ASA/ANSI S3.46-2013
(Revision of ANSI S3.46-1997)

Reaffirmed by ANSI October 11, 2018

AMERICAN NATIONAL STANDARD

Methods of Measurement of Real-Ear Performance Characteristics of Hearing Aids

Secretariat:

Acoustical Society of America

Approved on August 12, 2013

American National Standards Institute, Inc.

Abstract

This Standard provides definitions for terms used in the measurement of real-ear performance characteristics of hearing aids, provides procedural and reporting guidelines, and identifies essential characteristics to be reported by the manufacturer of equipment used for this purpose. Acceptable tolerances for the control and measurement of sound pressure levels are indicated. Where possible, sources of error have been identified and suggestions provided for their management.

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ANSI/ASA S3.46-2013

Accredited Standards Committee S3, Bioacoustics

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

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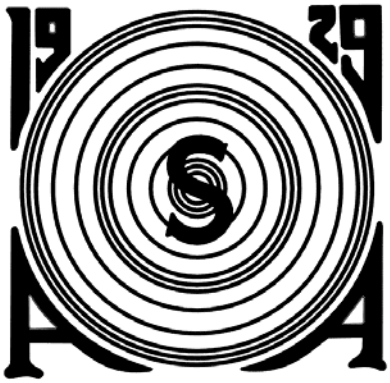

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Foreword

[This Foreword is for information only and is not a part of the American National Standard ANSI/ASA S3.46-2013 American National Standard Methods of Measurement of Real-Ear Performance Characteristics of Hearing Aids.]

This Standard was developed under the jurisdiction of Accredited Standards Committee S3, Bioacoustics, which has the following scope:

> *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 S3.46-1997, which has been technically revised. Changes in this edition include an expansion of the scope to include measurement of certain acoustic properties of the ear which are related to hearing aid fitting.

Major non-editorial changes in this edition include:

- Scope. This standard covers the terminology, procedures and essential equipment characteristics for the measurement of the acoustic output and acoustic gain of hearing aids, coupled to human ears, in a variety of acoustic environments and for the measurement of certain acoustic properties of the ear related to the application of hearing aids.

- 3.1.4 coupled sound source. An earphone or hearing aid receiver and any tubing used to couple its acoustic output, without leakage, to the ear canal or the cavity in a coupler.

- 3.3.6 long-term average speech spectrum. The sound pressure level in contiguous 1/3 octave bands measured over the duration of a speech sample. Abbreviation, LTASS.

- 3.4.6 real-ear aided response. The following note was added to the definition:

  "NOTE The term Real-Ear Saturation Response (RESR) has sometimes been used for the REAR with a stimulus SPL of 85 or 90 dB. The use of this term is deprecated in favor of REAR85 or REAR90."

- 3.4.10 real-ear to coupler difference. Difference in decibels, as a function of frequency, between the SPL produced near the tympanic membrane in an occluded ear canal by a coupled sound source having a high acoustic impedance and that produced in the HA-1 configuration of the 2 cm^3 earphone coupler by the same coupled sound source. Abbreviation, RECD.

- 3.4.11 real-ear to dial difference. Difference in decibels, as a function of frequency, between the SPL produced near the tympanic membrane by an audiometric sound source and the hearing level indicated by the audiometer driving the sound source. Abbreviation, REDD.

- 4.3.2 For a speech-like stimulus, report the SPL and the bandwidth over which it is determined, the LTASS and, if digitized, the sampling rate and number of bits. If standardized or commercially available, report the source and identifying information. If the speech has been modified by other than linear filtering, provide a description of the processing or a reference where it can be found.

- 6.10 Real-ear to coupler difference method

- 6.11 Real-ear to dial difference method

- Annex A: Descriptions added for Tone burst and Speech-like stimuli. International Speech Test Signal recommended as speech-like test stimulus.

- Annex C Issues in RECD measurement and application added.

This standard was editorially corrected and republished in September 2014 after discovery of a typographical error in the explanation following Equation (C.1) in Clause C.2 The definitions for Z_{sc} and Z_{se} had been inadvertently transposed and are corrected in this edition.

The 1997 edition of ANSI S3.46 was the basis for IEC standard 61669-2001: *Equipment for the measurement of real-ear acoustical characteristics of hearing aids* and ISO 12124-2001: *Procedures for the measurement of real-ear acoustical characteristics of hearing aids*. Taken together, these standards are comparable to ANSI/ASA S3.46. These standards are currently being combined and revised and are expected to remain comparable to this revision of ANSI/ASA S3.46.

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

C.J. Struck, *Chair*
G.J. Frye, *Vice-Chair*

S.B. Blaeser, *Secretary*

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..... M.D. Burkhard (Alt.)

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

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..... M.J. White (Alt.)

U.S. Army Research Laboratory, Human Research and Engineering Directorate ..... T.R. Letowski
..... P. Henry (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:

J.R. Bareham	K.D. Kryter	H. Teder
A.J. Brammer	R.L. McKinley	L.A. Wilber
R.F. Burkard	P.D. Schomer	W.A. Yost
A.J. Campanella	C.J. Struck	

Working Group S3/WG 80, Probe-Tube Measurements of Hearing Aid Performance, which assisted Accredited Standards Committee S3, Bioacoustics, in the preparation of this standard, had the following membership:

W. Cole, *Chair*

S.W. Armstrong	A. Gebert	D.A. Preves
R.A. Bentler	M.C. Killion	G. Ravn
J.L. DaBell	C.B. King	L. Revit
B.L. Fedor	B. Kruger	O. Saltykov
G.J. Frye	F.M. Kruger	D.M. Warren

Suggestions for improvements of 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

The performance characteristics of hearing aids in real ears can differ significantly from those determined in accordance with standards such as ANSI/ASA S3.22-2009 and ANSI/ASA S3.35-2010 because of differing acoustic input and loading conditions presented by individual real ears. Measuring methods that take into account the acoustic coupling and the influence of the individual wearer on the acoustic signal and the performance of hearing aids are therefore important in the fitting of these devices. Such measurement methods have come to be known as "real-ear measurements" and are sometimes performed clinically in less-than-ideal acoustic environments. The accuracy and repeatability of measurements made under such conditions are complex functions of sound-field uniformity, the nature of the stimulus and background noise, the hearing aid under evaluation, the method of stimulus control, the location of the sound source, the nature of the data acquisition, analysis and presentation, and the degree of subject movement permitted. This standard addresses these issues by providing terminology for procedures and equipment, by recommending measurement methods and reporting requirements, and by identifying key equipment parameters and acceptable tolerances.

NOTE Throughout this standard, the term "real ear" is used to emphasize the fact that these measurements are made in the ear canal of a human subject.

American National Standard

Methods of Measurement of Real-Ear Performance Characteristics of Hearing Aids

1 Scope, purpose, and applications

1.1 Scope

This standard covers the terminology, procedures and essential equipment characteristics for the measurement of the acoustic output and acoustic gain of hearing aids, coupled to human ears, in a variety of acoustic environments and for the measurement of certain acoustic properties of the ear related to the application of hearing aids. These measurements can be divided into two classes: a) direct measures of sound pressure level (SPL), and b) insertion measurements. Direct measures (previously called *in situ* measurements) report SPL developed in an ear canal, with or without a hearing aid in place and are expressed as dB gain relative to the SPL at a field reference point. Insertion measurements report ear canal SPL with a hearing aid in place relative to the ear canal SPL without the hearing aid. Behavioral measures of real-ear hearing aid performance, such as functional gain, are excluded from this standard.

1.2 Purpose

The purpose of this standard is to assist those making or interpreting the results of real-ear performance measurements of hearing aids by promoting consistency in terminology, procedures and equipment specification.

1.3 Applications

Applications of this standard include the selection, ordering and fitting of hearing aids; the collection and reporting of research data; and the selection of equipment used for the measurement of real-ear performance characteristics of hearing aids. Unless otherwise stated, the measurements and requirements in this standard apply to a minimum frequency range of 200 to 6000 Hz.

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 S1.1 *American National Standard Acoustical Terminology.*

ANSI/ASA S3.5-1997 (R2012) *American National Standard Methods for Calculation of the Speech Intelligibility Index*.

ANSI/ASA S3.7-1995 (R2008) *American National Standard Methods for Coupler Calibration of Earphones.*

ANSI/ASA S3.20-1995 (R2008) *American National Standard Bioacoustical Terminology*.

ANSI/ASA S3.22-2009 American *National Standard Specification of Hearing Aid Characteristics*.