BS EN 61672-1:2013

BSI Standards Publication

Electroacoustics — Sound level meters

Part 1: Specifications

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National foreword

This British Standard is the UK implementation of EN 61672-1:2013. It is identical to IEC 61672-1:2013. It supersedes BS EN 61672-1:2003 which is withdrawn.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.

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(IEC 61672-1:2013)

Electroacoustique -
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Partie 1: Spécifications
(CEI 61672-1:2013)

Elektroakustik -
Schallpegelmesser -
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Foreword

The text of document 29/812/FDIS, future edition 2 of IEC 61672-1, prepared by IEC/TC 29 "Electroacoustics" in cooperation with the International Organization of Legal Metrology (OIML), was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61672-1:2013.

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)	2013-08-04
– latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-11-04

This document supersedes EN 61672-1:2003.

EN 61672-1:2013 includes the following significant technical changes with respect to EN 61672-1:2003.

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 %.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61672-1:2013 was approved by CENELEC as a European Standard without any modification.

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 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 60942	-	Electroacoustics - Sound calibrators	EN 60942	-
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	2009
IEC 61000-6-2	2005	Electromagnetic compatibility (EMC) Part 6-2: Generic standards - Immunity for industrial environments	EN 61000-6-2 + corr. September	2005 2005
IEC 61094-6	-	Measurement microphones Part 6: Electrostatic actuators for determination of frequency response	EN 61094-6	-
IEC 61183	-	Electroacoustics - Random-incidence and diffuse-field calibration of sound level meters	EN 61183	-
IEC 62585	-	Electroacoustics - Methods to determine corrections to obtain the free-field response of a sound level meter	EN 62585	-
ISO/IEC Guide 98-4	2012	Uncertainty of measurement Part 4: Role of measurement uncertainty in conformity assessment	-	-
ISO/IEC Guide 99		International vocabulary of metrology - Basic and general concepts and associated terms (VIM)	-	-
CISPR 16-1-1 + corr. October + corr. October + A1	2010 2010 2011 2010	Specification for radio disturbance and immunity measuring apparatus and methods Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus	EN 55016-1-1 - - + A1	2010 - - 2010

CONTENTS

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

[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.

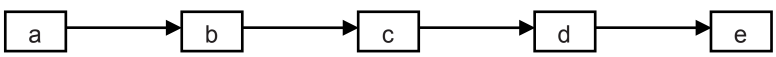
Note 3 to entry: In symbols and as an example, A-weighted and F-time-weighted sound level $L_{AF}(t)$ at observation time t can be represented by

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

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 $L_{\mathrm{Aeq},T}$ is given by

$$L_{\mathrm{Aeq},T} = 10 \lg \left[\frac{(1/T)\int_{t-T}^{t} p_{\mathrm{A}}^{2}(\xi)\mathrm{d}\xi}{p_{0}^{2}} \right] \mathrm{dB} \qquad (2)$$

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;
– $p_{\mathrm{A}}(\xi)$ 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 $E_{\mathrm{A,1h}}$.

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

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

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

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

where

- $E_{A,T}$ is the A-weighted sound exposure in pascal-squared seconds over time interval $\boldsymbol{T}$ (see Equation (3));
- E_0 is the reference value given by $p_0^2 T_0 = (20\ \mu Pa)^2 \times (1\ s) = 400 \times 10^{-12}\ Pa^2s$;
- 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

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

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

3.32
coverage probability
probability that the set of true quantity values of a measurand is contained within a specified coverage interval

[SOURCE: ISO/IEC Guide 98-4:2012, definition 3.2.8]

3.33
acceptance limit
specified upper or lower bound of permissible measured quantity values

[SOURCE: ISO/IEC Guide 98-4:2012, definition 3.3.8]

4 Reference environmental conditions

Reference environmental conditions for specifying the electroacoustic performance of a sound level meter are:

- air temperature 23 °C;
- static pressure 101,325 kPa;
- relative humidity 50 %.

5 Performance specifications

5.1 General

5.1.1 Generally, a sound level meter is a combination of a microphone, a preamplifier, a signal processor, and a display device. Performance specifications of this standard apply to any design for microphone and preamplifier that is appropriate for a sound level meter.

The signal processor includes the combined functions of an amplifier with a specified and controlled frequency response, a device to form the square of the frequency-weighted, time-varying sound-pressure signal, and a time integrator or time averager. Signal processing that is necessary to conform to the specifications of this standard is an integral part of a sound level meter.

In this standard, a display device provides a physical and visible display, or storage, of measurement results. Any stored measurement result shall be available for display by means of a manufacturer-specified device, for instance a computer with associated software.

5.1.2 Performance specifications of this Clause apply under the reference environmental conditions of Clause 4.

5.1.3 For specifying the maximum-permitted emission of, and immunity to the effects of exposure to, radio-frequency fields, sound level meters are classified into three groups as follows:

– group X sound level meters: self-contained instruments that include sound level measurement facilities according to this standard and which specify internal battery power for the normal mode of operation, requiring no external connections to other apparatus to measure sound levels;
– group Y sound level meters: self-contained instruments that include sound level measurement facilities according to this standard and which specify connection to a public supply of electric power for the normal mode of operation, requiring no external connections to other apparatus to measure sound levels; and

– group Z sound level meters: instruments that include sound level measurement facilities according to this standard and which require two or more items of equipment, which are essential constituent parts of the sound level meter, to be connected together by some means for the normal mode of operation. The separate items may be operated from internal batteries or from a public supply of electric power.

5.1.4 The configuration of the complete sound level meter and its normal mode of operation shall be stated in the Instruction Manual. If appropriate, the configuration of the complete sound level meter includes a windscreen and other devices that are installed around the microphone as integral components for the normal mode of operation.

5.1.5 A sound level meter that is stated in the Instruction Manual to be a class 1 or class 2 sound level meter shall conform to all relevant class 1 or class 2 specifications, respectively, that are provided in this standard. A class 2 sound level meter may provide some class 1 capabilities, but if any capability conforms only to the class 2 specifications, the instrument is a class 2 sound level meter. A sound level meter may be specified as a class 1 instrument in one configuration and a class 2 instrument in another configuration (for example, with a different microphone or preamplifier).

5.1.6 The Instruction Manual shall state the models of microphones with which the complete sound level meter conforms to the specifications for class 1 or class 2 performance for sound waves incident on the microphone from the reference direction in a free field or with random incidence, as applicable. The Instruction Manual shall describe appropriate procedures for use of the sound level meter.

5.1.7 The Instruction Manual shall state how the microphone and preamplifier are to be mounted, if applicable, to conform to the specifications for directional response and frequency weightings. An extension device or cable may be required to conform to the specifications. In this event, the sound level meter shall be stated in the Instruction Manual as conforming to the applicable specifications for directional response and frequency weighting only when the specified devices are installed.

5.1.8 Computer software may be an integral part of the sound level meter. The Instruction Manual shall describe the means by which a user can identify the version of the software that is installed to operate the functions of a sound level meter.

5.1.9 A sound level meter shall have frequency-weighting A. As a minimum, a time-weighting sound level meter shall provide a means to indicate A-frequency-weighted and F-time-weighted sound level. As a minimum, an integrating-averaging sound level meter shall provide a means to indicate A-weighted, time-averaged sound level. As a minimum, an integrating sound level meter shall provide a means to indicate A-weighted sound exposure level. Sound level meters may contain any or all of the design features for which performance specifications are given in this standard. A sound level meter shall conform to the applicable performance specifications for those design features that are provided.

If the sound level meter only indicates sound exposure level, time-averaged sound level shall be determined by application of Equation (6) for the averaging time.

5.1.10 Sound level meters conforming to class 1 acceptance limits also shall provide frequency-weighting C. Sound level meters that measure C-weighted peak sound levels shall also be able to measure C-weighted time-averaged sound levels. Frequency-weighting Z is optional. The Instruction Manual shall describe all frequency weightings that are provided.

5.1.11 A sound level meter may have more than one display device.

NOTE An analogue or digital output connection alone is not a display device.

5.1.12 A sound level meter may have more than one level range with a suitable level range control. The Instruction Manual shall (a) identify the level range(s) by the lower and upper limits of the nominal A-weighted sound level at 1 kHz and (b) provide instructions for the operation of the level range control. The Instruction Manual should also provide recommendations for selecting the optimum level range to display the results of a measurement of sound level or sound exposure level.

5.1.13 The reference sound pressure level, reference level range, and reference orientation shall be stated in the Instruction Manual. The reference sound pressure level should preferably be 94 dB. The Instruction Manual shall state the reference direction for each model of microphone intended for use with the sound level meter. The location of the microphone reference point shall also be stated.

NOTE A sound pressure level of 94 dB corresponds closely to the level of a time-mean-square sound pressure of 1 Pa^2 or a root-mean-square sound pressure of 1 Pa.

5.1.14 A hold feature shall be provided for measurements of maximum time-weighted sound level and peak sound level if the sound level meter is capable of measuring these quantities. The Instruction Manual shall describe the operation of the hold facility and the means for clearing a display that is held.

5.1.15 Electrical signals are used to assess conformance to many specifications of this standard. Electrical signals are to be equivalent to signals from the output of the microphone. As appropriate for each specified model of microphone, the design goal and applicable acceptance limits shall be stated in the Instruction Manual for either the electrical characteristics of the device, or the means, used to insert signals into the electrical input of the preamplifier. Electrical characteristics include the resistive and reactive components of the electrical impedance at the output of the device. The design goal for the impedance shall be specified for a frequency of 1 kHz.

5.1.16 The microphone shall be removable to allow insertion of electrical test signals to the input of the preamplifier.

5.1.17 The Instruction Manual shall state the greatest sound pressure level at the microphone and the greatest peak-to-peak voltage that can be applied at the electrical input to the preamplifier without causing damage to the sound level meter.

5.1.18 Performance specifications in this standard apply, as applicable, to any time or frequency weightings operated in parallel and to each independent channel of a multi-channel sound level meter. A multi-channel sound level meter may have two or more microphone inputs. The Instruction Manual shall describe the characteristics and operation of each independent channel.

5.1.19 Specifications for the electroacoustical response of a sound level meter apply after an initial time interval following switching on the power. The initial time interval, stated in the Instruction Manual, shall not exceed 2 min. The sound level meter shall be allowed to reach equilibrium with the prevailing ambient environment before switching on the power.

5.1.20 In subsequent subclauses, acceptance limits are provided for allowable values of measured deviations from design goals. Annex A describes the relationship between tolerance interval, corresponding acceptance interval and the maximum-permitted uncertainty of measurement.

5.1.21 Conformance to a performance specification is demonstrated when the following criteria are both satisfied: (a) measured deviations from design goals do not exceed the applicable acceptance limit AND (b) the corresponding uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty of measurement given in Annex B for a coverage probability of 95 %.

5.1.22 Annex C gives examples of evaluation of conformance to specifications of this standard.

5.2 Adjustments at the calibration check frequency

5.2.1 At least one model of sound calibrator shall be stated in the Instruction Manual for checking or adjusting the overall sensitivity of a sound level meter so as to optimize the electroacoustical performance over the complete frequency range.

5.2.2 For class 1 sound level meters, the sound calibrator shall conform to the class 1 specifications of IEC 60942. For class 2 sound level meters, the sound calibrator shall conform to either the class 1 or the class 2 specifications of IEC 60942.

NOTE Laboratory standard sound calibrators are not suitable for general field applications with sound level meters because their performance characteristics are specified in IEC 60942 only for a limited range of environmental conditions.

5.2.3 For the reference sound pressure level on the reference level range and for a calibration check frequency in the range from 160 Hz to 1 250 Hz, a procedure and data shall be provided in the Instruction Manual so that an adjustment applied to the sound level displayed in response to application of the sound calibrator yields the required indication at the calibration check frequency.

5.2.4 The adjustment data shall be determined in accordance with IEC 62585 and shall apply for environmental conditions at least within the ranges of 80 kPa to 105 kPa for static pressure, 20 °C to 26 °C for air temperature, and 25 % to 70 % for relative humidity. The adjustment data shall apply for microphones of all models stated in the Instruction Manual for use on the sound level meter and for any associated devices provided by the manufacturer of the sound level meter for mounting a microphone on the instrument. Variations in the values of the adjustment data within these ranges of environmental conditions shall be included in the associated uncertainty for the adjustment data.

5.2.5 The difference between the adjustment data measured according to IEC 61672-2 and the adjustment data from the Instruction Manual shall not exceed ±0,3 dB.

5.3 Corrections to indicated levels

5.3.1 General

5.3.1.1 Corrections from the Instruction Manual for the influence of various effects may be used in measurements of sound level by a user and in tests of the performance of the sound level meter. IEC 62585 provides methods for the determination of the correction data and the associated uncertainties of measurement for a coverage probability of 95 %, including the associated coverage factor, as appropriate.

5.3.1.2 Corrected results shall be obtained by adding the appropriate correction data to indicated levels. Part 2 of this standard provides the methods and criteria that shall be used to validate the correction data for the purpose of pattern evaluation.

5.3.2 Reflections and diffraction

5.3.2.1 For microphones of all models that are stated in the Instruction Manual to be for use on the sound level meter, the Instruction Manual shall provide corrections and the associated uncertainties for the typical effects of reflections from, and diffraction around, the case of the sound level meter. The corrections and uncertainties are for the microphone mounted on the sound level meter for the normal mode of operation. The effects of reflections and diffraction are relative to the response of the microphone alone and are measured in accordance with the procedure from IEC 62585.

5.3.2.2 Corrections for the effects of reflections and diffraction and the associated uncertainties of measurement shall be determined in accordance with IEC 62585 for a coverage probability of 95 %, including the associated coverage factor, as appropriate.

5.3.3 Windscreens

5.3.3.1 The correction data to be included in the Instruction Manual include corrections for the average effects of a windscreen on directional response and on the relative frequency-weighted free-field response of the sound level meter, at least for sound incident from the reference direction, or on the relative frequency-weighted random-incidence response, as applicable.

5.3.3.2 Windscreen-correction data are required if the Instruction Manual states that the sound level meter conforms to the specifications of this standard both in a configuration that includes a windscreen and in a configuration that does not include a windscreen.

5.3.3.3 When a windscreen and its associated accessories are not rotationally symmetric about the principal axis of the microphone, free-field correction data for the effect of the windscreen and accessories on directional response and frequency response shall be provided for various sound-incidence angles in appropriate planes through the principal axis of the microphone.

5.3.3.4 Corrections for the effects of a windscreen and accessories and the associated uncertainties of measurement shall be determined in accordance with IEC 62585.

5.3.3.5 The difference between a windscreen correction measured according to IEC 61672-2 and the corresponding windscreen correction given in the Instruction Manual shall not exceed the applicable acceptance limits given in Table 1.

Table 1 – Acceptance limits for the difference between a measured windscreen correction and the corresponding correction given in the Instruction Manual

Frequency kHz	**Acceptance limits**, dB	
	Performance class	
	1	**2**
0,063 to 2	±0,5	±0,5
>2 to 8	±0,8	±0,8
>8 to 12,5	±1,0	…
>12,5 to 16	±1,5	…

5.3.4 Format for correction data

5.3.4.1 Correction data and the associated uncertainties of measurement shall be given separately in tabular form in the Instruction Manual. The uncertainties given in the Instruction Manual shall not exceed the corresponding maximum-permitted uncertainties given in IEC 62585 and shall represent real and realistic (non-zero) uncertainties, even if a correction is zero.

5.3.4.2 The data required by 5.3.1 to 5.3.3 shall be provided in the following formats.

– For class 1 sound level meters, the data shall be stated in tabular form at one-third-octave intervals for nominal frequencies from 63 Hz to 1 kHz and then at one-twelfth-octave intervals for nominal frequencies greater than 1 kHz to at least 16 kHz.

– For class 2 sound level meters, the data shall be stated in tabular form at one-third-octave intervals for nominal frequencies from 63 Hz to at least 8 kHz.

– As required, corrections for the average effects of a stated type of windscreen on the relative frequency-weighted free-field response of the sound level meter in the reference direction, or the relative frequency-weighted random-incidence response, shall be stated in tabular form at one-third-octave intervals for nominal frequencies from 1 kHz to 16 kHz for class 1 sound level meters and for nominal frequencies from 1 kHz to 8 kHz for class 2 sound level meters.

Annex D gives frequencies at one-third-octave, one-sixth-octave, and one-twelfth-octave intervals.

5.3.5 Corrections for use during periodic testing

5.3.5.1 If the Instruction Manual recommends a multi-frequency sound calibrator, a comparison coupler, or an electrostatic actuator for periodic testing of the acoustical response of a sound level meter, the Instruction Manual shall provide correction data to obtain frequency-weighted sound levels equivalent to those that would be displayed under reference environmental conditions in response to plane progressive sinusoidal sound waves incident from the reference direction or from random directions, as applicable. Applicable correction data and associated uncertainties shall be determined in accordance with procedures given in IEC 62585 and shall be verified by pattern-evaluation testing.

5.3.5.2 Electrostatic actuators shall conform to the requirements of IEC 61094-6.

5.3.5.3 The correction data required by 5.3.5.1 shall be provided at least for frequencies of 125 Hz, 1 kHz, and 8 kHz and shall apply for stated configurations of a sound level meter (including microphone and preamplifier), and a model of sound calibrator, comparison coupler, or electrostatic actuator. The correction data shall be provided for all models of microphones or microphone-windscreen configurations for which the sound level meter is stated in the Instruction Manual to conform to the specifications of this standard. The uncertainties of the correction data shall be provided for at least the above-mentioned frequencies and configurations.

5.3.5.4 IEC 62585 provides maximum-permitted uncertainties for the corrections that are applied to indicated levels to obtain the equivalent frequency-weighted free-field or random-incidence sound levels when the manufacturer recommends use of (1) a sound calibrator, or (2) a comparison coupler, or (3) an electrostatic actuator for testing the frequency response of a sound level meter. The maximum-permitted uncertainties in IEC 62585 do not contain a component for inter-sample variability.

5.4 Directional response

5.4.1 At any frequency in the range of a sound level meter, the directional-response design goal is equal response to sounds from all directions of sound incidence. Table 2 specifies acceptance limits for deviations from the design goal as limits on the maximum absolute value of the difference between displayed sound levels at any two sound-incidence angles within certain angular regions around the reference direction.

5.4.2 The directional-response requirements of Table 2 apply for the configuration of a sound level meter as stated in the Instruction Manual for the normal mode of operation or for those components of a sound level meter that are intended to be located in a sound field. The specifications in Table 2 apply for sinusoidal progressive sound waves at any sound-incidence angle within the indicated ranges, including the reference direction and in any plane containing the principal axis of the microphone, if necessary.

5.4.3 For any frequency within the specified ranges, the requirements of Table 2 apply for any orientation of the sound level meter, or applicable components, around the reference direction. The requirements of Table 2 apply for indications of any frequency-weighted sound levels.

5.4.4 For any pair of sound levels displayed within each range of sound-incidence angles in Table 2, and at any frequency in a specified range, the measured absolute values of the differences between the displayed sound levels shall not exceed the applicable limits given in Table 2.

Table 2 – Acceptance limits for deviations of directional response from the design goal

Frequency kHz	**Maximum absolute value of the difference between displayed sound levels at any two sound-incidence angles within ±θ degrees from the reference direction** dB					
	θ = 30°		**θ = 90°**		**θ = 150°**	
	Performance class					
	1	**2**	**1**	**2**	**1**	**2**
0,25 to 1	1,0	2,0	1,5	3,0	2,0	5,0
>1 to 2	1,0	2,0	2,0	4,0	4,0	7,0
>2 to 4	1,5	4,0	4,0	7,0	6,0	12,0
>4 to 8	2,5	6,0	7,0	12,0	10,0	16,0
>8 to 12,5	4,0	…	10,0	…	14,0	…

5.4.5 If detailed tables of relative directional response are provided in the Instruction Manual, for class 1 and class 2 sound level meters, the frequency of the sound signal shall be from 250 Hz to 2 kHz at nominal one-third-octave intervals, then from greater than 2 kHz to 8 kHz at nominal one-sixth-octave intervals. For class 1 sound level meters, the frequency of the sound signal also shall be from greater than 8 kHz to 12,5 kHz at one-twelfth-octave intervals. See Annex D for frequencies at one-third-octave, one-sixth-octave, and one-twelfth-octave intervals. At each frequency, angular intervals for the tables of relative directional response shall not exceed 10°.

5.5 Frequency weightings

5.5.1 For all frequency weightings, the design goal includes a 0 dB weighting at 1 kHz. Annex E provides analytical expressions that may be used to calculate the C, A, and Z frequency weightings.

5.5.2 Table 3 gives the design-goals for frequency weightings A, C, and Z, rounded to a tenth of a decibel, along with the corresponding acceptance limits for class 1 and class 2 sound level meters. For a given performance class, acceptance limits in Table 3 apply on all level ranges and after applying the adjustments described in 5.2 for the response to application of the sound calibrator at the calibration check frequency and under reference environmental conditions.

5.5.3 For microphones where the reference direction is not along the axis of symmetry, the measured responses at all reference directions shall not exceed the acceptance limits in Table 3.

5.5.4 For the configuration of the sound level meter stated in the Instruction Manual for the normal mode of operation, the frequency weightings and acceptance limits of Table 3 apply for the relative frequency-weighted free-field response and for the relative frequency-weighted random-incidence response, as applicable.

5.5.5 Relative frequency-weighted random-incidence response shall be determined by the free-field method of IEC 61183. For the frequencies of Table 3, the Instruction Manual shall provide tables of directivity indexes applicable to the normal configuration of a sound level meter equipped with a microphone designed for measurement of sounds that impinge on the microphone with random angles of incidence.

5.5.6 At any nominal frequency in Table 3, measured deviations of the relative frequency-weighted free-field response, or the relative frequency-weighted random-incidence response, from the applicable design-goal frequency weighting from Table 3, or as calculated from the expressions in Annex E, shall not exceed the corresponding acceptance limits.

5.5.7 For frequencies between two consecutive nominal frequencies in Table 3, design-goal frequency weightings C or A shall be computed from Equation (E.1) or (E.6) from Annex E, respectively, and rounded to a tenth of a decibel. Applicable acceptance limits then are the larger of the limits given in Table 3 for the two consecutive frequencies.

5.5.8 If a sound level meter provides one or more optional frequency responses, the Instruction Manual shall state the design-goal frequency response and the acceptance limits that are maintained around the design goal(s). If an optional frequency response is specified in an International Standard, the design-goal frequency response shall be as specified in that International Standard.

5.5.9 For a steady sinusoidal electrical input signal at 1 kHz, the measured difference between the indicated level of any C-weighted or Z-weighted measurement quantity and the indicated level of the corresponding A-weighted measurement quantity shall not exceed ± 0,2 dB. This requirement applies at the reference sound pressure level on the reference level range. It does not apply to indications of peak sound level.

Table 3 – Frequency weightings and acceptance limits

Nominal frequency Hz	**Frequency weightings** dB			**Acceptance limits**, dB	
				Performance class	
	A	**C**	**Z**	**1**	**2**
10	-70,4	-14,3	0,0	+3,0; -∞	+5,0; -∞
12,5	-63,4	-11,2	0,0	+2,5; -∞	+5,0; -∞
16	-56,7	-8,5	0,0	+2,0; -4,0	+5,0; -∞
20	-50,5	-6,2	0,0	±2,0	±3,0
25	-44,7	-4,4	0,0	+2,0; -1,5	±3,0
31,5	-39,4	-3,0	0,0	±1,5	±3,0
40	-34,6	-2,0	0,0	±1,0	±2,0
50	-30,2	-1,3	0,0	±1,0	±2,0
63	-26,2	-0,8	0,0	±1,0	±2,0
80	-22,5	-0,5	0,0	±1,0	±2,0
100	-19,1	-0,3	0,0	±1,0	±1,5
125	-16,1	-0,2	0,0	±1,0	±1,5
160	-13,4	-0,1	0,0	±1,0	±1,5
200	-10,9	0,0	0,0	±1,0	±1,5
250	-8,6	0,0	0,0	±1,0	±1,5
315	-6,6	0,0	0,0	±1,0	±1,5
400	-4,8	0,0	0,0	±1,0	±1,5
500	-3,2	0,0	0,0	±1,0	±1,5
630	-1,9	0,0	0,0	±1,0	±1,5
800	-0,8	0,0	0,0	±1,0	±1,5
1 000	0	0	0	±0,7	±1,0
1 250	+0,6	0,0	0,0	±1,0	±1,5
1 600	+1,0	-0,1	0,0	±1,0	±2,0
2 000	+1,2	-0,2	0,0	±1,0	±2,0
2 500	+1,3	-0,3	0,0	±1,0	±2,5
3 150	+1,2	-0,5	0,0	±1,0	±2,5
4 000	+1,0	-0,8	0,0	±1,0	±3,0
5 000	+0,5	-1,3	0,0	±1,5	±3,5
6 300	-0,1	-2,0	0,0	+1,5; -2.0	±4,5
8 000	-1,1	-3,0	0,0	+1,5; -2,5	±5,0
10 000	-2,5	-4,4	0,0	+2,0; -3,0	+5,0; -∞
12 500	-4,3	-6,2	0,0	+2,0; -5,0	+5,0; -∞
16 000	-6,6	-8,5	0,0	+2,5; -16,0	+5,0; -∞
20 000	-9,3	-11,2	0,0	+3,0; -∞	+5,0; -∞

NOTE Frequency weightings were calculated by use of the analytical expressions in Annex E with frequency f computed from $f = f_r\ [10^{0,1(n-30)}]$ with f_r = 1 000 Hz and n an integer between 10 and 43. The weightings were rounded to a tenth of a decibel.

5.6 Level linearity

5.6.1 For the entire extent of the total range, the measured signal level should be a linear function of the sound pressure level at the microphone. Level linearity specifications apply for measurements of time-weighted sound levels, time-averaged sound levels, and sound exposure levels.

5.6.2 Acceptance limits on level linearity deviations apply for measurements of electrical signals inserted into the microphone preamplifier through the applicable input device.

5.6.3 On any level range and for a given frequency, the anticipated signal level shall be the starting point specified in the Instruction Manual on the reference level range plus the change in the level of the input signal relative to the level of the input signal that caused the display of the starting point. At 1 kHz, the starting point at which to begin tests of level linearity shall be the indication of the reference sound pressure level.

5.6.4 On the reference level range, the extent of the linear operating range shall be at least 60 dB at 1 kHz.

5.6.5 Measured values of level linearity deviations shall not exceed ±0,8 dB for class 1 and ±1,1 dB for class 2 sound level meters.

5.6.6 Any 1 dB to 10 dB change in the level of the input signal shall cause the same change in the displayed sound level. Measured deviations from this design goal shall not exceed ±0,3 dB for class 1 and ±0,5 dB for class 2 sound level meters.

5.6.7 The specifications in 5.6.5 and 5.6.6 apply over the total level range for any frequency within the frequency range of the sound level meter and for any frequency weighting or frequency response provided.

NOTE In principle, the requirements for level linearity apply at least for any frequency from 16 Hz to 16 kHz for class 1 sound level meters and from 20 Hz to 8 kHz for class 2 sound level meters.

5.6.8 If level linearity deviation is measured at low frequencies, evaluation of the test results should account for the ripple that occurs with F-time-weighted measurements of sinusoidal signals.

NOTE At 16 Hz, the ripple causes a fluctuation in indicated sound level of approximately ±0,2 dB.

5.6.9 At 1 kHz, linear operating ranges on adjacent level ranges shall overlap by at least 30 dB for sound level meters that measure time-weighted sound levels. The overlap shall be at least 40 dB for sound level meters that measure time-averaged sound levels or sound exposure levels.

5.6.10 For each level range, the nominal A-weighted sound levels, and the nominal C-weighted and Z-weighted sound levels, if provided, shall be stated in the Instruction Manual for the lower and upper boundaries of the linear operating ranges over which sound levels can be measured without display of under-range or overload conditions. Linear operating ranges shall be stated in the Instruction Manual at least for frequencies of 31,5 Hz, 1 kHz, 4 kHz, 8 kHz, and 12,5 kHz for class 1 sound level meters and 31,5 Hz, 1 kHz, 4 kHz, and 8 kHz for class 2 sound level meters.

NOTE The frequencies required for the specification in 5.6.10 were selected to minimize the amount of information to be provided in the Instruction Manual as well as the cost of conformance tests.

5.6.11 For the frequencies specified in 5.6.10, the Instruction Manual shall state the starting point at which to begin tests of level linearity on a specified level range.

5.7 Self-generated noise

5.7.1 For the more-sensitive level ranges, sound levels shall be stated in the Instruction Manual that would be indicated when the sound level meter is placed in a low-level sound field that does not add significantly to the self-generated noise. These sound levels shall correspond to the highest level of self-generated noise anticipated for each combination of microphone model and sound level meter specified in the Instruction Manual, including any anticipated effects of aging of components.

5.7.2 For all available frequency weightings, levels of self-generated noise shall be stated in the Instruction Manual as time-weighted sound levels or as time-averaged sound levels, as applicable.

5.7.3 For all available frequency weightings, the Instruction Manual also shall state the levels of the highest anticipated self-generated noise when the electrical input device replaces the microphone and the input is terminated as stated in the Instruction Manual.

5.7.4 The sound levels stated in the Instruction Manual for self-generated noise shall be at reference environmental conditions.

5.7.5 The Instruction Manual shall describe procedures for measuring low-level sounds with consideration of the influence of self-generated noise.

5.8 Time-weightings F and S

5.8.1 Design-goal exponential time constants are 0,125 s for time-weighting F and 1 s for time-weighting S. The design goals for the corresponding rates of decay of a time-weighted sound level, after the sudden cessation of a steady 4 kHz sinusoidal electrical input signal, are 34,7 dB/s for time weighting F and 4,3 dB/s for time weighting S. Time weightings that are provided shall be described in the Instruction Manual.

NOTE In English, F and S stand for fast and slow.

5.8.2 Acceptance limits for deviations of measured rates of decrease in the displayed sound level from the design-goal decay rates are +3,8 dB/s; -3,7 dB/s for time-weighting F and +0,8 dB/s; -0,7 dB/s for time-weighting S. These requirements apply for any level range.

5.8.3 For a steady sinusoidal electrical signal at 1 kHz, the measured deviation of the indication of A-weighted sound level with time-weighting S and A-weighted, time-averaged sound level, if available, from the indication of A-weighted sound level with time-weighting F shall not exceed ±0,1 dB. These requirements apply at the reference sound pressure level on the reference level range.

5.9 Toneburst response

5.9.1 The specification for measurement of the sound level for a transient signal is given in terms of 4 kHz tonebursts applied to the electrical input facility.

5.9.2 For the A, C, and Z frequency weightings, the reference toneburst response to a single 4 kHz toneburst shall be as given in column 2 of Table 4 for maximum F or maximum S sound levels, and in column 3 for sound exposure levels. Measured deviations of toneburst responses from the corresponding reference toneburst responses shall not exceed the applicable acceptance limits over the specified range of toneburst durations.

5.9.3 The reference toneburst responses and acceptance limits of Table 4 also apply to integrating-averaging sound level meters that do not display sound exposure level. For such instruments, the sound exposure level of a toneburst shall be calculated by application of Equation (4) from a measurement of time-averaged sound level and the corresponding averaging time. The averaging time shall be that displayed by the sound level meter and shall include the occurrence of the toneburst.

5.9.4 For any toneburst duration between two consecutive toneburst durations in Table 4, the reference toneburst response shall be determined by application of Equation (7) or (8), as appropriate. Applicable acceptance limits are those for the shorter toneburst duration where limits are given.

Table 4 – Reference 4 kHz toneburst responses and acceptance limits

Toneburst duration, T_b ms	**Reference 4 kHz toneburst response, δ_{ref}, relative to the steady sound level** dB		**Acceptance limits** dB **Performance class**	
	$L_{AFmax} - L_A$ $L_{CFmax} - L_C$ **and** $L_{ZFmax} - L_Z$; **Eq. (7)**	$L_{AE} - L_A$ $L_{CE} - L_C$ **and** $L_{ZE} - L_Z$; **Eq. (8)**	**1**	**2**
1 000	0,0	0,0	±0,5	±1,0
500	-0,1	-3,0	±0,5	±1,0
200	-1,0	-7,0	±0,5	±1,0
100	-2,6	-10,0	±1,0	±1,0
50	-4,8	-13,0	±1,0	+1,0; -1,5
20	-8,3	-17,0	±1,0	+1,0; -2,0
10	-11,1	-20,0	±1,0	+1,0; -2,0
5	-14,1	-23,0	±1,0	+1,0; -2,5
2	-18,0	-27,0	+1,0; -1,5	+1,0; -2,5
1	-21,0	-30,0	+1,0; -2,0	+1,0; -3,0
0,5	-24,0	-33,0	+1,0; -2,5	+1,0; -4,0
0,25	-27,0	-36,0	+1,0; -3,0	+1,5; -5,0
	$L_{ASmax} - L_A$ $L_{CSmax} - L_C$ **and** $L_{ZSmax} - L_Z$; **Eq. (7)**			
1 000	-2,0		±0,5	±1,0
500	-4,1		±0,5	±1,0
200	-7,4		±0,5	±1,0
100	-10,2		±1,0	±1,0
50	-13,1		±1,0	+1,0; -1,5
20	-17,0		+1,0; -1,5	+1,0; -2,0
10	-20,0		+1,0; -2,0	+1,0; -3,0
5	-23,0		+1,0; -2,5	+1,0; -4,0
2	-27,0		+1,0; -3,0	+1,0; -5,0

NOTE 1 For the purpose of this standard and for time-weighting sound level meters, reference 4-kHz toneburst response δ_{ref} for maximum time-weighted sound levels is determined from the following approximation

$$\delta_{ref} = 10 \lg \left(1 - e^{-T_b / \tau}\right) \text{ dB} \quad (7)$$

where

T_b is a specified duration of a toneburst in seconds, for example from column 1,

τ is a standard exponential time constant as specified in 5.8.1, and

e is the base of the natural logarithm.

Equation (7) applies for isolated 4 kHz tonebursts.

NOTE 2 For the purpose of this standard and for integrating and integrating-averaging sound level meters, reference 4-kHz toneburst response δ_{ref} for sound exposure levels is determined from the following approximation:

$$\delta_{ref} = 10 \lg \left(T_b / T_0\right) \text{ dB} \quad (8)$$

where

T_b is a specified duration of a toneburst in seconds, for example from column 1, and

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

NOTE 3 Reference 4-kHz toneburst responses in Table 4 are valid for the A, C, and Z frequency weightings. Other frequency weightings can have other reference toneburst responses.

5.9.5 Reference toneburst responses and corresponding acceptance limits apply for any toneburst duration within the ranges specified in Table 4 and on the reference level range over a range of steady input signal levels. The range of steady 4 kHz input signals, from which the tonebursts are extracted, extends from an input equivalent to a display at 3 dB less than the specified upper boundary of the linear operating range down to an input equivalent to a display at 10 dB above the specified lower boundary. Measured deviations of toneburst responses from the corresponding reference toneburst response shall not exceed the specified acceptance limits, provided the toneburst response produces an indication that is at least 10 dB greater than the highest anticipated level of A-weighted self-generated noise as specified in 5.7.3.

5.9.6 There shall be no overload indication during any measurement of toneburst response over the range of input signal levels specified in 5.9.5.

5.10 Response to repeated tonebursts

5.10.1 The specification for the response to repeated tonebursts applies for the A weighting and for the C and Z weightings, where provided, and for any sequence of 4 kHz tonebursts of equal amplitude and equal duration. Measured deviations of time-averaged sound levels from the time-averaged sound levels calculated for the toneburst sequence shall not exceed the applicable acceptance limits of Table 4 for the sound-exposure-level toneburst response.

5.10.2 The specification for the response to repeated tonebursts applies on the reference level range for toneburst durations between 0,25 ms and 1 s and from 3 dB less than the specified upper boundary of the linear operating range at 4 kHz down to an input equivalent to a sound level that is 10 dB above the lower boundary of the linear operating range at 4 kHz.

5.10.3 In any total measurement duration, the difference δ_{ref}, in decibels, between the theoretical time-averaged sound level of a sequence of n tonebursts extracted from the steady 4 kHz sinusoidal signal and the time-averaged sound level of the corresponding steady sinusoidal signal is given by

$$\delta_{ref} = 10 \lg \left(n T_b / T_m\right) \text{ dB} \quad (9)$$

where

T_b is a toneburst duration and

T_m is total measurement duration, both in seconds.

The corresponding steady sinusoidal signal shall be time averaged over the total measurement duration.

5.11 Overload indication

5.11.1 A sound level meter shall be provided with an overload indicator that shall be operative for each applicable display device. The Instruction Manual shall describe the operation and interpretation of the overload indications.

5.11.2 An overload condition shall be displayed before the acceptance limits for level linearity deviation or toneburst response are exceeded for sound levels above the upper boundary of a linear operating range. This requirement applies on all level ranges and for any frequency from 31,5 Hz to 12,5 kHz for class 1 sound level meters, or from 31,5 Hz to 8 kHz for class 2 sound level meters.

5.11.3 The overload indicator shall operate for both positive-going and negative-going one-half-cycle signals extracted from a steady sinusoidal electrical signal. The extracted signals shall start and stop at zero crossings. For positive-going and negative-going one-half-cycle signals, measured differences between the corresponding input signal levels that first cause an overload indication shall not exceed 1,5 dB.

5.11.4 When a sound level meter is used to measure F or S time-weighted sound levels, the overload indication shall be presented as long as the overload condition exists or 1 s, whichever is the greater.

5.11.5 When time-averaged sound levels or sound exposure levels are being measured, the overload indicator shall latch on when an overload condition occurs. The latched condition shall remain until the measurement results are reset. The latching requirements also apply to measurements of maximum time-weighted sound level, peak sound level, and other quantities calculated during, or displayed after, a measurement interval.

5.12 Under-range indication

5.12.1 For all level ranges, an under-range condition shall be displayed when the indicated time-weighted sound level, time-averaged sound level, or sound exposure level is less than the lower boundary of the linear operating range for the selected level range.

5.12.2 An under-range display shall be presented for at least as long as the under-range condition exists or 1 s, whichever is the greater. The Instruction Manual shall describe the operation and interpretation of under-range indications.

NOTE The under-range indication does not necessarily account for the influence of self-generated noise from the microphone (see 5.7) because the specifications for level linearity deviations apply for measurements of electrical signals inserted into the preamplifier through the applicable input device (see 5.6).

5.13 C-weighted peak sound level

5.13.1 Sound level meters may display C-weighted peak sound levels. On each level range, the Instruction Manual shall state the nominal range of C-weighted peak sound levels for which the differences between indications of C-weighted peak sound level and C-weighted sound level do not exceed the applicable acceptance limits. On at least the reference level range, the extent of the peak level range shall be at least 40 dB for indications of C-weighted peak sound levels. Within the specified ranges, C-weighted peak sound levels shall be indicated without display of an overload condition.

NOTE Z-weighted peak sound levels are not the same as C-weighted peak sound levels.

5.13.2 The specifications for indications of C-weighted peak sound levels are given in terms of the response to one-cycle, and positive-going and negative-going half-cycle electrical signals. The one-cycle and half-cycle signals shall be extracted from steady sinusoidal signals and applied to the input of the preamplifier. Complete cycles and half-cycles shall start and stop on zero crossings.

5.13.3 Measured deviations of (1) a difference between an indication of a C-weighted peak sound level, L_{Cpeak}, and the corresponding indication of the C-weighted sound level of the steady signal, L_{C}, from (2) the corresponding reference difference given in Table 5 shall not exceed the applicable acceptance limits given in Table 5.

Table 5 – Reference differences for C-weighted peak sound levels and acceptance limits

Number of cycles in test signal	**Nominal frequency of test signal** Hz	**Reference difference** $L_{\mathrm{Cpeak}} - L_{\mathrm{C}}$ dB	**Acceptance limits,** dB	
			Performance class	
			1	**2**
one	31,5	2,5	±2,0	±3,0
one	500	3,5	±1,0	±2,0
one	8 000	3,4	±2,0	±3,0
positive half cycle	500	2,4	±1,0	±2,0
negative half cycle	500	2,4	±1,0	±2,0
NOTE Test-signal frequencies are the exact, not nominal frequencies; see Annex D.				

5.14 Stability during continuous operation

5.14.1 A sound level meter shall be able to operate continuously in moderate-level sound fields without significant change in sensitivity. Evaluation of this design goal shall use the difference between the A-weighted sound levels indicated in response to steady 1 kHz electrical signals applied at the beginning and end of a 30 min period of operation. For each indication, the level of the electrical input signal shall be as required to display the calibration sound pressure level on the reference level range.

5.14.2 Measured differences between the initial and final indications of A-weighted sound level shall not exceed ±0,1 dB for class 1 sound level meters or ±0,3 dB for class 2 sound level meters. The indicated sound level may be a time-averaged sound level, an F-time-weighted sound level, or an S-time-weighted sound level, as applicable.

5.15 High-level stability

5.15.1 A sound level meter shall be able to operate continuously in response to high sound levels without significant change in sensitivity. Evaluation of this design goal shall use the measured difference between the A-weighted sound levels indicated in response to a steady 1 kHz electrical signal at the beginning and end of a 5 min period of continuous exposure to the signal. The level of the steady electrical input signal shall be as required to display the sound level that is 1 dB less than the upper boundary of the 1 kHz linear operating range on the least-sensitive level range.

5.15.2 Measured differences between the initial and final indications of A-weighted sound level shall not exceed ±0,1 dB for class 1 sound level meters or ±0,3 dB for class 2 sound level meters. The indicated sound level may be a time-averaged sound level, an F-time-weighted sound level, or an S-time-weighted sound level, as applicable.

5.16 Reset

5.16.1 Sound level meters intended for the measurement of time-averaged sound level, sound exposure level, maximum time-weighted sound level, and frequency-weighted peak sound level shall contain a facility to clear the data storage device and re-initiate a measurement.

5.16.2 Use of a reset facility shall not cause spurious indications on a display device or to data that are stored.

5.17 Thresholds

If user-selectable thresholds are provided for an integrating-averaging or an integrating sound level meter, the performance of the thresholds and method of operation shall be described in the Instruction Manual for measurements of time-averaged sound levels or sound exposure levels.

5.18 Display

5.18.1 The acoustical quantity that is being measured shall be clearly indicated on the display or by the controls. The indications shall be described in the Instruction Manual and shall include the frequency weighting and the time weighting or averaging time, as applicable. The indication may be by means of a suitable letter symbol or an abbreviation. Examples of appropriate letter symbols are given with the definitions, equations, and tables in this standard.

5.18.2 The display device(s) shall be described in the Instruction Manual and shall permit measurements with a resolution of 0,1 dB or better, over a display range of at least 60 dB.

5.18.3 For digital display devices updated at periodic intervals, the indication at each display update shall be the value of the user-selected quantity at the time of the display update. Other quantities may be indicated at the time of the display update and, if so, the displayed quantities shall be described in the Instruction Manual.

5.18.4 If a digital indicator is provided, the Instruction Manual shall state the display update rate and the conditions to be achieved after initiating a measurement when the first valid indication is displayed.

5.18.5 When results of a measurement are provided at a digital output, the Instruction Manual shall describe the method for transferring or downloading of digital data to an external data-storage or display device. The computer software as well as the hardware for the interface shall be identified.

5.18.6 Each alternative device for displaying the signal level, stated in the Instruction Manual as conforming to the specifications of this standard, is an integral part of the sound level meter. Each such alternative device shall be included as part of the components required for demonstration of conformance to the performance specifications in this clause as well as the applicable environmental specifications of Clause 6.

5.19 Analogue or digital output

5.19.1 If an analogue or digital output is provided, the characteristics of the output shall be described in the Instruction Manual. For analogue outputs, the characteristics shall include the frequency weighting, the range of output signal levels, the internal electrical impedance at the output, and the recommended range of load impedances.

5.19.2 Connecting any passive impedance without stored electrical energy, including a short circuit, to an analogue output shall not affect any measurement in progress by more than 0,1 dB.

5.19.3 If an analogue or digital output is not provided for general applications, an output shall be provided for use in testing the characteristics of a class 1 sound level meter and may be provided for a class 2 sound level meter.

5.19.4 For steady sinusoidal electrical input signals at any frequency in the range of a class 1 or class 2 sound level meter, for frequency weightings A, C, and Z, and for any input signal level within the extent of the linear operating range on any available level range, the design goal for the difference between the signal level indicated on the display device and the corresponding signal level indicated at the analogue or digital output is 0,0 dB with acceptance limits of ±0,1 dB.

5.20 Timing facilities

5.20.1 A class 1 sound level meter that indicates time-averaged sound level or sound exposure level shall be able to display the elapsed time at the end of an integration period, or an equivalent indication of the integration time interval. The capability to preset an averaging or integration time interval may also be provided. Recommended preset integration time intervals are 10 s, 1 min, 5 min, 10 min, 30 min, 1 h, 8 h, and a duration of 24 h. Time of day may also be displayed. If the sound level meter can display the time of day, the nominal drift in the displayed time over a period of 24 h should be stated in the Instruction Manual. If applicable, the Instruction Manual shall describe the procedure to preset an averaging or integration time interval and to set the time of day.

5.20.2 For signal levels within the range of a display device, the Instruction Manual shall state the minimum and maximum averaging and integration times for measurement of time-averaged sound levels and sound exposure levels, respectively.

5.21 Radio frequency emissions and disturbances to a public power supply

5.21.1 If the sound level meter is designed to accept the connection of interface or interconnection cables, the Instruction Manual shall state the lengths and types of typical cables (for example, shielded or unshielded) and the characteristics of all devices to which the cables are expected to be attached.

5.21.2 The quasi-peak level of the radio-frequency electric field strength emitted from the enclosure port of the sound level meter shall not exceed 30 dB for frequencies from 30 MHz to 230 MHz, and shall not exceed 37 dB for frequencies from 230 MHz to 1 GHz. At 230 MHz, the lower limit applies. Field strength levels are relative to a reference value of 1 µV/m. The requirements apply for complete sound level meters of group X or Y and at a distance of 10 m. The Instruction Manual shall state the operating mode(s) of the sound level meter, and any connecting devices, that produce the greatest radio-frequency emissions.

NOTE An enclosure port is the physical boundary of a sound level meter through which electromagnetic fields can radiate or impinge.

5.21.3 For group Y and group Z sound level meters, the maximum disturbance conducted to the public supply of electric power shall not exceed the quasi-peak and average voltage-level limits given in Table 6 at an a.c. power port. If the quasi-peak level of the maximum disturbance conducted by a sound level meter to the public power supply does not exceed the limit for the average voltage level, the sound level meter shall be deemed to conform to the quasi-peak and average voltage-level limits.

Table 6 – Limits for conducted disturbance to the voltage of a public supply of electric power

Frequency range MHz	**Limits on voltage level of disturbance** (re 1µV) dB	
	Quasi-peak level	**Average level**
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50

Lower limits for voltage levels apply at the transition frequencies. Limits on the levels of voltage disturbances decrease linearly with 20 times the base-10 logarithm of the frequency in the range from 0,15 MHz to 0,50 MHz.

NOTE See Annex H of CISPR 16-1-1:2010 for the characteristics of quasi-peak measuring receivers.

5.22 Crosstalk

5.22.1 Crosstalk, or leakage of signals between pairs of channels, may be a concern for multi-channel sound level meters.

5.22.2 For a class 1 or class 2 multi-channel sound level meter system, and at any frequency from 10 Hz to 20 kHz, the difference shall be at least 70 dB between (a) the level indicated on the display device, in response to a steady signal applied to the electrical input facility of one channel and adjusted to indicate the upper boundary of the applicable linear operating range, and (b) the corresponding signal level indicated for any other channel. Termination devices, as stated in the Instruction Manual, shall be installed in place of the microphones on the other inputs.

5.23 Power supply

5.23.1 An indication shall be provided to confirm that the power supply is sufficient to operate the sound level meter in conformance to the specifications of this Standard.

5.23.2 The Instruction Manual shall state the maximum and minimum power supply voltages at which the sound level meter conforms to the specifications of this standard. With a sound calibrator applied to the microphone, the measured change in the displayed sound level shall not exceed ±0,1 dB for class 1 sound level meters and ±0,2 dB for class 2 sound level meters when the supply voltage is reduced from the maximum to the minimum.

5.23.3 If internal batteries are used to power the sound level meter, the acceptable battery types shall be stated in the Instruction Manual and preferably on the instrument.

5.23.4 The Instruction Manual shall state the continuous operating time, under reference environmental conditions, to be expected for the specified normal mode of operation when full capacity batteries are installed.

5.23.5 For sound level meters powered by internal batteries and designed to be able to indicate sound levels over a duration that exceeds the nominal battery life, the Instruction Manual shall describe the recommended means for operating the sound level meter from an external power supply.

5.23.6 For sound level meters that are intended to operate from a public supply of a.c. electrical power, the Instruction Manual shall state the nominal voltage and frequency of the supply and the associated acceptance limits.

6 Environmental, electrostatic, and radio-frequency requirements

6.1 General

6.1.1 A sound level meter shall conform to all specifications of Clause 6 that apply to the intended use of the instrument. When a sound signal is applied to the microphone, the windscreen should be removed, if appropriate.

6.1.2 Each specification for the influence of an operating environment applies to a sound level meter that is turned on and set to perform a measurement in a typical manner. The Instruction Manual shall state the typical time interval needed for the sound level meter to stabilize after changes in environmental conditions.

6.1.3 Specifications for the influence of variations in static pressure, air temperature, and relative humidity apply for sound levels indicated in response to application of a sound calibrator operating at a frequency in the range from 160 Hz to 1250 Hz. The influence of variations in static pressure, air temperature, and relative humidity on the sound pressure level generated by the sound calibrator shall be known.

6.1.4 Combinations of air temperature and relative humidity, that yield a dewpoint greater than +39 °C or less than –15 °C, shall not be used to test conformance to the specifications of this standard.

6.2 Static pressure

6.2.1 Over the range of static pressure from 85 kPa to 108 kPa, measured deviations of a displayed sound level from the sound level displayed at the reference static pressure shall not exceed ±0,4 dB for class 1 sound level meters or ±0,7 dB for class 2 sound level meters.

6.2.2 Over the range of static pressure from 65 kPa up to, but not including, 85 kPa, measured deviations of a displayed sound level from the sound level displayed at the reference static pressure shall not exceed ±0,9 dB for class 1 sound level meters or ±1,6 dB for class 2 sound level meters. The Instruction Manual shall provide guidance and procedures to use the sound level meter at locations or under conditions where the static pressure is less than 85 kPa.

NOTE The frequency response of the microphone can depend on the static pressure. Using a sound calibrator to adjust the sensitivity of a sound level meter at the calibration check frequency provides no information on the influence of static pressure on frequency response.

6.3 Air temperature

6.3.1 The influence of variations in air temperature on the measured signal level is specified over the range of air temperatures from -10 °C to +50 °C for class 1 sound level meters and for temperatures from 0 °C to +40 °C for class 2 sound level meters. Temperature ranges apply for a complete sound level meter.

6.3.2 For components of a sound level meter (for example, a computer) designated in the Instruction Manual as intended to operate only in an environmentally controlled enclosure (for example, indoors), the air temperature range may be restricted to +5 °C to +35 °C. The restricted temperature range does not apply to the microphone.

6.3.3 Measured deviations of the sound level displayed at any temperature from the sound level displayed at the reference air temperature shall not exceed ±0,5 dB for class 1 sound level meters or ±1,0 dB for class 2 sound level meters. This specification applies over the applicable ranges of air temperatures given in 6.3.1 or 6.3.2, for any relative humidity within the range given in 6.4.

6.3.4 Measured values of level linearity deviation at 1 kHz over the stated linear operating range on the reference level range shall not exceed the applicable acceptance limits given in 5.6. This level-linearity specification applies over the ranges of air temperature given in 6.3.1 or 6.3.2 and for a relative humidity that is within ±20 % relative humidity of the reference relative humidity.

6.4 Humidity

Measured deviations of a sound level displayed at any relative humidity from the sound level displayed at the reference relative humidity shall not exceed ±0,5 dB for class 1 sound level meters or ±1,0 dB for class 2 sound level meters. This specification applies over the range of relative humidity from 25 % to 90 %, for any air temperature within the applicable ranges given in 6.3.1 or 6.3.2, as limited by the range of dewpoints specified in 6.1.4.

6.5 Electrostatic discharge

6.5.1 A sound level meter, or multi-channel sound level meter system, shall continue to operate as intended after exposure to a contact discharge of electrostatic voltage of up to ±4 kV and to an air discharge of electrostatic voltage of up to ±8 kV. The polarity of the electrostatic voltage is relative to earth ground. Methods for applying the electrostatic discharges are given in IEC 61000-4-2.

6.5.2 Exposure to the electrostatic discharges specified in 6.5.1 shall cause no permanent degradation of performance or loss of function in the sound level meter. The performance or function of a sound level meter may be temporarily degraded or lost because of electrostatic discharges, if so stated in the Instruction Manual. The specified degradation or loss of function shall not include any change of operating state, change of configuration, or corruption or loss of stored data.

6.6 A.C. power-frequency and radio-frequency fields

6.6.1 Exposure to specified a.c. power-frequency and radio-frequency fields shall not cause any change in the operating state, change of configuration, or corruption or loss of stored data. This requirement applies to a complete sound level meter or to the applicable components, or to a multi-channel sound level meter system, and for any operating mode consistent with normal operation. The operating mode(s) of the sound level meter, and any connecting devices, shall be as stated in the Instruction Manual for the least immunity to the effects of exposure to a.c. power-frequency and radio-frequency fields.

6.6.2 The specification for immunity to the effects of exposure to a.c. power-frequency fields shall apply for exposure to a uniform magnetic field with a root-mean-square strength of 80 A/m at frequencies of 50 Hz and 60 Hz. The uniformity of the magnetic field shall be evaluated in the absence of the sound level meter.

6.6.3 The specification for exposure to a.c. power-frequency fields applies to the orientation of the sound level meter that is stated in the Instruction Manual to have the least immunity to the effects of such exposure.

6.6.4 The specification for immunity to the effects of exposure to radio-frequency fields shall apply over the range of carrier frequencies from 26 MHz to 1 GHz. The signal at the carrier frequency of the radio-frequency field shall be amplitude modulated by a 1 kHz steady sinusoidal signal to a depth of 80 %. When unmodulated and in the absence of the sound level meter, the radio-frequency field shall have a uniform root-mean-square electric field strength of 10 V/m.

6.6.5 Additionally, tests for immunity to the effects of exposure to radio-frequency fields shall cover the frequency range from 1,4 GHz to 2,0 GHz with a root-mean-square electric field strength of 3 V/m (unmodulated) with sinusoidal amplitude modulation at 1 kHz to a depth of 80 %, as well as the frequency range from greater than 2,0 GHz to 2,7 GHz, with a root-mean-square electric field strength of 1 V/m (unmodulated) with sinusoidal amplitude modulation at 1 kHz to a depth of 80 %. A sound level meter may conform to the specifications of this standard at unmodulated, root-mean-square electric field strengths greater than the specified field strengths. If so, the applicable field strengths should be stated in the Instruction Manual.

6.6.6 Immunity of a sound level meter to the effects of exposure to a.c. power-frequency and radio-frequency fields shall be demonstrated with a 925 Hz sinusoidal sound signal applied to the microphone. With no a.c. power-frequency or radio-frequency field applied, the sound source shall be adjusted to display an A-weighted sound level of 74 dB ± 1 dB, with time-weighting F or as a time-averaged sound level. The sound level shall be displayed on the level range for which the lower boundary is closest to, but not greater than, 70 dB, if more than one level range is provided. If the sound level meter only displays sound exposure level, the corresponding time-averaged sound level should be calculated by application of Equation (6) for the averaging time.

6.6.7 Measured deviations of a displayed sound level from the sound level displayed in the absence of an a.c. power-frequency or radio-frequency field shall not exceed ±1,0 dB for class 1 sound level meters or ±2,0 dB for class 2 sound level meters.

6.6.8 For group Y or group Z sound level meters with an a.c. input power port and, if available, an a.c. output power port, immunity to radio-frequency common-mode interference shall be demonstrated over the frequency range from 0,15 MHz to 80 MHz. The radio-frequency field shall be amplitude modulated by a 1 kHz sinusoidal signal to a depth of 80 %. When unmodulated, the root-mean-square, radio-frequency voltage shall be 10 V when emitted from a source having an output impedance of 150 Ω. Immunity to the effects of fast transients on the power supply shall apply for a signal having a 2 kV peak voltage and a repetition frequency of 5 kHz in accordance with Table 4 of IEC 61000-6-2:2005. The additional specification given in Table 4 of IEC 61000-6-2:2005 also applies for immunity to voltage dips, voltage interruptions, and voltage surges.

6.6.9 For group Z sound level meters with signal or control ports, the requirements of Table 2 in IEC 61000-6-2:2005 apply for immunity to radio-frequency, common-mode interference over the frequency range from 0,15 MHz to 80 MHz for a root-mean-square voltage of 10 V when unmodulated. These requirements apply where any interconnecting cable between parts of the sound level meter exceeds a length of 3 m. Requirements for immunity to the effects of fast transients on the public power supply system apply for a signal having a 2 kV peak voltage and a repetition frequency of 5 kHz in accordance with Table 2 of IEC 61000-6-2:2005.

6.6.10 A sound level meter may be stated in the Instruction Manual to conform to the specifications of this standard for exposure to radio-frequency fields at a sound level less than 74 dB. In this event, measured deviations of the displayed sound level from the sound level displayed in the absence of a radio-frequency field shall not exceed the applicable acceptance limits of 6.6.6 for sound levels less than 74 dB down to the stated lower level. This requirement applies on all applicable level ranges for all specifications relevant to the group. The lower level, stated in the Instruction Manual to the nearest decibel, shall apply to all modes of operation of the sound level meter.

6.7 Mechanical vibration

Microphones used with sound level meters are often sensitive to exposure to mechanical vibration. For capacitive microphone types, the sensitivity is usually greatest for vibrations in the direction normal to the plane of the diaphragm. The Instruction Manual shall provide advice to users of sound level meters on means to minimize the influence of mechanical vibration on sound levels indicated by a sound level meter. The Instruction Manual shall also warn users that mechanical vibration of a sound level meter can significantly affect the indicated levels at the lower boundary of the measurement range at frequencies within the range of a sound level meter.

7 Provision for use with auxiliary devices

7.1 An optional extension device or cable may be provided by the manufacturer of the sound level meter for installation between the microphone and the preamplifier or between the preamplifier and the other components of a sound level meter. If such device or cable is provided, details shall be given in the Instruction Manual for any corrections to be applied to the results of measurements made in this manner.

7.2 The Instruction Manual shall state the typical effect on electroacoustical performance when optional accessories supplied by the manufacturer of the sound level meter are used. The data shall apply to all relevant characteristics of the sound level meter that are affected by installation of the accessories. Optional accessories include windscreens or rain protection devices to be installed around the microphone. For any recommended type of windscreen, data shall be provided for the typical effect of the accessory, in the absence of wind, on microphone sensitivity, directional response, and frequency weighting.

7.3 The Instruction Manual shall state whether the sound level meter conforms to the specifications of this standard for the same performance class when an optional accessory is installed. If the sound level meter does not conform to all applicable specifications for the original performance class when an optional accessory is installed, the Instruction Manual shall state whether the sound level meter conforms to all specifications for another class or that it no longer conforms to the specifications for either class 1 or class 2 performance.

7.4 If internal or external bandpass filters are provided for spectral analysis of a sound-pressure signal, the Instruction Manual shall describe how the sound level meter is to be used to measure filtered sound pressure levels.

7.5 Details shall be provided in the Instruction Manual for the connection of manufacturer-provided auxiliary devices to a sound level meter and for the effects, if any, of such devices on the electroacoustical characteristics of the sound level meter.

8 Marking

8.1 A sound level meter that conforms to all applicable specifications of this standard shall be marked to show the IEC reference number and the applicable year of publication of the edition of this standard. The marking shall identify the supplier responsible for the technical specifications applicable to the complete sound level meter. The marking on the sound level meter shall include the model designation and serial number. The performance class of the complete sound level meter in accordance with the specifications of this standard may be placed on the sound level meter or shown on a screen of the display device.

8.2 If the sound level meter consists of several separate units, each principal unit or component shall be marked as described in 8.1, as practicable.

9 Instruction Manual

9.1 General

An Instruction Manual shall be supplied with each sound level meter or equivalent instrument that conforms to the specifications of this standard.

a) The Instruction Manual shall contain all the information required by Clauses 4, 5, 6, and 7. It shall also contain the information required by 9.2 and 9.3.
b) If the sound level meter consists of several separate components, an Instruction Manual shall be available for the combination that forms the complete sound level meter. The Instruction Manual shall describe all necessary components and their mutual influence.

c) An Instruction Manual shall be provided as a printed, or printable, document in one or more parts.

9.2 Information for operation

The Instruction Manual shall contain the following operational information as applicable to the sound level meter.

9.2.1 General

a) A description of the type of sound level meter; the classification group X, Y, or Z for immunity to the effects of exposure to radio-frequency fields; and the performance designation as class 1 or class 2 according to the specifications of this standard. If relevant, a description of the configurations of the sound level meter that conform to the specifications for class 1 or class 2 performance.

b) A description of the complete sound level meter and its configuration for the normal mode of operation including a windscreen and associated devices, as applicable. The description shall include the method of mounting the microphone with identification of additional items and the procedure for installing a windscreen around the microphone. Additional items include an extension device or cable that may be needed for a particular sound level meter to conform to the specifications of this standard for the stated performance class.

c) The models of microphones with which the complete sound level meter conforms to the specifications for class 1 or class 2 performance for sound from the reference direction in a free field or with random incidence, as applicable.

d) If an extension device or cable is required, a statement that the sound level meter conforms to the specifications for directional response and frequency weighting only when the specified device or cable is installed.

e) The characteristics and operation of each independent channel of a multi-channel sound level meter.

f) Advice on means to minimize the influence of mechanical vibration on indicated sound levels and to warn that mechanical vibration can affect indicated levels at the lower boundary of the measurement range at frequencies within the range of the sound level meter.

9.2.2 Design features

a) A description of the acoustical quantities that the sound level meter is capable of measuring on each display device, for example time-weighted sound level, time-averaged sound level, or sound exposure level, separately or in combinations, along with explanations of all abbreviations, letter symbols, and icons that are displayed.

b) For the sound level meter in the configuration for the normal mode of operation, detailed tabulations, as functions of sound incidence angle and frequency, of the free-field response to sinusoidal plane waves relative to the corresponding free-field response in the reference direction.

c) A description of the frequency weightings that conform to the specifications of this standard.

d) A description of the time weightings that are provided.

e) Identification of the level ranges by the nominal A-weighted sound levels at the lower and upper boundaries of the linear operating ranges at 1 kHz.

f) A description of the operation of the level range controls.

g) A description of all display devices, including the modes of operation and applicable display-update rates for digital displays. If more than one display device is provided, a statement as to which of these devices conform to the specifications of this standard and which are for other purposes.

h) The total range of A-weighted sound levels that can be measured at 1 kHz without exceeding the applicable acceptance limits.

i) If provided, the range of C-weighted peak sound levels that may be measured on each level range.

j) A means to identify the version of all software that is integral to operation of the sound level meter.

k) Information about the design-goal characteristics and the acceptance limits that should be maintained for quantities that the sound level meter is capable of indicating but for which no performance specifications are provided in this standard. The characteristics include optional frequency weightings.

9.2.3 Power supply

a) For sound level meters powered by internal batteries, recommendations for acceptable battery types and the nominal duration of continuous operation for the normal mode of operation under reference environmental conditions when full capacity batteries are installed.

b) The method to confirm that the power supply is sufficient to operate the sound level meter in conformance to the specifications of this standard.

c) For battery-powered sound level meters designed to be able to measure sound levels over a duration that exceeds the nominal battery life, a description of the means to operate the sound level meter from an external power supply.

d) For sound level meters that are intended to operate from a public supply of a.c. electrical power, a statement of the nominal root-mean-square voltage and frequency of the supply and the acceptance limits around the nominal values.

9.2.4 Adjustments at the calibration check frequency

a) Identification of the model(s) of sound calibrator(s) that may be used to check and maintain the required indication of the sound level meter under reference environmental conditions.

b) The calibration check frequency.

c) The procedure to check, and data for adjusting, the indication of the sound level meter in response to application of a recommended sound calibrator. The procedure and data shall apply for the reference sound pressure level on the reference level range and at the calibration check frequency.

9.2.5 Corrections to indicated levels

a) Separate tables of correction data and the associated expanded uncertainties of measurement determined in accordance with IEC 62585.

b) At environmental conditions close to reference environmental conditions and at the frequencies and under the test conditions specified in IEC 62585, corrections shall be provided for the typical effects of reflections from the case of the instrument and diffraction around the microphone.

c) Corrections for the average effects of a windscreen on directional response and on the relative frequency-weighted response for the sound level meter and in the reference direction or on the relative frequency-weighted random-incidence response, if applicable.

d) Corrections for use in periodic testing to determine the equivalent free-field sound level when a multi-frequency sound calibrator, a comparison coupler, or an electrostatic actuator is recommended in the Instruction Manual for evaluating the acoustical response.

9.2.6 Operating the sound level meter

a) The reference direction.

b) Procedures for measuring sounds that arrive principally from the reference direction or with random incidence, including recommendations to minimize the influence of the instrument case and the observer, if present, when measuring a sound.

c) Procedures for measuring low-level sounds on the more-sensitive level ranges with consideration of the influence of self-generated noise.

d) After reaching equilibrium with the ambient environment and switching on the power, the elapsed time until the sound level meter may be used to measure the level of sounds.

e) Guidance and procedures for measuring sound levels at locations where the static pressure is from 65 kPa up to, but not including, 85 kPa.

f) The procedure to pre-set an averaging or integration time interval and to set the time of day, if applicable.

g) The minimum and maximum averaging times for measurement of time-averaged sound levels and the minimum and maximum integration times for measurement of sound exposure levels, as applicable.

h) The operation of the hold feature and the means for clearing a display that is held.

i) The operation of the reset facility for measurements of time-averaged sound level, sound exposure level, maximum time-weighted sound level, and peak sound level. A statement as to whether operation of the reset facility clears an overload indication. The nominal delay time between operation of the reset facility and re-initiation of a measurement.

j) The operation and interpretation of overload and under-range indications and the means for clearing the indications.

k) The performance and operation of any user-selectable thresholds for measurements of time-averaged sound level or sound exposure level.

l) The method to transfer or download digital data to an external data storage or display device and identification of the software and hardware to accomplish those tasks.

m) For sound level meters that allow the connection of interface or interconnection cables, recommendations for typical cable lengths and types (for example, shielded or unshielded) and a description of the characteristics of devices to which the cables are expected to be attached.

n) For electrical outputs, the frequency weighting, the range of root-mean-square voltages for sinusoidal output signals, the internal electrical impedance at the output, and the recommended range of load impedances.

9.2.7 Accessories

a) A description of the average effects on the relevant characteristics of a sound level meter, in the absence of wind, of enclosing the microphone within a recommended windscreen, rain protection device, or other accessory provided or recommended in the Instruction Manual for use with the sound level meter. Relevant characteristics include directional response and frequency weightings. A statement of the performance class to which the sound level meter conforms when such accessories are installed, or a statement that the sound level meter no longer conforms to either class 1 or class 2 specifications.

b) Corrections to be applied to the results of measurements made, or a procedure to be followed, when an optional extension device or cable is placed between the output of the preamplifier and the other components of the sound level meter.

c) Information concerning the use of the sound level meter when equipped with bandpass filters.

d) Information concerning connection of manufacturer-provided auxiliary devices to a sound level meter and the effects of such auxiliary devices on the characteristics of the sound level meter.

9.2.8 Influence of variations in environmental conditions

a) Identification of the components of the sound level meter intended to be operated only in an environmentally controlled enclosure.

b) The effects of electrostatic discharges on the operation of the sound level meter. A statement of the temporary degradation or loss, if any, in the performance or function of the sound level meter resulting from exposure to electrostatic discharges. For sound level meters that require internal access for maintenance by a user, a statement, if needed, of precautions against damage by electrostatic discharges.

c) A statement that the sound level meter conforms to the basic specification of this standard for the required immunity to a.c. power-frequency and radio-frequency fields. Alternatively, if applicable, a statement of the F-time-weighted or time-averaged sound levels less than 74 dB, on all applicable level ranges, for which the sound level meter conforms to the specifications of this standard upon exposure to a.c. power-frequency and radio-frequency fields. The information shall specify the frequency of the a.c. power field.

9.3 Information for testing

The Instruction Manual shall contain the following information for testing, as applicable to a sound level meter:

a) The reference sound pressure level.

b) The reference level range.

c) The microphone reference point for models of microphone stated to be for use with the sound level meter.

d) For the A-weighted sound levels displayed (1) in response to the sound pressure produced by a calibrated multi-frequency sound calibrator, or (2) as the indications obtained by use of a comparison coupler, or (3) in response to simulation of sound pressure by an electrostatic actuator, correction data to obtain A-weighted sound levels equivalent to the response in a free field to plane sinusoidal sound waves incident from the reference direction or with random incidence, as applicable. Correction data and the associated expanded uncertainties shall be supplied at least for the frequencies required for periodic testing. The model of sound calibrator, comparison coupler, or electrostatic actuator for which the correction data are valid, shall be identified.

e) Directivity indexes for determining relative frequency-weighted random-incidence response.

f) Tables of the nominal A-weighted sound levels at the upper and lower boundaries of the linear operating ranges on each level range. Sound levels shall be tabulated at least at frequencies of 31,5 Hz, 1 kHz, 4 kHz, 8 kHz, and 12,5 kHz for class 1 sound level meters and 31,5 Hz, 1 kHz, 4 kHz, and 8 kHz for class 2 sound level meters. Sound levels should preferably be tabulated for all frequency weightings available in the sound level meter.

g) For each frequency for which A-weighted sound levels are specified at the lower and upper boundaries of the linear operating ranges, the starting point at which to begin tests of level linearity deviation on the reference level range. At 1 kHz, the starting point shall be the reference sound pressure level.

h) For each specified model of microphone, a description of the electrical design goal, and applicable acceptance limits, for the input device, or the means, used to insert electrical signals into the input of the microphone preamplifier.

i) For each model of microphone for which the sound level meter is stated to conform to the specifications of this standard, the time-weighted and time-averaged sound levels, as appropriate, corresponding to the highest anticipated level of self-generated noise produced when the sound level meter is placed in a low-level sound field. The highest anticipated levels of self-generated noise should also be stated for the case when a specified electrical input device or the specified means is installed in place of the microphone and terminated in a specified manner. Levels of self-generated noise shall be stated for the more-sensitive level ranges of a sound level meter that has more than one level range. Levels of self-generated noise shall be stated for each available frequency weighting. The averaging time for time-averaged sound level shall be stated and shall be at least 30 s.

j) For each model of microphone for which the sound level meter is stated to conform to the specifications, the greatest sound pressure level at the microphone, and the greatest peak-to-peak voltage at the input of the preamplifier, that the sound level meter is designed to accommodate.

k) The maximum and minimum power supply voltages at which the sound level meter conforms to the specifications of this standard.

l) The typical time interval needed for the sound level meter to stabilize after changes in environmental conditions.

m) If applicable, the unmodulated, root-mean-square electric field strength greater than the specified field strengths for which the sound level meter conforms to the specifications of this standard.

n) The mode(s) of operation of the sound level meter, and of any connection devices that produce the greatest radio-frequency emission levels on a stated level range. A description of the configurations of the sound level meter that produce the same, or lower, radio-frequency emission levels.

o) The operating mode(s) of the sound level meter, and of any connection devices, that have the least immunity to the effects of exposure to a.c. power-frequency and radio-frequency fields, and the corresponding reference orientation of the sound level meter relative to the principal direction of an electromagnetic field.

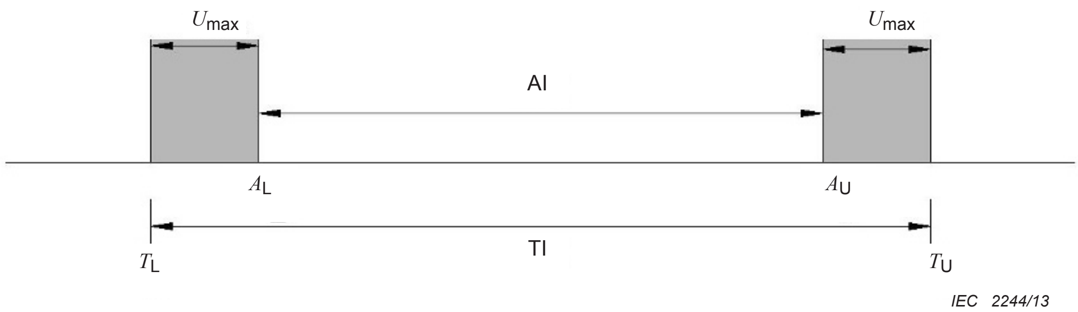
Annex A
(informative)

Relationship between tolerance interval, corresponding acceptance interval and the maximum-permitted uncertainty of measurement

This standard, in common with others written by IEC/TC29, uses adaptations of the guidelines from ISO/IEC Guide 98-4 *Uncertainty of measurement — Part 4: Role of measurement uncertainty in conformity assessment* (equivalent to guidance document JCGM 106 from the Joint Committee for Guides in Metrology), as the basis for demonstration of conformance of an instrument to the specifications given in this standard,

ISO/IEC Guide 98-4 describes guarded acceptance in terms of tolerance intervals, acceptance intervals and uncertainties of measurement.

To promote clarity for users and testing laboratories, IEC/TC29 has adopted a policy whereby tolerance limits around design goals are not explicitly stated, but can be determined if required from the specified acceptance limits for allowed deviations from a design goal and the corresponding specified maximum-permitted uncertainty of measurement, by using the illustration in Figure A.1.



Key

AI acceptance interval

TI tolerance interval

U_{max} guard band for the maximum-permitted uncertainty of measurement for a 95 % coverage interval

A_L lower acceptance limit

A_U upper acceptance limit

T_L lower tolerance limit

T_U upper tolerance limit

Figure A.1 – Relationship between tolerance interval, corresponding acceptance interval and the maximum-permitted uncertainty of measurement

The limits of an acceptance interval are associated with the acceptance interval and not with the guard band for the maximum-permitted uncertainty of measurement. Hence a measured deviation equal to a limit of an acceptance interval demonstrates conformance to a specification, providing also that the uncertainty of the measurement from the laboratory performing a test does not exceed the specified maximum-permitted uncertainty.

Annex B
(normative)

Maximum-permitted uncertainties of measurement

Table B.1 gives the maximum-permitted uncertainties, for a coverage probability of 95 %, applicable to pattern-evaluation tests and periodic tests to demonstrate conformance of a sound level meter to the specifications of this standard.

NOTE The maximum-permitted uncertainties of measurement in Table B.1 are not equivalent to the uncertainties associated with the measurement of a sound level.

Table B.1 – Maximum-permitted uncertainties of measurement for a coverage probability of 95 %

Requirement	Table or subclause	Maximum-permitted uncertainty of measurement dB
Directional response: θ = 30°	Table 2; 250 Hz to 1 kHz	0,25
Directional response: θ = 30°	Table 2; >1 kHz to 2 kHz	0,25
Directional response: θ = 30°	Table 2; >2 kHz to 4 kHz	0,35
Directional response: θ = 30°	Table 2; >4 kHz to 8 kHz	0,45
Directional response: θ = 30°	Table 2; >8 kHz to 12,5 kHz	0,55
Directional response: θ = 90° & 150°	Table 2; 250 Hz to 1 kHz	0,25
Directional response: θ = 90° & 150°	Table 2; >1 kHz to 2 kHz	0,45
Directional response: θ = 90° & 150°	Table 2; >2 kHz to 4 kHz	0,45
Directional response: θ = 90° & 150°	Table 2; >4 kHz to 8 kHz	0,85
Directional response: θ = 90° & 150°	Table 2; >8 kHz to 12,5 kHz	1,15
Frequency weightings A, C, Z	Table 3, 10 Hz to 4 kHz	0,60
Frequency weightings A, C, Z	Table 3, >4 kHz to 10 kHz	0,70
Frequency weightings A, C, Z	Table 3, >10 kHz to 20 kHz	1,00
A vs. C or Z at 1 kHz	5.5.9	0,20
Level linearity deviation	5.6.5	0,30
1 dB to 10 dB change in level	5.6.6	0,25
F and S decay rates	5.8.2	3,50 dB/s for F; 0,40 dB/s for S
F vs. S level at 1 kHz	5.8.3	0,20
Toneburst response	5.9.2, Table 4	0,30
Repeated tonebursts	5.10.1, Table 4	0,30
Overload indication	5.11.3	0,25
C-weighted peak sound levels	5.13.3, Table 5	0,35
Stability during continuous operation	5.14.2	0,10
High-level stability	5.15.2	0,10
Analogue electrical output	5.19.2	0,15
Power supply voltage	5.23.2	0,20

Requirement	Table or subclause	**Maximum-permitted uncertainty of measurement** dB
Static pressure influence	6.2.1; 6.2.2	0,30
Air temperature influence	6.3.3; 6.3.4	0,30
Humidity influence	6.4	0,30
Combined temperature and humidity	6.3.3, 6.3.4, 6.4	0,35
AC and radio-frequency fields	6.6.6	0,30

NOTE 1 The maximum-permitted uncertainties of measurement for directional response are in accordance with the specifications in 5.4 and Table 2.

NOTE 2 The maximum-permitted uncertainties of measurement for directional response and frequency weightings do not include any uncertainty introduced by inter-sample variability of the microphone or any uncertainty associated with use of an accessory that may be fitted around the microphone.

Annex C
(informative)

Example assessments of conformance to specifications of this standard

C.1 General

C.1.1 The purpose of this annex is to clarify the use of measurement results and uncertainties of measurement in assessments of conformance to the specifications of IEC 61672-1 in either pattern-evaluation tests (IEC 61672-2) or periodic tests (IEC 61672-3) of sound level meters.

C.1.2 This annex demonstrates assessment of conformance using some general illustrative examples.

C.2 Conformance criteria

C.2.1 According to the requirements in this standard, conformance to a specification is established when measured deviations from design goals do not exceed the corresponding acceptance limits AND the uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty of measurement for a coverage probability of 95%.

C.2.2 With these two criteria, there are four possible outcomes:

(1) Measured deviations do not exceed acceptance limits AND actual uncertainty does not exceed maximum-permitted uncertainty

CONFORMANCE TO THE SPECIFICATION

(2) Measured deviations do not exceed acceptance limits AND actual uncertainty exceeds maximum-permitted uncertainty

NON-CONFORMANCE BECAUSE THE ACTUAL UNCERTAINTY EXCEEDS THE MAXIMUM-PERMITTED UNCERTAINTY

(3) Measured deviations exceed acceptance limits AND actual uncertainty does not exceed maximum-permitted uncertainty

NON-CONFORMANCE BECAUSE MEASURED DEVIATIONS EXCEED THE ACCEPTANCE LIMITS

(4) Measured deviations exceed acceptance limits AND actual uncertainty exceeds maximum-permitted uncertainty

NON-CONFORMANCE BECAUSE NEITHER CRITERION IS SATISFIED

NOTE In practice, a laboratory can sometimes pre-determine the uncertainty of a measurement. If the pre-determined uncertainty exceeds the maximum-permitted uncertainty the laboratory would not attempt to perform the test.

C.3 Example test results

C.3.1 Table C.1 gives examples of test results to explain the method of determining conformance or non-conformance to the specifications of this standard. This method applies for any tests in this standard where acceptance limits and maximum-permitted uncertainties are specified.

Table C.1 – Examples of assessment of conformance

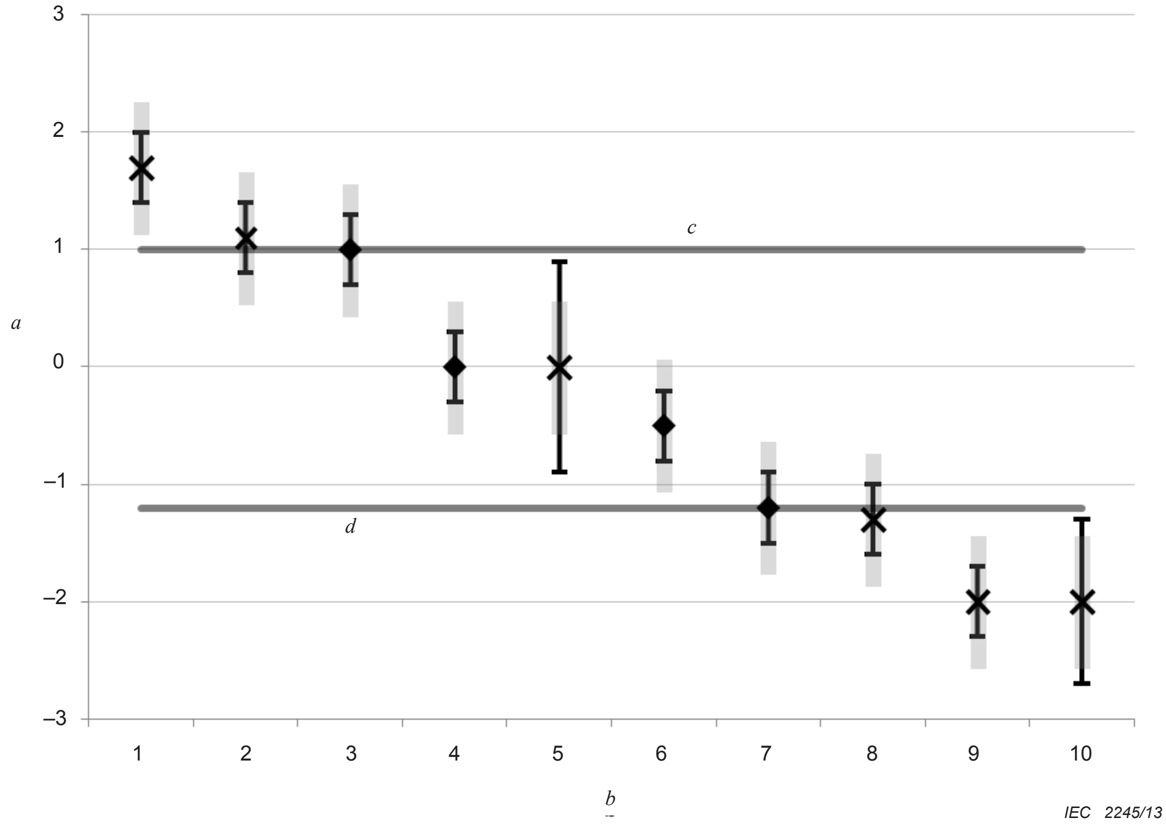
Example number	Measured deviation from design goal dB	Acceptance limits dB	Actual uncertainty dB	Maximum-permitted uncertainty dB	Conforms to specifications Yes or No	Reasons for conformance or non-conformance
1	+1,7	+1,0; -1,2	0,3	0,5	No	Deviation exceeds acceptance limits
2	+1,1	+1,0; -1,2	0,3	0,5	No	Deviation exceeds acceptance limits
3	+1,0	+1,0; -1,2	0,3	0,5	Yes	Deviation within acceptance limits AND uncertainty within maximum-permitted
4	0,0	+1,0; -1,2	0,3	0,5	Yes	Deviation within acceptance limits AND uncertainty within maximum-permitted
5	0,0	+1,0; -1,2	0,9	0,5	No	Deviation within acceptance limits BUT uncertainty exceeds maximum-permitted
6	-0,5	+1,0; -1,2	0,3	0,5	Yes	Deviation within acceptance limits AND uncertainty within maximum-permitted
7	-1,2	+1,0; -1,2	0,3	0,5	Yes	Deviation within acceptance limits AND uncertainty within maximum-permitted
8	-1,3	+1,0; -1,2	0,3	0,5	No	Deviation exceeds acceptance limits
9	-2,0	+1,0; -1,2	0,3	0,5	No	Deviation exceeds acceptance limits
10	-2,0	+1,0; -1,2	0,7	0,5	No	Deviation exceeds acceptance limits AND uncertainty exceeds maximum-permitted

C.3.2 Figure C.1 shows the ten example assessments of conformance from Table C.1 in graphical form.

C.3.3 In Figure C.1, the lower and upper acceptance limits are indicated by the heavy horizontal lines. The measured deviations from the design goal are shown by the solid markers. A diamond-shaped marker indicates conformance to the specification and a cross-shaped marker indicates non-conformance.

C.3.4 In Figure C.1, the actual uncertainty of measurement is indicated by the vertical error bars and the maximum-permitted uncertainty is indicated by the vertical shaded area.

C.3.5 The practice illustrated in Table C.1 and Figure C.1 for assessing conformance applies equally for pattern-evaluation testing as well as periodic testing.



Key

a Deviation from design goal, dB

b Example number from Table C.1

c Upper acceptance limit

d Lower acceptance limit

A diamond-shaped marker indicates conformance to the specification and a cross-shaped marker indicates non-conformance. The actual uncertainty of measurement is indicated by the vertical error bars and the maximum-permitted uncertainty is indicated by the vertical shaded area.

Figure C.1 – Examples of assessment of conformance

Annex D
(normative)

Frequencies at fractional-octave intervals

D.1 The Instruction Manual is required to provide correction data at various fractional-octave frequency increments. This annex provides the means to calculate the exact values of the frequencies for certain increments.

D.2 Frequencies at fractional-octave intervals shall be calculated by means of the following expression:

$$f_x = f_r \left[10^{\left(\frac{3}{10}\right)\left(\frac{x}{b}\right)} \right] \quad \text{(D.1)}$$

where

– f_x is the frequency for index × (Hz);

– f_r is a reference frequency of 1000 Hz;

– $10^{(3/10)}$ is the nominal octave ratio for a base-10 system;

– x is any integer (positive, negative, or zero); and

– b is the step-width designator for a fractional-octave frequency interval (for example, b = 3 for one-third-octave intervals, b = 6 for one-sixth-octave intervals, and b = 12 for one-twelfth-octave intervals).

D.3 Tables D.1, D.2, and D.3 show the frequencies calculated according to Equation (D.1), but shown in kilohertz, for one-third-octave, one-sixth-octave, and one-twelfth-octave intervals, respectively. Calculated frequencies are shown to five significant decimal digits. Ranges of index x were chosen to be compatible with the specifications of this standard. Other frequencies may be calculated by appropriate choice of index x.

D.4 Frequencies in Table D.1 at one-third-octave intervals were calculated for index x ranging from −13 to +14.

Table D.1 – Frequencies at one-third-octave intervals

Frequency, kHz			
0,050 119	0,251 19	1,258 9	6,309 6
0,063 096	0,316 23	1,584 9	7,943 3
0,079 433	0,398 11	1,995 3	10,000
0,100 00	0,501 19	2,511 9	12,589
0,125 89	0,630 96	3,162 3	15,849
0,158 49	0,794 33	3,981 1	19,953
0,199 53	1,000 00	5,011 9	25,119

D.5 Frequencies in Table D.2 at one-sixth-octave intervals were calculated for index x ranging from +6 to +20.

Table D.2 – Frequencies at one-sixth-octave intervals

Frequency, kHz		
1,995 3	3,548 1	6,309 6
2,238 7	3,981 1	7,079 5
2,511 9	4,466 8	7,943 3
2,818 4	5,011 9	8,912 5
3,162 3	5,623 4	10,000

D.6 Frequencies in Table D.3 at one-twelfth-octave intervals were calculated for index x ranging from +1 to +52.

Table D.3 – Frequencies at one-twelfth-octave intervals

Frequency, kHz			
1,059 3	2,238 7	4,731 5	10,000
1,122 0	2,371 4	5,011 9	10,593
1,188 5	2,511 9	5,308 8	11,220
1,258 9	2,660 7	5,623 4	11,885
1,333 5	2,818 4	5,956 6	12,589
1,412 5	2,985 4	6,309 6	13,335
1,496 2	3,162 3	6,683 4	14,125
1,584 9	3,349 7	7,079 5	14,962
1,678 8	3,548 1	7,498 9	15,849
1,778 3	3,758 4	7,943 3	16,788
1,883 6	3,981 1	8,414 0	17,783
1,995 3	4,217 0	8,912 5	18,836
2,113 5	4,466 8	9,440 6	19,953

Annex E
(normative)

Analytical expressions for frequency-weightings C, A, and Z

E.1 General

This annex provides analytical expressions for calculating the design goals for frequency weightings C, A, and Z.

E.2 Frequency-weighting C

E.2.1 For any frequency f in hertz, the C-weighting characteristic C(f) shall be calculated, in decibels, from

$$C(f) = 10\,\lg\left[\frac{f_4^2 f^2}{\left(f^2 + f_1^2\right)\left(f^2 + f_4^2\right)}\right]^2 \text{dB} - C_{1000} \tag{E.1}$$

E.2.2 Normalization constant $C_{1\,000}$ represents the electrical gain, in decibels, needed to provide a frequency weighting of 0 dB at 1 000 Hz.

E.2.3 The C-weighting characteristic has two low-frequency poles at frequency f_1, two high-frequency poles at frequency f_4, and two zeros at 0 Hz. With these poles and zeros, the power response for the C-weighting characteristic, relative to the response at the reference frequency f_r of 1 000 Hz, will be reduced by D^2 = 1/2 (approximately -3 dB) at $f_L = 10^{1,5}$ Hz and $f_H = 10^{3,9}$ Hz.

E.2.4 Pole frequencies f_1 and f_4 in Equation (E.1) shall be determined, in hertz, from the solution of a bi-quadratic equation that yields

$$f_1 = \left(\frac{-b - \sqrt{b^2 - 4c}}{2}\right)^{1/2} \tag{E.2}$$

and

$$f_4 = \left(\frac{-b + \sqrt{b^2 - 4c}}{2}\right)^{1/2} \tag{E.3}$$

Constants b and c in Equations (E.2) and (E.3) shall be determined from

$$b = \frac{1}{1-D}\left[f_r^2 + \frac{f_L^2 f_H^2}{f_r^2} - D\left(f_L^2 + f_H^2\right)\right] \tag{E.4}$$

with $D = +\sqrt{D^2} = +\sqrt{1/2}$ and

$$c = f_L^2 f_H^2 \tag{E.5}$$

and where f_r, f_L, and f_H are given in E.2.3.

E.3 Frequency-weighting A

E.3.1 The A-weighting characteristic A(f) shall be calculated, in decibels, from

$$A(f) = 10\,\mathrm{lg}\left[\frac{f_4^2 f^4}{\left(f^2+f_1^2\right)\left(f^2+f_2^2\right)^{1/2}\left(f^2+f_3^2\right)^{1/2}\left(f^2+f_4^2\right)}\right]^2 \mathrm{dB} - A_{1000} \qquad \text{(E.6)}$$

E.3.2 Normalization constant $A_{1\,000}$ represents the electrical gain, in decibels, needed to provide a frequency weighting of 0 dB at 1 000 Hz.

E.3.3 The A-weighting characteristic has two coupled first-order, high-pass filters added to the C-weighting characteristic. For each additional high-pass filter, the cut-off frequency is given by $f_A = 10^{2,45}$ Hz.

E.3.4 With the cut-off frequency f_A from E.3.3, the poles in the response at frequencies f_2 and f_3, that are required in Equation (E.6) to implement the additional high-pass filters for the A-weighting characteristic, shall be determined, in hertz, from

$$f_2 = \left(\frac{3-\sqrt{5}}{2}\right) f_A \qquad \text{(E.7)}$$

and

$$f_3 = \left(\frac{3+\sqrt{5}}{2}\right) f_A \qquad \text{(E.8)}$$

NOTE For frequency-weighting A, the addition of the coupled high-pass filters to the C-weighting characteristic is equivalent to the addition of two zeros at 0 Hz and poles at frequencies f_2 and f_3.

E.4 Pole frequencies and normalization constants

E.4.1 Approximate values for pole frequencies f_1 to f_4 in Equations (E.1) and (E.6) are:

f_1 = 20,60 Hz; f_2 = 107,7 Hz; f_3 = 737,9 Hz; and f_4 = 12 194 Hz.

E.4.2 Normalization constants $C_{1\,000}$ and $A_{1\,000}$, rounded to the nearest 0,001 dB, are –0,062 dB and –2,000 dB, respectively.

E.5 Frequency weighting Z

For any frequency in the range of a sound level meter, the Z-weighting characteristic Z(f) shall be given, in decibels, by

$$Z(f) = 0 \text{ dB} \qquad \text{(E.9)}$$

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