BRITISH STANDARD

BS ISO
12124:2001

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

ICS 17.140.50

National foreword

This British Standard reproduces verbatim ISO 12124:2001 and implements it as the UK national standard.

The UK participation in its preparation was entrusted by Technical Committee EH/1, Acoustics, to Subcommittee EH/1/1, Hearing, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Health and Environment Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 July 2001

Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii to v, a blank page, pages 1 to 17 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 37526 9

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)

Contents

Annex

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

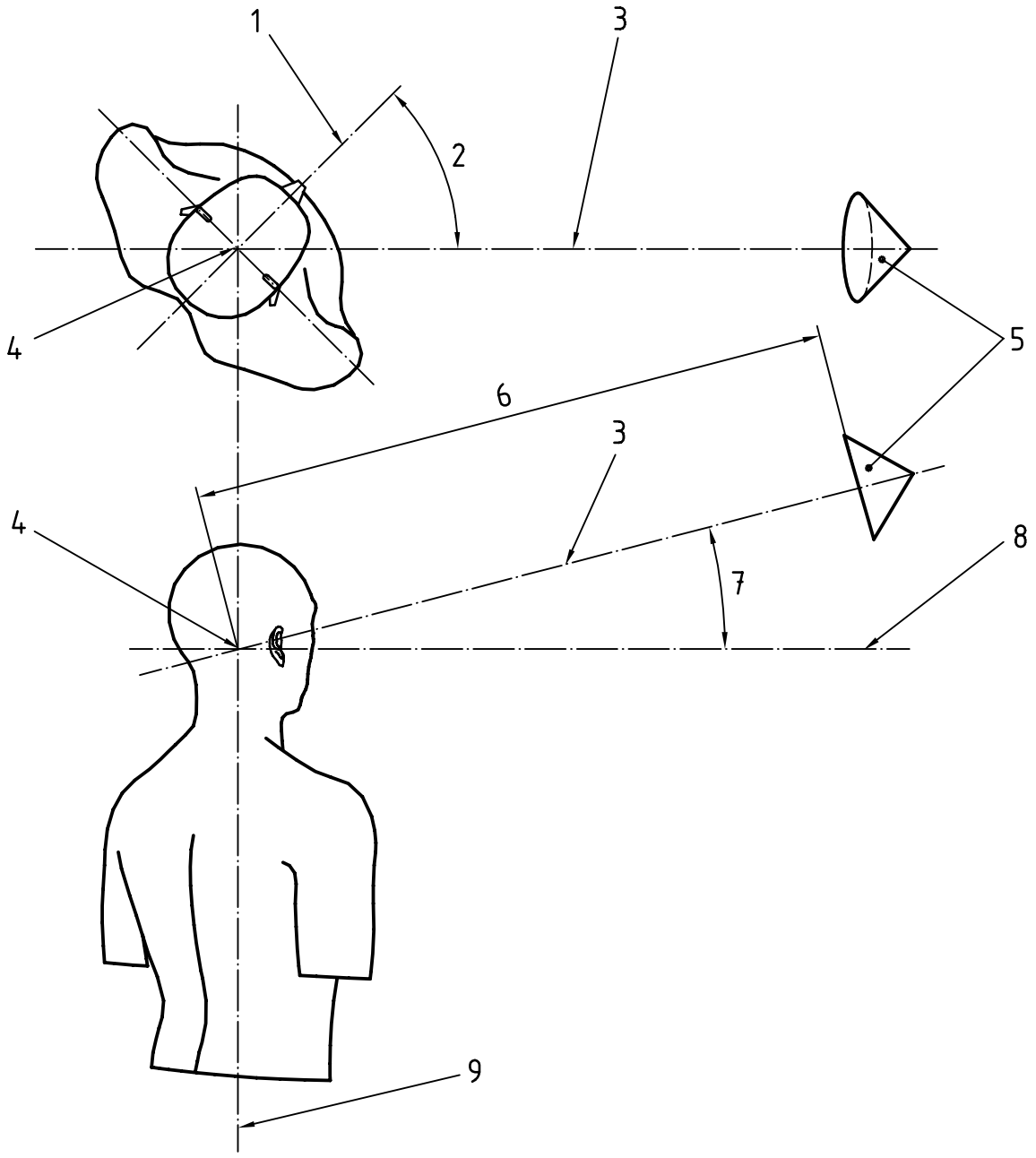
[ISO 8253-2]

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

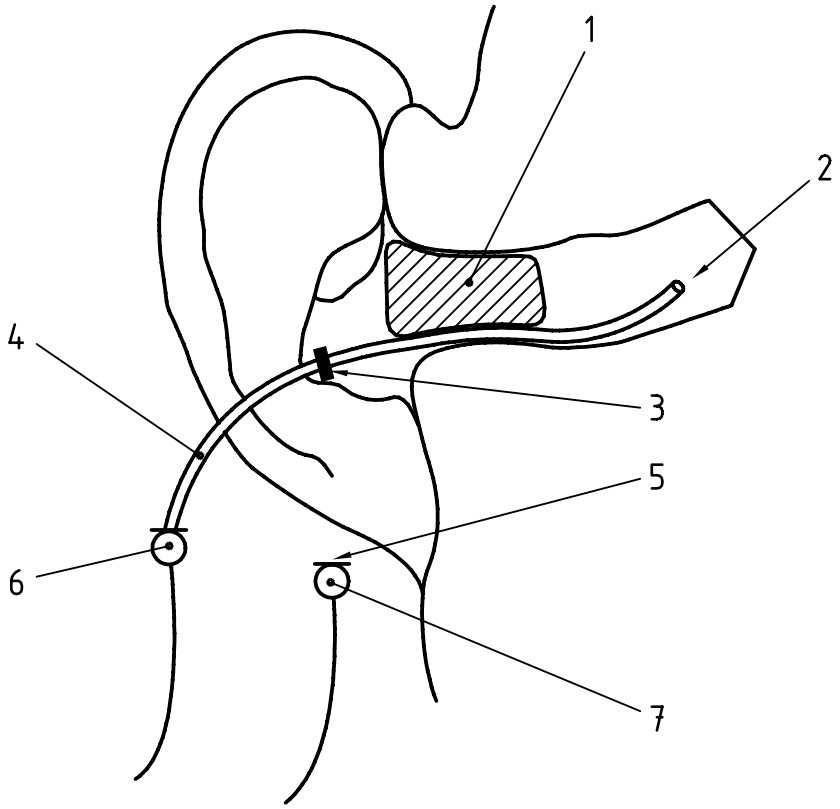
[ISO 8253-2]



Key

1	Plane of symmetry
2	Azimuth angle of sound incidence
3	Test axis
4	Subject reference point
5	Sound source
6	Working distance
7	Elevation angle of sound incidence
8	Subject reference plane
9	Axis of rotation

Figure 1 — Test arrangement



Key

1	Hearing aid or earmould
2	Measurement point
3	Marking or marking device
4	Probe extension tube
5	Field reference point
6	Probe microphone
7	Reference microphone

Figure 2 — Measurement arrangement

4 Limitations

Measurements of real-ear acoustical characteristics of hearing aids are influenced by the characteristics of the hearing aid, the test equipment, the test signal, the method of equalization, the test environment, the degree of subject movement permitted, the hearing aid subject interface and the physical characteristics of the subject.

NOTE Display and printing of results can be influenced by the method of analysis and presentation.

5 Conditions for test environment

5.1 Environmental conditions

Environmental conditions in the test space at the time of the test shall be within the range specified by the equipment manufacturers.

5.2 Ambient background noise

Ambient background noise in the test space shall not alter the test results by more than 1 dB at any frequency. The level of noise permitted depends upon the measuring equipment being used, the level of the test signal and the hearing aid under test. The test signal shall be at least 10 dB above the noise floor in all frequency bands. For any test signal type, removal of the test signal should cause the level at the field reference point to drop by at least 10 dB.

Hearing aids with automatic gain control circuitry, or which apply other non-linear signal processing techniques, might respond to ambient background noise in a way which may not be apparent from the measured output. When testing such devices, the ambient background noise level shall be below the activation threshold of the automatic gain control circuitry or other signal processing technique at all frequencies, or at a level which will not influence the resulting measurement by more than 1 dB.

5.3 Acoustical properties

The physical size and absorption characteristics of the test space influence the accuracy of real-ear measurements. The extent of this influence depends upon the test signal used, the working distance, the method of sound field equalization, subject movement, and the type of hearing aid being tested.

In order to minimize errors due to reflected sound, the field reference point should be chosen such that the distance from both the field reference point and the sound source to the nearest reflective surface is at least twice the working distance.

5.4 Sound field characteristics

The environment in which measurements are made can vary considerably. See ISO 8253-2 for a description of three types of sound field that should provide a suitable test environment. The free sound field and the diffuse sound field are well defined. In practice, it is not always possible to meet these specifications and therefore a third sound field, the quasi-free sound field, may be used, but only if the effects can be defined and quantified. The type of sound field used shall be stated. The test space shall allow the test signal level to be controlled to within 3 dB of the desired test signal level.

6 Preparation of subject

6.1 Otoscopic examination

Using an otoscope, the ear canal should be inspected by a suitably qualified person for excess cerumen and any abnormalities giving contraindication of fitness to undertake the test. Any abnormality that might influence the measurements should be recorded and considered before the test is initiated.

6.2 Position of subject

The subject should be comfortably seated upright at the subject test position. Unless otherwise specified by the equipment manufacturer, it is recommended that the subject be located at a minimum working distance of 0,5 m, and at an azimuth angle of sound incidence of 0° or 45° and an elevation angle of sound incidence of 0° (see Figure 1). The position of the subject shall be stated.

Alternatively, elevation angles of sound incidence between 0° and 45° may be used. If so, this should be stated.

6.3 Instructions to subject

Information on the test procedure shall be given unambiguously to the subject and should be fully understood. The subject shall be instructed to remain silent and avoid unnecessary movement during the measurements. The subject shall also be informed that he/she may interrupt the test at any time in the case of discomfort.

7 Measurement procedure

7.1 Equipment

All measurements of real-ear acoustical characteristics of hearing aids shall be made using test equipment in accordance with IEC 61669.

7.2 Calibration

Pretest calibration of the test equipment should be carried out directly, using a calibrator complying with IEC 60942, or indirectly following the manufacturer's instructions. Any setting-up procedures should also be performed in accordance with the manufacturer's instructions.

7.3 Equalization methods

7.3.1 Substitution method — Stored equalization

Following the equipment manufacturer's instructions, record the test signal at the subject reference point with the subject absent. The recording shall be updated whenever there is a change in the acoustic environment.

WARNING — This method requires a uniform sound field.

7.3.2 Modified pressure method — Stored equalization

Place the subject in the subject test position. Following the equipment manufacturer's instructions, determine the relevant equipment settings necessary to produce the desired test signal level then record the test signal. All objects that will be present during subsequent tests should be in position (including the tester). The recording shall be updated whenever there is a change in the subject's position, the field reference point or the acoustic environment.

7.3.3 Modified pressure method — Concurrent equalization

Equalization is not a separate process but occurs automatically during measurement by monitoring the test signal level.

This is the preferred method as other methods may produce unreliable results when measurements are made under non-ideal conditions. These other methods might only be suitable under laboratory conditions.

7.4 Test signal

7.4.1 Test signal characteristics

The test signal type may be narrow-band (pure tone, warble tone, narrow-band noise, etc.), or wide-band (broad-band noise, composite signal, speech weighted noise, etc.). The type of test signal used shall be recorded and specified according to the instructions of the equipment manufacturer.

7.4.2 Choice of test signal level

Special consideration shall be given to hearing aids with automatic gain control circuitry or which apply other signal processing techniques. For aided tests, this level shall be chosen with concern for subject safety and comfort.

When it is desired to test hearing aid performance in the linear operating region, the lowest possible test signal level should be used. Linearity should be verified by observing that over the frequency range 200 Hz to 6 000 Hz, or as

otherwise desired, a change in test signal level causes the same change at the measurement point. The frequency range used shall be stated.

NOTE The SPL presented to the hearing aid microphone can significantly exceed the test signal level because of the location of the hearing aid microphone and subject position.

7.5 Location of the subject

The subject shall be located at the subject test position (see 6.2) during all measurements except the initial sound field recording of the substitution method.

7.6 Location of the tester

The test signal level requirements shall be met with either the tester present or absent.

7.7 Choice of field reference point

This point may be recommended by the manufacturer or dictated by the physical construction of the equipment. Choose the field reference point to provide repeatable test signal levels that are within 3 dB of the desired value at the subject reference point.

The results of the measurements (REUR, REAR) depend upon the choice of field reference point. For devices operating linearly, REIG is independent of the field reference point. Care shall be taken to ensure that the presence of the hearing aid during the aided measurement does not alter the test signal.

7.8 Choice of measurement point

The measurement point shall be chosen such that a $\pm$ 2 mm change in its position shall produce a change of less than 2 dB in the measurement of interest over the frequency range 200 Hz to 6 000 Hz. For unoccluded measurements, this will generally require that the measurement point be within 6 mm of the tympanic membrane. Occluded measurements will, in general, additionally require that the measurement point be at least 5 mm beyond the sound outlet of the hearing aids (see annex A).

When locating the position of the sound inlet of the probe microphone at the measurement point, care should be taken to ensure the subject does not experience any discomfort.

WARNING — Take care to avoid blocking or compressing the probe microphone extension tube.

NOTE 1 Deeply inserted earmoulds and shells might not meet these requirements.

NOTE 2 Further information regarding the positioning of the probe microphone sound inlet can be found in annex A.

7.9 Location and coupling of the hearing aid

The hearing aid shall be placed on the subject and acoustically coupled to the ear canal in the manner of normal use. Care should be taken to avoid movement of the probe microphone sound inlet and the measurement point and to avoid blocking or compressing the probe extension tube. It is recommended that the hearing aid be fitted with a fresh battery.

7.10 Real-ear unaided response (REUR) curve

If this measurement is to be used in an REIG calculation, the field reference point, the test signal level and the measurement point shall be the same as that used in the REAR measurement.

For stored equalization methods, record the sound field with the reference microphone at the appropriate field reference point and the subject positioned as required (see 7.3.1 and 7.3.2).

Locate the subject in the subject test position.

Position the reference microphone at the appropriate field reference point as required.

Position the sound inlet of the probe microphone at the appropriate measurement point (see 7.8).

Select an appropriate test signal level and type within the capabilities of the equipment used (see 7.4.2).

Instruct the subject to remain silent and still.

Follow the equipment manufacturer's instructions to record an REUR curve.

7.11 Real-ear unaided gain (REUG) curve

If this measurement is to be used in an REIG calculation, the field reference point, the test signal level and the measurement point shall be the same as that used in the REAG measurement.

For stored equalization methods, record the sound field with the reference microphone at the appropriate field reference point and the subject positioned as required (see 7.3.1 and 7.3.2).

Locate the subject in the subject test position.

Position the reference microphone at the appropriate field reference point as required.

Position the sound inlet of the probe microphone at the appropriate measurement point (see 7.8).

Select an appropriate test signal level and type within the capabilities of the equipment used (see 7.4.2).

Instruct the subject to remain silent and still.

Follow the equipment manufacturer's instructions to record an REUG curve.

7.12 Real-ear occluded response (REOR) curve

For stored equalization methods, record the sound field with the reference microphone at the appropriate field reference point and the subject positioned as required (see 7.3.1 and 7.3.2).

Locate the subject in the subject test position.

Position the reference microphone at the appropriate field reference point as required.

Position the sound inlet of the probe microphone at the appropriate measurement point (see 7.8).

Insert the hearing aid or earmould, taking care not to change the location of the probe microphone sound inlet, collapse the probe tube, or create an acoustic leak around the hearing aid or earmould. The latter two problems can be avoided by providing a small bore through the hearing aid or earmould for probe tube insertion. This bore should be sealed after use. Inserting the probe tube through a vent used for acoustic modification may alter the effect of the vent and influence the measured results. Venting, if present, should be as normally used.

Ensure the hearing aid is switched off.

Select an appropriate test signal level within the capabilities of the equipment used (see 7.4.2).

Instruct the subject to remain silent and still.

Follow the equipment manufacturer's instructions to record an REOR curve.

7.13 Real-ear occluded gain (REOG) curve

For stored equalization methods, record the sound field with the reference microphone at the appropriate field reference point and the subject positioned as required (see 7.3.1 and 7.3.2).

Locate the subject in the subject test position.

Position the reference microphone at the appropriate field reference point as required.

Position the sound inlet of the probe microphone at the appropriate measurement point (see 7.8).

Insert the hearing aid or earmould, taking care not to change the location of the probe microphone sound inlet, collapse the probe tube, or create an acoustic leak around the hearing aid or earmould. The latter two problems can be avoided by providing a small bore through the hearing aid or earmould for probe tube insertion. This bore should be sealed after use. Inserting the probe tube through a vent used for acoustic modification may alter the effect of the vent and influence the measured results. Venting, if present, should be as normally used.

Ensure the hearing aid is switched off.

Select an appropriate test signal level and type within the capabilities of the equipment used (see 7.4.2).

Instruct the subject to remain silent and still.

Follow the equipment manufacturer's instructions to record an REOG curve.

7.14 Real-ear aided response (REAR) curve

If this measurement is to be used in an REIG calculation, the field reference point, the test signal level and the measurement point shall be the same as that used in the REUR measurement.

For stored equalization methods, record the sound field with the reference microphone at the appropriate field reference point and the subject positioned as required (see 7.3.1 and 7.3.2).

Locate the subject in the subject test position.

Position the reference microphone at the appropriate field reference point as required.

Position the sound inlet of the probe microphone at the appropriate measurement point (see 7.8).

Insert the hearing aid or earmould, taking care not to change the location of the probe microphone sound inlet, collapse the probe tube, or create an acoustic leak around the hearing aid or earmould. The latter two problems can be avoided by providing a small bore through the hearing aid or earmould for probe tube insertion. This bore should be sealed after use. Inserting the probe tube through a vent used for acoustic modification may alter the effect of the vent and influence the measured results. Venting, if present, should be as normally used.

Turn the hearing aid on and adjust the user gain control to the desired setting.

Select an appropriate test signal level and type within the capabilities of the equipment used (see 7.4.2).

Instruct the subject to remain silent and still.

Follow the equipment manufacturer's instructions to record an REAR curve.

7.15 Real-ear aided gain (REAG) curve

If this measurement is to be used in an REIG calculation, the field reference point, the test signal and the measurement point shall be the same as that used in the REUG measurement.

For stored equalization methods, record the sound field with the reference microphone at the appropriate field reference point and the subject positioned as required (see 7.3.1 and 7.3.2).

Locate the subject in the subject test position.

Locate the reference microphone at the appropriate field reference point as required.

Position the sound inlet of the probe microphone at the appropriate measurement point (see 7.8).

Insert the hearing aid or earmould, taking care not to change the location of the probe microphone sound inlet, collapse the probe tube, or create an acoustic leak around the hearing aid or earmould. The latter two problems can be avoided by providing a small bore through the hearing aid or earmould for probe tube insertion. This bore should be sealed after use. Inserting the probe tube through a vent used for acoustic modification may alter the effect of the vent and influence the measured results. Venting, if present, should be as normally used.

Turn the hearing aid on and adjust the user gain control to the desired setting.

Select an appropriate test signal level and type within the capabilities of the equipment used (see 7.4.2).

Instruct the subject to remain silent and still.

Follow the equipment manufacturer's instructions to record an REAG curve.

7.16 Real-ear insertion gain (REIG) curve

Use one of the following procedures.

a) **Procedure 1**

   1) Record the REUR curve following 7.10.
   2) Record the REAR curve following 7.14.
   3) Determine the REIG curve by subtracting the REUR from the REAR.

b) **Procedure 2**

   1) Record the REUG curve following 7.11.
   2) Record the REAG curve following 7.15.
   3) Determine the REIG curve by subtracting the REUG from the REAG.

8 Data to be recorded

Record the following:

a) details of the subject, test ear and tester, together with the date of test;

b) details of the equipment used, including the manufacturer, model, serial number, software version and date of last full calibration;

c) the real-ear acoustical characteristic measured;

d) the test signal type and level, type of sound field, field reference point, measurement method and method of equalization used;

e) the azimuth angle of sound incidence, elevation angle of sound incidence and the working distance;

f) for the hearing aid used, the type of hearing aid, the power source and the settings of all controls or programming together with any accessories used;

g) the nature of the acoustic coupling (type of earmould, tubing, earhook, venting, etc.);

h) ambient conditions in the test space.

Annex A
(informative)

Positioning the probe microphone sound inlet at the measurement point

A.1 Introduction

This annex suggests some methods that may be used to position the probe microphone sound inlet (probe extension tube if used) at the preferred measurement point in the subject's ear canal. It is assumed that, once positioned, the position is maintained for all measurements. Although it is appreciated that the subsequent insertion of a hearing aid or earmould may result in slight movement of the measurement point, it is assumed that, once positioned, the probe microphone sound inlet remains fixed for all measurements.

To achieve the measurement conditions specified in 7.8, it is generally required that the sound inlet of the probe microphone be within 6 mm of the tympanic membrane and at least 5 mm beyond the sound outlet of the hearing aid. These conditions might not always be met for deeply inserted earmoulds or hearing aids and it might be necessary for the sound inlet of the probe microphone to be within 5 mm of the hearing aid sound outlet.

A.2 Visual positioning

Using an otoscope, the ear canal should be inspected to ascertain the approximate length of the canal and to identify any obstruction which may be present.

Using a marker or marking device, which may be supplied by the manufacturer, mark the probe extension tube about 30 mm from the sound inlet. This length should be adjusted to accommodate longer or shorter ear canals as appropriate.

Insert the probe extension tube into the ear canal until the marking is adjacent to the inter-tragal notch. Care should be taken to ensure the subject does not experience any discomfort during this process. The canal may be straightened by deflection of the pinna to assist insertion.

Using an otoscope, visually inspect the position of the extension tube and the sound inlet and readjust it to the desired measurement point if necessary.

If necessary, move the position of the marker.

A.3 Acoustically assisted positioning

Insert the probe extension tube as described under A.2.

Record the real-ear unaided gain or real-ear unaided response and observe the measurement in the region above 4 kHz.

Move the sound inlet towards the tympanic membrane by 2 mm and repeat the above measurements, observing any change in the region above 4 000 Hz.

If there is no significant difference between the first and second measurements, the probe microphone sound inlet is now at the desired measurement point and should be marked accordingly.

If there is significant change, the sound inlet should be moved a further 2 mm closer to the tympanic membrane and the measurements should be repeated.

When the desired measurement point has been located, the position of the extension tube should be marked accordingly.

A.4 Acoustic positioning — Method 1

Present a continuous 6 000 Hz narrow-band test signal at 70 dB SPL and continuously record the probe microphone measurements.

Carefully insert the probe microphone extension tube into the ear canal entrance while observing the probe microphone measurements.

Slowly move the sound inlet of the extension tube further into the canal, taking care not to cause any discomfort to the subject, while continually observing the probe microphone measurements. The measured level should reduce as the sound inlet reaches a point about 14 mm from the tympanic membrane and then increase again as the sound inlet is inserted further into the canal.

Observe the position of the probe extension tube which results in the minimum reading and insert the tube a further 8 mm from this point.

Care should be taken to minimize the influence of the tester's hand on the measurement. This method may also be carried out using a swept test signal while observing the measured level in the 6 000 Hz region.

A.5 Acoustic positioning — Method 2

Equipment can facilitate an acoustic positioning method which utilizes the monitoring of standing waves and out-phasing during the probe microphone extension tube insertion, where measurements made at frequencies above 8 000 Hz can be displayed. If available, the following method may be used.

Select the appropriate measurement mode as specified by the manufacturer.

Slowly move the sound inlet of the extension tube further into the ear canal, taking care not to cause any discomfort to the subject, while continually observing the displayed probe microphone measurement curve. When valleys appear on the measurement curve at frequencies above 8 000 Hz, the sound inlet of the extension tube will be positioned approximately 5 mm to 10 mm from the eardrum.

This method should be used with care as the possible overlapping of peaks and valleys can cancel each other and the presence of valleys might not be apparent on the displayed measurement curve.

A.6 Geometrical positioning

Locate the surface of the hearing aid or earmould which corresponds to the position of the subjects ear canal floor leading to the inter-tragal notch.

Lay the probe extension tube along this surface with the sound inlet positioned 5 mm beyond the tip of the hearing aid or earmould.

Mark the point on the probe extension tube which corresponds to the position of the inter-tragal notch on the outer surface of the earmould or hearing aid. Reinsert the extension tube into the ear canal until the marker is adjacent to the inter-tragal notch.

Bibliography

[1] IEC 60118-0, *Hearing aids — Part 0: Measurement of electro-acoustical characteristics*.

[2] IEC 60118-7, *Hearing aids — Part 7: Measurement of performance characteristics of hearing aids for quality inspection for delivery purposes*.

[3] IEC/TR 60118-8, *Hearing aids — Part 8: Methods of measurement of performance characteristics of hearing aids under simulated in situ working conditions*.

[4] IEC 60050-801:1994, *International Electrotechnical Vocabulary (IEV) — Chapter 801: Acoustics and electro-acoustics*.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001. Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL