BRITISH STANDARD

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60318-5:2006

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

The European Standard EN 60318-5:2006 has the status of a British Standard

ICS 17.140.50

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National foreword

This British Standard was published by BSI. It is the UK implementation of EN 60318-5:2006. It is identical with IEC 60318-5:2006. It supersedes BS 6111:1981 which is withdrawn.

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A list of organizations represented on EPL/29 can be obtained on request to its secretary.

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English version

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

(IEC 60318-5:2006)

Electroacoustique -
Simulateurs de tête et d'oreille humaines
Partie 5: Coupleur de 2 cm³
pour la mesure des appareils de
correction auditive et des écouteurs
couplés à l'oreille par des embouts
(CEI 60318-5:2006)

Elektroakustik -
Simulatoren des menschlichen Kopfes
und Ohres
Teil 5: 2-cm³-Kuppler zur Messung
von mittels Ohreinsätzen angekoppelten
Hörgeräten und Ohrhörern
(IEC 60318-5:2006)

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 29/600/FDIS, future edition 1 of IEC 60318-5, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60318-5 on 2006-09-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2007-06-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-09-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60318-5:2006 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60118-7	NOTE	Harmonized as EN 60118-7:2005 (not modified).
IEC 61094-1	NOTE	Harmonized as EN 61094-1:1994 (not modified).

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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

1 Scope

This part of IEC 60318 describes an acoustic coupler for loading an earphone or hearing aid with a specified acoustic impedance when determining its physical performance characteristics, in the frequency range 125 Hz to 8 kHz. It is suitable for air conduction hearing aids and earphones, coupled to the ear by means of ear inserts e.g. ear moulds or similar devices.

The sound pressure developed by an earphone is not, in general, the same in the coupler as in a person's ear. However, it can be used as a simple and ready means for the exchange of specifications and of physical data on hearing aids and for the calibration of specified insert earphones used in audiometry.

2 Normative references

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

IEC 61094-4, *Measurement microphones – Part 4: Specifications for working standard microphones*

ISO 389-2, *Acoustics – Reference zero for the calibration of audiometric equipment – Part 2: Reference equivalent threshold sound pressure levels for pure tones and insert earphones*

BIPM/IEC/ISO/IUPAC/IUPAP/OIML:1995, *Guide to the expression of uncertainty in measurement (GUM)*

3 Terms and definitions

For the purposes of this part of IEC 60318, the following terms and definitions apply:

3.1
acoustic coupler
cavity of predetermined shape and volume which is used for the calibration of an earphone in conjunction with a microphone to measure the sound pressure developed within the cavity

3.2
effective volume
equivalent volume of air of the acoustical compliance of the coupler formed by the cavity and the microphone at a frequency of 250 Hz

4 Construction

4.1 General

The coupler consists essentially of a cylindrical cavity whose effective volume is nominally 2 000 mm^3. The base of the cylindrical cavity contains the diaphragm of a microphone, or a microphone with an adapter. A protection grid may or may not be fitted. The microphone measures the sound pressure level in the coupler. The coupler shall be constructed of hard, dimensionally stable, non-porous and non-magnetic material. The general construction of the coupler and mounting of the microphone shall aim to minimise the response of the microphone to vibration (for example from an earphone) or to extraneous sound outside the cavity.

NOTE The external diameter of the coupler should be kept as small as possible in order to minimise diffractional errors which might affect the measurements when the coupler has to be placed in a free sound field.

Where tolerances are specified in this part of IEC 60318, these shall be reduced by an amount equal to the actual expanded measurement uncertainty of the test laboratory before deciding if a device conforms with the stated requirement.

4.2 Cavity dimensions

4.2.1 The critical dimensions of the coupler are those which determine the shape and volume of the cavity terminated by a measurement microphone, and the capillary leak.

4.2.2 The effective volume of the coupler shall be:

2 000 $mm^3 \pm 70$ mm^3.

The contributions of any front cavity associated with the microphone and of the finite diaphragm impedance, etc., shall be included in the effective volume of the coupler. Therefore, the height of the cylindrical cavity should be designed such that the effective volume of the coupler conforms to the requirement for all models of microphone intended for use with the coupler.

4.2.3 The diameter d_1 of the cylindrical cavity shall be within

18,0 mm $\leq d_1 \leq$ 21,0 mm.

4.3 Calibrated pressure type microphone

4.3.1 General

A coupler configuration using a WS1P microphone shall be used for the calibration of audiometers equipped with an insert earphone. The overall pressure sensitivity level of the microphone and the associated measuring system shall be known by calibration with an expanded measurement uncertainty (k = 2) of no more than 0,2 dB, over the frequency range covered by the audiometer.

For other purposes – for instance for hearing aid measurements – other microphones, including those with smaller dimensions, can be used provided that the specified volume is preserved. The use of an alternative microphone and the associated measurement uncertainty of the pressure sensitivity level shall be stated by the user.

4.3.2 Microphone type WS1P

The diameter of the free portion of the diaphragm of the microphone shall not exceed the diameter of the cylindrical cavity.

The internal shape of the base of the coupler shall enable a microphone type WS1P (as specified in IEC 61094-4), without its protecting grid, to be fitted into the base. The microphone used shall have a high acoustical impedance such that its equivalent volume shall be less than 200 mm^3 at frequencies between 125 Hz and 8 000 Hz.

NOTE A measurement microphone that conforms to the requirements of IEC 61094-1 for laboratory standard microphones also conforms to the requirements of IEC 61094-4 for working standard microphones.

4.3.3 Alternative microphone

If it is necessary to use a microphone for which the diameter of the free part of the diaphragm is less than the diameter of the coupler cavity, the microphone shall be located concentrically in the base of the coupler cavity. Preferably a microphone type WS2P (as specified in IEC 61094-4), either with or without protection grid, should be used.

NOTE 1 When a type WS2P microphone is used in place of a type WS1P, differences in the coupler output levels of up to ±1 dB for frequencies up to 6 kHz, and ± 2 dB for frequencies between 6 kHz and 8 kHz, may be expected. Similar data for other types of microphone – for instance for electret microphones – are not available.

NOTE 2 A measurement microphone that conforms to the requirements of IEC 61094-1 for laboratory standard microphones also conforms to the requirements of IEC 61094-4 for working standard microphones.

NOTE 3 Measurements performed with a WS2P microphone equipped with a protection grid and with an LS2P microphone should not differ by more than 0,3 dB at frequencies up to 8 kHz.

4.4 Static pressure equalisation

Any change in the static pressure within the cavity caused by assembly of the earphone to the coupler and microphone shall decay toward the static ambient pressure with a time constant of less than 1,5 seconds. If this necessitates the introduction of a controlled leak in the coupler, it shall have the following characteristics.

a) It shall not alter the cavity volume by more than 20 mm^3.

b) It shall attenuate external sound reaching the cavity, with the entrance blocked, by at least 16 dB at 100 Hz, increasing by 6 dB per octave for increasing frequency.

NOTE Equalisation can be realised, for example, by a capillary tube with a diameter of 0,6 mm and a length of 12,5 mm containing a wire with a diameter of 0,5 mm.

5 Calibration

5.1 Reference environmental conditions

Reference ambient pressure:	101,325 kPa
Reference temperature:	23 °C
Reference relative humidity:	50 %.

5.2 Calibration procedure

The manufacturer shall describe a calibration method for the microphone system used in the coupler in an instruction manual.

Ideally, the calibration should be performed at the reference environmental conditions given in 5.1 with the following tolerances:

Ambient pressure:	± 3,000 kPa
Temperature:	± 3 °C
Relative humidity:	± 20 %.

If it is not possible to fulfil these requirements, the actual environmental conditions shall be stated.

6 Coupling of earphones and hearing aids to the coupler

6.1 Audiometers with insert earphones

Insert earphones with standardised reference equivalent threshold sound pressure levels shall be connected to the acoustic coupler as specified in the relevant ISO standard. For other earphones the manufacturer of the audiometer shall describe the method of connection.

NOTE Reference equivalent threshold sound pressure levels of an insert earphone for audiometers and its connection to the 2 cm^3 coupler are standardised in ISO 389-2.

6.2 Hearing aids of the in-the-ear type

The hearing aid shall be connected directly to the cavity of the coupler as indicated in Figure 1. The connection between the hearing aid and the coupler shall be made airtight by using a suitable seal. In doing so care shall be taken not to introduce additional volume to the cavity which can affect the measured performance of the hearing aid.

6.3 Hearing aids with insert earphone

Where possible, the ear insert used with the human ear shall be replaced by an ear mould substitute consisting essentially of a rigid tube, connected coaxial with the cavity, of length

18,00 mm ± 0,20 mm

and internal diameter

3,00 mm ± 0,06 mm

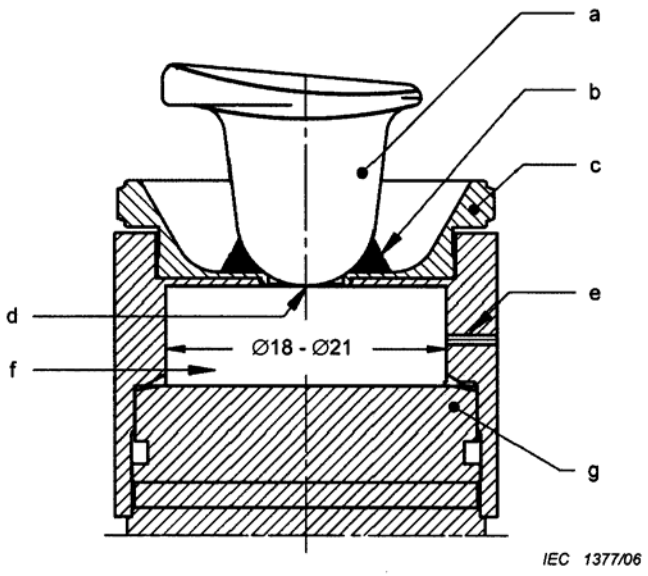
representing the tubular portion of an average ear mould.

The connection between the nub of the earphone and the ear mould substitute shall be made airtight by using a suitable seal. In doing so care shall be taken not to introduce additional volume to the cavity which can affect the measured performance of the earphone.

An example of an earphone connected to the 2 cm^3 coupler with an ear mould substitute is shown in Figure 2. It illustrates the principle features of the connection method. However other forms may also be used, provided that they conform to the above specifications.

If it is inappropriate to disconnect the ear insert used with the human ear from the receiver, the ear insert shall be connected directly to the entrance of the cylindrical cavity and shall be coaxial with it. An airtight seal shall be ensured. In doing so care shall be taken not to introduce additional volume to the cavity which can affect the measured performance of the earphone.

Dimensions in millimetres



Key

a In-the-ear type hearing aid (ITE)

b Airtight sealing material

c Ear mould holder for ITE hearing aids

d Tip of hearing aid or insert should be flush with cavity wall

e Static pressure equalization

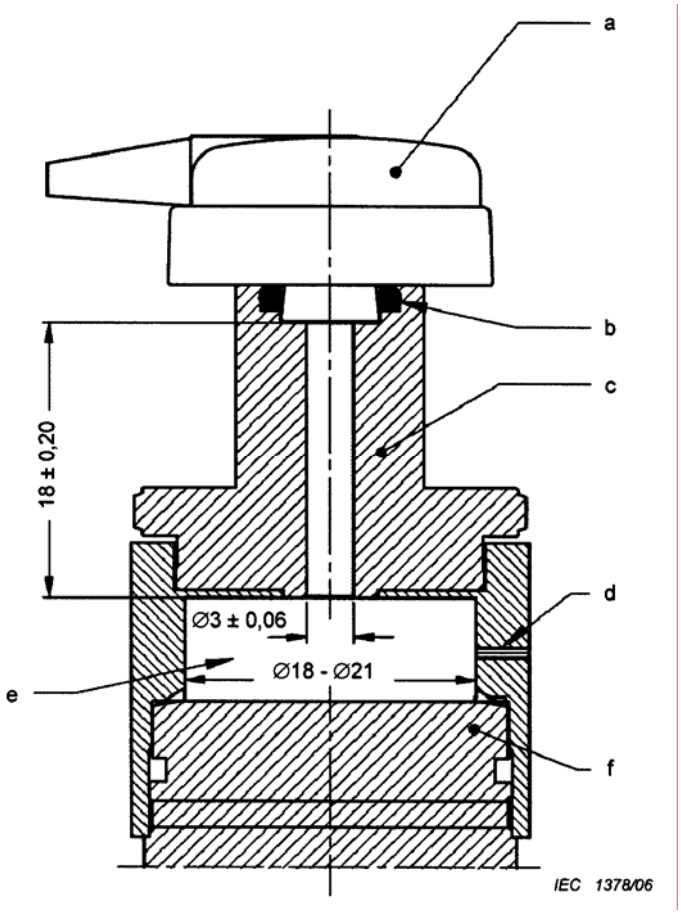
f Coupler cavity of 2 000 $mm^3 \pm 70$ mm^3 effective volume

g Pressure response microphone

NOTE This diagram is only intended as a schematic representation, illustrating the principle of connecting the hearing aid to the coupler. Effective airtight seals should be assured at all connection points.

Figure 1 – Connection of an in-the-ear type of hearing aid to the coupler

Dimensions in millimetres



Key

a Insert earphone

b Airtight seal

c Ear mould substitute for insert earphones

d Static pressure equalization

e Coupler cavity of 2 000 mm^3 ± 70 mm^3 effective volume

f Pressure response microphone

NOTE This diagram is only intended as a schematic representation, illustrating the principle of connecting the earphone to the coupler. Effective airtight seals should be assured at all connection points.

Figure 2 – Connection of an insert earphone to the coupler

6.4 Hearing aids of the behind-the-ear type and spectacle hearing aids

The hearing aid with its acoustic outlet attachment (e.g. hook and flexible connecting tube of behind-the-ear hearing aids or nub and flexible connecting tube of spectacle hearing aids) shall be connected to the 2 cm^3 coupler with an ear mould substitute as described in 6.3. This shall be accomplished by means of a small coupling device of rigid material, having the same internal diameter as the nominal diameter at the end of the acoustic outlet attachment ± 0,06 mm and a length of

5,0 mm ± 0,1 mm.

The connection between the small coupling device and the ear mould substitute shall be made airtight by using a suitable seal. In doing so care shall be taken not to introduce additional volume to the cavity which can affect the measured performance of the hearing aid.

The material, length and internal diameter of the connecting tube between the hearing aid and the small coupling device shall conform to the manufacturer's specifications. In particular the connecting tube can be of flexible or rigid material.

This connecting tube between the hearing aid and the small coupling device shall be connected to the nub of a spectacle hearing aid or to the hook, if any, of a behind-the-ear hearing aid. The connecting tube shall not be connected directly to the behind-the-ear type of hearing aid if this aid is intended to be used with a hook.

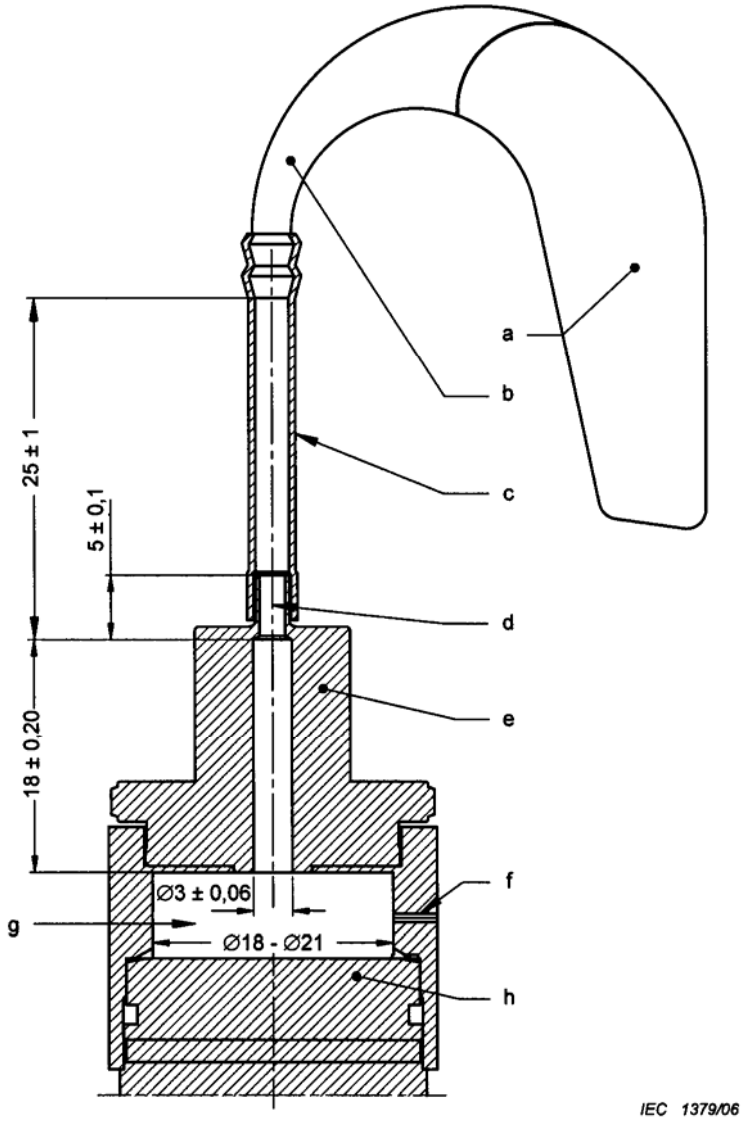
Unless otherwise specified, the length of the connecting tube measured from the end of the hook or from the end of the nub to the entrance of the 3 mm diameter rigid tube of the ear mould substitute shall be

25 mm ± 1 mm.

The principal features of the coupler with ear mould substitute and small coupling device, showing the connection arrangement for a behind-the-ear hearing aid are indicated in Figure 3. As an example, the internal diameter of the small coupling device is chosen to be 2 mm in accordance with the tubing most commonly used. Other forms than the one illustrated may be used, provided that they conform to the above specifications.

NOTE The manufacturer’s specifications for the dimensions of the tubing should be in accordance with the average conditions found in practical use of the hearing aid. If, for some unusual reason, it is impossible to simulate the average conditions of practical use with the ear mould substitute specified above in the coupler, an appropriate different system may be used if fully described.

Dimensions in millimetres



Key

a	Behind-the-ear type hearing aid (BTE)
b	Acoustical outlet of hearing head (hook)
c	Flexible or rigid connecting tube, typically ∅ 2 mm internal
d	Small coupling device having the same internal diameter as the nominal diameter of the acoustical outlet attachment of the hearing aid, typically ∅ 2 mm
e	Ear mould substitute for hearing heads
f	Static pressure equalization
g	Coupler cavity of 2 000 mm^3 ± 70 mm^3 effective volume
h	Pressure response microphone

NOTE This diagram is only intended as a schematic representation, illustrating the principle of connecting the hearing aid to the coupler. Effective airtight seals should be assured at all connection points.

Figure 3 – Connection of a behind-the-ear type of hearing aid to the coupler

7 Maximum permitted expanded uncertainty of measurements

Table 1 specifies the maximum permitted expanded uncertainty U_{max} for a probability of approximately 95 % equivalent to a coverage factor of k = 2, associated with the measurements undertaken in this part of IEC 60318, see the *Guide to the expression of uncertainty in measurement*. One set of values for U_{max} is given for basic type approval measurements.

The expanded uncertainties of measurements given in Table 1 are the maximum permitted for demonstration of conformance to the requirements of this part of IEC 60318. If the actual expanded uncertainty of a measurement performed by the test laboratory exceeds the maximum permitted value in Table 1, the measurement shall not be used to demonstrate conformance to the requirements of this part of IEC 60318.

Table 1 – Values of U_{max} for basic measurements

Measured quantity	Relevant subclause number	Basic U_{max} (k=2)
Effective volume	4.2.2	30 mm^3
Height of cylindrical cavity	4.2.2	0,10 mm
Diameter of cylindrical cavity	4.2.3	0,06 mm
Sound attenuation	4.4	0,1 dB
Ambient pressure	5.2	0,1 kPa
Temperature	5.2	0,5 °C
Relative humidity	5.2	5 %
Internal diameter of ear-mould substitute or small coupling device	6.3, 6.4	0,02 mm
Length of ear-mould substitute or small coupling device	6.3, 6.4	0,02 mm

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

[5] ANSI S3.7:1995 (R2003), *Method for coupler calibration of earphones*

[6] IEC 61094-1, *Measurement microphones – Part 1: Specifications for laboratory standard microphones*

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

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

Publication	Year	Title	EN/HD	Year
IEC 61094-4	-[1)]	Measurement microphones Part 4: Specifications for working standard microphones	EN 61094-4	1995[2)]
ISO 389-2	-[1)]	Acoustics - Reference zero for the calibration of audiometric equipment Part 2: Reference equivalent threshold sound pressure levels for pure tones and insert earphones	EN ISO 389-2	1996[2)]
BIPM/IEC/ISO/ IUPAC/OIML	1995	Guide to the expression of uncertainty in measurement (GUM)	-	-

1) Undated reference.

2) Valid edition at date of issue.

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