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Acoustics — Reference zero for the calibration of audiometric equipment —

Part 6: Reference threshold of hearing for test signals of short duration

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

Partie 6: Niveaux liminaires d'audition de référence pour signaux d'essai de courte durée

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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 389-6 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 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

IEC 60645-3 specifies audiometric test signals of short duration. These short-duration signals consist of clicks and tone-bursts, and they are used in different diagnostic tests, e.g. in Evoked Response Audiometry such as auditory electrophysiology (electrocochleography, auditory brainstem responses, etc.), and transient evoked otoacoustic emissions. This part of ISO 389 specifies reference threshold values for the short-duration signals.

The reference hearing threshold data for specific transducers described herein will promote agreement and uniformity in the expression of results of hearing threshold measurements.

Acoustics — Reference zero for the calibration of audiometric equipment —

Part 6:
Reference threshold of hearing for test signals of short duration

1 Scope

This part of ISO 389 specifies reference hearing threshold levels for tests signals of short duration applicable to the calibration of audiometric equipment where such signals are used.

NOTE 1 Some notes on different parameters and their effects on threshold levels are given in Annex A.

NOTE 2 Preferred test conditions for determining hearing thresholds for standardization are specified in ISO 389-9.

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*

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

IEC 60318-4, *Electroacoustics — Simulators of human head and ear — Part 4: Occluded-ear simulator for the measurement of earphones coupled to the ear by inserts* [1)]

IEC 60318-6, *Electroacoustics — Simulators of human head and ear — Part 6: Mechanical coupler for the measurements on bone vibrators* [2)]

IEC 61094-1, *Measurement microphones — Part 1: Specifications for laboratory standard microphones*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 389-1 and the following apply.

3.1
short-duration signal
signal having a duration of less than 200 ms

1) Revision of IEC 60711:1981.

2) Revision of IEC 60373:1990.

3.2
click
transient acoustic or vibratory signal whose frequency spectrum covers a broad frequency range, and which is produced by applying a single rectangular pulse to a transducer

3.3
tone-burst
sinusoidal signal multiplied by a time window of less than 200 ms

3.4
condensation signal
short-duration signal, the initial pressure wave of which causes an over-pressure relative to ambient pressure, or the initial force wave of which causes an over-force relative to the static force at the plane of the output port of the transducer

3.5
rarefaction signal
short-duration signal, the initial pressure wave of which causes an under-pressure relative to ambient pressure, or the initial force wave of which causes an under-force relative to the static force at the plane of the output port of the transducer

3.6
alternating polarity signal
series of short-duration signals, alternating between rarefaction and condensation signals

3.7
reference pulse
electric rectangular pulse (single monophasic rectangular wave) of (100 ± 10) μs duration with rise and fall times less than 25 μs as specified in IEC 60645-3:2007, 5.2

NOTE The signal output of the transducer can vary considerably depending upon the type used.

3.8
reference tone-burst
electric signal consisting of five periods of the fundamental sine wave and having a linear rise and fall of 1,6 periods and a duration of three periods as specified in IEC 60645-3:2007, 5.3

NOTE 1,6 periods of linear rise and fall corresponds to two periods from zero to 100 % amplitude. The signal envelope remains at the 100 % amplitude for one period. The reference tone-burst can also be described according to the '2-1-2' concept where '2' indicates the number of periods from zero to 100 % amplitude and back to zero, and '1' is the 100 % amplitude period.

3.9
reference equivalent threshold sound pressure level
RETSPL
at a specified frequency, the median value of the equivalent threshold sound pressure levels of a sufficiently large number of ears of otologically normal persons, of both sexes, aged between 18 years and 25 years inclusive, expressing the threshold of hearing in a specified ear simulator for a specified type of earphone

3.10
reference equivalent threshold vibratory force level, monaural listening
RETVFL
at a specified frequency, the median value of the equivalent threshold vibratory force levels of a sufficiently large number of ears of otologically normal persons, of both sexes, aged between 18 years and 25 years inclusive, expressing the threshold of hearing in a specified mechanical coupler for a specified configuration of bone vibrator

3.11
reference threshold sound pressure level
RTSPL
at a specified frequency, the median value of the threshold sound pressure levels of a sufficiently large number of otologically normal persons, of both sexes, aged between 18 years and 25 years inclusive, expressing the threshold of hearing under free-field conditions

3.12
peak-to-peak equivalent signal level
root-mean-square (r.m.s.) value of a long-duration sinusoidal signal which, when compared under the same test conditions with a short-duration output signal from the transducer under test, has the same peak-to-peak value (i.e. difference between the extreme positive and the extreme negative values) as the short-duration signal

NOTE 1 For clicks (3.2), the long-duration sinusoidal signal should have a frequency of 1 000 Hz, and for tone-bursts (3.3) its frequency should equal the fundamental frequency of the tone-burst.

NOTE 2 The term peak-to-peak equivalent signal level is often called peak equivalent signal level.

NOTE 3 The peak level of a short-duration signal is between 3 dB and 9 dB greater than the peak-to-peak equivalent level, i.e. 3 dB when the signal is quite symmetrical around the zero baseline and 9 dB when it is completely on one side of the zero level.

NOTE 4 The recommended abbreviations for peak-to-peak equivalent (pe) sound pressure level and vibratory force level are peSPL and peVFL.

3.13
peak-to-peak equivalent reference equivalent threshold sound pressure level or vibratory force level
peRETSPL/peRETVFL
peak-to-peak equivalent RETSPL or RETVFL value

NOTE The equivalence in this clause when the full terms (peRETSPL or peRETVFL) are used is between two different signals. When short-duration signals are standardized as sound pressure levels or vibratory force levels for hearing threshold purposes, a further equivalence occurs due to the method of measuring hearing threshold levels in an ear simulator or on a mechanical coupler, respectively, i.e. in terms of equivalent threshold sound pressure or vibratory force levels.

3.14
peak-to-peak equivalent reference threshold sound pressure level
peRTSPL
peak-to-peak equivalent RTSPL value

4 Specifications

The reference hearing threshold levels depend on the type of test signal (click, tone-burst), the type of transducer (earphone, bone vibrator, loudspeaker) and the equipment used for calibration (ear simulator, free field). The recommended standard values for the click signal based on the reference pulse are given in Tables 1 to 3. They are derived from determinations of the threshold of hearing of otologically normal persons (conditions given in References [4] to [6]).

Similarly, the recommended standard values for the reference tone-burst signals are given in Table 4. They are derived from determinations of the threshold of hearing of otologically normal persons (conditions given in References [6] to [8]).

Table 1 — Recommended peRETSPLs for groups of clicks based on the electric reference pulse with a repetition rate of 20 Hz and a duration of 1 s for the click train sequence — Earphones (monaural hearing)

Type of earphone	Ear simulator used according to	peRETSPL (re 20 µPa) dB [a]
Sennheiser HDA 200	IEC 60318-1	28,0
Maico BERAphone	IEC 60318-1	33,0 [b]
Telephonics TDH-39	IEC 60318-1	31,0
Beyer DT 48	IEC 60318-1	32,0 [b]
Sennheiser HDA 280	IEC 60318-1	31,5 [b]
Etymotic Research ER-2	IEC 60318-4	43,5 [b]
Etymotic Research ER-3A	IEC 60318-4	35,5 [b]

[a] Values are rounded to the nearest half decibel.

[b] Experimental data were reported from one laboratory only.

NOTE The listed median values are based on alternating polarity clicks with 100 µs electric pulse length.

Table 2 — Recommended peRTSPLs for groups of clicks based on the electric reference pulse with a repetition rate of 20 Hz and a duration of 1 s for the click train sequence — Loudspeakers (binaural hearing)

Type of loudspeaker	Microphone used	peRTSPL (re 20 µPa) dB[a]
KEF RDM1	WS2F according to IEC 61094-1	20,0[b]

[a] Values are rounded to the nearest half decibel.

[b] Experimental data were reported from one laboratory only.

NOTE 1 The listed median values are based on alternating polarity clicks with 100 µm electric pulse length.

NOTE 2 Loudspeaker values are only applicable under free-field conditions (ISO 8253-2).

Table 3 — Recommended peRETVFLs for groups of clicks based on the electric reference pulse with a repetition rate of 20 Hz and a duration of 1 s for the click train sequence — Bone vibrators (without any masking of the non-test ear)

Type of bone vibrator	Mechanical coupler used according to	peRETVFL (re 1 µN) dB[a]
Radioear B-71	IEC 60318-6	51,5[b]

[a] Values are rounded to the nearest half decibel.

[b] Experimental data were reported from one laboratory only.

NOTE The listed median values are based on alternating polarity clicks with 100 µs electric pulse length.

Table 4 — Recommended peRETSPLs for groups of reference tone-bursts with a repetition rate of 20 Hz and a duration of 1 s for the tone-burst train sequence — Earphones (monaural hearing, median values)

Earphone (ear simulator)	peRETSPL (re 20 µPa) dB[a]							
	Frequency							
	250 Hz	500 Hz	1 000 Hz	2 000 Hz	3 000 Hz	4 000 Hz	6 000 Hz	8 000 Hz
Sennheiser HDA 200 (ear simulator: IEC 60318-1)	28,0 [b]	21,5	19,5	20,0	22,0*	29,0	38,0[b]	41,0
Sennheiser HDA 280 (ear simulator: IEC 60318-1)	33,0 [b]	23,5 [b]	21,5 [b]	25,0[b]	—	29,5 [b]	—	41,0 [b]
Telephonics TDH-39 (ear simulator: IEC 60318-1)	32,0 [b]	23,0	18,5	25,0	25,5 [b]	27,5	36,0 [b]	41,0
Etymotic Research ER-3A (ear simulator: IEC 60318-4)	28,0 [b]	23,5 [b]	21,5 [b]	28,5 [b]	—	32,5 [b]	—	—

[a] Values are rounded to the nearest half decibel.

[b] Experimental data were reported from one laboratory only.