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

**Part 3:
Reference equivalent threshold
vibratory force levels for pure tones
and bone vibrators**

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

*Partie 3: Niveaux de référence équivalents de force vibratoire
liminaire pour les vibrateurs à sons purs et les ossivibrateurs*



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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).

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).

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

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

This second edition cancels and replaces the first edition (ISO 389-3:1994), which has been technically revised. It also incorporates the Technical Corrigendum ISO 389-3:1994/Cor 1:1995.

ISO 389 consists of the following parts, under the general title *Acoustics — Reference zero for the calibration of audiometric equipment*:

- *Part 1: Reference equivalent threshold sound pressure levels for pure tones and supra-aural earphones*
- *Part 2: Reference equivalent threshold sound pressure levels for pure tones and insert earphones*
- *Part 3: Reference equivalent threshold vibratory force levels for pure tones and bone vibrators*
- *Part 4: Reference levels for narrow-band masking noise*
- *Part 5: Reference equivalent threshold sound pressure levels for pure tones in the frequency range 8 kHz to 16 kHz*
- *Part 6: Reference threshold of hearing for test signals of short duration*
- *Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions*
- *Part 8: Reference equivalent threshold sound pressure levels for pure tones and circumaural earphones*
- *Part 9: Preferred test conditions for the determination of reference hearing threshold levels*

Introduction

Each part of ISO 389 specifies a specific reference zero for the calibration of audiometric equipment. ISO 389-1, ISO 389-2 and ISO 389-8 are applicable to audiometric equipment for the transmission of pure tones by air conduction.

For clinical diagnostic and other audiometric purposes, it is often necessary to compare the measured hearing threshold levels of a person for sound transmitted to the inner ear by the air-conduction and bone-conduction pathways, respectively. Bone-conducted sound is provided for this purpose by an electromechanical vibrator applied to the mastoid prominence or to the forehead of the person under test.

The reference zero for the calibration of audiometric equipment for air conduction is defined in ISO 389-1, ISO 389-2 and ISO 389-8 in terms of reference equivalent threshold sound pressure levels (RETSPL), i.e. threshold sound pressure levels produced in an ear simulator or acoustic coupler of specified characteristics by supra-aural, circumaural or insert earphones of various patterns, when excited electrically at a level corresponding to the threshold of hearing of young otologically normal persons. Similarly, this part of ISO 389 provides a reference zero for bone-conduction audiometry in terms of reference equivalent threshold vibratory force levels (RETVFL), i.e. the vibratory force levels produced by a bone vibrator on a specified mechanical coupler when the vibrator is excited electrically at a level corresponding to the threshold of hearing of young otologically normal persons. In some countries, the preferred location is the mastoid prominence; in other countries, the forehead location is used in addition to the mastoid prominence. Different RETVFL values are valid for each of the two positions (see [Annex C](#)).

For bone-conduction measurements, it is necessary to specify the static force of application of the vibrator to the test subject and to the mechanical coupler, as well as certain geometrical features of the vibrator tip. In addition, it is usually necessary to apply masking noise to the ear not under test, since excitation of the cranial bones by the vibrator may be heard by that ear instead of (or in addition to) the ear intended for the test. An appropriate specification of the masking noise is, therefore, required as an adjunct to the reference equivalent threshold vibratory force levels, and such a specification is given in this part of ISO 389. Due to the so-called “occlusion effect” whereby the wearing of the transducer needed to provide the (air-conducted) masking noise causes a lowering of the bone-conduction threshold of hearing of the ear receiving the masking signal, it is necessary for the level of masking noise to be raised to cancel out the occlusion effect and provide adequate masking of the ear not under test. The specification of masking noise given in this part of ISO 389 is based on the procedures used in the experimental investigations from which the reference zero of this part of ISO 389 is derived.

Use of this reference zero to calibrate audiometers will ensure that measured bone-conduction hearing threshold levels of persons with unimpaired hearing or with hearing losses of purely sensorineural type (i.e. having unimpaired outer and middle ear function) will be compatible with the air-conduction hearing threshold levels of the same persons when using the reference zero of ISO 389-1, ISO 389-2 or ISO 389-8, respectively. Although exact equivalence of air-conduction and bone-conduction thresholds for any individual in these classes cannot be expected, due to biological variability of sound transmission through the external and middle ear and through the cranial bones, this part of ISO 389 will ensure that systematic deviations averaged over groups of such persons are reduced to a practical minimum.

This part of ISO 389 is based on an assessment of technical data provided by laboratories in three countries using methods of threshold testing which, in the respects described, were essentially uniform. Examination of the data showed that the experimental results were consistent. It has, therefore, been possible to standardize a reference zero by means of RETVFL values which are to be used for all bone vibrators used in audiometry having similar characteristics to those used by the laboratories. The systematic uncertainties introduced by this deliberate simplification will be small in comparison to the usual step size of hearing level controls in clinical audiometers (5 dB).

Acoustics — Reference zero for the calibration of audiometric equipment —

Part 3: Reference equivalent threshold vibratory force levels for pure tones and bone vibrators

1 Scope

This part of ISO 389 specifies the following data applicable to the calibration of bone vibrators for pure-tone bone-conduction audiometry:

- a) reference equivalent threshold vibratory force levels (RETVFL), corresponding to the threshold of hearing of young otologically normal persons by bone-conduction audiometry;
- b) essential characteristics of the bone vibrator and the method of coupling to the test subject, and to the mechanical coupler;
- c) essential characteristics of the masking noise and the baseline masking noise level applied to the ear not under test.

Guidance on the practical application of this part of ISO 389 in the calibration of audiometers is given in [Annex B](#).

RETVFL is the vibratory force level transmitted to a mechanical coupler of specified characteristics by a vibrator when applied to the mechanical coupler under stated conditions of test and when energized at the voltage level corresponding to the normal threshold of hearing for location on the mastoid prominence.

NOTE 1 Values for the differences in reference equivalent threshold vibratory force levels between location on the forehead and mastoid are included for information in [Annex C](#).

NOTE 2 Recommended procedures for carrying out bone-conduction audiometry are specified in ISO 8253-1.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 389-1, *Acoustics — Reference zero for the calibration of audiometric equipment — Part 1: Reference equivalent threshold sound pressure levels for pure tones and supra-aural earphones*

ISO 389-2, *Acoustics — Reference zero for the calibration of audiometric equipment — Part 2: Reference equivalent threshold sound pressure levels for pure tones and insert earphones*

ISO 389-4, *Acoustics — Reference zero for the calibration of audiometric equipment — Part 4: Reference levels for narrow-band masking noise*

IEC 60318-6, *Electroacoustics — Simulators of human head and ear — Part 6: Mechanical coupler for the measurement of bone vibrators*