

ANSI/ASA S3.36-2012

AMERICAN NATIONAL STANDARD

Specification for a Manikin for Simulated *in-situ* Airborne Acoustic Measurements

ANSI/ASA S3.36-2012

Accredited Standards Committee S3, Bioacoustics

Standards Secretariat
Acoustical Society of America
35 Pinelawn Road, Suite 114 E
Melville, NY 11747-3177

The American National Standards Institute, Inc. (ANSI) is the national coordinator of voluntary standards development and the clearinghouse in the U.S.A. for information on national and international standards.

The Acoustical Society of America (ASA) is an organization of scientists and engineers formed in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.



ANSI/ASA S3.36-2012
(Revision of ANSI S3.36-1985)

AMERICAN NATIONAL STANDARD
Specification for a Manikin for Simulated *in-situ*
Airborne Acoustic Measurements

Secretariat:

Acoustical Society of America

Approved on November 30, 2012 by:

American National Standards Institute, Inc.

Abstract

The present standard describes a manikin for airborne acoustic measurements. It comprises a head with external ears and ear canals, and a torso that simulates a median human adult. It is intended primarily as an instrument for measuring the response of acoustical devices under simulated *in situ* conditions. Acoustical performance requirements are given as well as informative geometric descriptions.

AMERICAN NATIONAL STANDARDS ON ACOUSTICS

The Acoustical Society of America (ASA) provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Vibration and Shock, S3 on Bioacoustics, S3/SC 1 on Animal Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, trade associations, organizations with a general interest, and government representatives). The standards are published by the Acoustical Society of America as American National Standards after approval by their respective Standards Committees and the American National Standards Institute (ANSI).

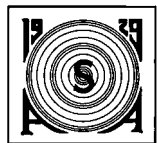
These standards are developed and published as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

Each of the Accredited Standards Committees (operating in accordance with procedures approved by ANSI) is responsible for developing, voting upon, and maintaining or revising its own Standards. The ASA Standards Secretariat administers Committee organization and activity and provides liaison between the Accredited Standards Committees and ANSI. After the Standards have been produced and adopted by the Accredited Standards Committees, and approved as American National Standards by ANSI, the ASA Standards Secretariat arranges for their publication and distribution.

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort be made towards their resolution.

The use of an American National Standard is completely voluntary. Their existence does not in any respect preclude anyone, whether he or she has approved the Standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the Standards.

NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this Standard.



Acoustical Society of America
ASA Secretariat
35 Pinelawn Road, Suite 114E
Melville, New York 11747-3177
Telephone: 1 (631) 390-0215
Fax: 1 (631) 390-0217
E-mail: asastds@aip.org

© 2012 by Acoustical Society of America. This standard may not be reproduced in whole or in part in any form for sale, promotion, or any commercial purpose, or any purpose not falling within the provisions of the U.S. Copyright Act of 1976, without prior written permission of the publisher. For permission, address a request to the Standards Secretariat of the Acoustical Society of America.

Contents

1	Scope.....	1
2	Normative references	1
3	Terms and definitions	2
4	Physical characteristics of the manikin.....	6
	4.1 Construction.....	6
	4.2 Materials	6
	4.3 Markings	7
	4.4 Documentation.....	8
5	Standard ambient reference conditions.....	8
6	Acoustical characteristics of the manikin.....	8
	6.1 Measurement conditions	8
	6.2 Frequency response	13
	6.3 Pressure response field calibration	15
7	Other properties.....	15
	7.1 Openings	15
	7.2 Test for sound leakage	15
8	Application-specific requirements.....	16
	8.1 Hearing aid simulated insertion gain measurement	16
	8.2 Insertion loss measurement of hearing protectors	16
	8.3 Headphone and earphone measurements.....	16
	8.4 Room acoustics and automotive acoustics measurements	16
	8.5 Telephony – Handset and headset measurements.....	16
	Annex A (informative) Supplementary data: Ear Drum (DRP) to Ear Reference Point (ERP) transfer function	17
	Annex B (informative) Manikin dimensions	19
	B.1 Definitions of manikin head and torso dimensions	19
	B.2 Comparison of manikin dimensions and average human data	19
	Annex C (informative) Cross-sectional head and torso contours for a manikin that fulfills the acoustical specifications of this standard	20
	C.1 Torso.....	20
	C.2 Head	20
	C.3 Precision	29
	Annex D (informative) Dimensions and cross-sectional contours for a pinna simulator that fulfills the acoustical specifications of this standard	30
	D.1 Pinna simulator	30
	D.2 Precision	33

Tables

Table 1 — Sound levels at positions around the test point for verifying the sound source under free field test conditions	10
Table 2 — Allowable variation of sound field sound pressure levels within each plane for corresponding directional microphone free field rejection	12
Table 3 — Nominal (0° elevation, 0° azimuth) free field frequency response and tolerances of the manikin (in dB)	14
Table 4 — Nominal diffuse field frequency response of the manikin and tolerances (in dB).....	15
Table A.1 — DRP to ERP transfer function	17
Table B.1 — Dimensions for manikins that fulfill the acoustical specifications of this standard and average human data	19
Table D.1 — Pinna simulator dimensions	30

Figures

Figure 1 — Manikin geometrical references.....	3
Figure 2 — Coordinate scheme for azimuth and elevation angles	4
Figure 3 — Pinna simulator dimension definitions	7
Figure 4 — Positions for verifying the sound source under free field test conditions	10
Figure 5 — Nominal (0° elevation, 0° azimuth) free field frequency response of the manikin with tolerances.....	13
Figure 6 — Nominal diffuse field frequency response of the manikin with tolerances.....	14
Figure A.1 — DRP to ERP transfer function	18
Figure B.1 — Definitions of manikin head and torso dimensions	19
Figures C.1 – C.5 — Cross-section contours of the torso of the manikin. Grid lines are to be reproduced at 2-cm spacing for a full-size manikin. Numbers adjacent to the contours give the distance in cm below (–) the ear canal entrance for the contour. A symbol ⊕ encircles the reference axis of rotation of the manikin.....	21
Figures C.6 – C.10. Cross-section contours of the head of the manikin. Grid lines are to be reproduced at 2-cm spacing for a full-size manikin. Numbers adjacent to the contours give the distance in cm above (+) or below the ear canal entrance. The symbol ● encircles the reference for location of the ears on the manikin head. The symbol ⊕ encircles the reference and axis of rotation of the manikin.....	26

Figures D.1 – D.3 — Cross-section contours of the pinna simulator. Grid lines are at 1-cm spacing. Numbers in the margins give the distance in mm above (+) and below (-) the ear canal entrance. The symbol ● encircles the reference for location of the ears on the manikin head. (The ● symbols are on a vertical line parallel to the axis of rotation of the manikin.) The grid lines are to be reproduced with 10-mm spacing for a full-size manikin. 31

Foreword

[This Foreword is for information only, and is not a part of the American National Standard ANSI/ASA S3.36-2012 *American National Standard Specification for a Manikin for Simulated in situ Airborne Acoustic Measurements*.]

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 S3.36-1985, which has been technically revised. At the time of preparation of this standard there was a parallel effort in IEC/TC 29, SC-29C Working Group 9 to revise IEC/TR 60959:1990 (in fact, identical to ANSI S3.36-1985), which resulted in IEC 60318-7. The IEC 60318-7 document and this standard have many common elements; however, this standard does differ from IEC 60318-7 in some respects. Notable differences include:

- The Scope of Use for the manikin includes other applications in addition to hearing aid measurements.
- Dimensional information is found in informative annexes.
- Recommendations for documentation of the manikin calibration are included.
- Specification of harmonic distortion of the test system is reduced to 0.5%.
- Conditions and specifications for the free field sound source are detailed.
- Angular resolution for tests is reduced to $\pm 1^\circ$.
- The specification for the free field on-axis response of the manikin is revised, considering the response of several different commercially available manikins.
- The free field manikin response tolerance is specified only at 0° azimuth, whereas tolerances in IEC 60318-7 apply to all azimuth angles (0° , 90° , 180° , and 270°).
- The manikin diffuse field response is specified in place of the 90° , 180° , and 270° angle responses.
- A diffuse field response test procedure is detailed.
- Nominal manikin response and tolerances are provided in both graphical and tabular format.
- Requirements for field pressure calibration are provided.
- A number of application-specific requirements are included. For mouth-simulator-equipped manikins for telecom applications, reference is made to ITU-T Rec. P.58.
- The DRP to ERP transfer function is provided in an annex instead of the DRP to EEP transfer function.
- A table of the dimensional data for three commercially available manikins and average human data is included in an informative annex.

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*

Acoustical Society of America	C.J. Struck
.....	M.D. Burkhard (Alt.)
American Academy of Audiology	D. Ostergren
.....	S. Gordon-Salant (Alt.)
American Academy of Otolaryngology, Head and Neck Surgery, Inc.	R.A. Dobie
.....	L.A. Michael (Alt.)
American Industrial Hygiene Association	T.K. Madison
.....	D. Driscoll (Alt.)
American Speech-Language-Hearing Association (ASHA)	L.A. Wilber
.....	P. Mason (Alt.)
Beltone/GN Resound	S. Petrovic
Council for Accreditation in Occupational Hearing Conservation (CAOHC)	L.D. Hager
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
Frye Electronics, Inc.	G.J. Frye
.....	K.E. Frye (Alt.)
G.R.A.S. Sound & Vibration	J. Soendergaard
.....	B. Schustrich (Alt.)
Hearing Industries Association	T.A. Victorian
.....	C.M. Rogin (Alt.)
National Electrical Manufacturers Association, Signaling Protection & Communication Section (NEMA – 3SB)	J. McNamara
.....	R. Reisinger (Alt.)
National Hearing Conservation Association	G.L. Poling
National Institute for Occupational Safety and Health (NIOSH)	M. Stephenson
.....	W.J. Murphy (Alt.)

National Institute of Standards and Technology	V. Nedzelniisky R.P. Wagner (Alt.)
National Park Service	G.R. Stanley K. Fristrup (Alt.)
Natus Medical, Inc.	Y. Hekimoglu P. Becke (Alt.)
Ocean Conservation Research	M. Stocker
Starkey Laboratories	D.A. Preves T.H. Burns (Alt.)
U.S. Air Force	R.L. McKinley B.D. Simpson (Alt.)
U.S. Army Aeromedical Research Lab	W.A. Ahroon
U.S. Army CERL	D.K. Delaney 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 67, Manikins, which assisted Accredited Standards Committee S3, Mechanical Vibration and Shock, in the development of this standard, had the following membership.

C.J. Struck, Chair

M. Alexander	R. McKinley	J. Soendergaard
W. Bray	W. Murphy	J. Stewart
M. Killion	M. Nilsson	R. Wagner
T. Letowski	D. Preves	K. A. Woo

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, 35 Pinelawn Road, Suite 114E, Melville, New York 11747-3177. Telephone: 631-390-0215; FAX: 631-390-0217; E-mail: asastds@aip.org.

Introduction

This standard describes a head and torso simulator (a.k.a. manikin) for acoustical measurements such as hearing aid simulated insertion gain, insertion loss of hearing protectors, headphone and earphone response, speech and room acoustics, automotive acoustics, measurements of telephone handsets, headsets, and hands-free or loudspeaking telephones.

The manikin described in this standard is intended for airborne acoustic measurements and is not suitable for measurements which depend upon vibration transmission paths such as bone conduction, nor for measurements requiring the simulation of bone or flesh. The acoustical performance of the head and torso simulator has been specified to provide diffraction effects similar to those encountered around the median adult human head and torso.

The frequency response tolerances in this document were developed using free and diffuse field data provided by the three known manufacturers of compliant test manikins. Additional data for a common alternative configuration of one of the manikins with a legacy ear simulator was also included.

Significant changes to this document since the last revision (1985) include:

- Emphasis is on the acoustical response of the manikin. Dimensional information is moved to informative annexes.
- The Scope of Use for the manikin includes other applications in addition to hearing aid measurements.
- Recommendations for documentation of the manikin calibration are included.
- Specification of harmonic distortion of the test system is reduced to 0.5%.
- Conditions and specifications for the free field sound source are detailed.
- Angular resolution for tests is reduced to $\pm 1^\circ$.
- The specification for the free field on-axis response of the manikin is revised, considering the response of three different commercially available manikins, one equipped with either of the ANSI/ASA S3.25 ear simulators.
- The manikin response tolerances are reduced in the critical frequency range from 1 to 5 kHz, considering the small variation between the data for the different manikins.
- The manikin diffuse field response is specified in place of the 90°, 180°, and 270° angle responses.
- The figure depicting the pinna simulator is updated.
- A diffuse field response test procedure is detailed.
- Nominal manikin responses and tolerances are also depicted as graphs.
- Requirements for field pressure calibration are provided.
- A number of application-specific requirements are included. For mouth-simulator-equipped manikins for telecom applications, reference is made to ITU-T Rec. P.58.
- A table of the dimensional data for three commercially available manikins and average human data is included in an informative annex.
- An informative annex provides the DRP to ERP transfer function.
- The bibliography includes additional updated references.

This is a preview of "ANSI/ASA S3.36-2012". [Click here to purchase the full version from the ANSI store.](#)

American National Standard

Specification for a Manikin for Simulated *in-situ* Airborne Acoustic Measurements

1 Scope

This standard describes a manikin which is intended to simulate the acoustical effects of a median human adult, including diffractions affecting the *in-situ* performance of electroacoustic devices used on or near a person. The manikin consists of a head mounted on a torso that extends to the waist. The head is equipped with pinnae and ear simulators with acoustic impedance terminations and microphones located at positions corresponding to those of eardrums on a median human adult. Measurement results obtained with the manikin may differ substantially from similar results obtained on an individual person due to anatomical variations. Median dimensions provided in the annexes were drawn from the population samples described in the Bibliography.

The manikin is described by the acoustical performance requirements of this standard. Physical dimensions of manikins that meet these requirements are provided for information but are not part of the standard. Dimensional information can be found in Annexes B, C and D.

For test application specific requirements, the user is referred to clause 8 for additional information, pertinent test standards, and/or any modifications to the basic specifications required for that particular application.

Manikins for binaural recording are outside the scope of this standard.

2 Normative references

The following referenced documents are useful 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 S1.11 American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters

ANSI/ASA S3.20 American National Standard Bioacoustical Terminology

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

ANSI/ASA S3.35 American National Standard Methods of Measurement of Performance of Hearing Aids under Simulated *in-situ* Working Conditions

ANSI/ASA S12.42 American National Standard Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures

ANSI/ASA S12.51 / ISO 3741 American National Standard Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for reverberation test rooms