BS EN 60118-0:2015

BSI Standards Publication

Electroacoustics — Hearing aids

Part 0: Measurement of the performance characteristics of hearing aids

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National foreword

This British Standard is the UK implementation of EN 60118-0:2015. It is identical to IEC 60118-0:2015. It supersedes BS EN 60118-0:1993, BS EN 60118-2:1996, BS EN 60118-1:1995 and BS EN 60118-6:1999, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/29, Electroacoustics.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Electroacoustics - Hearing aids - Part 0: Measurement of the performance characteristics of hearing aids (IEC 60118-0:2015)

Electroacoustique - Appareils de correction auditive - Partie 0: Mesure des caractéristiques fonctionnelles des appareils de correction auditive (IEC 60118-0:2015)

Akustik - Hörgeräte - Teil 0: Messung der Leistungsmerkmale von Hörgeräten (IEC 60118-0:2015)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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European foreword

The text of document 29/867A/FDIS, future edition 3 of IEC 60118-0, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60118-0:2015.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-04-14
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-07-14

This document supersedes EN 60118-0:1993, EN 60118-1:1995, EN 60118-2:1995, EN 60118-6:1999.

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Endorsement notice

The text of the International Standard IEC 60118-0:2015 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated :

IEC 60068 (series)	NOTE	Harmonized as EN 60068 (series).
IEC 60118-7:2005	NOTE	Harmonized as EN 60118-7:2005.
IEC 60118-8:2005	NOTE	Harmonized as EN 60118-8:2005.
IEC 60118-12	NOTE	Harmonized as EN 60118-12.
IEC 60118-15	NOTE	Harmonized as EN 60118-15.
IEC 60318-1	NOTE	Harmonized as EN 60318-1.
IEC 60118-15	NOTE	Harmonized as EN 60118-15.
IEC 60318-4:2010	NOTE	Harmonized as EN 60318-4:2010.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60318-5	-	Electroacoustics - Simulators of human head and ear -- Part 5: 2 cm^3 coupler for the measurement of hearing aids and earphones coupled to the ear by means of ear inserts	EN 60318-5	-
ISO 3	-	Preferred numbers; Series of preferred numbers	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROACOUSTICS – HEARING AIDS –

Part 0: Measurement of the performance characteristics of hearing aids

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60118-0 has been prepared by IEC technical committee 29: Electroacoustics.

This third edition cancels and replaces the second edition published in 1983 and its Amendment 1:1994 as well as IEC 60118-1:1995, Amendment 1:1998, IEC 60118-2:1983, Amendment 1:1993, Amendment 2:1997 and IEC 60118-6:1999. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the use of an acoustic coupler according to IEC 60318-5;
b) the addition of measurements for automatic gain control circuits, for induction pick-up coil inputs and for electrical inputs.

The text of this standard is based on the following documents:

FDIS	Report on voting
29/867A/FDIS	29/874/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60118 series, published under the general title *Electroacoustics – Hearing aids*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ELECTROACOUSTICS – HEARING AIDS –

Part 0: Measurement of the performance characteristics of hearing aids

1 Scope

This part of IEC 60118 gives recommendations for the measurement of the performance characteristics of air conduction hearing aids based on a free field technique and measured with an acoustic coupler.

This part of IEC 60118 is applicable to the measurement and evaluation of the electroacoustical characteristics of hearing aids, for example for type testing and manufacturer data sheets.

The test results obtained by the methods specified in this part of IEC 60118 will express the performance under conditions of the test and may deviate substantially from the performance of the hearing aid under actual conditions of use.

This part of IEC 60118 uses an acoustic coupler according to IEC 60318-5 which is only intended for loading a hearing aid with a specified acoustic impedance and is not intended to model the sound pressure in a person’s ear. The use of this acoustic coupler will yield different results from those obtained using the occluded ear simulator of IEC 60318-4 as used in former editions of IEC 60118-0.

For the measurement of the performance characteristics of hearing aids for simulated *in situ* working conditions, IEC 60118-8 can be used. For measurement of hearing aids under typical user settings and using a speech-like signal, IEC 60118-15 can be used.

For the measurement of the performance characteristics of hearing aids for production, supply and delivery quality-assurance purposes, IEC 60118-7 can be used. The frequency range has been extended to 8 kHz in this part of IEC 60118 as opposed to 5 kHz in IEC 60118-7.

Though the number of measurements covered by this part of IEC 60118 is limited, it is not intended that all measurements described herein are mandatory.

In cases of custom-made in-the-ear instruments, the data supplied by the manufacturer applies only to the particular hearing aid being tested.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60318-5, *Electroacoustics – Simulators of human head and ear – Part 5: 2 cm³ coupler for the measurement of hearing aids and earphones coupled to the ear by means of ear inserts*

ISO 3, *Preferred numbers -- Series of preferred numbers*

3 Terms and definitions

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

3.1
hearing aid
wearable instrument intended to aid a person with impaired hearing

Note 1 to entry: A hearing aid usually consists of a microphone, amplifier, signal processor and earphone, powered by a low-voltage battery and possibly also containing an induction pick-up coil. It is fitted using audiometric and prescriptive methods.

Note 2 to entry: Hearing aids can be placed on the body (BW), behind the ear (BTE), in the ear (ITE) or in the canal (ITC).

3.2
SPL
sound pressure level
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure, p, to the square of a reference value, p_0, expressed in decibels, where the reference value, p_0, is 20 μPa

Note 1 to entry: This note applies to the French language only.

[SOURCE: ISO/TR 25417:2007, 2.2]

3.3
acoustic coupler
device for measuring the acoustic output of sound sources where the sound pressure is measured by a calibrated microphone coupled to the source by a cavity of predetermined shape and volume which does not necessarily approximate the acoustical impedance of the normal human ear

3.4
ear simulator
device for measuring the acoustic output of sound sources where the sound pressure is measured by a calibrated microphone coupled to the source so that the overall acoustic impedance of the device approximates that of the normal human ear at a given location and in a given frequency band

[SOURCE: IEC 60318-4:2010, 3.4]

3.5
input sound pressure level
sound pressure level at the hearing aid reference point

3.6
frequency response
sound pressure level measured in the acoustic coupler expressed as a function of frequency under specified test conditions

3.7
basic frequency response curve
frequency response curve obtained at RTS with an input sound pressure level of 60 dB

3.8
input-output characteristic
for a single frequency, a plot of the sound pressure level measured in the acoustic coupler on the ordinate, against the sound pressure level applied to the hearing aid on the abscissa, with equal decibel scale divisions on each axis

3.9
vertical reference
line through or on a hearing aid which is vertical when the aid is positioned as worn on a head and torso simulator (as per Figure C.1 in IEC 60118-8:2005) or, in the case of custom-made hearing aids, as worn by a seated individual

3.10
reference point
point on the hearing aid chosen for the purpose of defining its position

3.11
test point
position in the test enclosure to which the measurements of the sound pressure level refer or at which the strength of the magnetic field is determined and at which the hearing aid reference point is located for test purposes

3.12
test space
space which contains the test point where the hearing aid is placed for testing

3.13
HFA
high-frequency average
average of gain or SPL in decibels at 1 000 Hz, 1 600 Hz and 2 500 Hz

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.2]

3.14
acoustic gain
at each test frequency, the difference in decibels obtained by subtracting the input SPL from the SPL developed by the output from the hearing aid in the acoustic coupler

[SOURCE: IEC 60118-7:2005, 3.5, modified — "to the hearing aid microphone" has been deleted]

3.15
gain control
manually or electronically operated control for the adjustment of overall gain

[SOURCE: IEC 60118-7:2005, 3.6]

3.16
OSPL90
output SPL for 90 dB input SPL
SPL developed in the acoustic coupler with an input SPL of 90 dB with the gain control of the hearing aid full-on

Note 1 to entry: It is recognized that the maximum output level may occur with more, or occasionally with less, input SPL than 90 dB. However, the differences are usually small over the frequency range of interest and the single input SPL of 90 dB makes automatic recording of the OSPL90 curve very convenient.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.7]

3.17
HFA-OSPL90
high-frequency average OSPL90
high-frequency average of the OSPL90

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.8, modified — "SPL levels" has been deleted from the definition.]

3.18
HFA-FOG
high-frequency average full-on gain
HFA gain for an input SPL of 50 dB when the gain control of the hearing aid is at its full-on position

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.9]

3.19
RTS
reference test setting of the gain control
for an input SPL of 60 dB, the setting of the gain control required to produce an HFA-gain within ± 1,5 dB of the HFA-OSPL90 minus 77 dB, or, if the full-on HFA gain for an input SPL of 60 dB is less than the HFA-OSPL90 minus 77 dB, the full-on setting of the gain control

Note 1 to entry: For most hearing aids, the use of an input SPL of 60 dB and a 17 dB difference from the OSPL90 helps to ensure that, for an overall speech level of 65 dB SPL, peaks do not exceed the OSPL90.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.10]

3.20
RTG
reference test gain
HFA gain for an input SPL of 60 dB with the gain control at RTS

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.11]

3.21
AGC
automatic gain control
means (other than peak clipping) by which the gain is automatically controlled as a function of the level of the signal being amplified

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.13]

3.22
AGC hearing aid
hearing aid incorporating automatic gain control (AGC)

[SOURCE: IEC 60118-7:2005, 3.14]

3.23
compression
type of AGC in which an incremental change in input sound pressure level produces a smaller incremental change of output sound pressure level

3.24
expansion
type of AGC in which an incremental change in input sound pressure level produces a larger incremental change of output sound pressure level

3.25
directional hearing aid
hearing aid for which the gain is dependent on the direction of sound incidence when measured under free-field conditions

[SOURCE: IEC 60118-7:2005, 3.15]

3.26
non-directional hearing aid
hearing aid for which the gain is independent of the direction of sound incidence when measured under free-field conditions

[SOURCE: IEC 60118-7:2005, 3.16]

3.27
supply voltage
voltage at the battery terminals of the hearing aid with the hearing aid switched on

3.28
magneto-acoustical sensitivity
at a specified frequency and under essentially linear input/output conditions, the quotient of the sound pressure in pascals (Pa) produced by the hearing aid in the acoustic coupler and the magnetic field strength in milliamperes per metre (mA/m) at the test point

3.29
MASL
magneto-acoustical sensitivity level
twenty times the logarithm to the base 10 of the ratio of the magneto-acoustical sensitivity to the reference sensitivity 20 Pa/(1 mA/m)

Note 1 to entry: MASL is expressed in decibels.

Note 2 to entry: This note applies to the French language only.

3.30
maximum magneto-acoustical sensitivity level
maximum obtainable MASL, allowing all possible settings of the hearing aid controls

3.31
SPLIV
SPL in a vertical magnetic field
SPL developed in the acoustic coupler with the gain control at RTS when the input is –30 dB re 1 A/m (= 31,6 mA/m) sinusoidal alternating magnetic field parallel to the vertical reference with T-programme selected

Note 1 to entry: This note applies to the French language only.

3.32
HFA-SPLIV
high frequency average SPL in a vertical magnetic field
high-frequency average of the SPLIV levels

Note 1 to entry: This note applies to the French language only.

3.33
ETLS
equivalent test loop sensitivity
difference in decibels obtained by subtracting the RTG + 60 dB from the HFA-SPLIV

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60118-7:2005, 3.19, modified — In the definition, "HFA-SPLI" has been replaced by "HFA-SPLIV".]

3.34
SPLITS
SPL for an inductive telephone simulator
SPL developed in the coupler by a hearing aid with the gain control in the RTS when the input is the magnetic field generated by a telephone magnetic field simulator

Note 1 to entry: This note applies to the French language only.

3.35
HFA-SPLITS
high frequency average (HFA) SPL for an inductive telephone simulator
high-frequency average of the SPLITS values

Note 1 to entry: This note applies to the French language only.

3.36
RSETS
relative simulated equivalent telephone sensitivity
difference in decibels obtained by subtracting the RTG + 60 dB SPL from the HFA-SPLITS

Note 1 to entry: This note applies to the French language only.

3.37
TMFS
telephone magnetic field simulator
device for producing a magnetic field of consistent level and geometric shape when driven by a current of $I = 6/N$ mA, where N is the number of coil turns

Note 1 to entry: This note applies to the French language only.

4 General conditions

4.1 Acoustic test method

The preferred acoustic test procedure is based on a method of measurement in which the sound pressure level at the hearing aid reference point is kept constant to simulate free field conditions. This is accomplished in a test enclosure or acoustic test box by the use of a pressure-calibrated control microphone, on the assumption that the sound field is homogeneous around the reference point of the hearing aid.

This method is designated "constant entrance sound pressure method" or shortened "pressure method" throughout this part of IEC 60118.

As an alternative to the pressure method, storage of a test enclosure frequency response correction curve may be used. This method is designated “substitution method”.

For testing directional hearing aids, manufacturer and purchaser should use acoustic test boxes of the same make and type to secure identical measurement conditions.

NOTE 1 The test results can differ substantially from those obtained under real free-field conditions, especially for body-worn types of hearing aids having the sound entry located on the surface of the outer housing where the housing may have physical dimensions comparable to the wavelength of the incident sound.

For measuring the variation of acoustical parameters of hearing aids as a function of the direction of sound incidence, plane progressive wave conditions (i.e. not having standing wave conditions) are required.

NOTE 2 Small acoustic test boxes in which progressive wave conditions are not present cannot therefore be used for this purpose.

NOTE 3 The results from testing directional hearing aids may not represent the true directional characteristics of the hearing aid.

4.2 Acoustic coupler

Measurements of the hearing aid performance characteristics are made using a 2 cm^3 acoustic coupler in accordance with IEC 60318-5.

NOTE The basic specifications of IEC 60318-5 are limited to the frequency range 125 Hz to 8 000 Hz.

For any type of air conduction hearing aids, sound leakage from the coupling tube shall be low enough not to affect the test result. One way of accomplishing this is to use a rigid tube. The dimensions of the tubing shall be maintained in accordance with IEC 60318-5.

4.3 Measurement frequency range

All measurements shall be made for a stated frequency range (also named bandwidth) of 200 Hz to 8 000 Hz.

4.4 Reporting of data

All data reported shall be clearly labelled: "According to IEC 60118-0:2015".

5 Test enclosure and test equipment

5.1 General

The conditions specified in 5.2 to 5.6 apply. Measurements shall be made at the ISO R40 preferred frequencies (1/40 decade or 1/12 octave) as specified in ISO 3 unless otherwise stated.

5.2 Unwanted stimuli in the test enclosure

Unwanted stimuli in the test enclosure, such as ambient noise, mechanical vibrations and electrical or magnetic stray fields shall be sufficiently low so as not to affect the test results by more than 0,5 dB. This can be verified if the output level of the hearing aid falls by at least 10 dB in each frequency analysis band, when the signal source is switched off.

5.3 Sound source

5.3.1 The sound source (pure-tone) shall be capable of producing at the test point the requisite sound pressure levels between 50 dB and 90 dB, with a minimum step size of 5 dB.

The level of the sound source shall be within ± 1,5 dB of the indicated value over the frequency range from 200 Hz to 3 000 Hz, and within ± 2,5 dB of the indicated value over the range from 3 000 Hz to 8 000 Hz.

If the calibration of the sound source depends on ambient conditions, corrections for such dependence shall be made when necessary.

5.3.2 The frequency of the sound source shall be within ± 2 % of the indicated value. The frequency interval between data points in frequency response curves shall not exceed one-twelfth octave or 100 Hz, whichever is greater.

5.3.3 For frequency response and full-on gain measurements, the total harmonic distortion of the sound source shall not exceed 1 % for a sound pressure level up to and including 70 dB and 2 % for a sound pressure level greater than 70 dB and up to and including 90 dB.

For harmonic distortion measurements, the total harmonic distortion of the sound source at the frequencies of the THD measurement shall not exceed 0,5 % up to and including a sound pressure level of 70 dB and 1 % for a sound pressure level greater than 70 dB and up to and including 90 dB.

5.4 Measurement system for the measurement of the sound pressure level and harmonic distortion produced by a hearing aid

The equipment for the measurement of the sound pressure level produced by the hearing aid shall fulfil the following requirements.

a) The sound pressure level measurement system shall be accurate within ± 0,5 dB at the frequency of calibration.
b) The indication of sound pressure level relative to the indication at the frequency of calibration shall be measured with an expanded uncertainty of no more than ± 1 dB in the range from 200 Hz to 5 000 Hz and within ± 2 dB in the range from 5 000 Hz to 8 000 Hz.

   If, under certain conditions, it is necessary to use a selective measuring system in order to ensure that the response of the hearing aid to the signal can be differentiated from inherent noise in the hearing aid, the use of the selective system shall be stated in the test report.
c) The total harmonic distortion in the measuring equipment shall be less than 1 % for sound pressure levels up to 130 dB and less than 2 % for levels above, up to and including 145 dB.

5.5 Direct-current measuring system

The direct-current measuring system shall have the following characteristics:

a) a tolerance of ± 5 % at the value of current measured;
b) direct-current voltage drop across current-measuring device ≤ 50 mV;
c) an impedance not exceeding 1 Ω over the frequency range 200 Hz to 8 000 Hz.

One method of realizing item c) above is to bypass the current meter with an 8 000 μF capacitor. The capacitor should not shunt the battery or the power supply.

5.6 Magnetic field source for ETLS and MASL measurements

5.6.1 For the measurement of the equivalent test loop sensitivity (ETLS) and the magneto-acoustical sensitivity level (MASL), the magnetic field strength produced by the magnetic loop is computed from the geometry of the loop.

5.6.2 As the material and the construction of the power source may influence the results, the actual type of source should be stated.

NOTE 1 For example, the magnetic field strength in the centre of a square loop with a side of "*a*" metres and carrying a current of "*i*" amperes is given by:

$$H = \frac{2\sqrt{2}}{\pi} \frac{i}{a} \text{ A/m}$$

In the centre of a circular loop with a diameter of "*d*" in metres, carrying a current of "*i*" amperes, the magnetic field strength is given by:

$$H = \frac{i}{d} \text{ A/m}$$

NOTE 2 One way to secure essentially constant current conditions is to drive the magnetic field source from a device having a constant electromotive force and an internal impedance at least 100 times greater than the magnetic field source input impedance in the frequency range 200 Hz to 8 000 Hz, which, in the case of a low impedance generator, can be accomplished by a resistor connected in series with the output of the generator.

5.6.3 The test space shall be remote from any field-disturbing iron or other ferromagnetic material or other material in which eddy currents can be induced that could give rise to a field disturbance.

5.6.4 The magnetic field source shall be provided with a calibration expressing the relationship between the magnetic field strength in amperes per metre at the test point and the input current in amperes.

5.6.5 The magnetic field source shall be of such shape and dimensions that inside a sphere of diameter 10 cm of which the centre is the test point, the deviation from nominal values in magnitude and direction is less than ± 5 % and ± 10°, respectively.

NOTE A square loop with a side length "*a*" greater than 0,5 m or a circular loop with a diameter "*d*" greater than 0,56 m will meet these specifications.

5.6.6 The total harmonic distortion of the magnetic field shall not exceed 1 %.

NOTE This condition will be met if the distortion of the input current is less than 1 %.

5.6.7 The magnetic field strength at the test point shall be maintained within a tolerance of ± 20 % over the frequency range 200 Hz to 8 000 Hz.

6 Test conditions

6.1 General

Procedures for controlling the sound field and establishing test conditions for the hearing aid are described below.

6.2 Control of the sound field

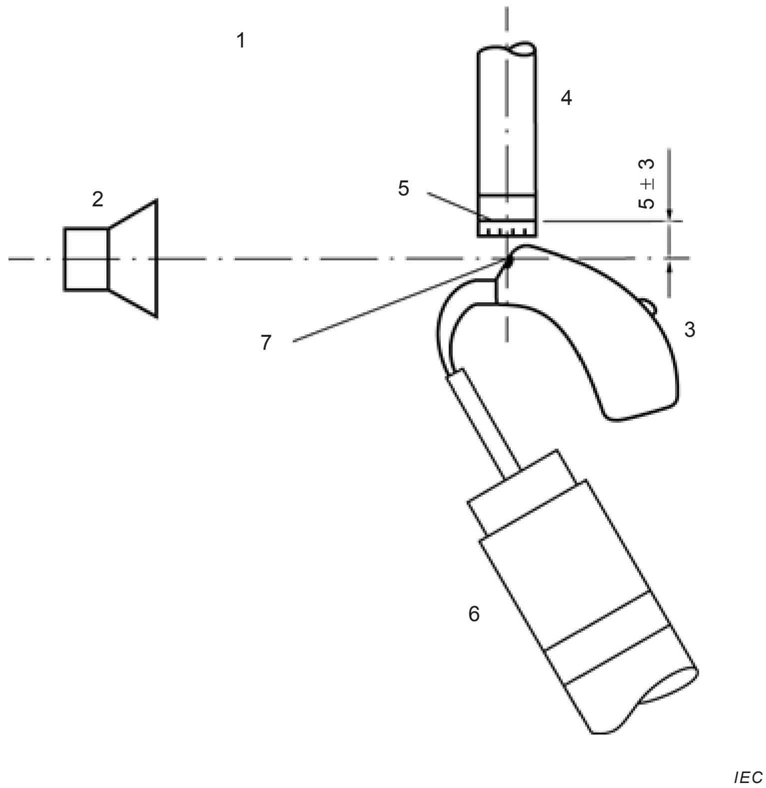
6.2.1 The hearing aid reference point is the midpoint of the hearing aid sound inlet port(s). The input SPL at the hearing aid reference point is kept constant:

a) by means of a control microphone (pressure method – see 6.2.2);

b) with electronic data storage (substitution method – see 6.2.3).

6.2.2 If the pressure method is used, the inlet to the control microphone shall be placed as close as possible to the hearing aid reference point without touching it. For a 15 mm or smaller diameter microphone, the distance from the centre of the diaphragm to the hearing aid reference point shall be 5 mm ± 3 mm. The axis of the control microphone shall be orthogonal to the speaker axis and shall intersect it at the hearing aid reference point. A line through the hearing aid reference point shall coincide with the sound source axis. Figure 1 and Figure 2 show examples of test arrangements.

Dimensions in millimetres



Key

1 Test space

2 Sound source

3 Hearing aid

4 Control microphone

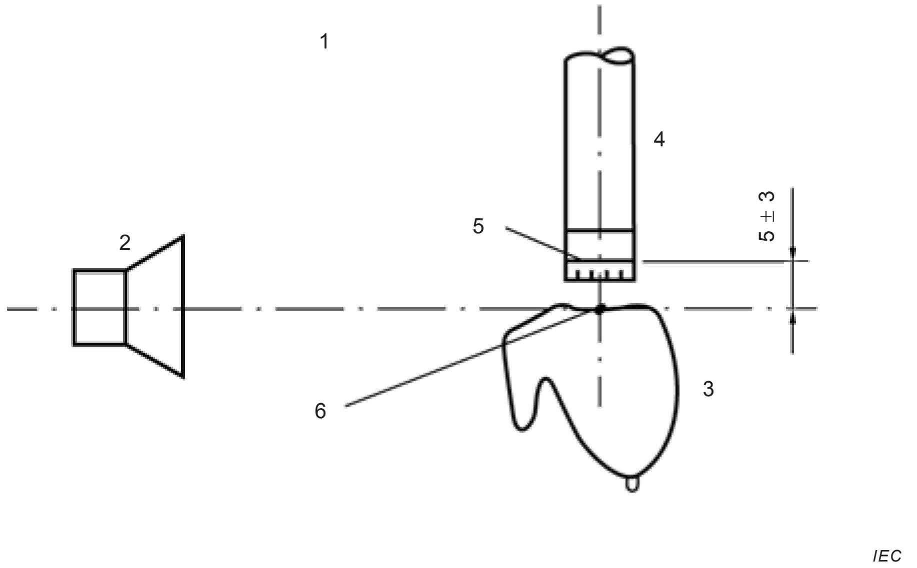
5 Diaphragm

6 Acoustic coupler

7 Hearing aid reference point

Figure 1 – Example of test arrangement for behind-the-ear hearing aid

Dimensions in millimetres



Key

1 Test space

2 Sound source

3 Hearing aid

4 Control microphone

5 Diaphragm

6 Hearing aid reference point

Figure 2 – Example of test arrangement for in-the-ear hearing aid

6.2.3 An alternative method of keeping the sound pressure level constant, referred to as the substitution method, is to position the pressure-calibrated control microphone 5 mm ± 3 mm from the hearing aid reference point and measure the SPL at discrete frequencies with the model of hearing aid to be tested in its test position. By suitable means, for instance digital equipment, store and subsequently reproduce the required voltages for constant SPL at the hearing aid reference point with either the control microphone still in place or a dummy simulating that microphone in the same place in order to fulfil pressure method conditions.

NOTE Methods of test that do not keep the control microphone or a dummy in place may give results that differ from those obtained using the methods in 6.2.2 and 6.2.3. Different results may also occur if the sound field is calibrated with a hearing aid other than the model under test in place.

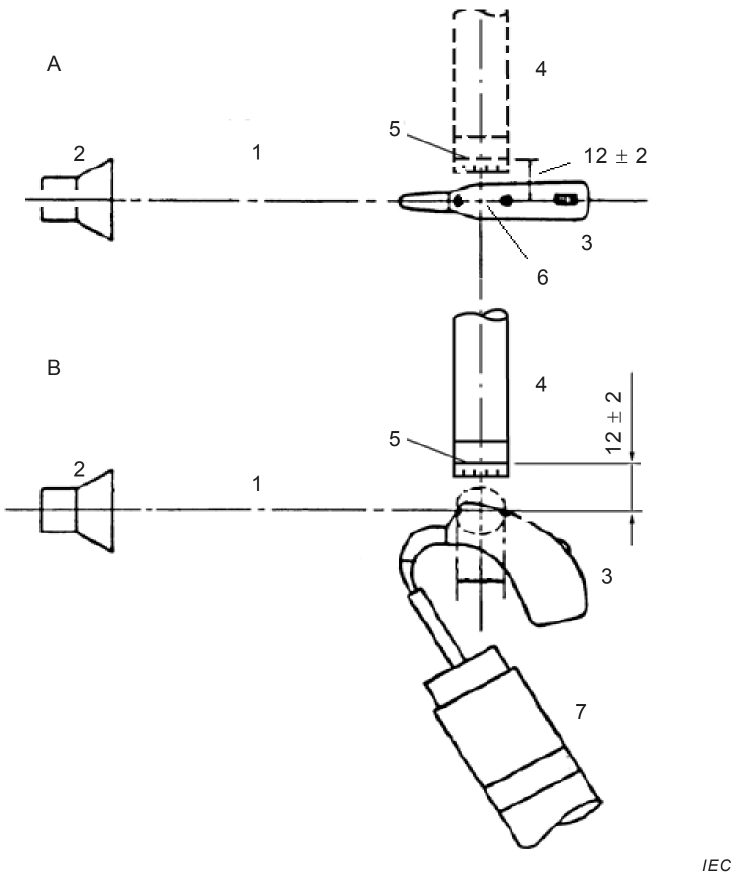
6.2.4 For both methods mentioned above, the use of a 15 mm or smaller microphone is recommended. The diameter of the microphone actually used shall be stated.

6.2.5 Care should be taken that neither the acoustic coupler nor the mechanical support for the hearing aid will appreciably disturb the sound field in the vicinity of the hearing aid at the test frequencies used, and they should not introduce spurious effects arising from mechanical resonances or mechanical vibrations, nor should they in any respect affect any mechanical or acoustical property of the hearing aid under test.

6.3 Measurement configuration for directional hearing aids

The measurement of directional hearing aids requires a special measurement configuration. The sound source should approximate a plane progressive wave. The midpoint of the hearing aid sound inlet port array is the hearing aid reference point. The diameter of the control microphone shall be 15 mm or smaller. The distance from the centre of the diaphragm to the reference point shall be 12 mm ± 2 mm. The axis of the control microphone shall be orthogonal to the sound source axis and shall intersect at the hearing aid reference point (see Figure 3). A line through the front and rear sound inlet ports of the hearing aid shall coincide with the speaker axis. In the case of multiple front or rear entry ports, the line passes through the hearing aid reference point.

Dimensions in millimetres



Key

A	Topview	4	Control microphone
B	Sideview	5	Diaphragm
1	Test space	6	Hearing aid reference point
2	Sound source	7	Acoustic coupler
3	Hearing aid		

Figure 3 – Example of test arrangement for directional hearing aid

6.4 Normal operating conditions for a hearing aid

6.4.1 General

The normal operating conditions apply for measurements where no other conditions are prescribed. The normal operating conditions are specified in 6.4.2 to 6.4.6.

6.4.2 Battery or supply voltage

Preferably a suitable power supply that simulates the voltage and internal impedance of real batteries should be used. Alternatively an actual battery of the type recommended by the manufacturer for use in the hearing aid may be employed.

The type of power source used and the open circuit voltage shall be stated. The open circuit voltage is the supply voltage with the hearing aid disconnected.

For the battery simulator, the open circuit voltages and series internal resistors given in Table 1 shall be used.

Table 1 – Resistors and open circuit voltages for zinc-air battery simulators

Battery type IEC/ANSI designation	Series resistor Ω	Open circuit voltage V
PR521/5A	8,2	1,3
PR70/10A	6,2	1,3
PR41/312	6,2	1,3
PR48/13	6,2	1,3
PR44/675	3,3	1,3
Tolerance of open circuit voltage: ± 0,05 V Tolerance of series resistor: ± 5 %		

6.4.3 Settings of controls

The manufacturer shall specify the full on gain (FOG) settings used for testing by providing test settings, a set of programmed settings or by reference to physical control settings. The manufacturer shall also specify the means to obtain RTS.

The hearing aid shall be set to have the widest available frequency response range, the greatest available HFA-OSPL90 and, if possible, the greatest HFA-FOG. Where possible, the AGC function of AGC hearing aids shall be set to have minimum effect for all tests except those of 9.8.2. For the tests of 9.8.2, the AGC function shall be set to have maximum effect. For the purposes of this part of IEC 60118, both compression and expansion shall be considered as a part of the AGC function.

Other adaptive features, such as some noise suppression, and feedback suppression systems etc., which may affect the validity of measurements made with steady-state pure-tone signals, should be disabled. The settings used for testing shall be specified by the manufacturer by providing either a test program, a set of programmed settings or by reference to physical control settings.

6.4.4 Ambient conditions

Actual conditions in the test space at the time of test should be within the following ranges, and shall be stated:

Temperature:	23 °C ± 5 °C
Relative humidity:	0 % to 80 %
Atmospheric pressure:	$101{,}3\,^{+5}_{-20}$ kPa

If other conditions apply, these conditions shall be stated. If the calibration of the measurement system depends on ambient conditions, corrections for such dependence shall be made.

6.4.5 Sound outlet system

For acoustic connection to the coupler for the different hearing aid sound outlet systems such as insert earphones, ear-hook type or sound tubing, IEC 60318-5 applies.

The sound outlet system used shall be stated.

6.4.6 Accessories

For accessories used in connection with the hearing aid, the particular accessories shall be stated.

7 Test procedures

7.1 Frequency response curves

All published curves showing variation of a parameter with frequency shall be plotted on a grid having a linear decibel ordinate scale and a logarithmic frequency abscissa scale with the length of one decade on the abscissa equal to the length of 50 dB ± 2 dB on the ordinate.

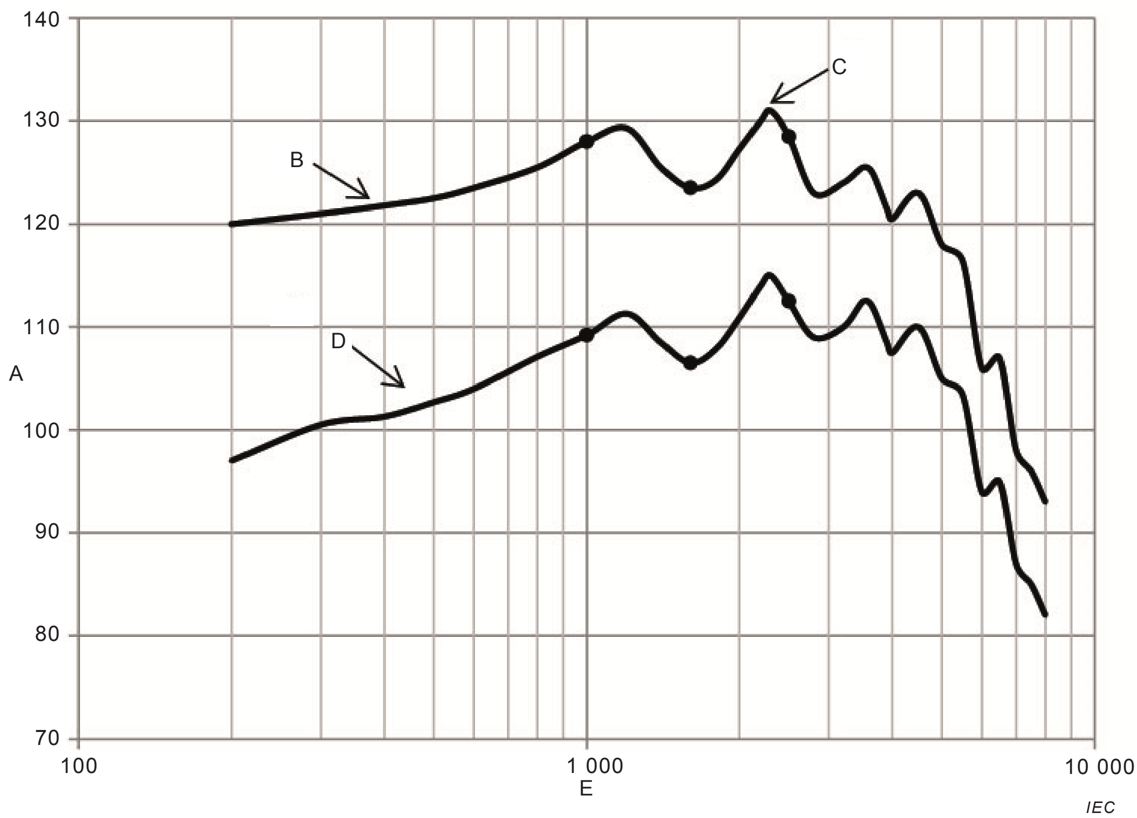
7.2 OSPL90 frequency response curve

The test procedure for the output sound pressure level frequency response curve for an input sound pressure level of 90 dB (OSPL90 frequency response curve) is as follows.

a) Program and or set the gain control to full-on and set other controls as stated in 6.4.3.

b) Keeping the input sound pressure level constant at 90 dB, vary the frequency of the sound source over the frequency range 200 Hz to 8 000 Hz. Measure and record the OSPL90 frequency response curve so obtained.

c) Obtain from the above data the maximum OSPL90 and the HFA-OSPL90 output values (Figure 4).



Key

A Hearing aid output (SPL, in decibels)

B OSPL90 curve

C Maximum OSPL90

D Basic frequency response curve

E Frequency (in hertz)

Figure 4 – Example of OSPL90 curve and basic frequency response curve

7.3 Full-on gain response curve

The test procedure is as follows:

a) Program and or set the gain control full-on and set other controls as stated in 6.4.3.

b) Keeping the input sound pressure level constant at 50 dB, vary the frequency of the sound source over the frequency range 200 Hz to 8 000 Hz. Measure and record the full-on gain frequency response curve so obtained.

c) The full-on gain is recorded as the difference obtained by subtracting 50 dB from the acoustic coupler SPL versus frequency.

d) Obtain from above data the maximum full-on gain and the HFA-FOG.

7.4 Basic frequency response curve

7.4.1 Test procedure

The test procedure is as follows.

a) Program and or set the gain control to the RTS and set other controls as stated in 6.4.3.

b) Keeping the input sound pressure level constant at 60 dB, vary the frequency of the sound source over the frequency range 200 Hz to 8 000 Hz. Measure and record the basic frequency response curve so obtained (Figure 5).

c) Optionally, repeat the measurement and recording for such other values of the input sound pressure level as will adequately show the behavior of the hearing aid at various input levels.

For hearing aids with directional microphones, the measurement can be made at a number of stated orientations relative to the orientation described in 6.3.

7.4.2 Frequency range

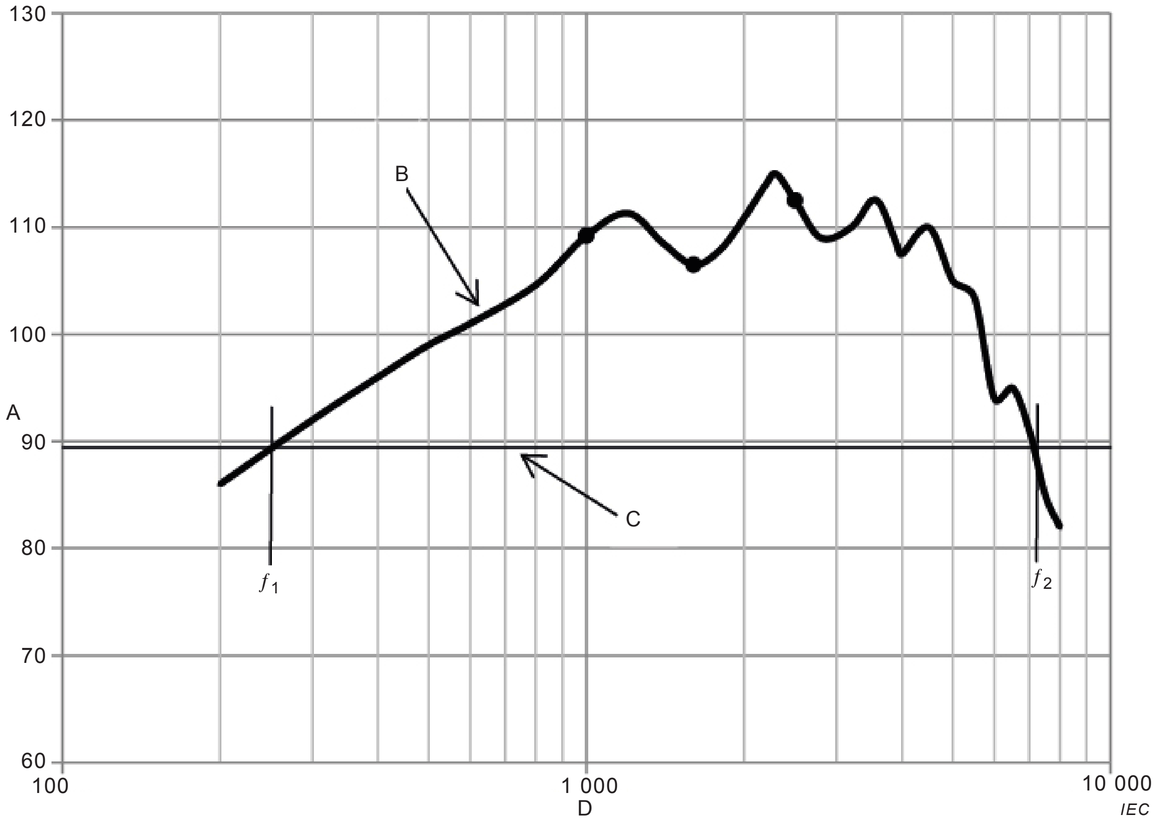
The test procedure is as follows.

a) Obtain from the above measurement the HFA output level.

b) Determine the lowest (f_1) and highest (f_2) frequencies at which the frequency response curve has the value of HFA output level minus 20 dB (see Figure 5).

c) The frequency range is assigned to be from f_1 to f_2.

If f_1 and f_2 cannot be determined because they would fall outside the frequency range, they can be shown as < 200 Hz and > 8 000 Hz.



Key

A Hearing aid output (SPL, in decibels)

B Basic frequency response curve

C HFA minus 20 dB level

D Frequency (in hertz)

Figure 5 – Example of determination of frequency range from basic frequency response curve

7.4.3 Reference test gain (RTG)

Report the reference test gain as the HFA gain with the gain control at RTS and an input SPL of 60 dB. The reference test gain shall be stated for information purposes only.

7.5 Total harmonic distortion

The test procedure is as follows.

a) Program and or set the gain control to the RTS and set other controls as stated in 6.4.3.

b) Measure and state total harmonic distortion in percent at the frequencies and levels as outlined in Table 2 (the frequencies actually used shall be stated).

c) If the specified frequency response curve rises 12 dB or more between any distortion test frequency and its second harmonic, distortion tests at that frequency may be omitted.

NOTE Care should be taken when measuring the total harmonic distortion, because errors can be caused by spurious signals, for example noise and hum.

Table 2 – Distortion test frequencies and input sound pressure levels

Distortion test frequency	Input SPL
500 Hz	70 dB
800 Hz	70 dB
1 600 Hz	65 dB
3 200 Hz	60 dB

7.6 Equivalent input noise

The broadband equivalent input noise is measured as follows.

a) With the sound source switched off, the sound pressure level of the ambient noise in the test space at the hearing aid reference point is measured using a measurement bandwidth of 200 Hz to 8 000 Hz and an averaging time of at least 0,5 s. The ambient noise in the test space shall be at least 10 dB below the equivalent input noise level as calculated in f).

b) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.

c) Determine the HFA gain for an input SPL of 50 dB.

d) Switch off the input sound source.

e) Measure the total steady-state output noise sound pressure level using a measurement bandwidth of 200 Hz to 8 000 Hz and an averaging time of at least 0,5 s. To determine that the test equipment noise is adequately low, the measured noise should decrease by at least 10 dB when the hearing aid is turned off.

f) Calculate the equivalent input noise level according to the following formula:

   equivalent input noise level = (total output noise SPL) minus (HFA output gain for an input SPL of 50 dB).

If low-level expansion is active in the hearing aid during the measurement, this condition shall be stated by the manufacturer.

7.7 Battery current

Program and/or set the gain control to the RTS and set other controls as stated in 6.4.3. Measure the current with an input sound pressure level of 65 dB at 1 000 Hz. The current measurement system shall conform to 5.5.

7.8 Measurements for hearing aids having induction pick-up coil

7.8.1 General

In order for the user of the hearing aid to be able to switch from the microphone input of the hearing aid to the induction pick-up coil position without significant changes of loudness, the sensitivity of the induction pick-up shall be measured. The frequency response curves measured acoustically and magnetically can differ significantly because of the differing input transducers, but in most cases they should not intentionally differ.

For testing a hearing aid with pick-up coil for use with a magnetic loop, the equivalent test loop sensitivity (ETLS) and the maximum HFA magneto-acoustical sensitivity level (HFA MASL) can be measured.

The vertical reference shall be specified by the manufacturer or estimated from an inspection of the hearing aid.

7.8.2 Equivalent test loop sensitivity (ETLS)

The test procedure is as follows:

a) Create a vertical magnetic field parallel to the vertical reference. The hearing aid shall be positioned such that the hearing aid reference point is at the test point as described in 5.6.5. The orientation shall be reported.
b) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.
c) Program and/or set the hearing aid to the "T" (telecoil) mode.
d) For a magnetic field strength of 31,6 mA/m and the input selector of the hearing aid in T-position, measure and calculate the HFA-SPLIV.
e) Calculate the equivalent test loop sensitivity (ETLS) as the HFA-SPLIV minus (RTG + 60 dB).

7.8.3 Maximum HFA magneto-acoustical sensitivity level (HFA MASL) of induction pick-up coil

The test procedure is as follows.

a) Create a vertical magnetic field parallel to the vertical reference. The hearing aid shall be positioned such that the hearing aid reference point is at the test point as described in 5.6.5. The orientation shall be reported.
b) Program and/or set the gain control full-on and set other controls as stated in 6.4.3.
c) Program and/or set the hearing aid to the "T" (telecoil) mode.
d) Adjust the magnetic field strength to –40 dB re 1 A/m (= 10 mA/m).
e) Determine the HFA output SPL.
f) Calculate the maximum HFA magneto-acoustical sensitivity level HFA MASL, according to the following formula:

   HFA MASL = output SPL minus 20 lg [H/(1 mA/m)] dB

   where H is the magnetic field strength at the test point in milliamperes per metre.

8 Characteristics of electrical input circuits for hearing aids

8.1 Electrical characteristics

8.1.1 General

In order for the user of the hearing aid to be able to switch from the microphone input of the hearing aid to a source connected to the electrical input without significant changes of loudness, the sensitivities of the electrical input and the microphone shall match each other properly.

8.1.2 Input impedance

The modulus of the impedance at the signal input terminal shall be at least 2 000 Ω in the frequency range 200 Hz to 10 kHz and shall be specified by the manufacturer.

8.1.3 Input sensitivity

The input sensitivity is the signal level at the electrical input terminal which results in the same HFA output as produced by an input sound pressure level to the microphone relative to 20 μPa of 70 dB.

The nominal input sensitivity relative to 1 V shall be –54 dB ± 6 dB. The manufacturer shall state the tolerance of their nominal value.

The signal input terminal shall be designed to withstand a d.c. voltage of at least 1,5 V and an a.c. voltage of at least 1,0 V (r.m.s. value).

8.2 Mechanical characteristics and electrical function of connector system for electrical input

It is recommended to use one of the three-terminal connector systems (the three-terminal polarized plug or the three-terminal circular connector system) specified in IEC 60118-12.

The pins of the three-terminal polarized plug shall have the following electrical functions: thick pin – common; mid pin – supply voltage (if used); third pin – signal.

The pins of the three-terminal circular connector system shall have the following electrical functions: pin 1 – common; pin 2 – supply voltage (if any); pin 3 – signal.

9 Additional optional test procedures

9.1 General

For measuring additional hearing aid functions optional measurements can be made.

9.2 Effects of tone control and gain control

9.2.1 Basic frequency response: effect of tone control

The test procedure is as follows.

a) Program and/or set the tone control to the required setting.
b) Program and/or set the gain control to the RTS and set other controls as stated in 6.4.3.
c) Keeping the input sound pressure level constant at 60 dB, vary the frequency of the sound source over the frequency range 200 Hz to 8 000 Hz. Measure and record the basic frequency response curve so obtained;
d) Repeat the test in c) with the various tone control settings to be tested.

9.2.2 Frequency response: effect of gain control position

The test procedure is as follows.

a) Proceed as stated in 7.4.1 a), b) and c).

b) Program and/or set the gain control from the full-on position downward in approximately 10 dB steps at 1 600 Hz.

c) Keeping the input sound pressure level constant at 60 dB, vary the frequency of the sound source over the frequency range 200 Hz to 8 000 Hz. Measure and record the frequency response curve so obtained.

d) Repeat the test in c) with the various gain control settings to be tested.

9.2.3 Characteristics of the gain control

The test procedure is as follows.

a) Program and/or set the gain control full on, and set other controls as stated in 6.4.3.

b) Adjust the input SPL to 60 dB.

c) Adjust the frequency to 1 600 Hz.

d) Determine the acoustic gain.

e) Repeat the test with a sufficient number of gain control settings to cover its full range.

f) Plot the acoustic gain relative to the full-on gain versus settings of the gain control, using a linear scale for the position of the gain control.

9.3 Intermodulation distortion

The difference frequency distortion is measured using an input signal composed of two sinusoidal signals f_1 and f_2 having amplitudes within 1,5 dB of each other, f_2 being higher in frequency than f_1. The levels of the second order ($f_2 - f_1$) and the third order ($2f_1 - f_2$) distortion products shall be measured and expressed as percentage of decibels referred to the output level of f_2. Higher order components may also be measured.

The test procedure is as follows.

a) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.

b) Select a suitable number of frequencies f_2 in the range 350 Hz to 8 000 Hz.

c) Adjust frequency f_1 such that $f_2 - f_1$ = 125 Hz.

d) Adjust the levels of f_1 and f_2 for a total level of 64 dB SPL (i.e., each tone is set to 61 dB SPL).

e) Measure the sound pressure levels at $f_2 - f_1$ and $2f_1 - f_2$ with a suitable filter. The output level of the filter should decrease by at least 10 dB when signal f_2 is switched off. The bandwidth of the filter should be stated.

f) Plot the difference frequency output distortion products as a function of f_2.

9.4 Effects of variation of battery or supply voltage and internal resistance

9.4.1 Full-on gain

The test procedure is as follows:

a) Program and/or set the gain control full-on and set other controls as stated in 6.4.3.

b) Adjust the frequency to 1 600 Hz.

c) Adjust the input SPL to 50 dB.

d) Determine the acoustic gain.

e) Repeat the test for various values of the supply voltage within the specified voltage range for normal operation of the battery.

f) Plot the acoustic gain relative to the full-on gain obtained at normal battery voltage versus voltage.

g) Repeat the test at a constant supply voltage for various values of the internal resistance within the resistance range of interest for the battery recommended for the hearing aid.

h) Plot the acoustic gain relative to the gain obtained at normal internal resistance versus internal resistance.

9.4.2 OSPL90

The test procedure is as follows.

a) Program and/or set the gain control to full-on and set other controls as stated in 6.4.3.
b) Adjust the frequency to 1 600 Hz.
c) Adjust the input SPL to 90 dB.
d) Measure the OSPL90.
e) Repeat the test for various values of the supply voltage within the voltage range of the hearing aid.
f) Plot the OSPL90 values relative to the value obtained at normal battery voltage, versus voltage.
g) Repeat the test at a constant supply voltage for various values of the internal resistance within the resistance range of interest for the battery recommended for the hearing aid.
h) Plot the OSPL90 values relative to the value obtained at normal internal resistance versus internal resistance.

9.4.3 Total harmonic distortion

Repeat the procedure described in 7.5 using appropriate battery or supply voltages within a range as stated by the hearing aid manufacturer.

Repeat the procedure described in 7.5 using various values of the internal resistance within a range as stated by the hearing aid manufacturer.

9.4.4 Total intermodulation distortion

Repeat the procedure described in 9.3 using appropriate battery or supply voltages within a range as stated by the hearing aid manufacturer.

Repeat the procedure described in 9.3 using various values of the internal resistance within a range as stated by the hearing aid manufacturer.

9.5 Equivalent input noise in one-third-octave bands

The equivalent input noise measured as a function of frequency in the range of measurement 200 Hz to 8 000 Hz is measured in one-third-octave bands by the test procedure as follows.

a) With the sound source switched off, the sound pressure level of the ambient noise in the test space at the hearing aid reference point is measured in one-third-octave bands with centre frequencies in the range of measurement. The ambient noise in the test space shall be at least 10 dB below the equivalent input noise level as calculated in g) in each third-octave band. An example is shown in Figure 8.
b) With the hearing aid and the sound source switched off, the spectrum of the test equipment noise is measured in one-third-octave bands with centre frequencies in the range of measurement. The test equipment noise shall be at least 10 dB below the output noise level as measured in f). An example is shown in Figure 7.
c) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.
d) Determine the acoustic gain for pure-tones as the difference between the output and input sound pressure levels at the centre frequencies of the one-third-octave filters in the range of measurement for an input sound pressure level of 50 dB. An example is shown in Figure 6.
e) Switch off the input sound source.

f) Measure the hearing aid output noise sound pressure level for one-third-octave bands with centre frequencies in the range of measurement. An example is shown in Figure 7.

g) Calculate the equivalent input noise level for each one-third-octave band according to the following formula:

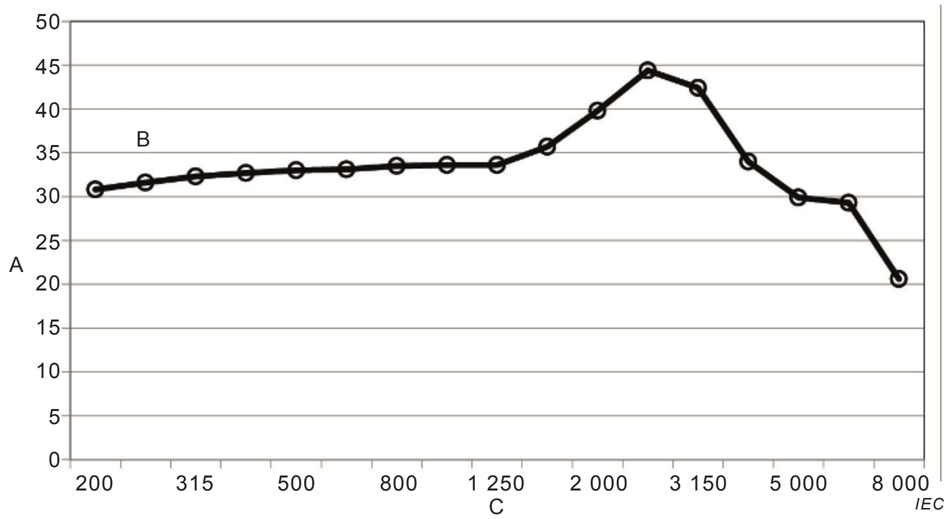
   equivalent input noise per one-third-octave band = (output noise level measured in f) minus (pure-tone gain measured in d).

   An example is shown in Figure 8.

Results for which the test equipment noise measured in b) is not 10 dB or more below the output noise measured in f) and/or the ambient noise measured in a) is not 10 dB or more below the equivalent input noise calculated in g) should be removed or be marked as invalid.

Measurements in a), b), d) and f) may be carried out by continuous recording.

If low-level expansion is active in the hearing aid during the measurement, this condition shall be stated by the manufacturer.



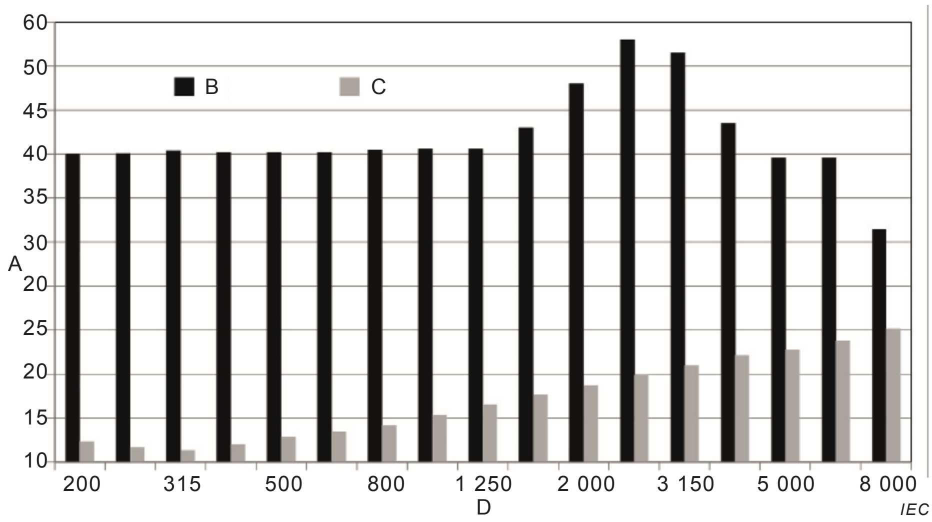
Key

A Gain (in decibels)

B Hearing aid gain

C One-third-octave-band centre frequency (in hertz)

Figure 6 – Example of hearing aid acoustic gain



Key

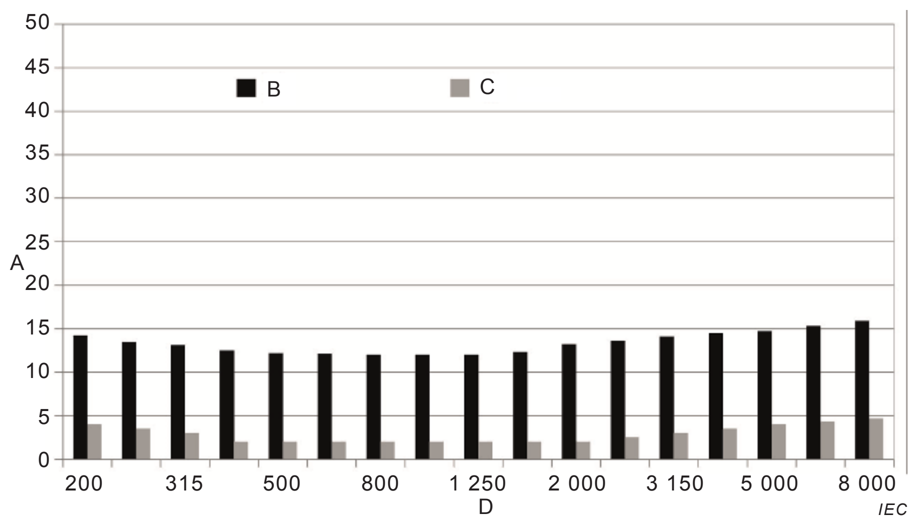
A Noise (SPL, in decibels)

B Hearing aid output noise

C Test equipment noise

D One-third-octave-band centre frequency (in hertz)

Figure 7 – Example of hearing aid output noise and test equipment noise



Key

A Noise (SPL, in decibels)

B Hearing aid equivalent input noise

C Ambient noise

D One-third-octave-band centre frequency (in hertz)

Figure 8 – Hearing aid equivalent input noise and ambient noise

9.6 Additional measurements for hearing aids having induction pick-up coil

9.6.1 General

All measurements shall be made in a vertical magnetic field generated by a magnetic loop with the hearing aid placed as normally worn on the ear. The hearing aid shall be positioned such that the hearing aid reference point is at the test point as described in 5.6.5. The orientation shall be reported.

9.6.2 Basic frequency response

The test procedure is as follows.

a) Adjust the magnetic field strength at the test point to 31,6 mA/m ± 5 % at 1 600 Hz.
b) Program and/or set the gain control to the RTS. Set other controls to the positions used for the acoustic measurements of the basic frequency response.
c) Vary the frequency of the source over the frequency range 200 Hz to 8 000 Hz, keeping the magnetic field strength constant at 31,6 mA/m.
d) For continuous recording, the sweep rate shall be such that the response does not differ by more than 1,0 dB from the steady-state value at any frequency.
e) The frequency response is plotted as the acoustic coupler SPL versus frequency.

9.6.3 Frequency response with full-on gain control setting

The purpose of this test is to determine the frequency response with induction pick-up coil input at full-on gain control setting. The input magnetic field strength shall be sufficiently low to ensure essentially linear input-output conditions.

The test procedure is as follows.

a) Program and/or set the gain control full-on and set other controls, if any, in such a position that maximum gain is obtained.
b) Adjust the magnetic field strength at the test point to 10 mA/m ± 5 % at 1 600 Hz.
c) Vary the frequency of the source over the frequency range 200 Hz to 8 000 Hz, keeping the magnetic field strength constant.
d) The frequency response curve is plotted as the acoustic coupler SPL versus frequency. The magnetic input field strength shall be stated.

9.6.4 Effect of gain control position on frequency response

The purpose of this test is to show the effect, if any, of the gain control position on the frequency response curve with induction pick-up coil input.

NOTE This test is particularly useful at high gain control settings to detect tendencies to internal magnetic inductive feed-back in hearing aids equipped with induction pick-up coil.

The test procedure is as follows.

a) Proceed as in a), b) and c) of 9.6.3.
b) Program and/or set the gain control from a full-on position downwards in approximately 10 dB steps at 1 600 Hz.
c) At each setting of the gain control, vary the frequency over the range 200 Hz to 8 000 Hz, keeping the magnetic field strength constant.
d) The frequency responses at each gain control setting should be plotted as the SPL of the acoustic coupler versus frequency.

9.6.5 Harmonic distortion

The test procedure is as follows.

a) Program and/or set the controls of the hearing aid in the same way as in 9.6.2 b). Apply a magnetic input field strength of 100 mA/m at 1 600 Hz and measure the output sound pressure level. In case this output level differs from the level measured under otherwise identical conditions with an acoustic input sound pressure level of 70 dB, the gain of the hearing aid shall be re-adjusted so that the output level with magnetic input is the same as with an acoustic input sound pressure level of 70 dB. If the gain available will not permit this, the full-on gain position should be used.
b) Vary the frequency of the source over the frequency range 200 Hz to 5 000 Hz and analyse the output signal for levels at the harmonic frequencies nf or record the total harmonic distortion. The bandwidth of the filter should be stated. For continuous recording the sweep rate shall be such that the response does not differ by more than 1 dB from the steady-state value at any frequency. In the event that the basic frequency response curve rises by 12 dB or more between any test frequency and its second harmonic, distortion tests at that frequency may be omitted;
c) If required, repeat the procedure described in b) with other magnetic input field strengths. Plot the harmonic distortion versus the frequency of the source and/or versus the magnetic field strength.

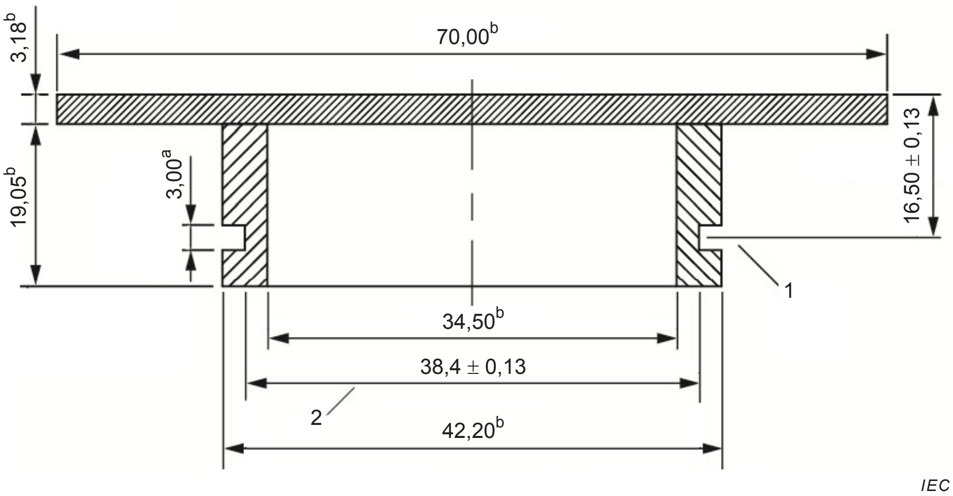
9.7 Additional measurements for hearing aids having induction pick-up coil for use with a telephone

9.7.1 General

For testing a hearing aid with pick-up coil for use with a telephone, a telephone magnetic field simulator (TMFS) can be used to measure the SPLITS response curve, the HFA-SPLITS and the relative simulated equivalent telephone sensitivity (RSETS). The telephone magnetic field simulator (TMFS) is shown in Figure 9.

NOTE The suggested number of coil turns of the TMFS is 10 turns.

Dimensions in millimetres



Key

1 Midpoint of coil thickness

2 Centre-to-centre diameter of coil

a Chosen to accommodate the number of turns and wire size.

b Not critical (example only).

Figure 9 – Telephone magnetic field simulator (TMFS)

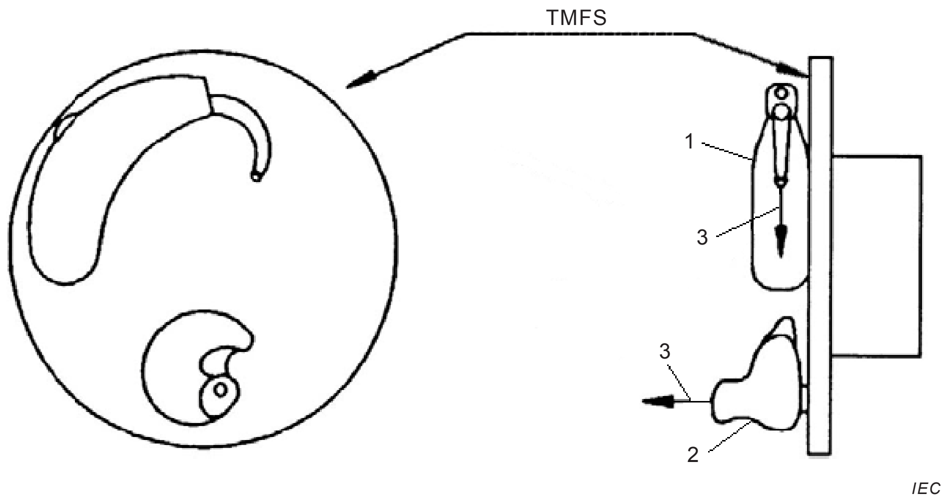
9.7.2 SPLITS response curve

The test procedure is as follows.

a) Position the hearing aid on the test surface of the TMFS and orient it for maximum output, subject to the following constraints:
   1) a BTE hearing aid should lie as flat as possible on the test surface;
   2) the faceplate of an ITE or ITC hearing aid should be parallel to the test surface of the TMFS and as close as possible to it.

   See Figure 10.
b) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.
c) Program and/or set the hearing aid to the "T" (telecoil) mode.
d) Adjust the current in the coil to a current of 6/N mA where N is the number of coil turns of the TMFS.
e) Record the SPLITS response curve expressed as the coupler SPL as a function of frequency in the range 200 Hz to 8 000 Hz.

For a BTE hearing aid, the values obtained may depend on which surface of the hearing aid is in contact with the test surface of the TMFS. In this case, the manufacturer should state for which ear the data apply and indicate the anticipated difference if worn on the opposite ear.



Key

1 BTE (left ear)

2 ITE or ITC

3 To coupler

Figure 10 – Example of hearing aids on TMFS for SPLITS test

9.7.3 HFA-SPLITS

The HFA-SPLITS is obtained by averaging the SPLITS values at three HFA frequencies.

9.7.4 Relative simulated equivalent telephone sensitivity (RSETS)

The RSETS is obtained by subtracting the RTG + 60 dB SPL from the HFA-SPLITS.

9.8 Additional measurements applying to AGC hearing aids

9.8.1 General

These measurements shall be performed at 2 000 Hz and may also be performed at one or more frequencies in the range from 200 Hz to 8 000 Hz.

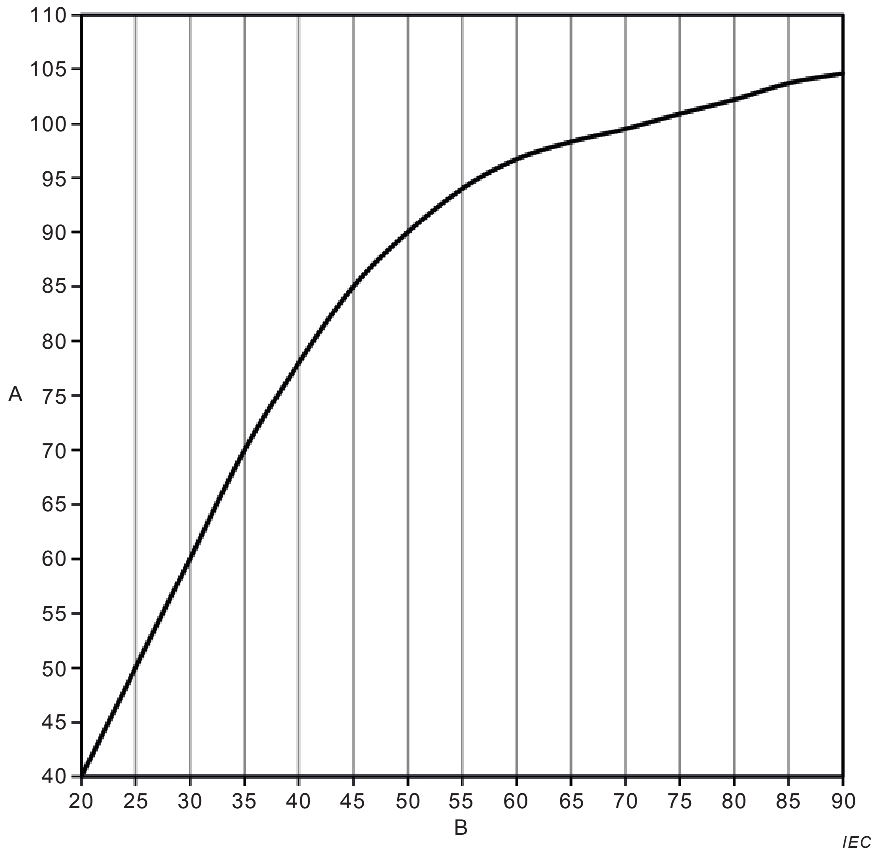
The selected frequencies shall be stated by the manufacturer.

9.8.2 Steady-state input-output characteristics

The test procedure is as follows.

a) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.
b) Measure the acoustic coupler SPL for input sound pressure levels in the range from 50 dB or lower to at least 90 dB, in steps not greater than 5 dB, at each of the selected AGC test frequencies.
c) Plot the output SPL versus input SPL; use linear decibel scales and same size divisions for ordinate and abscissa. An example is given in Figure 11.

The duration of each of the steps should be long enough to allow the output signal to reach steady-state conditions.



Key

A Output (SPL, in decibels)

B Input (SPL, in decibels)

Figure 11 – Example of a steady-state input-output characteristic

9.8.3 Dynamic AGC characteristics (attack and release time)

The test procedure is as follows.

a) Program and/or set the gain control to RTS and set other controls as stated in 6.4.3.
b) Select an AGC test frequency with the input sound pressure level alternating between 55 dB and 90 dB.
c) Measure acoustic coupler SPL over time; the duration at each level has to be long enough to allow the output signal to reach steady-state conditions.

   NOTE To display the output signal over time an oscilloscope can be connected to the measuring amplifier.

d) Determine the attack time from the time plot of the envelope of acoustic output.

   The attack time is defined as the time span from the level change from 55 dB to 90 dB SPL to the point where the signal has stabilized within 3 dB.

e) Determine the release time from the time plot of the envelope of acoustic output.

   The release time is defined as the time taken for the level to fall from 90 dB to 55 dB SPL, to the point where the level has stabilized to within 4 dB.

9.9 Additional optional measurements with ear simulator, according to IEC 60318-4

9.9.1 General

To obtain SPL response curves which are more representative of performance in a human ear, an ear simulator according to IEC 60318-4 can be used for measurements of the OSPL90 frequency response curve, the full-on gain response curve and the basic frequency response curve.

9.9.2 Output sound pressure level frequency response curve for an input sound pressure level of 90 dB

Follow the procedure as described in 7.2 a) and b).

9.9.3 Full-on gain response curve

Follow the procedure as described in 7.3 a), b) and c).

9.9.4 Basic frequency response curve

Follow the procedure as described in 7.4.1 a) and b).

9.9.5 Presentation of data

The manufacturer has to clearly label the response curves "obtained according to IEC 60118-0:2015 with ear simulator according to IEC 60318-4".

To avoid confusion, stating of any numerical data should be avoided.

10 Maximum permitted expanded uncertainty of measurements

Table 3 specifies the maximum permitted expanded uncertainty for a coverage factor of $k = 2$, associated with the measurements undertaken in this part of IEC 60118.

The expanded uncertainties of measurement given in Table 3 are the maximum permitted for demonstration of conformance to the requirements of this part of IEC 60118.

If the actual expanded uncertainty of a measurement exceeds the maximum permitted value in Table 3, the measurement shall not be used to demonstrate conformance to the requirements of this part of IEC 60118.

Table 3 – Values of U_{max} for basic measurements

Measured quantity	U_{max}
Sound pressure level 200 Hz to 4 000 Hz	2,0 dB
Sound pressure level greater than 4 000 Hz	2,5 dB
Magnetic field strength level	1,0 dB
Frequency	0,5 %
Total harmonic distortion	0,5 %
Temperature	0,5 °C
Relative humidity	5 %
Ambient pressure	0,1 kPa

The measurement uncertainty is composed of several factors:

– uncertainty of equipment used, such as sound generators, level meters, measuring microphones, coupler, etc.;
– tolerances of the acoustic coupling of the hearing aid to the coupler. Such tolerances could be related to diameter and length of tubing;
– accuracy and care of positioning the hearing aid in the test space.

The measurement uncertainty can be determined by considering the above factors.

NOTE It is good practice to validate the uncertainty by comparing measurement results with an accredited test laboratory.

The interpretation of the measurement uncertainty is different for the manufacturer, who has to guarantee the nominal data, and the purchaser.

– Manufacturer production test limits: tolerance minus measurement uncertainty.
– Purchaser measurement acceptance limits: nominal data plus measurement uncertainty.

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