Converting to 230-Volt Line Power

Model 131A is shipped from the factory with the power transformer connected for 115-volt line power, unless ordered for 230-volt use. Converting a 115-volt unit for 230-volt operation is a simple matter:

1. Remove power cord.
2. Loosen two captive thumb screws on rear panel and remove panel.
3. The conversion switch is located on the chassis. Use a thin-bladed screwdriver to move the 115-230 switch to the 230 position.
4. Replace 1/4-ampere fuse with a 1/8-ampere fuse of the same type.

Connecting Signal Common and Chassis Ground When Using 600Ω Balanced Output.

The instrument is shipped from the factory with the signal common floating above chassis ground in order to obtain 600Ω balanced output from a single ended output amplifier. It is important to understand the grounding of the instrument before attempting to make any external connection to the BNC connectors or binding posts.

When the 50Ω/600Ω selector is switched to 50Ω, all the BNC connector shells are connected to the signal common. When it is switched to 600Ω, it is advised to restrict the BNC connector shells from connecting to any of the four binding posts of 600Ω BAL. OUT, since the BNC shells are connected to one of the balanced signal outputs. See Figure 2-5.

Connecting Signal Common and Chassis Ground When Using 50Ω Output.

1. Remove power cord.
2. Loosen two captive thumb screws on rear panel and remove panel.
3. Solder a jumper wire between the ground lugs (green wire) of the SYNC OUT connector and the power connector (Figure 2-4).

- This connection must be removed when using the 600Ω balanced output.

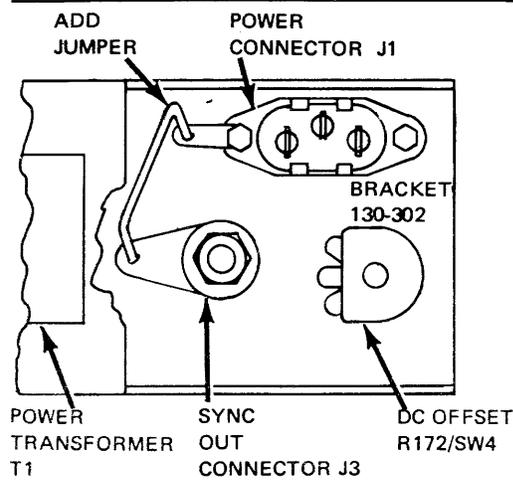


Figure 2-4. Common Ground Connection Diagram

Connecting Sync Out to an Oscilloscope

When in the 600Ω balanced mode, the SYNC OUT connector must not be connected directly to an oscilloscope since the BNC shells are connected to one of the balanced output signals. Connecting directly to the scope without isolating with a pulse transformer will cause attenuator B (see Figure 2-1) to be shorted, thus, one-half of the output impedance (300Ω) will be lost. The amplitude will remain the same, but the result is a 300Ω single ended output.

An error in signal common connection will not damage the instrument. See Figure 2-5.

The VCG IN may be connected to any ac or dc voltage source if the signal common is floating from earth ground.

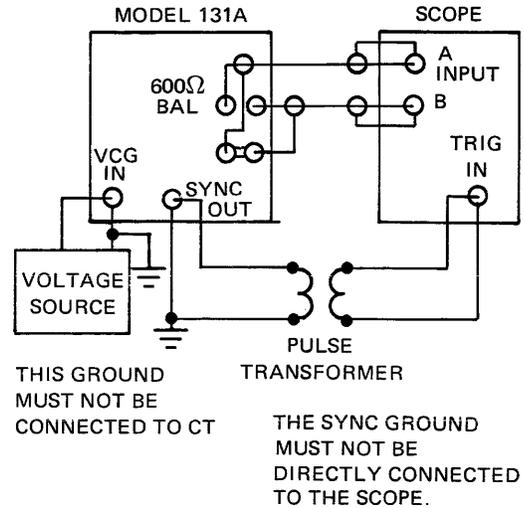


Figure 2-5. 600Ω Sync Out Connections

Connecting Chassis Ground to Center Tap

If it is desirable to balance the 600Ω output about chassis ground, connect the center tap (CT) to the chassis by placing the metal strap between CT and chassis on the binding posts.

SECTION 3

CIRCUIT DESCRIPTION

GENERAL DESCRIPTION

Refer to the block diagram of the Model 131A Function Generator, Figure 3-1.

Basically, a square wave is applied to the input of an integrator composed of a wideband differential dc amplifier, integrating resistor R, and capacitor C. The output of the integrator is fed into the hysteresis switch. The hysteresis and output switches function like a Schmitt trigger with the limit points set at the waveform extremes, firing when the triangle wave reaches +1.25 volts and -1.25 volts. The firing sets the hysteresis and the output switches which reverse the square wave fed into the integrator, causing the triangle wave to reverse direction. The result is simultaneous generation of a square wave and triangle wave

of the same frequency with the positive half cycle of the square wave coincident with the negative slope of the triangle wave.

The frequency of oscillation is determined by the magnitude of the capacitor across the integrator and the amplitude of the current into the integrator. The capacitance across the integrator is changed by rotating the frequency Hz selector. The amplitude of the current into the integrator is determined by four parameters which are summed in the VCG circuit: 1) The ± 5 volt square wave fed from the hysteresis switch, 2) the frequency dial voltage, 3) the frequency vernier voltage, and 4) the VCG analog voltage input.

The sine wave is produced by shaping the triangle wave. The triangle wave is fed into a shaping network

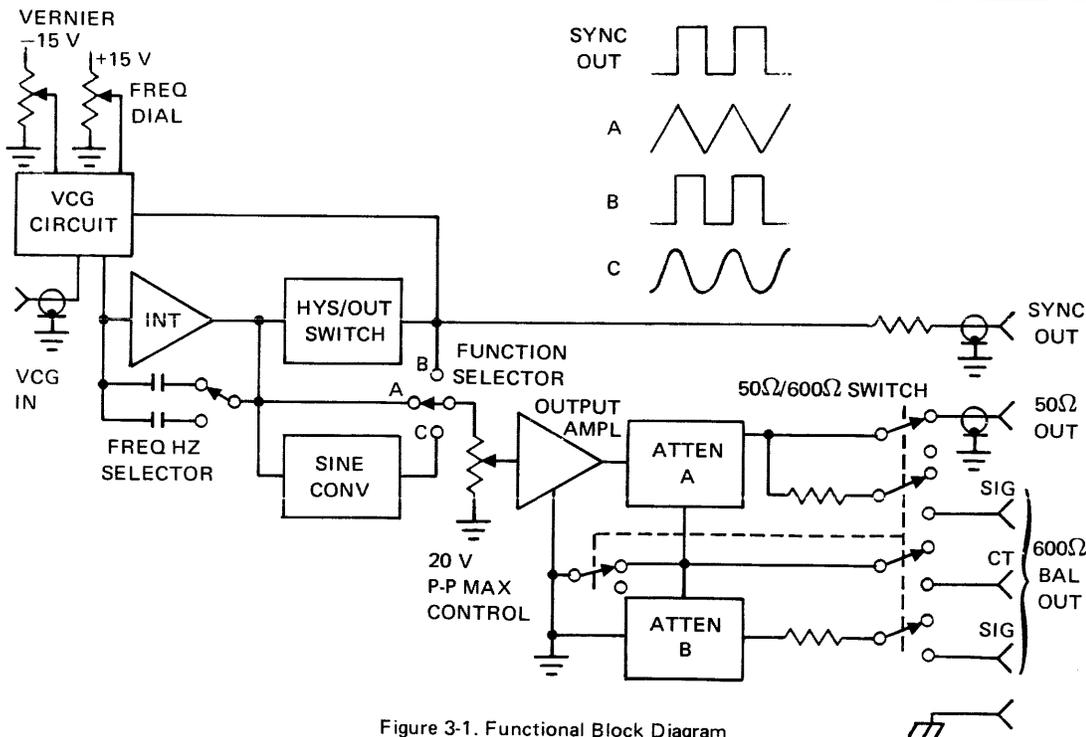


Figure 3-1. Functional Block Diagram

composed of resistors and diodes. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus the slope is maximum. As the triangle wave voltage increases; diodes with current limiting resistors conduct, successively, causing the slope of the output to be less.

Since the diode break points are mathematically computed and fitted to the true sine shape, the resultant waveform is an almost pure sine wave. The circuitry is completely symmetrical about ground, using a complimentary pair of diodes on each break point. The sine wave produced by shaping is considerably less in amplitude than the triangle wave input and is thus amplified to be equal to the triangle wave.

The triangle wave output of the integrator, the sine wave output, and the square wave coupled through a divider are fed to the function selector switch. The

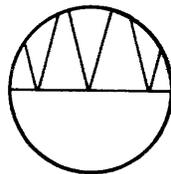
switch is coupled to the attenuator which in turn drives the output power amplifier.

All instrument circuits, except the switch set and the power amplifier output stage, operate with regulated ± 15 volt supplies. The switch set requires regulated ± 6 volts. The power amplifier output stage required unregulated ± 22 volts.

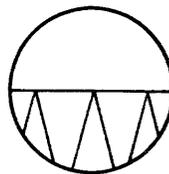
In the Model 131A, a precision step attenuator and an output impedance selector switch is placed between the output amplifier and the output terminals. This circuit allows the output impedance to be selected, either 50Ω single ended or 600Ω balanced. In both cases the properly terminated output signal is 10 V p-p. When the output impedance selector is in the 50Ω position, all positions on the step attenuator provide 50 ohm impedance. When in the 600Ω BAL OUT position, each position on the step attenuator provides 600Ω balanced about signal ground.

Triangle Amplitude

1. Set frequency dial for 2.0 (X1K range) and function selector to ∇ .
2. Connect oscilloscope, with 1A5 plug-in, to red-wire lug on function switch.
3. Adjust R56 on main board for positive peak at +1.25 volts ± 5 mV (see sketch).
4. Adjust R59 for negative peak at -1.25 volts ± 5 mV.



Negative Peak



Positive Peak

Output Amplifier ✓

1. Connect oscilloscope to 50 Ω OUT connector with 50-ohm terminator (\square function).
2. Set FREQ HZ selector for X1K (VERNIER full cw) and frequency dial at 2.0.
3. Turn 20 V P-P MAX control fully ccw.
4. Adjust R150 for amplitude symmetry about ground.
5. Set FREQ HZ selector for X1M (2.0 dial setting).
6. Turn 20 V P-P MAX control fully cw.
7. Adjust C64 for best square-wave response without peaking.

First VCG Null ✓

1. Connect oscilloscope to 50 Ω OUT connector.
2. Set FREQ HZ selector to X1K. Set dial at 1/100 of full scale.
3. Short and open VCG IN to signal ground (outside of BNC connector) while monitoring output frequency variation. Adjust R11 for minimum frequency change.

Time Symmetry ✓

1. Connect unit and oscilloscope, with 1A1 plug-in set for alternate display, as shown in Figure 4-1.
2. Set FREQ HZ selector for X100K with VERNIER in full cw position (\square function).
3. Set frequency dial for 2 kHz on oscilloscope (1/100 dial FS).

4. Adjust R28 for time symmetry at 100:1 frequency ratio.
5. Turn VERNIER fully ccw and adjust R22 for time symmetry at 1000:1.
6. Repeat Steps 4 and 5, as necessary, for optimum symmetry at 100:1 and 1000:1.
7. Check for waveform time symmetry at the .2 and 2 frequency-dial settings.
8. Check to assure FREQ HZ selector is set to X100K position with VERNIER turned fully ccw.
9. Turn frequency dial fully cw.
10. Check for 1000:1 frequency ratio.
11. Adjust R8, if necessary, for slightly greater than 1000:1 ratio.

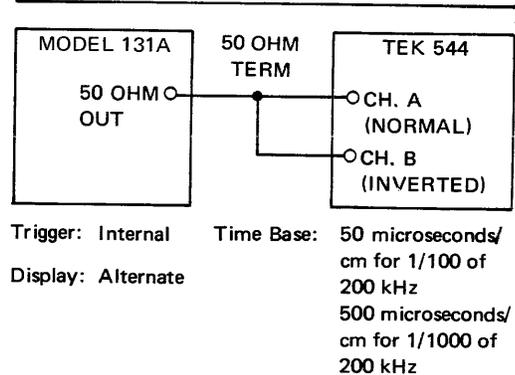


Figure 4-1.
Time Symmetry Measurement for Test Setup

Frequency Calibration ✓

1. Connect counter to 50 Ω OUT connector.
2. Set FREQ HZ selector to X10K and VERNIER fully cw.
3. Align 2.0 dial mark with the dial indicator index and alternately switch from X10K to X1K range while adjusting R4 for a balanced error between the two positions.
4. Set FREQ HZ selector to X100K and dial at 2.0.
5. Adjust C16 to obtain 200.0 kHz on counter display.
6. Set FREQ HZ selector to X1M. Adjust C12 to obtain 2.00 MHz on counter display.
7. Dial alignment - No alignment is necessary if the dial is the push-on type. If it has a set screw, consult the factory for CAL procedure.

Sine Distortion, Amplitude, and Balance ✓

1. Set FREQ HZ selector for X1K (VERNIER full cw), function selector to \sim , and frequency dial at 2.0.
2. Connect oscilloscope, with 1A5 plug-in, to orange wire on function switch.
3. Adjust R133 to obtain 2.5 V p-p ± 25 mV output.
4. Adjust R128 to balance output.
5. Connect the unit, distortion analyzer, and oscilloscope as shown in Figure 4-2.
6. Adjust R126 and R127 for minimum sine distortion (see photo).

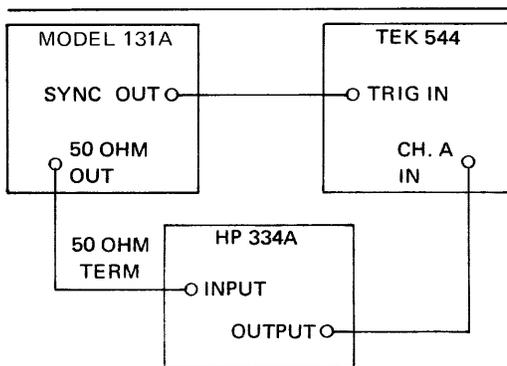
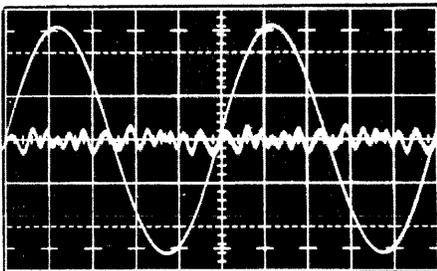


Figure 4-2. Distortion Analysis Test Set-up.



7. Set FREQ HZ selector to X10K.
8. Repeat Step 6 for Steps 1 and 7 to obtain least distortion at both X1K and X10K ranges.
9. Repeat Steps 2, 3, and 4.
10. Connect spectrum analyzer and check sine distortion at 2 MHz.

TROUBLESHOOTING

Basic Techniques

Troubleshooting the Model 131A requires no special technique. Listed below 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 procedure. Many out-of-specification indications can be corrected by performing specific calibration procedures.
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 possible malfunction symptoms, their probable causes, and the prescribed remedies. Also listed in this table are the test points at which measurements are to be made and the parameter tolerances at these points. To use the troubleshooting chart, locate the symptom listed in Column 1 and follow the corresponding procedures. Localize the fault to a specific stage by checking the parameters given for the major test points. Then check the dc operating voltages at the pins of solid-state devices. Check associated passive elements with a high input impedance ohmmeter (power off) before replacing a suspected semiconductor element.

Troubleshooting Hints

The interactive nature of a closed loop presents a somewhat special problem when approached from a troubleshooting standpoint. The simplest way to reduce problem complexity is to open the loop, thereby removing the interaction. The basic units of the loop can then be tested individually. The following step-by-step procedure describes how this is done. (The generator loop is all contained on the Main Board.) Consult next paragraph for removal of cover and panels.

1. Set instrument controls for 20 V p-p, 2 kHz sine-wave output.
2. Check at coaxial-wire lug of function selector switch for a 2.5 V p-p square wave. If normal, check output amplifier (Q34-Q40).
3. Unsolder and lift the end of R51 (TP7). This is the output of the integrator and input to the hysteresis switch. The generator loop has now been opened.
4. Inject a 2.5 V p-p triangle waveform into the hysteresis switch input lead (TP7).

Table 4-2. TROUBLE SHOOTING CHART

Symptom	Probable Cause	Corrective Procedures
No outputs at 50 Ω OUT connector	Blown fuse	Replace F1 a. 1/4A–115 Vac b. 1/8A–230 Vac
	Power Supply	Check TP1/TP2 for +15 V; TP1/TP3 for –15 V; TP1/TP5 for +6 V; TP1/TP6 for –6 V. Troubleshoot associated regulator.
	Output amplifier	Check at wiper (grn/wht wire) of function selector switch for waveform as selected by position of switch. a. If waveform is present, troubleshoot output amplifier. b. If no waveforms are present, refer to Troubleshooting Hints .
	50 Ω /600 Ω Output Switch	Check to see that output is present at switch. If it is, the switch is defective.
No sine wave output	Sine amplifier	Check for 260 mV p-p sine wave at pin 4 of IC8. a. If present, check IC8 circuit. <i>NOTE:</i> Triangle wave must be present at pin 2 of A1 to obtain sine wave output. b. If <i>not</i> present, check A1 circuit.
No triangle, sine, or square wave	Generator loop	Refer to Troubleshooting Hints .
All waveforms low in amplitude	Power amplifier	a. Check front-panel amplitude control. b. Perform balance adjustment for power amplifier.
	Power supply	Check for proper voltages.
Frequency out of tolerance	Power supply	Check for proper power supply voltages as stated above.
	Maladjustment	Perform calibration procedure.
Sine wave not in spec	Maladjustment	Perform Sine Distortion, Amplitude, and Balance adjustment.
	Sine converter	Check for 260 mV p-p sine wave at pin 4 of IC8. a. If normal, check sine amplifier IC8. b. If abnormal, check A1 circuit.
Time symmetry of waveforms not correct	Maladjustment	Perform Time Symmetry and frequency adjustments.
Output impedance in the 600 Ω BAL position is only 300 Ω single ended	Half of output attenuator shorted	Isolate all BNC shells from CT or chassis ground. The common mistake is to connect sync out directly to scope without a pulse transformer.

5. Check at the coaxial-wire lug of the function selector switch for a 2.5 V p-p square wave at the injected frequency.
 - a. If present, hysteresis and output switches are okay. Proceed to Step 6.
 - b. If abnormal, check Q6-Q16 stages.
6. Vary frequency dial from ccw to cw while observing TP11 with a scope. Voltage at this point should remain at 0 volts throughout dial rotation. If a voltage variation is observed, check IC1 stage.
7. Vary frequency dial from ccw to cw while observing TP4. Voltage reading should vary from 0 to approximately -6 volts. If voltage does not vary, check IC2 stage and IC1 stage.
8. Vary frequency dial from ccw to cw while observing TP9. Voltage reading should remain at 0 volts. If voltage varies check IC3 stage.
9. Vary frequency dial from ccw to cw while observing TP10. Voltage should vary from 0 volts to approximately +6 volts. If voltage does not vary, check IC2 stage and IC3 stage.
10. Vary frequency dial from ccw to cw while observing TP8. Voltage reading should remain at 0 volts. If voltage varies, check IC4 and IC5 stages.
11. Re-install R51.

REMOVAL OF DUST COVERS AND PANELS

1. To gain access for calibration or maintenance, proceed as follows:
 - a. Remove power cord.
 - b. Loosen the two knurled captive screws on the rear panel.
 - c. Pull off the rear panel.
 - d. Remove the cover.
2. To gain access to any part mounted on bracket assembly behind rear panel, proceed as follows:
 - a. Remove rear panel and dust cover as described in Step 1 above.
 - b. Remove one heat-sink mounting screw.
 - c. Remove bottom transformer mounting-block screw.
 - d. Remove the two screws, lock washers, and hexnuts holding two wafers of FREQ HZ switch to bracket assembly.
 - e. Remove four bracket-assembly retaining screws.
 - f. Carefully pull bracket assembly to rear to obtain working room. Enough slack is available in the wiring for all normal operations.
3. To remove the front panel, proceed as follows:
 - a. Remove rear panel and dust cover as described in Step 1 above.
 - b. Remove all knobs, except frequency dial.

NOTE

Recalibration of the frequency dial is not required if the frequency dial is not removed.

- c. Unsolder BNC connections.
- d. Tag and unsolder frequency-dial potentiometer leads.
- e. Pull light bulb from indicator lens.
- f. Remove four front-panel retaining screws.
- g. Carefully pull off front panel with frequency dial/potentiometer still attached.

REPLACEMENT OF SWITCH WAFERS AND POTENTIOMETERS

1. To replace FREQ HZ switch wafer C or D or the VERNIER potentiometer, proceed as follows:
 - a. Remove rear panel and dust cover as previously described.
 - b. Separate bracket assembly from chassis as previously described.
 - c. Tag and unsolder leads to part being replaced.
 - d. Pull defective part off shaft and repair or replace with recommended replacement part.
2. To replace FREQ HZ switch wafer A or B, proceed as follows:
 - a. Remove rear panel and dust cover as previously described.
 - b. Remove front panel as previously described.
 - c. Tag and unsolder wires to switch wafers A and B.
 - d. Unsolder wafer B PC-tabs from printed circuit board.
 - e. Lift switch shaft slightly to free PC-tabs, rotate switch shaft so wafers clear board parts, and pull shaft end free of rear-mounted wafers C and D.
 - f. Repair or replace defective part.
3. To repair or replace function selector wafers or 20 V P-P MAX potentiometer, proceed as follows:
 - a. Remove rear panel and dust cover as previously described.
 - b. Loosen set screws holding potentiometer and switch knobs to inner and outer shafts and remove knobs.
 - c. Tag and unsolder wires to defective part.
 - d. Unsolder potentiometer PC-tabs, lift shaft slightly to free tabs, rotate switch shaft so wafers clear board parts, and pull switch/

- potentiometer assembly out of front panel hole.
- e. Repair or replace defective part.

REPLACEMENT OF SINE CONVERTER

1. Remove rear panel and dust cover as previously described.
2. Unsolder the five pins of sine converter A1 from top of the printed circuit board, using a solder syringe.
3. Lift assembly from bottom of the board; a thin pencil-type soldering iron can be used, if necessary, to apply temporary heat during removal.

SECTION 5

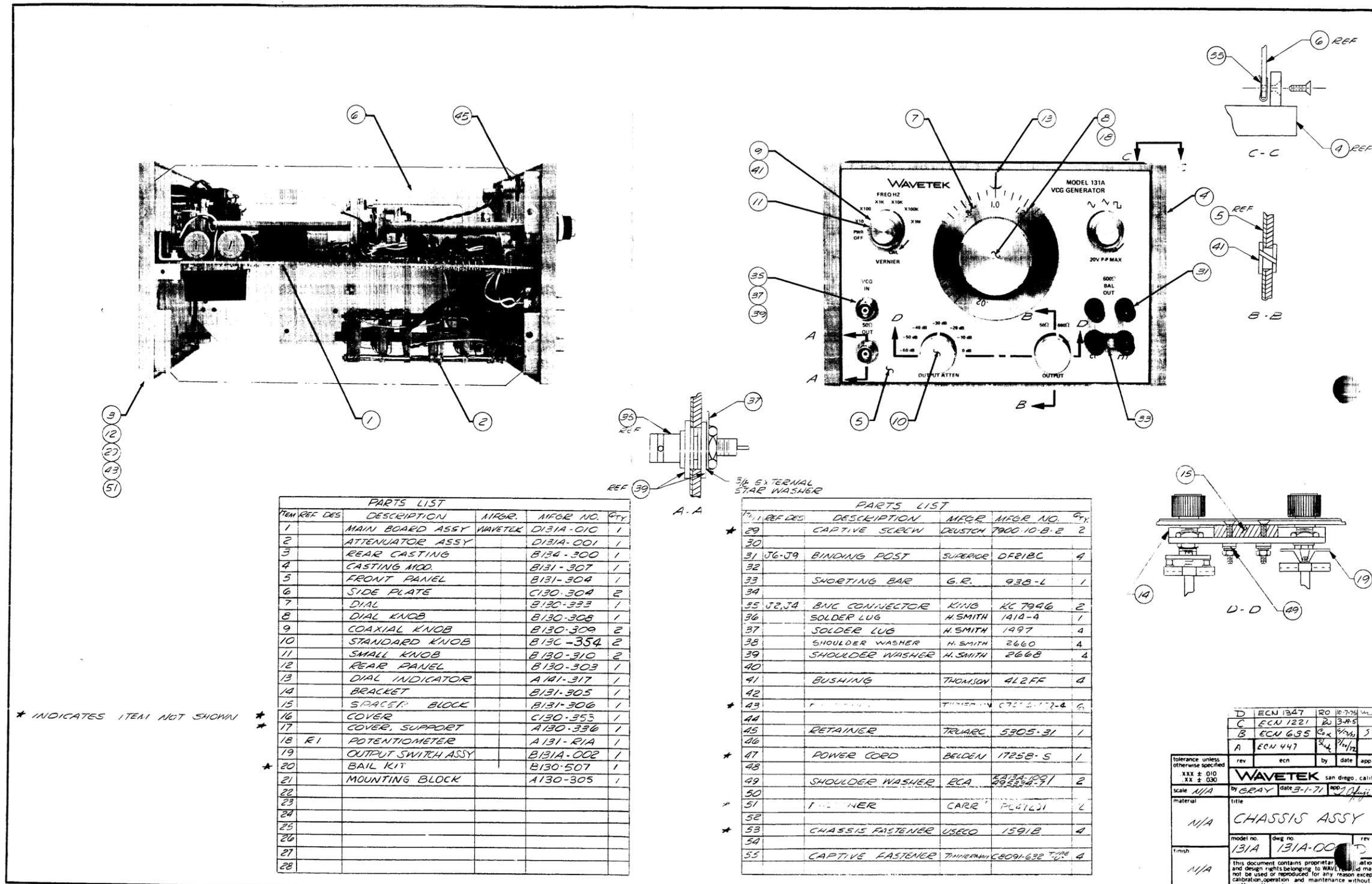
DATA PACKAGE

INTRODUCTION

In this section are the schematics and assembly drawings for the Model 131A. Parts lists and list of manufacturers are included for ordering spare or replacement parts. **IMPORTANT** — When ordering a part from Wavetek, give all pertinent data — Part number, circuit reference number, value of the component and/or function performed.

LIST OF MANUFACTURERS

American Radionics	American Radionics, Inc. Danbury, Connecticut	IMB	IMB Electronics Products Santa Fe Springs, California
Amp	Amphenol Connector Division Broadview, Illinois	IRC	IRC Inc. Philadelphia, Pennsylvania
ARCO	Arco Electronics Great Neck, L.I., New York	Kings	Kings Electronics Co., Inc. Tickahoe, New York
Boots	Boots-Townsend Aircraft Santa Ana, California	Littelfuse	Littelfuse Inc. Des Plaines, Illinois
Corn	Corning Glass Works Bradford, Pennsylvania	Motorola	Motorola Semiconducts Products Phoenix, Arizona
CRL	Centralab Division of Globe-Union Milwaukee, Wisconsin	RCA	RCA Semiconductor Division Somerville, New Jersey
CTS	Chicago Telephone Systems Los Angeles, California	Richey	Richey Electronics Nashville, Tennessee
Electro	Electro Cube, Inc. Willow Grove, Pennsylvania	Semtech	Semtech Corporation Newbury Park, California
Erie	Erie Technological Products Inc. Erie, Pennsylvania	HHSmith	Herman H. Smith, Inc. Brooklyn, New York
Fair	Fairchild Semiconductor Corporation Palo Alto, California	Sprague	Sprague Electric Company North Adams, Massachusetts
		Stack	Stackpole Carbon Company St. Marys, Pennsylvania
		Switchcraft	Switchcraft, Inc. Chicago, Illinois
		TI	Texas Instruments, Inc. Dallas, Texas
		USECO	USECO Inc. Mt. Vernon, New York
		Wakefield	Wakefield Engineering, Inc. Wakefield, Massachusetts
		Wavetek	Wavetek San Diego, California



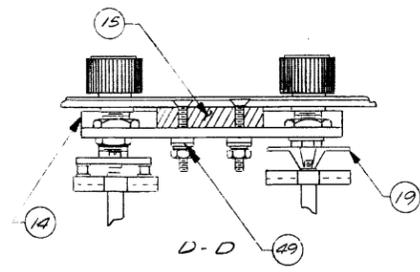
PARTS LIST

ITEM	REF	DES	DESCRIPTION	MFR	MFGR NO.	QTY
1			MAIN BOARD ASSY	WAVETEK	D131A-010	1
2			ATTENUATOR ASSY		D131A-001	1
3			REAR CASTING		B134-300	1
4			CASTING MOD.		B131-307	1
5			FRONT PANEL		B131-304	1
6			SIDE PLATE		C130-304	2
7			DIAL		B130-333	1
8			DIAL KNOB		B130-308	1
9			COAXIAL KNOB		B130-309	2
10			STANDARD KNOB		B130-354	2
11			SMALL KNOB		B130-310	2
12			REAR PANEL		B130-303	1
13			DIAL INDICATOR		A141-317	1
14			BRACKET		B131-305	1
15			SPACER BLOCK		B131-306	1
16			COVER		C130-353	1
17			COVER, SUPPORT		A130-336	1
18	R1		POTENTIOMETER		A131-R1A	1
19			OUTPUT SWITCH ASSY		B131A-002	1
20			BAIL KIT		B130-507	1
21			MOUNTING BLOCK		A130-305	1
22						
23						
24						
25						
26						
27						
28						

* INDICATES ITEM NOT SHOWN *

PARTS LIST

ITEM	REF	DES	DESCRIPTION	MFR	MFGR NO.	QTY
29			CAPTIVE SCREW	DEUSTCH	7900-10-B-2	2
30						
31	J6-J9		BINDING POST	SUPERIOR	DFR1BC	4
32						
33			SHORTING BAR	G.R.	938-L	1
34						
35	J2,J4		BNC CONNECTOR	KING	KC 7946	2
36			SOLDER LUG	H.SMITH	1A1A-4	1
37			SOLDER LUG	H.SMITH	1A97	4
38			SHOULDER WASHER	H.SMITH	2660	4
39			SHOULDER WASHER	H.SMITH	2668	4
40						
41			BUSHING	THOMSON	412FF	4
42						
43				THOMSON	C75-2-17-4	6
44						
45			RETAINER	TRUARC	5305-31	1
46						
47			POWER CORD	BELDEN	1725B-S	1
48						
49			SHOULDER WASHER	ECA	B13A-100 29532-71	2
50						
51			THIMBLER	CARR	PL41J1	2
52						
53			CHASSIS FASTENER	US800	1591B	4
54						
55			CAPTIVE FASTENER	THOMSON	C8091-632	4



D	ECN 1347	RO 10-7-75	WJ
C	ECN 1221	BJ 3-4-75	
B	ECN 635	CS 4-24-75	S
A	ECN 447	SL 7-14-72	

tolerance unless otherwise specified
 XXX ± 0.10
 XX ± 0.30

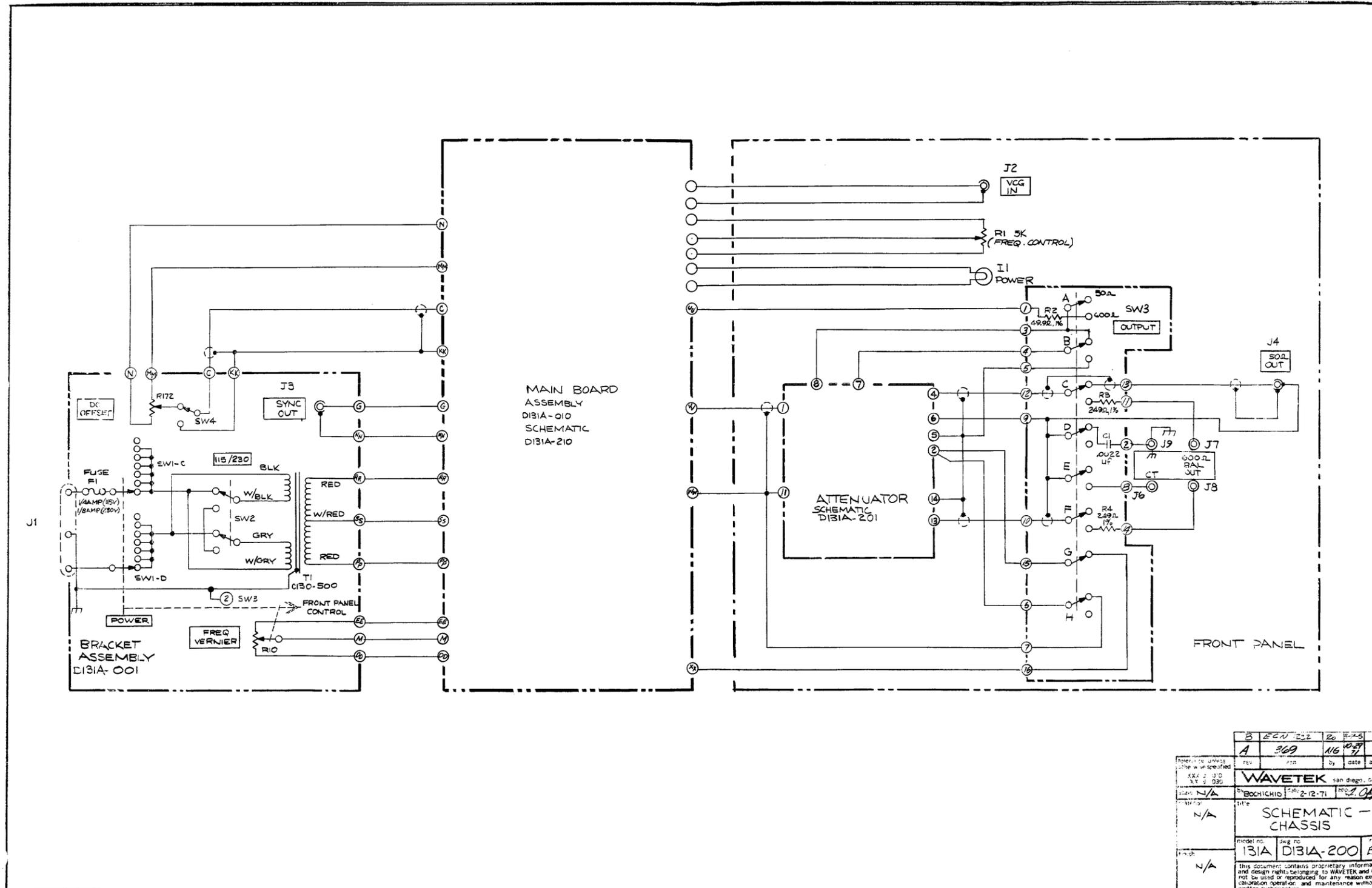
scale N/A by BEAY date 3-1-71 app JJJ

material N/A title CHASSIS ASSY

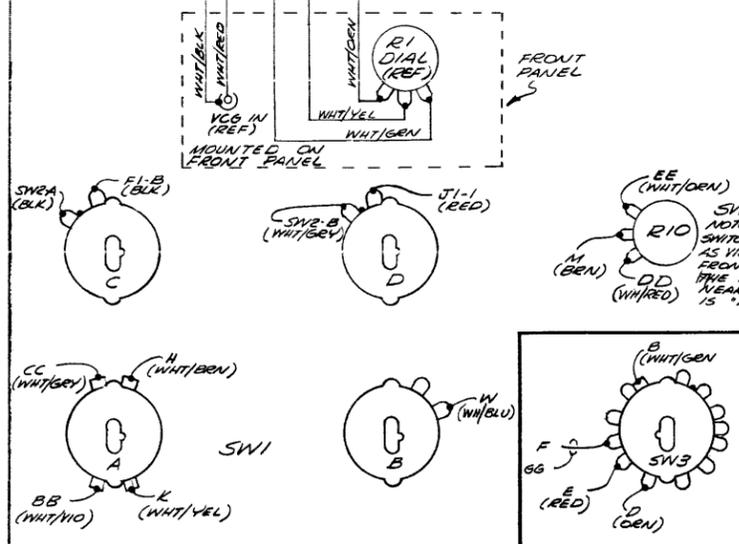
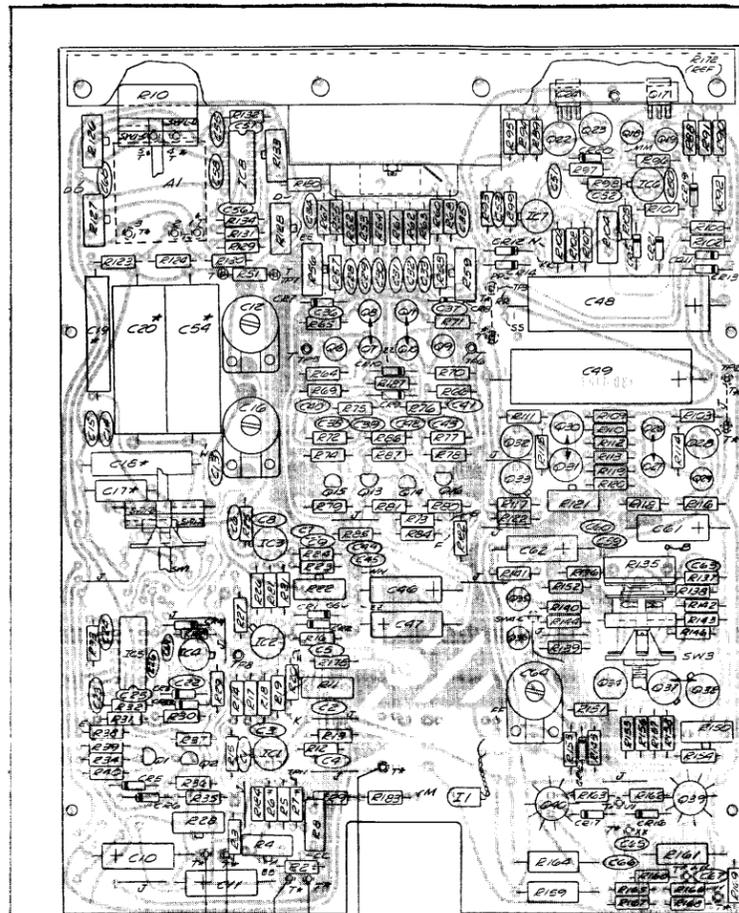
model no. 131A dwg no. 131A-00 rev 1

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.



Rev	369	116	10/87
Author	BOCHICHO		
Date	2-12-71		
By	J. O'Neil		
App			
Model No.	131A	Des No.	D131A-200 B
<small>This document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, repair, and maintenance without written authorization.</small>			

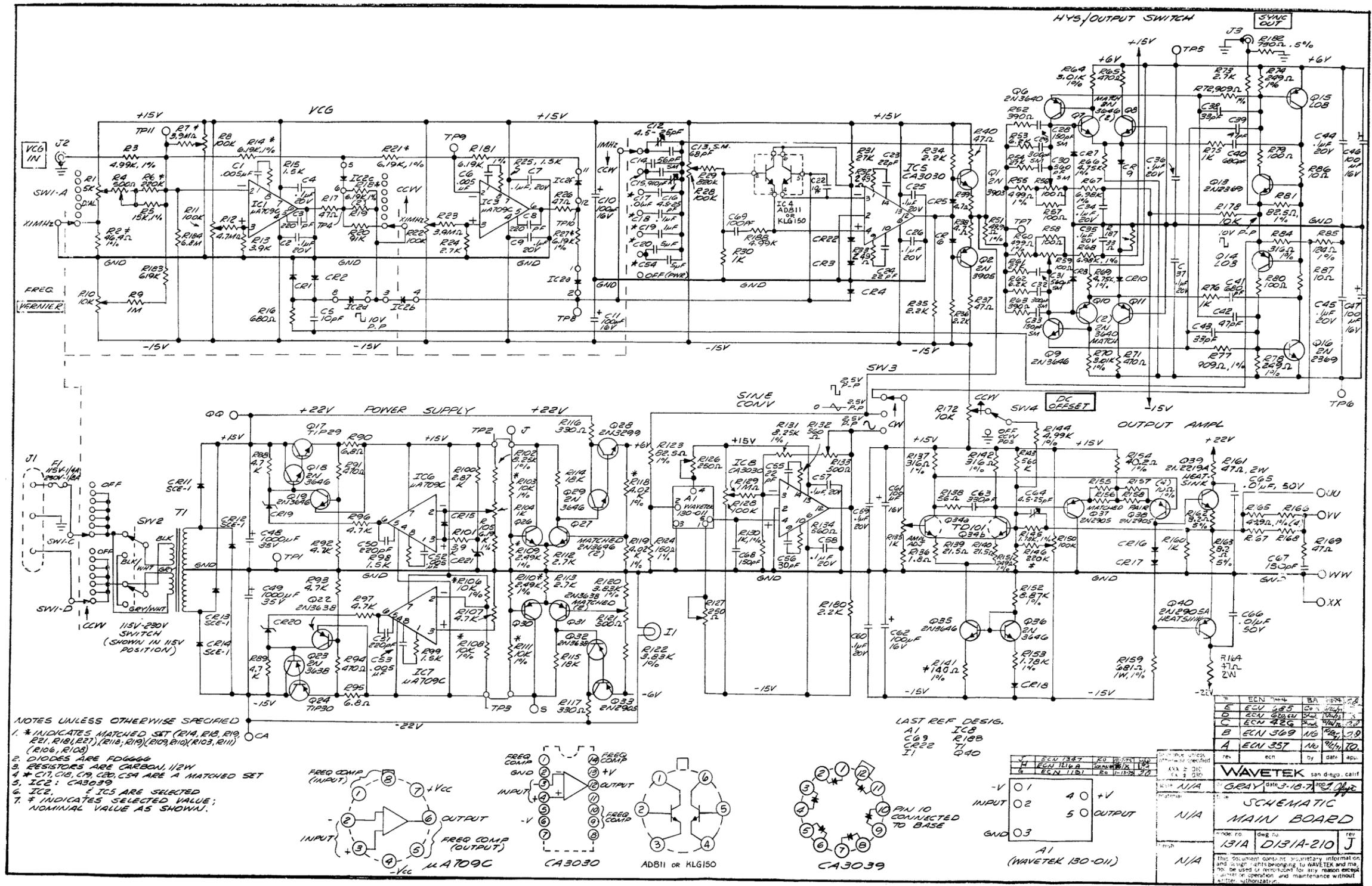


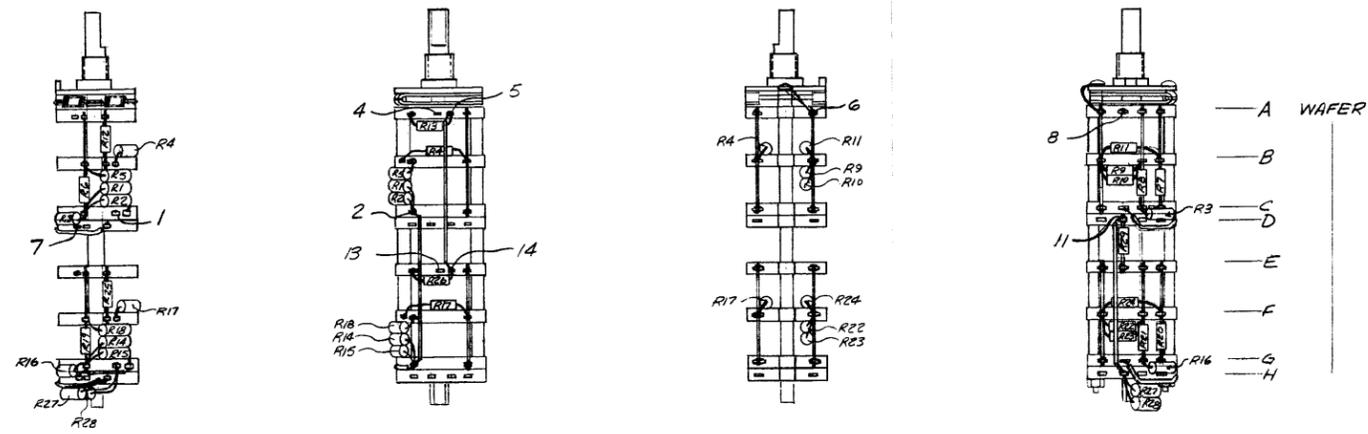
PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
1	C14 *	SILVER MICA, 200V, 5% 50pF	AECC	DMIS-560J 1
2	C13	5%, 68pF		680J 1
3	C28, C33	150pF		151J 2
4	C29, C32	500pF		301J 2
5	C30, C31	500pF		561J 2
6	C15	1%, 910pF		911F 1
7	C5, C22	CERAMIC DISC, 1000V, 10pF	CEL	DD-100 2
8	C23, C24, C55	22pF		DD-220 3
9	C38, C43	33pF		DD-330 2
10	C39, C42	47pF		DD-470 2
11	C67, C68	150pF		DD-151 2
12	C63	330pF		DD-331 1
13	C40, C41	680pF		DD-681 2
14	C3, C8, C50, C51	220pF		DD-221 4
15	C1, C6, C52, C53	50V, .005F		CK502 4
16	C65, C66	50V, .01F		CK-103 2
17	C2, C4, C7, C9, C25, C26, C34, C37, C44, C45, C57, C60	20V, .1uF		UK20-104 16
18	C17	POLY, 100V, 1%, .01uF	WAVETEK	130-501-B 1
19	C18	.1uF		1
20	C19	.1uF		1
21	C20, C54	MVLR, 200V, 10%, 50uF		1
22	C10, C11, C46, C47, C61, C62	ELECTROLYTIC, 16V, 100uF	SABGUL	3000R30000 6
23	C48, C49	35V, 100uF		39DD08035014 2
24	C12, C16, C64	VARIABLE 4.5-25pF	ERIE	503-001-37A 3
25	C56	CERAMIC DISC 1000V 30pF	CRL	DD300 1
26	C69	1KV 100pF		DD101 1
30	CR1-CR10	DIODE FDG666	FAIRCHILD	FDG666 15
31	CR11-CR14	1N4001	SPRINT	1N4001 4
32	CR19-CR21	ZENER	WAVETEK	130-506 3
33				
34				
35				
36	Q17	MODIFIED PER 130-316	T.J.	T1P29 1
37	Q24	MODIFIED PER 130-316		T1P30 1
38	Q25	2N1905A	FAIRCHILD	2N1905A 1
39	Q28	2N3399		2N3399 1
40	Q16	2N3640	MOTOROLA	2N3640 1
41	Q9, Q10, Q19, Q20, Q21, Q26	2N3646	FAIRCHILD	2N3646 6
42	Q22, Q23, Q32	2N3638		2N3638 3
43	Q1	2N3903	MOTOROLA	2N3903 1
44	Q2	2N3905		2N3905 1
45	Q34	7D101	SPRINT	7D101 1
46	Q37, Q38	MATCHED 2N2905A(8)	FAIRCHILD	2N2905A 2
47	Q10, Q11	2N3640(1)	MOTOROLA	2N3640 2
48	Q7, Q8	2N3646(1)	FAIRCHILD	2N3646 4
49	Q30, Q31	2N3638(-9)		2N3638 2
50	Q14, Q15	LOB		LOB 2
51	Q13, Q16	2N2905A		2N2905A 2
52	Q40	2N2905A		2N2905A 1
53	Q39	2N2219A	MOTOROLA	2N2219A 1
54				
55				
56				

PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
57	IC1, IC3	LINEAR IC (-13)	FAIRCHILD	UA709C 2
58	IC5	LINEAR IC (-15)	RCA	CA3030 1
59	IC4	DUAL TRANS	ANALOG	AD811 1
60	IC2	LINEAR	RCA	CA3039 1
61	IC6, IC7	LINEAR	FAIRCHILD	UA709C 2
62	IC8	LINEAR	RCA	CA3030 1
63				
64				
65				
66	R58, R59	POTENTIOMETER 100Ω	CEL	BA103-801 2
67	R24, R27	250Ω		-021 2
68	R4	500Ω		-502 3
69	R121, R133			
70	R135	1K	CTS	N130-SW-ASSY 1
71	R104	1K	CRL	BA1603-803 1
72	R8, R11, R22, R28, R125, R130	100K		-819 6
73				
74				
75	R10	10K	CTS	130-R1A 1
76	R162, R163	CARBON, 2W, 5%, 8.2Ω	STROLE	RC20GF8R2J 2
77	R136	CARBON, 1/4W, 5%, 1.8Ω	STROLE	RC20GF1R8J 1
78	R90, R95			
79	R26, R27	10Ω		100J 2
80	R138	56Ω		560J 1
81	R17, R20, R21, R40, R169	47Ω		470J 5
82	R57, R58, R79, R80	100Ω		101J 4
83	R16, R17	10% 330Ω		331K 2
84	R52, R63	5% 390Ω		391J 2
85	R25, R71, R91, R94	10% 470Ω		471K 4
86	R12, R13A	560Ω		561K 2
87	R16	680Ω		681K 1
88	R30, R75, R76, R160	1K		102K 4
89	R15, R25, R26, R29	1.5K		152K 4
90	R94, R99	2.2K		222K 4
91	R24, R78, R12, R13, R13	2.7K		272K 4
92	R13, R101	3.9K		392K 2
93	R28, R29, R32, R47, R101	4.7K		472K 7
94	R53, R62	5% 6.2K		622J 2
95	R128	10% 10K		103K 1
96	R14, R15	18K		183K 2
97	R21, R54, R61	27K		273K 3
98	R20	91K		913K 1
99	R6, R146*	220K		224K 2
100				
101	R143	560K		564K 1
102	R29	820K		824K 1
103	R129	1MΩ		105K 1
104				
105	R7, R23	3.9MΩ		395K 2
106	R12	4.7MΩ		475K 1
107	R149	6.8MΩ		685K 1
108	R182	5%, 750Ω		751J 1
109	R187	33Ω		330J 1
110	R161, R164	2W, 10%, 47Ω		RC20GF47J 2
111	R159	METAL FILM, 1/4W, 1%, 681Ω	IEC	MEC-RN70D 1
112	R32, R33	M/F 1/2W 1%, 68Ω	GRUNIG	REC-RN50D 2
113	R188	M/F 1/2W 1%, 4.99K		RN50D 1
114				
115				
116	R109, R110	MATCHED RESISTOR		
117	R118, R119	METAL FILM, 1/4W, 1%, 4.02K (1)	COVING	RNG0D 2
118	R103, R104, R108, R111	10K (1.3)		4
119	R11, R18, R19, R27, R81	6.19K (-3)		6
120				
121				
122				
123				

PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
124	R155-R158	METAL FILM, 1/4W, 1%, 10Ω	COVING	EN60D 4
125	R159, R160			2
126	R2 F			46.4Ω
127	R81, R165, R168			49.9Ω
128	R154			40.2Ω
129	R81, R123			82.5Ω
130	R85			124Ω
131	R124			150Ω
132	R79, R158			249Ω
133	R84, R157, R142			316Ω
134	R53, R60			499Ω
135	R72, R77			909Ω
136	R130	1K		1K
137	R145, R153			1.78K
138	R100			2.87K
139	R64, R70			3.01K
140	R120, R122			3.93K
141	R141 *			14.3Ω
142	R66, R69			4.75K
143	R3, R144			4.99K
144				
145	R105			6.19K
146	R67, R68			6.98K
147	R102, R131			8.25K
148	R152			8.87K
149	R5			15K
150	R133			6.19K
151	R7			1M
152				
153	SW1-C	WAFER	CTS	130-SW1-C 2
154	SW1-A			T106 1
155	SW1	DETENT	WAVETEK	130-SW1 1
156	SW1-B	WAFER		133-SW1-1 1
157	SW3	SWITCH		130-400 1
158				
159				
160				
161				
162				
163				
164				
165				
166				
167				
168				
169				
170				
171				
172				
173				
174				
175				
176				
177				
178				
179				
180				
181				
182				
183				

PARTS LIST				
REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
184				
185				
186				
187				
188				
189				
190				
191				
192				
193				
194				
195				
196				
197				
198				
199				
200				
201				
202				
203				
204				
205				
206				
207				
208				
209				
210				
211				
212				
213				
214				
215				
216				
217				
218				
219				
220				
221				
222				
223				
224				
225				
226				
227				
228				
229				
230				
231				
232				
233				
234				
235				
236				
237				
238				
239				
240				
241				
242				
243				
244				
245				
246				
247				
248				
249				
250				
251				
252				
253				

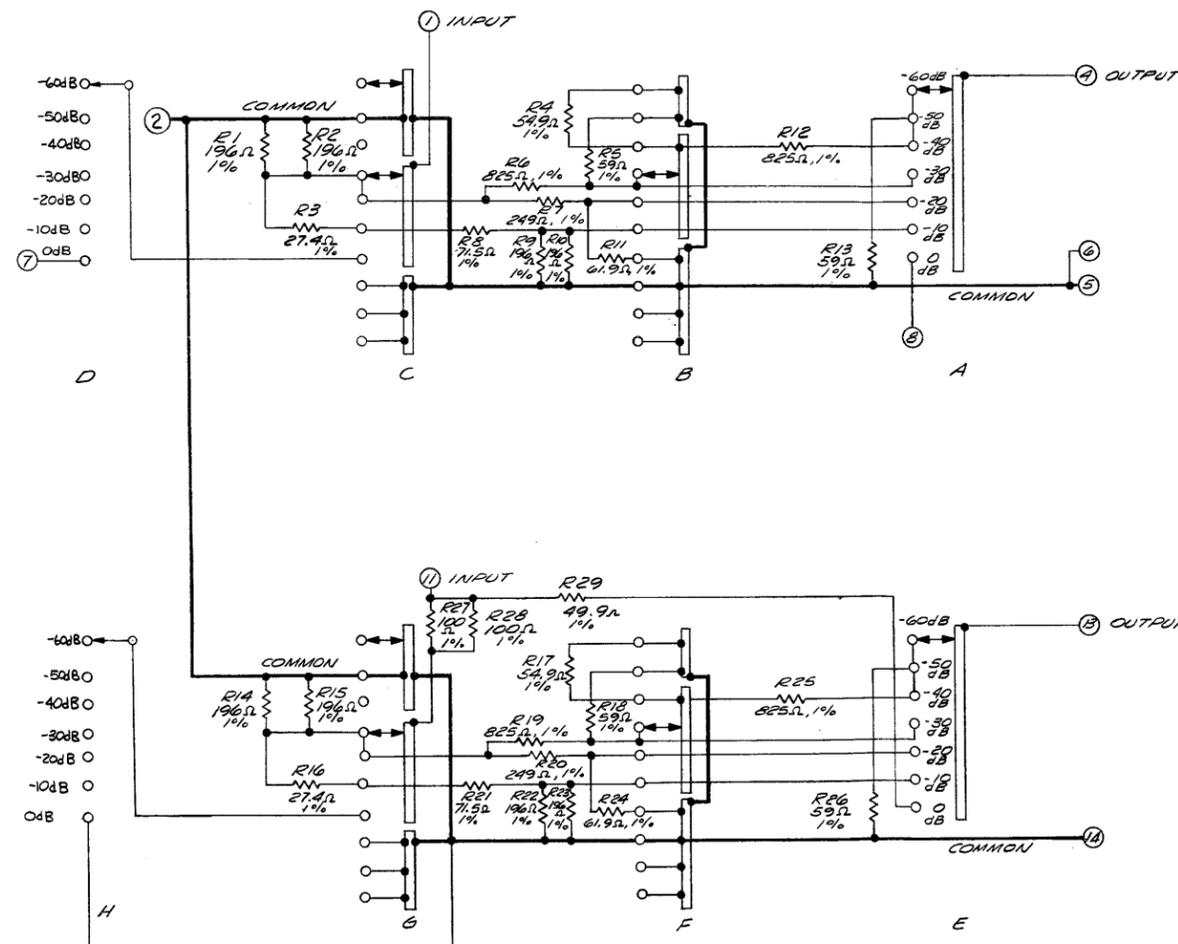




PARTS LIST					
ITEM	REF. DES.	DESCRIPTION	MFGR	MFGR NO	QTY
1	R3, R16	RES. METALFILM, 1/4W, 1%, 274Ω	CORNING	RN60D	2
2	R29	49.9Ω			1
3	R4, R17	54.9Ω			2
4	R5, R13 R18, R26	59Ω			4
5	R11, R24	61.9Ω			2
6	R8, R21	71.5Ω			2
7	R27, R28	100Ω			2
8	R1, R2, R9 R10, R14 R15, R22 R23	196Ω			6
9	R7, R20	249Ω			2
10	R6, R12 R19, R25	825Ω			4
11					
12					
13					
14					
15		DETENT AND WAFER ASSY	WAVETEK	131A-SW1	1
16					
17					
18					
19					
20					

NOTES UNLESS OTHERWISE SPECIFIED
 1 NUMBERS INDICATE WIRE TERMINATION POINTS SEE D131A-200

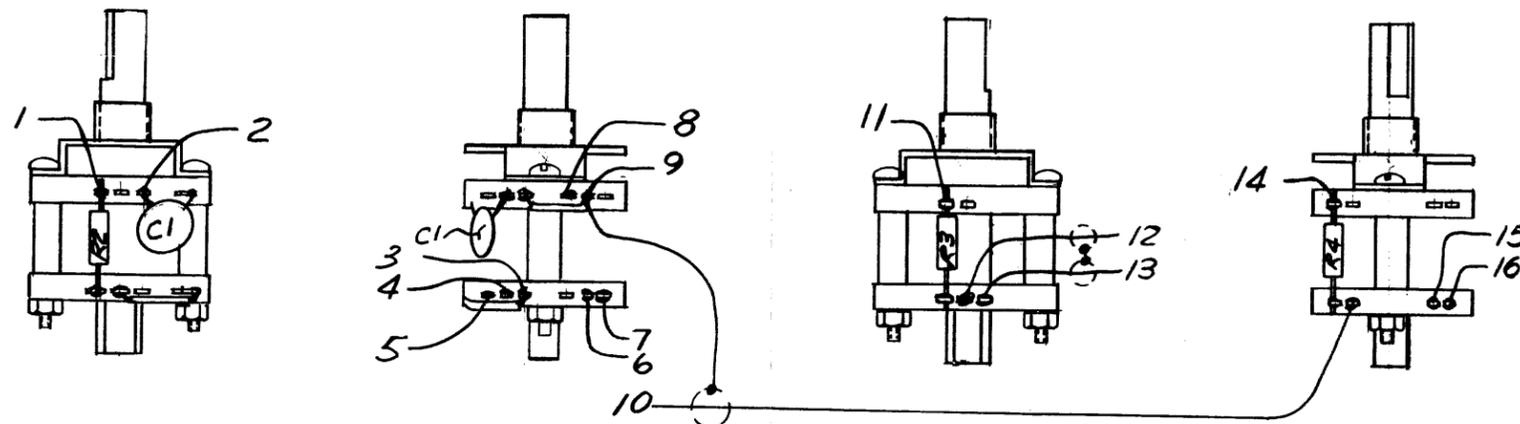
tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
scale FULL	WAVETEK san diego, calif by BDX:KCH:IO date 2-15-71 <i>app. J. Off.</i>				
material N/A	title ASSY - ATTENUATOR SW				
finish N/A	model no.	dwg no.	rev		
	131A	D131A-001			
this document contains proprietary 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.					



NOTES: UNLESS OTHERWISE SPECIFIED

1. CIRCLED NUMBERS, I.E. ① ETC, INDICATE WIRING INTERCONNECTIONS
2. SEE SCHEMATIC 131A-200

tolerance unless otherwise specified	rev	ecn	by	date	app.
XXX ± 0.10 XX ± 0.50					
scale N/A	WAVETEK san diego, calif				
material N/A	by GRAY date 2-12-71 app. J.O.P.				
finish N/A	title SCHEMATIC ATTENUATOR				
	model no.	des. no.	rev		
	131A	D131A-201			
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					



NOTES:
1 FOR SCHEMATIC SEE D131A-200

PARTS LIST					
ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
1	R2	RES METALFILM 1/4W, 1% 49.9Ω	CORNING	RN60D	1
2	R3, R4	249Ω			2
3					
4					
5	CI	CAPACITOR, DISC 1000V, .0022uf	CRL	DD-222	1
6					
7		DETENT	WAVETEK	134-304-7	1
8		WAFER	CTS	T109	2
9		STANDOFF (1/2" SPACER)	CTS		2

TOLERANCE UNLESS OTHERWISE SPEC	XXX .010	XX .030	ANGLES .030	REV	ECH	BY	DATE	APP
SCALE FULL	WAVETEK SAN DIEGO CALIF.							
MATERIAL N/A	BY BOCHKIN DATE 2-16-71 1/2							
FINISH N/A	TITLE ASS'Y OUTPUT SWITCH							
	MODEL NO 131A	DWG NO B131A-002	REV					
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.								

9045 Balboa Ave., San Diego, California Tel. 279-2200, P.O. Box 651, San Diego, California 92112