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**Acoustics — Reference zero for  
the calibration of audiometric  
equipment —**

**Part 1:  
Reference equivalent threshold sound  
pressure levels for pure tones and  
supra-aural earphones**

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*Acoustique — Zéro de référence pour l'étalonnage d'équipements  
audiométriques*

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*Partie 1: Niveaux de référence équivalents de pression acoustique  
liminaire pour les écouteurs à sons purs supra-auraux*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). (standards.iteh.ai)

The committee responsible for this document is ISO/TC 43, *Acoustics*.

This second edition cancels and replaces the first edition (ISO 389-1:1998), which has been technically revised.

The main changes compared to the previous edition are as follows:

- data for additional models of earphone have been introduced;
- wording and definitions have been aligned with the current versions of standards in the field of audiology.

A current list of all parts in the ISO 389 series can be found on the ISO website.

## Introduction

Each document in the ISO 389 series specifies reference threshold levels for the calibration of audiometric equipment. This document is applicable to equipment for pure-tone air-conduction audiometry that uses supra-aural earphones.

In principle, reference equivalent threshold sound pressure levels (RETSPLs) would be rendered independent of earphone model if they were referred to an ear simulator having acoustical properties exactly simulating those of the average human ear. A device designed with this aim in view is standardized in IEC 60318-1. The original data for the ISO 389 series were presented in ISO 389:1985, Addendum 1, which was prepared based on an assessment of technical data provided by laboratories listed in [Annex B](#) on RETSPL values specified on the IEC 60318-1 ear simulator and covering a variety of earphone models. These data were analysed to produce a set of RETSPL values which are, within an acceptable uncertainty, applicable to earphones of any model within a broadly defined class. A note on the derivation of the standard values and the origin of the data input is given in [Annex B](#) for information.

In recent years, new supra-aural earphone models have been developed and other models have been revised. If applicable, their RETSPLs were specified both on the IEC 60318-1 ear simulator and the IEC 60318-3 acoustic coupler, as a result of direct threshold measurements under the preferred test conditions given in ISO 389-9. These model-specific RETSPL values are given in this document in separate tables, along with the IEC 60318-3 acoustic coupler RETSPLs for Telephonics TDH 39<sup>1)</sup> and Beyer DT 48<sup>2)</sup> earphones, which were adopted from the former editions of ISO 389.

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1) TDH 39 is the name of a product supplied by Telephonics. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product name.

2) DT 48 is the name of a product supplied by Beyerdynamic. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

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# Acoustics — Reference zero for the calibration of audiometric equipment —

## Part 1: Reference equivalent threshold sound pressure levels for pure tones and supra-aural earphones

### 1 Scope

This document specifies a standard reference zero for the scale of hearing threshold level applicable to pure-tone air conduction audiometers, to promote agreement and uniformity in the expression of hearing threshold level measurements throughout the world.

It states the information in a form suitable for direct application to the calibration of audiometers, that is, in terms of the reference equivalent threshold sound pressure levels of generic supra-aural earphones specified in 4.2, measured on an ear simulator complying with IEC 60318-1 and in terms of model-specific data given in two additional tables for the IEC 60318-3 acoustic coupler and the IEC 60318-1 ear simulator, respectively.

The data are based on an assessment of the information available from the various standardizing laboratories responsible for audiometric standards and from scientific publications.

Some notes on the application and derivation of the reference levels are given in Annexes A and B.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60318-1:2009, *Electroacoustics — Simulators of human head and ear — Part 1: Ear simulator for the measurement of supra-aural and circumaural earphones*

IEC 60318-3, *Electroacoustics — Simulators of human head and ear — Part 3: Acoustic coupler for the calibration of supra-aural earphones used in audiometry*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

#### 3.1

##### air conduction

transmission of sound through the external and middle ear to the inner ear

### 3.2

#### **acoustic coupler**

device for measuring the acoustic output of sound sources where the sound pressure is measured by a calibrated microphone coupled to the source by a cavity of predetermined shape and volume which does not necessarily approximate the acoustic impedance of the normal human ear

Note 1 to entry: An acoustic coupler is specified in IEC 60318-3.

### 3.3

#### **ear simulator**

device for measuring the acoustic output of sound sources where the sound pressure is measured by a calibrated microphone coupled to the source so that the overall acoustic impedance of the device approximates that of the normal human ear at a given location and in a given frequency band

Note 1 to entry: An ear simulator is specified in IEC 60318-1.

### 3.4

#### **hearing threshold**

lowest sound pressure level or vibratory force level at which, under specified conditions, a person gives a predetermined percentage of correct detection responses on repeated trials

### 3.5

#### **otologically normal person**

person in a normal state of health who is free from all signs or symptoms of ear disease and from obstructing wax in the ear canal, and who has no history of undue exposure to noise, exposure to potentially ototoxic substances, or familial hearing loss

### 3.6

#### **equivalent threshold sound pressure level for monaural earphone listening**

sound pressure level set up by the earphone in a specified *acoustic coupler* (3.2) or *ear simulator* (3.3) when the earphone is actuated by that voltage which, with the earphone applied to the ear concerned, would correspond to the *hearing threshold* (3.4) for a given ear, at a specified frequency, for a specified model of earphone and for a stated force of application of the earphone to the human ear

### 3.7

#### **reference equivalent threshold sound pressure level**

##### **RETSPL**

median value of the *equivalent threshold sound pressure levels* (3.6) of a sufficiently large number of ears of *otologically normal persons* (3.5), of both sexes, aged between 18 years and 25 years inclusive, expressing the threshold of hearing in a specified acoustic coupler or ear simulator for a specified type of earphone at a specified frequency

Note 1 to entry: Other statistical quantities, e.g. mean or modal values, have been used for the derivation of reference data given in this document (see also [Annex B](#)).

Note 2 to entry: The relationship between hearing threshold levels for *air conduction* (3.7) and age is specified in ISO 7029.

## 4 Specifications

### 4.1 General

The reference equivalent threshold sound pressure levels (RETSPLs) depend on the model of earphone and on the model of acoustic coupler or ear simulator used for calibration. To reduce the uncertainty of hearing threshold measurements, the model-specific data sets given in 4.3 or 4.4 shall be applied whenever available for the respective earphone in conjunction with the respective ear simulator/acoustic coupler. If model-specific data sets are not available and the earphone complies with the requirements of 4.2. a) to h), the generic data set given in 4.2 shall be used.



## 4.2 Generic supra-aural earphones in conjunction with an IEC 60318-1 ear simulator

The RETSPL values for generic supra-aural earphones in an ear simulator complying with IEC 60318-1 are given in [Table 1](#). The values are applicable to earphones meeting the following requirements:

- a) the earphone and its cushion, if any, shall be axially symmetrical;
- b) the construction and material shall be suitable for providing a good acoustic seal between the earphone (or its cushion) and the human ear;
- c) when placed in contact with a plane surface, the contact area of the earphone (or its cushion) shall be compatible with the sagittal dimensions of the human pinna;
- d) no part of the earphone (or its cushion) shall protrude beyond the plane of contact given in c), and the recess shall be approximately in the form of a truncated cone;
- e) the contour of the earphone (or its cushion) shall be such that contact with an ear simulator of the type specified in IEC 60318-1 is effective only at a diameter of 25 mm;

NOTE 1 This requirement means that the angle at the vertex of any recess cone which is tangential to the earphone contour on a diameter exceeding 25 mm will be greater than 116°.

- f) the material of the cushion shall not be so soft as to cause significant deformation when the earphone is applied to the ear simulator as determined by the following test:
  - 1) when a static force of 5 N is changed to 10 N;
  - 2) the output sound pressure level at 1 kHz for a given input voltage shall not change by more than 0,2 dB;
- g) the contour of the earphone (or its cushion) shall be such that, when placed on the human ear, contact is made with the pinna and not with the cranial tissue posterior to the pinna;

NOTE 2 This requirement excludes earphones of the circumaural type.

- h) a headband shall be provided to hold the earphone on the human pinna with a static force of  $4,5 \text{ N} \pm 0,5 \text{ N}$ .

The RETSPL values apply when the earphone is coupled to the ear simulator as follows:

- a) the earphone and the ear simulator are coaxial and the axis is vertical;
- b) without acoustic leakage;
- c) with the static force given in [Table 1](#).