

MODEL LAG-55

## AUDIO GENERATOR SINE SQUARE

OPERATING INSTRUCTIONS



LEADER ELECTRONICS CORP.

# AUDIO GENERATOR SINE SQUARE

## MODEL LAG-55

### GENERAL

The LEADER Model LAG-55 Audio Generator is a dependable high quality instrument designed as a source for measurements in the frequency range from 20 to 200,000 cps.

A very stable Wien bridge oscillator circuit is utilized. The frequency range is covered in four decade bands and indicated on a clear easy-to-read dial.

Three different waveforms are available, (1) sine waves of low distortion, (2) clean cut square waves and (3) complex or mixed, which are useful in audio testing, servicing and maintenance. The complex wave is a mixture of the power line and an internal high frequency in a 4:1 ratio, used for the intermodulation, or IM, distortion measurements with the built-in high pass filter and an external scope.

A very constant output level is maintained due to the use of a thermistor in the negative feedback circuit.

### FEATURES

- A. Sine, square and complex waveforms available for all types of audio testing in laboratories, plants and service shops.
- B. Stable operation due to the use of printed circuitry.
- C. IM distortion tests with the internal high pass filter and an external scope.
- D. Rugged construction suited for plant and field use.
- E. Minimum pull-in at the line frequency and its harmonics.
- F. Mounted in a steel cabinet, with an attractive two-tone panel.
- G. Designed for the maximum ease and troublefree operation.

### SPECIFICATIONS

Frequency Range	20 to 200,000 cps on four ranges
(Direct reading)	A 20 to 200 cps
	B 200 to 2000 cps
	C 2 to 20 Kc
	D 20 to 200 Kc
Frequency Accuracy	within (2% + 2 cps)
Frequency Stability	1% for 5% line voltage change
Output Impedance	over 1.5 K $\Omega$ at maximum output
Waveform Output:	
Sine Wave	20 to 200,000 cps
Response	within 0.5 dB referred to 1 Kc
Output Voltage	over 5 volts rms (High Z load)

Distortion	less than 1% to 20 Kc
Square Wave	20 to 20,000 cps
Response	within 0.5 dB referred to 1 Kc
Output Voltage	25 volts peak-to-peak (High Z load)
Complex Wave	
High Frequency	above 4 Kc
Low Frequency	Line frequency, 50 or 60 cps
Amplitude Ratio	4:1 (low F to high F)
Output Voltage	25 volts peak-to-peak (High Z load)
High Pass Filter	effective above 4 Kc
Tube Complement	1-6AV6 2-6AR5 1-12AT7 1-6X4
Power Supply	AC 50/60 cps,           volts; 28 VA
Size and Weight	6¾" × 12½" × 8½"; 11 lb (17 × 32 × 21.5 cm; 5 kg)

## DESCRIPTION

The LAG-55 Audio Generator is a convenient source of signals for general audio measurements. Due to the wide frequency range and a choice of waveforms, it will find many uses in the laboratories, service shops and manufacturing plants.

It is made up of the following circuits :

1. A stable Wien bridge type capacitance tuned oscillator
2. A wave clipper for generating the square waves
3. A mixing circuit for forming the complex wave
4. Cathode follower and output controls
5. High pass filter for IM distortion measurements
6. Power supply

These are shown in the block diagram, Fig. 1.

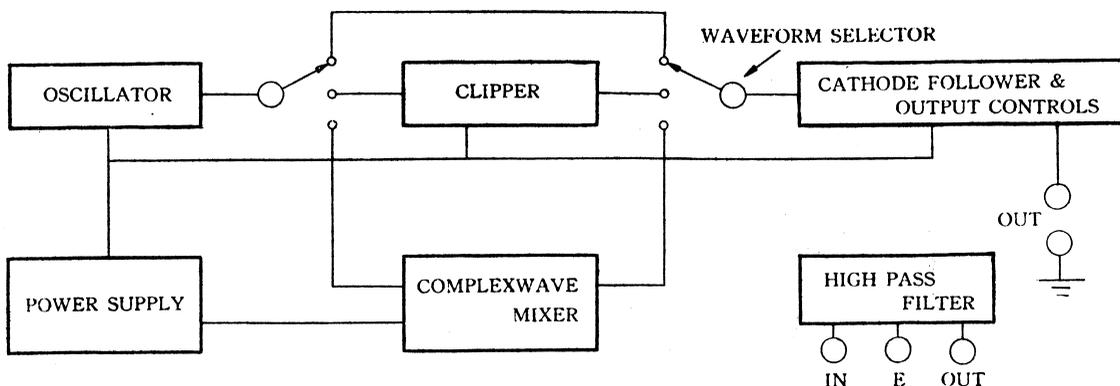


Fig. 1 BLOCK DIAGRAM OF LEADER LAG-55

The oscillator uses the familiar bridge type circuit for stability and excellent waveform. A thermistor (temperature sensitive resistor) is used for stabilizing the feedback and also the output

level. A higher degree of stabilization is obtainable as compared with the lamps which are frequently used for the same purpose.

The frequency range from 20 to 200,000 cps is covered in four decades which are calibrated directly on the dial. The sine wave output has very low distortion which makes it suitable for detecting overloads, distortion, etc., in hi-fi amplifiers by observation on a scope.

The square waves are generated by feeding the sine waves from the oscillator into a clipping stage. Square wave testing of amplifiers and circuit networks up to 20 Kc can be achieved due to the sharp rise characteristics.

The complex waveform is produced by mixing the output of the oscillator and the line frequency voltage in the ratio of 4 to 1, the generally accepted ratio for the IM distortion measurements. It is possible to evaluate the non-linearity of the circuit elements under operating conditions.

The output of the three waveforms are selected and impressed on the cathode follower tube. The generator outputs is taken from the cathode circuit and is adjustable by a fine and a stepped control.

The high pass filter used for the IM distortion measurements is an independent unit contained in the cabinet. It is a three section network whose characteristic is shown in Fig. 2. Frequencies above about 4 Kc are passed without appreciable loss.

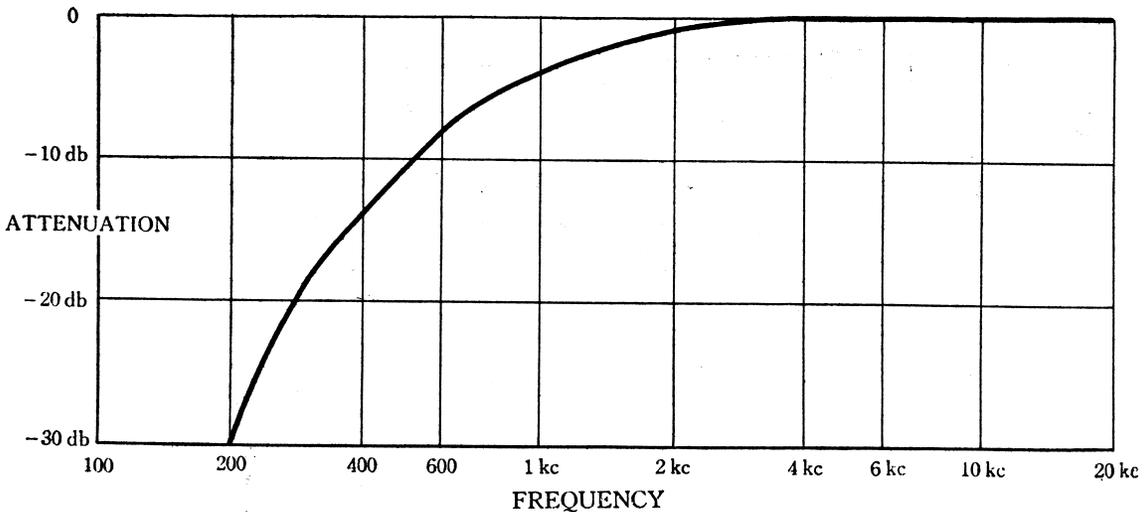


Fig. 2 HIGH PASS FILTER RESPONSE

The power supply consists of the heater and well-filtered plate sources for the tubes.

The internal design of the LAG-55 is such that the power supply and the oscillator sections have been well isolated for the best performance. Particular attention has been given to the shielding and the circuit arrangement so that the annoying pull-in effect of the line frequency on the oscillator at or near the line frequency and its related harmonics has been minimized. Printed circuitry has been utilized to its best advantage for stability and dependability in the operation of the LAG-55.

## PANEL CONTROLS

**FREQUENCY RANGE:** One of the four frequency ranges are selected by this switch. The ranges are marked A, B, C and D and the desired frequency is adjusted by turning the large center knob. The four ranges are clearly marked on the respective scales on the dial.

**WAVEFORM;** The desired waveform for the tests is selected by this switch. It also controls the AC power to the LAG-55.

**OUTPUT ADJUST:** The output voltage is continuously adjustable by this control.

**OUTPUT MULTIPLIER:** A 5-step divider is used to attenuate the output voltage. Each step reduces the output by 1/10.

**OUTPUT TERMINALS:** The generator output is taken from these terminals.

**HP FILTER:** The three terminals mounted vertically at the right of the panel are for the high pass filter to be used for the IM distortion measurements.

## OPERATION

The LAG-55 is designed for the specified line voltage. It is recommended that this be used for the best results. However a  $\pm 8\%$  variation is permissible.

The connections from the generator to the amplifier or the apparatus under test should be as short as possible. If a shielded cable is used, it must have low capacitance, especially when the measurements are to be made at the higher frequencies.

It is good practice to warm up the LAG-55 for about 15 minutes before use for stabilization of the circuits.

## APPLICATIONS

### \* Frequency Response Measurements

In measuring the amplifier characteristics for the frequency and power responses, etc., the equipment is set up as shown in Fig. 3.

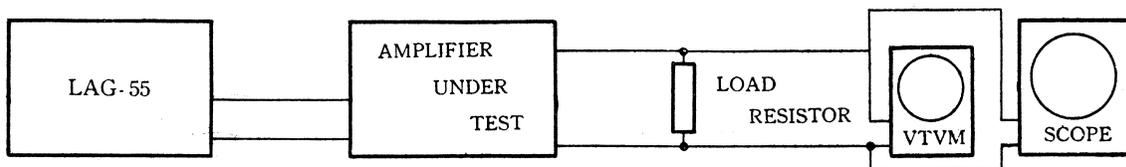


Fig. 3 SET UP FOR AMPLIFIER MEASUREMENTS

The load resistor should match the amplifier output impedance and have a power dissipation rating of at least twice that of the normal output. The output level is indicated on the VTVM. An oscilloscope is used to observe the output waveforms.

For the preliminary adjustments, set the LAG-55 to a frequency between 400 and 1000 cps on the SINE wave position. The generator output will depend upon the amplifier under test. In general, for the complete amplifier including the preamplifier, or the preamplifier only, set the OUTPUT MULTIPLIER to  $\times 100$  or  $\times 10$ , and for the power amplifier only, set to  $\times 1 K$  or  $\times 10 K$ . The OUTPUT ADJUSTER is used for the fine voltage control.

The power output of the amplifier is calculated by the following formula

$$\text{WATTS output} = \frac{(\text{Voltage across LOAD RESISTOR})^2}{\text{LOAD RESISTOR in OHMS}}$$

In measuring the preamplifier response, the output voltage measurements are taken as the basis in determining the characteristics.

As the input to the amplifier is increased, the power or the voltage readings will increase linearly to a certain point, after which it will flatten out, indicating overload and consequent distortion. There will be noticeable distortion when the waveform as observed on the scope just begins to flatten at both peaks in a normal pushpull amplifier, or one peak in a single ended type.

The frequency response of the amplifier is measured by varying the frequency over the desired range at a constant input voltage. The output of the LAG-55 is very constant and usually very slight or no change of the level setting is required as the ranges are changed.

The measurement of the gain and the sensitivity requires the use of a VTVM in the millivolt range to measure the actual input voltage for a specified output voltage or power.

In all measurements, excepting the input/output characteristics, care should be taken that the amplifier is not overloaded by observing the waveforms on the scope.

#### \* Square Wave Testing

The testing of the amplifiers by the square waves will reveal many characteristics which cannot be detected on the response curves.

The testing set up is the same as shown in Fig. 3. The LAG-55 is set for the SQUARE WAVE output, and the frequency is varied from 20 to about 15,000 cps.

In an excellent amplifier, the output waveform will be square without distortion over a wide range. If there is any fault or defect in its design, the choice of components, etc., the various wave shapes will give an indication. Some of these waveforms are shown in Fig. 4.

Rapid checking of the frequency response is possible by observing the wave shapes on the scope. If the low frequency response is poor, there will be a drooping effect. If the high frequency response is poor, there will be a rounding off of the leading edge.

An amplifier with good response will pass square waves over a considerable range of frequencies. At the higher frequencies, note the generator frequency where the shape departs from the square. It is generally accepted that this change will occur at about the ninth or the eleventh harmonic of the fundamental frequency, or where the amplifier response will start to fall in a "flat" amplifier. If the fundamental is say, 2.2 kc then the amplifier is "good" to the range between about 19 Kc to 24 Kc. The square wave is composed of a large number of only the odd-numbered harmonics and this must be borne in mind when testing.

The use of the square waves in the design work will be helpful in checking the performance of the intermediate amplifier stages. A low capacitance probe is used for the scope input to check the various grid, plate and feedback circuits.

It should be noted that the square wave input voltage must be kept below the overload point since the amplifier itself will produce such waves when overloaded.

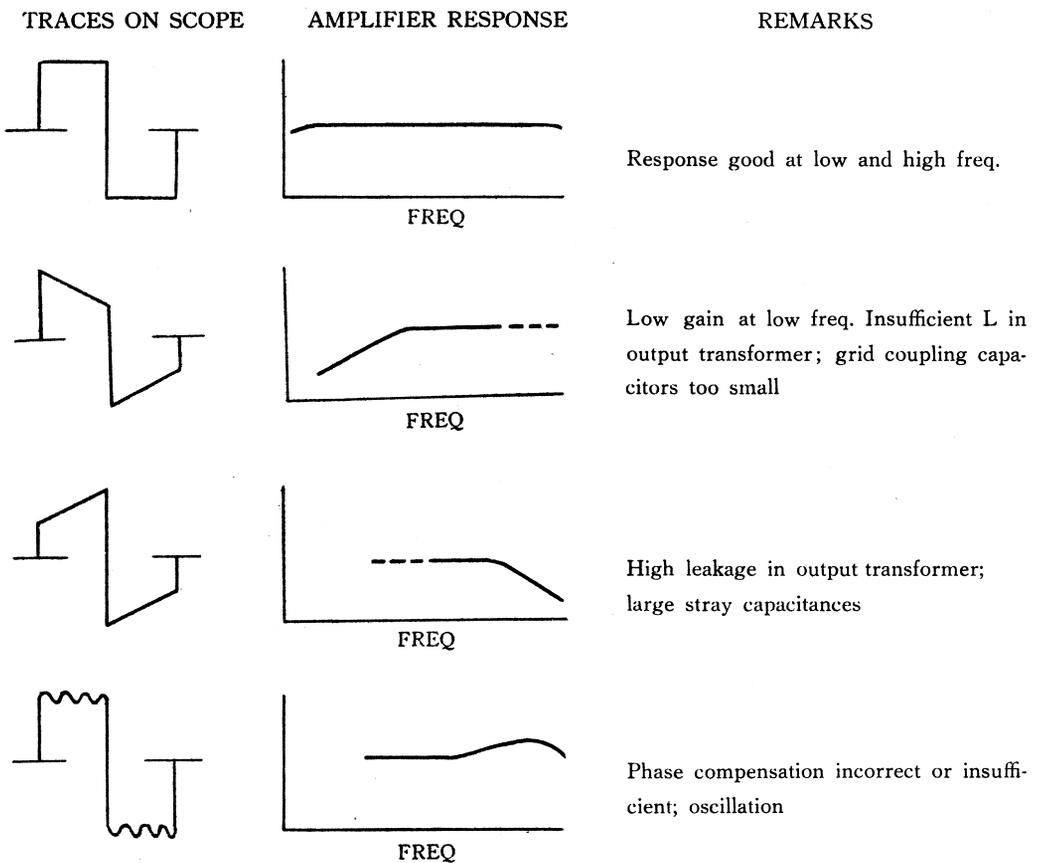


Fig. 4 SQUARE WAVE TESTING

#### \* IM (Intermodulation) Distortion Measurements

The oscilloscopic method is employed for the IM distortion measurements with the LAG-55. A complex wave of a low and a high frequency is impressed on the amplifier under test. The voltage ratio is 4:1 (low to high) which is mixed in the generator.

The procedure is as follows. The LAG-55, the amplifier under test, the load resistor, the VTVM and the scope are connected in the same manner as for the frequency response tests, Fig. 3. The amplifier tone controls must be set for the "flat" response.

Set the WAVEFORM selector to SINE and the frequency to 2 Kc. Adjust the generator output so that the power in the load is at the rated amplifier output, more or less, where the input wave shows no clipping on the scope. For example, if the power is 15 watts, the measured voltage will be 15.5 volts on the VTVM across a 16 ohm load. Adjust the scope controls for the pattern height to cover about 75% to the screen and for 2 or 3 cycles of the wave. Make a note of the pattern height on the scope's calibrating screen for the "peak" value reference.

Set the WAVEFORM selector to COMPLEX and the oscillator frequency to 6 Kc. The mixed wave will then appear on the scope. The sweep is set to the frequency of the AC power supply to show one cycle of the wave. (Synchronizing to the line frequency will be helpful.)

The generator output is adjusted so that the height of the peaks of this pattern is the same as the sine wave reference. This step is necessary to equalize the peak outputs for both waveforms.

The vertical input lead to the scope is disconnected from the resistor and connected to the OUT terminal of the high pass filter. The IN and the E terminals of the filter are connected respectively to the high and the low potential terminals of the resistor. See Fig. 5.

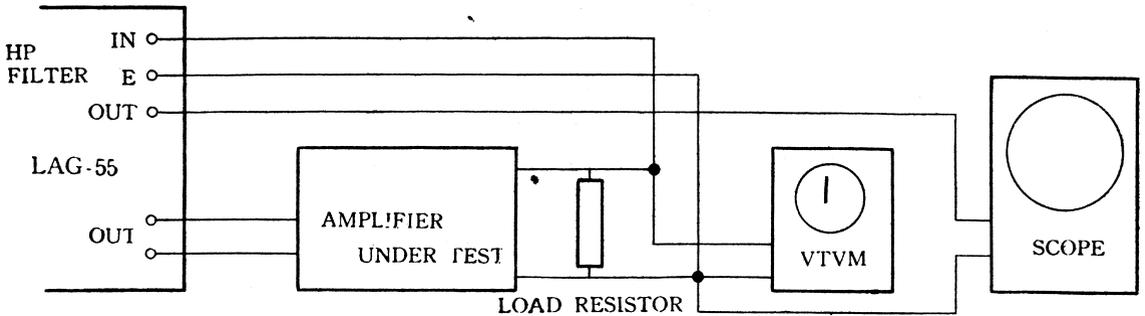


Fig. 5 IM DISTORTION TEST SET-UP

Adjust the Vertical gain of the scope for the pattern to cover about 50 to 75% of the screen diameter. **DO NOT TOUCH THE AMPLIFIER GAIN CONTROL.**

The presence of the IM distortion will be indicated by the notches in the pattern as shown in Fig. 6. on the right. The depth of the notch is a measure of the IM distortion. It is calculated from the formula

$$\text{Per Cent IM Distortion} = \frac{a - b}{a + b} \times 100$$

where a and b are measured on the scope screen.

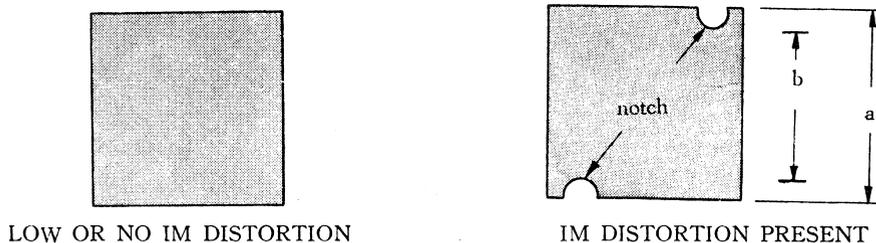


Fig. 6 IM DISTORTION PATTERNS

# APPENDIX

## DECIBEL TABLES

The amplifier response/frequency characteristics are plotted on the semi-log section paper. The output voltage at 400 cps (or 1Kc) is taken as the reference value. This voltage should be about 50% of that which produces the rated power or the voltage output. The output voltage should be recorded for each frequency. The voltage ratio for each reading is computed by referring to the 400 cps value.

The following table gives the various voltage ratios in decibels. The reader is referred to the handbooks or texts for more detailed tabulations.

The gain ratio from 1 to 10 corresponds to 0 to +20 db, and the loss ratio from 1 to 0.1 correspond to 0 to -20 dB. The minus sign should not be omitted in the loss measurements.

**TABLE I VOLTAGE RATIO-DECIBELS**

VOLT RATIO for LOSS	dB		VOLT RATIO for GAIN	VOLT RATIO for LOSS	dB		VOLT RATIO for GAIN
	-	+			-	+	
1.00	0.		1.0	0.333	9.54		3.0
0.909	0.828		1.1	0.286	10.9		3.5
0.833	1.58		1.2	0.250	12.0		4.0
0.769	2.28		1.3	0.222	13.0		4.5
0.714	2.92		1.4	0.200	14.0		5.0
0.666	3.52		1.5	0.182	14.8		5.5
0.625	4.08		1.6	0.167	15.6		6.0
0.588	4.61		1.7	0.154	16.2		6.5
0.555	5.10		1.8	0.143	16.9		7.0
0.526	5.57		1.9	0.133	17.5		7.5
0.500	6.02		2.0	0.125	18.0		8.0
0.454	6.85		2.2	0.117	18.6		8.5
0.417	7.60		2.4	0.111	19.1		9.0
0.384	8.30		2.6	0.105	19.5		9.5
0.357	8.94		2.8	0.100	20.0		10.0

FOR VOLTAGE RATIOS OUTSIDE ABOVE RANGE	GAIN RATIO	ADD
	11 to 100	20 dB
	110 to 1000	40 dB
	1100 to 10000	60 dB
	11000 to 100000	80 dB
	LOSS RATIO	ADD
	0.091 to 0.01	-20 dB
	0.0091 to 0.001	-40 dB
0.00091 to 0.0001	-60 dB	
0.000091 to 0.00001	-80 dB	

## CONVERSION TABLES

The following tables will be convenient for the rapid conversion of the power and the voltages in a 16 ohm load resistor.

The POWER RATIO in dB gives the output power level in decibels referred to an arbitrary unit of 0 dB=1 WATT. It will be of aid in plotting the power response curves.

For load resistances other than 16 ohms, TABLE III gives the factor "K" by which the voltage must be multiplied. For resistances which are not listed, "K" is obtained from the following formula :

$$K = \frac{1}{4} \sqrt{\text{RESISTANCE in OHMS}}$$

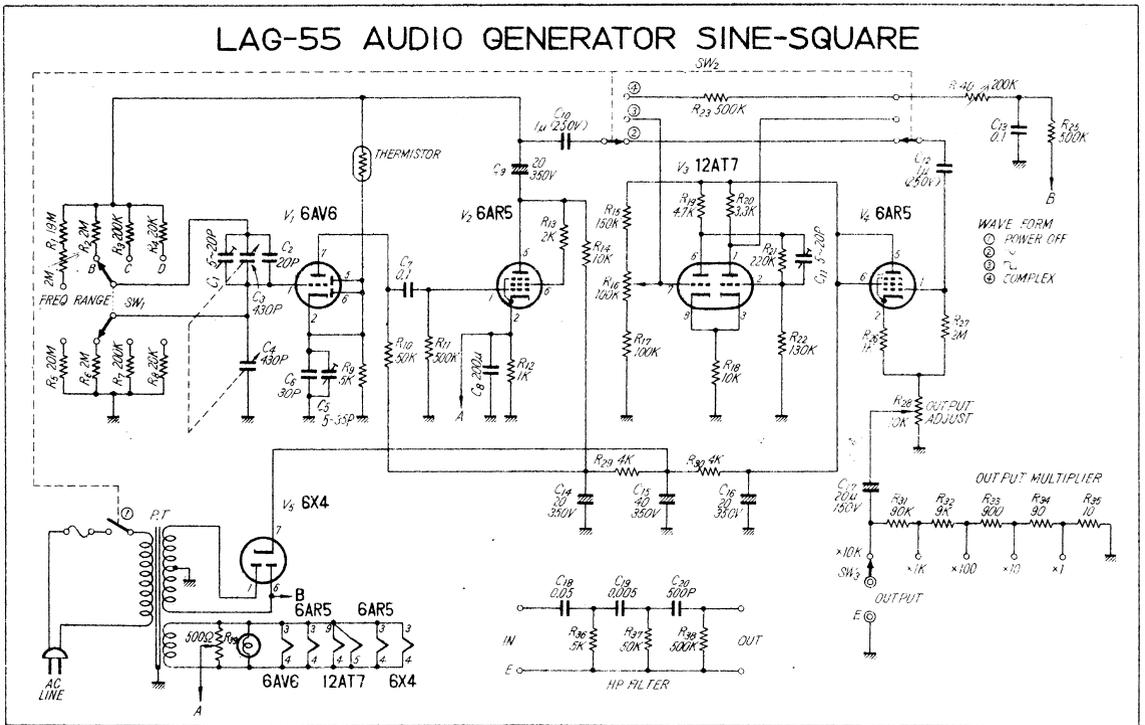
**TABLE II POWER-VOLTS-DECIBELS**

POWER in WATTS	VOLTS	
	SINE WAVE	POWER RATIO DB
.001	0.126	-30
.002	0.179	-27
.005	0.283	-23
.010	0.400	-20
.020	0.565	-17
.050	0.894	-13
.100	1.26	-10
.200	1.79	- 7
.500	2.83	- 3
1.000	4.00	0
2.	5.65	+ 3
3.	6.93	4.8
4.	8.00	6.0
5.	8.94	7.0
6.	9.80	7.8
7.	10.6	8.5
8.	11.3	9.0
9.	12.0	9.5
10.	12.6	10.0
11.	13.3	10.4
12.	13.8	10.8
13.	14.4	11.1

POWER in WATTS	VOLTS	
	SINE WAVE	POWER RATIO DB
14.	14.9	+11.5
15.	15.5	11.7
16.	16.0	12.0
17.	16.5	12.3
18.	17.0	12.5
19.	17.4	12.7
20.	17.9	13.0
21.	18.3	13.2
22.	18.8	13.4
23.	19.2	13.6
24.	19.6	13.8
25.	20.0	14.0
26.	20.4	14.2
27.	20.8	14.3
28.	21.1	14.4
29.	21.5	14.6
30.	21.9	14.7
31.	22.3	14.9
32.	22.6	15.0
33.	23.0	15.2
34.	23.3	15.3
35.	23.7	15.5

TABLE III VOLTAGE MULTIPLIER

LOAD RESISTOR in OHMS	MULTIPLIER "K"
3.2	0.447
4.	0.500
8.	0.707
12.	0.865
20.	1.12
32.	1.42
50.	1.77
100.	2.50
250.	3.95
600.	6.13
1000.	7.90
2000.	11.2
5000.	17.7



# LEADER TEST INSTRUMENTS

## LEADER ELECTRONICS CORP.

HEAD OFFICE NO. 850, TSUNASHIMA-CHO, KOHOKU-KU,  
YOKOHAMA, JAPAN.

BRANCH OFFICE NO. 4-73, NIHONBASHI-SUJI, NANIWA-KU,  
OSAKA, JAPAN.