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

Part 8:

**Reference equivalent threshold sound
pressure levels for pure tones and
circumaural earphones**

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

*Partie 8: Niveaux de référence équivalents de pression acoustique
liminaire pour les écouteurs à sons purs circumauraux*



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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 389-8 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

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 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 equivalent threshold sound pressure levels for acoustic 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 on preferred test conditions for the standardization of reference equivalent threshold sound pressure levels or vibratory force levels, is under preparation.

Introduction

This part of ISO 389 has been established in order to be able to use the same earphone for pure tone audiometry in the frequency range 125 Hz to 16 000 Hz. It specifies reference values from 125 Hz to 8 000 Hz. ISO/TR 389-5 specifies values from 8 000 Hz to 16 000 Hz.

The reference values are based on information provided by laboratories in different countries, representing the most reliable data available at this time.

At present, reference values for only one type of circumaural earphone, SENNHEISER HDA 200, are available. This earphone provides a good attenuation of background noise and its frequency response is without pronounced resonances on a human ear as well as on an ear simulator.

Acoustics — Reference zero for the calibration of audiometric equipment —

Part 8: Reference equivalent threshold sound pressure levels for pure tones and circumaural earphones

1 Scope

This part of ISO 389 specifies reference equivalent threshold sound pressure levels (RETSPLs) for pure tones in the frequency range from 125 Hz to 8 kHz, applicable to the calibration of air conduction audiometers equipped with a particular model of circumaural earphones (SENNHEISER HDA 200).

NOTE Some notes and references on the derivation and the test conditions used to determine the recommended reference levels are given in Annex A and the Bibliography.

The sound attenuation of the earphone is given in Annex B. For speech audiometers of types A-E and B-E (see IEC 60645-2), the correction figures of the earphone for a free-field equivalent output are given in Annex C.

2 Normative references

The following referenced documents are indispensable for the application 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.

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 4869-1, *Acoustics — Hearing protectors — Part 1: Subjective method for the measurement of sound attenuation*

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

IEC 60318-2:1998, *Electroacoustics — Simulators of human head and ear — Part 2: An interim acoustic coupler for the calibration of audiometric earphones in the extended high-frequency range*

IEC 60645-2, *Audiometers — Part 2: Equipment for speech audiometry*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 389-1, ISO 4869-1, IEC 60318-1 and IEC 60645-2 apply.

4 Specifications

The reference equivalent threshold sound pressure levels depend on the model of earphone and on the combination of the coupler or ear simulator and adapter used to calibrate it. Values for a closed-type circumaural earphone, SENNHEISER HDA 200, using an ear simulator and adapter as specified in IEC 60318-1 and IEC 60318-2:1998, Figure 1, respectively, are given in Table 1.

Table 1 — Reference equivalent threshold sound pressure levels of a circumaural earphone for a specified ear simulator and a specified adapter

Frequency Hz	RETSPL (ref. 20 μ Pa), in dB ^b
	Model of earphone
	SENNHEISER HDA 200
125	30,5
160 ^a	26,0
200 ^a	22,0
250	18,0
315 ^a	15,5
400 ^a	13,5
500	11,0
630 ^a	8,0
750	6,0
800 ^a	6,0
1 000	5,5
1 250 ^a	6,0
1 500	5,5
1 600 ^a	5,5
2 000	4,5
2500 ^a	3,0
3 000	2,5
3 150 ^a	4,0
4 000	9,5
5 000	14,0
6 000	17,0
6 300 ^a	17,5
8 000 ^c	17,5
^a	Values for these frequencies are partly derived by interpolation.
^b	Values rounded to the nearest half decibel.
^c	Value taken from ISO/TR 389-5.

NOTE Values for the HDA 200 earphone are based on the results from five laboratories (see Annex A). They are derived from determinations of the threshold of hearing of otologically normal persons under conditions as close as possible to those described in Reference [1].

The characteristics of earphones depend on temperature. It is therefore recommended to calibrate audiometers equipped with these earphones as closely as possible within the temperature range 21 °C to 25 °C.

The headband force of the circumaural earphone HDA 200 shall be within $10,0 \text{ N} \pm 1,0 \text{ N}$. The headband force shall be measured when the two earphones are separated by 145 mm and the height of the earphone is adjusted to provide a distance of 130 mm measured between the centre (top) of the headband and a line between the centres of the earphones.

Annex A
(informative)

Notes on the derivation of the reference equivalent threshold sound pressure levels for the circumaural audiometric earphone HDA 200

The reference equivalent threshold sound pressure levels for the circumaural audiometric earphone specified in this part of ISO 389 are obtained from the results of five independent experimental investigations (see References [2] to [6]). Specific details of the tests are given in Table A.1.

Table A.1 — Investigations of equivalent threshold sound pressure levels for a circumaural audiometric earphone (HDA 200)

	Reference				
	[2]	[3]	[4]	[5]	[6]
Type of test earphone	SENNHEISER HDA 200				
Number of test subjects	31	24	24	38	27
Number of ears tested	62	24	24	38	27
Males/females	17/14	13/11	15/9	15/23	13/14
Age range of test subjects, in years	18 to 25	18 to 25	18 to 23	18 to 25	18 to 25
Frequencies tested, in kHz	0,125 – 0,25 – 0,5 – 0,75 – 1 – 1,5 – 2 – 3 – 4 – 6	0,125 – 0,25 – 0,5 – 0,75 – 1 – 1,5 – 2 – 3 – 4 – 6	0,125 to 6,3 in one-third-octave steps and 0,75 – 1,5 – 3 – 6	0,125 – 0,25 – 0,5 – 0,75 – 1 – 1,5 – 2 – 3 – 4 – 6	0,125 to 6,3 in one-third-octave steps and 0,75 – 1,5 – 3 – 6
Type of ear simulator used	IEC 60318-1				
Type of adapter used for test earphone	IEC 60318-2:1998, Figure 1				
Statistical quantity used	Median				

Annex B (informative)

Sound attenuation of the earphone HDA 200

The sound attenuation of the audiometric earphone HDA 200 is given in Table B.1 as a function of centre frequency. The data were obtained in accordance with ISO 4869-1 from 16 test subjects using one-third-octave bands of noise as test signals in a diffuse sound field.

Table B.1 — Sound attenuation of the earphone HDA 200

Centre frequency Hz	Mean values of sound attenuation ^a dB
63	16,5
125	14,5
250	16,0
500	22,5
1 000	28,5
2 000	32,0
4 000	45,5
8 000	44,0

^a Values rounded to the nearest half decibel.

Data are taken from Reference [3].

Annex C (informative)

Correction figures for free-field equivalent output of the circumaural earphone HDA 200

The difference between the free-field sensitivity level G_F and the coupler sensitivity level G_C of the circumaural audiometric earphone HDA 200 using one-third-octave bands of noise as test signals is given in Table C.1 as a function of centre frequency. The data were obtained under binaural listening conditions from 16 test subjects, using one-third-octave bands of noise as test signals. However the results are equally applicable for monaural listening. In order to obtain the equivalent free-field sound-pressure levels produced by the earphone, the values in Table C.1 should be added to the measured sound pressure levels produced by the HDA 200 in the same ear simulator and adapter specified in Table 1.

NOTE These correction figures may be used for the calibration of equipment for speech audiometry.

Table C.1 — Difference between the free-field sensitivity level G_F and the coupler sensitivity level G_C of the circumaural audiometric earphone HDA 200 using an ear simulator with an adapter according to Table 1, and one-third-octave bands of noise as test signals

Centre frequency Hz	$G_F - G_C$ ^b dB
125	– 5,0
160 ^a	– 4,5
200 ^a	– 4,5
250	– 4,5
315 ^a	– 5,0
400	– 5,5
500	– 2,5
630 ^a	– 2,5
800 ^a	– 3,0
1 000	– 3,5
1 250	– 2,0
1 600	– 5,5
2 000	– 5,0
2 500	– 6,0
3 150	– 7,0
4 000	– 13,0
5 000	– 14,5
6 300	– 11,0
8 000	– 8,5
^a Values for these frequencies are derived by interpolation.	
^b Values rounded to the nearest half decibel.	

Data are taken from Reference [3].

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- [8] ISO 8253-1, *Acoustics — Audiometric test methods — Part 1: Basic pure tone air and bone conduction threshold audiometry*

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- 1) Under preparation as ISO 389-9.
 - 2) Under revision. To be upgraded to an International Standard.

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