AMERICAN NATIONAL STANDARD

Method for Measurement and Calibration of Earphones

ANSI/ASA S3.7-2016

Accredited Standards Committee S3, Bioacoustics

Standards Secretariat
Acoustical Society of America
1305 Walt Whitman Road, Suite 300
Melville, NY 11747

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ANSI/ASA S3.7-2016
(Revision of ANSI/ASA S3.7-1995 (R2008))

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Secretariat:

Acoustical Society of America

Approved on August 22, 2016, by:

American National Standards Institute, Inc.

ABSTRACT

This standard describes measurement methods for earphones and earphone transducers using couplers or ear simulators. Guidance is provided for the selection of the appropriate coupler or ear simulator for a given earphone and application. Methods for measurement of calibrated frequency response, input-output linearity, electrical impedance, and non-linear distortion, are described.

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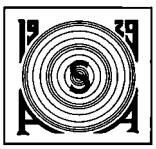

Acoustical Society of America
ASA Secretariat
1305 Walt Whitman Road, Suite 300
Melville, New York 11747
Telephone: 1 (631) 390-0215
Fax: 1 (631) 923-2875
E-mail: asastds@acousticalsociety.org

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Foreword

[*This Foreword is for information only and is not a part of the American National Standard* ANSI/ASA S3.7-2016 American National Standard Method for Measurement and Calibration of Earphones*. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard.*]

This standard comprises a part of a group of definitions, standards, and specifications for use in bioacoustics. It was developed and approved by Accredited Standards Committee S3 Bioacoustics, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S3 is as follows:

> *Standards, specifications, methods of measurement and test, and terminology in the fields of psychological and physiological acoustics, including aspects of general acoustics which pertain to biological safety, tolerance and comfort.*

This standard is a revision of ANSI/ASA S3.7-1995 (R2008) *American National Standard Method for Coupler Calibration of Earphones*. That version of the standard, in addition to coupler calibration methods, contained detailed information about the audiometric ear, the 6 cm^3 coupler, and the 2 cm^3 coupler. Since that time, IEC 60318 was reorganized into several parts, which now include the same information about the aforementioned couplers (IEC 60318, Parts 1, 3, and 5, respectively). Given that the manufacture of these couplers has changed little if at all in more than 25 years, the fact that the IEC and ANSI/ASA specifications for these couplers are essentially identical, and the fact that manufacturers of these couplers do not produce different versions of the devices to meet alternative versions of the standards, harmonization was deemed appropriate. The first step in this process was the move of the detailed coupler specifications to the nationally adopted international standard (NAIS) ANSI/ASA S3.55, Parts 1, 3, and 5, which correspond directly to their IEC 60318 counterparts. This revision of ANSI/ASA S3.7 focuses upon measurement methods for earphones, and now also points to the appropriate parts of NAIS ANSI/ASA S3.55 where the detailed coupler information now resides. References in other standards that previously pointed to ANSI/ASA S3.7 for a particular coupler will now point to the appropriate NAIS ANSI/ASA S3.55 part instead, as these documents are revised and updated.

Major changes in this document since the last revision include:

- Revised title and scope.
- Updated references, including ANSI/ASA S3.55/IEC 60318, Parts 1, 3, and 5.
- Terms and definitions are updated.
- Reference is made to IEC 60268-7 for earphones for consumer applications.
- Clauses describing couplers and artificial ears are replaced with information about which coupler or ear simulator to use for a particular application, referencing the aforementioned documents.
- Only one measurement method is given. This is fully revised and updated.
- Measurements at constant available power are removed.
- All figures are updated and redrawn.
- Information about adaptors and configurations for insert earphones is updated and moved to an informative annex. This same information also appears in ANSI/ASA S3.22-2014.
- An informative annex has been added describing difference frequency and intermodulation distortion measurements.
- An informative annex has been added regarding the uncertainty of measurement including an example uncertainty budget calculation for a typical earphone test.
- The Bibliography is revised with updated references.

At the time this Standard was submitted to Accredited Standards Committee S3, Bioacoustics for approval, the membership was as follows:

C.J. Struck, *Chair*
P.B. Nelson, *Vice-Chair*

S.B. Blaeser, *Secretary*

Acoustical Society of America ..... C.J. Struck
..... P.B. Nelson (Alt.)

American Academy of Audiology ..... C. Schweitzer
..... T. Ricketts (Alt.)

American Academy of Otolaryngology, Head and Neck Surgery, Inc. ..... R.A. Dobie
..... A. Kim (Alt.)

American Industrial Hygiene Association ..... T.K. Madison
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American Speech-Language-Hearing Association (ASHA) ..... L.A. Wilber
..... N. DiSarno (Alt.)

Beltone/GN Resound ..... S. Petrovic

Council for Accreditation in Occupational Hearing Conservation (CAOHC) ..... B. Charlton
..... B. Kirchner (Alt.)

Diagnostic Group ..... T. McColley
..... P. Dobrowski (Alt.)

ETS – Lindgren Acoustic Systems ..... S. Dunlap
..... D. Winker (Alt.)

Etymotic Research, Inc. ..... M.C. Killion
..... J.K. Stewart (Alt.)

Food and Drug Administration ..... S-C Peng
..... V. Dasika (Alt.)

G.R.A.S. Sound & Vibration ..... B. Schustrich

Hearing Industries Association ..... A. Bopp
..... M. Jones (Alt.)

International Hearing Society ..... R. Giles

National Electrical Manufacturers Association,
Signaling Protection & Communication Section (NEMA – 3SB) ..... R. Reiswig

National Hearing Conservation Association ..... E. Fallon
..... R. Danielson (Alt.)

National Institute for Occupational Safety and Health (NIOSH) ..... W.J. Murphy
..... C.L. Themann (Alt.)

National Institute of Standards and Technology ..... R.P. Wagner
..... S. Fick (Alt.)

National Park Service ..... M. McKenna
..... K. Fristrup (Alt.)

Ocean Conservation Research ..... M. Stocker

Starkey Hearing Technologies ..... D.A. Preves

U.S. Air Force ..... R.L. McKinley
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U.S. Army Aeromedical Research Laboratory ..... W.A. Ahroon

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U.S. Army Research Laboratory, Human Research and Engineering Directorate ..... A.A. Scharine
..... A. Foots (Alt.)

University of Cincinnati Animal Audiology Clinic/Bioacoustics Lab ..... P.M. Scheifele
..... D.K. Brown (Alt.)

Individual Experts of the Accredited Standards Committee S3, Bioacoustics, were:

R. F. Burkard	A. J. Campanella	C. J. Struck
M. D. Burkhard	R. L. McKinley	L. A. Wilber
	P. D. Schomer	

Working Group S3/WG 37, Couplers, Ear Simulators, and Earphones, which assisted Accredited Standards Committee S3, Bioacoustics, in the development of this standard, had the following membership.

C. J. Struck, Chair

D. Barrentine	G. Hess	S. Petrovic
D. A. Preves	J. K. Stewart	R. Wagner
D. Wiggins	M. Wille	K. A. Woo

Suggestions for improvements to this standard will be welcomed. They should be sent to Accredited Standards Committee S3, Bioacoustics, in care of the Standards Secretariat of the Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, New York 11747. Telephone: 631-390-0215; FAX: 631-923-2875; E-mail: asastds@acousticalsociety.org.

Introduction

This standard describes test methods and procedures for the measurement and calibration of earphones and receivers using couplers or ear simulators. Only the electroacoustic response is considered. Digital, wireless, and systems with signal processing are beyond the scope of this standard. Although there are no performance tolerances in this standard, the results of the tests in this standard may be used as the basis for establishing performance tolerances.

The earphone response, as perceived by the listener, is largely dependent upon the insertion gain of the system, i.e., the ratio of the pressure response as measured *in-situ* to the open-ear response in a given sound field (e.g., free field, diffuse field). This correction to an equivalent sound field pressure is beyond the scope of this standard.

Noise isolation afforded by earphones (analogous to hearing protectors) as well as measurements or limit recommendations for the maximum output of earphones in order to protect the hearing of the listener are also beyond the scope of this standard.

Couplers used for earphone measurements are not designed to represent the real ear, but rather only to provide a convenient, stable, and reproducible acoustical load to enable a simple and ready means for the exchange of specifications and physical data. Often, as in production testing, exact correlation between the real-ear and coupler response is not required. Couplers are specified in ANSI/ASA S3.55-2014/Part 1/IEC 60318-1:2009, ANSI/ASA S3.55-2015/Part 3/IEC 60318-3:2014, and ANSI/ASA S3.55-2014/Part 5/IEC 60318-5:2006.

Alternatively, ear simulators (as described in ANSI/ASA S3.25-2009) may be used to provide an acoustic impedance approximating the median adult human ear and equivalent sound pressure at the eardrum. The occluded ear simulator is used in test systems such as manikins. For telephony measurements, the ear simulators described in ITU-T Rec. P.57 are used.

ANSI/ASA S3.36-2012 describes a manikin (a.k.a. head and torso simulator) which is intended to simulate the acoustics of a median human adult, including diffractions affecting the in-situ performance of electroacoustic devices used on or near a person, where the effects of the pinna and realistic positioning of an earphone are also considered.

American National Standard

Method for Measurement and Calibration of Earphones

1 Scope

The electroacoustic test methods described in this standard are primarily for use with circumaural (over-the-ear), supra-aural (against-the-ear) and insert (ear-canal) type earphones, but may be applied to other types as well. Although these methods are generally applicable to earphones for all uses, the most common application of these methods are for earphones intended for hearing aids and audiometric testing and for receivers or other electroacoustic transducers intended for use in an earphone. In all cases, connection to the device under test is analog electrical; Digital, USB, or wireless systems are not considered. For additional requirements and tests for earphones for consumer audio applications, reference is made to IEC 60268-7.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/ASA S1.6-2016 American National Standard Preferred Frequencies and Filter Band Center Frequencies for Acoustical Measurements

ANSI/ASA S3.6 American National Standard Specifications for Audiometers

ANSI/ASA S3.20 American National Standard Bioacoustical Terminology

ANSI/ASA S3.22 American National Standard Specification of Hearing Aid Characteristics

ANSI/ASA S3.25-2009 American National Standard for an Occluded Ear Simulator

ANSI/ASA S3.36-2012 American National Standard Specification for a Manikin for *in-situ* Airborne Acoustic Measurements

ANSI/ASA S3.55/Part 1/IEC 60318-1 American National Standard Electroacoustics – Simulators of Human Head and Ear – Part 1: Ear Simulator for the Measurement of Supra-aural and Circumaural Earphones (a nationally adopted international standard)

ANSI/ASA S3.55/Part 3/IEC 60318-3 American National Standard Electroacoustics – Simulators of Human Head and Ear – Part 3: Acoustic Coupler for the Calibration of Supra-aural Earphones Used in Audiometry (a nationally adopted international standard)

ANSI/ASA S3.55/Part 5/IEC 60318-5 MOD American National Standard Electroacoustics – Simulators of Human Head and Ear – Part 5: 2 cm^3 Coupler for the Measurement of Hearing Aids and Earphones Coupled to the Ear by Means of Ear Inserts (a modified nationally adopted international standard)

IEC 60263:1982 Scales and sizes for plotting frequency characteristics and polar diagrams

IEC 60268-5:2003 Sound system equipment – Part 5: Loudspeakers