Standard Methods of Measurements for Amplifiers

The complete text of IHFM-A-200 adopted in December, 1958

1.0. Standard Test Conditions

Standard test conditions shall be maintained for all tests except as otherwise specified.

1.1. Power Line Voltage

The amplifier shall be tested on 117 volts, RMS.

1.2. Power Line Frequency

Power line frequency shall be within ±2% of the lowest supply frequency for which the amplifier is rated.

1.3. Power Line Voltage Waveform

Power line voltage waveform shall be sinusoidal with less than 2% harmonic content.

1.4. Operating Temperature

The amplifier shall be preconditioned by operating at ⅓ rated power output for at least one hour in an ambient temperature not less than 20° C. in still air, and in normal operating position unless otherwise specified (Reference *1.8.*).

1.5. Vacuum Tube Characteristics

Where the performance of the amplifier is significantly affected by one or more tube characteristics, tests shall be made using selected tubes in which these critical characteristics are within ±10% of the significant published characteristics.

1.6. Signal Input

1.6.1.

Signal input waveform shall be sinusoidal with the RMS total of all components, other than the fundamental, less than 20% of rated harmonic distortion of the amplifier to be tested, at the level of measurement.

1.6.2.

Frequency shall be within ±2% of value specified for test.

1.7. Load

1.7.1.

Amplifiers rated to supply signal power to one or more loudspeakers shall be terminated in a resistance load, with not more than 10% reactive component at any frequency up to five times the highest test frequency, capable of continuously dissipating the full output of the amplifier while maintaining its resistance at the rated value of ±1%.

1.7.2.

When more than one output impedance is provided, each one in turn shall be terminated with a resistance load as in *1.7.1.* and the test repeated.

1.7.3.

Amplifiers intended to supply signal voltages to the input circuit of a subsequent amplifier shall be terminated by a load consisting of a 0.1-megohm ±5% resistor shunted by a 1000 μμf ±5% capacitor unless otherwise specified by the manufacturer.

1.7.4.

An amplifier intended for simultaneously supplying signal power for loudspeakers and a signal voltage to a subsequent amplifier shall be tested with one load per *1.7.3.* and one load per *1.7.1–1.7.2.* in place.

1.8. Shields, Covers, and Bottom Plates

If normally supplied, shields shall be in place and fastened. If accessory cases are available, the one resulting in the highest operating temperature shall be used.

1.9. Connection of Line Cord

The line cord shall be connected for minimum hum on the highest gain input and shall not be changed for any other test. One side of the power source to the amplifier shall be grounded.

1.10. Controls

1.10.1.

GAIN, LEVEL, and other controls whose primary function is the adjustment of gain shall be preset to the position of maximum gain.

1.10.2.

TONE, LOUDNESS-CONTOUR, and other controls whose primary function is adjustment of frequency response shall be preset for flattest *electrical* frequency response.

1.10.3.

For controls that vary both gain and frequency response, such as LOUDNESS controls, the position of flattest electrical frequency response shall take precedence over the position for maximum gain.

1.10.4.

Automatic controls actuated by signals within the system shall be disabled.

2.0. Tests and Ratings

2.1. Output

2.1.1. Purpose

To measure and express the capability of an amplifier to supply signal energy to its load.

2.1.2. Definition of Terms

2.1.2.1.

CONTINUOUS POWER OUTPUT shall mean the greatest single-frequency power that can be obtained for a period of not less than 30 seconds without exceeding rated total harmonic distortion when the amplifier is operated under STANDARD TEST CONDITIONS. POWER OUTPUT shall be expressed in terms of watts as defined by the formula

$$P = \frac{E^2}{R}$$

P = POWER OUTPUT
E = RMS voltage across load
R = Resistance of the load in ohms.

2.1.2.2.

MUSIC POWER OUTPUT shall mean the greatest single-frequency power that can be obtained without exceeding rated total harmonic distortion when the amplifier is operated under STANDARD TEST CONDITIONS except that the measurement shall be taken immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal values.

2.1.2.3.

VOLTAGE OUTPUT shall mean the RMS voltage developed across the load of paragraph *1.7.3.*

2.1.3. Test Procedure

2.1.3.1. Measurement of CONTINUOUS POWER OUTPUT

2.1.3.1.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*)

2.1.3.1.2.

Adjust INPUT FREQUENCY to value specified for the test.

2.1.3.1.3.

Adjust SIGNAL INPUT LEVEL to the maximum value for which the total harmonic distortion percentage is the same as the rated distortion for the amplifier.

2.1.3.1.4.

Measure the RMS voltage across the load.

2.1.3.1.5.

Compute the POWER OUTPUT by the formula of *2.1.2.1.*

2.1.3.1.6.

Accuracy of measurement shall be sufficient to assure statement of the POWER OUTPUT within ± ½ db.

2.1.3.2. Measurement of MUSIC POWER OUTPUT

2.1.3.2.1.

Operate amplifier under STANDARD TEST CONDITIONS with no signal applied and note significant supply voltages.

2.1.3.2.2.

Perform procedure of *2.1.3.1.1.* through *2.1.3.1.6.* except that the significant supply voltages shall be maintained at the same value as they were under no-signal conditions.

2.1.3.3. Measurement of VOLTAGE OUTPUT

Perform the tests of *2.1.3.1.1.* through *2.1.3.1.4.* inclusive.

2.1.4. Rating of Power Output

2.1.4.1.

It shall be standard to rate power amplifiers in terms of MUSIC POWER OUTPUT and/or CONTINUOUS POWER OUTPUT at the standard frequency of 1000 cycles per second except that split-frequency range amplifiers shall be tested as in *2.1.4.3.*

2.1.4.2.

It shall be standard to rate voltage amplifiers in accordance with the definitions of *2.1.2.4.* obtained by using the procedure of *2.1.3.3.* for the standard test frequency of 1000 cps except that split-frequency-range amplifiers shall be tested as in *2.1.4.3.*

2.1.4.3. Split-Frequency-Range Amplifiers

The low-frequency channel shall be tested at a frequency at least two octaves below the crossover frequency. The high-frequency channel shall be tested at a frequency at least two octaves above the crossover frequency.

2.1.5.

POWER BANDWIDTH is intended to express the CONTINUOUS POWER (*2.1.2.1.*) handling *vs.* frequency capabilities for the rated total harmonic distortion. It shall be standard to rate amplifier POWER BANDWIDTH by stating the lowest frequency and the highest frequency for which the total single-tone distortion measured 3 db below rated CONTINUOUS POWER OUTPUT, will be equal to the rated single-tone distortion.

2.2. Sensitivity

2.2.1. Purpose

To measure and express the minimum SIGNAL INPUT required to produce rated POWER OUTPUT.

2.2.2. Definition of Terms

2.2.2.1.

SENSITIVITY for a power amplifier shall mean the INPUT VOLTAGE LEVEL, expressed in millivolts or volts, which, when applied to the input terminals of an amplifier operating under STANDARD TEST CONDITIONS (paragraph *1.0.*), will develop rated power in the load.

2.2.2.2.

SENSITIVITY for a voltage amplifier shall mean the INPUT VOLTAGE LEVEL, expressed in millivolts or volts, which, when applied to the input terminals of an amplifier operating under STANDARD TEST CONDITIONS (paragraph *1.0.*), will develop rated voltage across the load.

2.2.3. Test Procedure

2.2.3.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*)

2.2.3.2.

For each input in turn, apply sufficient INPUT SIGNAL LEVEL at 1000 cps to develop rated power or voltage.

2.2.4. Ratings

It shall be standard to express the SENSITIVITIES at the various inputs of an amplifier by a tabulation of the values obtained in the test procedure of *2.2.3.*

2.3. Frequency Response

2.3.1. Purpose

To measure and rate the accuracy with which the FREQUENCY RESPONSE of an amplifier conforms to EQUALIZER FREQUENCY RESPONSE as defined in *2.3.2.2.* and to FLAT FREQUENCY RESPONSE as defined in *2.3.2.3.*

2.3.2. Definition of Terms

2.3.2.1.

FREQUENCY RESPONSE shall mean the variation in voltage gain as a function of frequency when the amplifier is operated under STANDARD TEST CONDITIONS (paragraph *1.0.*).

2.3.2.2.

EQUALIZER FREQUENCY RESPONSE shall mean one or more of the named and recognized frequency characteristics.

2.3.2.3.

FLAT FREQUENCY RESPONSE shall mean constant output voltage for constant INPUT VOLTAGE LEVEL independent of frequency.

2.3.2.4.

ZERO-REFERENCE FREQUENCY shall be 1000 cps for flat inputs and the standard reference frequency for each equalizer characteristic.

2.3.3. Test Procedure

2.3.3.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*) with measured INPUT SIGNAL LEVEL for every test frequency.

2.3.3.2.

Adjust INPUT SIGNAL LEVEL to develop a measured output across the load. This output shall be no higher than 10 db below rated output and no lower than 20 db above residual noises.

2.3.3.3.

Measure the voltage gain at ZERO-REFERENCE FREQUENCY (*2.3.2.4.*). Use this voltage gain as a reference gain.

2.3.3.4.

Measure the voltage gain at various test frequencies between specified frequency limits for flat channels and between frequency limits as defined by the equalizer characteristic for equalized inputs.

2.3.3.5.

Compute the ratio in db of the gain obtained from *2.3.3.4.* to the ZERO-REFERENCE GAIN of *2.3.3.3.*

2.3.3.6.

Repeat *2.3.3.1.* through *2.3.3.5.* for each frequency characteristic to be rated (equalizers, tone controls, etc.).

2.3.4. Ratings

2.3.4.1.

It shall be standard to express the FREQUENCY RESPONSE of flat-frequency-response channels by a curve with the result of *2.3.3.5.* plotted as the ordinate on semi-logarithmic paper. The relation between db and frequency scales on the curve shall be such that a 20-db change on the ordinate shall correspond in length to one decade of frequency variation on the abscissa.

2.3.4.2.

It shall be standard to express the FREQUENCY RESPONSE of equalized input channels as the difference between the db response obtained in *2.3.3.5.* and that of the standard equalization.

2.3.4.3.

It shall be standard to rate the frequency response of each equalized channel and of each flat-frequency-response channel by two numbers which shall be equal to the maximum positive and maximum negative deviation from the response at ZERO-REFERENCE FREQUENCY shown in the curve of *2.3.4.1.*

2.4. Distortion

2.4.1. Purpose

To measure and rate the distortion of an amplifier.

2.4.2. Definition of Terms

2.4.2.1.

For the purposes of this standard, distortion shall mean the presence of frequency components in the output which were not present in the input signal.

2.4.2.2.

Single-tone distortion shall mean the distortion resulting when a single-frequency input is applied.

2.4.3. Test Procedure

2.4.3.1. Single-Tone Distortion

For this test, the indicating instrument shall have full wave rectifying characteristics, shall respond to the average value, and shall be calibrated to indicate the RMS value of a sinusoidal waveform.

2.4.3.1.1.

Operate the amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*).

2.4.3.1.2.

Apply a signal input at frequency specified for the test.

2.4.3.1.3.

Measure voltage at output and designate by the symbol E_o.

2.4.3.1.4.

Remove the component of the output voltage corresponding to the input voltage waveform and measure the value of the residual components and designate by the symbol E_R.

2.4.3.1.5.

Compute the per cent distortion from the formula:

$\frac{E_R}{E_o} \times 100$ for the power output level given by

$$P = \frac{E_o^2}{R_{load}}$$

2.4.3.2.

The distortion reading obtained with the signal source connected to the distortion-measuring instrument shall be less than 1/5 of the measured distortion of the amplifier under test.

2.4.4. Ratings

2.4.4.1.

It shall be standard to rate distortion at 1000 cps except that split-frequency-range amplifiers shall be tested as in *2.1.4.3.*

2.4.4.2.

It shall be standard to rate distortion for amplifiers at rated output and at 3 and 20 db below rated output.

2.5 Hum and Noise

2.5.1. Purpose

To measure the internally generated HUM and NOISE in an amplifier and establish a method for meaningful comparison between amplifiers of varying sensitivities.

2.5.2. Definition of Terms

2.5.2.1.

HUM shall mean the voltage, at line frequency and its multiples, delivered to its load by an amplifier operating with no input signal applied.

2.5.2.2.

NOISE shall mean all voltage components, other than HUM as defined in *2.5.2.1.* delivered to its load by an amplifier operating with no input signal applied.

2.5.2.3.

The term OPEN CIRCUIT shall refer to NOISE or HUM measurements made when all input terminals of the amplifier are open circuited.

2.5.2.4.

The term CLOSED CIRCUIT shall refer to NOISE or HUM measurements made when active input terminals of the amplifier are short circuited.

2.5.2.5.

HUM AND NOISE FACTOR shall be defined as the ratio in db of the HUM and NOISE voltage in the output to the signal-output voltage at ZERO-REFERENCE FREQUENCY.

2.5.3. Test Procedure

For this test, HUM and NOISE voltages shall be measured with an instrument which has full-wave rectifying characteristics, responds to the average value, and is calibrated to indicate the RMS value of a sinusoidal waveform.

In addition, the frequency response of the instrument shall be weighted so that it follows the 40 db (A) curve of ASA Standard Z 24.3—1944.

2.5.3.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*) with all gain controls set at maximum.

2.5.3.2.

Apply a ZERO-REFERENCE-FREQUENCY test signal of sufficient amplitude to develop rated output.

2.5.3.3.

Measure and record the RMS output voltage.

2.5.3.4.

Disconnect the test signal source. Measure and record the HUM and NOISE voltage output.

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