

CEA Standard

Test Methods of Measurement for
Audio Amplifiers

CEA-490-A R-2008

December 2001



CEA[®]
Consumer Electronics Association

www.CE.org

NOTICE

Consumer Electronics Association (CEA®) Standards, Bulletins and other technical publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards, Bulletins and other technical publications shall not in any respect preclude any member or nonmember of CEA from manufacturing or selling products not conforming to such Standards, Bulletins or other technical publications, nor shall the existence of such Standards, Bulletins and other technical publications preclude their voluntary use by those other than CEA members, whether the standard is to be used either domestically or internationally.

Standards, Bulletins and other technical publications are adopted by CEA in accordance with the American National Standards Institute (ANSI) patent policy. By such action, CEA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Standard, Bulletin or other technical publication.

This CEA Standard is considered to have International Standardization implication, but the International Electrotechnical Commission activity has not progressed to the point where a valid comparison between the CEA Standard and the IEC document can be made.

This Standard does not purport to address all safety problems associated with its use or all applicable regulatory requirements. It is the responsibility of the user of this Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

This document is copyrighted by the Consumer Electronics Association (CEA®) and may not be reproduced, in whole or part, without written permission. Federal copyright law prohibits unauthorized reproduction of this document by any means. Organizations may obtain permission to reproduce a limited number of copies by entering into a license agreement. Requests to reproduce text, data, charts, figures or other material should be made to CEA.

(Formulated under the cognizance of the CEA's **R3 Audio Systems Committee**.)

Published by
©CONSUMER ELECTRONICS ASSOCIATION 2011
Technology & Standards Department
www.CE.org

All rights reserved

This is a preview of "CEA 490-A-2001 (R200...". [Click here to purchase the full version from the ANSI store.](#)

FOREWORD

This standard was developed under the auspices of the Consumer Electronics Association's (CEA) R4 Video Systems Committee, and is maintained by the CEA's R3 Audio Systems Committee.

Since adoption of the IHF Amplifier Standard (IHF-A-201, 1966), many changes have occurred in amplifier design. These changes have been prompted by technological advancement in circuit topology, in component characteristics, in test equipment and methods of measurement, and in engineering psycho-acoustics. Also, changing conditions in the marketplace driven by consumer demand for new features like home theater and surround sound have prompted industry to consider and implement additional design changes resulting in a proliferation of multi-channel amplifiers in receivers. However, the purpose of an amplifier remains the same—to increase the power level of an electrical signal that represents speech or music. Ultimately, that signal will be reproduced as sound.

EIA-RS-490 (1981), Standard Methods of Measurement for Audio Amplifiers, superseded IHF-A-201 (1966). EIA-RS-490 (1981) was specifically meant to standardize methods of measurement for audio amplifiers. In formulating EIA-RS-490 (1981), greater emphasis was placed upon those characteristics that reflect the ability of an amplifier to faithfully aid in the reproduction of the original sound under conditions similar to those used by the listener. The revised standard test conditions more accurately reflected the performance of the amplifier in actual use.

This standard, CEA-490-A, is the successor to EIA-RS-490. The revisions reflected in EIA-RS-490 (1981) brought the standard in compliance with the Federal Trade Commission (FTC) Rule, Power Output Claims for Amplifiers Utilized in Home Entertainment Products, 46 CFR 432 (1974). The revisions incorporated into this latest edition, CEA-490-A, were motivated by recent changes to the FTC Amp Rule and questions the FTC posed in a subsequent Supplemental Notice of Proposed Rulemaking and include:

- a) A standard method for measuring the output power of multi-channel amplifiers used in home theater and surround sound applications;
- b) Standard language for primary ratings of amplifiers that allows consumers to make an "apples-to-apples" comparison between various brands and models of amplifiers;
- c) Changes in the preconditioning power of amplifiers to make CEA-490-A consistent with changes made by the FTC to its Amplifier Rule as amended in the Federal Register on December 22, 2000;
- d) Changes in preconditioning operating time from one-hour to 30 minutes; and
- e) The inclusion of a formal Scope section in the standard that clearly defines the audio products are to be covered by CEA-490-A.

NOTE--Self-powered loudspeakers (including powered speakers used in multimedia applications and powered subwoofers), as well as manufacturer-packaged audio and home theater systems (systems that include loudspeakers), are specifically not covered by CEA-490-A and may be considered under a separate standard-setting activity.

This page intentionally left blank.

CONTENTS

1 Scope.....	1
2 References.....	1
2.1 Normative References.....	1
2.1.1 Normative Reference List	1
2.1.2 Normative Reference Acquisition	1
3 Definitions of Terms—General	1
3.1 Power Amplifier	1
3.2 Preamplifier	2
3.3 Integrated Amplifier.....	2
3.4 Amplifier	2
3.5 Receiver	2
3.6 Tuner/Preamplifier.....	2
3.7 Rated Characteristic.....	2
3.7.1 Rated Frequency.....	2
3.7.2 Rated Bandwidth.....	2
3.7.3 Rated Load	2
3.7.4 Nominal Load	2
3.8 Reference Characteristic	2
3.9 Channel of Amplification	2
3.10 Line Input.....	3
3.11 MM-Phono Input.....	3
3.12 MC-Phono Input.....	3
3.13 Percentage of Xth Harmonic Distortion	3
3.14 Percentage of Total Harmonic Distortion (THD).....	3
3.15 Percentage of Weighted Total Harmonic Distortion (WTHD).....	3
3.16 Percentage of Total Harmonic Distortion Plus Noise (THD+N)	3
3.17 Percentage of SMPTE Intermodulation Distortion (SMPTE-IM).....	3
3.18 Percentage of Dual Tone Intermodulation Distortion	4
3.19 Transient Intermodulation Distortion (TIM)	4
3.20 Power Output	4
3.20.1 dBW	4
3.21 Weighting	4
3.22 Clipping Point	5
3.23 Pink Noise	5
3.24 Slew Factor.....	5
4 Standard Test Conditions	5
4.1 AC Power Line	5
4.2 Operating Temperature.....	5
4.2.1 Power or Integrated Amplifier, or Receiver Preconditioning	5
4.2.2 Preamplifier Pre-Conditioning.....	5
4.3 Input Reference Level	5
4.3.1 Line Input Terminals.....	5
4.3.2 MM-Phono Inputs.....	5
4.3.3 MC-Phono Inputs	5
4.4 Output Reference Level	5
4.5 Load Impedance	6
4.6 Input Termination	6
4.6.1 Each Line	6
4.6.2 Each MM-Phono Input	6

4.6.3 Each MC-Phone Input.....	6
4.7 Connection of AC Line Cord	6
4.8 Control Settings.....	6
4.8.1 Gain Control	6
4.8.1.1 Input-Gain	6
4.8.1.2 Balance.....	6
4.8.2 Tone, Loudness-Contour and Other	6
4.9 Test Equipment.....	6
4.9.1 Test Frequency	6
4.9.2 Voltmeter	6
4.9.3 Harmonic Distortion Measurement Device	6
4.9.4 SMPTE Intermodulation-Distortion	7
4.9.5 Dual Tone Intermodulation Distortion	7
4.9.6 Spectrum Analyzer	7
4.9.7 Oscilloscope Display.....	7
4.9.8 A-Weighted Noise Measurement Device	7
4.9.9 ITU-R/ARM Noise Measurement Device	7
5 Test and Ratings, Single-Channel Amplifiers	7
5.1 Power Output Rating.....	7
5.2 Dynamic Headroom.....	8
5.2.1 Output Level	8
5.2.2 Maximum Peak-to-Peak Output Voltage Level	8
5.2.3 Dynamic Headroom Rating.....	8
5.3 Clipping Headroom.....	8
5.4 Total Harmonic Distortion	8
5.5 Maximum Voltage Output	9
5.5.1 Gain Control Settings.....	9
5.6 Output and Total Harmonic Distortion (THD) versus Frequency	9
5.7 Sensitivity.....	9
5.8 Maximum Input Signal.....	9
5.8.1 Gain Adjustment from Single Input	10
5.8.2 Input Terminals & Equalized Frequency Response	10
5.9 Input Impedance versus Frequency	10
5.9.1 Input Impedance Measurement Method	10
5.9.2 Input Impedance & Phono-Input Terminals	11
5.9.2.1 Input Terminal Impedance Rating	11
5.10 Output Impedance versus Frequency	11
5.10.1 Terminals Supplying Signal Voltage to Subsequent Equipment.....	11
5.10.2 Terminals Supplying Power to Loudspeaker.....	11
5.10.3 Output Impedance Measurement Method	11
5.10.4 Output Impedance & Equivalent Two-Network Values.....	12
5.10.5 Output Impedance Rating	12
5.11 Damping Factor versus Frequency	12
5.11.1 Wideband Damping Factor Rating	12
5.11.2 Low Frequency Damping Factor Rating.....	12
5.12 Weighted Signal-To-Noise Ratio (S/N).....	12
5.12.1 Output Noise Power	12
5.12.2 A-Weighted Signal-To-Noise Ratio Rating	12
5.12.3 ITU-R/ARM Signal-To-Noise Ratio.....	12
5.13 Response versus Frequency.....	13
5.13.1 Frequency Response Rating	13
5.13.1.1 Standard Equalized Frequency Response	13
5.13.2 Varied Frequency Response	13
5.13.2.1 Amplifier Frequency Response Variance.....	13
5.13.2.2 Low- or High- Pass Filter Controls.....	13

5.13.2.3 Cutoff Frequency Rating	13
5.13.2.4 Slope Rating	14
5.13.2.5 Power Amplifier—Amplifier Gain Adjustment.....	14
5.13.2.6 Multiple Control—Frequency Interaction	14
5.13.3 Amplifier Output/Input Connection.....	14
5.14 Crosstalk versus Frequency	14
5.14.1 Crosstalk Rating	14
5.14.2 Weighted Crosstalk Rating	14
5.15 SMPTE Intermodulation Distortion versus Output	15
5.15.1 Ratings for Multiple Load Impedances.....	15
5.15.2 Multiple Output Terminals	15
5.15.2.1 Line Input	15
5.15.2.2 Multiple Line Inputs	15
5.15.2.3 Output.....	15
5.15.3 SMPTE Intermodulation Distortion Rating.....	16
5.16 Dual Tone Intermodulation Distortion versus Frequency.....	16
5.16.1 Multiple Load Impedances.....	16
5.16.2 Multiple Output Terminals	16
5.16.2.1 Line Inputs	16
5.16.2.2 Outputs.....	16
5.16.3 Dual Tone Intermodulation Distortion Rating.....	16
5.17 Transient-Overload Recovery Time.....	17
5.17.1 Standard Equalized Frequency Response.....	17
5.17.2 Transient Overload Recovery Time Rating	17
5.18 Slew Factor.....	17
5.18.1 Standard Equalized Frequency Response.....	18
5.18.2 Slew Factor Rating	18
5.19 Reactive-Load	18
5.19.1 Input Signal	18
5.19.2 Output Voltage Level.....	18
5.19.3 Reactive Load Rating	19
5.20 Capacitive Load	19
6 Test and Ratings, Multi-Channel Amplifiers.....	19
6.1 Performance of a Multi-Channel Amplifier.....	19
6.2 Separation versus Frequency	19
6.2.1 Separation Rating	19
6.3 Difference of Response versus Frequency	19
6.3.1 Source Signal Level.....	20
6.3.2 Multiple Input Terminals/Multiple Channels	20
6.3.3 Difference of Frequency Response Rating.....	20
6.4 Gain Tracking Error.....	20
6.4.1 Source Signal	20
6.4.2 Gain Control	20
6.4.3 Gain-Tracking Error Rating.....	20
6.5 Tone-Control Tracking Error	20
6.5.1 Frequency Response	20
6.5.2 Frequency-Response-Affecting Control Adjustment.....	21
6.5.3 Tone-Control Tracking Error Rating	21
7 Rating	21
7.1 Primary Rating and Disclosure	21
7.2 Secondary Ratings and Disclosures	21

This page intentionally left blank.

Standard Test Methods of Measurement for Audio Amplifiers

1 Scope

This standard defines test conditions and test measurement procedures for determining various performance characteristics of single-channel and multi-channel power amplifiers, pre-amplifiers, integrated amplifiers, receivers, and tuner/pre-amplifiers that use AC mains power. These performance characteristics include power output, total harmonic distortion (THD), and sensitivity, among others.

This standard is intended to apply to defined devices intended for home audio and/or professional audio use. In addition, this standard is intended to apply only to those amplifiers that have power output ratings greater than five watts per channel when measured in accordance with the procedures specified herein.

2 References

2.1 Normative References

The following standards contain provisions that, through reference in this text, constitute normative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in 2.1.1.

2.1.1 Normative Reference List

Federal Trade Commission (FTC) Power Output Claims for Amplifiers Utilized in Home Entertainment Products, 16 CFR 432

IEC 60651, Sound Level Meters (January, 1979)

ITU-R BS.468-4, Measurement of audio-frequency noise voltage level in sound broadcasting (July, 1986)

2.1.2 Normative Reference Acquisition

FTC:

- FTC Regulations, U.S. Government Printing Office, Washington, DC 20401; Internet <http://www.gpo.gov/nara/cfr/index.html>

IEC Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email global@ihs.com
- IEC Central Office, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland; Phone +41 22 919 02 11; Fax +41 22 919 03 00; Internet <http://www.iec.ch>; Email pubinfor@iec.ch

ITU Standards:

- International Telecommunications Union, Place des Nations, CH-1211 Geneva 20, Switzerland; Phone +41 22 730 5111; Fax +41 22 733 7256; Internet <http://www.itu.int/publications/itu-r/index.html>; Email itumail@itu.int

3 Definitions of Terms—General

Within the scope of CEA-490-A, the following definitions shall apply.

3.1 Power Amplifier

A device having separate input and output terminals, whose purpose is to provide a larger output power than its required input power over the audio range (or a portion thereof), normally construed to mean 20 Hz to 20 kHz.

For CEA-490-A purposes, the term power amplifier shall also apply to the power amplifier section of an integrated amplifier or receiver.