LFG-1300S

FUNCTION GENERATOR

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1. DESCRIPTION

The LFG-1300S Figure 1, is an extremely versatile signal source for design, development and service applications.

It provides a choice of sine, triangle, sawtooth, square and pluse signals over the frequency range of 0.002 Hz to 2 MHz. Voltage control of the frequency of the master oscillator permits linear or logarithmic sweep using internal or externally-applied sweep control. In addition, an internal modulator permits amplitude modulation with the option of a suppressed-carrier mode. Calibrated control of the output level is provided, as well as variable dc offset. A fixed TTL output is also provided.

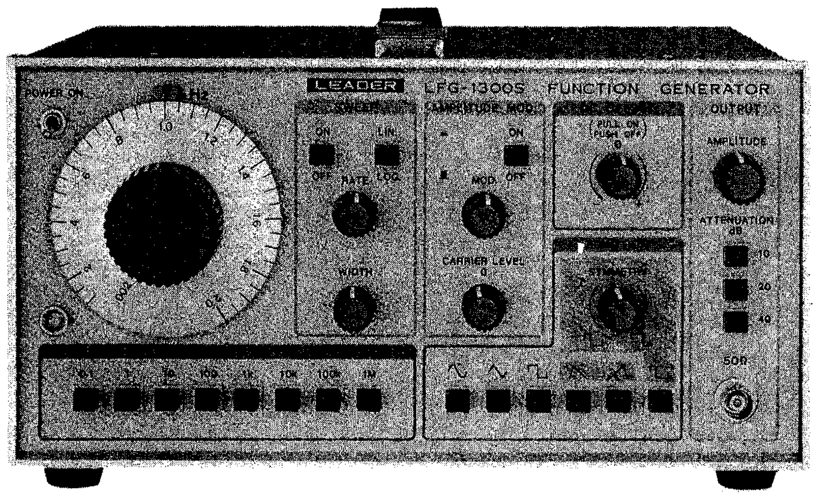

Figure 1. LFG-1300S Function Generator

2. FEATURES

1. Wide frequency range, 0.002 Hz to 2 MHz in eight ranges.
2. Choice of output waveform includes sine, triangle, sawtooth square and pulse signals. In addition, control of dc offset permits the superimposition of d-c levels on the output signal.
3. A separate TTL output with a fan-out of 20 permits direct drive of TTL logic circuits.
4. Low distortion, a THD of 0.5% or less is maintained throughout the frequency range.
5. Built in swept frequency function provides a choice of linear or logarithmic sweep with variable sweep width and rate. A sawtooth for horizontal axis drive to an oscilloscope is provided.
6. External sweep-control voltage applied at the VCG connector, permits external control of frequency, sweep, or frequency modulation of the master oscillator.
7. An internal amplitude modulator permits both AM and double-sideband suppressed-carrier modulation for communications and instrumentation applications.
8. Step attenuators provide 10, 20, and 40 dB steps for a total attenuation of 70 dB into a 50 ohm load. An output control provides continuous control of signal level into the attenuator.

3. SPECIFICATIONS

Frequency Range	(0.02 Hz–2 MHz in 8 ranges, uncalibrated to 0.002 Hz):
	0.02 Hz–0.2 Hz.
	0.2 Hz–2 Hz.
	2 Hz–20 Hz.
	20 Hz–200 Hz.
	200 Hz–2 kHz.
	2 KHz–20 kHz.
	20 KHz–200 kHz.
	200 KHz–2 MHz.
Accuracy	0.02 Hz to 200 kHz: ± 3% rdg, ± 3% f.s.
	200 kHz to 2 MHz: ± 5% rdg, ± 5% f.s.; for sawtooth
Waveforms	
Sine wave	
Voltage	20 V p-p (7 V rms) open circuit.
Distortion	10 Hz–20 kHz; < 0.5%
	20 kHz–100 kHz; < 1%
	100 kHz–2 MHz; < 3%
Flatness	0.02 Hz–2 MHz within ± 0.3 dB.
Triangle	
Voltage	20 V p-p open circuit.
Symmetry	1% (0.02 Hz to 100 kHz).
Sawtooth	
Voltage	20 V p-p open circuit.
Symmetry	15:85 or 85:15 fixed.
Square Wave Output	
Voltage:	20 V p-p open circuit.
Symmetry	1% (0.02 Hz to 100 KHz).
Rise Time	Less than 100 ns.
Pulse	
Voltage	20 V p-p open circuit.
Symmetry	9:1–1:9 Continuously Variable.
TTL Output	
Fan Out	20 TTL.

DC Level	Controlled by dc Offset: ± 10 V.
Sweep Capabilities	
Type	Linear or Logarithmic.
Rate (duration)	0.2 Hz to 50 Hz (5 s to 20 ms).
Width	1,000: 1 max, continuously variable.
Ramp Output (for oscilloscope H-input)	0 to + 10 V.
AM Capabilities	
Modulation Level	0 to 100%.
Carrier Level	Adjusted by front panel control.
Output Level Control	
Attenuator	10, 20, 40 dB (0-70 dB, 10 dB steps).
Impedance	50 Ω.
Max Level	20 V p-p adjustable.
Rear Panel Inputs/ Outputs VCO	Input for external frequency control signal.
Mod	Input for AM signal.
GCV	Output for oscilloscope H-Axis.
TTL	Fixed level TTL output, fan out = 20.
Physical	
Size (WxHxD)	250 X 125 X 250 mm.
Weight	9 lbs, 4 kg approx.
Power Requirements	100, 117, 200 or 234 V ac, 50–60 Hz.

4. CONTROLS AND CONNECTORS

Front Panel. Refer to Fig. 4-1.

(1)	POWER ON Switch	Set to on, to power the unit. The pilot lamp (17) will light.
(2)	Frequency dial	Provides continuous control of frequency within the range selected by (16). To obtain operating frequency multiply dial reading by selected range button (16).
(3)	SWEEP ON-OFF Switch	Master oscillator is swept when ON; operates CW when OFF.
(4)	RATE Control	Controls the sweep repetition rate from 0.2 Hz (5 S) to 50 Hz (20 mS).
(5)	LIN-LOG Switch	Selects linear or logarithmic sweep mode.
(6)	MOD Control	Controls percentage of modulation for AM operation.

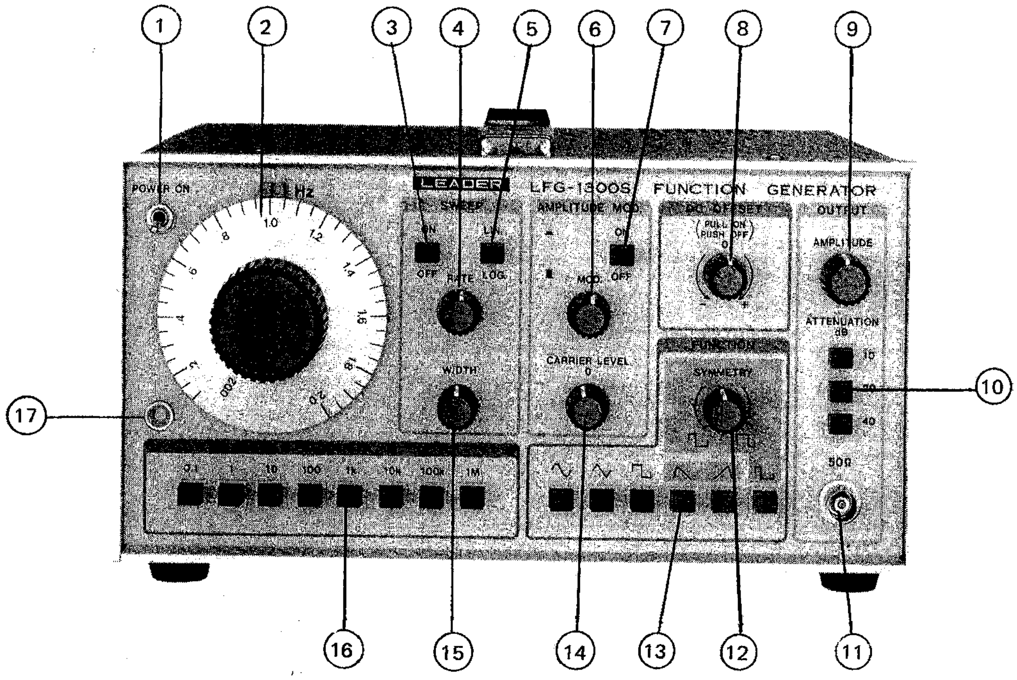

Figure 4-1.

(7)	AM ON-OFF Switch	Turns on AM modulator and accepts modulating signal from the MOD IN jack on the rear panel.
(8)	DC OFFSET Control	Adds a dc offset voltage to the output signal. Pull out to activate dc offset. Voltage added is positive for CW rotation and negative for CCW rotation. When all function selector buttons are off (out from panel) the dc offset, alone, is available at the output connector. Depress this control to remove dc offset.
(9)	AMPLITUDE Control	Provides continuous level control into the output attenuators.
(10)	ATTENUATION Switches	Provide calibrated attenuation values of 10, 20 and 40 dB. Total attenuation is 70 dB when all switches are depressed.
(11)	50Ω Output Connector	Delivers all output signals into the intended 50 ohm termination.
(12)	SYMMETRY Control	Provides control of symmetry for pulse waveform only. When set to mid range, symmetrical square waveforms are obtained. Turning the control CW increases the width of the positive excursion; CCW rotation reduces the width of the positive excursion. Repetition rate is not altered by changing the setting of the SYMMETRY control.
(13)	Function push-buttons	These five push-buttons select sine, triangle, square, pulse, or sawtooth waveforms.
(14)	CARRIER LEVEL Control	Controls the carrier ratio in the AM mode, and permits balanced operation whereby the carrier is suppressed and double sideband, suppressed-carrier operation is obtained.
(15)	WIDTH Control	Sets the upper frequency limit in sweep generator operation; the frequency dial (2) sets the lower limit. A maximum frequency ratio of 1000 to 1 is available.
(16)	FREQUENCY Range Push-Buttons	Selects the frequency range of operation. Multiply the frequency dial reading by the factor printed above the depressed push-button.
(17)	Pilot lamp	Glows green when the unit is powered.

Rear Panel. Refer to Fig. 4-2.

(18)	VCG IN Connector	Accepts input for external *V*oltage *C*ontrol *G*enerator applications. Maximum frequency range is obtained with a voltage range of 0 to 10 V.
(19)	GCV OUT Connector	Provides *G*enerator *C*ontrol *V*oltage output proportional to the frequency of operation and varies between 0 and +5 V dc according to the setting of the front panel frequency dial.
(20)	TTL OUT Connector	Provides TTL-level drive signals as determined by the front-panel control settings.
(21)	MOD IN Connector	Accepts externally-applied signals to amplitude modulate the carrier sup-

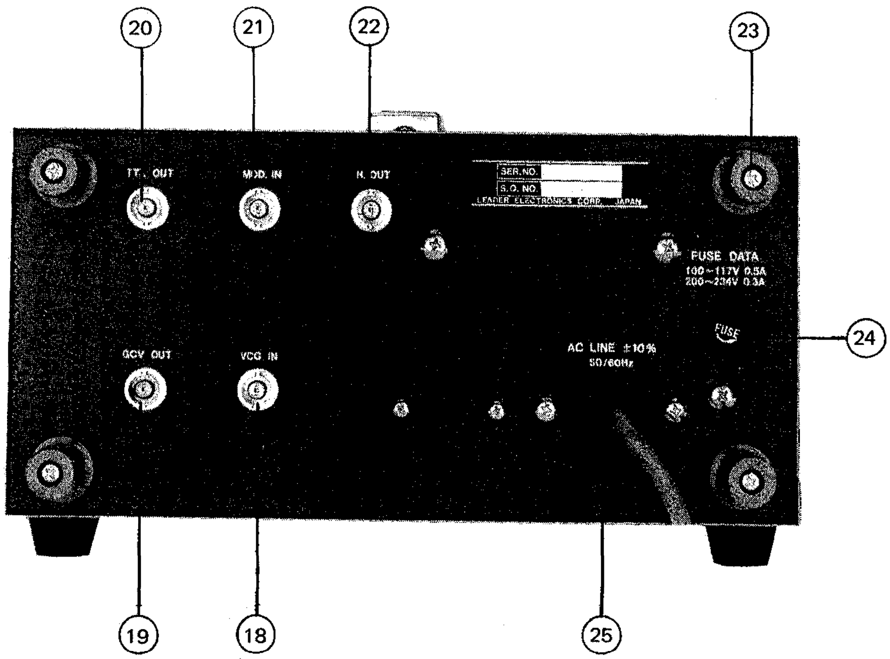

Figure 4-2.

plied by the internal VCO. Optimum level is 0.3 Vrms. Excessive input level can cause distortion due to saturation; insufficient input level can result in nonlinear modulation.

(22) **H OUT Connector** — Provides X-axis deflection for an oscilloscope used to display frequency response during sweep operations. Sawtooth signals from 0 to +1 V are repeated at the rate set by the RATE control (4).

(23) **Rear panel legs** — Permit the unit to be supported by the rear panel and provides a means for power cord storage.

(24) **FUSE** — 0.5A for 117V operation.

(25) **AC LINE Connector**

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5. OPERATING INSTRUCTIONS

5.1 Operating Precautions

5-1-1

Line voltage should be within ±10% of 117 Vac.

5-1-2

Do not apply external voltages to the output connector. Use a suitable blocking capacitor if the circuit point to be driven is above or below ground potential.

5.2 Signal Generator Operation

5-2-1 Sine Wave Signals

NOTE

The generator synthesizes sine waves using shaping networks that employ multiple diodes. Although overall distortion is as specified in section 3, the output waveform may contain small transient spikes.

1. For most applications, terminate the output cable in 50 ohms.
2. Set the front panel controls as shown in Fig. 5-1.
3. Set operating frequency by selecting the multiplier with the appropriate FREQUENCY push-button and setting the dial for the desired frequency. For example, to obtain a 600 Hz sine wave set the dial to 6 and depress the 100 FREQUENCY push-button.
4. Output level is determined by the setting of the AMPLITUDE control. With all attenuator switches released (out), output level varies between 0.35 and approximately 3.5 V rms throughout the range of the AMPLITUDE control. These values apply when the generator output is properly terminated in 50 ohms. Multiply by 2 (add 6 dB) if the generator output is not terminated.
   Depressing any combination of the ATTENUATOR push-buttons inserts attenuation equal to the sum, in decibels, indicated on the push-buttons that are depressed. For example, 70 dB of attenuation is inserted when all three push-buttons are depressed. Table 5-1 shows the relation between attenuator settings and output voltage for both open-circuit and terminated outputs.

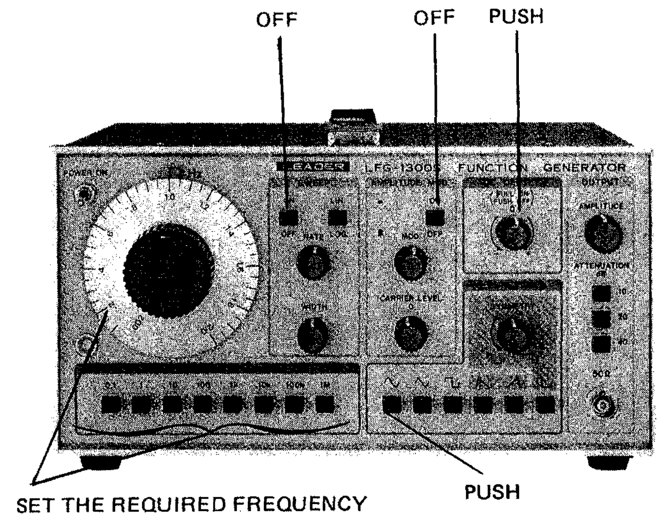


Figure 5-1. Sine Wave Operation

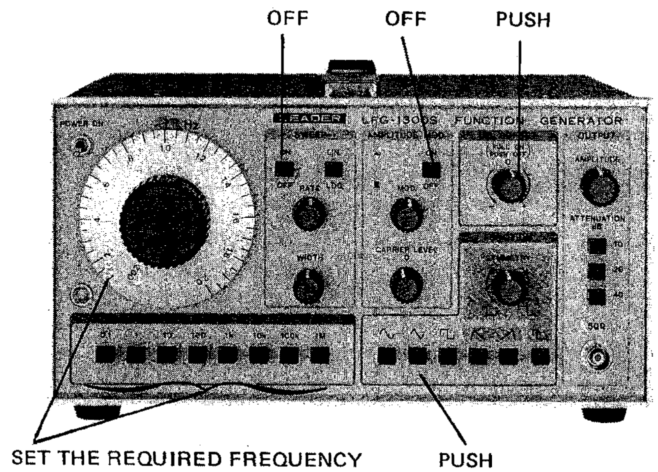


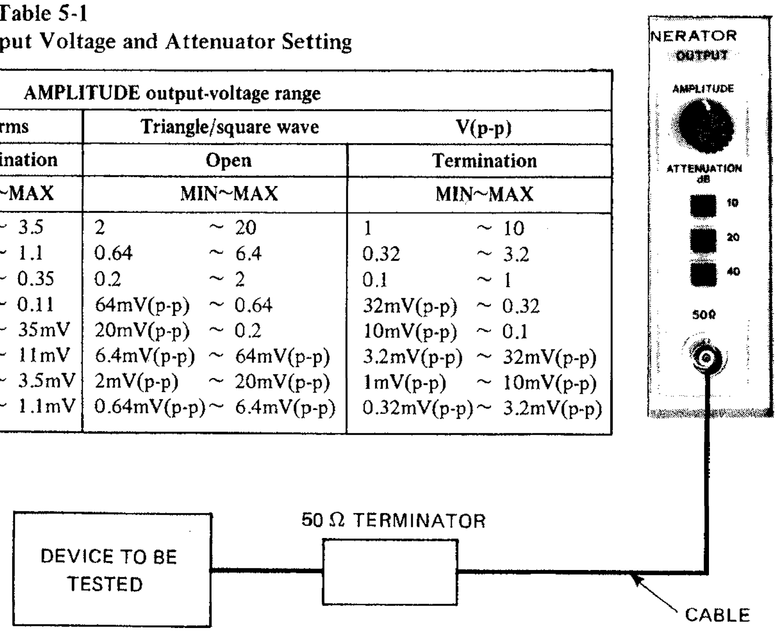
Figure 5-2. Triangle Wave Operation

5-2-2 Triangle-wave Signals

1. Follow paragraph 5-2-1, but depress the triangle wave push-button. Refer to Fig. 5-2.
2. Output levels for complex waves are usually measured in peak-to-peak values. The right half of Table 5-1 gives the relation between AMPLITUDE and ATTENUATOR settings in peak-to-peak values for both terminated and open-circuited output conditions.
3. Triangle signals are particularly useful for detecting the onset of clipping in an amplifier, as indicated by a rounding of the peaks. Refer to Fig. 5-3.

Table 5-1
Relationship Between Output Voltage and Attenuator Setting

Attenuation dB	Setting of attenuators dB	AMPLITUDE output-voltage range			
		Sine wave Vrms		Triangle/square wave V(p-p)	
		Open	Termination	Open	Termination
	10 20 40	MIN~MAX	MIN~MAX	MIN~MAX	MIN~MAX
0		0.7 ~ 7.0	0.35 ~ 3.5	2 ~ 20	1 ~ 10
10	10	0.22 ~ 2.2	0.11 ~ 1.1	0.64 ~ 6.4	0.32 ~ 3.2
20	20	70mV ~ 0.7	35mV ~ 0.35	0.2 ~ 2	0.1 ~ 1
30	10 20	22mV ~ 0.22	11mV ~ 0.11	64mV(p-p) ~ 0.64	32mV(p-p) ~ 0.32
40	40	7mV ~ 70mV	3.5mV ~ 35mV	20mV(p-p) ~ 0.2	10mV(p-p) ~ 0.1
50	10 40	2.2mV ~ 22mV	1.1mV ~ 11mV	6.4mV(p-p) ~ 64mV(p-p)	3.2mV(p-p) ~ 32mV(p-p)
60	20 40	0.7mV ~ 7mV	0.35mV ~ 3.5mV	2mV(p-p) ~ 20mV(p-p)	1mV(p-p) ~ 10mV(p-p)
70	10 20 40	0.22mV ~ 2.2mV	0.11mV ~ 1.1mV	0.64mV(p-p) ~ 6.4mV(p-p)	0.32mV(p-p) ~ 3.2mV(p-p)



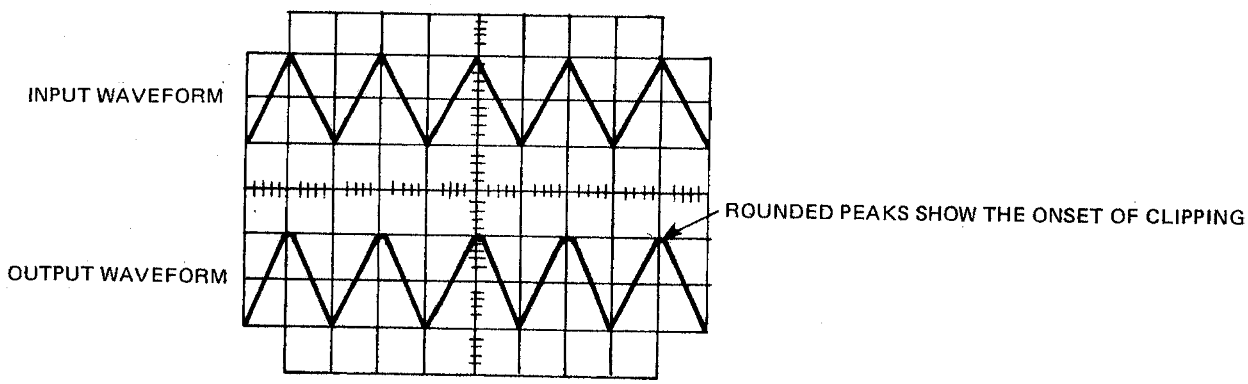


Figure 5-3. Using Triangle Waveform to Detect Clipping

5-2-3 Square-wave Signals

1. Follow paragraph 5-2-1, but depress the square wave push-button. Refer to Fig. 5-4.
2. Output levels for complex waves are usually measured in peak-to-peak values. The right half of Table 5-1 gives the relation between AMPLITUDE and ATTENUATOR settings for both terminated and open-circuited output conditions.

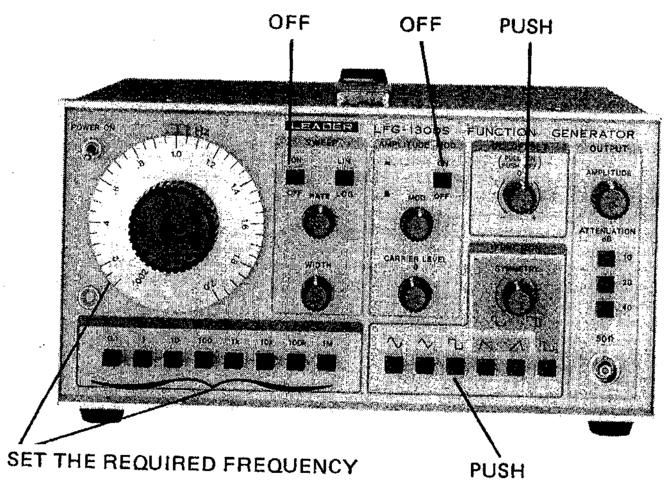


Figure 5-4. Square Wave Operation

5-2-4 Sawtooth Signals

1. Follow paragraph 5-2-1, but depress the /\ or /| push-buttons for a falling or rising voltage ramp. Waveform symmetry is fixed at a value of 15:85 or 85:15. See Fig. 5-5.

5-2-5 Pulse Signals

1. Follow paragraph 5-2-1, but depress the ⊓_ (pulse) push-button.
2. Adjust SYMMETRY control for the desired pulse width or duty cycle. When the SYMMETRY control is set to approximately mid-range a symmetrical square wave of 50% duty cycle is produced. Turning the SYMMETRY control CCW decreases the duration of the positive portion of the waveform. Turning the control CW from center increases the duration of the positive portion of the waveform. In this way a wide range of both positive-negative pulse widths is available.
3. Adjust DC OFFSET control to obtain the desired base level for the pulse signal. Refer to Section 5-3.

5.3 DC Offset

Output signals are resolved around zero when the DC OFFSET control is depressed. Pull out this control to activate the dc offset. At the mid-range setting the dc offset voltage is zero. Turn clockwise to obtain positive dc offsets, counterclockwise to obtain negative dc offsets. Maximum load current is 100 mA into 50 ohms. Refer to Fig. 5-6.

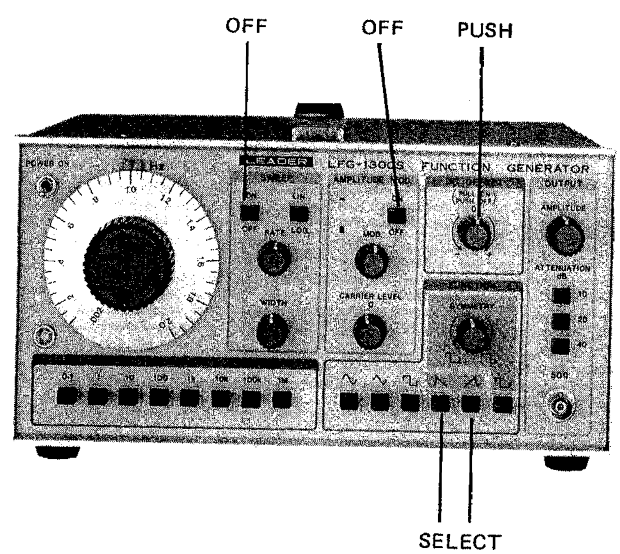


Figure 5-5. Sawtooth Operation

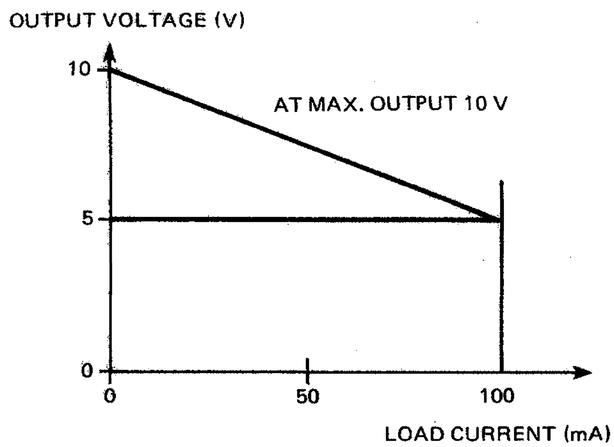


Figure 5-6. Relationship of Maximum Load Current to Offset Voltage

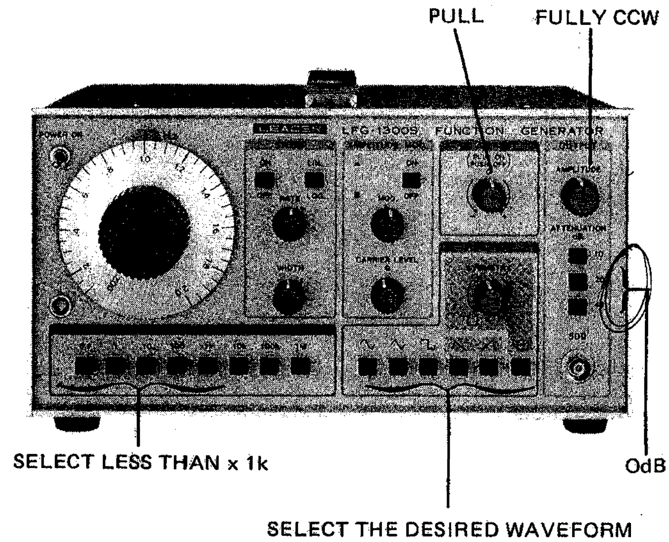


Figure 5-7. DC Offset Operation

The offset voltage is added at the input to the attenuators. Therefore switch all attenuators out when using the offset function. Refer to Fig. 5-7.

To measure the dc offset voltage at the OUT connector, depress one of the function push-buttons partially so that all push-buttons are released (out from panel); the dc offset voltage can now be measured without the effect of ac signals.

DC offsets, can be used to set up bias conditions in direct coupled circuits. It is also extremely useful in obtaining pulses or other signals with a variable reference level. A direct-coupled oscilloscope is useful in setting these conditions.

NOTES:

1. High-amplitude output signals used in conjunction with dc offset can result in clipping at the plus and minus 10 volt levels. (±5 V when the output is terminated.) Refer to Fig. 5-8. Reduce AMPLITUDE as needed to prevent clipping.
2. A normal dc offset of a few tenths of a volt exists when the DC OFFSET knob is pushed in. To eliminate this residual offset, turn DC OFFSET on by pulling out the control. Reset DC OFFSET for zero volts DC.

5.4 TTL Output

The TTL OUT connector will supply square or pulse signals at TTL levels for a maximum fan out of 20 TTL gates.

Level conversion is required to drive CMOS gates because the threshold levels are different. Figure 5-9 shows how the conversion can be made using an open collector TTL device such as the SN7406. An alternative is to use a TTL-CMOS interface IC such as the SN75367.

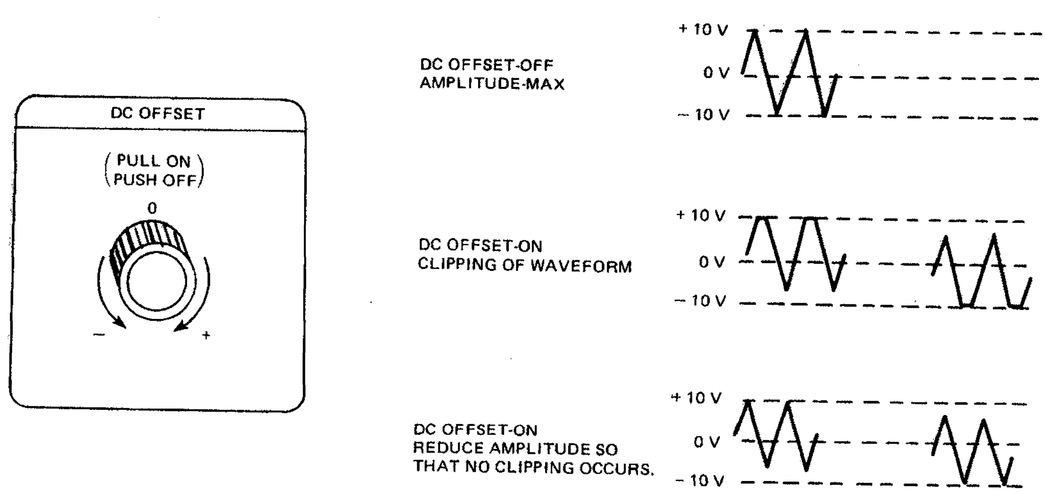


Figure 5-8 Clipping in DC Offset Operation

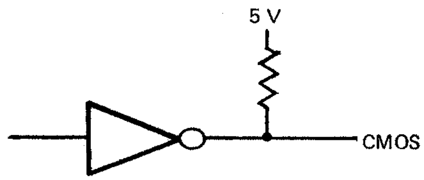


Figure 5-9 TTL- to -CMOS Level Conversion

5.5 Sweep Generator Operation

1. Set up the generator for sine wave operation as in paragraph 5-2-1.
2. Connect the H OUT connector on the rear panel to the X axis (H deflection) input of the oscilloscope or X-Y plotter.
3. Depress the SWEEP ON-OFF switch to ON.
4. Set the LIN-LOG switch as required.
5. Select the frequency range key so that the upper sweep frequency limit will be found in that range.
6. Set the lower sweep frequency limit with the frequency dial.
7. Set the upper sweep frequency limit using the WIDTH control.
8. Set the sweep RATE as desired.

The rate should be at 1/10 or less of the lower sweep frequency limit.

For example, a 20Hz to 20 kHz log sweep is obtained as shown in Fig. 5-10. Select the X 10 KHz range key and set the frequency dial to 0.002 (20 Hz). Set the WIDTH control for a maximum sweep frequency of 20 kHz. Set sweep rate to 0.5 sec (2 Hz) or longer.

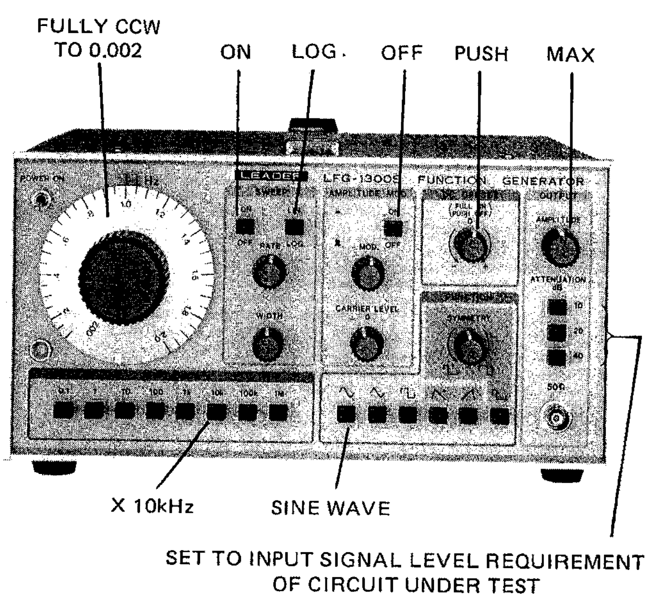


Figure 5-10. Sweep Frequency Operation

Calibration of upper and lower limits of the sweep range can be accomplished as follows:

a. Connect an oscilloscope to the GCV OUT connector on the rear panel. Set the oscilloscope for direct coupled operation; turn horizontal deflection off. Set vertical sensitivity to 0.5 V/cm.

b. Turn the sweep off on the LFG-1300S.

c. Set the front panel frequency dial to the intended lower sweep frequency limit.

d. Adjust oscilloscope vertical position control to locate the spot on the next to lowest graticule line. See Fig. 5-11*a*.

e. Set the frequency dial to the intended upper limit of the sweep range. Change the oscilloscope sensitivity if spot deflection is insufficient or off scale.

f. Note the position of the new vertical position of the spot. See *b* of the figure. The two reference points on the oscilloscope now represent the control voltage limits for the limits of the sweep range.

g. Reset the frequency dial to the low limit of the sweep range.

h. Depress the SWEEP push-button.

i. Adjust the WIDTH control so that the top of the vertical trace is at the graticule position established in Step f.

j. Reset the frequency so that the bottom of the vertical trace is on the lower reference graticule line. Reset WIDTH, if necessary so that the vertical trace lies between the two reference marks. The sweep frequency range is then set to the intended limits.

9. Connect the terminated output cable to the equipment under test. Refer to Fig. 5-12. Be sure to use a suitable blocking capacitor if the feed point is above ground or if the 50 ohm terminator will alter bias conditions in the circuit under test.

5.6 Amplitude Modulator Operation

1. Set the operating controls for sine wave operation. Refer to paragraph 5-2-1. Set the frequency controls for the desired carrier frequency.
2. Apply the modulating signal to the MOD IN terminal on the rear panel. The optimum input signal level is 0.3 Vrms. Higher levels will cause distortion due to overmodulation and clipping. Lower levels tend to deteriorate modulation linearity.
3. Depress the AMPLITUDE MOD ON-OFF switch and monitor the output signal.
4. Set CARRIER LEVEL to 0 (midrange).
5. Set the MOD control fully CW.
6. Set the CARRIER LEVEL control for an indication of 100% modulation. See Fig. 5-13. The MOD control will now vary the percentage of modulation between zero and 100%. Reset the MOD control for the desired percentage of modulation. Refer to Fig. 5-13.
7. Double-sideband (DSB) suppressed-carrier operation can be obtained by turning the CARRIER control counterclockwise until the DSB waveform shown in Fig. 5-13 is obtained.

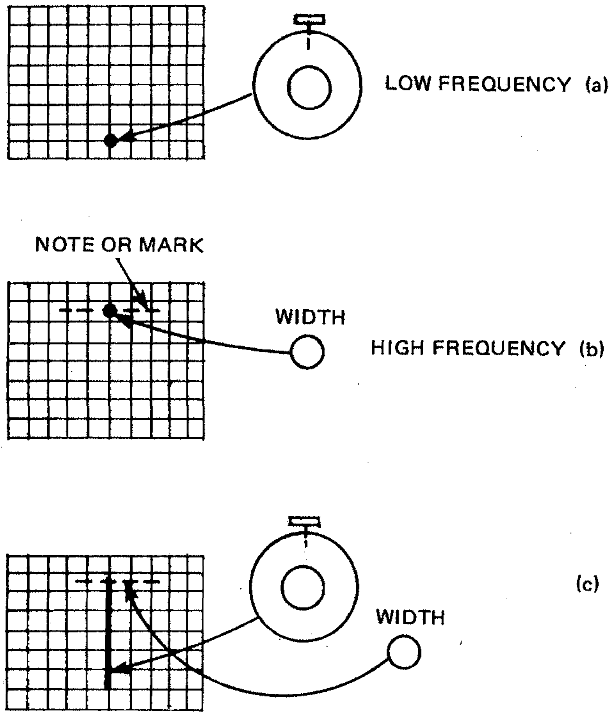


Figure 5-11

5.7 External Frequency Control

External control of signal frequency is achieved by applying a dc control voltage to the VCG connector on the rear panel.

The applied control voltage operates in conjunction with the front-panel frequency push-buttons to obtain the desired frequency. A positive-going voltage increases frequency.

For example, if the frequency dial is set fully CW, to 0.002 and a positive control voltage is applied, the frequency increases. At the maximum input of +10 V the operating frequency will be twice that selected by the range push-button. If the 1 kHz range is selected, output frequency will be 2 kHz when a +10 V dc is applied.

If the frequency dial is set to 2.0, and a negative control voltage of −10 V dc is applied, the frequency decreases to 0.002 times the range selected.

The relation between control voltage, frequency-dial settings and output frequency is described for the 1 kHz range in Fig. 5-14. The maximum frequency control range is 1000 to 1.

5.8 Frequency (Sweep) Modulation by External Control

The master oscillator may be frequency modulated by an ac signal applied at the VCG connector. The input impedance at the VCG connector is 10 kohms.

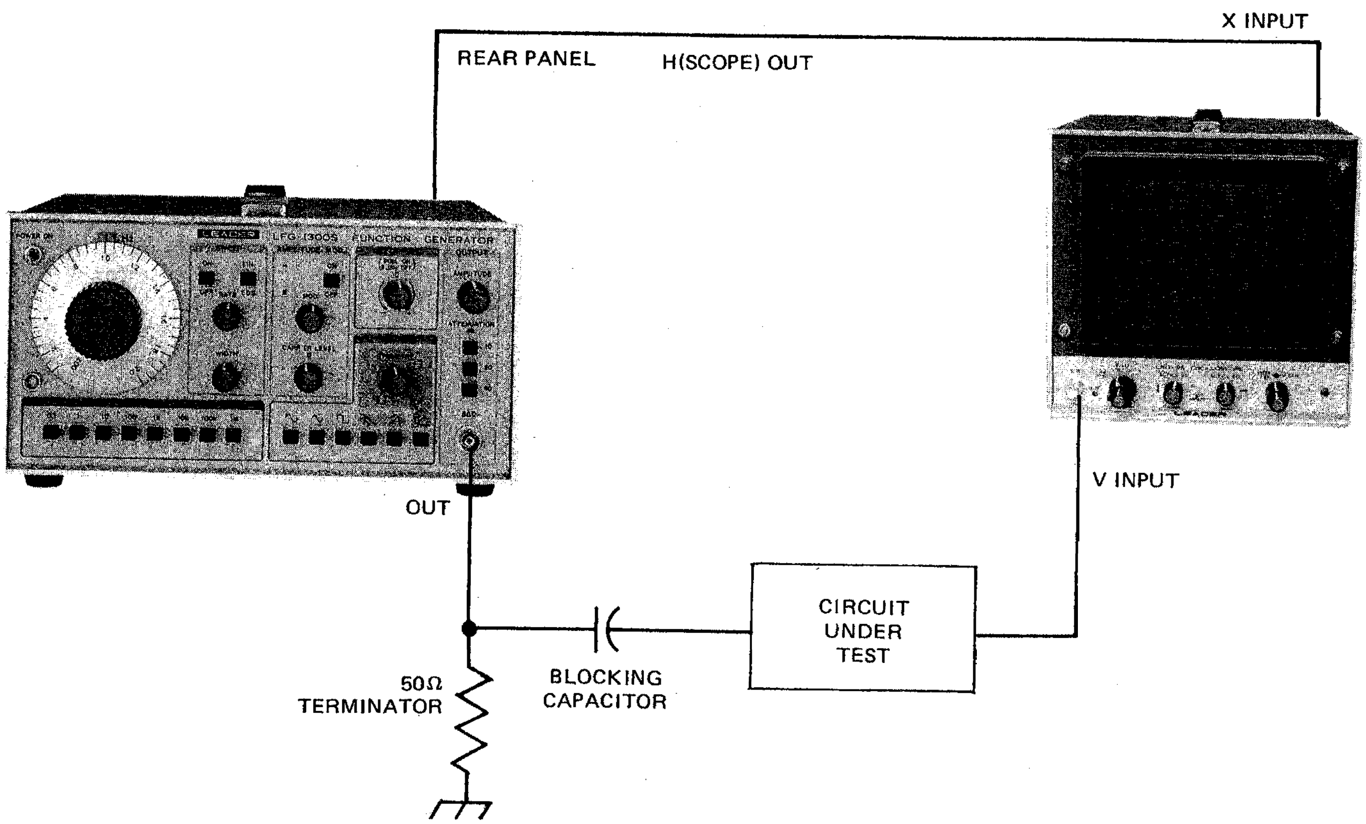
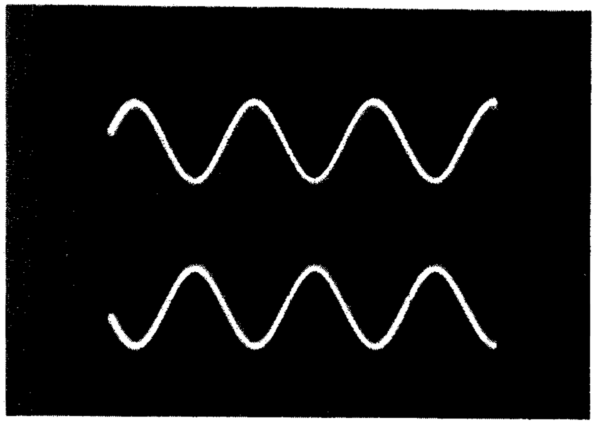
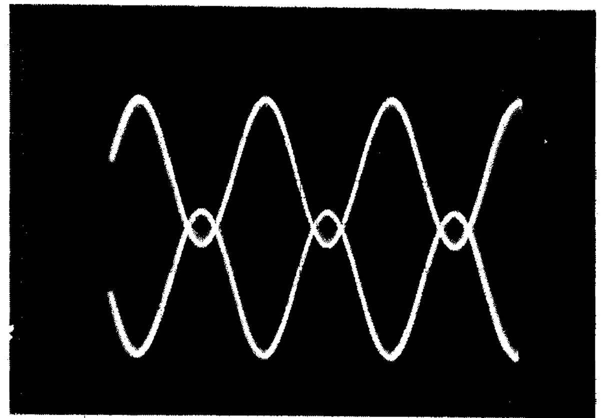


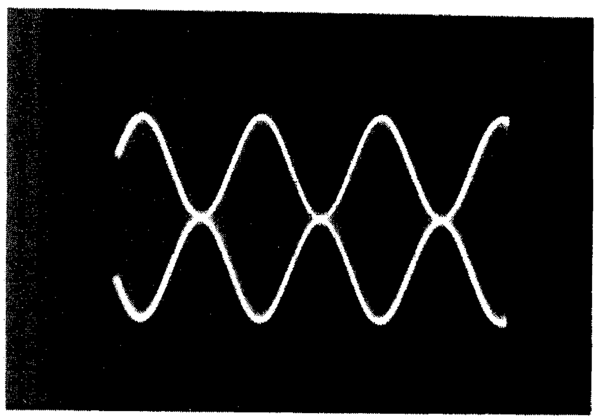
Figure 5-12 Set up for Frequency Response Measurements



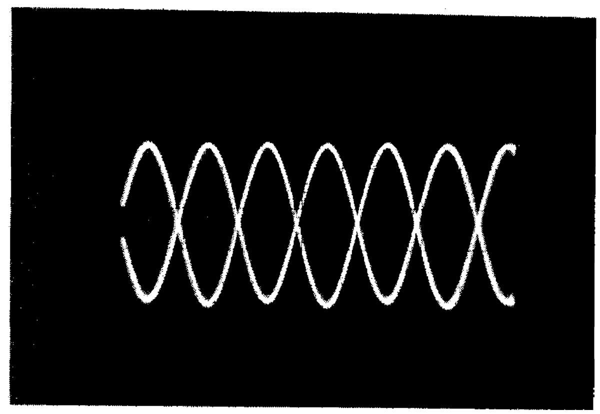
50% MODULATION



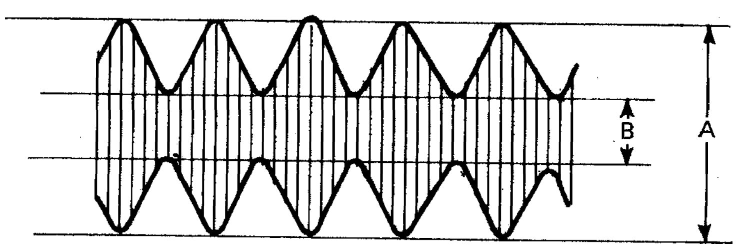
OVER 100% MODULATION



100% MODULATION



DSB (DOUBLE SIDE BAND)



HOW TO DETERMINE MODULATION % FROM SCOPE WAVEFORM

$$M\ (\text{MODULATION}) = \frac{A - B}{A + B} \times 100\%$$

Figure 5-13. AM Waveforms

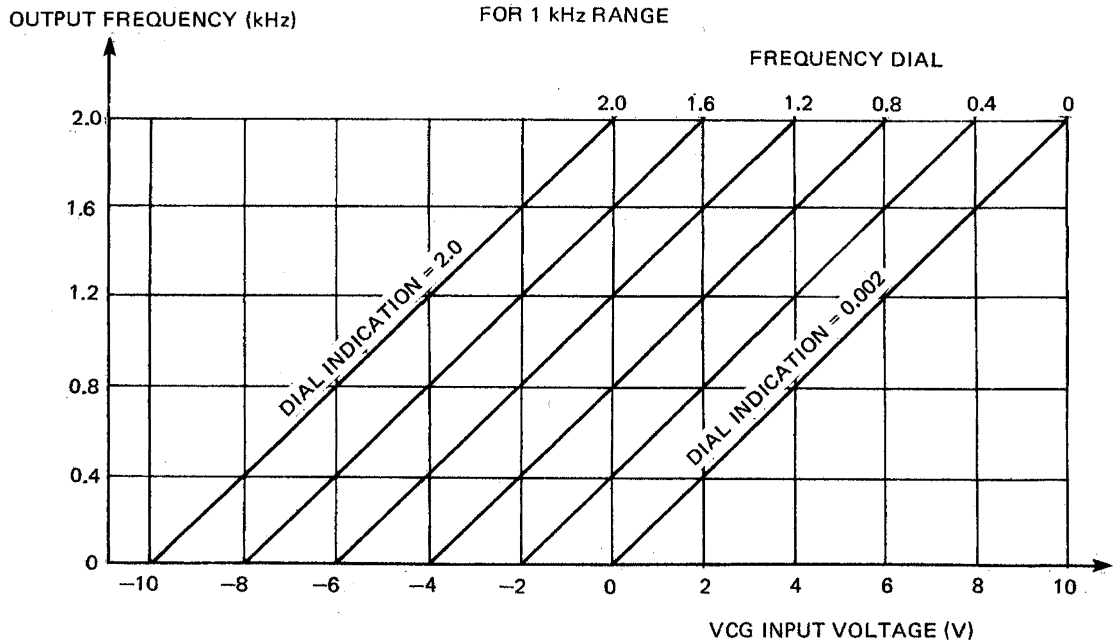


Figure 5-14. Relationship of Output Frequency, Frequency Dial Setting and VCG Input Voltage.

Deviation or frequency shift is determined by the applied voltage and the selected frequency range. Table 5-2 shows the relation between the selected range and the frequency shift per applied control voltage. The shift is given per volt of applied control.

For example, consider a required deviation of 10 kHz at a center frequency of 500 kHz. Since 500 kHz is obtained in the X1M range, the frequency shift is 200 kHz per volt, as indicated in Table 5-2.

The required input voltage can be calculated as follows.

$$\text{Input voltage} = 1\ \text{V} \times \frac{10\ \text{kHz}}{200\ \text{kHz}}$$
$$= 0.05\ \text{V} = 50\ \text{mV}$$

Thus the 10 kHz deviation is obtained with an ac signal of 50 mV peak-to-peak.

Table 5-2
Relationship Between Frequency Range and Frequency Shift per VCG Input Volt

Frequency range	X0.1	X1	X10	X100	X1k	X10k	X100k	X1M
Frequency shift per 1 V	0.02Hz	0.2Hz	2Hz	20Hz	200Hz	2kHz	20kHz	200kHz

6. MAINTENANCE

6.1 Disassembly

1. Remove the six screws shown in Fig. 6-1.
2. Lift the top cover straight up and off.
3. Turn the unit upside-down and remove the four screws from the bottom. Do not remove the screws from the mounting feet or bail.
4. Lift off the bottom cover.

6.2 Fuses

Fuse rating is 0.5A for 117 V operation. Replace with fuses of this rating only.

6.3 Calibration Check

6-3-1 Test Equipment Required

Equipment		*Minimum specifications*
Digital Multimeter	–	3-1/2 digits
Oscilloscope	–	10 mV sensitivity 20 MHz bandwidth dc coupled input
Distortion meter	–	full scale ≤ 1% at 2 kHz
Frequency counter	–	0.2 Hz–2 MHz
DC power supply	–	+ 10 V dc
Terminator	–	50 ohm feed-through, BNC

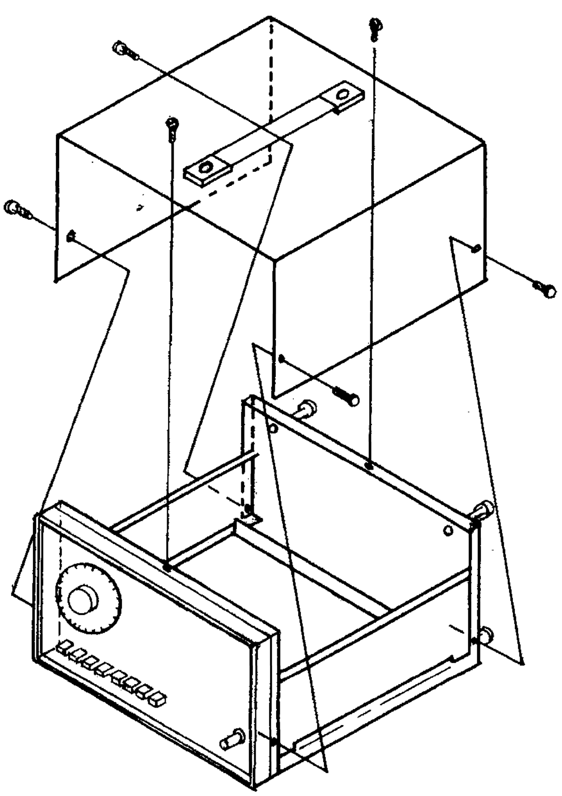


Figure 6-1. Disassembly

6-3-2 Initial Setup

Set front panel controls as follows:

Frequency Dial	–	fully clockwise
Frequency Range	–	1 k
SWEEP	–	OFF
LIN/LOG	–	LIN
RATE	–	clockwise
WIDTH	–	clockwise
AMPLITUDE MOD.	–	OFF
DC OFFSET	–	push off
FUNCTION	–	triangle
AMPLITUDE	–	clockwise
ATTENUATION	–	0 dB

Refer to Fig. 7-1 for location of adjustments and test points.

6-3-3 Power Supply Check

Measure and confirm supply voltages at the points given in Table 6-1.

Table 6-1
Power Supply Voltages

Voltage	Test Point	Adjust	Tolerance
+5 V	IC304	–	±5%
−5 V	IC305	–	±5%
+15 V	IC302	–	±5%
−15 V	IC303	–	±5%
+10 V	TP-4	VR302	To Limit of Voltmeter Accuracy
−10 V	TP-3		

6-3-4 Sweep Generator

1. Monitor the H OUT connector on the rear panel with an oscilloscope.
2. Confirm the presence of the waveform shown in Fig. 6-2.
3. Adjust VR301 if necessary, to obtain the indicated waveform.
4. Connect the scope probe to TP-5. Confirm the waveform shown in Fig. 6-2, but the amplitute should now be 5 to 8 V (p-p).

5. Turn the RATE control fully counterclockwise.
6. Confirm the waveform shown in Fig. 6-3.
7. Connect the scope probe to TP-6.
8. Turn the RATE control fully clockwise.
9. Confirm the waveform shown in Fig. 6-4.

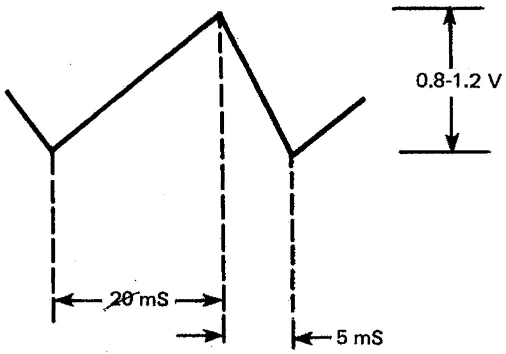


Figure 6-2. H-OUT Waveform with RATE Control Fully Clockwise

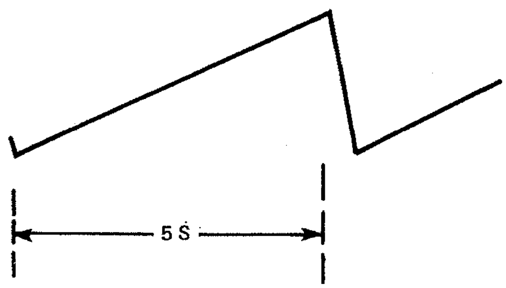


Figure 6-3. TP-5 Waveform With RATE Control Fully Counterclockwise.

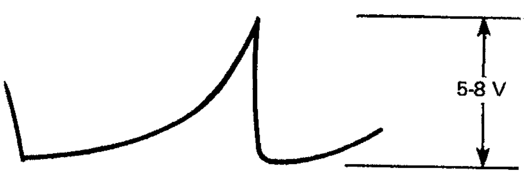


Figure 6-4. TP-6 Waveform With RATE Control Fully Clockwise

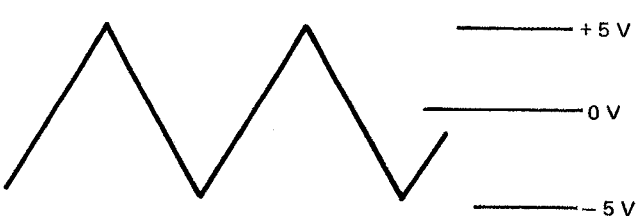


Figure 6-5. TP-2 Waveform

6-3-5 Oscillator Check

1. Set controls as in paragraph 6-3-2.
2. Connect the oscilloscope to the GVC OUT connector. Use direct coupling.
3. Check that the output voltage is zero.
4. Turn the frequency dial fully counterclockwise.
5. Check that the output voltage is + 2 to + 8 V.
6. Set the frequency dial to 2.0.
7. Connect the oscilloscope probe to TP-2.
8. Confirm the waveform shown in Fig. 6-5.

6-3-6 Frequency Adjustment

1. Select the 1 k frequency range.
2. Set the frequency dial fully clockwise.
3. Connect the dc voltmeter to the emitter of Q104.
4. Adjust VR101 for a reading of 0.0 volts.
5. Connect the frequency counter to the OUTPUT connector.
6. Set the frequency dial to 0.2.
7. Adjust VR106 for a reading of 200 Hz.
8. Set the frequency dial to 2.0.
9. Adjust VR112 for a reading of 2 kHz.
10. Repeat steps 5-9 for the remaining frequency ranges using the dial settings and adjustment potentiometers shown in Table 6-2.

Table 6-2
Frequency Adjustments

RANGE	DIAL SETTING	
	0.2	2.0
x0.1	–	R142*/VR103
x1	–	R143*/VR103
x10	–	R144*/VR103
x100	–	VR105
x1k	VR106	VR112
x10k	–	VR107
x100k	–	VR108
x1M	–	VR109/VC101

*Values selected during manufacture and should not require change under normal conditions.

6-3-7 Sine Wave Adjustment

1. Select the sine wave function.
2. Select the 1 k range; set the frequency dial to 2.0.
3. Connect the distortion meter to the OUTPUT connector.
4. Adjust VR110 and VR111 for minimum distortion.
5. Disconnect the distortion meter and connect the oscilloscope to the OUTPUT connector.

6. Set OUTPUT AMPLITUDE fully clockwise.
7. Adjust VR210 for an output level of 20 V (p-p).

6-3-8 DC Offset Adjustment

1. Set OUTPUT AMPLITUDE fully clockwise, Attenuation 0 dB, and function push-buttons off. (Depress one of the function push-buttons partially to release the key that had been previously selected.)
2. Select the 1 k frequency range.
3. Connect the oscilloscope to the OUTPUT connector; use direct (dc) coupling for the oscilloscope.
4. Depress the DC OFFSET control. Residual dc offset should be less than 500 mV.
5. Pull out the DC OFFSET control and turn fully clockwise. The dc output voltage should be at least +10 V dc.
6. Turn the DC OFFSET control fully counterclockwise. The output voltage should be at least −10 V dc. If it is not, readjust VR210.

6-3-9 Amplitude Adjustment

Triangle wave

1. Select triangle function at a frequency of 1 kHz.
2. Connect an oscilloscope to the OUTPUT connector.
3. Adjust VR203 for a reading of 20 V (p-p).

Square wave

4. Select equare wave function at a frequency of 1kHz.
5. Adjust VR202 for a reading of 20 V (p-p).
6. Adjust VR201 so that the dc level is zero volts. Refer to Fig. 6-6.
7. Repeat steps 1-6 until no further improvement is possible.

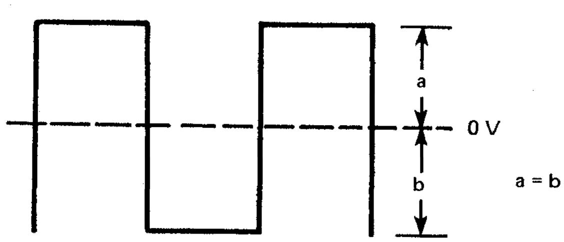


Figure 6-6. Square Wave Level Adjustment

6-3-10 Amplitude Modulator Adjustment

1. Set the following controls:

function	–	sine wave
frequency range	–	100 k
frequency dial	–	2.0
AMPLITUDE	–	max. clockwise
AMPLITUDE MOD switch	–	ON
AMPLITUDE MOD control	–	fully CCW

2. Connect the audio generator and oscilloscope as shown in Fig. 6-7.
3. Adjust the CARRIER LEVEL control to obtain the waveform in Fig. 6-7.
4. Reset AMPLITUDE for about 1/3 of maximum.
5. Adjust CARRIER LEVEL for the waveform shown in Fig. 6-8.
6. Adjust VR207 to equalize the A and B parts of the waveform shown in Fig. 6-8.
7. Reset CARRIER LEVEL for the waveform shown in Fig. 6-9 (double sideband, suppressed carrier).
8. Set CARRIER LEVEL for 100% modulation.
9. Remove the modulating signal from the MOD IN connector.
10. Push the AM MOD switch to OFF.
11. Adjust AMPLITUDE for a reference 4 divisions on the oscilloscope.
12. Push the AM MOD switch to ON.
13. Adjust VR208 for an oscilloscope display of 2 divisions.
14. Adjust VR209 to obtain the same dc level when the AM MOD switch is ON and OFF.

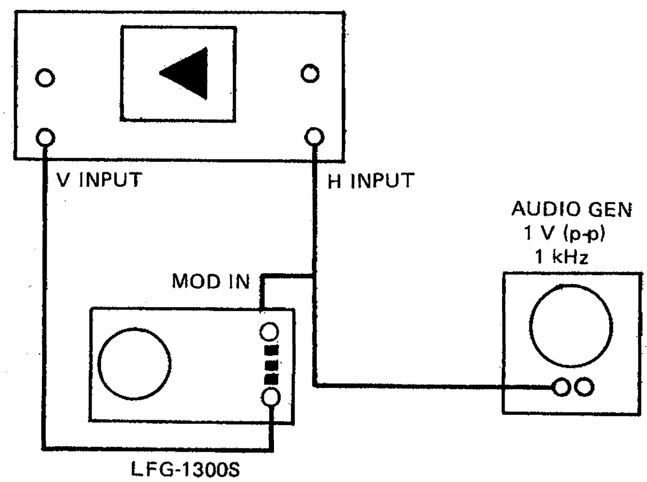


Figure 6-7. Setup For Amplitude Modulator Adjustment

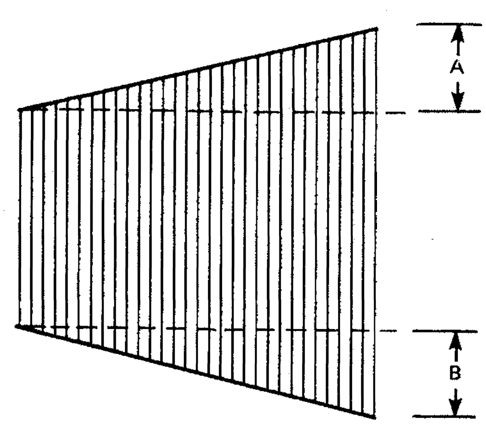


Figure 6-8. Modulator Symmetry Adjustment

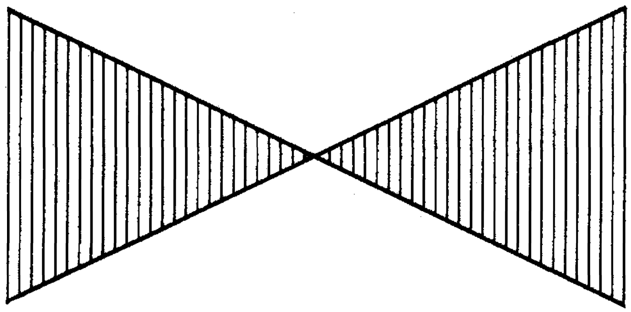


Figure 6-9.

6-3-11 Output Flatness

1. Connect the oscilloscope to the OUTPUT connector using a 50 ohm "through" terminator.
2. Check for an output flat to within 0.3 dB between 1 kHz and 2 MHz.
3. Reset VC115, if necessary, to obtain the specified flatness.

6-3-12 GCV Output

DC output

1. Set the frequency dial to 2.0.
2. Connect the voltmeter to the GCV OUT connector.
3. Confirm a voltage reading of approximately 5.5 V.

Sweep signal output

4. Set: frequency range – 10
   frequency dial – 0.002
   SWEEP – ON
   WIDTH – fully CW
   RATE – mid range
5. Connect the oscilloscope to the GCV OUT connector.
6. Confirm the waveforms shown in Fig. 6-10.
7. Set the WIDTH control fully CCW.
8. Check that the amplitude of the output signal is reduced by a factor of 100 as compared with the reading of Step 6.

6-3-13 VCG IN Check

1. Set: frequency range – 1 k
   frequency dial – fully CW
2. Connect the frequency counter to the OUTPUT connector and connect a variable dc power supply to the VCG IN connector.
3. Set the VCG IN voltage to + 10 V.
4. Check for an output frequency between 1.8 and 2.4 kHz.

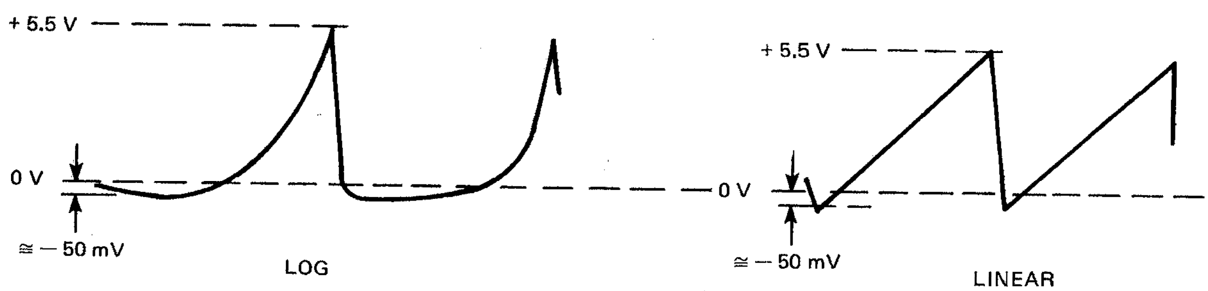


Figure 6-10. GCV Output

7. SCHEMATIC AND PCB DIAGRAMS

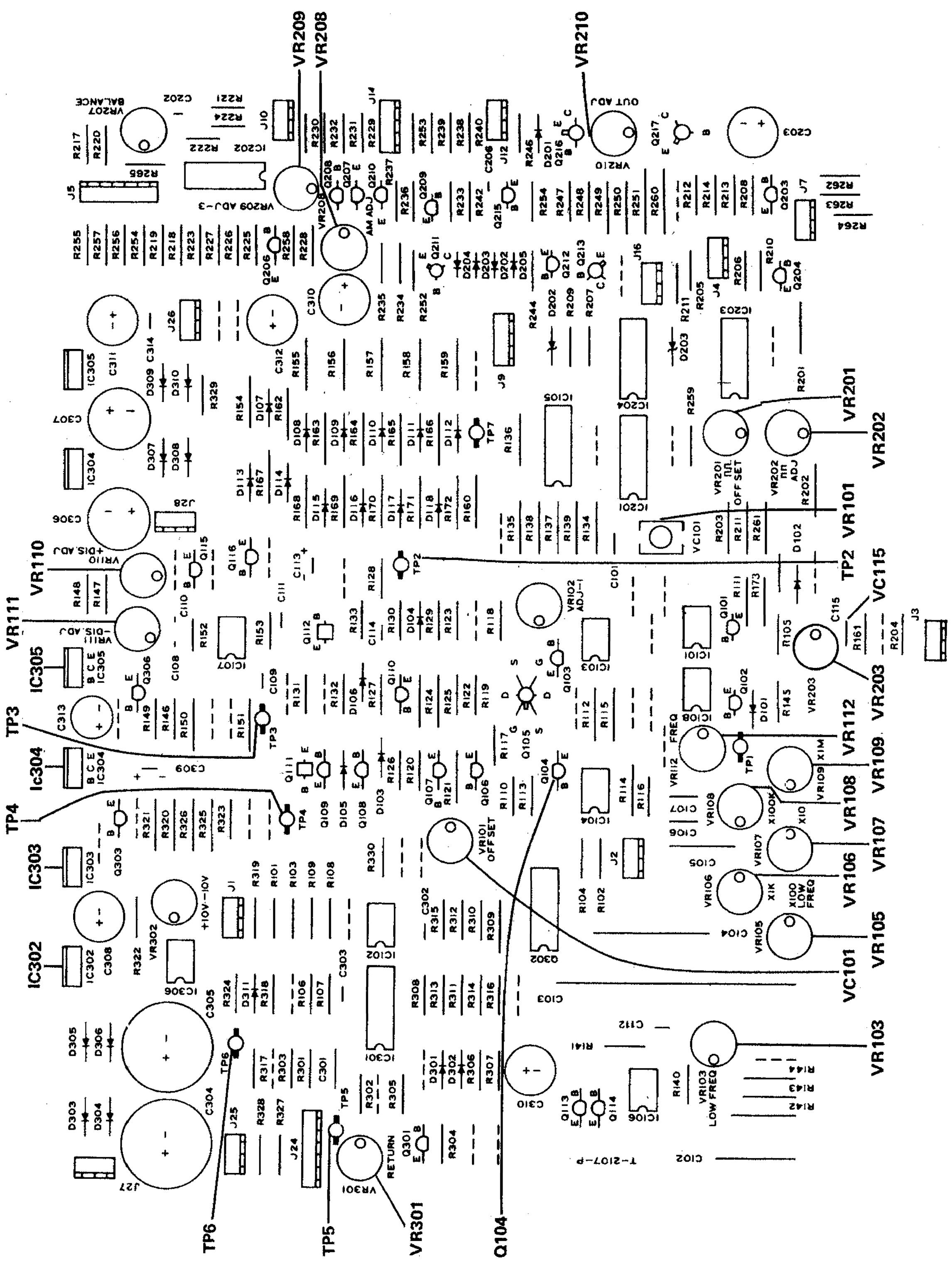


Figure 7-1. Main Board

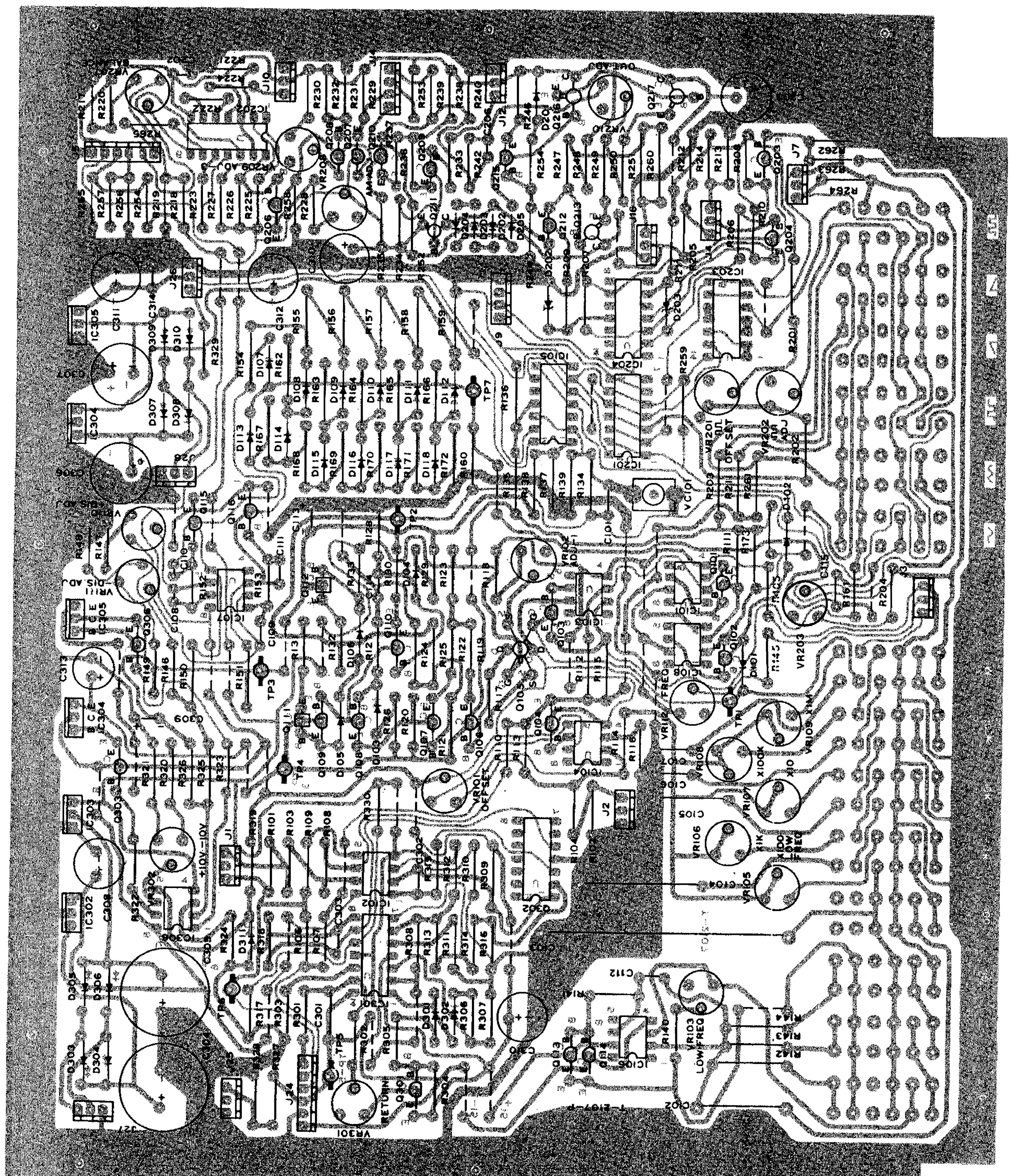


Figure 7-2. Main Board

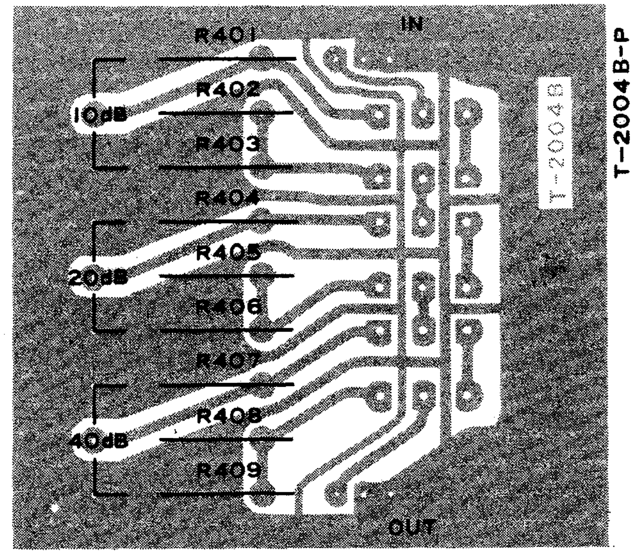


Figure 7-3. Attenuator T-2004B

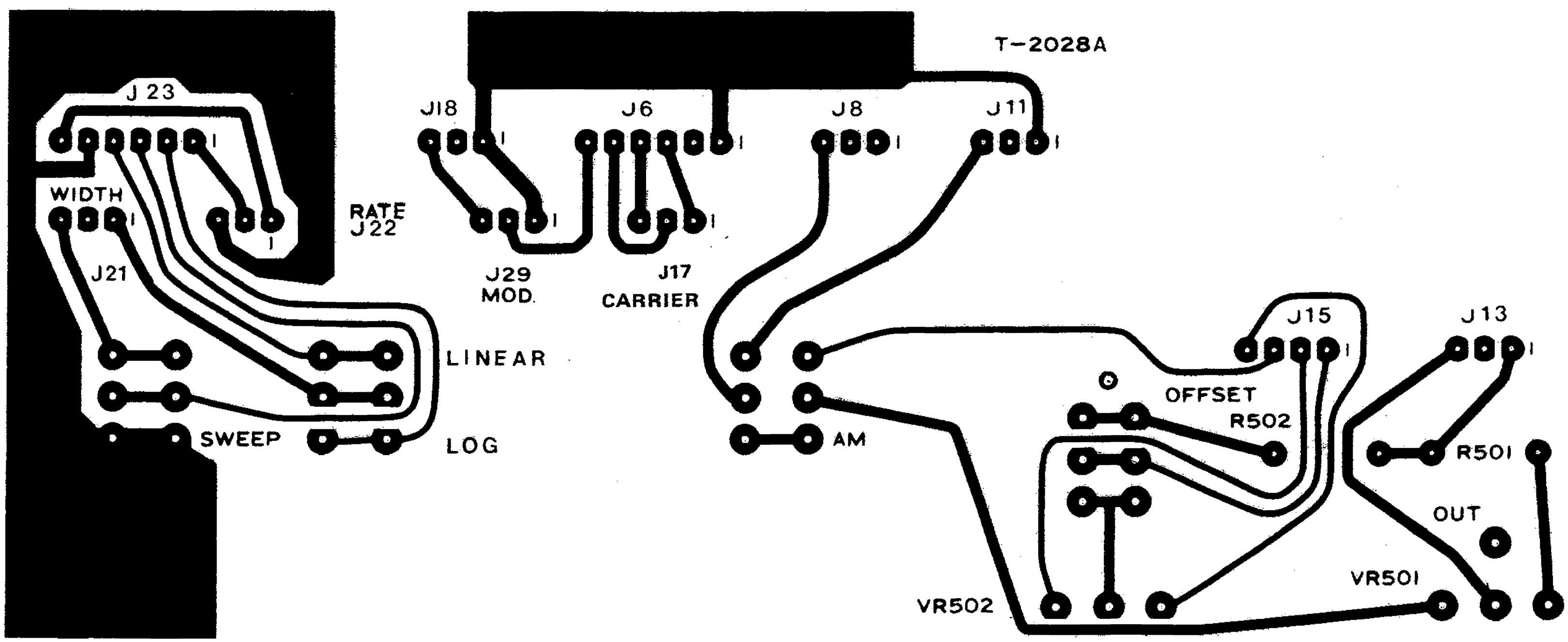


Figure 7-4. Control Board T-2028A

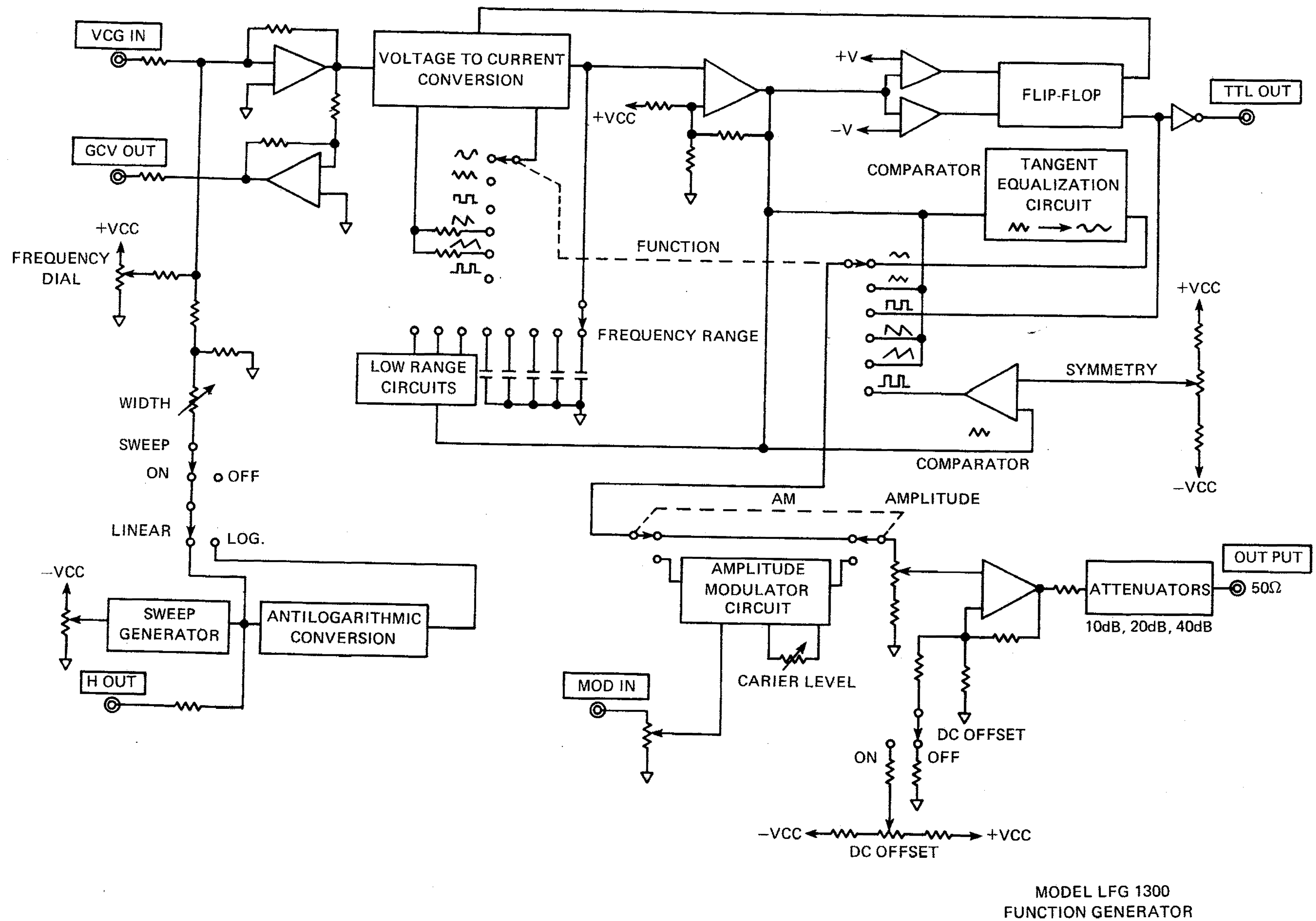


Figure 7-5 Block Diagram

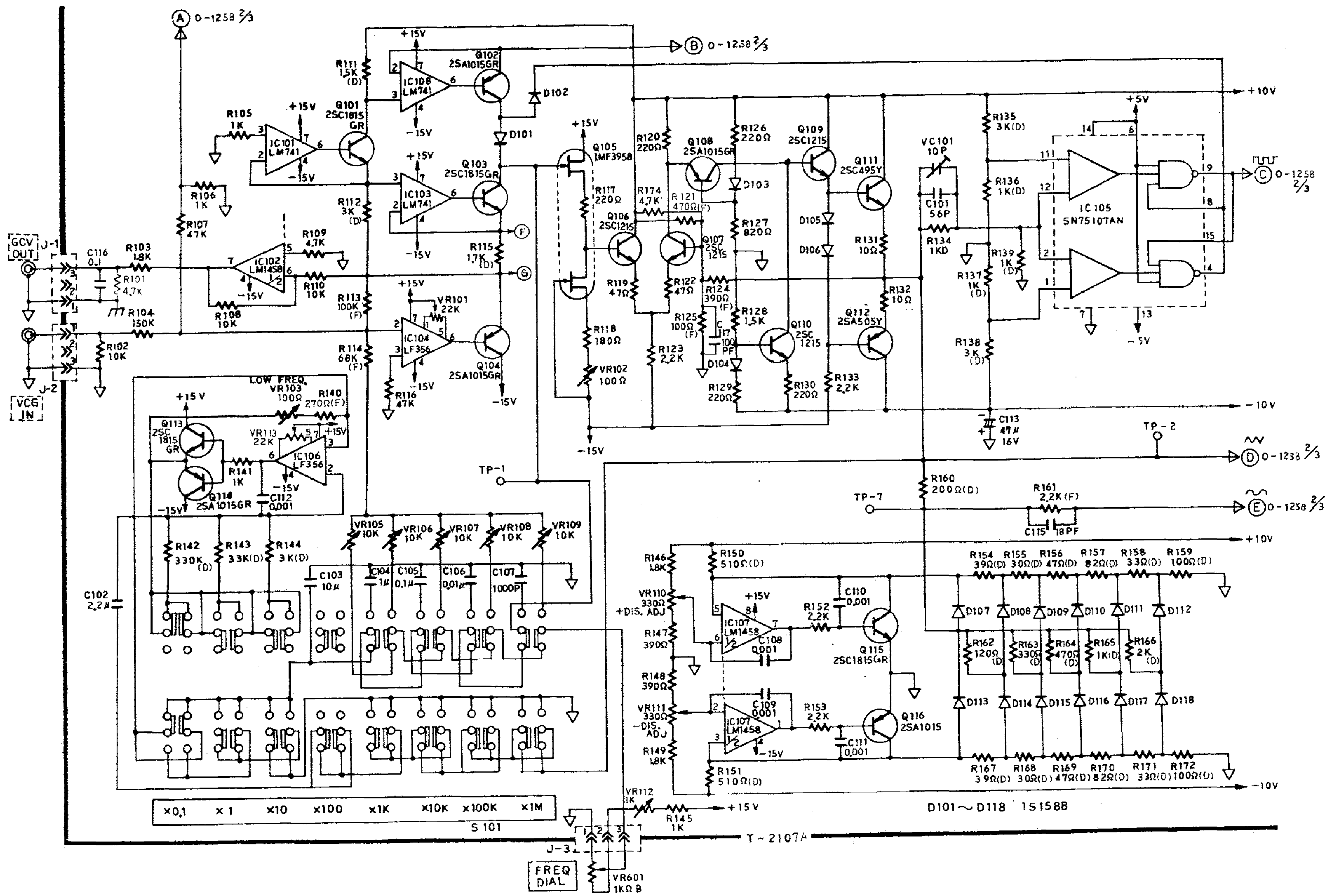


Figure 7-6 LFG-1300S Function Generator Schematic Diagram, Sheet 1 of 3

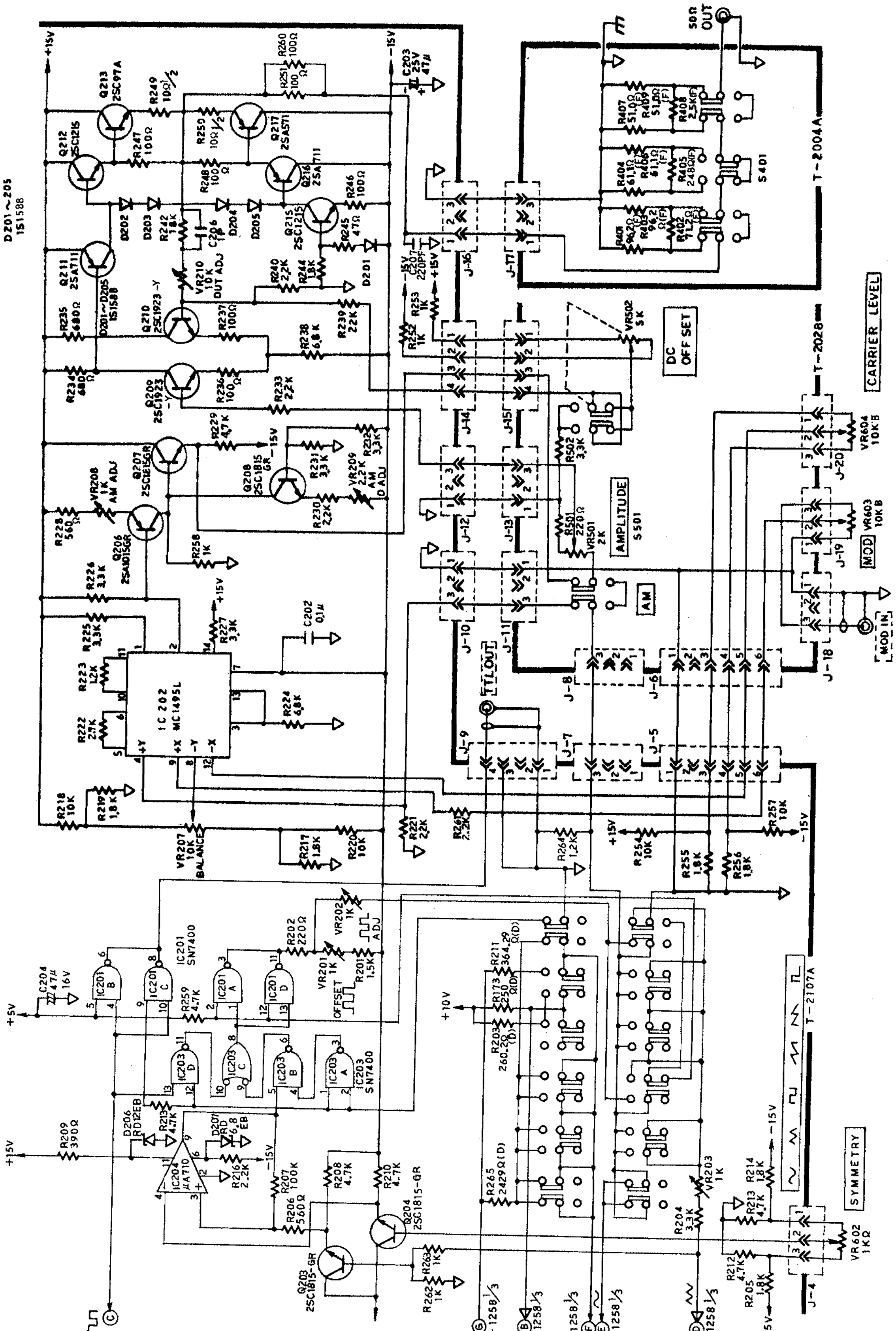


Figure 7-7 LFG-1300S Function Generator Schematic Diagram, Sheet 2 of 3

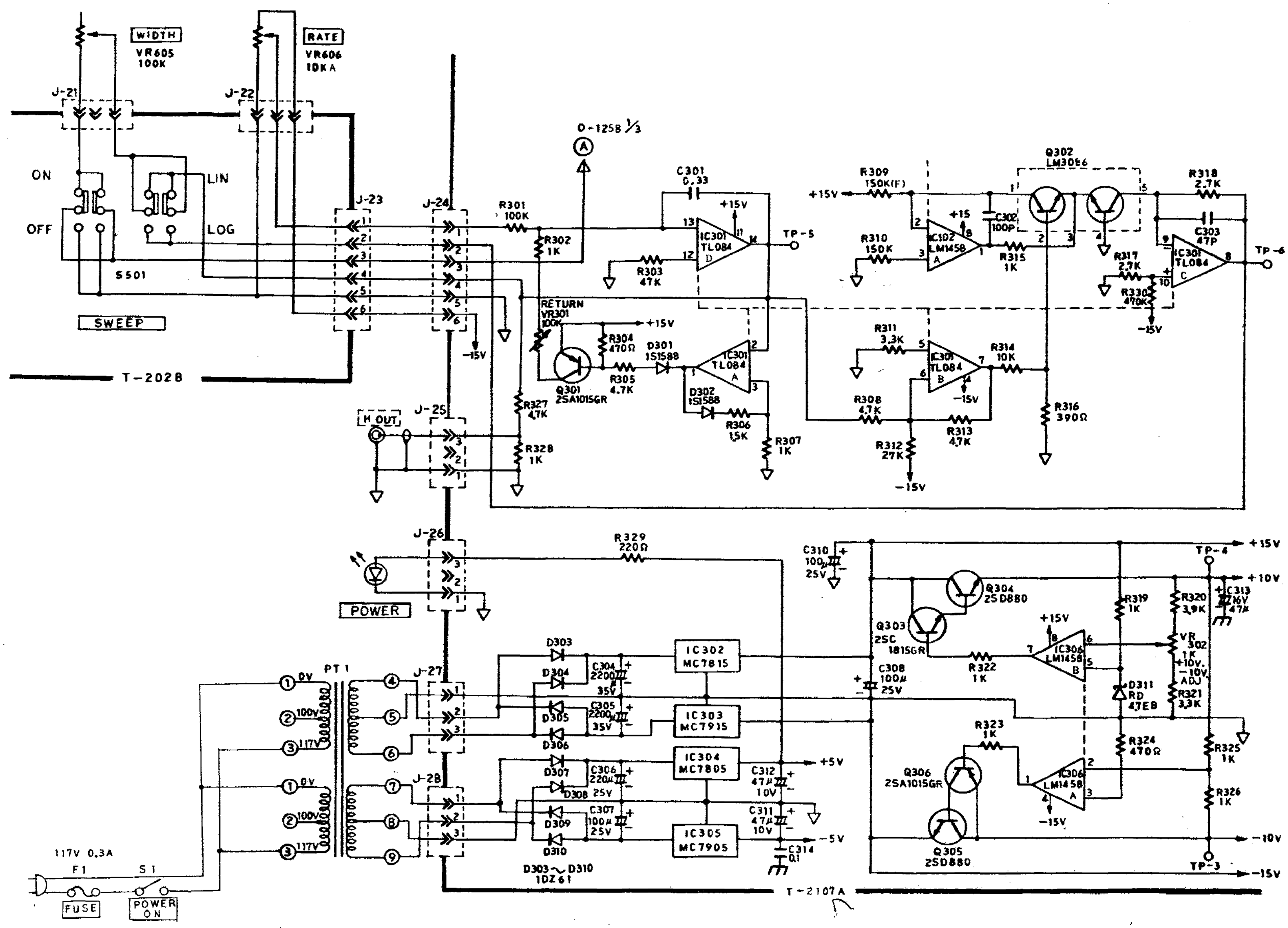


Figure 7-8 LFG-1300S Function Generator Schematic Diagram, Sheet 3 of 3

8. PARTS LIST

SCH. No.	Symbol No.	Description			
		RESISTORS			
1/3	R101	Carbon film	¼W	4.7k	±5%
1/3	R102	Carbon film	¼W	10k	±5%
1/3	R103	Carbon film	¼W	1.8k	±5%
1/3	R104	Carbon film	¼W	120k	±5%
1/3	R105	Carbon film	¼W	1k	±5%
1/3	R106	Carbon film	¼W	1k	±5%
1/3	R107	Carbon film	¼W	47k	±5%
1/3	R108	Carbon film	¼W	10k	±5%
1/3	R109	Carbon film	¼W	4.7k	±5%
1/3	R110	Carbon film	¼W	10k	±5%
1/3	R111	Metal film	¼W	1.5k	±5%
1/3	R112	Metal film	¼W	3k	±5%
1/3	R113	Metal film	¼W	100k	±1%
1/3	R114	Metal film	¼W	68k	±1%
1/3	R115	Metal film	¼W	1.7k	±1%
1/3	R116	Carbon film	¼W	47k	±5%
1/3	R117	Carbon film	¼W	220Ω	±5%
1/3	R118	Carbon film	¼W	180Ω	±5%
1/3	R119	Carbon film	¼W	47Ω	±5%
1/3	R120	Carbon film	¼W	220Ω	±5%
1/3	R121	Metal film	¼W	470Ω	±1%
1/3	R122	Carbon film	¼W	47Ω	±5%
1/3	R123	Carbon film	¼W	2.2k	±5%
1/3	R124	Metal film	¼W	390Ω	±1%
1/3	R125	Metal film	¼W	100Ω	±1%
1/3	R126	Carbon film	¼W	220Ω	±5%
1/3	R127	Carbon film	¼W	820Ω	±5%
1/3	R129	Carbon film	¼W	220Ω	±5%
1/3	R130	Carbon film	¼W	220Ω	±5%
1/3	R131	Carbon film	¼W	10Ω	±5%
1/3	R132	Carbon film	¼W	10Ω	±5%
1/3	R133	Carbon film	¼W	2.2k	±5%
1/3	R134	Metal film	¼W	1k	±5%
1/3	R135	Metal film	¼W	3k	±5%
1/3	R136	Metal film	¼W	1k	±5%
1/3	R137	Metal film	¼W	1k	±5%
1/3	R138	Metal film	¼W	3k	±5%
1/3	R139	Metal film	¼W	1k	±5%
1/3	R140	Metal film	¼W	270Ω	±1%
1/3	R141	Carbon film	¼W	1k	±5%
1/3	R142	Metal film	¼W	330k	±5%
1/3	R143	Metal film	¼W	33k	±5%
1/3	R144	Metal film	¼W	3k	±5%
1/3	R145	Carbon film	¼W	1k	±5%
1/3	R146	Carbon film	¼W	1.8k	±5%
1/3	R147	Carbon film	¼W	390Ω	±5%
1/3	R148	Carbon film	¼W	390Ω	±5%
1/3	R149	Carbon film	¼W	1.8k	±5%
1/3	R150	Metal film	¼W	510Ω	±5%

SCH. No.	Symbol No.	Description			
		RESISTORS			
1/3	R151	Metal film	¼W	510Ω	±5%
1/3	R152	Carbon film	¼W	2.2k	±5%
1/3	R153	Carbon film	¼W	2.2k	±5%
1/3	R154	Metal film	¼W	39Ω	±5%
1/3	R155	Metal film	¼W	30Ω	±5%
1/3	R156	Metal film	¼W	47Ω	±5%
1/3	R157	Metal film	¼W	82Ω	±5%
1/3	R158	Metal film	¼W	33Ω	±5%
1/3	R159	Metal film	¼W	100Ω	±5%
1/3	R160	Metal film	¼W	200Ω	±5%
1/3	R161	Metal film	¼W	2.2k	±1%
1/3	R162	Metal film	¼W	120Ω	±1%
1/3	R163	Metal film	¼W	330Ω	±1%
1/3	R164	Metal film	¼W	470Ω	±1%
1/3	R165	Metal film	¼W	1k	±1%
1/3	R166	Metal film	¼W	2k	±1%
1/3	R167	Metal film	¼W	39Ω	±1%
1/3	R168	Metal film	¼W	30Ω	±1%
1/3	R169	Metal film	¼W	47Ω	±1%
1/3	R170	Metal film	¼W	82Ω	±1%
1/3	R171	Metal film	¼W	33Ω	±1%
1/3	R172	Metal film	¼W	100Ω	±1%
2/3	R173	Metal film	¼W	250Ω	±1%
2/3	R201	Metal film	¼W	1.5kΩ	±1%
2/3	R202	Metal film	¼W	220Ω	±1%
2/3	R203	Metal film	¼W	260.2Ω	±0.5%
2/3	R204	Carbon film	¼W	3.3k	±5%
2/3	R205	Carbon film	¼W	1.8k	±5%
2/3	R206	Carbon film	¼W	560Ω	±5%
2/3	R207	Carbon film	¼W	100k	±5%
2/3	R208	Carbon film	¼W	4.7k	±5%
2/3	R210	Carbon film	¼W	4.7k	±5%
2/3	R211	Metal film	¼W	364.29Ω	±0.5%
2/3	R212	Carbon film	¼W	4.7k	±5%
2/3	R213	Carbon film	¼W	4.7k	±5%
2/3	R214	Carbon film	¼W	1.8k	±5%
2/3	R216	Carbon film	¼W	2.2k	±5%
2/3	R217	Carbon film	¼W	1.8k	±5%
2/3	R218	Carbon film	¼W	10k	±5%
2/3	R219	Carbon film	¼W	1.8k	±5%
2/3	R220	Carbon film	¼W	10k	±5%
2/3	R221	Carbon film	¼W	2.2k	±5%
2/3	R222	Carbon film	¼W	1.2k	±5%
2/3	R223	Carbon film	¼W	2.2k	±5%
2/3	R224	Carbon film	¼W	6.8k	±5%
2/3	R225	Carbon film	¼W	3.3k	±5%

SCH. No.	Symbol No.	Description		
		RESISTORS		
2/3	R226	Carbon film ¼W	3.3k	±5%
2/3	R227	Carbon film ¼W	3.3k	±5%
2/3	R228	Carbon film ¼W	560Ω	±5%
2/3	R229	Carbon film ¼W	4.7k	±5%
2/3	R230	Carbon film ¼W	2.2k	±5%
2/3	R231	Carbon film ¼W	3.3k	±5%
2/3	R232	Carbon film ¼W	3.3k	±5%
2/3	R233	Carbon film ¼W	100Ω	±5%
2/3	R234	Carbon film ¼W	680Ω	±5%
2/3	R235	Carbon film ¼W	680Ω	±5%
2/3	R236	Carbon film ¼W	100Ω	±5%
2/3	R237	Carbon film ¼W	100Ω	±5%
2/3	R238	Carbon film ¼W	6.8k	±5%
2/3	R239	Carbon film ¼W	22k	±5%
2/3	R240	Carbon film ¼W	2.2k	±5%
2/3	R242	Carbon film ¼W	18k	±5%
2/3	R244	Carbon film ¼W	1.8k	±5%
2/3	R245	Carbon film ¼W	47Ω	±5%
2/3	R246	Carbon film ¼W	100Ω	±5%
2/3	R247	Carbon film ¼W	100Ω	±5%
2/3	R248	Carbon film ¼W	100Ω	±5%
2/3	R249	Carbon film ½W	10Ω	±5%
2/3	R250	Carbon film ½W	10Ω	±5%
2/3	R251	Metal film ½W	100Ω	±1%
2/3	R252	Carbon film ¼W	1k	±5%
2/3	R253	Carbon film ¼W	1k	±5%
2/3	R254	Carbon film ¼W	10k	±5%
2/3	R255	Carbon film ¼W	1.8k	±5%
2/3	R256	Carbon film ¼W	1.8k	±5%
2/3	R257	Carbon film ¼W	10k	±5%
2/3	R258	Carbon film ¼W	2.2k	±5%
2/3	R259	Carbon film ¼W	4.7k	±5%
2/3	R260	Metal film ½W	100Ω	±1%
2/3	R261	Carbon film ¼W	2.2k	±5%
2/3	R262	Carbon film ¼W	1k	±5%
2/3	R264	Carbon film ¼W	1.2k	±5%
2/3	R265	Metal film ¼W	2429Ω	±0.5%
3/3	R301	Carbon film ¼W	100k	±5%
3/3	R302	Carbon film ¼W	1k	±5%
3/3	R303	Carbon film ¼W	47k	±5%
3/3	R304	Carbon film ¼W	470Ω	±5%
3/3	R305	Carbon film ¼W	4.7k	±5%
3/3	R306	Carbon film ¼W	1.5k	±5%
3/3	R307	Carbon film ¼W	1k	±5%
3/3	R308	Carbon film ¼W	4.7k	±5%
3/3	R309	Metal film ¼W	150k	±1%
3/3	R310	Carbon film ¼W	150k	±5%

SCH. No.	Symbol No.	Description		
		RESISTORS		
3/3	R311	Carbon film ¼W	3.3k	±5%
3/3	R312	Carbon film ¼W	27k	±5%
3/3	R313	Carbon film ¼W	4.7k	±5%
3/3	R314	Carbon film ¼W	10k	±5%
3/3	R315	Carbon film ¼W	1k	±5%
3/3	R316	Carbon film ¼W	390Ω	±5%
3/3	R317	Carbon film ¼W	2.7k	±5%
3/3	R318	Carbon film ¼W	2.7k	±5%
3/3	R319	Carbon film ¼W	1k	±5%
3/3	R320	Metal film ¼W	3.3k	±5%
3/3	R321	Metal film ¼W	3.3k	±5%
3/3	R322	Carbon film ¼W	1k	±5%
3/3	R324	Carbon film ¼W	470Ω	±5%
3/3	R325	Metal film ¼W	1k	±5%
3/3	R326	Metal film ¼W	1k	±5%
3/3	R327	Carbon film ¼W	4.7k	±5%
3/3	R328	Carbon film ¼W	1k	±5%
3/3	R329	Carbon film ¼W	220Ω	±5%
3/3	R330	Carbon film ¼W	470kΩ	±5%
2/3	R401	Metal film ½W	96.2Ω	±1%
2/3	R402	Metal film ½W	71.2Ω	±1%
2/3	R403	Metal film ½W	96.2Ω	±1%
2/3	R404	Metal film ½W	61.1Ω	±1%
2/3	R405	Metal film ½W	248Ω	±1%
2/3	R406	Metal film ½W	61.1Ω	±1%
2/3	R407	Metal film ½W	51.0Ω	±1%
2/3	R408	Metal film ½W	2.5k	±1%
2/3	R409	Metal film ½W	51.0Ω	±1%
2/3	R501	Carbon film ¼W	220Ω	±5%
2/3	R502	Carbon film ¼W	3.3k	±5%
		VARIABLE RESISTORS		
1/3	VR101	Metal glaze ½W	22k	
1/3	VR102	Metal glaze ½W	100Ω	
1/3	VR103	Metal glaze ½W	100Ω	
1/3	VR105	Metal glaze ½W	10k	
1/3	VR106	Metal glaze ½W	10k	
1/3	VR107	Metal glaze ½W	10k	
1/3	VR108	Metal glaze ½W	10k	
1/3	VR109	Metal glaze ½W	10k	
1/3	VR110	Metal glaze ½W	330Ω	
1/3	VR111	Metal glaze ½W	330Ω	
1/3	VR112	Metal glaze ½W	1k	
2/3	VR201	Metal glaze ½W	1k	
2/3	VR202	Metal glaze ½W	1k	
2/3	VR203	Metal glaze ½W	1k	

SCH. No.	Symbol No.	Description			
		VARIABLE RESISTORS			
2/3	VR207	Metal glaze	½W	10k	
2/3	VR208	Metal glaze	½W	1k	
2/3	VR209	Metal glaze	½W	2.2k	
2/3	VR210	Metal glaze	½W	10k	
3/3	VR301	Metal glaze	½W	100k	
3/3	VR302	Metal glaze	½W	1k	
2/3	VR501	2k (VM10E 2kB L = 15)			
2/3	VR502	5k (VM10E - VER 22 - 5kB)			
1/3	VR601	1kΩB (SFC P22AC 1-7)			
2/3	VR602	1k (V16L 4N 16SB 1k)			
2/3	VR603	10kΩB (V16L 4N 1583 10k)			
2/3	VR604	10kΩB (V16L 4N 1583 10k)			
3/3	VR605	100k (V16L 4N 1583 100k)			
3/3	VR606	10kΩA (V16L 4N 15SA 10k)			
		CAPACITORS			
1/3	C101	Mica	50V	56pF	±10%
1/3	C102	Mica	100V	2.2μF	±5%
1/3	C103	Mica	100V	10μF	±5%
1/3	C104	Mica	100V	1μF	±5%
1/3	C105	Mica	100V	0.1μF	±5%
1/3	C106	Plastic film		0.01μF	±5%
1/3	C107	Plastic film		1000pF	±5%
1/3	C108	Ceramic	50V	0.001μF	
1/3	C109	Ceramic	50V	0.001μF	
1/3	C110	Ceramic	50V	0.001μF	
1/3	C111	Ceramic	50V	0.001μF	
1/3	C112	Ceramic	50V	0.001μF	
1/3	C113	Electrolytic	16V	47μF	
	C115	Mica	500V	7pF	±10%
	C116	Ceramic	50V	0.1μF	
2/3	C202	Plastic film		0.1μF	
2/3	C203	Electrolytic	25V	47μF	
2/3	C204	Electrolytic	16V	47μF	
	C206	Mica	500V	1pF	±10%
3/3	C301	Plastic film		0.33 μF	
3/3	C302	Mica	50V	100pF	±10%
3/3	C303	Mica	50V	47pF	±10%
3/3	C304	Electrolytic	35V	2200μF	
3/3	C305	Electrolytic	35V	2200μF	
3/3	C307	Electrolytic	25V	100μF	
3/3	C308	Electrolytic	25V	100μF	
3/3	C309	Electrolytic	25V	100μF	
3/3	C310	Electrolytic	25V	100μF	
3/3	C311	Electrolytic	10V	47μF	
3/3	C312	Electrolytic	10V	47μF	
3/3	C313	Electrolytic	16V	47μF	
3/3	C314	Ceramic	50V	0.1μF	

SCH. No.	Symbol No.	Description		
		VARIABLE CAPACITOR		
1/3	VC101	Ceramic	500V	10pF
		TRANSISTORS		
1/3	Q101	NPN	2SC1815-GR	
1/3	Q102	PNP	2SA1015-GR	
1/3	Q103	NPN	2SC1815-GR	
1/3	Q104	PNP	2SA1015-GR	
1/3	Q105	Dual J-FET	IMF3958	
1/3	Q106	NPN	2SC1215	
1/3	Q107	NPN	2SC1215	
1/3	Q108	PNP	2SA1015-GR	
1/3	Q109	NPN	2SC1215	
1/3	Q110	NPN	2SC1215	
1/3	Q111	NPN	2SC495-Y	
1/3	Q112	PNP	2SA505-Y	
1/3	Q113	NPN	2SC1815-GR	
1/3	Q114	PNP	2SA1015-GR	
1/3	Q115	NPN	2SC1815-GR	
1/3	Q116	PNP	2SA1015-GR	
2/3	Q203	NPN	2SC1815-GR	
	Q204	NPN	2SC1815-GR	
2/3	Q206	PNP	2SA1015-GR	
2/3	Q207	NPN	2SC1815-GR	
2/3	Q208	NPN	2SC1815-GR	
2/3	Q209	NPN	2SC1923-Y	
2/3	Q211	PNP	2SA711	
2/3	Q212	NPN	2SC1215	
2/3	Q213	NPN	2SC97A	
	Q214			
2/3	Q215	NPN	2SC1215	
2/3	Q216	PNP	2SA711	
2/3	Q217	PNP	2SA571	
3/3	Q301	PNP	2SA1015-GR	
3/3	Q302		LM3086	
3/3	Q303	NPN	2SC1815-GR	
3/3	Q304	NPN	2SD880	
3/3	Q305	NPN	2SD880	
3/3	Q306	PNP	2SA1015-GR	
		DIODES		
1/3	D101		35V	1S1588
1/3	D102		35V	1S1588
1/3	D103		35V	1S1588
1/3	D104		35V	1S1588
1/3	D105		35V	1S1588

SCH. No.	Symbol No.	Description
		DIODES
1/3	D106	35V 1S1588
1/3	D107	35V 1S1588
1/3	D108	35V 1S1588
1/3	D109	35V 1S1588
1/3	D110	35V 1S1588
1/3	D111	35V 1S1588
1/3	D112	35V 1S1588
1/3	D113	35V 1S1588
1/3	D114	35V 1S1588
1/3	D115	35V 1S1588
1/3	D116	35V 1S1588
1/3	D117	35V 1S1588
1/3	D118	35V 1S1588
2/3	D202	35V 1S1588
2/3	D203	35V 1S1588
2/3	D204	35V 1S1588
2/3	D205	35V 1S1588
2/3	D206	Zener RD12EB
2/3	D207	Zener RD6.8EB
3/3	D301	35V 1S1588
3/3	D302	35V 1S1588
3/3	D303	Rect 200V 1DZ61
3/3	D304	Rect 200V 1DZ61
3/3	D305	Rect 200V 1DZ61
3/3	D306	Rect 200V 1DZ61
3/3	D307	Rect 200V 1DZ61
3/3	D308	Rect 200V 1DZ61
3/3	D309	Rect 200V 1DZ61
3/3	D310	Rect 200V 1DZ61
3/3	D311	Zener 4.7V RD4.7EB
		LED SLP-751
		IC
1/3	IC101	LM741
1/3-3/3	IC102	LM1458
1/3-3/3	IC103	LM741
1/3-3/3	IC104	LF356
1/3-3/3	IC105	SN75107AN

SCH. No.	Symbol No.	Description
		IC
1/3-3/3	IC106	LF356
1/3-3/3	IC107	LM1458
1/3-3/3	IC108	LM741
2/3	IC201	TTL SN7400
2/3	IC202	MC1495L
2/3	IC203	TTL SN7400
	IC204	SN72710N
3/3	IC301	TL084
3/3	IC302	MC7815
3/3	IC303	MC7915
3/3	IC304	MC7805
3/3	IC305	MC7905
3/3	IC306	LM1458
		SWITCHES
1/3	S101	Push Q-409 81
2/3	S201	Push Q-423
2/3	S401	Push S-3-26
2/3,3/3	S501	Push S-7-26
		Toggle ST-1106D
		Slide SD2S-202N-91B
		PRINTED CIRCUIT BOARDS
1/3-3/3		T-2107
2/3		T-2004
2/3,3/3		T-2028
		TRANSFORMER
		J-407
		FUSE
		MZ TTPF 100V 0.5A