INTERNATIONAL STANDARD

ISO 8253-2

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Acoustics — Audiometric test methods —

Part 2: Sound field audiometry with pure-tone and narrow-band test signals

Acoustique — Méthodes d'essais audiométriques —

Partie 2: Audiométrie en champ acoustique avec des sons purs et des bruits à bande étroite comme signaux d'essai

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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.

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 8253-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

This second edition cancels and replaces the first edition (ISO 8253-2:1992), of which it constitutes a minor revision.

ISO 8253 consists of the following parts, under the general title *Acoustics — Audiometric test methods*:

— *Part 1: Basic pure-tone air and bone conduction threshold audiometry*

— *Part 2: Sound field audiometry with pure-tone and narrow-band test signals*

— *Part 3: Speech audiometry*

Introduction

ISO 8253-1 covers procedures for the determination of thresholds of hearing using pure tones presented to the subject by means of earphone or bone vibrator.

This part of ISO 8253 covers procedures for the determination of thresholds of hearing in a sound field. In general, sound field testing implies binaural listening to a test signal, presented by means of one or more loudspeakers in a test room. The test signal may be a pure tone, a frequency-modulated tone or a narrow band of noise. The acoustical characteristics of the sound field are determined by the choice of test signal, by the number and acoustical properties of the loudspeakers used, as well as by the acoustical characteristics of the test room.

Sound field audiometry may be used for various purposes, e.g. the evaluation of hearing acuity in young children and the determination of the functional gain of a hearing aid when worn by a particular listener.

Acoustics — Audiometric test methods —

Part 2:
Sound field audiometry with pure-tone and narrow-band test signals

1 Scope

This part of ISO 8253 specifies relevant test signal characteristics, requirements for free, diffuse, and quasi-free sound fields, and procedures for sound field audiometry using pure tones, frequency-modulated tones or other narrow-band test signals presented by means of one or more loudspeakers. The primary purpose is the determination of hearing threshold levels in the frequency range 125 Hz to 8 000 Hz, but this range can be extended to 20 Hz to 16 000 Hz.

This part of ISO 8253 does not include specifications for the use of hand-held loudspeakers. Speech as a test signal is not covered.

The purpose of this part of ISO 8253 is to ensure that tests of hearing, using sound field audiometry, give as high a degree of accuracy and reproducibility as possible.

Examples of graphical representations of the results are given in Annex A.

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 226, *Acoustics — Normal equal-loudness-level contours*

ISO 266, *Acoustics — Preferred frequencies*

ISO 389-7, *Acoustics — Reference zero for the calibration of audiometric equipment — Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions*

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

IEC 60581-7:1986, *High fidelity audio equipment and systems — Minimum performance requirements — Part 7: Loudspeakers*

IEC 60645-1, *Electroacoustics — Audiometric equipment — Part 1: Pure-tone audiometers*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

1) To be published. (Revision of ISO 8253-1:1989)

3 Terms and definitions

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

3.1
air conduction
transmission of signal through the external and middle ear to the inner ear

3.2
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 drugs, or of familial hearing loss

3.3
reference point
midpoint of a straight line connecting the ear canal openings of the listener when positioned in the listening position in the sound field

3.4
reference axis
axis perpendicular to the radiating surface of the loudspeaker

NOTE 1 For single radiator or horn loudspeakers, the axis passes through the geometric centre of the diaphragm or the horn.

NOTE 2 For multi-unit loudspeakers, the position of the axis is defined by the manufacturer.

3.5
threshold of hearing
level of a sound at which, under specified conditions, a person gives 50 % of correct detection responses on repeated trials

3.6
threshold sound pressure level
for a given listener, a specified signal and a specified manner of signal presentation, sound pressure level at the **reference point** (3.3) in the specific sound field, in the absence of the listener, which in the presence of the listener in the test position would correspond to the **threshold of hearing** (3.5) of the listener

3.7
reference threshold sound pressure level
for a specific signal and a specified manner of signal presentation, median value of the **threshold sound pressure levels** (3.6) of a sufficiently large number under test of **otologically normal persons** (3.2), of both genders, aged between 18 years and 25 years inclusive, expressing the **threshold of hearing** (3.5) at the **reference point** (3.3) in the specific sound field

3.8
hearing level
for a specified signal and a specified manner of signal presentation, sound pressure level of this signal at the **reference point** (3.3) in the specific sound field minus the appropriate **reference threshold sound pressure level** (3.7)

3.9
hearing threshold level
for a specified signal and a specified sound field, **threshold of hearing** (3.5) expressed either as **hearing level** (3.8) or as sound pressure level

3.10
carrier frequency of a frequency-modulated tone
average value of the periodically varying tone frequency

NOTE The carrier frequency is designated as the nominal test frequency.

3.11
frequency deviation
maximum difference between the instantaneous frequency of the frequency-modulated tone and the carrier frequency

3.12
free sound field
sound field where the boundaries of the room exert a negligible effect on the sound waves

3.13
quasi-free sound field
sound field where the boundaries of the room exert only a moderate effect on the sound waves

NOTE The requirements for a quasi-free sound field are specified in 5.4.

3.14
diffuse sound field
sound field which in a given region has statistically uniform energy density, for which the directions of propagation at any point are randomly distributed

3.15
white noise
noise whose power spectral density is independent of frequency

3.16
noise bandwidth
difference between the upper and lower band-edge frequencies of a noise band

NOTE At these frequencies the power spectral density of the noise is reduced to one-half of its average within the noise band.

3.17
centre frequency of a noise band
geometric mean of the band-edge frequencies which define the **noise bandwidth** (3.16)

3.18
functional gain of a hearing aid
for a specified test signal, a specified type of sound field, a specified manner of signal presentation, and for a particular listener, difference in thresholds of hearing of the listener with and without the hearing aid

4 Test signal characteristics

4.1 General

This part of ISO 8253 covers test signals that are either pure tones, frequency-modulated (FM) tones or narrow bands of noise.

4.2 Pure tones

Pure tones shall be used only in a free sound field which is in accordance with the specifications given in 5.2.

NOTE In other types of sound field, pure tones may show large spatial variations in sound pressure level due to standing waves.

When test tones of fixed frequencies are used, they shall be chosen from the audiometric test frequencies given in IEC 60645-1 or the frequencies given in ISO 266.

The actual frequency shall be within ± 1,5 % of the nominal frequency. This corresponds to the specification of an audiometer complying with the requirements of IEC 60645-1, type 1 and type 2.

4.3 FM tones

FM tones are defined by the following characteristics, which shall be reported:

a) carrier frequency;

b) waveform of modulating signal;

c) repetition rate of modulating signal;

d) frequency deviation.

The carrier frequency shall be chosen from the audiometric test frequencies as specified in IEC 60645-1 or the frequencies given in ISO 266.

The waveform of the modulating signal shall be either sinusoidal or triangular. The triangular waveform shall have symmetrical rising and falling portions on a linear or on a logarithmic frequency scale.

The carrier frequency shall be within ± 3 % of its nominal frequency.

The repetition rate of the modulating signal shall be within the range 4 Hz to 20 Hz with a tolerance of ± 10 % of its nominal value.

The frequency deviation shall be in the range ± 2,5 % to ± 12,5 % with a tolerance of ± 10 % of its nominal value.

If the modulating waveform is sinusoidal, its total harmonic distortion shall not exceed 5 %. If it is triangular, its ramps shall not deviate from a linear form by more than 5 % of its amplitude. For the triangular waveform, the durations of the rising and falling portions shall not differ by more than 10 %.

4.4 Narrow bands of noise

The centre frequency and the bandwidth of a narrow band of noise shall comply with the specifications for narrow-band masking noise according to IEC 60645-1. The centre frequency and the bandwidth shall be reported.

NOTE 1 When bandwidths exceed one-third octave, reference threshold sound pressure levels may differ from those valid for bandwidths up to one-third octave.

NOTE 2 Signal power outside the passband, which is mainly determined by the slopes and stop-band rejection characteristics of the filter, may influence the results of sound field audiometry, in particular on hearing-impaired test subjects.

4.5 Harmonic distortion

If pure tones are available as test signals, the linearity of the complete system shall be such that the total harmonic distortion does not exceed 5 % at 125 Hz and 3 % at 250 Hz, 500 Hz and 1 000 Hz when measured acoustically at the reference point in the test room. These conditions shall be met over the whole dynamic range available.

NOTE It is usually sufficient to measure the harmonic distortion at the maximum available output sound pressure level.

The harmonic distortion of loudspeakers can only be tested in a free sound field. Where only a quasi-free or a diffuse sound field is available, harmonic distortion may be measured electrically across the loudspeaker input terminal. The total harmonic distortion shall be less than 1 % and the loudspeaker shall comply with the specifications given in IEC 60581-7:1986, Clause 10.

If pure tones are not available as test signals, the linearity of the equipment shall be tested by connecting an external pure-tone generator to replace the original test signal source.

When FM tones are used as test signals, the r.m.s. output level of the external pure-tone generator shall be equal to that delivered by the test signal source when in normal use.

When narrow bands of noise are used as test signals, the output of the external pure-tone generator shall be set to a level 9 dB above the root mean square (r.m.s.) value delivered by the test signal source when in normal use.

4.6 Signal gating

The signal shall be either presented as singular sound bursts of a duration in the range 1 s to 2 s or repeatedly gated on and off. The requirements given in IEC 60645-1 regarding rise and fall times, on/off-times and on/off ratio as well as under- and overshoot shall be complied with when measured electrically at the loudspeaker terminals with pure tones as test signals.

NOTE The reverberation characteristics of the test room may exert a significant influence on the decay of the acoustic test signal.

4.7 Signal level control

4.7.1 Step size

The signal level shall be variable in intervals of 5 dB or less.

4.7.2 Accuracy

The maximum accumulated error in the difference between any two signal level settings over the total signal level range of the attenuator shall not exceed 3 dB, as measured acoustically at the reference point. In addition, the specifications given in IEC 60645-1 shall be complied with.

4.7.3 Dynamic range

In the frequency range 500 Hz to 6 000 Hz, the test signal hearing level at the reference point shall cover at least the range 0 dB to 80 dB.

NOTE It is desirable that the same test signal hearing level range be covered outside this frequency range.

4.8 Means and scales for calibration

The equipment shall provide means for adjusting the level of each test sound separately. The scale shall be expressed in hearing level or sound pressure level. Measurements shall be made with a sound level meter conforming to IEC 61672-1, type 1.

For pure tones and one-third-octave bands of noise in a frontally incident field, and for one-third-octave bands of noise in a diffuse sound field, reference threshold sound pressure levels corresponding to the normal binaural threshold of hearing as specified in ISO 226 shall be taken as reference threshold sound pressure levels. These data shall be used also for FM tones complying with the requirements of 4.3. For other combinations of test signal and sound field type, no standardized data exist.

NOTE 1 In practice, other angles of incidence are also used, e.g. 45°. No standardized reference threshold sound pressure levels presently exist. However, in Annex B, correction values for 45° and 90° angles of incidence are given.