BRITISH STANDARD

BS EN
60645-3:2007

Electroacoustics — Audiometric equipment —

Part 3: Test signals of short duration

The European Standard EN 60645-3:2007 has the status of a British Standard

ICS 13.140; 17.140.50

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 60645-3:2007. It is identical to IEC 60645-3:2007. It supersedes BS EN 60645-3:1995 which is withdrawn.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 - Audiometric equipment - Part 3: Test signals of short duration

(IEC 60645-3:2007)

Electroacoustique - Equipements audiométriques - Partie 3: Signaux d'essai de courte durée (CEI 60645-3:2007)

Akustik - Audiometer - Teil 3: Kurzzeit-Hörprüfsignale (IEC 60645-3:2007)

This European Standard was approved by CENELEC on 2007-06-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

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

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

Ref. No. EN 60645-3:2007 E

Foreword

The text of document 29/595/CDV, future edition 2 of IEC 60645-3, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel Unique Acceptance Procedure and was approved by CENELEC as EN 60645-3 on 2007-06-01.

This European Standard supersedes EN 60645-3:1995.

Specific changes in EN 60645-3:2007 concern new figures of reference signals and changes in definitions.

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)	2008-03-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2010-06-01

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive MDD (93/42/EEC). See Annex ZZ.

Annexes ZA and ZZ have been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60645-3:2007 was approved by CENELEC as a European Standard without any modification.

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CONTENTS

INTRODUCTION

Developments in the field of hearing measurements for diagnostic, hearing conservation and rehabilitation purposes have resulted in the availability of a wide range of audiometers. In addition it is possible to consider the audiometer in terms of a set of functional units that can be specified independently. By specifying these functional units it is then possible to specify the performance of other audiometric equipment that uses these units. IEC 60645, *Electroacoustics – Audiometric equipment*, consists of a number of parts. Part 3 covers the requirements for reference and other test signals of short duration.

Examples of test methods, where such signals are commonly used, are the recording of brainstem evoked potentials and evoked otoacoustic emissions. Reference signals are described in order to provide a basis for calibration and as a recommendation for use when there is no specific reason to have an alternative signal. The method of measurement of acoustic and vibratory signals is described.

ELECTROACOUSTICS – AUDIOMETRIC EQUIPMENT –

Part 3: Test signals of short duration

1 Scope

This part of IEC 60645 specifies a means of describing the physical characteristics of audiometric reference and test signals of short duration and methods for their measurement.

The object of this standard is to ensure that audiometric stimuli of short duration are specified and measured in the same way and that the calibration of equipment using such signals is carried out using defined methods.

This standard does not describe the method of use of short duration test signals.

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 60318-1, *Electroacoustics – Simulators of human head and ear – Part 1: Ear simulator for the calibration of supra-aural earphones*

IEC 60318-3, *Electroacoustics – Simulators of human head and ear – Part 3: Acoustic coupler for the calibration of supra-aural earphones used in audiometry*

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 60318-6, *Electroacoustics – Simulators of human head and ear – Part 6: Mechanical coupler for the measurements on bone vibrators* [1)]

IEC 60645-1:2001, *Electroacoustics – Audiological equipment – Part 1: Pure-tone audiometers*

IEC 60711, *Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts* [2)]

ISO 389-6, *Acoustics – Reference zero for the calibration of audiometric equipment – Part 6: Reference equivalent threshold sound pressure levels for acoustic test signals of short duration* [3)]

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1) To be published (revision of IEC 60373).

2) Will be published later as IEC 60318-4.

3) To be published.

3 Terms and definitions

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

3.1
short-duration signal
signal having a duration of less than 200 ms

3.2
click
transient acoustic or vibratory signal whose frequency spectrum covers a broad frequency range, produced by applying a single rectangular electrical pulse to the terminals of the transducer

NOTE See Figures 1 and 2.

3.3
tone-burst
sinusoidal signal having a duration of less than 200 ms

NOTE 1 Figure 3 shows a reference tone-burst (see 5.3).

NOTE 2 A tone-burst is sometimes called a brief tone or a tone pip.

3.4
condensation signal
short-duration signal, the initial sound pressure wave of which causes an over-pressure relative to ambient pressure, or the initial vibratory force wave of which causes an over-force relative to the static force at the plane of the output port of the transducer

3.5
rarefaction signal
short duration signal, the initial sound pressure wave of which causes an under-pressure relative to ambient pressure, or the initial vibratory force wave of which causes an under-force relative to the static force at the plane of the output port of the transducer

3.6
alternating polarity signal
series of short-duration signals, consisting of rarefaction and condensation signals in alternating order

3.7
initial sound pressure or vibratory force wave of a click
first half wave of sound pressure or vibratory force, the amplitude of which is larger than 0,5 times the amplitude of the next half wave with opposite polarity

3.8
duration of initial sound pressure or vibratory force wave of a click
time interval between the two zero crossings of the initial sound pressure or vibratory force wave

3.9
duration of a tone-burst
time interval between the half maximum amplitude points on the rising and falling portions of the envelope of the tone-burst

NOTE See Figure 3 (key 4).

3.10
rise and fall times of a tone-burst
time intervals between the 10 % and 90 % amplitude points of the rising portion and the 90 % and 10 % amplitude points on the falling portion of the envelope of the tone-burst

NOTE See Figure 3 (keys 3 and 5).

3.11
peak-to-peak equivalent signal level
r.m.s value of a long duration sinusoidal signal which, when compared under the same test conditions with a short duration output signal from the transducer under test, has the same peak-to-peak value (i.e. difference between the extreme positive and the extreme negative values) as the short duration signal

NOTE 1 See Figure 2.

NOTE 2 Both the short and the long duration signals are measured by means of an ear simulator, or a free-field microphone, or a mechanical coupler, respectively.

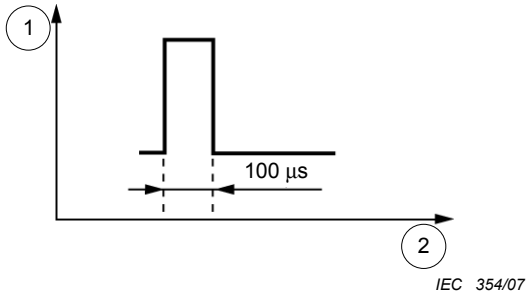
NOTE 3 For clicks, the long duration sinusoidal signal should have a frequency of 1 000 Hz, and for tone-bursts its frequency should equal the fundamental frequency of the tone-burst.

NOTE 4 The equivalence in this definition is between two different signals. When short duration signals are standardised as sound pressure levels or vibratory force levels for hearing threshold purposes a further equivalence occurs (see 6.6) due to the method of measuring hearing thresholds and storing the data from those measurements in an ear simulator, that is in terms of equivalent threshold vibratory force or sound pressure levels.

NOTE 5 The term peak-to-peak equivalent signal level is often called peak equivalent signal level.

NOTE 6 The peak level of a short duration signal is anywhere between 3 dB and 9 dB greater than the peak-to-peak equivalent level, i.e. 3 dB when the signal is quite symmetrical around the zero baseline and 9 dB when it is completely on one side of the zero level.

NOTE 7 The recommended abbreviations for peak-to-peak equivalent sound pressure level and vibratory force level are peSPL and peVFL.

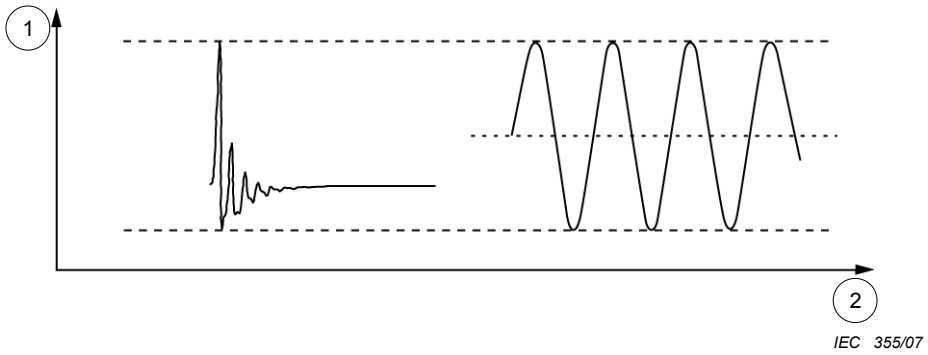


Key

1 Level

2 Time

Figure 1 – Temporal characteristics of an electric reference pulse



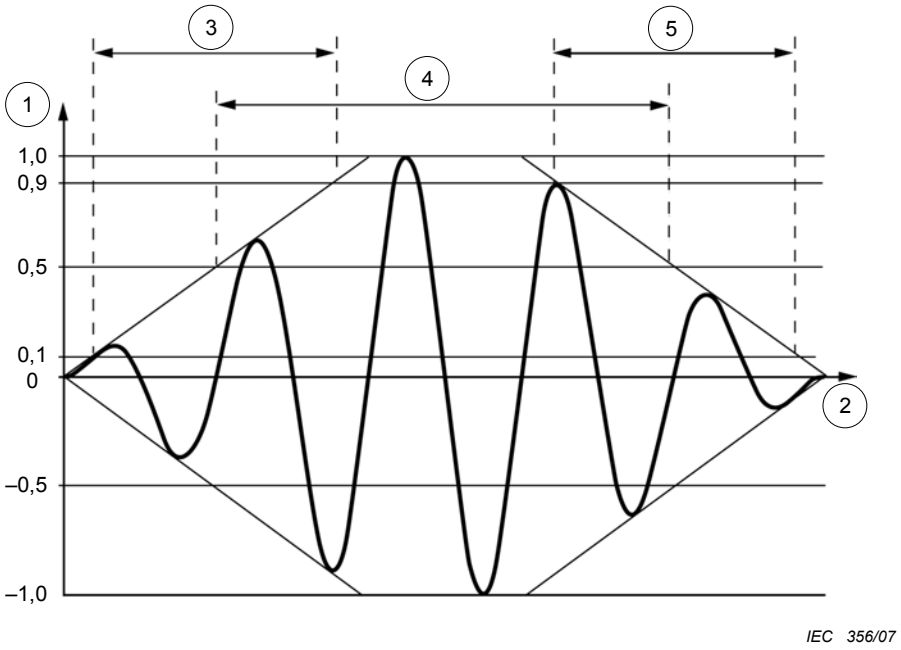
Key

1 Level

2 Time

Figure 2 – Illustration of the method of measurement of peak-to-peak equivalent signal levels

The left part of the figure shows an example of the acoustic click signal generated by an electric rectangular pulse applied to a transducer (100 µs electric pulse fed to a TDH-39 earphone with MX-41/AR cushion and measured on an ear simulator IEC 60318-1) and the right part presents the long duration sinusoidal signal.



Key

1 Level

2 Time

3 Rise time

4 Duration

5 Fall time

Figure 3 – Temporal characteristics of an electrical reference tone-burst

4 General requirements

Equipment using short duration signals shall meet the requirements of IEC 60645-1:2001 as appropriate.

5 Reference signals

5.1 General

The following reference signals are described for the purposes of standardization.

5.2 Reference pulse

The reference pulse (see Figure 1) shall be an electric rectangular pulse (single monophasic rectangular wave) of (100 ± 10) µs duration with rise and fall times less than 25 µs.

NOTE 1 The same definition of rise-/fall times and duration as given in Figure 3 applies to the reference pulse.

NOTE 2 The signal output of the transducer may vary considerably depending upon the type used.

5.3 Reference tone-burst

The reference tone-burst shall be an electrical signal consisting of five periods of the fundamental sine wave and having a linear rise and fall. The tone-burst shall have 1,6 periods of rise and fall time, and duration of three periods as defined in Figure 3.

NOTE 1,6 periods of linear rise or fall corresponds to two periods from zero to 100 % amplitude. The signal envelope remains at the 100 % amplitude for one period. The reference tone-burst may also be described according to the '2-1-2' concept where '2' indicates the number of periods from zero to 100 % amplitude and back to zero and '1' is the 100 % amplitude period.

6 Calibration and measurement of short-duration signals

6.1 For each signal type the following characteristics of an instrument generating signals of short duration shall be measured and reported by the manufacturer.

– type of reference signal used;
– type of transducer and associated type of ear simulator, mechanical coupler or sound level meter used and the method of coupling the transducer to the measurement system;
– level measured in dB in terms of peak-to-peak equivalent sound pressure level or peak-to-peak equivalent vibratory force level;
– polarity of electric output signal (i.e. positive (condensation), negative (rarefaction), alternating or random initial phase).
– the shape of the envelope rise and fall (linear, $\cos^2$, hanning etc.).

NOTE The polarity of the measuring system including its transducer has to be known in order to identify the polarity of the acoustic or vibratory signal.

6.2 The equipment shall be calibrated using reference signals defined in Clause 5. Where other signals are used, the difference in reference threshold levels obtained by those signals and by the appropriate reference signals defined in Clause 5 shall be stated by the manufacturer.

6.3 For earphone presentation, the acoustic characteristics of the short-duration signals shall be measured on an artificial ear (IEC 60318-1) or occluded-ear simulator (IEC 60711). If an acoustic coupler (IEC 60318-5, IEC 60318-3) is used for routine calibration, the relationship between measurements on the artificial ear (IEC 60318-1) or occluded-ear simulator (IEC 60711) and the acoustic coupler shall be stated by the manufacturer.

6.4 For sound-field presentation of short-duration signals, using reference signals defined in Clause 5, the measuring microphone shall be placed at the subject's measurement point in the absence of the listener. The reference point is the midpoint of a straight line connecting the entrances to the listener's ear canal openings when positioned in the testing position in the sound field.

NOTE Measurements should be made with a Class 1 sound-level meter conforming to IEC 61672-1 using the procedures described in ISO 8253-2.

6.5 Equipment for presenting short-duration signals by means of a bone vibrator shall be calibrated using reference signals defined in Clause 5. For this purpose, the bone vibrator shall be placed on a mechanical coupler according to IEC 60318-6, connected to suitable equipment to provide for the measurement of peak-to-peak voltage.

6.6 Reference equivalent threshold sound pressure level values are given in ISO 389-6.

6.7 The measurement system shall have a known amplitude and phase response. The phase response of the measuring system shall be taken into consideration.

7 Instruction manual

An instrument generating short-duration auditory test signals shall be supplied with an instruction manual that shall contain, in addition to the requirements of 15.2 in IEC 60645-1: 2001 the following information:

a) type of auditory signal(s) (e.g. clicks or tone-bursts);

b) type of transducer(s) and its/their headband force;

c) sound field system;

d) type of ear simulator or mechanical coupler used for calibration and the method of coupling the transducer(s);

e) type of calibration (e.g. in terms of peak-to-peak equivalent sound pressure level or vibratory force level or in terms of hearing level);

f) acoustic or vibratory signal levels for a given setting of the output-level control;

g) polarity of resulting acoustic or vibratory signal (e.g. positive, negative, alternating or random);

h) repetition rate(s);

i) duration of the initial sound pressure or vibratory force wave of a click and/or duration and rise/fall times of acoustic or vibratory tone-bursts;

j) the subjective relationship in terms of hearing level between the test signals and the reference signals in this document;

Bibliography

[1] IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

NOTE Harmonized as EN 61672-1:2003 (not modified).

[2] ISO 8253-1, *Acoustics – Audiometric test methods – Part 1: Basic pure tone air and bone conduction threshold audiometry*

NOTE Harmonized as EN ISO 8253-1:1998 (not modified).

[3] ISO 8253-2, *Acoustics – Audiometric test methods – Part 2: Sound field audiometry with pure tone and narrow-band test signals*

NOTE Harmonized as EN ISO 8253-2:1998 (not modified).

[4] Recommended standard for short-latency auditory evoked potentials. *J. Clin. Neuro-physiol*. 19841, pp. 32-40.

[5] DAVIS, H. Auditory brainstem responses: preferred frequency-selective stimuli. In *Sensory Evoked Potentials. An international conference on standards for auditory brainstem response testing.* Eds. A. Starr, C. Rosenberg, M. Don and H. Davis. Centro Ricerche e Studi, Amplifon, Milan, 1984, pp. 65-69.

[6] STAPELLS, D.R., PICTON, T.W. and SMITH, A.D. The calibration of click intensity. In *Sensory evoked pofentials. An internafional conference on standards for auditory brainstem response testing.* Eds. A. Starr. C. Rosenbery, M. Don and H. Davis. Centro Ricerche e Studi, Amplifon, Milan, 1984, pp.35-38.

[7] STAPELLS, D.R., PICTON, T.W. and SMITH, A.D. Normal hearing thresholds for clicks. *J. Acoust. Soc. Am.*, 1982, 72,.pp. 74-79.

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 60318-1	-[1)]	Electroacoustics - Simulators of human head and ear - Part 1: Ear simulator for the calibration of supra-aural earphones	EN 60318-1	1998[2)]
IEC 60318-3	-[1)]	Electroacoustics - Simulators of human head and ear - Part 3: Acoustic coupler for the calibration of supra-aural earphones used in audiometry	EN 60318-3	1998[2)]
IEC 60318-5	-[1)]	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	EN 60318-5	2006[2)]
IEC 60318-6	200X[3)]	Electroacoustics - Simulators of human head and ear - Part 6: Mechanical coupler for the measurements on bone vibrators	-	-
IEC 60645-1	2001	Electroacoustics - Audiological equipment - Part 1: Pure-tone audiometers	EN 60645-1	2001
IEC 60711	-[1)]	Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts	HD 443 S1	1983[2)]
ISO 389-6	-[1)]	Acoustics - Reference zero for the calibration of audiometric equipment - Part 6: Reference threshold of hearing for test signals of short duration	-	-

[1)] Undated reference.

[2)] Valid edition at date of issue.

[3)] To be published.

Annex ZZ
(informative)

Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commisssion and the European Free Trade Association and within its scope the standard covers only the following essential requirements out of those given in Annex I of the EC Directive 93/42/EEC:

– Essential requirement I – 3

– Essential requirement I – 6

– Essential requirement II – 12.8

– Essential requirement II – 13

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

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