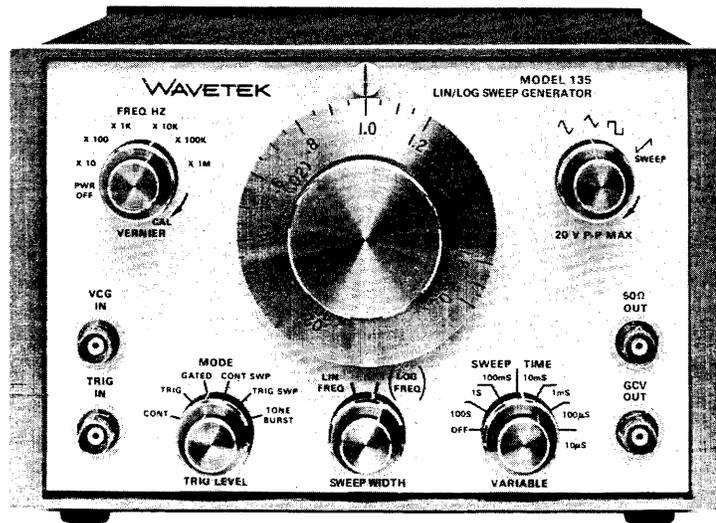


INSTRUCTION MANUAL

# MODEL 135 LIN/LOG SWEEP GENERATOR



# WAVETEK

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### SCOPE OF MANUAL

This manual contains instructions for operating, testing, and maintaining the Wavetek Model 135 Sweep Generator. 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 this manual, it is not always possible to incorporate these changes 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 135 is a precision source of sine, square, triangle, and sawtooth waveforms with selectable and variable outputs over a dynamic frequency range of 0.2 Hz to 2 MHz. Frequency control by external voltage for either dc programming or wideband ac modulation is also provided. The instrument can be operated as a triggered or gated CW generator and as a continuous or triggered sweep generator. Additionally, the frequency sweep may be selected as either a linear function for use in narrow band linear sweep applications, or logarithmic function, normally used in wideband sweep testing.

# SECTION 1

## SPECIFICATIONS

### PHYSICAL AND ELECTRICAL SPECIFICATIONS

#### VERSATILITY

##### Waveforms

Sine , square , triangle , and sweep .

##### Dynamic Frequency Range

0.2 Hz 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 , triangle , and sweep , selectable; amplitude variable over 40 dB, 50 $\Omega$  output impedance (600 $\Omega$  available); 20 V p-p into open circuit and 10 V p-p into 50 $\Omega$  load from 50 $\Omega$  source impedance; short circuit current is  $\pm 100$  milliamperes.

##### GCV Output

Zero to 5 V (max) proportional to the frequency of the main generator. Output impedance 600 $\Omega$ .

##### Sync Output

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

##### DC Offset

$\pm 5$  V offset ( $\pm 2.5$  V offset into 50 $\Omega$  load) controlled from rear panel; peak amplitude limited by the dynamic range of the output amplifier.

##### VCG – Voltage Controlled Generator

Frequency of generator may be dc-programmed or ac-modulated by external 0 to  $\pm 5$  V signal. Voltage control circuitry is capable of 1000:1 frequency variation without changing the range multiplier. The VCG amplifier has a 100 kHz bandwidth in the linear sweep mode only and a slew rate of 0.1 V/ $\mu$ s. 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.

#### OPERATIONAL MODES

##### Continuous\*

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

##### Trigger\*\*

One complete cycle is generated by applying a pulse to the trigger input.

##### Gated\*\*

Same as trigger except that cycles continue for the duration of input gate signal.

##### Continuous Sweep\*

The main generator is frequency modulated by the sweep generator. When swept, the main generator frequency rises from the frequency set by the dial and range settings to a frequency selected by the sweep-width control. Sweep rate and sweep function (LIN or LOG) are selected by front panel controls.

##### Trigger Sweep

Same as continuous sweep mode except one complete sweep cycle is generated for each input trigger pulse. Main generator continues to oscillate between sweep cycles.

##### Tone-Burst

Main generator is gated by the sweep output (internally connected). The tone-burst rate, frequency, and length can be independently controlled.

##### Trigger Input

1 V peak into 10 k $\Omega$  impedance dc coupled to 200 kHz, proportionally greater at higher frequencies.

\*Both generators free run.

\*\*Sweep generator free runs; main generator is triggered or gated.

**Sweep Time**  
10  $\mu$ s to 100 s.

**Sweep Width**  
Up to 1000:1 with front panel control.

#### HORIZONTAL PRECISION

**Dial Accuracy**  
For LIN FREQ,  $\pm 2\%$  of full scale, 1 Hz to 2 MHz.  
For (LOG FREQ), approximate dial calibrations are shown in parentheses.

**Electronic Frequency Vernier**  
For LIN FREQ, one turn for approximately 1% control of full scale. For (LOG FREQ), one turn for approximately 1% control of the output frequency.

**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

#### 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  $\pm 5^\circ$ C. For operation from 0°C to 55°C, derate all specifications by factor of 2.

#### MECHANICAL

**Dimensions**  
8- $\frac{1}{2}$  inches wide, 5- $\frac{1}{4}$  inches high, 11- $\frac{1}{2}$  inches deep.

**Weight**  
9 lb net, 13 lb shipping.

**Power**  
105 V to 125 V or 200 V to 250 V, 50 Hz to 400 Hz.  
Less than 25 watts (continuous).

#### NOTE

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

## 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 maintenance instructions are provided in Section 4.

#### 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 procedural 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 Operating Controls and Figure 2-1 for operating control descriptions.)

| Name          | Required Characteristics     |
|---------------|------------------------------|
| Oscilloscope  | 30 MHz, or higher            |
| Plug-in       | Dual channel                 |
| Plug-in       | Peak mV measuring capability |
| Counter-Timer | 10 MHz (4 digits)            |

- Turn FREQ HZ selector to the X1K position. (This connects ac power to the unit and selects the frequency multiplier.)
- Connect oscilloscope to the 50 $\Omega$  OUT connector with 50-ohm terminator.
- Set frequency dial to the 1.0 mark, MODE selector to CONT, and LIN FREQ/(LOG FREQ) selector to LIN FREQ.
- Set function selector to .
- Rotate 20 V P-P MAX control to maximum clockwise position.
- Check for 1 kHz sine wave with greater than 10 V p-p amplitude on oscilloscope.
- Select  and  with function selector and check for 10 V p-p amplitude on oscilloscope.
- Turn frequency dial from maximum counterclockwise to maximum clockwise position and check for frequency change.
- Set LIN FREQ/(LOG FREQ) selector to (LOG FREQ) and turn frequency dial from maximum counterclockwise to maximum clockwise position and check for frequency change. Frequency of the generator output should approximately correspond to the frequency indicated on the dial in parenthesis.
- Set LIN FREQ/(LOG FREQ) selector to LIN FREQ.
- Rotate 20 V P-P MAX control from maximum clockwise to maximum counterclockwise position and check for decreasing amplitude.
- Rotate VERNIER to maximum clockwise position. Set frequency to 20 Hz with counter. Connect 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 approximately from 20 Hz to 2 kHz.
- Set MODE selector to TRIG. Disconnect power supply from VCG IN connector. Rotate TRIG LEVEL control while observing oscilloscope. One cycle of the desired waveform should appear.
- Set MODE selector to GATED. Rotate TRIG LEVEL control while observing oscilloscope. Waveform should appear at clockwise position and disappear at counterclockwise position.
- Set MODE selector to CONT SWP. Set frequency to 20 Hz with counter. Set SWEEP WIDTH to 2.0. Set SWEEP TIME to 1 s. Dis-

- played frequency should sweep recurringly from 20 Hz to 2 kHz at a 1 second rate.
16. Set MODE to TRIG SWP. Rotate TRIG LEVEL control, while observing oscilloscope. Displayed frequency should sweep once from 20 Hz to 20 kHz in 1 second.
  17. Set LIN FREQ/(LOG FREQ) selector to (LOG FREQ). Repeat steps 15 and 16.
  18. Set MODE selector to TONE BURST. Rotate TRIG LEVEL control, while observing oscilloscope. Tone bursts at 20 Hz should appear with burst duration varying with rotation of TRIG LEVEL control.
  19. Remove 50-ohm terminator installed in Step 2.
  20. Connect oscilloscope to GCV OUT connector.
  21. Set frequency dial to 2.0, MODE switch to CONT, and LIN FREQ/(LOG FREQ) selector to LIN FREQ and (LOG FREQ). The output should read  $+5\text{ V} \pm 200\text{ mV}$  in either position.
  22. Connect oscilloscope to SYNC OUT connector.
  23. Set frequency dial to 2.0. Oscilloscope should display a 2 kHz square wave.

#### NOTE

*With the frequency dial in the extreme clockwise position (the bottom of the dial) and with the frequency VERNIER control turned fully counterclockwise, it is possible for the generator to stop oscillating. This is well below 1/1000th of the top of the dial. This condition is easily corrected by turning the frequency VERNIER control in a clockwise direction until oscillation again occurs.*

*Oscillation can also be stopped by applying a negative voltage to the VCG summing node when the MODE selector switch is set to TRIG SWP and the SWEEP WIDTH control is set to maximum. To correct this condition, turn the frequency dial counterclockwise until oscillation again occurs (usually well below 1/1000th of the top of the dial). Do not attempt to purposely stop the generator in this manner.*

#### OPERATING CONTROLS

Operating controls and electrical connections for the Model 135 are shown in Figure 2-1. The function of each is described below.

#### Front Panel Controls

1. **FREQ HZ/Power Switch** — Selects the generator frequency range. When turned to the extreme counterclockwise position, the power switch is in the PWR OFF position.
2. **Frequency VERNIER** — Allows precision control over the output frequency. When frequency dial is set at 0.02 (1/100th of range) VERNIER controls frequency to approximately 0.002 (1/1000th of range). When in the full clockwise position (CAL), the settings on the main dial will be calibrated.
3. **Frequency Dial** — Provides main frequency control. The dial setting multiplied by the frequency range setting (above) equals the output frequency of the generator. Generator frequency is also affected by frequency VERNIER.
4. **Frequency Index** — Indicates frequency dial setting by illuminated scribe line when instrument power is turned on.
5. **Function Selector** — Selects the appropriate output waveform available at  $50\Omega$  OUT connector. Waveforms are sine , triangle , square , and sweep .
6. **Amplitude Control** — Maximum clockwise position gives the full output amplitude of 20 V peak-to-peak into an open circuit or 10 V peak-to-peak into a  $50\Omega$  load. Counterclockwise rotation will continuously reduce the output amplitude. The control enables a maximum of 40 dB variation (100:1). For maximum output amplitude, knob must be turned to extreme clockwise position.
7.  **$50\Omega$  OUT** — Provides selected generator output connection. Generator may operate into an open circuit providing 20 V peak-to-peak maximum, or into a  $50\Omega$  load providing a 10 V peak-to-peak output.
8. **GCV OUT** — Provides output voltage connection from the GCV amplifier to an external circuit through 600 ohm impedance. This voltage is directly proportional to the frequency indicated on the dial.
9. **SWEEP TIME and VARIABLE** — Determines the frequency of the sawtooth generator ap-

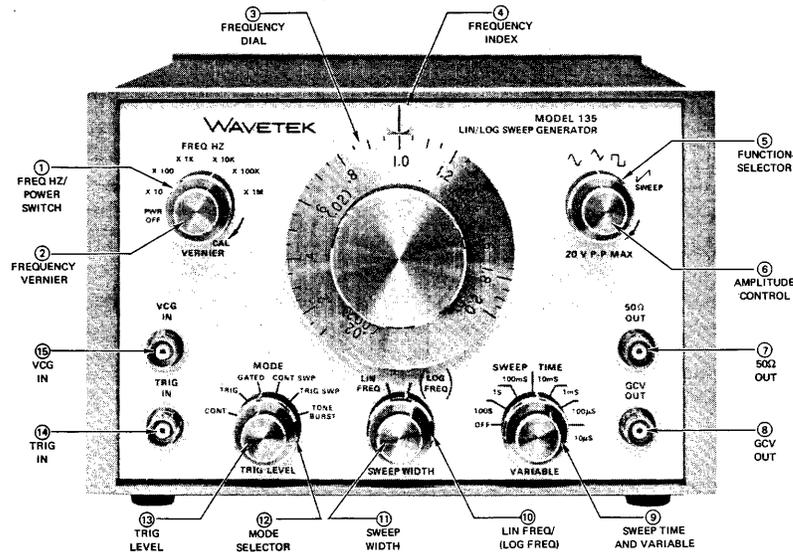


Figure 2-1. Operating Controls

pearing at the GCV OUT connector. Frequency of the sawtooth generator is independent of the frequency of the main generator. In each of the sweep modes, the sawtooth generator determines the duration of the sweep cycle. Frequency range is selected by the SWEEP TIME (larger) control and fine frequency adjustment is provided by turning the VARIABLE (smaller) control. The larger switch detent position is located between two time ranges. With the VARIABLE control in the full clockwise position, the sweep time is equal to the time to the right of the detent setting. However, moving the VARIABLE control to the full counterclockwise position provides a sweep time of approximately 100 times the SWEEP TIME setting.

10. **LIN FREQ/(LOG FREQ)** – Selects linear or logarithmic response for VCG input.
11. **SWEEP WIDTH** – Provides maximum to minimum sweep width for linear and logarithmic capabilities by controlling the amount of peak frequency change added to the basic generator frequency set by the frequency dial, VERNIER control, and VCG IN signal.
12. **MODE Selector** – Selects the operating mode of the main generator as follows:

- a. **CONT** = Continuous Mode – Main generator operates at a fixed frequency and runs continuously. GCV OUT is proportional to the frequency dial output.
- b. **TRIG** = Triggered Mode – Main generator will provide one complete cycle of output for each pulse applied to the TRIG IN connector. Manual triggering can be accomplished by rotating the TRIG LEVEL control (13) from the fully counterclockwise position to the fully clockwise position. GCV OUT is proportional to the frequency dial output.
- c. **GATED** = Gated Mode – Operates the same as Triggered Mode except the main generator continues to provide an output as long as the signal at the TRIG IN connector exceeds the gating level. Refer to TRIG LEVEL (13). GCV OUT is proportional to the frequency dial output.
- d. **CONT SWP** = Continuous with Sweep Mode – Main generator operates continuously and repetitively sweeps from the minimum to the maximum frequency as determined by the sweep controls.
- e. **TRIG SWP** = Triggered Sweep Mode – Main generator oscillates at the start or low frequency. When a trigger signal is applied, the frequency sweeps to the maximum frequen-

- cy as determined by SWEEP WIDTH control and then returns to the low frequency until another trigger is applied.
- f. **TONE BURST** = Internal Gated Mode — Operates the same as the Gated Mode with no TRIG IN input.
13. **TRIG LEVEL** — Adjusts the sensitivity of the trigger input circuitry. When rotated to the fully counterclockwise position, approximately  $-7.5$  volts are required for triggering. At midpoint, extremely low voltages will trigger the instrument. By rotating the TRIG LEVEL control, the generator can be manually triggered. In the Gated Mode, the generator will begin to run continuously as the control is rotated past the midpoint in a clockwise direction.
14. **TRIG IN** — Provides dc coupled input with  $10\text{ k}\Omega$  input impedance. The TRIG LEVEL control adjusts the sensitivity of the generator to the dc coupled input.
15. **VCG IN** — Provides for connection of 0 to  $\pm 5$  volt dc programming or wideband ac input signal directly or through the log converter to the VCG circuit. With 0 volt input, the generator output frequency is determined by the frequency range selected and the frequency dial setting. A positive VCG voltage will increase and a negative voltage will decrease the selected frequency.

#### REAR PANEL CONTROLS

**DC OFFSET** — Adjusts the amount of dc or baseline offset above or below signal ground. The detent position gives normal vertical symmetry with control through zero offset to maximum positive offset.

**SYNC OUT** — Provides a synchronizing wave output at the same frequency of the main generator. Output amplitude is greater than 1 V p-p into an open circuit at  $600\Omega$  output impedance.

#### GENERAL NOTES

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

*A 50-ohm termination results in 10 V p-p maximum output level. Open-circuit ter-*

*mination gives 20 V p-p. Loads between these limits provide intermediate maximum output levels.*

*The frequency VERNIER control must be in full clockwise position for calibrated frequency operation over the 0.1 to 2 dial range. If this control is in full counterclockwise position, dial range is uncalibrated, but extended to approximately 1/1000 of full scale.*

*A 1 volt peak signal is required for trigger rates up to 200 kHz. Proportionally higher voltage is required for higher frequencies.*

#### OPERATION

The Model 135 LIN/LOG Sweep Generator can function in either the linear or logarithmic capability in the following six operational modes, as selected by the MODE and LIN FREQ/(LOG FREQ) switch settings. Location of the linear scale is on the outer rim of the frequency selector and the logarithmic scale is innermost on the dial with graduations in parentheses.

**CONT** — Continuous Frequency Operation provides a fixed-frequency output for the selected frequency, amplitude, and waveform. The output frequency is determined by the FREQ HZ range selector and frequency dial settings. Output amplitude is controlled with the 20 V P-P MAX continuously-variable potentiometer, and the waveform is selected by the function selector.

**TRIG** — Trigger Operation provides a one-cycle output of the selected waveform with the application of an external trigger. The external signal may be either ac or stepped dc from +1 volt to +12 volts, applied at the TRIG IN connector. TRIG LEVEL control is used to establish the threshold bias.

**GATED** — Gated Operation provides a multicycle output of the selected waveform, frequency, and amplitude when an external signal is applied to the TRIG IN connector. Burst duration is a function of external signal duration.

**CONT SWP** — Continuous Sweep Operation provides an internally-generated, sweep frequency output of the selected waveform, amplitude, and low-end frequency. Sweep width and sweep time are selected in conjunction with the low-frequency limit established by the setting of the frequency dial and FREQ HZ range se-

lector. The output frequency increases from the lower frequency to the upper frequency, which is established by the setting of the SWEEP WIDTH selector, at the rate set by the SWEEP TIME selector. When the upper frequency is reached, the output frequency returns rapidly to the lower limit and the cycle is repeated.

**TRIG SWP** — Trigger Sweep Operation provides a sweep-frequency output at the selected frequency, amplitude, and waveform each time an external signal is applied to the TRIG IN connector. Sweep width and time are selectable as in continuous sweep operation, but the sweep cycle is not repeated until another external trigger arrives.

**TONE BURST** — Tone Burst Operation provides internally-generated, recurring bursts of fixed frequencies. Burst duration is adjustable with the TRIG LEVEL control. Frequency, amplitude, and waveform are selected as in continuous frequency operation.

**Operating as a Function Generator**

1. Set MODE selector to CONT position.
2. Set function selector for desired waveform.
3. Set FREQ HZ range selector to desired multiplier.
4. Set desired frequency dial mark under illuminated index.
5. Set 20 V P-P MAX control for desired output level.
6. If triggered/gated operation is desired, inject a 1 volt peak signal into TRIG IN connector with MODE selector in TRIG or GATED position. Trigger operation provides one cycle of the selected waveform for each step-voltage input. Gated operation produces a tone burst with its duration equal to the duration of the step voltage.

**Operating as a Voltage Controlled Generator (VCG)**

1. Set MODE selector to CONT position.
2. Set function selector for desired waveform.
3. Set FREQ HZ range selector to desired multiplier.
4. Connect external voltage source (dc programming or wideband ac signal) to VCG IN connector.

**NOTE**

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

*A negative voltage applied to the VCG input with the dial at the bottom may cause the generator to stop oscillating. Operation in such a manner is not recommended.*

5. 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.
6. Set 20 V P-P MAX control for desired output level.
7. The nomograph in Figure 2-2 shows the characteristics of the VCG circuit for linear frequencies. 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.

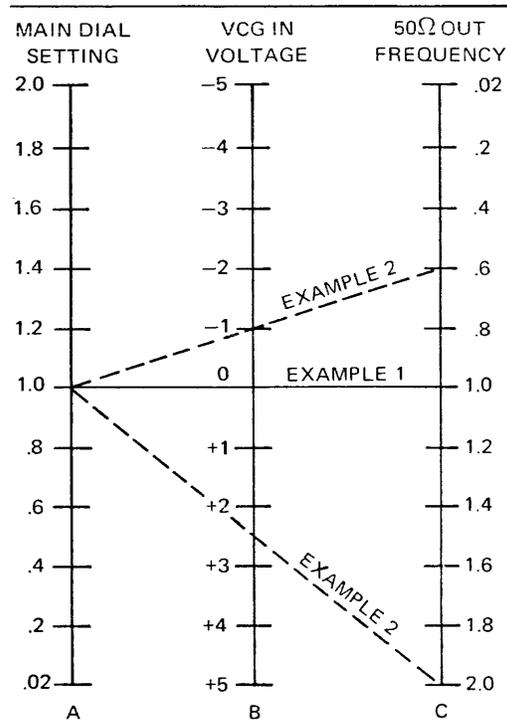


Figure 2-2. VCG Voltage-to-Frequency Nomograph

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  $-1$  volt to  $+2.5$  volts for the VCG voltage. This results in a swept output from 0.6 to 2.0 on the dial. Remember to multiply the dial times the range.

#### Operating as a Sweep Generator

1. Set MODE selector to CONT SWP.
2. Set function selector for desired waveform.
3. Set FREQ HZ range selector to desired multiplier.
4. Set the SWEEP TIME control to the desired sweep time. The sweep time control operates in the following manner. The larger knob provides the coarse adjustment. There are 7 detent positions covering sweep times from 100 s to 10  $\mu$ s. The VARIABLE control is a vernier covering sweep times between one or more detent positions. When the VARIABLE control is in the full clockwise position, the sweep time is equal to the time indicated at the right of the detent mark.
5. Set the SWEEP WIDTH control as follows:
  - a. Turn SWEEP WIDTH control fully counter-clockwise.
  - b. Set frequency dial to desired position.
  - c. Set FREQ HZ selector to desired multiplication factor.
  - d. Connect oscilloscope or counter-timer to  $50\Omega$  OUT connector.

#### NOTE

*When turning SWEEP WIDTH control clockwise, do not exceed maximum of frequency range selected.*

- e. Turn SWEEP WIDTH control clockwise to sweep through frequency range.

#### Example

Suppose you want to sweep from 15 kHz to 20 kHz. Connect oscilloscope or counter-timer to  $50\Omega$  OUT connector for monitoring frequencies. Set the frequency dial to 1.5 and the FREQ HZ selector to X10K. Set SWEEP TIME control to 1 s. The starting frequency is now set at 15 kHz and clockwise movement of the SWEEP WIDTH control will sweep through the frequencies from 15 kHz to 20 kHz.

6. Set 20 V P-P MAX control for desired output level.
7. If triggered-sweep operation is desired, inject a 1 volt peak signal into the TRIG IN connector with MODE selector in TRIG SWP position. Trigger-sweep operation provides one frequency excursion of the selected waveform for each step-voltage input.

#### Operating as a Tone Burst Generator

1. Set the MODE selector to TONE BURST.
2. Set function selector to desired waveform.
3. Set the frequency of the carrier by the main dial.
4. Set the duration of the burst (number of cycles per burst) by varying the TRIG LEVEL.
5. Set the repetition rate with the SWEEP TIME control.
6. Set the 20 V P-P MAX control for the desired output level.

#### Operating as a Ramp Generator

1. Connect coaxial cable between SYNC OUT (on rear panel) and TRIG IN connectors.
2. Set function selector to sweep  $\swarrow$ .
3. Turn SWEEP WIDTH control fully counter-clockwise.
4. Set SWEEP MODE to TRIG SWP.
5. Adjust TRIG LEVEL control for sweep generator firing point.
6. Set ramp parameters as follows:
  - a. Repetition rate with FREQ HZ selector and frequency dial.
  - b. Ramp amplitude with 20 V P-P MAX control.
  - c. Ramp slope with SWEEP TIME controls.
  - d. Ramp baseline with DC OFFSET potentiometer.

#### Converting to 230 Volt Line Power

The Model 135 LIN/LOG Sweep Generator 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 thumbscrews 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.





set for 2 kHz (X100 kHz range), in the linear mode, SWEEP TIME for 1 ms, and SWEEP WIDTH turned fully clockwise, the selected waveform frequency at the 50 $\Omega$  OUT connector increases from 2 kHz to 200 kHz linearly in 1 ms each time a trigger occurs. Continuous linear sweep operation with the preceding settings produces a recurring 2 kHz to 200 kHz output at a 1 kHz repetition rate.

The MODE switch disconnects the sawtooth signal from the summing junction of input voltages in the continuous, triggered, gated, and tone-burst modes. Gated operation directly couples the external gating pulse from the trigger input BNC to the trigger/gate control circuit. Disconnection of the main generator trigger circuit for the duration of the external signal is accomplished by the trigger/gate control circuit. Trigger operation places capacitance between the compara-

tor and control circuit to differentiate the external pulse and momentarily disconnect the trigger circuit, allowing one cycle of the selected waveform to be produced by the main generator.

During tone-burst operation, the sweep generator output is connected to the trigger comparator input. Since the SWEEP WIDTH control disconnects the sawtooth signal from the VCG input in the tone-burst mode, the tone-burst output is a fixed frequency with the burst duration established by the setting of the trigger level control.

To prevent reconnection of the main generator trigger circuit before a full cycle is completed, the hysteresis/output switch synchronizing pulse is applied to the trigger/gate control circuit.

# SECTION 4

## MAINTENANCE

### INTRODUCTION

This section provides instructions for testing, calibrating, troubleshooting, and repairing the Model 135. The instructions are concise and for 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 an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to decrease the turnaround time. Test point and adjustment locations are illustrated in Section 5.

### RECOMMENDED TEST EQUIPMENT

Table 4-1 contains a list of recommended test equipment.

Table 4-1. TEST EQUIPMENT

| Name                               | Required Characteristics  |
|------------------------------------|---|
| Oscilloscope<br>Plug-in<br>Plug-in | 30 MHz, or higher<br>Dual channel<br>Peak mV measuring capability |
| Digital Voltmeter                  | 4 digits  |
| Counter-Timer                      | 10 MHz (4 digits)   |
| Function Generator                 | Wavetek Model 110 or 130  |

### CHECKOUT AND CALIBRATION

The following paragraphs provide complete sequential calibration procedures for the Model 135. Instrument checkout procedures are indicated by a checkmark (✓) following the procedure title. A quick checkout of the instrument can be performed by comparing the indicated parameters with the tolerances given in the Specifications of Section 1.

### NOTE

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

### Preliminary Procedures

1. Set LIN FREQ/(LOG FREQ) selector to LIN FREQ position to calibrate the main board.
2. Set FREQ HZ selector to X100K, VERNIER control fully clockwise, and frequency dial to 2.0.
3. Set MODE selector to CONT, LIN FREQ/(LOG FREQ) selector to (LOG FREQ), and SWEEP TIME selector to OFF position.
4. Allow one-half of an hour for warmup.

### Removal of Dust Cover

To gain access for calibration or maintenance, proceed as follows:

1. Remove power cord.
2. Loosen the two knurled captive screws on the rear panel.
3. Pull off the rear panel.
4. Remove the cover.

### Removal of Front and Back Panels

1. 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 this Section under Removal of Dust Cover.
  - b. Remove one heat-sink mounting screw.
  - c. Remove one transformer mounting-block screw from bottom of board.
  - d. Remove the two screws, lock washers, and hex nuts 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 work room. Enough slack is available in the wiring for all normal operations.
2. To remove the front panel, proceed as follows:
  - a. Remove rear panel and dust cover as described in this Section under Removal of Dust Cover.
  - b. Remove all knobs.
  - c. Disconnect BNC connections.
  - d. Remove  $\frac{1}{2}$  inch nut from frequency dial potentiometer shaft.
  - e. Remove light bulb from indicator lens.
  - f. Remove four front panel retaining screws.
  - g. Carefully pull off front panel.

#### Power Supply Regulation

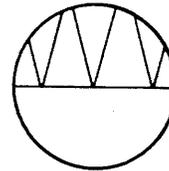
1. Connect voltmeter between TP1 (common) and TP2 (+) on main board.
2. Adjust R104 for +15 Vdc  $\pm 100$  mV.
3. Connect voltmeter between TP1 (common) and TP3 (-) on main board. Since the negative supply is referenced to the +15 volt supply, the voltmeter should indicate -15 Vdc  $\pm 100$  mV.
4. Connect voltmeter between TP4 (+) and TP6 (common) on sweep board.
5. Adjust R43 on log converter board for +15 V  $\pm 25$  mV.
6. Connect voltmeter between TP5 (-) and TP6 (common) on sweep board. Since the negative supply is referenced to the +15 volt supply, the voltmeter should indicate -15 V  $\pm 50$  mV.

#### Square Wave Amplitude Symmetry

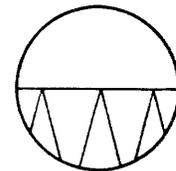
1. Set function selector to  $\square$ .
2. Connect oscilloscope with 1A5 plug-in to coaxial wire lug on function switch. **REF To TP-1**
3. Adjust R121 until square wave negative peak is equal in amplitude to positive peak  $\pm 5$  mV.

#### Triangle Amplitude

1. Set frequency dial for 2.0 (X1K range) and function selector to  $\wedge$ .
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  $\pm 5$  mV (see sketch).
4. Adjust R59 for negative peak at -1.25 volts  $\pm 5$  mV.



Negative Peak



Positive Peak

#### Output Amplifier ✓

1. Connect oscilloscope to 50 $\Omega$  OUT connector with 50-ohm terminator ( $\square$  function).
2. Set FREQ HZ selector for X1K (VERNIER fully clockwise) and frequency dial at 2.0.
3. Turn 20 V P-P MAX control fully counterclockwise ~~while out after~~ wise.
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 clockwise.
7. Adjust C64 for best square wave response without peaking.

#### First VCG Null ✓

1. Connect oscilloscope to 50 $\Omega$  OUT connector.
2. Set FREQ HZ selector to X1K. Set dial at 1/100 of full scale (0.02).
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 clockwise position ( $\square$  function).
3. Set frequency dial for 2 kHz on oscilloscope (1/100 dial full scale).
4. Adjust R28 for time symmetry at 100:1 frequency ratio.
5. Turn VERNIER fully counterclockwise and adjust R22 for bottom-of-dial time symmetry.
6. Repeat Steps 4 and 5, as necessary, for optimum symmetry.
7. Check for waveform time symmetry at the 0.2 and 2 frequency dial settings.
8. Check for 1000:1 frequency ratio at X100K, dial fully clockwise, VERNIER fully counterclockwise.

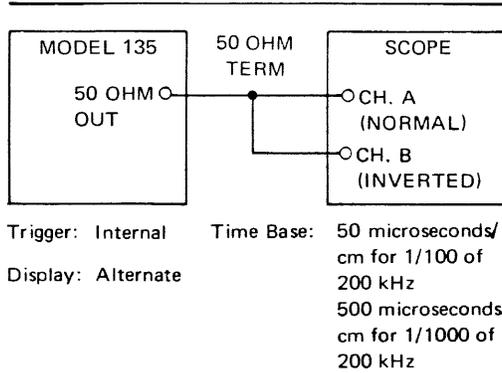


Figure 4-1.

Time Symmetry Measurement for Test Setup

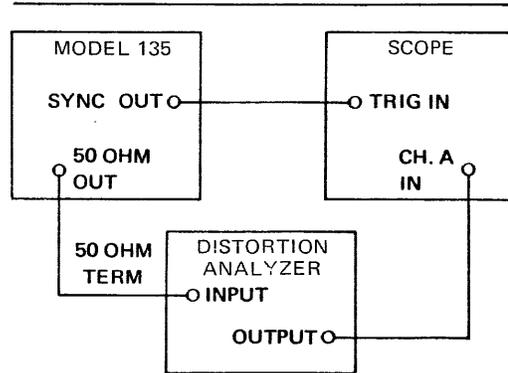


Figure 4-2. Distortion Analysis Test Setup

- If necessary, adjust R8 for slightly  $>1000:1$  ratio.

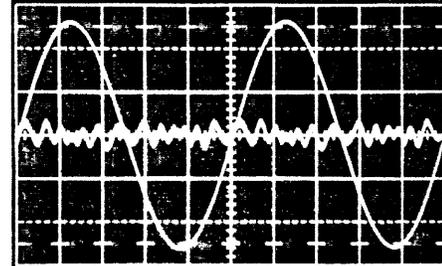
**Frequency Calibration**

- Connect counter to  $50\Omega$  OUT connector with 50-ohm terminator.
- Set FREQ HZ selector to X10K and VERNIER fully clockwise.
- 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.
- Set FREQ HZ selector to X100K and dial at 2.0.
- Adjust C16 to obtain 200.0 kHz on counter display.
- Set FREQ HZ selector to X1M. Adjust C12 to obtain 2.00 MHz on counter display.
- No dial alignment is necessary, if the dial is the push-on type. If it has a set screw, consult the dial alignment procedure at the end of this section.

**Sine, Distortion, Amplitude, and Balance ✓**

- Set FREQ HZ selector to X1K (VERNIER fully clockwise), function selector to  $\sim$  and frequency dial at 2.0.
- Connect oscilloscope, with 1A5 plug-in, to orange wire on function switch.
- Adjust R133 to obtain 2.5 V p-p  $\pm 25$  mV output.
- Adjust R128 to balance output.
- Connect the unit, distortion analyzer, and oscilloscope as shown in Figure 4-2.

- Adjust R126 and R127 for minimum sine distortion (see photo).



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

**Sweep Amplitude ✓**

- Connect oscilloscope with 1A5 (or type W) plug-in, to TP3 on sweep board.
- Set SWEEP TIME to 1 ms/10 ms with VARIABLE fully counterclockwise.
- Adjust R54 on sweep board for 0 V (+0 mV, -5 mV).
- Adjust R63 on sweep board for +5 V (+20 mV, -0 mV).

**X10K FREQ RANGE****Input Scaling Amplifier Null (LOG)**

1. Set SWEEP TIME to OFF position.
2. Connect oscilloscope to GCV OUT.
3. Set frequency dial to maximum clockwise position and frequency VERNIER to maximum counterclockwise position.
4. Short and open coaxial wire lug, next to yellow wire lug on LIN FREQ/(LOG FREQ) switch (SW3 on sweep board) to TP6 (common sweep board) through 1 k $\Omega$  resistor. Monitor output voltage variation. Adjust R1 on log converter board for minimum voltage change (less than 3 mV).

**Output Amplifier Null (Log Converter Board) (LOG)**

1. Connect oscilloscope to 50 $\Omega$  OUT connector.
2. Short and open TP1 (summing node) on log converter board to TP6 (common) on sweep board through 1 k $\Omega$  resistor while monitoring output frequency variation. Adjust R20 on log converter board for minimum frequency change (less than 10% change when a complete cycle is displayed on oscilloscope).

**Frequency Dial Alignment (LOG)**

1. Connect counter to 50 $\Omega$  OUT connector.
2. Turn frequency dial and VERNIER fully clockwise.
3. Adjust R17 on log converter board for 200  $\pm$ 5 Hz while monitoring the frequency on counter.
4. Set frequency dial for 2.0.
5. Adjust R7 on log converter board to obtain 200  $\pm$ 2 kHz on counter.

**NOTE**

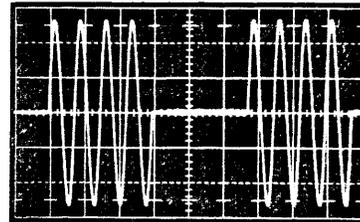
*Readjustment may be required after the internal temperature of the instrument is stabilized.*

**GCV Amplifier Gain**

1. Connect voltmeter to GCV OUT.
2. Adjust R10 on log converter board to obtain +5 V  $\pm$ 100 mV.
3. Set LIN FREQ/(LOG FREQ) selector to LIN FREQ.
4. Observe that the voltage difference between two modes is less than 200 mV.

**Trigger/Gated Output  $\checkmark$** 

1. Connect oscilloscope to 50 $\Omega$  OUT connector.
2. Set main generator output for 20 kHz (TOD).
3. Set MODE selector to TONE BURST (SWEEP TIME 1 ms/10 ms, VARIABLE fully clockwise).
4. Adjust TRIG LEVEL for appropriate tone-burst pattern.
5. Adjust R50 on main board until base line is 0 V  $\pm$ 15 mV (see photo).

**TROUBLESHOOTING****Basic Techniques**

Troubleshooting the Model 135 requires no special techniques. 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 securely 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, probable causes, prescribed remedies, test points

at which measurements are made, and 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. Next 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.

Table 4-2. TROUBLESHOOTING CHART

| Symptom                           | Probable Cause   | Corrective Procedures   |
|-----------------------------------|------------------|---|
| No outputs at 50Ω OUT connector   | Blown fuse       | Replace F1.<br>a. 1/4A – 115 Vac.<br>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.<br>a. If waveform is present, troubleshoot output amplifier.<br>b. If no waveforms are present refer to Main Generator Troubleshooting Hints. |
| No sine wave output               | Sine amplifier   | Check for 260 mV p-p sine wave at pin 4 of IC8.<br>a. If present, check IC8 circuit.<br>b. If not present, check A1 circuit.<br><i>NOTE: Triangle wave must be present at pin 2 of A1 to obtain sine wave output.</i>                                   |
| No triangle, sine, or square wave | Generator loop   | Refer to Main Generator Troubleshooting Hints.  |
| All waveforms low in amplitude    | Power amplifier  | a. Check front-panel amplitude control.<br>b. Perform balance adjustment for power amplifier.   |
|                                   | Power supply     | Check for correct voltages.   |
| Frequency out of tolerance        | Power supply     | Check for correct 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.<br>a. If normal, check sine amplifier IC8.<br>b. If abnormal, check A1 circuit.   |

Table 4-2. TROUBLESHOOTING CHART (Continued)

| Symptom  | Probable Cause   | Corrective Procedures   |
|--|--|---|
| Time symmetry of waveforms not correct   | Maladjustment  | Perform Time Symmetry and Frequency adjustments.  |
| Triggered, gated, tone burst, and triggered sweep modes inoperative; continuous sweep normal | Trigger comparator fault                                 | Check at R32/R33 junction (sweep board) for +5 V with trigger level control fully clockwise. If abnormal, check Q1 – Q4 on sweep board. |
| Triggered, gated and tone burst modes inoperative; triggered sweep and continuous normal     | Trigger/gate controller fault or trigger circuit failure | Check Q5 – Q6 on sweep board and Q3 – Q5 on main board.   |
| Sawtooth sweep not in spec   | Maladjustment  | Perform Sweep Amplitude and Sweep Time adjustments.   |

#### Main Generator 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.)

1. Set instrument controls for 10 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).
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 all right. Proceed to Step 6.
  - b. If abnormal, check Q6 – Q16 stages.
6. Vary frequency dial from counterclockwise to clockwise 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 counterclockwise to clockwise 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 counterclockwise to clockwise while observing TP9. Voltage reading should remain at 0 volts. If voltage varies, check IC3 stage.
9. Vary frequency dial from counterclockwise to clockwise 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 counterclockwise to clockwise while observing TP8. Voltage reading should remain at 0 volts. If voltage varies, check IC4 and IC5 stages.
11. Re-install R51 and remove Q3 to isolate trigger circuit from integrator. If generator operates normally, check Q3 – Q5 stages. If abnormal, check Q1 and Q2 stages.

#### Sweep Generator Troubleshooting Hints

To check the sweep generator including the trigger sweep switching circuit, use the following procedure.

1. Set instrument controls as follows:
  - a. SWEEP TIME to 100 s.
  - b. SWEEP WIDTH to 2.
  - c. MODE at TRIG SWP.
  - d. TRIG LEVEL fully counterclockwise.
  - e. Frequency dial at 0.1 mark.

- Check transistor junctions given in the following chart for indicated states with the sweep generator in the standby condition prior to the application of a sweep trigger. If all stages are normal, either IC2 or IC3 is faulty. If an abnormal "switch state" is encountered, check all junctions of the transistor before deciding that is the defective stage.

**Standby Condition**

|       |     |    |     |     |     |     |      |      |
|-------|-----|----|-----|-----|-----|-----|------|------|
| Stage | Q7  | Q8 | Q9  | Q10 | Q11 | Q12 | Q13A | Q13B |
| State | OFF | ON | OFF | ON  | ON  | OFF | ON   | OFF  |

In some cases, it will be helpful to turn the TRIG LEVEL control quickly from fully counterclockwise to fully clockwise and back to counterclockwise, while checking transistor junctions. The following chart lists the sweep generator states immediately after triggering.

|       |     |    |     |     |     |     |      |      |
|-------|-----|----|-----|-----|-----|-----|------|------|
| Stage | Q7  | Q8 | Q9  | Q10 | Q11 | Q12 | Q13A | Q13B |
| State | OFF | ON | OFF | OFF | OFF | ON  | OFF  | ON   |

**Positive Slope Condition (Approximately 97 Seconds)**

|       |     |     |    |     |     |     |      |      |
|-------|-----|-----|----|-----|-----|-----|------|------|
| Stage | Q7  | Q8  | Q9 | Q10 | Q11 | Q12 | Q13A | Q13B |
| State | OFF | OFF | ON | OFF | OFF | OFF | OFF  | ON   |

**Negative Slope Condition (Approximately 3 Seconds)**

|       |    |     |     |     |     |     |      |      |
|-------|----|-----|-----|-----|-----|-----|------|------|
| Stage | Q7 | Q8  | Q9  | Q10 | Q11 | Q12 | Q13A | Q13B |
| State | ON | OFF | OFF | ON  | OFF | OFF | ON   | OFF  |

**Log Converter Troubleshooting Hints**

The simplest way to reduce problem complexity is to isolate the log converter from the VCG circuit of the main generator. Examination of the output voltage of the converter can be accomplished by injecting a known current into the input summing node.

- Disconnect wire at terminal FA of the log converter.
- Connect 4.99KΩ 1% resistor to terminal FA.
- Connect open end of resistor to positive (+) terminal of a stable and pure variable voltage source that is capable of supplying 0 to 5 volts at 1 mA.
- Connect negative (-) terminal of voltage source to ground at terminal R.
- Examine output of IC1 while varying the voltage source from 0 to 5 volts. The maximum negative output should be approximately 625 mV.

- Examine output of IC4 while varying the voltage source from 0 to 5 volts. The voltage change should be approximately 625 mV with the reference voltage approximately -1.9 volts.
- Examine output of IC5 at terminal GA while varying the voltage source from 0 to 5 volts. The output voltage should read approximately as follows:

| Voltage Source | Output at GA |
|----------------|--------------|
| 0 V            | 5 mV         |
| 1 V            | 313 mV       |
| 2 V            | 625 mV       |
| 3 V            | 1.25 V       |
| 4 V            | 2.5 V        |
| 5 V            | 5 V          |

**Replacement of Switch Wafers and Potentiometers**

- To replace FREQ HZ switch wafer C or D or the VERNIER potentiometer, proceed as follows:
  - Remove rear panel and dust cover as previously described.
  - Separate bracket assembly from chassis as previously described.
  - Tag and unsolder leads to part being replaced.
  - Pull defective part off shaft and repair or replace with recommended replacement part.
- To replace FREQ HZ switch wafer A or B, proceed as follows:
  - Remove rear panel and dust cover as previously described.
  - Remove front panel as previously described.
  - Tag and unsolder wires to switch wafers A and B.
  - Unsolder wafer B PC tabs from printed circuit board.
  - 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.
  - Repair or replace defective part.
- To repair or replace function selector wafers or 20 V P-P MAX potentiometer, proceed as follows:
  - Remove rear panel and dust cover as previously described.
  - 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.

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

**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.

**Connecting Signal and Chassis Grounds**

The instrument is shipped from the factory with the signal ground floating above chassis ground, unless otherwise specified. A common signal/chassis ground can be obtained as follows:

1. Remove power cord.

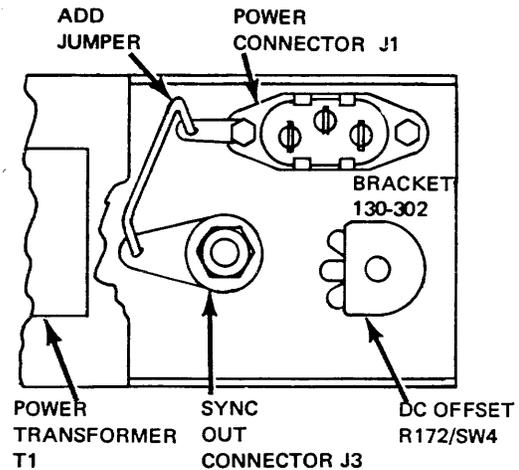


Figure 4-3. Common Ground Connection Diagram

# SECTION 5

## DATA PACKAGE

### INTRODUCTION

This section contains data packages for the Model 135. Each data package is a quick-access document, containing maintenance data arranged for convenient viewing of the schematic diagram and all supporting data. Each data package includes a parts-location illustration, a replaceable parts list, voltage/waveform data, and a schematic diagram. Voltage and waveform data are provided on the diagrams at indicated test

points as an aid to troubleshooting. Also, a list of manufacturers is included in this section.

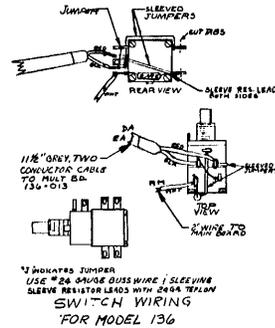
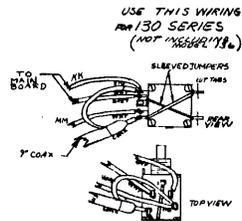
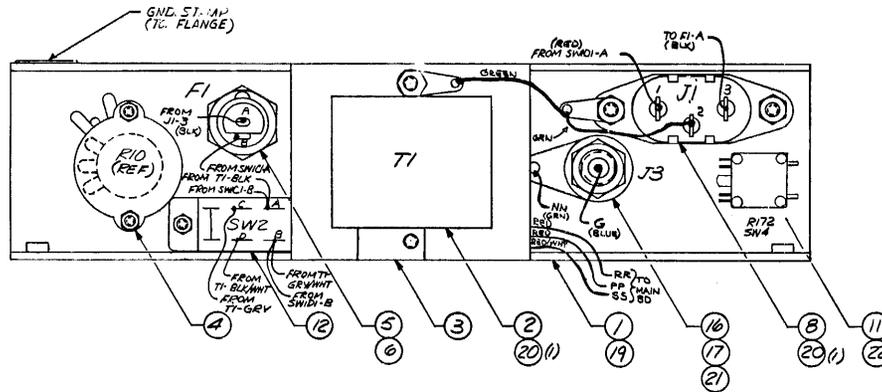
### RECOMMENDED SPARE PARTS LIST

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

| DESCRIPTION     | MANUFACTURER | PART NO.            | QTY |
|-----------------|--------------|---------------------|-----|
| DIODE           | FAIRCHILD    | FD6666              | 2   |
| DIODE           | SEMTECH      | SCE-1               | 1   |
| DIODE           | WAVETEK      | 130-506             | 1   |
| FUSE 1/8A 250 V | BUSSMAN      | MDL 1/8             |     |
| FUSE 1/4A 115 V | LITTELFUSE   | 313-250             | 1   |
| IC              | RCA          | *CA3030 (-15)       | 1   |
| IC              | RCA          | *CA3030 (-16)       | 1   |
| IC              | RCA          | *CA3036 (-17)       | 1   |
| IC              | FAIRCHILD    | * $\mu$ A709C (-14) | 1   |
| IC              | MOTOROLA     | MC816P              | 1   |
| IC              | FAIRCHILD    | * $\mu$ A709C (-13) | 1   |
| IC              | RCA          | *CA3039 (-18)       | 1   |
| IC              | RCA          | *CA3036 (-31)       | 1   |
| LAMP            | MURA         | L28/40              | 1   |
| SINE MODULE     | WAVETEK      | 130-011             | 1   |
| TRANSISTOR      | FAIRCHILD    | 2N2905              | 1   |
| TRANSISTOR      | FAIRCHILD    | 2N3299              | 1   |
| TRANSISTOR      | FAIRCHILD    | 2N3646              | 2   |
| TRANSISTOR      | FAIRCHILD    | 2N3638              | 1   |
| TRANSISTOR      | MOTOROLA     | MPS3640             | 1   |
| TRANSISTOR      | MOTOROLA     | 2N3903              | 1   |
| TRANSISTOR      | MOTOROLA     | 2N3905              | 1   |
| TRANSISTOR      | SPRAGUE      | TD101               | 1   |
| TRANSISTOR      | FAIRCHILD    | 2N2369              | 1   |
| TRANSISTOR      | TEXAS INST   | *TIP 29             | 1   |
| TRANSISTOR      | TEXAS INST   | *TIP 30             | 1   |
| TRANSISTOR      | FAIRCHILD    | 2N3563              | 1   |
| TRANSISTOR      | MOTOROLA     | 2N2219A             | 1   |

| DESCRIPTION           | MANUFACTURER | PART NO.       | QTY |
|-----------------------|--------------|----------------|-----|
| TRANSISTOR            | FAIRCHILD    | 2N2905A        | 1   |
| TRANSISTOR<br>MATCHED | SILICONIX    | U233           | 1   |
| TRANSISTOR<br>MATCHED | MOTOROLA     | *MPS3640 (-10) | 2   |
| TRANSISTOR<br>MATCHED | FAIRCHILD    | *2N2905 (-8)   | 2   |
| TRANSISTOR<br>MATCHED | FAIRCHILD    | *2N3646 (-11)  | 2   |
| TRANSISTOR            | FAIRCHILD    | *2N3638 (-9)   | 2   |

\* Denotes special parts that should be ordered from Wavetek. These parts have been tested or selected by Wavetek for optimum performance.



PARTS LIST

| ITEM | REF DES   | DESCRIPTION                  | MFGR        | MFGR NO      | QTY |
|------|-----------|------------------------------|-------------|--------------|-----|
| 1    |           | BRACKET                      | WAVETEK     | 6/30-302     | 1   |
| 2    | T1        | TRANSFORMER                  |             | C130-500     | 1   |
| 3    |           | TRANSFORMER BRACKET          |             | A130-306     | 1   |
| 4    |           | STANDOFF (MODEL 130ONLY)     | HN SMITH    | 2342         | 2   |
| 5    | F1        | FUSE/1/4AMP/15V              | LITTELFUSE  | 3/R-250      | 1   |
| 6    |           | FUSE HOLDER                  |             | 34201/2      | 1   |
| 7    |           | FUSE 1/8AMP, 250V            |             | MIL 118      | 1   |
| 8    | J1        | POWER RECEPTACLE             | SWITCHLEAF  | LAC3-6       | 1   |
| 9    | R76       | RESISTOR 1/4W 10% CARBON 24K | STANPALE    | AC046242K    | 1   |
| 10   |           |                              |             |              |     |
| 11   | R172, SW4 | DC OFFSET SWITCH 10K/5W      | A-B         | 70K02020K30A | 1   |
| 12   | SW2       | 115-230V SWITCH              | SWITCHBOARD | 46254LE      | 1   |
| 13   |           |                              |             |              |     |
| 14   |           | MICA INSULATOR               | WVTK        | A740-307     | 1   |
| 15   |           | HEATSINK                     |             | A130-311     | 1   |
| 16   | J3        | BNC CONNECTOR                | KINS        | KC7946       | 1   |
| 17   |           | SHOULDER WRENCH              | SMITH       | 2648         | 2   |
| 18   |           |                              |             |              |     |
| 19   |           | FASTENERS #6-32              | SOUNCO      | 74-11-106-13 | 4   |
| 20   |           | SOLDER LUG                   | H.H. SMITH  | 1474-A       | 2   |
| 21   |           | SOLDER LUG                   |             | 1497         | 1   |
| 22   |           | KNOB                         | ELMA        | 020-222      | 1   |
| 23   |           |                              |             |              |     |
| 24   |           |                              |             |              |     |
| 25   |           |                              |             |              |     |

FOR 15V MODEL  
FOR 230V MODEL  
MODEL 136 ONLY

| REV | DATE      | BY | CHKD | APPD |
|-----|-----------|----|------|------|
| J   | DEC 14 82 | DL | DL   |      |
| H   | DEC 13 82 | DL | DL   |      |
| G   | DEC 13 82 | DL | DL   |      |
| F   | DEC 8 82  | DL | DL   |      |
| E   | DEC 5 81  | DL | DL   |      |
| D   | JUL 14 81 | DL | DL   |      |
| C   | DEC 31 80 | DL | DL   |      |
| B   | DEC 29 80 | DL | DL   |      |
| A   | DEC 28 80 | DL | DL   |      |

tolerance unless otherwise specified  
XXX & 010  
XX & 030

SCALE: N/A

MATERIAL: N/A

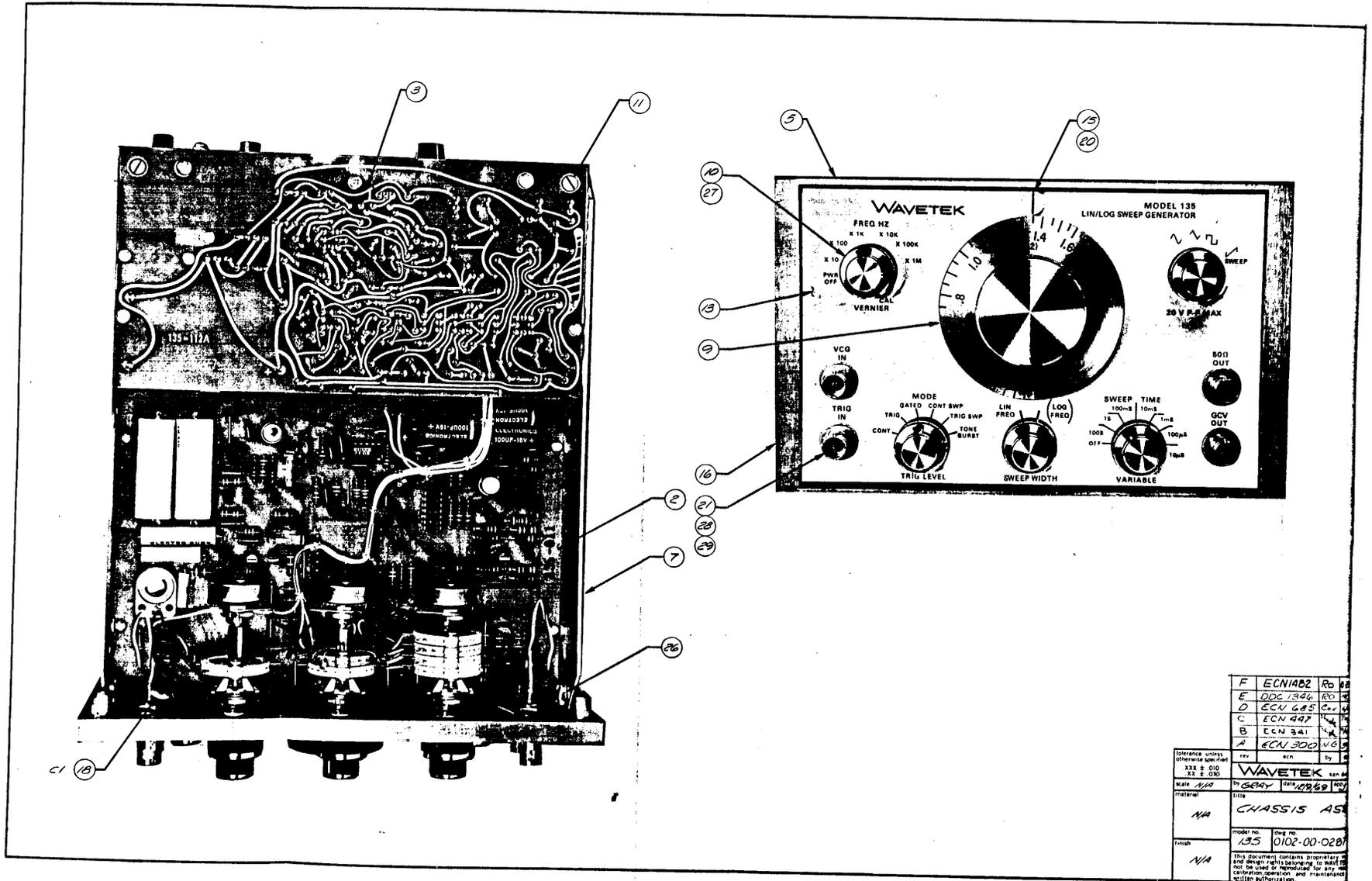
FINISH: N/A

WAVETEK  
SAN DIEGO, CALIF.  
1987 (REV. 11/11) SHEET 7-21-69 4002 34A

ASSY, BRACKET

MODEL NO: 130-136  
Dwg no: D130-001 J

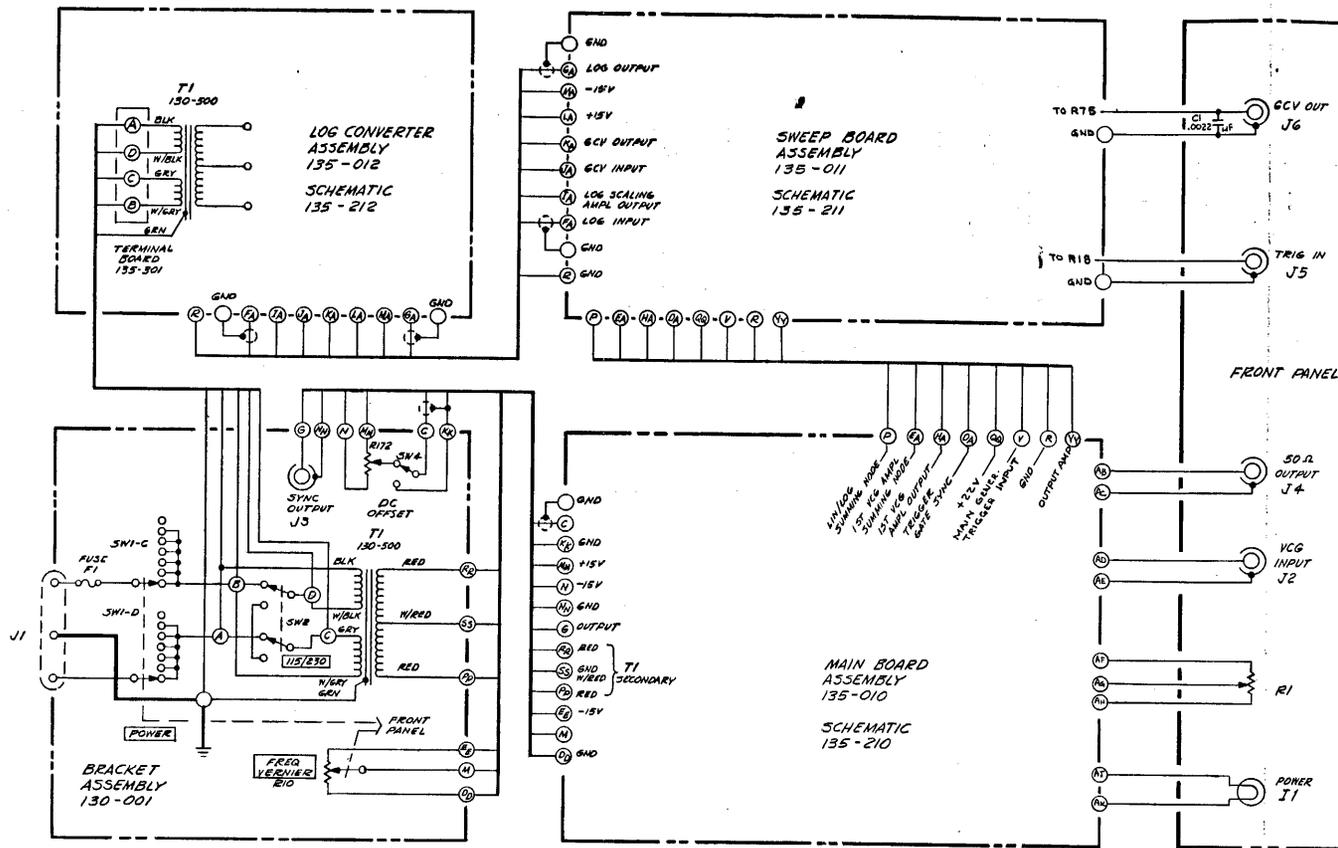
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|   |          |    |    |
|---|----------|----|----|
| F | ECN1462  | Ro | 14 |
| E | DDC 1344 | Ro | 14 |
| D | ECU 645  | Co | 14 |
| C | ECN 447  | Co | 14 |
| B | ECN 341  | Co | 14 |
| A | ECN 300  | Co | 14 |

|                                      |                    |         |              |         |
|--------------------------------------|--------------------|---------|--------------|---------|
| tolerance unless otherwise specified | rev                | 402     | by           | 4       |
| XXX ± 0.10<br>XX ± 0.05              | <b>WAVETEK</b> 135 |         |              |         |
| scale 1:1                            | by GENY            | 1/10/69 | 1/10/69      | 1/10/69 |
| material                             | CHASSIS AS         |         |              |         |
| model no.                            | 135                | one no. | 0102-00-0287 |         |
| finish                               | NA                 |         |              |         |

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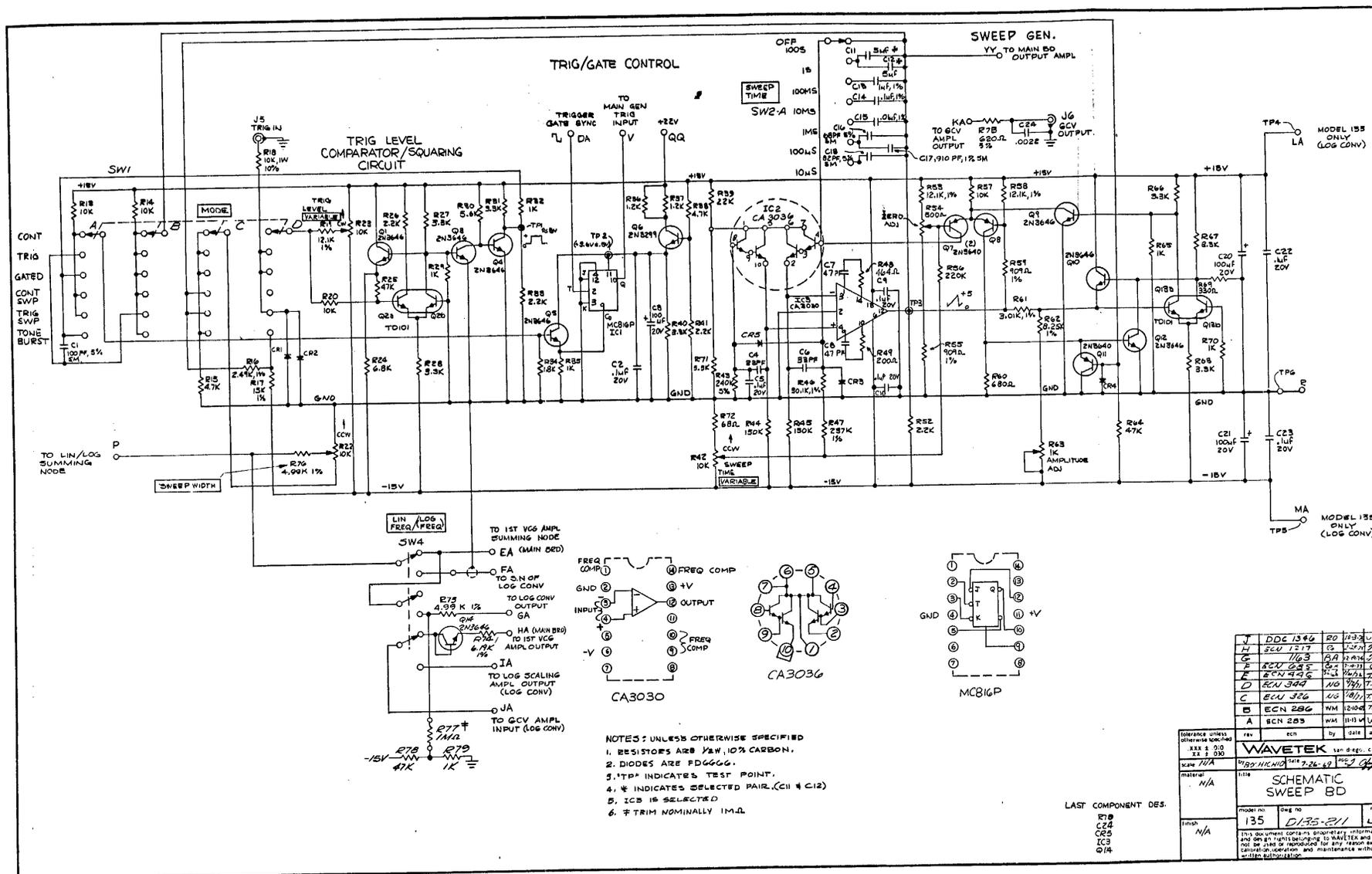


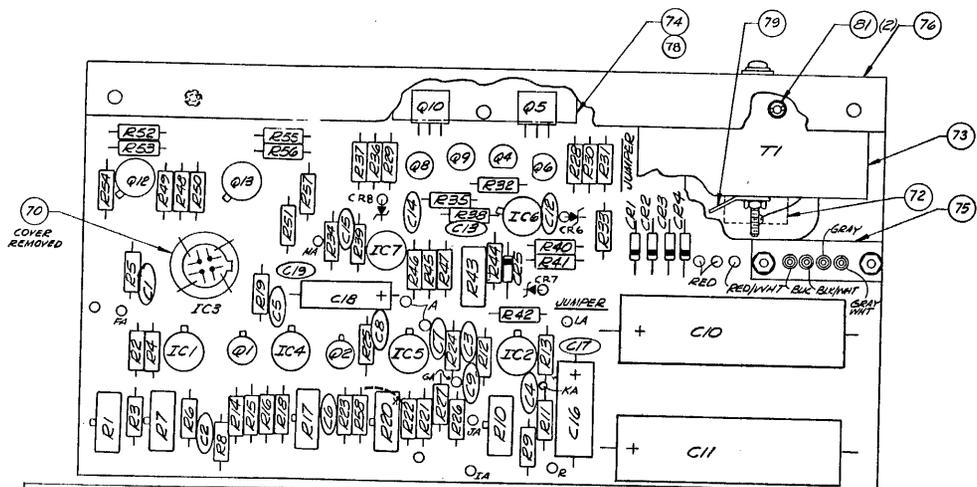
NOTES: UNLESS OTHERWISE SPECIFIED  
 1. LETTER DESIGNATIONS ARE INTERCONNECTION POINTS.

|                                      |  |              |        |         |
|--------------------------------------|--|--------------|--------|---------|
| Reference unless otherwise specified | A  | ECN 341      | SA     | 1/11/20 |
| rev.                                 |  | ecn          | by     | date    |
| X15 E 010<br>13 E 030                | <b>WAVETEK</b> <small>Low drag, cavt</small>   |              |        |         |
| Scale: N/A                           | By: HAST   | Date: 200603 | Rev: 1 | 1/11/20 |
| Material: NA                         | Title: SCHEMATIC, CHASSIS  |              |        |         |
| Model no: 135                        | Draw no: D135-200  | Rev: A       |        |         |
| Emp: NA                              | This document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except contractors, operators, and maintenance without written authorization. |              |        |         |









| ITEM        | REF DES | DESCRIPTION             | MFR     | MFR NO.   | QTY |
|-------------|---------|-------------------------|---------|-----------|-----|
| PARTS LIST  |         |                         |         |           |     |
| RESISTORS   |         |                         |         |           |     |
| 46          | R3      | NEAL FILM 1/4W 1% 576.0 | GRNMS   | EN60D     | 1   |
| 48          | R4      | 679.0                   |         |           | 1   |
| 49          | R41     | 287K                    |         |           | 1   |
| 50          | R11E24  | 499K                    |         |           | 2   |
| 51          | R44     | 6.18K                   |         |           | 1   |
| 52          | R42     | 8.25K                   |         |           | 1   |
| 53          | R45,47  | 10 K (64)               |         |           | 2   |
| 54          | R41,48  | 21.5K                   |         |           | 4   |
| 55          |         |                         |         |           |     |
| 56          |         |                         |         |           |     |
| 57          |         |                         |         |           |     |
| 58          |         |                         |         |           |     |
| TRANSISTORS |         |                         |         |           |     |
| 59          | Q13     | 2N2905                  | PARMCO  | 2N2905    | 1   |
| 60          | Q12     | 2N3299                  |         | 2N3299    | 1   |
| 61          | Q2,9    | 2N3638                  |         | 2N3638    | 2   |
| 62          |         |                         |         |           |     |
| 63          | Q10,6   | 2N3646                  |         | 2N3646    | 2   |
| 64          | Q5      | 71P29                   | T.I.    | 71P29     | 1   |
| 65          | Q10     | 71P30                   |         | 71P30     | 1   |
| 66          | Q1,2    | U235                    | SARGENT | U235      | 2   |
| 67          |         |                         |         |           |     |
| 68          |         |                         |         |           |     |
| 69          |         |                         |         |           |     |
| 70          |         | KURON OVEN 4571-2       | KURON   | 4571-2    | 1   |
| 71          |         |                         |         |           |     |
| 72          |         | TRANSFORMER HTS BLOK    | WAVTEK  | A 120-306 | 1   |
| 73          | T1      | TRANSFORMER             |         | C120-500B | 1   |
| 74          |         | HEATSINK                |         | A120-311  | 1   |

| ITEM       | REF DES | DESCRIPTION     | MFR     | MFR NO.      | QTY |
|------------|---------|-----------------|---------|--------------|-----|
| PARTS LIST |         |                 |         |              |     |
| 75         |         | TERMINAL BOARD  | WAVTEK  | A135-301     | 1   |
| 76         |         | BRACKET         |         | C132-302     | 1   |
| 77         |         | CIRCUIT BOARD   |         | C135-71E     | 1   |
| 78         |         | INSULATOR, MICA | WITK    | A740-307     | 1   |
| 79         |         | SOLDES LUG      | HSMTH   | 1414-4       | 1   |
| 80         |         |                 |         |              |     |
| 81         |         | PRESS NUT       | SARGENT | 74-11-106-13 | 2   |
| 82         |         |                 |         |              |     |
| 83         |         |                 |         |              |     |
| 84         |         |                 |         |              |     |
| 85         |         |                 |         |              |     |
| 86         |         | AMP PWS         | AMP     | G1182-2      | 10  |
| 87         |         |                 |         |              |     |
| 88         |         |                 |         |              |     |
| 89         |         |                 |         |              |     |
| 90         |         |                 |         |              |     |
| 91         |         |                 |         |              |     |
| 92         |         |                 |         |              |     |
| 93         |         |                 |         |              |     |
| 94         |         |                 |         |              |     |
| 95         |         |                 |         |              |     |
| 96         |         |                 |         |              |     |
| 97         |         |                 |         |              |     |
| 98         |         |                 |         |              |     |
| 99         |         |                 |         |              |     |
| 100        |         |                 |         |              |     |
| 101        |         |                 |         |              |     |
| 102        |         |                 |         |              |     |
| 103        |         |                 |         |              |     |
| 104        |         |                 |         |              |     |

| ITEM               | REF DES        | DESCRIPTION            | MFR     | MFR NO.       | QTY |
|--------------------|----------------|------------------------|---------|---------------|-----|
| PARTS LIST         |                |                        |         |               |     |
| CAPACITORS         |                |                        |         |               |     |
| 2                  | C2,4,6,9,12,14 | CERAMIC 1KV 220PF      | CEL     | DD-221        | 6   |
| 3                  | C7,19          | 20V .1uF               |         | UK20-10A      | 2   |
| 4                  | A13,15         | 50V .005uF             |         | CK-502        | 6   |
| 5                  | C7             | 1KV .001uF             |         | DD-102        | 1   |
| 6                  | C16,18         | ELECT 1KV 100uF        | SPRAGUE | 500D07010DC7  | 2   |
| 7                  | C10,11         | 35V 1000uF             |         | 99D1000035564 | 2   |
| 8                  |                |                        |         |               |     |
| 9                  |                |                        |         |               |     |
| DIODES             |                |                        |         |               |     |
| 11                 | C21,22,4       | 5CE-1                  | SEMTECH | 5CE-1         | 4   |
| 12                 | C25            | FD6666                 | PARMCO  | FD6666        | 1   |
| 13                 | CR6,7,8        | ZENER                  | WAVTEK  | 130-506       | 3   |
| 14                 |                |                        |         |               |     |
| 15                 |                |                        |         |               |     |
| INTEGRATED CIRCUIT |                |                        |         |               |     |
| 17                 | IC1,2,4,7      | (-13)                  | PARMCO  | 1A1709        | 6   |
| 18                 | IC3            | (-18)                  | ECA     | CA3039        | 1   |
| 19                 |                |                        |         |               |     |
| 20                 |                |                        |         |               |     |
| POTENTIOMETERS     |                |                        |         |               |     |
| 22                 | R7E10          | 100.0                  | CEL     | BA1603-801    | 2   |
| 23                 | R7A15          | 1K                     |         | -805          | 2   |
| 24                 | R1,20          | 100K                   |         | -813          | 2   |
| 25                 |                |                        |         |               |     |
| 26                 |                |                        |         |               |     |
| TRANSFAD           |                |                        |         |               |     |
| 27                 |                |                        | M.ROSS  | 10160         | 2   |
| 28                 |                |                        | WAVTEK  | 10123N        | 2   |
| RESISTORS          |                |                        |         |               |     |
| 29                 |                |                        |         |               |     |
| 30                 | R1,31,37       | CARBON 1/4W, 5%, 6.81K | SPRAGUE | EC206FGR01    | 2   |
| 31                 | R1,31,37       | 47.0                   |         | 470J          | 2   |
| 32                 | R6,23          | 100.0                  |         | 101J          | 2   |
| 33                 | R46,51         | 10% 220.0              |         | 221K          | 2   |
| 34                 | R4,57          | 500.0                  |         | 501K          | 2   |
| 35                 | R30,36         | 470.0                  |         | 471K          | 2   |
| 36                 | R3             | 560.0                  |         | 561K          | 1   |
| 37                 | R9             | 1K                     |         | 102K          | 1   |
| 38                 | R49,50         | 1.2K                   |         | 122R          | 2   |
| 39                 | R1,25          | 1.5K                   |         | 152K          | 6   |
| 40                 | R10            | 3.9K                   |         | 392K          | 1   |
| 41                 | R11,34         | 4.7K                   |         | 472K          | 7   |
| 42                 | R17            | 5% 36K                 |         | 363J          | 1   |
| 43                 | R58            | 10% 47K                |         | 473K          | 1   |
| 44                 | R2             | 1M                     |         | 105K          | 1   |
| 45                 | R4,15          | 6.8M                   |         | 685K          | 2   |

NOTES: UNLESS OTHERWISE SPECIFIED.  
 1. FOR INTERCONNECTIONS REFER SCHEMATIC 135-200  
 2. LETTER DESIGNATIONS ARE INTERCONNECTION POINTS.  
 3. WAVTEK PART NR A135-502 MAY BE SUBSTITUTED.

|   |          |      |      |
|---|----------|------|------|
| H | DDG 1346 | RD   | 1/15 |
| B | ECN 1151 | 1/15 | 1/15 |
| F | ECN 487  | 1/15 | 1/15 |
| E | ECN 406  | 5    | 1/15 |
| D | ECN 301  | 1/15 | 1/15 |
| C | ECN 377  | 5    | 1/15 |
| B | ECN 354  | 1/15 | 1/15 |
| A | ECN 300  | 1/15 | 1/15 |

WAVTEK  
 135 0135-012  
 ASSY  
 LOG CONVERTER

DATE: 1/15/80  
 BY: GEM  
 CHECKED: N/A  
 APPROVED: N/A

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|     |     |    |      |     |
|-----|-----|----|------|-----|
| REV | ECN | BY | DATE | APP |
|-----|-----|----|------|-----|

| REFERENCE DESIGNATORS | PART DESCRIPTION                    | ORIG-MFR-PART-NO | MFR   | WAVETEK NO.  | QTY/PT |
|-----------------------|-------------------------------------|------------------|-------|--------------|--------|
| 9                     | DIAL ASSY                           | 130-353-5        | WVTK  | 1201-00-0009 | 1      |
| 5                     | COVER ASSY                          | 130-353-1        | WVTK  | 1201-00-0017 | 1      |
| 6                     | PANEL, REAR<br>FROM:1400-00-1022    | 130-303-1        | WVTK  | 1400-00-1039 | 1      |
| 7 7A                  | RAIL, SIDE                          | 130-304          | WVTK  | 1400-00-1073 | 2      |
| 16                    | CASTING, FRONT<br>FROM:1400-00-1681 | 130-313-1        | WVTK  | 1400-00-1699 | 1      |
| 4                     | CASTING, REAR<br>FROM:1400-00-1681  | 134-300BS        | WVTK  | 1400-00-1749 | 1      |
| 13                    | PANEL, FRONT<br>FROM:1400-00-1782   | 134-302-2        | WVTK  | 1400-00-1809 | 1      |
| 11 11A                | SCREW                               | 135-302          | WVTK  | 1400-00-2004 | 2      |
| 15                    | INDICATOR, DIAL                     | 141-317          | WVTK  | 1400-00-2020 | 1      |
| NONE                  | CAP, CER., 0022, 1KV                | DD-222 LONG LEAD | CHL   | 1500-02-2201 | 1      |
| NONE                  | BNC CONN                            | KC-7906          | KING  | 2100-01-0002 | 4      |
| NONE                  | SOLDER LUG                          | 1497             | SMITH | 2100-04-0012 | 4      |
| NONE                  | COAX KNOB SET                       | RB-67-1-SB+0-M-4 | ROGAN | 2400-01-0009 | 5      |
| NONE                  | BUSHING NYLINER                     | 4L2FF            | THOMN | 2600-01-0002 | 5      |
| NONE                  | SPEEDNUT, TYPE "U"                  | C8091-632-4      | TINN  | 2800-09-0004 | 4      |
| NONE                  | PLUG BUTTON                         | PC47291          | UNCAR | 2800-09-0010 | 2      |

**WAVETEK**  
PARTS LIST

TITLE  
STD CHASSIS

ASSEMBLY NO.  
1101-00-0028  
PAGE: 1

REV

FILE THIS DRAWING UNDER DRAWING # 020

| REFERENCE DESIGNATORS | PART DESCRIPTION  | ORIG-MFR-PART-NO | MFR   | WAVETEK NO.  | QTY/PT |
|-----------------------|-------------------|------------------|-------|--------------|--------|
| NONE                  | FAST, CHASSIS     | 1591-811         | USECO | 2800-09-0021 | 6      |
| NONE                  | CAPTIVE SCREW     | CA1376-10-3-9    | TRIDP | 2800-23-0001 | 2      |
| NONE                  | WASHER, SHOULDER  | 2668             | SMITH | 2800-27-0004 | 4      |
| NONE                  | NYLON FLAT WASHER | 2264-N-385       | AMTON | 2800-28-0005 | 4      |
| NONE                  | RETAINING RING    | 5305-51          | THURC | 2800-36-0002 | 1      |
| NONE                  | PWR CONN          | 17256-H          | BELDN | 6001-80-0003 | 1      |

**WAVETEK**  
PARTS LIST

TITLE  
STD CHASSIS

ASSEMBLY NO.  
1101-00-0028  
PAGE: 2

REV

FILE THIS DRAWING UNDER DRAWING # 020

|  |  |      |                        |              |
|--|--|------|------------------------|--------------|
| REMOVE ALL BURRS AND BREAK SHARP EDGES | DRAWN  | DATE | WAVETEK                |              |
| MATERIAL                               | PROJ ENGR  |      | SAN DIEGO • CALIFORNIA |              |
|  | RELEASE APPROV   |      | TITLE                  |              |
|  |  |      | STD CHASSIS            |              |
| FINISH WAVETEK PROCESS                 | TOLERANCE UNLESS OTHERWISE SPECIFIED<br>XXX - .010 ANGLES - 1<br>XX - .030 |      | MODEL NO               | DWG NO.      |
|  | DO NOT SCALE DWG   |      | 135                    | 1101-00-0028 |
|  | SCALE  |      | CODE                   | REV          |
|  |  |      | 23338                  | SHEET OF     |