INTERNATIONAL STANDARD

ISO 12124

First edition
2001-03-15

Acoustics — Procedures for the measurement of real-ear acoustical characteristics of hearing aids

Acoustique — Méthodes pour le mesurage des caractéristiques acoustiques des appareils de correction auditive sur l'oreille réelle

Reference number
ISO 12124:2001(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12124 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

Annex A of this International Standard is for information only.

Introduction

The performance characteristics of hearing aids in actual use can differ significantly from those determined in accordance with standards such as IEC 60118-0 and IEC 60118-7, due to differing acoustical influence and coupling presented by individual ears. Measurement methods that take into account the acoustic coupling and the acoustical influence of the individual wearer on the performance of hearing aids are therefore important in the fitting of these devices. Such measurement methods have come to be known as "real-ear measurements" and are sometimes performed clinically in less than ideal acoustic environments. The accuracy and repeatability of measurements made under such conditions are complex functions of the sound field, the test environment, the nature of the test signal, the hearing aid under evaluation, the method of test signal control, the location of the sound source, the nature of the data acquisition, analysis and presentation, as well as the degree of subject movement permitted.

This International Standard details the terminology, test environment and test methods, and defines the necessary reference points to be used for the measurement of real-ear acoustical characteristics of hearing aids.

Acoustics — Procedures for the measurement of real-ear acoustical characteristics of hearing aids

1 Scope

This International Standard specifies procedures and requirements for measuring the real-ear acoustical characteristics of hearing aids. Its purpose is to ensure that the same measurements made on a given hearing aid on a given human ear and a given hearing aid, following the procedures described and using equipment complying with the requirements of IEC 61669, give substantially the same results.

Measurements of real-ear acoustical characteristics of hearing aids which apply non-linear or analytical processing techniques are valid only for the test signals used and conditions employed. These measurements should be performed in accordance with the hearing aid manufacturer's recommendations as they may require specific test signals or test conditions outside the scope of this International Standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8253-2, *Acoustics — Audiometric test methods — Part 2: Sound field audiometry with pure tone and narrow-band test signals*.

IEC 60942, *Electroacoustics — Sound calibrators*.

IEC 61669, *Electroacoustics — Equipment for the measurement of real-ear acoustical characteristics of hearing aids*.

3 Terms and definitions

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

3.1
test signal
acoustic signal at the field reference point

3.2
subject
person in whose ear canal the hearing aid performance is being characterized

3.3
subject test position
position with subject seated in a reproducible upright position with the head erect and the subject reference point located on the test axis at the working distance

3.4
subject reference point
point bisecting the line joining the centres of the openings of the ear canals of the subject (at the junction between concha and ear canal)

See Figure 1.

NOTE In cases of severe head shape abnormality or asymmetry, it may not be easy to determine the reference point of the subject. The subject reference point used should then be stated.

3.5
test axis
line joining the subject reference point to the sound source, passing along the axis of the sound source

See Figure 1.

3.6
working distance
distance from the subject reference point to the plane of the mounting ring or protective grille of the sound source, measured along the test axis

See Figure 1.

3.7
sound pressure level
SPL
20 times the logarithm to the base 10 of the ratio of a given root-mean-square sound pressure to the reference sound pressure

NOTE 1 Based on IEC 60050-801 (*International Electrotechnical Vocabulary*).

NOTE 2 Throughout this International Standard, all sound pressure levels refer to a reference level of 20 μPa.

3.8
band sound pressure level
sound pressure level measured for a defined band

3.9
test signal level
level of the test signal expressed as a sound pressure level

NOTE 1 It is expressed in decibels (dB).

NOTE 2 For broad-band signals, the frequency spectrum should be specified and stated.

3.10
equalization
process of controlling the test signal level as a function of frequency such that it does not vary from the desired level

3.11
reference microphone
microphone used to measure the test signal level in the measurement process and/or to control it in the equalization process

See Figure 2.

NOTE Alternatively it may be referred to as the controlling microphone.

3.12
sound inlet
aperture through which sound enters a microphone and at which the microphone is calibrated

NOTE In the case of a probe microphone (see 3.15) which includes an extension tube, this will be the open end of the probe tube.

3.13
field reference point
point at which the sound inlet of the reference microphone is located during equalization and/or measurement

See Figure 2.

3.14
tester
person carrying out the test on the subject

3.15
probe microphone
microphone adapted to determine the sound pressure level in the ear canal

NOTE The probe microphone may include an extension tube (see Figure 2).

3.16
test ear
ear of the subject in which the sound inlet of the probe microphone is placed

3.17
axis of rotation
straight line about which the subject can be rotated, passing through the subject reference point and lying in the vertical plane of symmetry

See Figure 1.

3.18
azimuth angle of sound incidence
angle between the plane of symmetry of the subject and the plane defined by the axis of rotation and the test axis

See Figure 1.

NOTE When the subject faces the sound source, the azimuth angle of sound incidence is defined as 0°. When the test ear of the subject faces the sound source, the azimuth angle is defined as 90°. When the non-test ear faces the sound source, the angle is defined as -90°.

3.19
subject reference plane
horizontal plane that contains the subject reference point

See Figure 1.

3.20
elevation angle of sound incidence
angle between the subject reference plane and the test axis

See Figure 1.

NOTE When the top of the subject points towards the sound source, the elevation angle is defined as $+90^\circ$. When the test axis lies in the reference plane, the elevation angle is defined as 0°.

3.21
measurement point
point in the ear canal of the test ear at which the sound inlet of the probe microphone is placed

See Figure 2.

3.22
test signal type
identification of the test signal in terms of its frequency spectrum and/or temporal properties

3.23
concurrent equalization
equalization performed at the time of measurement, based on the monitoring of the test signal level

NOTE Alternatively it may be referred to as real-time equalization.

3.24
stored equalization
equalization performed at the time of measurement, based on data recorded during a prior measurement of the sound field

3.25
substitution method
method of measurement using stored equalization where the reference microphone is located at the subject reference point and the subject is absent during the recording of the sound field data

3.26
modified pressure method
method of measurement using stored or concurrent equalization with the field reference point near the surface of the head, close to the test ear but outside the acoustic influence of the pinna and the hearing aid

NOTE The exact location of the field reference point should be specified by its perpendicular distance from the surface of the head, and its distance (in millimetres) forward of and above or below the centre of the ear canal entrance.

3.27
differential comparison
measurement in which the test signal level is subtracted from the SPL at the measurement point

NOTE When using broad-band signals, band sound pressure levels should be used.

3.28
real-ear unaided response
REUR
SPL as a function of frequency at the measurement point for a specified test signal level with the ear canal unoccluded

3.29
real-ear unaided gain
REUG
difference, in decibels, between the SPL at the measurement point and the test signal level, as a function of frequency, with the ear canal unoccluded

NOTE When using broad-band signals, band sound pressure levels should be used.

3.30
real-ear occluded response
REOR
SPL as a function of frequency at the measurement point for a specified test signal level with the hearing aid in place and turned off

3.31
real-ear occluded gain
REOG
difference, in decibels, between the SPL at the measurement point and the test signal level, as a function of frequency, with the hearing aid in place and turned off

NOTE When using broad-band signals, band sound pressure levels should be used.

3.32
real-ear aided response
REAR
SPL as a function of frequency at the measurement point for a specified test signal level, with the hearing aid in place and turned on

3.33
real-ear aided gain
REAG
difference, in decibels, between the SPL at the measurement point and the test signal level, as a function of frequency, with the hearing aid in place and turned on

NOTE When using broad-band signals, band sound pressure levels should be used.

3.34
real-ear insertion gain
REIG
difference, in decibels, between the aided response and the unaided response (REIG = REAR – REUR), or between the aided gain and the unaided gain (REIG = REAG – REUG), expressed as a function of frequency

NOTE The REAR and REUR must be derived using the same test signal level.

3.35
curve
real-ear acoustical characteristic (see 3.28 to 3.34) expressed and graphically displayed as a function of frequency

EXAMPLE Real-ear aided response curve.

3.36
free sound field
sound field where the boundaries of the room exert a negligible effect on the sound waves

[ISO 8253-2]

3.37
quasi-free sound field
sound field where the boundaries of the room exert only a moderate effect on the sound waves

[ISO 8253-2]

3.38
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

[ISO 8253-2]