IEC 61672-1

Edition 2.0 2013-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electroacoustics – Sound level meters –
Part 1: Specifications

Electroacoustique – Sonomètres –
Partie 1: Spécifications

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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ELECTROACOUSTICS – SOUND LEVEL METERS –

Part 1: Specifications

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 61672-1 has been prepared by IEC technical committee 29, Electroacoustics, in cooperation with the International Organization of Legal Metrology (OIML).

This second edition cancels and replaces the first edition published in 2002. This second edition constitutes a technical revision.

The main technical changes with respect to the previous edition are as follows:

In this second edition, conformance to specifications is demonstrated when:

a) measured deviations from design goals do not exceed the applicable acceptance limits, and
b) the uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty, with both uncertainties determined for a coverage probability of 95 %.

The text of this second edition is based on that of the first edition and the following documents:

FDIS	Report on voting
29/812/FDIS	29/823/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 of the IEC 61672 series, published under the general title *Electroacoustics – Sound level meters,* 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.

INTRODUCTION

For assessments of conformance to performance specifications, this second edition of IEC 61672-1 uses different criteria than were used for the 2002 first edition.

In the period from 1961 to 1985, International Standards for sound level meters did not provide any requirements or recommendations to account for the uncertainty of measurement in assessments of conformance to specifications.

This absence of requirements or recommendations to account for uncertainty of measurement created ambiguity in determinations of conformance to specifications for situations where a measured deviation from a design goal was close to a limit of the allowed deviation. If conformance was determined based on whether a measured deviation did or did not exceed the limits, the end-user of the sound level meter incurred the risk that the true deviation from a design goal exceeded the limits.

To remove this ambiguity, IEC Technical Committee 29, at its meeting in 1996, adopted a policy to account for measurement uncertainty in assessments of conformance in International Standards that it prepares.

The first edition (2002) of IEC 61672-1 accounted for measurement uncertainty by giving two explicit criteria for determining conformance to the specifications. The two criteria were (a) that measured deviations from design goals, extended by the expanded uncertainty of measurement, do not exceed the applicable tolerance limits and (b) that the expanded uncertainty of measurement does not exceed agreed-upon maximum values. For most performance specifications, the tolerance limits were calculated essentially by extending the allowances for design and manufacturing from the 1979 and 1985 International Standards for sound level meters by the applicable maximum-permitted expanded uncertainties of measurement. Tolerance limits were intended to represent the limits for true deviations from design goals with a coverage probability of 95 %.

This second edition of IEC 61672-1 uses an amended criterion for assessing conformance to a specification. Conformance is demonstrated when (a) measured deviations from design goals do not exceed the applicable *acceptance limits* and (b) the uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty. Acceptance limits are analogous to the allowances for design and manufacturing implied in the first edition (2002) of IEC 61672-1. Actual and maximum-permitted uncertainties are determined for a coverage probability of 95 %. The amended criterion for assessing conformance does not necessitate any change to the design of a sound level meter in order to conform to the specifications of this International Standard.

The maximum-permitted uncertainties of measurement are not equivalent to the uncertainties associated with the measurement of a sound level. The uncertainty of a measured sound level is evaluated from the anticipated deviations of the electroacoustical performance of the sound level meter from the relevant design goals as well as estimates of the uncertainties associated with the specific measurement situation. Unless more-specific information is available, the evaluation of the contribution of a specific sound level meter to a total measurement uncertainty can be based on the acceptance limits and maximum-permitted uncertainties specified in this standard.

ELECTROACOUSTICS – SOUND LEVEL METERS –

Part 1: Specifications

1 Scope

This part of IEC 61672 gives electroacoustical performance specifications for three kinds of sound measuring instruments:

- a time-weighting sound level meter that measures exponential-time-weighted, frequency-weighted sound levels;
- an integrating-averaging sound level meter that measures time-averaged, frequency-weighted sound levels; and
- an integrating sound level meter that measures frequency-weighted sound exposure levels.

Sound level meters conforming to the requirements of this standard have a specified frequency response for sound incident on the microphone from one principal direction in an acoustic free field or successively from random directions.

Sound level meters specified in this standard are intended to measure sounds generally in the range of human hearing.

NOTE The AU frequency weighting specified in IEC 61012 can be applied for measurements of A-weighted sound levels of audible sound in the presence of a source that contains spectral components at frequencies greater than 20 kHz.[1]

Two performance categories, class 1 and class 2, are specified in this standard. In general, specifications for class 1 and class 2 sound level meters have the same design goals and differ mainly in the acceptance limits and the range of operational temperature. Acceptance limits for class 2 are greater than, or equal to, those for class 1.

This standard is applicable to a range of designs for sound level meters. A sound level meter may be a self-contained hand-held instrument with an attached microphone and a built-in display device. A sound level meter may be comprised of separate components in one or more enclosures and may be capable of displaying a variety of acoustical signal levels. Sound level meters may include extensive analogue or digital signal processing, separately or in combination, with multiple analogue and digital outputs. Sound level meters may include general-purpose computers, recorders, printers, and other devices that form a necessary part of the complete instrument.

Sound level meters may be designed for use with an operator present or for automatic and continuous measurements of sound level without an operator present. Specifications in this standard for the response to sound waves apply without an operator present in the sound field.

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1 IEC 61012, *Filters for the measurement of audible sound in the presence of ultrasound.*

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 60942, *Electroacoustics – Sound calibrators*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61094-6, *Measurement microphones – Part 6: Electrostatic actuators for determination of frequency response*

IEC 61183, *Electroacoustics – Random-incidence and diffuse-field calibration of sound level meters*

IEC 62585, *Electroacoustics – Methods to determine corrections to obtain the free-field response of a sound level meter*

ISO/IEC Guide 98-4:2012, *Evaluation of measurement data – The role of measurement uncertainty in conformance assessment*

ISO/IEC Guide 99, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*[2]
Amendment 1:2010

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 98-4, ISO/IEC Guide 99, and IEC 61000-6-2, as well as the following apply.

NOTE All quantities are expressed in SI units.

3.1
sound pressure
difference between an instantaneous total pressure and the corresponding static pressure

Note 1 to entry: Sound pressure is expressed in pascals (Pa).

3.2
sound pressure level
ten times the logarithm to the base 10 of the ratio of the time-mean-square of a sound-pressure signal to the square of the reference value

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2 CISPR = *International Special Committee on Radio Interference*.

Note 1 to entry: Sound pressure level is expressed in decibels (dB).

Note 2 to entry: The reference value is 20 µPa.

3.3
frequency weighting
difference, as a specified function of frequency, between the level of the frequency-weighted signal indicated on the display device and the corresponding level of a constant-amplitude sinusoidal input signal

Note 1 to entry: Level difference is expressed in decibels (dB).

3.4
time weighting
exponential function of time, of a specified time constant, that weights the square of a sound-pressure signal

3.5
sound level
frequency-weighted sound pressure level
level with time weighting or time averaging of the square of a frequency-weighted sound-pressure signal

Note 1 to entry: Sound level is expressed in decibels (dB).

3.6
time-weighted sound level
ten times the logarithm to the base 10 of the ratio of the running time average of the time-weighted square of a frequency-weighted sound-pressure signal to the square of the reference value

Note 1 to entry: Time-weighted sound level is expressed in decibels (dB).

Note 2 to entry: For time-weighted sound level, example letter symbols are L_{AF}, L_{AS}, L_{CF}, and L_{CS} for frequency weightings A and C and time weightings F and S.

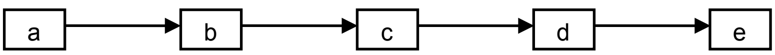
Note 3 to entry: In symbols and as an example, A-weighted and F-time-weighted sound level $L_{AF}(t)$ at observation time t can be represented by

$$L_{AF}(t) = 10 \lg \left[\frac{(1/\tau_F) \int_{-\infty}^{t} p_A^2(\xi) e^{-(t-\xi)/\tau_F} d\xi}{p_0^2} \right] \text{ dB} \qquad (1)$$

where

- τ_F is the exponential time constant in seconds for the F time weighting;
- ξ is a dummy variable of time integration from some time in the past, as indicated by -∞ for the lower limit of the integral, to the time of observation t;
- $p_A(\xi)$ is the A-weighted instantaneous sound-pressure signal; and
- p_0 is the reference value of 20 µPa.

Note 4 to entry: The sketch in Figure 1 illustrates the process indicated by Equation (1).



IEC 2243/13

Key

a Start with a frequency-weighted electrical input signal

b Square the input signal

c Apply a low-pass filter with one real pole at -1/τ (exponential time weighting)

d Take the base-10 logarithm

e Display the result in decibels with the square of a reference value of 20 µPa

Figure 1 – Principal steps involved in forming a time-weighted sound level

3.7
maximum time-weighted sound level
greatest time-weighted sound level within a stated time interval

Note 1 to entry: Maximum time-weighted sound level is expressed in decibels (dB).

Note 2 to entry: Example letter symbols for maximum time-weighted sound level are L_{AFmax}, L_{ASmax}, L_{CFmax}, and L_{CSmax} for frequency weightings A and C and time weightings F and S.

3.8
peak sound pressure
greatest sound pressure (positive or negative) during a stated time interval

Note 1 to entry: Peak sound pressure is expressed in pascals (Pa).

Note 2 to entry: A peak sound pressure can arise from a positive or negative instantaneous sound pressure.

3.9
peak sound level
ten times the logarithm to the base 10 of the ratio of the square of a frequency-weighted peak sound-pressure signal to the square of the reference value

Note 1 to entry: Peak sound level is expressed in decibels (dB).

Note 2 to entry: The reference value is 20 μPa.

3.10
time-averaged sound level
equivalent continuous sound level
ten times the logarithm to the base 10 of the ratio of the time average of the square of a frequency-weighted sound-pressure signal during a stated time interval to the square of the reference value

Note 1 to entry: Time-averaged or equivalent continuous sound level is expressed in decibels (dB).

Note 2 to entry: In symbols and as an example, time-averaged, A-weighted sound level $L_{\text{Aeq},T}$ is given by

$$L_{\text{Aeq},T} = 10 \lg \left[\frac{(1/T)\int_{t-T}^{t} p_{\text{A}}^2(\xi)\,\text{d}\xi}{p_0^2} \right] \text{dB} \tag{2}$$

where

– ξ is a dummy variable of time integration over the averaging time interval ending at the time of observation *t*;
– T is the averaging time interval;
– $p_{\text{A}}(\xi)$ is the A-weighted sound-pressure signal; and
– p_0 is the reference value of 20 μPa.

Note 3 to entry: In principle, time weighting is not involved in a determination of time-averaged sound level.

3.11
sound exposure
time integral of the square of a frequency-weighted sound-pressure signal over a stated time interval or event of stated duration

Note 1 to entry: Duration of integration is included implicitly in the time integral and is not always reported explicitly, although it is useful to state the nature of the event. For measurements of sound exposure over a specified time interval, duration of integration is usually reported and indicated by a suitable subscript to the letter symbol, for example as $E_{\text{A,1h}}$.

Note 2 to entry: In symbols and as an example, A-weighted sound exposure $E_{\text{A},T}$ is represented by

$$E_{A,T} = \int_{t_1}^{t_2} p_A^2(t)\mathrm{d}t \tag{3}$$

where $p_A^2(t)$ is the square of the A-weighted sound-pressure signal during integration time T starting at t_1 and ending at t_2.

Note 3 to entry: The unit of sound exposure is pascal-squared seconds (Pa^2s) if sound pressure is in pascals and running time is in seconds.

Note 4 to entry: For applications such as measurement of exposure to noise in the workplace, sound exposure in pascal-squared hours is more convenient than pascal-squared seconds.

3.12
sound exposure level
ten times the logarithm to the base 10 of the ratio of a sound exposure to the reference value

Note 1 to entry: Sound exposure level is expressed in decibels (dB).

Note 2 to entry: In symbols and as an example, A-weighted sound exposure level $L_{AE,T}$ is related to the corresponding time-averaged, A-weighted sound level $L_{Aeq,T}$ by

$$L_{AE,T} = 10 \lg\left[\frac{\int_{t_1}^{t_2} p_A^2(t)\mathrm{d}t}{p_0^2 T_0}\right]\mathrm{d}B = 10 \lg\left(\frac{E_{A,T}}{E_0}\right)\mathrm{dB} = L_{Aeq,T} + 10 \lg\left(\frac{T}{T_0}\right)\mathrm{dB} \tag{4}$$

where

– $E_{A,T}$ is the A-weighted sound exposure in pascal-squared seconds over time interval T (see Equation (3));

– E_0 is the reference value given by $p_0^2 T_0$ = (20 µPa)^2 × (1 s) = 400×10^{-12} Pa^{2}s;

– T is the measurement time interval, in seconds, starting at t_1 and ending at t_2, and

– T_0 is the reference value of 1 s for sound exposure level.

Note 3 to entry: Time-averaged, A-weighted sound level $L_{Aeq,T}$ during averaging time interval T is related to the corresponding A-weighted sound exposure $E_{A,T}$, or the A-weighted sound exposure level $L_{AE,T}$, occurring within that interval by

$$E_{A,T} = p_0^2\, T\left(10^{0,1\, L_{Aeq,T}}\right) \tag{5}$$

or

$$L_{Aeq,T} = 10 \lg\left(\frac{E_{A,T}}{p_0^2 T}\right)\mathrm{dB} = L_{AE,T} - 10 \lg\left(\frac{T}{T_0}\right)\mathrm{dB} \tag{6}$$

3.13
microphone
electroacoustic transducer by which electrical signals are obtained from acoustic oscillations

[SOURCE: IEC 60050-801:1994, definition 801-26-01]

3.14
microphone reference point
point specified on, or close to, the microphone to describe the position of the microphone

Note 1 to entry: The microphone reference point can be at the centre of the diaphragm of the microphone.

3.15
reference direction
inward direction toward the microphone reference point and specified for determining the directional response and frequency weighting of a sound level meter

Note 1 to entry: The reference direction can be specified with respect to an axis of symmetry.

3.16
sound-incidence angle
angle between the reference direction and a line between the acoustic centre of a sound source and the microphone reference point

Note 1 to entry: Sound-incidence angle is expressed in degrees.

3.17
relative directional response
for any frequency weighting and at any frequency of incident sinusoidal sounds, and in a specified plane containing the principal axis of the microphone, sound level indicated at a given sound-incidence angle minus the sound level indicated for sound at the same frequency from the same source and incident from the reference direction

Note 1 to entry: Relative directional response is expressed in decibels.

3.18
directivity factor
for a sound level meter, a measure of the deviation from an ideal directional response with equal sensitivity at all possible angles of sound incidence on the microphone

Note 1 to entry: Directivity factor is non-dimensional.

3.19
directivity index
ten times the base-ten logarithm of the directivity factor

Note 1 to entry: Directivity index is expressed in decibels.

3.20
relative frequency-weighted free-field response
for a given frequency, time-weighted or time-averaged, frequency-weighted sound level indicated by a sound level meter in response to plane progressive sinusoidal sound incident on the microphone from the reference direction minus the corresponding time-weighted or time-averaged sound level present at the position of the microphone reference point for the sound level meter and from the same sound source but in the absence of the sound level meter

Note 1 to entry: Relative frequency-weighted free-field response is expressed in decibels (dB).

Note 2 to entry: Relative frequency-weighted free-field response is called free-field sensitivity level in IEC 61183.

3.21
relative frequency-weighted random-incidence response
for a given frequency, time-averaged, frequency-weighted sound level indicated by a sound level meter in response to random-incidence sound minus the time-averaged sound pressure level present at the position of the microphone reference point for the sound level meter and from the same sound source but in the absence of the sound level meter

Note 1 to entry: Relative frequency-weighted random-incidence response is expressed in decibels (dB).

Note 2 to entry: Relative frequency-weighted random-incidence response is called random-incidence sensitivity level in IEC 61183.

3.22
level range
range of nominal sound levels measured for a particular setting of the controls of a sound level meter

Note 1 to entry: Level range is expressed in decibels (dB), for example, the 50 dB to 110 dB range.

3.23
reference sound pressure level
sound pressure level specified for testing the electroacoustic performance of a sound level meter

Note 1 to entry: Reference sound pressure level is expressed in decibels (dB).

3.24
reference level range
level range specified for testing the electroacoustic characteristics of a sound level meter and containing the reference sound pressure level

Note 1 to entry: Reference level range is expressed in decibels (dB), for example, the 50 dB to 110 dB range.

3.25
calibration check frequency
nominal frequency of the sinusoidal sound pressure produced by a sound calibrator

3.26
level linearity deviation
at a stated frequency, an indicated signal level minus the anticipated signal level

Note 1 to entry: Level linearity deviation is expressed in decibels (dB).

3.27
linear operating range

on any level range and at a stated frequency, the range of sound levels over which level linearity deviations do not exceed the applicable acceptance limits specified in this standard

Note 1 to entry: Linear operating range is expressed in decibels (dB).

3.28
total range
range of A-weighted sound levels, in response to sinusoidal signals, from the smallest sound level, on the most-sensitive level range, to the greatest sound level, on the least-sensitive level range, that can be measured without indication of overload or under-range and without exceeding the acceptance limits specified in this standard for level linearity deviation

Note 1 to entry: Total range is expressed in decibels (dB).

3.29
toneburst
one or more complete cycles of a sinusoidal electrical signal starting and stopping at a zero crossing of the waveform

3.30
toneburst response
maximum time-weighted sound level, or sound exposure level, measured in response to a toneburst minus the corresponding measured sound level of the steady input signal from which the toneburst was extracted

Note 1 to entry: Toneburst response is expressed in decibels (dB).

3.31
reference orientation
orientation of a sound level meter for tests to demonstrate conformance to the specifications of this standard for emissions of, and immunity to the effects of exposure to, radio-frequency fields