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(ASA 112-1995)
A Revision of
ANSI S3.7-1973 (R1986)

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AMERICAN NATIONAL STANDARD

Methods for Coupler Calibration of Earphones

Secretariat
Acoustical Society of America

Approved
American National Standards Institute, Inc.

ABSTRACT

The physical configuration and acoustical performance of couplers for calibration of supra-aural and insert earphones are specified. The standard which is a revision of S3.7-1973, describes a family of 6.0 cm³ and 2.0 cm³ couplers, and provides information on the methods for coupler calibration of the respective supra-aural and insert earphones. The family of 6.0 cm³ couplers includes the NBS 9-A Coupler for testing supra-aural earphones (ANSI S3.6-1989), the Type-1 Earphone coupler for testing supra-aural earphones without cushions, and the IEC Coupler for supra-aural earphones. The family of 2.0 cm³ earphone couplers includes the HA-1 Coupler for earphones mounted in an ear insert or an ear insert connected to an earphone, the HA-2 Coupler for tests in which an acoustic tube connects an earphone to an earmold or ear insert, the HA-3 Coupler for testing the modular portion of a hearing aid, and an HA-4 coupler for testing postauricular hearing aids or eyeglass hearing aids assumed to have a uniform 1.93 cm diameter sound path.

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Foreword

[This Foreword is not a part of American National Standard Method for Coupler Calibration of Earphones, S3.7-1995.) ASA Catalog No. 111-1995, revision of ANSI S3.7-1973 (R1986).]

This standard is a revision of American National Standard Method for Coupler Calibration of Earphones, ANSI S3.7-1973 (R1986). The American National Standard Method for Coupler Calibration of Earphones, ANSI S3.7-1973 was a revision and extension of American National Standard Z24.9-1949 (R 1971), which bore the same title. ANSI S3.7-1973 (R1986) supplemented the earlier standard by extending the method of calibration of supra-aural earphones to include the use of the National Bureau of Standard Type 9-A Coupler, and of the IEC (International Electrotechnical Commission) Artificial Ear, of the wide-band type, for the calibration of earphones used in audiometry. For calibration of hearing-aid earphones that are coupled to the ear canal by ear inserts, this American National Standard recommends the use of the basic Type-2 (2.0 cm³) coupler, with four variants to adapt it to particular forms of earphones. These are all consistent with the IEC Reference Coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts (which is described in Amendment 1 to this publication which is currently in preparation). Further, for real ear performance evaluation of hearing-aid earphones that are coupled to the ear canal by ear inserts, ear simulators have been designed and described in other standards. In particular, occluded ear simulators are described in ANSI S3.25-1979, ANSI S3.25-1989, and IEC Document 711-1982.

The Type-3 Coupler of Z24.9-1949 is not included in this revised American National Standard because it is not widely used, and does not appear in other American National Standards or in any international recommendations of the IEC or ISO (International Organization for Standardization). Moreover, there is no evidence that the Type-3 Coupler is in any way superior to the 2.0 cm³ couplers described herein.

The coupler calibration of circumaural earphones is not specifically considered in this standard because of the present lack of knowledge of the critical factors that affect the coupling between a circumaural earphone and a real ear or coupler. The working group that developed this standard felt that more research is needed to provide a secure basis for this calibration.

This standard was developed under the jurisdiction of Accredited Standards Committee S3, Bioacoustics, using the American National Standards Institute (ANSI) Accredited Standards Committee Procedure. The Acoustical Society of America provides the Secretariat for Accredited Standards Committee S3, Bioacoustics.

Accredited Standards Committee S3, Bioacoustics, under whose jurisdiction this standard was developed, 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, shock, and vibration which pertain to biological safety, tolerance, and comfort.

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

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Suggestions for improvements of this standard will be welcomed. They should be sent to the Accredited Standards Committee S3, at the Standards Secretariat, in care of the Acoustical Society of America, 120 Wall Street, 32nd Floor, New York, New York 10005-3993. Telephone (212) 248-0373; FAX (212) 248-0146.

American National Standard

Method for Coupler Calibration of Earphones

0 Introduction

The purpose of this standard (and the original standard ANSI S3.7-1973) is to provide information on and specification of couplers and their use for calibration of earphones.

In normal use, an earphone can be considered as part of a larger system consisting of the electrical source, the earphone, and the real ear. The earphone response, as perceived by the listener, depends on the physical characteristics of the entire system; if any element is changed, the system response will change accordingly. Furthermore, if a coupler is substituted for a real human ear, even a typical or average real ear, there will be, in general, differences in the system response. Moreover, the differences between the real-ear and coupler responses will generally be significantly different for different types of earphones.

It is unrealistic to expect that a coupler could adequately represent the real ear over a wide frequency range, be usable with all types of earphones, and be stable and reproducible. Approximations to real ears, called artificial ears or ear simulators, however, have been designed and described in standards. In particular, occluded ear simulators are described in ANSI S3.25 1979, Revised 1989, and IEC Document 711, 1982. Occluded ear simulators are most useful for calibration of earphones intended for operation within a closed ear canal or with an earmold inserted into and closing the ear canal to the external environment.

At best, the couplers covered in this standard approximate the average human ear only over a limited frequency range and with a restricted class of earphones. Often, as in production testing, exact correlation between real-ear and coupler responses are not required. The difference in sound pressure of an earphone on a coupler and the sound pressure generated by an earphone on real ears is greater than the difference in sound pressure of an earphone generated on several different couplers

(e.g., Sachs and Burkhard, 1972; ANSI S3.25-1989). When real ear responses are required, as in the calibration of new earphones for audiometry, real ear responses must be measured either directly using a probe-tube microphone or indirectly using loudness balance or other subjective methods. (See 4.1.4.4 of American National Standard Specifications for Audiometers, S3.6-1989.) When simulation of a complete ear is required, as in an acoustic test manikin (ANSI S3.36-1985), occluded ear simulators are used, also, as the terminating structure. When telephonometric calibrations of earphones without acoustic leaks are required the coupler described as IEC 318 artificial ear is used.

1 Scope, purpose, and applications

1.1 Scope

This standard specifies and describes earphone couplers that are in current use, together with their capabilities and limitations, and presents methods for the coupler calibration of earphones.

1.2 Purpose

The purpose of coupler calibration of earphones is to provide a simple, convenient, and reproducible means of determining the earphone's acoustical output. Each of the couplers described in this standard has been designed for use with a specific class of earphones. When so used, the couplers have acoustic-input impedances, which, over a limited frequency range, approximate the input impedances of the human ear under the specified conditions.

1.3 Applications

The couplers described in this standard are suitable for use with supra-aural (against-the-ear) and insert (ear-canal) type earphones. An adequate basis for the coupler calibration of circumaural earphones does not yet exist. The couplers described in this standard are not intended for calibration of

- a. earphones which are open in the back, or
- b. earphones with thick and solid or foam cushions (no hole in the middle) that hold the transducer at approximately 1 inch from the ear.

However, such earphones may, in suitable cases, be calibrated over a restricted frequency range by