

LFG-1300S  
FUNCTION GENERATOR  
SERVICE MANUAL

\*\*\*\*\*

<<WARNING>>

This service manual is for use by qualified personnel only. To avoid electrical shock, do not perform any service in this manual unless qualified to do so.

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## 1. SPECIFICATIONS

<b>Frequency Range</b>	0.002Hz to 2MHz in 8 decade ranges.
<b>Dial Accuracy</b>	± (3% set value + 3% full scale) for 0.02Hz to 200kHz. ± (5% set value + 5% full scale) for 200kHz to 2MHz.
<b>Output Signals</b>	Sine, Triangle, Square, Pulse, Sawtooth, DC, TTL output
<b>Sine Wave</b> Output voltage Distortion  Output flatness	20V <sub>p-p</sub> (approx. 7Vrms) into open circuit Less than 0.5% for 10Hz to 20kHz. Less than 1% for 20kHz to 100kHz. Less than 3% for 100kHz to 2MHz. With ± 0.3dB for 0.02Hz to 2MHz.
<b>Triangle Wave</b> Output voltage Symmetry	20V <sub>p-p</sub> into open circuit Less than 1% for 0.02Hz to 100kHz.
<b>Sawtooth Wave</b> Output voltage Symmetry	20V <sub>p-p</sub> into open circuit 15:85 or 85: 15, Fixed
<b>Square Wave</b> Output voltage Symmetry Rise time	20V <sub>p-p</sub> into open circuit Less than 1% for 0.02Hz to 100kHz. Less than 100ns.
<b>Pulse Wave</b> Output voltage Symmetry	20V <sub>p-p</sub> into open circuit Continuously variable, 9:1 to 1:9
<b>TTL Output</b> Fan out Output level	20TTL 2.4V to 5V for H. 0V to 0.4V for L.
<b>DC</b>	Any level within ± 10V by DC OFFSET.
<b>DC OFFSET</b>	-10V to + 10V Clipping level for superposed waveform: ±10V.
<b>Sweep</b> Sweep mode Sweep rate Sweep width  External sweep control (VCG) Sweep output (H. OUT)	LOG. or LINEAR is selectable. Continuously variable, 20ms (50Hz) to 5s (0.2Hz). Continuously variable, 10:1 to 1000:1 of frequency ratio. 0V to +10V (max. sweep width). This is connected to X-axis of an oscilloscope.

<b>Amplitude Modulation Depth</b> Modulation signal	Continuously variable, 0% to 95% or more. External input. Carrier suppress function is available.
<b>Output Connector</b> Output impedance Attenuators Accuracy	500Ω ± 5%. 10dB, 20dB, and 40dB. ± 1% of set value for less than 200kHz. ± 2% of set value for 200kHz and above.
<b>Rear Panel Connector</b> VCG IN  GCV OUT  MOD IN  H. OUT  TTL OUT	External frequency control input, maximum control at 0V to +10V, approx. 10kΩ of input impedance. Frequency control voltage output, approx. 0V to + 5V for a dial tuning, approx. 1.5kΩ of output impedance. AM modulation input, optimum input voltage 0.3Vrms, approx. 10kΩ of input impedance. X-axis signal for oscilloscope in sweep operation, 0V to + 1V sawtooth wave, approx. 1kΩ of output impedance. TTL level output. Fan out: 20TTL.
<b>Size and Weight</b>	250mm (W) X 125mm (H) X 250mm (D), 4kg. approx.
<b>Power Supply</b>  <b>Accessories</b>  Optional accessory	100V, 120V, 220V, 240VAC 50/60Hz, 20VA A connection cable LC-2048 (BNC 50Ω). 1 ea. Spare fuse ..... 1 ea. Circuit protection fuse ..... 1 ea. Instruction manual ..... 1 ea. Terminator LT-2049 50Ω (Separately available).

## 2. TEST EQUIPMENT REQUIRED

The following test equipment is required for calibration and servicing of the Model LFG-1300S. The suggested specifications are the minimum necessary for proper calibration of this instrument.

<u>Test Equipment</u>	<u>Minimum Specifications</u>
- Multimeter	Accuracy: <1% *LEADER Model LDM-853A
- Oscilloscope	Sensitivity: 10mV/div Bandwidth: 20MHz *LEADER Model 1021 Low capacitance probe *LEADER Model LF-180
- Frequency Counter	Frequency range: 0.2Hz to 2MHz *LEADER Model LDC-823A
- Audio Generator	Frequency: 1kHz *LEADER Model LAG-120B
- Distortion Meter	Full scale: 0.1% Frequency: 400Hz, 1kHz *LEADER Model 171
- AC Millivoltmeter	Sensitivity: 0.1Vrms Frequency Range: 2MHz

### 3. CALIBRATION PROCEDURE

#### 3.1 General

Calibration should be performed after a 30 minute warm-up period. It should also be confirmed that the unit is connected to the rated power line voltage.

All adjustments should be completed in the given order, because some adjustments interact with others.

During the adjustment procedure, remove the case only when necessary and replace immediately after making an adjustment. This will maintain all circuits at constant operating temperature.

When connecting the oscilloscope to the test point, use a low capacitance probe.

\*\*\* WARNING \*\*\*

Electrical shock hazards exist inside this instrument when covers are removed.

#### 3.2 Initial Control Settings

The initial control settings to be used for each check and adjustment are listed below. Any variations from these settings are stated in the applicable procedure.

FREQUENCY Dial	1.0
FREQUENCY Switch	x1k
SWEEP	
ON-OFF	OFF
LIN-LOG	LIN
RATE	Fully clockwise
WIDTH	Fully clockwise
AMPLITUDE MOD	
ON-OFF	OFF
MOD	Fully counterclockwise
CARRIER LEVEL	0
DC OFFSET	OFF
FUNCTION	Sine
OUTPUT	
AMPLITUDE	Fully clockwise
ATTENUATION	0dB

### 3.3 Power Supply

- Connect the DC voltmeter between test point(T-2107, main board) and chassis.
- Check the voltages according to Table 3-1.

Test point	Voltage	Tolerance	Adjustment
IC304, pin 2	+5V	+4.75V to +5.25V	-
IC305, pin 2	-5V	-4.75V to -5.25V	-
IC302, pin 2	+15V	+14.25V to +15.75V	-
IC303, pin 2	-15V	-14.25V to -15.75V	-
TP4	+10.0V	-	VR302, +10V
TP3	-10V	+1% of +10V supply	-

Table 3-1

### 3.4 Voltage Controlled Generator(VCG)

#### (1) Offset

- Set: FREQUENCY Dial Fully clockwise
- OUTPUT
- AMPLITUDE Fully clockwise
- Connect the DC voltmeter to emitter of Q104(T-2107, main board).
- Adjust VR101, OFFSET(T-2107, main board) for a voltage reading of 0.0Vdc.

#### (2) Frequency

- Connect the frequency counter to OUTPUT connector.
- Set: FREQUENCY Switch x1k
- FREQUENCY Dial .2
- Adjust VR106, x1k 200Hz ADJ(T-2107, main board) for a frequency reading of 200Hz.
- Set: FREQUENCY Dial 2.0
- Adjust VR112, x1k 2kHz ADJ(T-2107, main board) for a frequency reading of 2kHz.
- Repeat above adjustment for best calibration accuracy.



- Set: FREQUENCY Dial 2.0
- Adjust all remaining ranges by using the adjustments according to Table 3-2.
- \*NOTE\* It may be compromise to obtain a best calibration accuracy on all ranges.

Frequency(Range)	Adjustment
0.2Hz(x0.1)	VR103(x10)
2Hz(x1)	VR103(x10)
20Hz(x10)	VR103(x10)
200Hz(x100)	VR105(x100)
20kHz(x10k)	VR107(x10k)
200kHz(x100k)	VR108(x100k)
2MHz(x1M)	VR109/VC101(x1M)

Table 3-2

### 3.5 Functions

#### (1) Sine Wave

##### a. Distortion

- Set: FREQUENCY Dial 2.0
- FREQUENCY Switch x1k
- FUNCTION Sine
- OUTPUT
- AMPLITUDE Fully clockwise
- Connect the distortion meter to OUTPUT connector.
- \*NOTE\* Monitor the harmonic output of the distortion meter with the oscilloscope while an adjustment.
- Adjust VR110, +DIST and VR111, -DIST(T-2107, main board) alternately for minimum distortion.
- Set: FREQUENCY Switch x10
- Adjust VR113, LOW FREQ DIST(T-2107, main board) for minimum distortion.
- Set: FREQUENCY Dial .2
- Adjust VR114, SINE OFFSET(T-2107, main board) for minimum distortion.
- Repeat above adjustment for minimum distortion.

b. Output Level

- Set: OUTPUT  
          AMPLITUDE                      Fully clockwise
- Connect the oscilloscope to OUTPUT connector.
- Adjust VR210, SINE OUTPUT(T-2107, main board) for an amplitude of 20Vp-p.

(2) Triangular Wave

- Set: FREQUENCY Dial                      2.0  
      FREQUENCY Switch                    x1k  
      FUNCTION                             Triangle  
      OUTPUT  
      AMPLITUDE                           Fully clockwise
- Connect the oscilloscope to OUTPUT connector.
- Adjust VR203, TRIANGULAR OUTPUT(T-2107, main board) for an amplitude of 20Vp-p.

(3) Square Wave

- Set: FREQUENCY Dial                      2.0  
      FREQUENCY Switch                    x1k  
      FUNCTION                             Square  
      OUTPUT  
      AMPLITUDE                           Fully clockwise
- Connect the oscilloscope to OUTPUT connector.

a. Output Level

- Adjust VR202, SQUARE WAVE OUTPUT(T-2107, main board) for an amplitude of 20Vp-p.

b. Offset

- Adjust VR201, SQUARE OFFSET(T-2107, main board) for a center of the square wave to 0Vdc.

### 3.6 AM Modulation

- Set: FREQUENCY Dial 2.0
- FREQUENCY Switch x100k
- AMPLITUDE MOD
- ON-OFF ON
- MOD Midrange
- FUNCTION Sine
- OUTPUT
- AMPLITUDE Midrange

- Connect the oscilloscope to OUTPUT connector.
- Connect the audio generator to MOD IN connector and set the frequency to 1kHz, output level for 1Vp-p.
- Adjust CARRIER LEVEL control to obtain an AM signal. Refer to Figure 3-1.

#### (1) Balance

- Adjust VR207, AM BAL(T-2107, main board) to equalize the "A" and "B" of the waveform as shown in Figure 3-1.

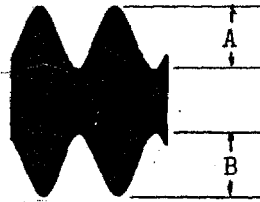


Figure 3-1

- Confirm that the DSB(Double Side Band) signal is obtained by adjusting the CARRIER LEVEL control. Refer to Figure 3-2.

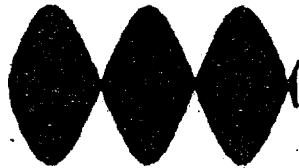


Figure 3-2

(2) Amplifier

- Set: AMPLITUDE MOD  
MOD Fully clockwise
- Adjust CARRIER LEVEL control for 100% modulation.
- Set: AMPLITUDE MOD  
ON-OFF OFF  
MOD Fully counterclockwise
- Adjust the oscilloscope sensitivity for 4 divisions display.

a. Gain

- Set: AMPLITUDE MOD  
ON-OFF ON
- Adjust VR208, AM GAIN(T-2107, main board) for a display of 2 divisions.

b. Offset

- Adjust VR209, AM OFFSET(T-2107, main board) for the same DC levels when the AM MOD switch is pushed on and off.

3.7 Rear Panel Outputs

(1) H OUT

- Set: SWEEP  
LIN-LOG LIN  
RATE Fully clockwise
- Connect the oscilloscope to H OUT connector on the rear panel.
- Set VR301, SAWTOOTH RETURN(T-2107, main board) to fully clockwise.
- Confirm that the fall time of the sawtooth should be 5ms or less.
- Confirm that the rise-up time of the sawtooth should be 20ms or less.

- Set: SWEEP RATE Fully counterclockwise
- The rise-up time of the sawtooth should be 5sec or longer.

(2) GCV OUT

- Connect the oscilloscope to GCV OUT connector on the rear panel. Use DC input mode.

a. DC Output

- Set: FREQUENCY Dial Fully clockwise
- SWEEP OFF
- ON-OFF OFF

- The output voltage should be 0Vdc.

- Set: FREQUENCY Dial Fully counterclockwise

- The output voltage should be between +2Vdc and +8Vdc.

b. Sawtooth Output

- Set: FREQUENCY Dial Fully clockwise
- SWEEP ON
- ON-OFF ON
- WIDTH Fully clockwise
- RATE Midrange

- Confirm that the waveform as shown in Figure 3-3.

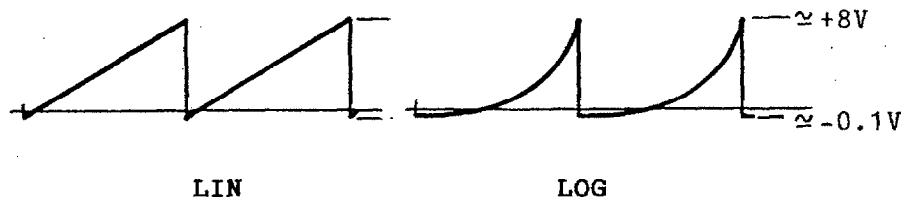


Figure 3-3

## 4. TROUBLESHOOTING PROCEDURE

### 4.1 General

Confirm that the any equipment used with the Model LFG-1300S is operating correctly.

Check all control settings, an incorrect setting can make a good unit appear defective. If there is any question about the function, refer to the Instruction Manual for correct operation.

Check all circuit for visual defects such as broken component, loose connection, open wire, poor soldering etc.

Some troubles can be solved with proper adjustment.

Check the voltage and waveform as shown in the Schematic Diagram to locate the defective circuit. Start with the power supply.

\*\*\* WARNING \*\*\*

Electrical shock hazards exist inside this instrument when covers removed.

### 4.2 Theory of Operation

The Model LFG-1300S is divided into five major sections; a Basic Function Generator including a Voltage Controlled Generator (VCG) and Sine Shaper, an AM Modulator, a Sweep Generator and an Output Amplifier/Attenuator with DC offset circuitry. Refer to "7. Block Diagram".

#### - Basic Function Generator

The basic function generator has a non-linear feedback loop consisting of a flip-flop and an integrator that produces the square and triangular waveforms.

In the VCG, the frequency is determined by the frequency dial VR601 and range switch S101. Frequency can also be controlled by an external VCG input J2 on the rear panel.

The sine shaper receives the triangular wave from the basic generator and converts it through a diode-resistance network to a sine wave. The sine, square and triangular wave are routed through a function switch S201 to the AM modulator.

- AM

When a AM modulator is selected, the amplitude of the output waveform can be modulated by an external input. Percentage of modulation can be controlled by VR603 and carrier suppression is controlled by VR604.

FM modulation can be obtained by applying voltage to the VCG input.

- Sweep Generator

Sweep generator is two generators. The master generator is a VCG and the secondary generator produces a sawtooth waveform that sweeps the frequency of the master generator. All outputs; sine, triangular or square can be swept linear or logarithmic on each range.

The sawtooth is applied to the H OUT connector on the rear panel.

- Output Amplifier and Attenuator

The output amplifier produces a high amplitude output directly coupled through the 50 ohm attenuator. Signal offset is controlled at this point. A 125mA fuse is installed on the attenuator pc board T-2004 to protect the output from any externally applied voltage.

The attenuator is a passive 10, 20, 40dB resistor network. Attenuation is 0dB with buttons out and 70dB with all buttons depressed.

Symmetry

Symmetry of the square wave is controlled by comparator Q203, Q204 and IC204. Adjusting VR602, symmetry control, changes the voltage applied to IC204 changing the symmetry of the applied square wave.

Power Supply

The power supply is a linear supply with outputs of +5, +10 and +15 volts. These supplies are controlled by IC302-IC306 with +10 volts adjustable by VR302.

### 4.3 Troubleshooting Aid

**\*\*\* WARNING \*\*\***

Electrical shock hazards exist inside this instrument when covers are removed.

- (1) Overall operation is not satisfactory, or no signal output.

Check the following points.

- Line fuse

0.315A time-lag fuse for 100V to 120V operation.

0.125A time-lag fuse for 200V to 240V operation.

\*CAUTION\* Use specified fuse only. Refer to section "10. Parts list".

- Secondary voltage of the power transformer.

- Regulated DC power supplies on the main board, T-2107. Refer to Table 4-1.

Test point	Voltage	Tolerance	Adjustment
IC304, pin 2	+5V	+4.75V to +5.25V	-
IC305, pin 2	-5V	-4.75V to -5.25V	-
IC302, pin 2	+15V	+14.25V to +15.75V	-
IC303, pin 2	-15V	-14.25V to -15.75V	-
TP4	+10.0V	-	VR302, +10V
TP3	-10V	+1% of +10V supply	-

Table 4-1

Yes: Proceed to step "(2)".

No: Troubleshoot regulated power supplies.

+5V: D307-310, IC304(T-2107, main board) and associated circuit.

-5V: D307-310, IC305(T-2107, main board) and associated circuit.

+15V: D303-306, IC302(T-2107, main board) and associated circuit.

-15V: D303-306, IC303(T-2107, main board) and associated circuit.

+10V: +15V and -15V supplies, Q303-304, IC306 (T-2107, main board) and associated circuit.

-10V: +15V, -15V and +10V supplies, Q305-306, IC306 (T-2107, main board) and associated circuit.

- Fuse, F401(soldered on the attenuator board, T-2004) for open. Refer to page 9-2 for replacement.

\*CAUTION\* Use specified fuse only. Refer to section "10. Parts list".



(2) Master Generator

a. No triangular wave comes out.

Check waveform at TP2(T-2107, main board) for triangular wave.

Yes: Troubleshoot output amplifier, attenuator, Function switch and associated circuit.

No: Troubleshoot voltage to current converter, Frequency switch and associated circuit.

b. No sine wave comes out

Confirm that the triangle function works correctly.

Check waveform at junction of R161(T-2107, main board) and Function switch.

Yes: Troubleshoot Function switch and associated circuit.

No: Troubleshoot sine converter and associated circuit.

c. No square wave comes out

Confirm that the triangle function works correctly.

Check waveform at junction of VR202(T-2107, main board) and Function switch for triangular wave.

Yes: Troubleshoot Function switch and associated circuit.

No: Troubleshoot square wave shaper and associated circuit.

d. No frequency change or intermittent by rotating Frequency dial.

Troubleshoot VR601, Frequency switch and associated circuit.

Troubleshoot low frequency feedback amplifier and associated circuit for x1 and lower ranges.

(3) AM Modulator

No modulated signal comes out

Confirm that the continuous wave came out from the OUTPUT connector.

Check waveform at emitter of Q207(T-2107, main board) for modulated signal.

Yes: Troubleshoot modulator and associated circuit.

No: Troubleshoot output stage and associated circuit.

(4) Sweep Mode

No sweep mode works

Confirm that the continuous wave came out from the OUTPUT connector, also the frequency to be changed by rotating the Frequency dial

Check waveform at TP5(T-2107, main board) for sawtooth wave which frequency is changed by rotate the RATE control.

Yes: Troubleshoot Sweep switch and associated circuit.

No: Troubleshoot sawtooth generator, log sweep shaper and associated circuit.

(5) Others

a. No SYMMETRY control works

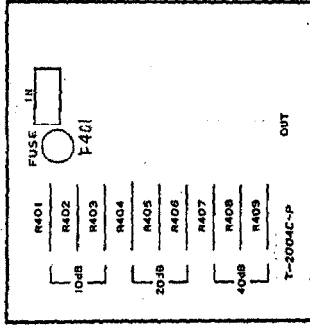
Check VR602 and associated circuit.

b. No DC OFFSET works

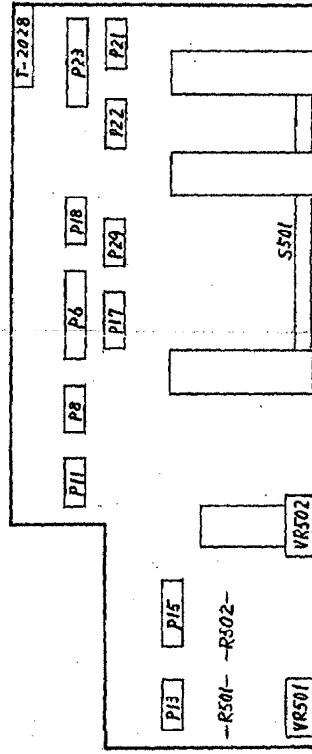
Check VR502 and associated circuit.



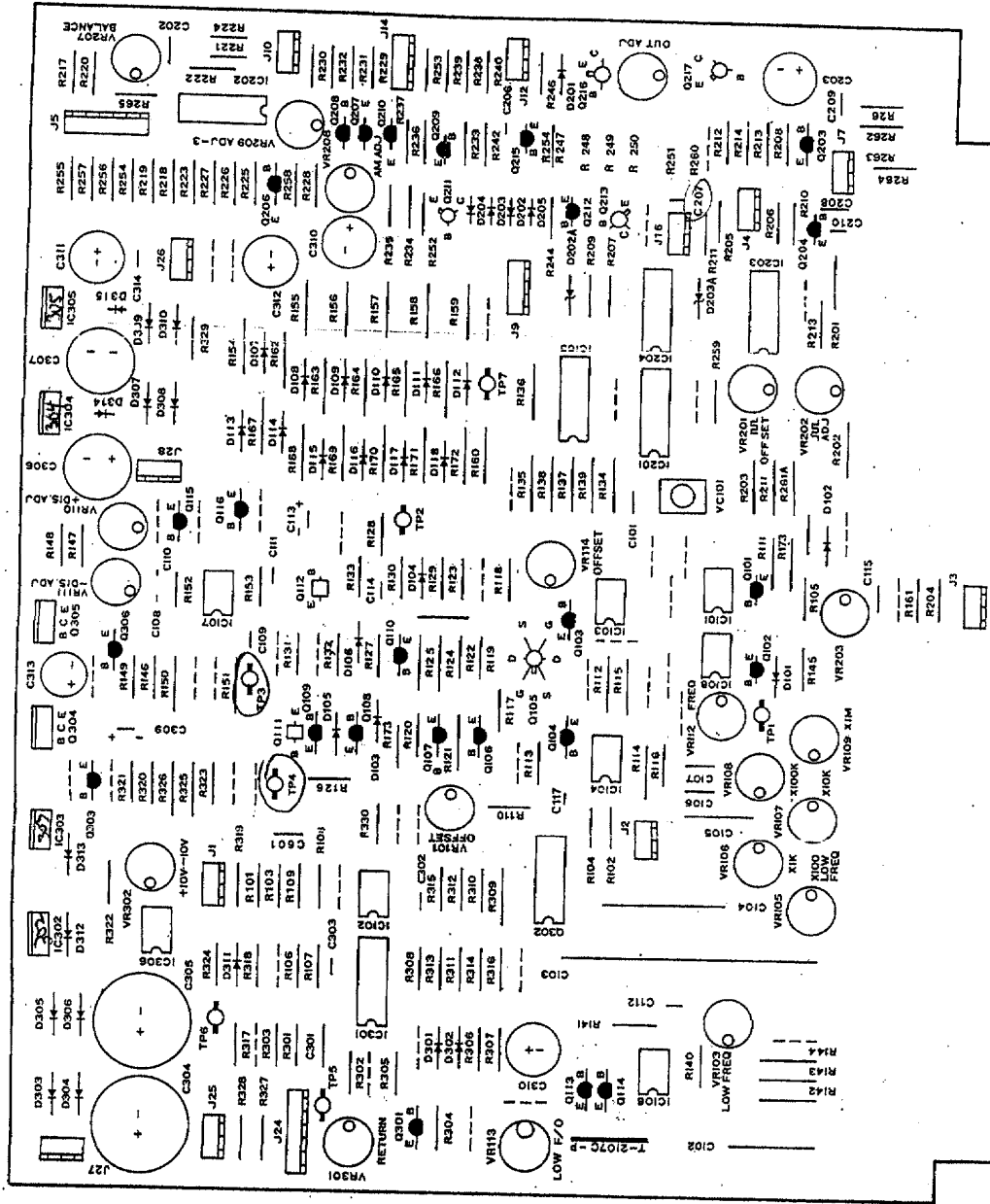
6. PRINTED CIRCUIT BOARD



Attenuator Board  
T-2004

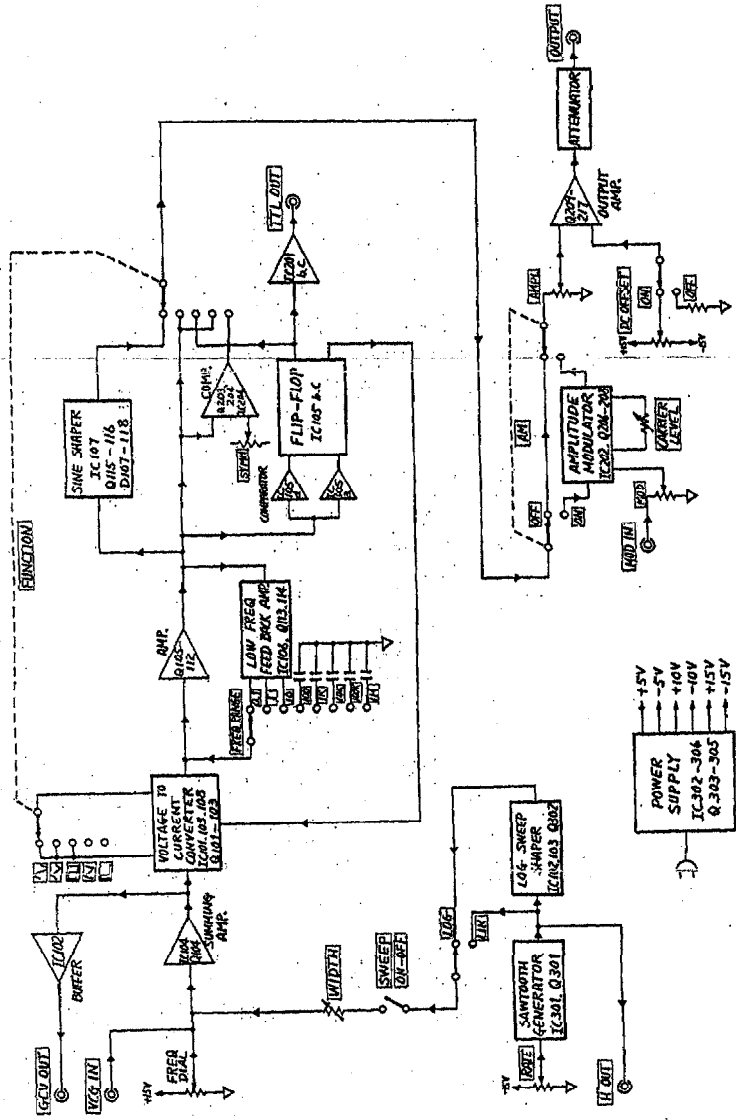


Control Board  
T-2028

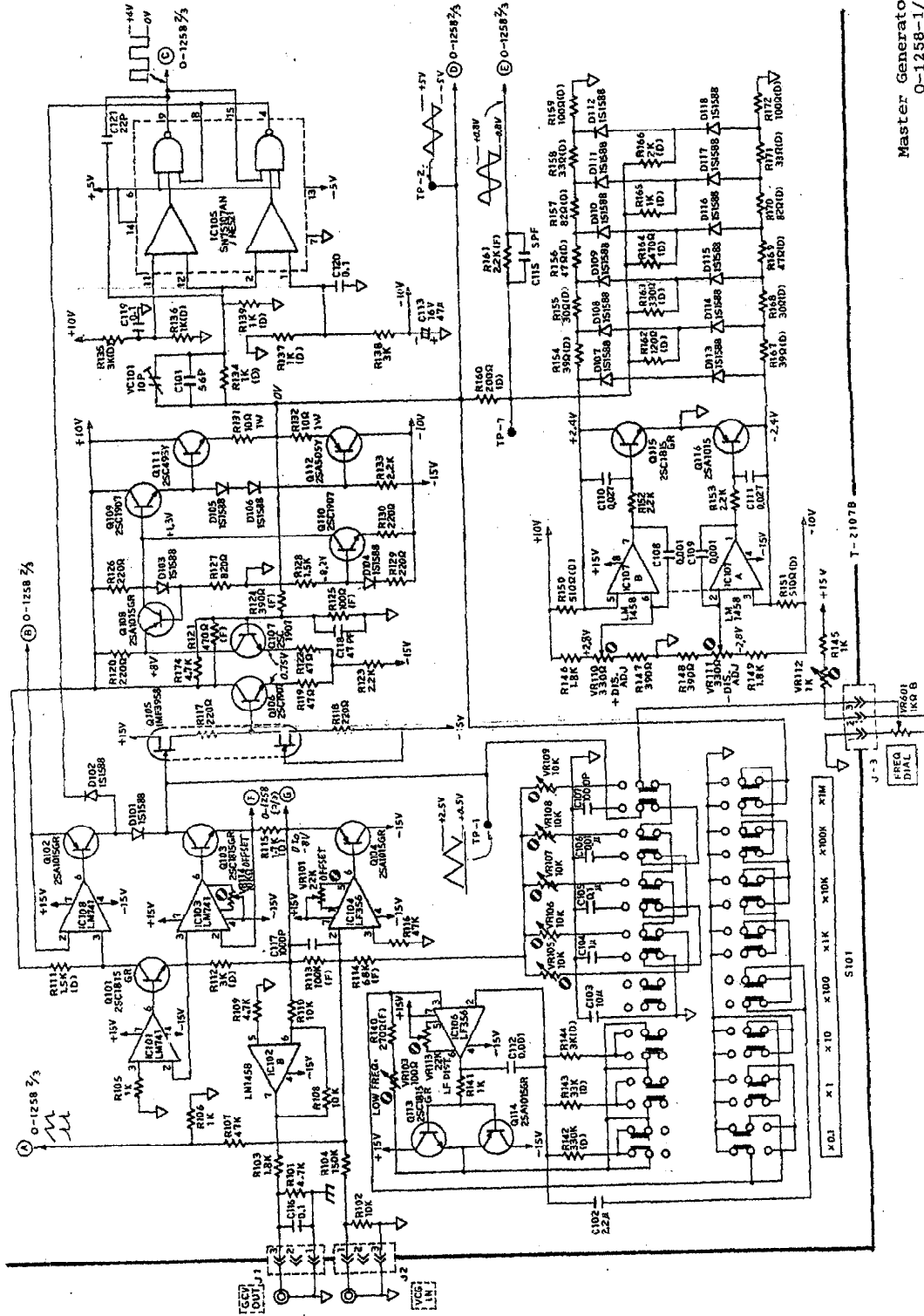


Main Board  
T-2107

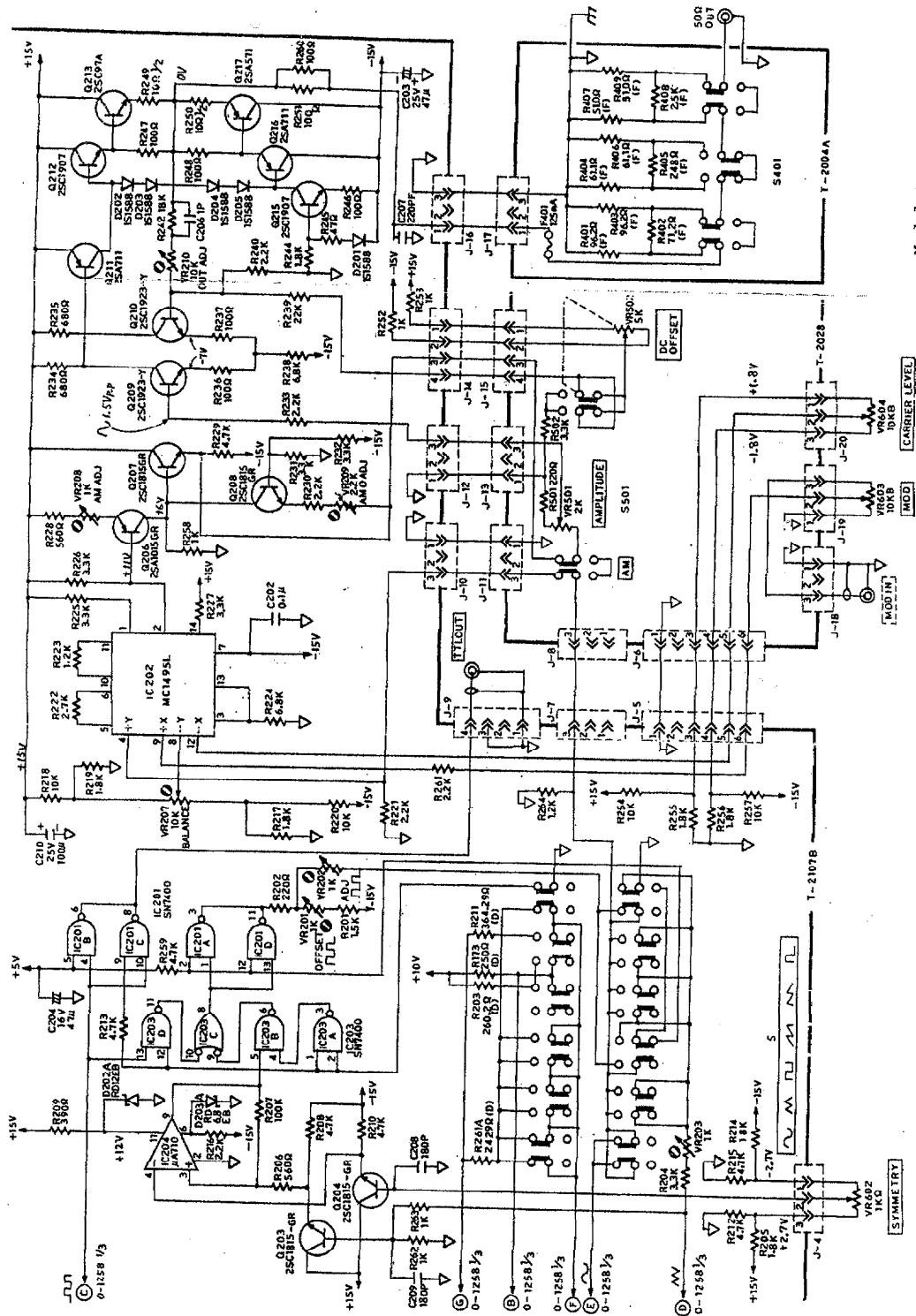
7. BLOCK DIAGRAM



8. SCHEMATIC DIAGRAM

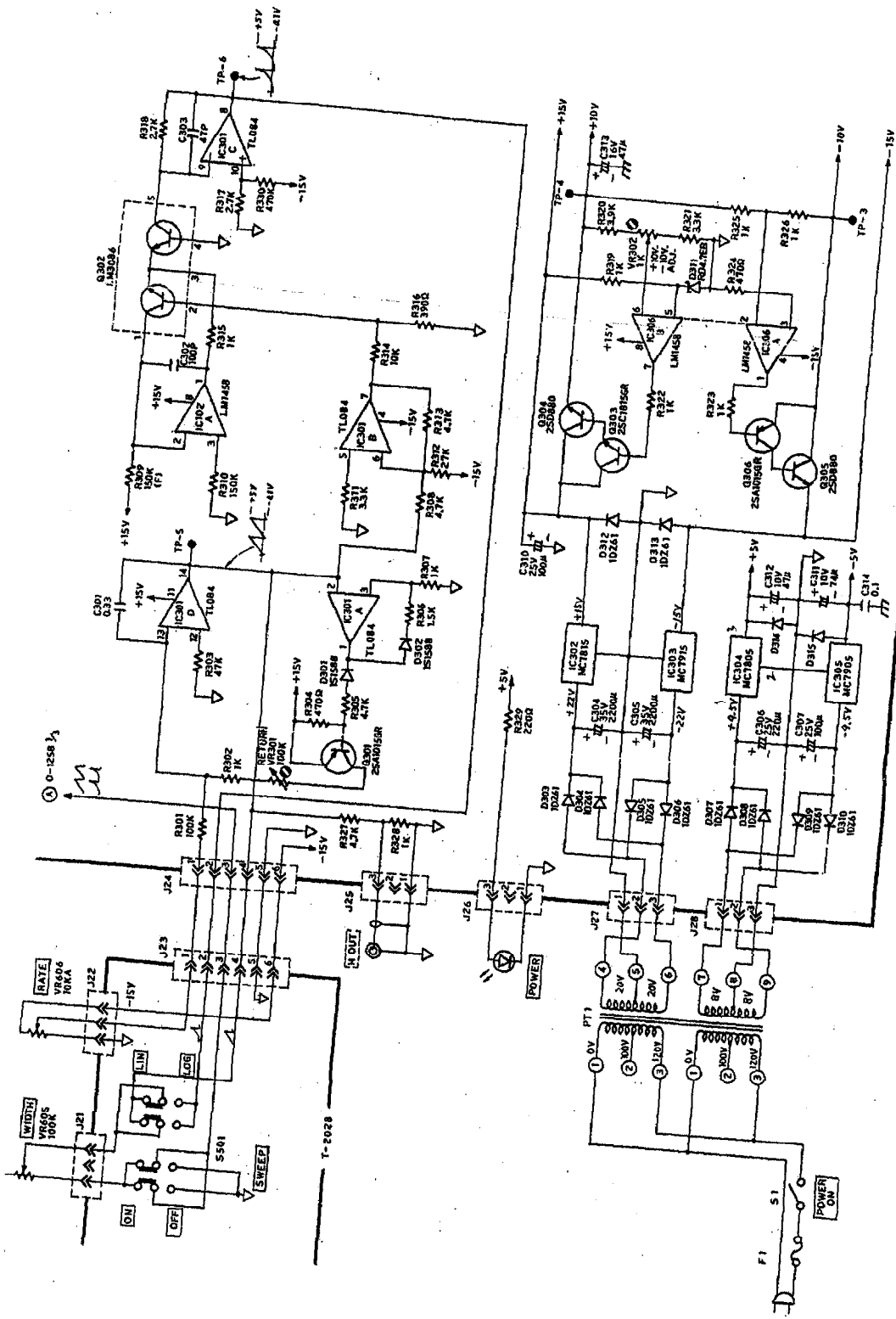


Master Generator  
O-1258-1/3



Modulator, Output Stage  
O-1258-2/3

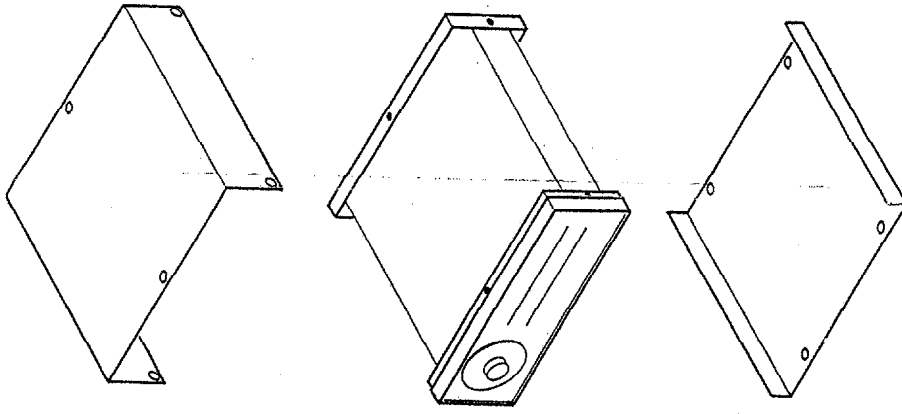


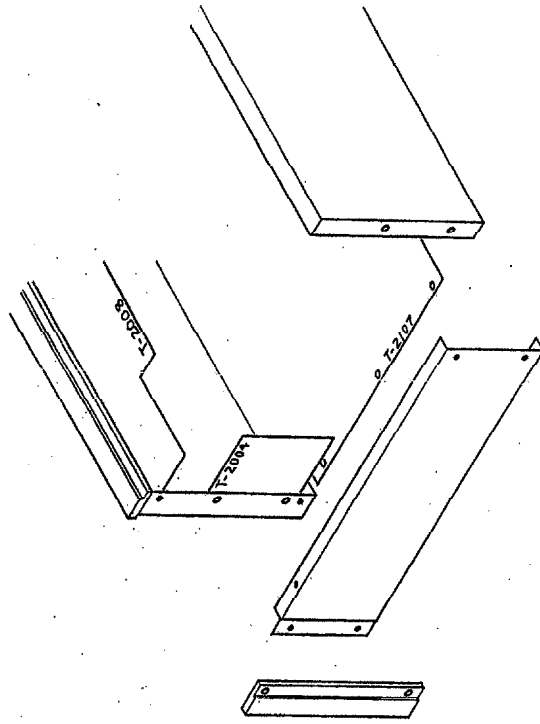


Power Supply  
0-1258-3/3

9. CABINET REMOVAL

- Take six screws off to remove the Top cover.
- Take four screws off to remove the Bottom cover.





## 10. PARTS LIST

No.	LDR PT No.	DESCRIPTION				
*** ATTENUATOR BOARD		T-2004 ***				
-RESISTORS-						
R401	1349629003	METAL FILM	96.2 OHM	1%	1/2W	
R402	1347129001	METAL FILM	71.2 OHM	1%	1/2W	
R403	1349629003	METAL FILM	96.2 OHM	1%	1/2W	
R404	1346119002	METAL FILM	61.1 OHM	1%	1/2W	
R405	1342480003	METAL FILM	248 OHM	1%	1/2W	
R406	1346119002	METAL FILM	61.1 OHM	1%	1/2W	
R407	1345109003	METAL FILM	51 OHM	1%	1/2W	
R408	1342501005	METAL FILM	2.5K OHM	1%	1/2W	
R409	1345109003	METAL FILM	51 OHM	1%	1/2W	
-SWITCH-						
S401	4020108000	PUSH	S-3-26 "ATTENUATION"			
*** CONTROL BOARD		T-2028 ***				
-RESISTORS-						
R501	1010221002	CARBON FILM	220 OHM	5%	1/4W	
R502	1010332001	CARBON FILM	3.3K OHM	5%	1/4W	
-VARIABLE RESISTORS-						
VR501	1813041002	CARBON FILM	2K OHM	20%	1/10W "AMPLITUDE"	
VR502	1910045000	CARBON FILM	5K OHM	20%	1/10W "DC OFFSET"	
-SWITCH-						
S501	4020109002	PUSH	S-7-26 "AM"			
-PC BOARD-		T-2028A				
	5902028001					
*** MAIN FRAME ***						
-VARIABLE RESISTORS-						
VR601	1940027009	PLASTIC	1K OHM	1.5%	1W	
VR602	1811106002	CARBON FILM	1K OHM	20%	1/8W "SYMMETRY"	
VR603	1811110003	CARBON FILM	10K OHM	20%	1/8W "MOD"	
VR604	1811110003	CARBON FILM	10K OHM	20%	1/8W "CARRIER LEVEL"	
VR605	1811114001	CARBON FILM	100K OHM	20%	1/8W "WIDTH"	
VR606	1811152009	CARBON FILM	10K OHM	20%	1/8W "RATE"	
-DIODE-						
D1	3130005006	LED	SLP-751			
-TRANSFORMER-						
T1	3800407001	POWER TRANSFORMER	J-407A			
-SWITCH-						
S1	4020130003	PUSH	S-1-33 "POWER"			

No.	LDR PT No.	DESCRIPTION			
(T-2107	CONT'D)				
R169	1364700007	METAL FILM	47 OHM	0.5X	1/4W
R170	1368200010	METAL FILM	82 OHM	0.5X	1/4W
R171	1363300041	METAL FILM	33 OHM	0.5X	1/4W
R172	1361000065	METAL FILM	100 OHM	0.5X	1/4W
R173	1362500016	METAL FILM	250 OHM	0.5X	1/4W
R174	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R201	1311501008	METAL FILM	1.5K OHM	1X	1/4W
R202	1312200000	METAL FILM	220 OHM	1X	1/4W
R203	1362602005	METAL FILM	260.2 OHM	0.5X	1/4W
R204	1010332001	CARBON FILM	3.3K OHM	5X	1/4W
R205	1010182008	CARBON FILM	1.8K OHM	5X	1/4W
R206	1010561006	CARBON FILM	560 OHM	5X	1/4W
R207	1010104008	CARBON FILM	100K OHM	5X	1/4W
R208	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R209	1010391007	CARBON FILM	390 OHM	5X	1/4W
R210	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R211	1382001003	METAL FILM	364.29 OHM	0.5X	1/4W
R212	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R213	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R214	1010182008	CARBON FILM	1.8K OHM	5X	1/4W
R215	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R216	1010222004	CARBON FILM	2.2K OHM	5X	1/4W
R217	1010182008	CARBON FILM	1.8K OHM	5X	1/4W
R218	1010103006	CARBON FILM	10K OHM	5X	1/4W
R219	1010182008	CARBON FILM	1.8K OHM	5X	1/4W
R220	1010103006	CARBON FILM	10K OHM	5X	1/4W
R221	1010222004	CARBON FILM	2.2K OHM	5X	1/4W
R222	1010272009	CARBON FILM	2.7K OHM	5X	1/4W
R223	1010122000	CARBON FILM	1.2K OHM	5X	1/4W
R224	1010682008	CARBON FILM	6.8K OHM	5X	1/4W
R225	1010332001	CARBON FILM	3.3K OHM	5X	1/4W
R226	1010332001	CARBON FILM	3.3K OHM	5X	1/4W
R227	1010332001	CARBON FILM	3.3K OHM	5X	1/4W
R228	1010561006	CARBON FILM	560 OHM	5X	1/4W
R229	1010472007	CARBON FILM	4.7K OHM	5X	1/4W
R230	1010222004	CARBON FILM	2.2K OHM	5X	1/4W
R231	1010332001	CARBON FILM	3.3K OHM	5X	1/4W
R232	1010332001	CARBON FILM	3.3K OHM	5X	1/4W
R233	1010222004	CARBON FILM	2.2K OHM	5X	1/4W
R234	1010681006	CARBON FILM	680 OHM	5X	1/4W
R235	1010681006	CARBON FILM	680 OHM	5X	1/4W
R236	1010101002	CARBON FILM	100 OHM	5X	1/4W
R237	1010101002	CARBON FILM	100 OHM	5X	1/4W
R238	1010682008	CARBON FILM	6.8K OHM	5X	1/4W
R239	1010223006	CARBON FILM	22K OHM	5X	1/4W
R240	1010222004	CARBON FILM	2.2K OHM	5X	1/4W
R242	1010183000	CARBON FILM	18K OHM	5X	1/4W
R244	1010182008	CARBON FILM	1.8K OHM	5X	1/4W
R245	1010470003	CARBON FILM	47 OHM	5X	1/4W
R246	1010101002	CARBON FILM	100 OHM	5X	1/4W
R247	1210101008	METAL OXIDE	100 OHM	5X	1W
R248	1210101008	METAL OXIDE	100 OHM	5X	1W
R249	1210479007	METAL OXIDE	4.7 OHM	5X	1W
R250	1210479007	METAL OXIDE	4.7 OHM	5X	1W
R251	1341000007	METAL FILM	100 OHM	1X	1/2W
R252	1010102004	CARBON FILM	1K OHM	5X	1/4W
R253	1010102004	CARBON FILM	1K OHM	5X	1/4W

No.	LDR PT No.	DESCRIPTION				
(T-2107	CONT'D)					
R254	1010103006	CARBON FILM	10K OHM	5%		1/4W
R255	1010182008	CARBON FILM	1.8K OHM	5%		1/4W
R256	1010182008	CARBON FILM	1.8K OHM	5%		1/4W
R257	1010103006	CARBON FILM	10K OHM	5%		1/4W
R258	1010102004	CARBON FILM	1K OHM	5%		1/4W
R259	1010472007	CARBON FILM	4.7K OHM	5%		1/4W
R260	1341000007	METAL FILM	100 OHM	1%		1/2W
R261	1010222004	CARBON FILM	2.2K OHM	5%		1/4W
R262	1010102004	CARBON FILM	1K OHM	5%		1/4W
R263	1010102004	CARBON FILM	1K OHM	5%		1/4W
R264	1010122000	CARBON FILM	1.2K OHM	5%		1/4W
R301	1010104008	CARBON FILM	100K OHM	5%		1/4W
R302	1010102004	CARBON FILM	1K OHM	5%		1/4W
R303	1010473009	CARBON FILM	47K OHM	5%		1/4W
R304	1010471005	CARBON FILM	470 OHM	5%		1/4W
R305	1010472007	CARBON FILM	4.7K OHM	5%		1/4W
R306	1010152009	CARBON FILM	1.5K OHM	5%		1/4W
R307	1010102004	CARBON FILM	1K OHM	5%		1/4W
R308	1010472007	CARBON FILM	4.7K OHM	5%		1/4W
R309	1311503002	METAL FILM	150K OHM	1%		1/4W
R310	1010154003	CARBON FILM	150K OHM	5%		1/4W
R311	1010332001	CARBON FILM	3.3K OHM	5%		1/4W
R312	1010273001	CARBON FILM	27K OHM	5%		1/4W
R313	1010472007	CARBON FILM	4.7K OHM	5%		1/4W
R314	1010103006	CARBON FILM	10K OHM	5%		1/4W
R315	1010102004	CARBON FILM	1K OHM	5%		1/4W
R316	10391007	CARBON FILM	390 OHM	5%		1/4W
R317	1010272009	CARBON FILM	2.7K OHM	5%		1/4W
R318	1010272009	CARBON FILM	2.7K OHM	5%		1/4W
R319	1010102004	CARBON FILM	1K OHM	5%		1/4W
R320	1010392009	CARBON FILM	3.9K OHM	5%		1/4W
R321	1010332001	CARBON FILM	3.3K OHM	5%		1/4W
R322	1010102004	CARBON FILM	1K OHM	5%		1/4W
R323	1010102004	CARBON FILM	1K OHM	5%		1/4W
R324	1010471005	CARBON FILM	470 OHM	5%		1/4W
R325	1361000001	METAL FILM	1K OHM	0.5%		1/4W
R326	1361000001	METAL FILM	1K OHM	0.5%		1/4W
R327	1010472007	CARBON FILM	4.7K OHM	5%		1/4W
R328	1010102004	CARBON FILM	1K OHM	5%		1/4W
R329	1010221002	CARBON FILM	220 OHM	5%		1/4W
R330	1010474001	CARBON FILM	470K OHM	5%		1/4W
R261A	1362429007	METAL FILM	2.429K OHM	0.5%		1/4W
-VARIABLE RESISTORS-						
VR101	1712011009	METAL GLAZE	22K OHM	25%		1/2W
VR103	1712002008	METAL GLAZE	100 OHM	25%		1/2W
VR105	1712010007	METAL GLAZE	10K OHM	25%		1/2W
VR106	1712010007	METAL GLAZE	10K OHM	25%		1/2W
VR107	1712010007	METAL GLAZE	10K OHM	25%		1/2W
VR108	1712010007	METAL GLAZE	10K OHM	25%		1/2W
VR109	1712010007	METAL GLAZE	10K OHM	25%		1/2W
VR110	1712004002	METAL GLAZE	330 OHM	25%		1/2W
VR111	1712004002	METAL GLAZE	330 OHM	25%		1/2W
VR112	1712006006	METAL GLAZE	1K OHM	25%		1/2W
VR113	1712011009	METAL GLAZE	22K OHM	25%		1/2W
VR114	1712010007	METAL GLAZE	10K OHM	25%		1/2W
VR201	1712006006	METAL GLAZE	1K OHM	25%		1/2W

No.	LDR PT No.	DESCRIPTION			
(T-2107 CONT'D)					
VR202	1712006006	METAL GLAZE	1K OHM	25%	1/2W
VR203	1712006006	METAL GLAZE	1K OHM	25%	1/2W
VR207	1712010007	METAL GLAZE	10K OHM	25%	1/2W
VR208	1712006006	METAL GLAZE	1K OHM	25%	1/2W
VR209	1712007008	METAL GLAZE	2.2K OHM	25%	1/2W
VR210	1712010007	METAL GLAZE	10K OHM	25%	1/2W
VR301	1712014005	METAL GLAZE	100K OHM	25%	1/2W
VR302	1712006006	METAL GLAZE	1K OHM	25%	1/2W
-CAPACITORS-					
C101	2110560001	MICA	56pF	10%	50V
C102	2150225005	PLASTIC FILM	2.2uF	5%	100V
C103	2150106007	PLASTIC FILM	10uF	5%	100V
C104	2150105014	PLASTIC FILM	1uF	5%	100V
C105	2160104000	PLASTIC FILM	0.1uF	5%	200V
C106	2200103004	PLASTIC FILM	0.01uF	5%	100V
C107	2190002003	PLASTIC FILM	1000pF	2%	125V
C108	2010102012	CERAMIC	1000pF	10%	50V
C109	2010102012	CERAMIC	1000pF	10%	50V
C110	2140273018	PLASTIC FILM	0.027uF	10%	50V
C111	2140273018	PLASTIC FILM	0.027uF	10%	50V
C112	2010102012	CERAMIC	1000pF	10%	50V
C113	2230470048	ELECTROLYTIC	47uF	20%	16V
C115	2120050005	MICA	5pF		500V
C116	2010104007	CERAMIC	0.1uF		50V
C117	2010102012	CERAMIC	1000pF	10%	50V
C118	2110470000	MICA	47pF	10%	50V
C119	2090016006	CERAMIC	0.1uF		50V
C120	2090016006	CERAMIC	0.1uF		50V
C121	2120220004	MICA	22pF	10%	500V
C202	2140104015	PLASTIC FILM	0.1uF	10%	50V
C203	2240470045	ELECTROLYTIC	47uF	20%	25V
C204	2230470048	ELECTROLYTIC	47uF	20%	16V
C206	2120010003	MICA	1pF		500V
C207	2130221030	PLASTIC FILM	220pF	10%	50V
C208	2110181003	MICA	180pF	10%	50V
C209	2110181003	MICA	180pF	10%	50V
C210	2240101044	ELECTROLYTIC	100uF	20%	25V
C301	2140334003	PLASTIC FILM	0.33uF	10%	50V
C302	2110101009	MICA	100pF	10%	50V
C303	2110470000	MICA	47pF	10%	50V
C304	2350222041	ELECTROLYTIC	2200uF	20%	35V
C305	2350222041	ELECTROLYTIC	2200uF	20%	35V
C306	2240221044	ELECTROLYTIC	220uF	20%	25V
C307	2240101044	ELECTROLYTIC	100uF	20%	25V
C310	2240101044	ELECTROLYTIC	100uF	20%	25V
C311	2220470041	ELECTROLYTIC	47uF	20%	10V
C312	2220470041	ELECTROLYTIC	47uF	20%	10V
C313	2230470048	ELECTROLYTIC	47uF	20%	16V
C314	2010104007	CERAMIC	0.1uF		50V
C602	2010104007	CERAMIC	0.1uF		50V

No.	LDR PT No.	DESCRIPTION		
(T-2107 CONT'D)				
-VARIABLE CAPACITOR-				
VC101	2910030006	CERAMIC	2-10pF	250V
-TRANSISTORS-				
Q101	3031815027	NPN	2SC1815-GR	
Q102	3011015021	PNP	2SA1015-GR	
Q103	3031815027	NPN	2SC1815-GR	
Q104	3011015021	PNP	2SA1015-GR	
Q105	3090009008	FET	2N3958	
Q106	3031907004	NPN	2SC1907	
Q107	3031907004	NPN	2SC1907	
Q108	3011015021	PNP	2SA1015-GR	
Q109	3031907004	NPN	2SC1907	
Q110	3031907004	NPN	2SC1907	
Q111	3033419012	NPN	2SC3419-Y	
Q112	3011356018	PNP	2SA1356-Y	
Q113	3031815027	NPN	2SC1815-GR	
Q114	3011015021	PNP	2SA1015-GR	
Q115	3031815027	NPN	2SC1815-GR	
Q116	3011015021	PNP	2SA1015-GR	
Q203	3031815027	NPN	2SC1815-GR	
Q204	3031815027	NPN	2SC1815-GR	
Q206	3011015021	PNP	2SA1015-GR	
Q207	3031815027	NPN	2SC1815-GR	
Q208	3031815027	NPN	2SC1815-GR	
Q209	3031923002	NPN	2SC1923-Y	
Q210	3031923002	NPN	2SC1923-Y	
Q211	3010711007	PNP	2SA711	
Q212	3031907004	NPN	2SC1907	
Q213	3030097009	NPN	2SC97A	
Q215	3031907004	NPN	2SC1907	
Q216	3010711007	PNP	2SA711	
Q217	3010571007	PNP	2SA571	
Q218	3031815018	NPN	2SC1815-Y	
Q219	3011015012	PNP	2SA1015-Y	
Q301	3011015021	PNP	2SA1015-GR	
Q303	3031815027	NPN	2SC1815-GR	
Q304	3040880001	NPN	2SD880-0	
Q305	3040880001	NPN	2SD880-0	
Q306	3011015021	PNP	2SA1015-GR	
-DIODES-				
D101	3110006004	DETECTOR	1S1588	
D102	3110006004	DETECTOR	1S1588	
D103	3110006004	DETECTOR	1S1588	
D104	3110006004	DETECTOR	1S1588	
D105	3110006004	DETECTOR	1S1588	
D106	3110006004	DETECTOR	1S1588	
D107	3110006004	DETECTOR	1S1588	
D108	3110006004	DETECTOR	1S1588	
D109	3110006004	DETECTOR	1S1588	
D110	3110006004	DETECTOR	1S1588	
D111	3110006004	DETECTOR	1S1588	
D112	3110006004	DETECTOR	1S1588	
D113	3110006004	DETECTOR	1S1588	
D114	3110006004	DETECTOR	1S1588	



No.	LDR PT No.	DESCRIPTION		
(T-2107	CONT'D)			
D115	3110006004	DETECTOR	1S1588	
D116	3110006004	DETECTOR	1S1588	
D117	3110006004	DETECTOR	1S1588	
D118	3110006004	DETECTOR	1S1588	
D201	3110006004	DETECTOR	1S1588	
D202	3110006004	DETECTOR	1S1588	
D203	3110006004	DETECTOR	1S1588	
D204	3110006004	DETECTOR	1S1588	
D205	3110006004	DETECTOR	1S1588	
D301	3110006004	DETECTOR	1S1588	
D302	3110006004	DETECTOR	1S1588	
D303	3110019003	RECTIFIER	1DZ61	
D304	3110019003	RECTIFIER	1DZ61	
D305	3110019003	RECTIFIER	1DZ61	
D306	3110019003	RECTIFIER	1DZ61	
D307	3110019003	RECTIFIER	1DZ61	
D308	3110019003	RECTIFIER	1DZ61	
D309	3110019003	RECTIFIER	1DZ61	
D310	3110019003	RECTIFIER	1DZ61	
D311	3120058000	ZENER	RD4.7EB	4.7V
D312	3110019003	RECTIFIER	1DZ61	
D313	3110019003	RECTIFIER	1DZ61	
D314	3110019003	RECTIFIER	1DZ61	
D315	3110019003	RECTIFIER	1DZ61	
D202A	3120059002	ZENER	RD12EB	12V
D203A	3120026007	ZENER	RD6.8EB	6.8V
-INTEGRATED CIRCUITS-				
IC101	3210741075	OP AMP	MC1741CP1	
IC102	3211458021	OP AMP	MC1458CP1	
IC103	3210741075	OP AMP	MC1741CP1	
IC105	3220002001	COMPARATOR	NE521	
IC107	3211458021	OP AMP	MC1458CP1	
IC108	3210741075	OP AMP	MC1741CP1	
IC201	3250000026	TTL	SN7400N	
IC202	3211495009	LINEAR	MC1495L	
IC203	3250000026	TTL	SN7400N	
IC204	3210710001	LINEAR	SN72710N	
IC301	3220037000	OP AMP	TLO84CN	
IC302	3213086004	TRANSISTOR ARRAY	LM3086	
IC302	3217815007	REGULATOR	HA17815P	+15V
IC303	3217915010	REGULATOR	MC7915CT	-15V
IC304	3217805004	REGULATOR	HA17805P	+5V
IC305	3217905017	REGULATOR	MC7905CT	-5V
IC306	3211458021	OP AMP	MC1458CP1	
-SWITCHES-				
S101	4000409000	Q-409	"POWER"	
S201	4000423004	Q-423	"FUNCTION"	
-PC BOARD-				
	5902107016			T-2107C