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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electroacoustics – Hearing aids – Part 15: Methods for characterising signal processing in hearing aids with a speech-like signal

Électroacoustique – Appareils de correction auditive – Partie 15: Méthodes de caractérisation du traitement des signaux dans les appareils de correction auditive avec un signal de type parole

IEC 60118-15:2012

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ELECTROACOUSTICS – HEARING AIDS –

Part 15: Methods for characterising signal processing in hearing aids with a speech-like signal

FOREWORD

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

CDV	Report on voting
29/719/CDV	29/730A/RVC

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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- withdrawn,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.

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INTRODUCTION

The characterisation 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. These standards use non speech-like test signals with the hearing aid set to specific settings which are, in general, not comparable with typical user settings.

This standard describes a recommended speech-like test signal, the International Speech Test Signal (ISTS), and a method for the characterisation of hearing aids using this signal with the hearing aid set to actual user settings or to the manufacturers' recommended settings for one of a range of audiograms. For the purposes of this standard the hearing aid is considered to be a combination of the physical hearing aid and the fitting software which accompanies it.

ELECTROACOUSTICS – HEARING AIDS –

Part 15: Methods for characterising signal processing in hearing aids with a speech-like signal

1 Scope

This part of IEC 60118 specifies a test signal designed to represent normal speech, the International Speech Test Signal (ISTS), together with the procedures and the requirements for measuring the characteristics of signal processing in air-conduction hearing aids. The measurements are used to derive the estimated insertion gain (EIG). For the purposes of characterizing a hearing aid for production, supply and delivery, the procedures and requirements to derive the coupler gain on a 2 cm^3 coupler as defined in IEC 60318-5 are also specified.

The procedure uses a speech-like test signal and the hearing aid settings are set to those programmed for an individual end-user or those recommended by the manufacturer for a typical end-user for a range of flat, moderately sloping or steep sloping audiograms, so that the measured characteristics are comparable to those which may be obtained by a wearer at typical user settings.

The purpose of this standard is to ensure that the same measurements made on a hearing aid following the procedures described, and using equipment complying with these requirements, give substantially the same results.

Measurements of the characteristics of signal processing in hearing aids which apply non-linear processing techniques are valid only for the test signal used. Measurements which require a different test signal or test conditions are outside the scope of this standard.

Conformance to the specifications in this standard is demonstrated only when the result of a measurement, extended by the actual expanded uncertainty of measurement of the testing laboratory, lies fully within the tolerances specified in this standard as given by the values given in 6.1.

Measurement methods that take into account the acoustic coupling of a hearing aid to the individual ear and the acoustic influence of the individual anatomical variations of an end-user on the acoustical performance of the hearing aid, known as real-ear measurements, are outside the scope of this particular standard.

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 60118-7, *Electroacoustics – Hearing aids – Part 7: Measurement of the performance characteristics of hearing aids for production, supply and delivery quality assurance purposes*

IEC 60118-8:2005, *Electroacoustics – Hearing aids – Part 8: Methods of measurement of performance characteristics of hearing aids under simulated in situ working conditions*

IEC 60318-4, *Electroacoustics – Simulators of human head and ear – Part 4: Occluded-ear simulator for the measurement of earphones coupled to the ear by means of ear inserts*

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*

IEC 61260, *Electroacoustics – Octave-band and fractional-octave-band filters*

3 Terms and definitions

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

3.1
sound pressure level
all sound pressure levels specified are measured in decibels (dB) referenced to 20 µPa

3.2
percentile sound pressure level
sound pressure level, in dB, below which a certain percentage of the measured sound pressure levels fall, measured in a 125 ms time interval, over a stated measurement period

Note 1 to entry: As an example: The 30th percentile sound pressure level is the sound pressure level below which 30 % of the measured sound pressure levels are found, and the remaining 70 % of the measured sound pressure levels are higher.

Note 2 to entry: The 99th percentile may be interpreted as a peak sound pressure level indicator.

Note 3 to entry: The definition of percentile used here is according to general statistics. This definition may differ from other sciences such as acoustics.

3.3
international speech test signal
ISTS
speech-like test signal as defined in this standard

3.4
long term average speech spectrum
LTASS
sound pressure level measured in one-third-octave bands averaged over a long time period of speech

Note 1 to entry: For this standard a time period of 45 s is chosen.

3.5
occluded ear simulator
OES
ear simulator as defined in IEC 60318-4

3.6
estimated insertion gain of a hearing aid
EIG
estimate of the real-ear insertion gain as may be obtained across a group of persons

Note 1 to entry: This estimate is based on measurements of hearing aid gain using an occluded ear simulator or a 2 cm^3 coupler, as defined in IEC 60318-5.

3.7
coupler gain of a hearing aid
hearing aid gain measured by means of a 2 cm^3 coupler, as defined in IEC 60318-5

3.8
LTASS gain of a hearing aid
estimated insertion gain or coupler gain provided for the long-term average speech spectrum of the international speech test signal

3.9
percentile gain of a hearing aid
estimated insertion gain or the coupler gain provided for a given percentile of the distribution of sound pressure levels in a one-third-octave band of the international speech test signal

4 Limitations

This standard provides a technical characterisation of hearing aids and is not defining a clinical procedure for insertion gain measurements. However, results are shown as estimated insertion gain in order to improve the understanding of the results in relation to in situ conditions.

The estimated insertion gain may differ substantially from in situ results obtained on an individual person, due to differences between in situ conditions and the use of ear simulator or coupler as well as anatomical variation of head, torso, pinna, ear canal, and eardrum. Care should be taken when interpreting the results.

5 Setup

5.1 System overview

The goal of the test method is to provide an estimate of the insertion gain as may be obtained across a group of persons. For the purpose of characterizing a hearing aid for production, supply and delivery also the coupler gain on a 2 cm^3 coupler as defined in IEC 60318-5 is provided.

This standard employs the international speech test signal (ISTS) for the measurement of hearing aid gain in one-third-octave bands and introduces the concept of gain for the long term average speech spectrum (LTASS gain) and the concept of time-aligned gain for a given percentile of the distribution of one-third-octave band sound pressure level of the ISTS (percentile gain) in 125 ms sections. Within each band, the LTASS gain is the gain averaged over the test duration. Within each band, the percentile gain for a given percentile is determined for each 125 ms section in the ISTS distribution which has the sound pressure level of the given percentile, and these gains are averaged over the duration of the test.

The methods of this standard yield an estimated insertion gain (EIG) (preferred) and a 2 cm^3 coupler gain (optional) for the LTASS and the 30^{th}, 65^{th} and 99^{th} percentiles of the ISTS.

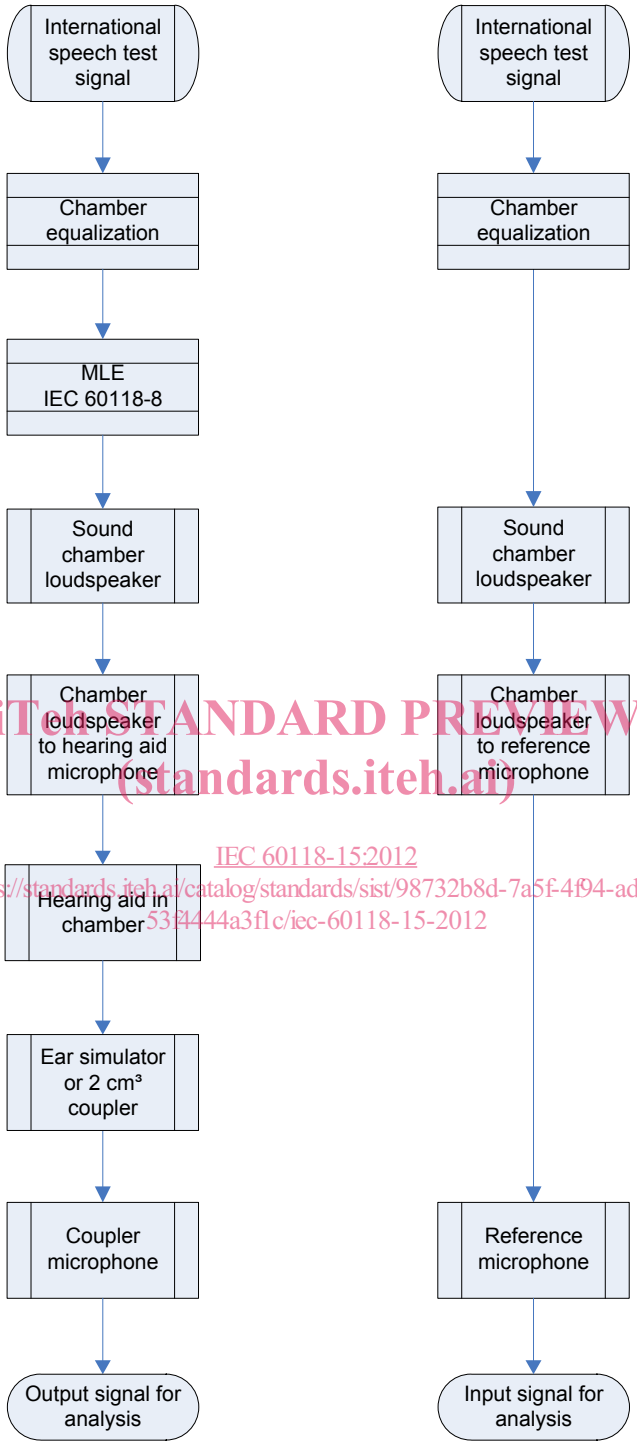
For the EIG measurement, the ISTS is spectrally shaped by the free-field to the hearing-aid-microphone transformation for the type of hearing aid being tested. The output of the hearing aid is preferably measured in an occluded ear simulator but may also be estimated from 2 cm^3 coupler sound pressure level by adding the occluded ear simulator to 2 cm^3 coupler difference. The EIG (calculated as the LTASS gain or as the speech gain at various percentile sound pressure levels) is derived by subtracting the relevant ISTS band level and the manikin unoccluded ear gain (IEC 60118-8:2005, Annex B) from the hearing aid output band level.

For the 2 cm^3 coupler gain measurements, the input to the hearing aid is the ISTS and its output is the 2 cm^3 coupler sound pressure level.

Figure 1 and Figure 2 show an overview of the method.

- Figure 1 shows the measurement procedure for the hearing aid response for determining the estimated insertion gain using an occluded ear simulator in accordance with IEC 60318-4 or a 2 cm^3 coupler in accordance with IEC 60318-5 and applying a free-field to hearing-aid-microphone transform of IEC 60118-8.
- Figure 2 shows the measurement procedure for the hearing aid response for determining the coupler gain using a 2 cm^3 coupler in accordance with IEC 60318-5.

5.2 Estimated insertion gain

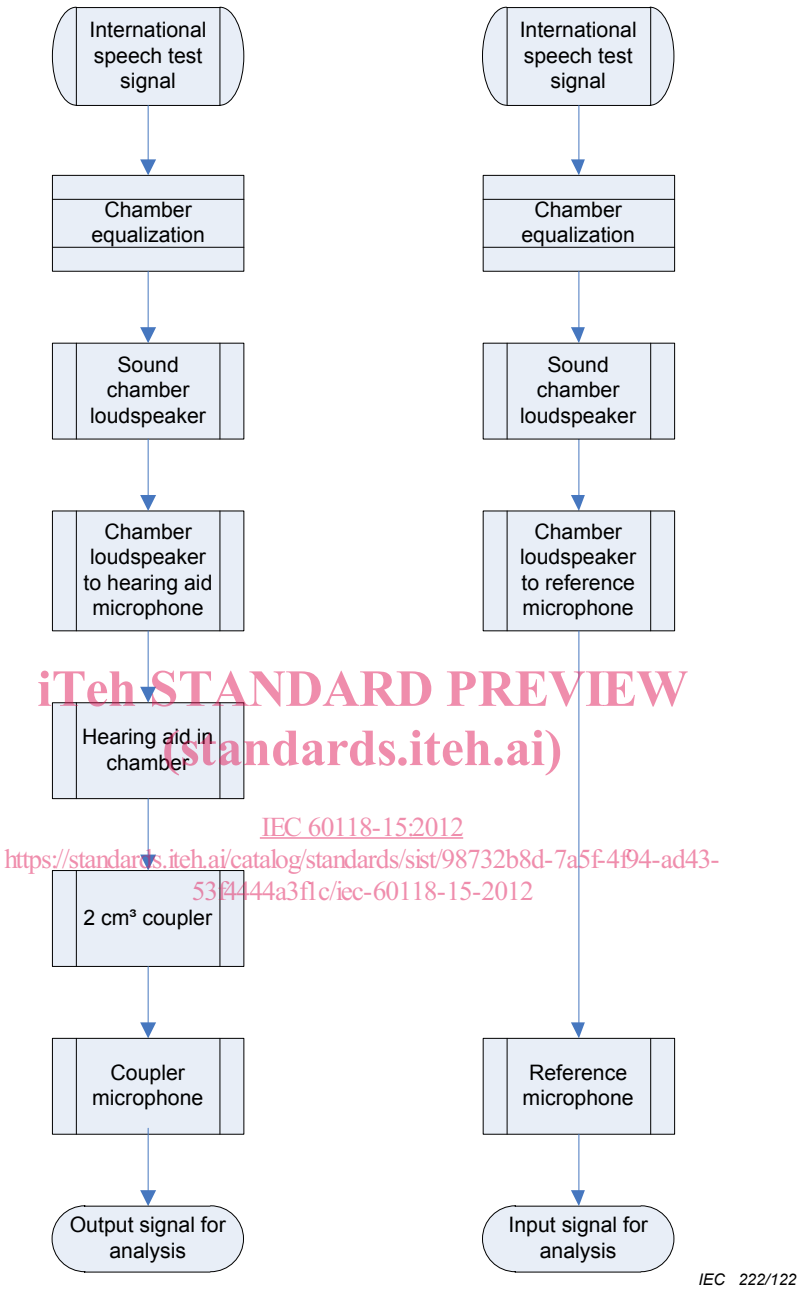


NOTE 1 The ear simulator complies with IEC 60318-4; the 2 cm^3 coupler is in accordance with IEC 60318-5.

NOTE 2 Blocks with vertical lines are actual physical parts of the measurement setup. Blocks with horizontal lines are pre- and post-processing steps in software.

Figure 1 – Measurement setup for the estimated insertion gain

5.3 Coupler gain



NOTE 1 The 2 cm^3 coupler complies with IEC 60318-5.

NOTE 2 Blocks with vertical lines are actual physical parts of the measurement setup. Blocks with horizontal lines are pre- and post-processing steps in software.

Figure 2 – Measurement setup for the coupler gain

6 Test equipment

6.1 Acoustical requirements

For the acoustical measurements the requirements for test equipment, test conditions and the acoustic test box as listed in IEC 60118-7 shall be followed. In particular, the following requirements apply:

a) The test box used shall provide essentially free field conditions in the frequency range 200 Hz to 8 kHz.

b) The hearing aid shall be positioned to reflect a frontal sound incidence (0 degrees azimuth and elevation as defined in IEC 61669). If this is not appropriate for the type of hearing aid, the actual incidence should be stated.

c) The input sound pressure level at the hearing aid reference point is kept constant by means of a reference microphone (pressure method) or by using the substitution method.

d) One-third-octave-band filters with nominal centre frequencies from 250 Hz to 6,3 kHz shall be used. The filters shall conform to the class 2 requirements of IEC 61260.

e) Unwanted stimuli in the acoustic test box, such as ambient noise and mechanical vibrations 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 at least 10 dB when the signal source is switched off.

f) The sound pressure level at the hearing aid reference point shall be accurate within ± 1,5 dB over the frequency range from 200 Hz to 2 kHz and within ± 2,5 dB from 2 kHz to 8 kHz.

g) The free-field response level of the reference microphone used to measure the test signal, along with its associated amplifier and readout device, shall be frequency independent within ± 1 dB in the frequency range 200 Hz to 5 kHz and within ± 2 dB in the frequency range 5 kHz to 8 kHz relative to the free-field response level at 1 kHz. The pressure response level calibration of the reference microphone system shall be known by calibration at one frequency between 250 Hz and 1 250 Hz, preferably at 1 kHz. The expanded uncertainty of the calibration shall not exceed 1 dB.

h) The relative pressure response level of the coupler microphone, along with its associated amplifier and readout device, shall be frequency-independent within ± 1 dB in the frequency range 200 Hz to 5 kHz and within ± 2 dB in the range 5 kHz to 8 kHz relative to the pressure sensitivity at 1 kHz. The pressure response level calibration of the coupler microphone system shall be known by calibration at one frequency between 250 Hz and 1 250 Hz, preferably at 1 kHz. The expanded uncertainty of the calibration shall not exceed 1 dB.

6.2 Test signal

6.2.1 Specification of ISTS

The international speech test signal (ISTS) shall be used as the test signal for the measurements of this standard. This signal is developed by the European Hearing Instrument Manufacturers Association which holds the copyright. It is available from this organization free of charge as a 16 bit or 24 bit file of type .wav.

The ISTS has been produced from recordings of female speakers of Arabic, English, French, German, Mandarin and Spanish. The recordings were cut into short segments and recomposed in random order. A description of the ISTS is given in Annex A and in [1][1]. The ISTS has the following essential characteristics:

a) The signal bandwidth is from 100 Hz to 16 kHz. For the measurements in this standard only the bandwidth is relevant that includes all one-third-octave bands with nominal centre frequencies from 0,25 kHz to 6,3 kHz.

b) The long term average speech spectrum (LTASS) is given in Table 1 and in Figure 3. It is the average LTASS for female talkers reported in [2]. For acoustical reproduction the accuracy shall be within ± 3 dB for all one-third-octave bands with nominal centre frequencies from 0,25 kHz to 6,3 kHz.

c) The 30th, 65th and 99th percentiles of the distribution of the sound pressure level in 125 ms time blocks in one-third-octave-octave bands are given in Table 1 and in

1 Figures in brackets refer to the Bibliography.