NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical with IEC 61672-1 (2002) 'Electroacoustics — Sound level meters — Part 1 : Specifications' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendations of the Acoustics and Recording Sectional Committee (LTD 5) and approval of the Electronics and Information Technology Division Council.

Existing IS 9779 : 1981 'Sound level meters' is based on IEC 60651 (1979). IEC 60651 (1979) has been withdrawn and replaced by IEC 61672-1 (2002) and IEC 61672-2 (2003). This revision has been undertaken to harmonize the Indian Standard with the IEC Standard. The other part of the series is given below:

IS 15575 (Part 2) : 2005 Electroacoustics — Sound level meters: Part 2 Pattern evaluation tests

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60942 (1997) Electroacoustics — Sound calibrators	IS 15059 : 2001 Electroacoustics — Sound calibrators	Identical
IEC 61000-4-2 (1995) Electromagnetic compatibility (EMC) — Part 4 : Testing and measurement techniques — Section 2 : Electrostatic discharge immunity test — Basic EMC Publication	IS 14700 (Part 4/Sec 2) : 1999 Electromagnetic compatibility (EMC) : Part 4 Testing and measurement techniques, Section 2 Electrostatic discharge immunity test — Basic EMC publication	do
IEC 61000-6-2 (1999) Electromagnetic compatibility (EMC) — Part 6-2 Generic standards — Immunity for industrial environments	IS 14700 (Part 6/Sec 2)[1] Electromagnetic compatibility (EMC) : Part 6 Generic standards, Section 2 Immunity for industrial environments	—

[1] Under preparation.

(*Continued on third cover*)

Indian Standard

ELECTROACOUSTICS — SOUND LEVEL METERS

PART 1 SPECIFICATIONS

1 Scope

1.1 This standard gives electroacoustical performance specifications for three kinds of sound measuring instruments:

- a conventional sound level meter that measures exponential time-weighted sound level;
- an integrating-averaging sound level meter that measures time-average sound level; and
- an integrating sound level meter that measures sound exposure level.

A single instrument may make any, or all, of the three kinds of measurements. Additional performance specifications are given for the measurement of maximum time-weighted sound level and peak C sound level. Frequency-weighting A is mandatory for all sound level meters specified in this standard.

1.2 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 from random directions.

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

NOTE For measurement of audible sound in the presence of ultrasound, the AU weighting, specified in IEC 61012 [1], may be applied.[1]

1.4 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 tolerance limits and the range of operational temperatures. Tolerance limits for class 2 specifications are greater than, or equal to, those for class 1 specifications.

1.5 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.

---

[1] Numbers in square brackets refer to the bibliography.

1.6 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.

2 Normative references

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

CISPR[2] 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

IEC 60050(801), *International Electrotechnical Vocabulary – Chapter 801: Acoustics and electroacoustics*

IEC 60942, *Electroacoustics – Sound calibrators*

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

IEC 61000-6-2:1999, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

ISO/IEC GUIDE EXPRES:1995, Guide to the expression of uncertainty in measurement

ISO Publication, ISBN 92-67-01075-1, *International vocabulary of basic and general terms in metrology*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in IEC 60050(801), the *International vocabulary of basic and general terms in metrology*, the *Guide to the expression of uncertainty in measurement*, and IEC 61000-6-2:1999, as well as the following apply. All quantities are expressed in SI units.

3.1
reference sound pressure
reference quantity conventionally chosen equal to 20 μPa for airborne sound

3.2
sound pressure level
twenty times the logarithm to the base ten of the ratio of the root-mean-square of a given sound pressure to the reference sound pressure

NOTE Sound pressure level is expressed in decibels (dB); symbol L_p.

[2] In English, CISPR stands for International Special Committee on Radio Interference.

3.3
frequency weighting
for a sound level meter, the difference between the level of the signal indicated on the display device and the corresponding level of a constant-amplitude steady-state sinusoidal input signal, specified in this standard as a function of frequency

NOTE The difference in level is expressed in decibels (dB).

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

3.5
time-weighted sound level
twenty times the logarithm to the base ten of the ratio of a given root-mean-square sound pressure to the reference sound pressure, root-mean-square sound pressure being obtained with a standard frequency weighting and standard time weighting

NOTE 1 Time-weighted sound level is expressed in decibels (dB).

NOTE 2 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 In symbols, A-weighted and time-weighted sound level, $L_{A\tau}(t)$, at any instant of time t is represented by

$$L_{A\tau}(t) = 20 \ \lg\left\{\left[(1/\tau)\int_{-\infty}^{t} p_A^2(\xi)e^{-(t-\xi)/\tau}d\xi\right]^{1/2} \Big/ p_0\right\} \quad (1)$$

where

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

In equation (1), the numerator of the argument of the logarithm is the exponential-time-weighted, root-mean-square, frequency-weighted sound pressure at observation time t.

NOTE 4 The sketch in figure 1 illustrates the process indicated by equation (1).

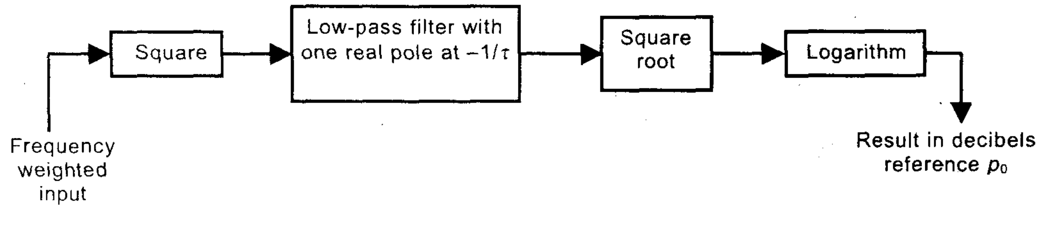

Figure 1 – Principal steps involved in forming an exponential-time-weighted sound level

3.6
maximum time-weighted sound level
greatest time-weighted sound level within a stated time interval

NOTE 1 Maximum time-weighted sound level is expressed in decibels (dB).

NOTE 2 For maximum time-weighted sound level, example letter symbols are L_{AFmax}, L_{ASmax}, L_{CFmax}, and L_{CSmax} for frequency weightings A and C and time weightings F and S.

3.7
peak sound pressure
greatest absolute instantaneous sound pressure during a stated time interval

3.8
peak sound level
twenty times the logarithm to the base ten of the ratio of a peak sound pressure to the reference sound pressure, peak sound pressure being obtained with a standard frequency weighting

NOTE 1 Peak sound level is expressed in decibels (dB).

NOTE 2 This standard provides specifications for measurement of peak C sound level; symbol L_{Cpeak}.

3.9
time-average sound level
equivalent continuous sound level
twenty times the logarithm to the base ten of the ratio of a root-mean-square sound pressure during a stated time interval to the reference sound pressure, sound pressure being obtained with a standard frequency weighting

NOTE 1 Time-average or equivalent continuous sound level is expressed in decibels (dB).

NOTE 2 In symbols, time-average, A-weighted sound level, L_{AT} or L_{AeqT}, is given by

$$L_{AT} = L_{AeqT} = 20\ \lg\left\{\left[(1/T)\int_{t-T}^{t} p_A^2(\xi)d\xi\right]^{1/2} \Big/ p_0\right\} \tag{2}$$

where

- ξ is a dummy variable of time integration over the averaging time interval ending at the time of observation t;
- T is the averaging time interval;
- $p_A(\xi)$ is the A-weighted instantaneous sound pressure; and
- p_0 is the reference sound pressure.

In equation (2), the numerator of the argument of the logarithm is the root-mean-square, frequency-weighted sound pressure over averaging time interval T.

NOTE 3 In principle, time weighting is not involved in a determination of time-average sound level.

3.10
sound exposure
time integral of the square of sound pressure over a stated time interval or event

NOTE 1 Duration of integration is included implicitly in the time integral and need not be reported explicitly, although the nature of the event should be stated. For measurements of sound exposure over a specified time interval such as 1 h, duration of integration should be reported.

NOTE 2 In symbols, A-weighted sound exposure E_A of a specified event is represented by

$$E_A = \int_{t_1}^{t_2} p_A^2(t)dt \tag{3}$$

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

The unit of A-weighted sound exposure is pascal-squared seconds if A-weighted sound pressure is in pascals and running time is in seconds.

NOTE 3 Sound exposure in pascal-squared hours is more convenient for applications such as measurement of exposure to noise in the workplace; see IEC 61252 [2].

3.11
sound exposure level

ten times the logarithm to the base ten of the ratio of a sound exposure to the reference sound exposure, reference sound exposure being the product of the square of the reference sound pressure and the reference time interval of 1 s

NOTE 1 Sound exposure level is expressed in decibels (dB).

NOTE 2 In symbols, A-weighted sound exposure level, L_{AE}, is related to a corresponding measurement of time-average, A-weighted sound level, L_{AT} or L_{AeqT}, by

$$L_{AE} = 10 \ \lg\left\{\left[\int_{t_1}^{t_2} p_A^2(t)dt\right]\Big/\left(p_0^2 T_0\right)\right\} \ = \ 10 \ \lg(E_A / E_0) \ = \ L_{AT} + 10 \ \lg(T/T_0) \tag{4}$$

where

- E_A is the A-weighted sound exposure in pascal-squared seconds (see equation (3));
- E_0 is the reference sound exposure of $(20 \ \mu\text{Pa})^2 \times (1 \text{ s}) = 400 \times 10^{-12} \ \text{Pa}^2\text{s}$;
- T_0 = 1 s; and
- $T = t_2 - t_1$ is the time interval for measurement, in seconds, for sound exposure level and time-average sound level.

NOTE 3 Time-average, A-weighted sound level L_{AT} or L_{AeqT} during time interval T is related to the total A-weighted sound exposure E_A occurring within that interval by

$$E_A = \left(p_0^2 T\right)\left(10^{0,1 L_{AT}}\right) \tag{5a}$$

or

$$L_{AT} = 10 \ \lg\left[E_A / \left(p_0^2 T\right)\right] \ = \ L_{AE} - 10 \ \lg(T/T_0) \tag{5b}$$

3.12
microphone reference point

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

NOTE The microphone reference point may be at the centre of the diaphragm of the microphone.

3.13
reference direction

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

NOTE The reference direction may be specified with respect to an axis of symmetry.

3.14
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 Sound-incidence angle is expressed in degrees.

3.15
level range

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

NOTE Level range is expressed in decibels (dB).

3.16
reference sound pressure level
sound pressure level specified for testing the electroacoustical performance of a sound level meter

NOTE Reference sound pressure level is expressed in decibels (dB).

3.17
reference level range
level range specified for testing the electroacoustical characteristics of a sound level meter and containing the reference sound pressure level

NOTE Reference level range is expressed in decibels (dB).

3.18
calibration check frequency
nominal frequency, in the range from 160 Hz to 1 250 Hz, of the sinusoidal sound pressure produced by a sound calibrator that is used in checking and adjusting a sound level meter

3.19
level linearity error
at a stated frequency, an indicated signal level minus the anticipated signal level

NOTE Level linearity error is expressed in decibels (dB).

3.20
linear operating range
on any level range and at a stated frequency, the range of sound levels over which level linearity errors are within the tolerance limits specified in this standard

NOTE Linear operating range is expressed in decibels (dB).

3.21
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 highest sound level, on the least-sensitive level range, that can be measured without indication of overload or under-range and within the tolerance limits specified in this standard for level linearity error

NOTE Total range is expressed in decibels (dB).

3.22
toneburst
one or more complete cycles of a sinusoidal signal starting and stopping at a zero crossing of the waveform

3.23
toneburst response
maximum time-weighted sound level, time-average sound level, or sound exposure level, measured in response to a sinusoidal electrical toneburst minus the corresponding measured sound level of the steady sinusoidal input signal from which the toneburst was extracted

NOTE Toneburst response is expressed in decibels (dB).

3.24
reference orientation
orientation of a sound level meter for tests to demonstrate conformance to the specifications of this standard for emissions of, and susceptibility to, radio frequency fields

4 Reference environmental conditions

Reference environmental conditions for specifying the 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 signal processor, and a display device.

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, 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 either 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 The performance specifications of this clause apply under the reference environmental conditions of clause 4.

5.1.3 For specifying the emission of, and susceptibility 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 mandatory 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, or both, as appropriate. 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 is to be mounted, if applicable, to conform to the specifications for directional response and frequency weightings. A microphone 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 provide unique identification for all such software.

5.1.9 As a minimum, a conventional 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-average 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.

5.1.10 A sound level meter shall have frequency-weighting A. Sound level meters conforming to class 1 tolerance limits also shall have frequency weighting C, at least for pattern evaluation tests. Sound level meters that measure peak C sound levels for non-steady sounds shall also measure C-weighted sound levels for steady sounds, at least for pattern evaluation tests. The ZERO frequency weighting (Z-weighting) 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 a.c., d.c., 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 describe the level range(s) by the nominal A-weighted sound level at 1 kHz. The instruction manual shall describe the operation of the level range controls and 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 instruction manual shall state the reference direction for each model of microphone intended for use with the sound level meter; the position of the microphone reference point shall also be stated.

NOTE A reference sound pressure level of 94 dB is preferred. Alternatively, a reference sound pressure level of 74 dB, 84 dB, 104 dB, 114 dB, or 124 dB may be specified. A sound pressure level of 94 dB corresponds closely to 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 C 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 Determination of conformance to many specifications of this standard requires the application of electrical signals. The electrical signals are to be equivalent to signals from the microphone. As appropriate for each specified model of microphone, the design goal and applicable tolerance limits shall be stated in the instruction manual for the electrical characteristics of the device, or the means, to insert signals into the electrical input facility. 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 instruction manual shall state the highest sound pressure level at the microphone and the greatest peak-to-peak voltage that can be applied at the electrical input facility without causing damage to the sound level meter.

5.1.17 Performance specifications in this standard apply, as appropriate, to any time or frequency weightings operated in parallel and to each independent channel of a multi-channel sound level meter. The instruction manual shall describe the characteristics and operation of each independent channel.

NOTE A multi-channel sound level meter may have two or more microphone inputs.

5.1.18 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.

5.1.19 Tolerance limits in this standard include allowances for design and manufacturing and for the maximum expanded uncertainties of measurement for the tests to demonstrate conformance to the specifications (see annex A).

NOTE In some cases, the tolerance limits in this standard are larger than the tolerance limits for corresponding characteristics in IEC 60651 and IEC 60804. Tolerance limits in IEC 60651 [3] and in IEC 60804 [4] did not include allowances for uncertainties of measurement.

5.2 Adjustments to indicated levels

5.2.1 At least one model of sound calibrator shall be stated in the instruction manual for checking and maintaining the correct indication on the display of the sound level meter.

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 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 the calibration check frequency, a procedure and data shall be provided in the instruction manual to adjust the sound level displayed in response to application of the sound calibrator specified in 5.2.1 and 5.2.2. Application of the procedure and the adjustment data shall yield the sound level or sound exposure level that would be indicated in response to plane progressive sinusoidal sound waves incident from the reference direction or in response to sounds at random incidence, as appropriate.

The procedure and data shall apply for environmental conditions at least within the applicable ranges specified in clause 6, including the reference environmental conditions. The adjustment data shall apply to microphones of all models stated in the instruction manual for use on the sound level meter and to any associated devices provided by the manufacturer of the sound level meter for mounting a microphone on the instrument. The data shall include corrections for the average effects of a windscreen on microphone frequency response if a windscreen is an integral component of the sound level meter for the normal mode of operation or if the instruction manual states that the sound level meter conforms to the specifications of this standard with a recommended windscreen installed around the microphone.

5.2.4 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 data for corrections for the deviation of the average microphone frequency response from a uniform frequency response, and for the average effects of reflections from the case of the sound level meter and diffraction around the microphone. The average effects of reflections and diffraction are relative to the sound pressure level at the position of the microphone and in the absence of the sound level meter.

If the instruction manual states that the sound level meter conforms to the specifications of this standard both with and without a windscreen installed around the microphone, the data described above shall be given for both configurations. The data for the configuration with windscreen shall include the corrections for the average effects of a windscreen on microphone frequency response. If a windscreen is an integral component of the sound level meter for the normal mode of operation, the windscreen correction data shall be given only for this configuration.

The corrections for the average frequency response of a microphone and for the average effects of reflections, diffraction, and windscreen, if applicable, shall apply for plane progressive sinusoidal sound waves incident from the reference direction and in the absence of wind. The information shall include the associated values for expanded uncertainties of measurement. The expanded uncertainties of measurement and the basic information shall be given in tabular form separately in the instruction manual.

NOTE The corrections for the average frequency response of the microphone and for the average effects of reflections and diffraction may be provided as two separate corrections or as a single combined correction.

5.2.5 The data required by 5.2.4 shall be provided in the following formats.

- For class 1 sound level meters, the data shall be stated in tabular form at nominal one-third-octave intervals for frequencies from 63 Hz to 1 kHz and then at nominal one-twelfth-octave intervals for 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 nominal one-third-octave intervals for frequencies from 63 Hz to at least 8 kHz.
- Corrections for the average effects of a windscreen on the microphone frequency response shall be stated in tabular form at nominal one-third-octave intervals from 1 kHz to 16 kHz for class 1 sound level meters and from 1 kHz to 8 kHz for class 2 sound level meters.

5.2.6 Deviations of the measured effects of microphone frequency response, reflection, diffraction, and windscreen, if applicable, from the effects stated in the instruction manual, extended by the expanded uncertainty of measurement, shall not exceed two thirds of the applicable tolerance limits in table 2.

5.2.7 If the instruction manual recommends a sound calibrator or an electrostatic actuator for use during periodic testing, the instruction manual shall provide adjustment data to obtain equivalent A-weighted sound levels that would be displayed under reference environmental conditions in response to plane progressive sinusoidal sound waves incident from the reference direction. These adjustment data shall apply to the A-weighted sound levels displayed in response to the sound pressure produced by a calibrated multi-frequency sound calibrator or in response to simulation of sound pressure by an electrostatic actuator.

5.2.8 The adjustment data shall be provided at least for frequencies of 125 Hz, 1 kHz, and either 4 kHz or 8 kHz and shall apply for stated combinations of a microphone, sound level meter, and a model of sound calibrator or electrostatic actuator. The adjustment data shall be provided for all models of microphones or microphone-windscreen configurations for which the sound level meter is stated to conform to the specifications of this standard. The deviation of a measurement of adjustment data from the data given in the instruction manual shall not exceed ±0,4 dB or half the magnitude of the applicable adjustment data whichever is the greater.

5.3 Directional response

5.3.1 Table 1 gives directional response requirements 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 1 apply for plane progressive sound waves at any sound-incidence angle within the indicated ranges, including the reference direction. At any frequency, the design goal is equal response to sounds from all directions of sound incidence.

Table 1 – Directional response limits including maximum expanded uncertainty of measurement

Frequency kHz	Maximum absolute difference in displayed sound levels at any two sound-incidence angles within ±θ degrees from the reference direction dB					
	θ = 30°		θ = 90°		θ = 150°	
	Class					
	1	2	1	2	1	2
0,25 to 1	1,3	2,3	1,8	3,3	2,3	5,3
>1 to 2	1,5	2,5	2,5	4,5	4,5	7,5
>2 to 4	2,0	4,5	4,5	7,5	6,5	12,5
>4 to 8	3,5	7,0	8,0	13,0	11,0	17,0
>8 to 12,5	5,5	...	11,5	...	15,5	...

NOTE Maximum absolute differences in displayed sound levels are extended by the expanded uncertainty of measurement for demonstration of conformance to the limits given above.

5.3.2 For any frequency within the specified ranges, the requirements of table 1 apply for any orientation of the sound level meter, or applicable components, around the reference direction.

5.4 Frequency weightings

5.4.1 At 1 kHz, the design goal for all frequency weightings is 0 dB with corresponding tolerance limits of ±1,1 dB for class 1 sound level meters and ±1,4 dB for class 2 sound level meters.

5.4.2 Table 2 gives the frequency weightings A, C, and Z, rounded to a tenth of a decibel and corresponding tolerance limits for class 1 and class 2 sound level meters. For a given performance class, tolerance limits in table 2 apply on all level ranges and after applying the adjustment described in 5.2 for the response to the sound calibrator at the calibration check frequency and under reference environmental conditions.

Table 2 – Frequency weightings and tolerance limits including maximum expanded uncertainty of measurement

Nominal frequency a) Hz	Frequency weightings b) dB			Tolerance limits (dB) Class	
	A	C	Z	1	2
10	−70,4	−14,3	0,0	+3,5; −∞	+5,5; −∞
12,5	−63,4	−11,2	0,0	+3,0; −∞	+5,5; −∞
16	−56,7	−8,5	0,0	+2,5; −4,5	+5,5; −∞
20	−50,5	−6,2	0,0	±2,5	±3,5
25	−44,7	−4,4	0,0	+2,5; -2,0	±3,5
31,5	−39,4	−3,0	0,0	±2,0	±3,5
40	−34,6	−2,0	0,0	±1,5	±2,5
50	−30,2	−1,3	0,0	±1,5	±2,5
63	−26,2	−0,8	0,0	±1,5	±2,5
80	−22,5	−0,5	0,0	±1,5	±2,5
100	−19,1	−0,3	0,0	±1,5	±2,0
125	−16,1	−0,2	0,0	±1,5	±2,0
160	−13,4	−0,1	0,0	±1,5	±2,0
200	−10,9	0,0	0,0	±1,5	±2,0
250	−8,6	0,0	0,0	±1,4	±1,9
315	−6,6	0,0	0,0	±1,4	±1,9
400	−4,8	0,0	0,0	±1,4	±1,9
500	−3,2	0,0	0,0	±1,4	±1,9
630	−1,9	0,0	0,0	±1,4	±1,9
800	−0,8	0,0	0,0	±1,4	±1,9
1 000	0	0	0	±1,1	±1,4
1 250	+0,6	0,0	0,0	±1,4	±1,9
1 600	+1,0	−0,1	0,0	±1,6	±2,6
2 000	+1,2	−0,2	0,0	±1,6	±2,6
2 500	+1,3	−0,3	0,0	±1,6	±3,1
3 150	+1,2	−0,5	0,0	±1,6	±3,1
4 000	+1,0	−0,8	0,0	±1,6	±3,6
5 000	+0,5	−1,3	0,0	±2,1	±4,1
6 300	−0,1	−2,0	0,0	+2,1; -2,6	±5,1
8 000	−1,1	−3,0	0,0	+2,1; -3,1	±5,6
10 000	−2,5	−4,4	0,0	+2,6; -3,6	+5,6; -∞
12 500	−4,3	−6,2	0,0	+3,0; -6,0	+6,0; -∞
16 000	−6,6	−8,5	0,0	+3,5; -17,0	+6,0; -∞
20 000	−9,3	−11,2	0,0	+4,0; -∞	+6,0; -∞

a) Nominal frequencies are from the R10 series given in table 1 of ISO 266:1997 [5].

b) C and A frequency weightings were calculated by use of equations (6) and (7) with frequency f computed from $f = (f_r)[10^{0,1(n-30)}]$ with f_r = 1 kHz and n an integer between 10 and 43. The results were rounded to a tenth of a decibel.

5.4.3 For the configuration of the sound level meter stated in the instruction manual for the normal mode of operation, the frequency weightings and tolerance limits of table 2 apply for the response to plane progressive sound waves incident on the microphone from the reference direction or with random incidence, or both as applicable.

5.4.4 At any frequency in table 2, the deviation of a displayed sound level from the sound pressure level present at the microphone position in the absence of the sound level meter, extended by the expanded uncertainty of measurement, shall not exceed the applicable tolerance limits. Sound pressure levels measured in the absence of the sound level meter shall be weighted by the applicable frequency weighting from equations (6), (7), or (8).

5.4.5 For frequencies between two consecutive frequencies in table 2, frequency weightings C or A shall be computed from equation (6) or (7) and rounded to a tenth of a decibel. The applicable tolerance limits then are the wider of the limits given in table 2 for the two consecutive frequencies.

5.4.6 The C-weighting characteristic is realized by 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 kHz, will be down by D^2 = 1/2 (approximately −3 dB) at $f_L = 10^{1,5}$ Hz and $f_H = 10^{3,9}$ Hz. The A-weighting characteristic is realized by adding two coupled first-order high-pass filters to the C-weighting characteristic. For each high-pass filter, the cut-off frequency is given by $f_A = 10^{2,45}$ Hz.

5.4.7 Practical realizations of frequency weightings C, A, and Z in table 2 may be derived from the analytical expressions in equations (6), (7), and (8) as functions of frequency, respectively.

5.4.8 For any frequency f in hertz, the C-weighting $C(f)$ shall be calculated, in decibels, from

$$C(f) = 20 \ \lg\left[\frac{f_4^2 f^2}{\left(f^2 + f_1^2\right)\left(f^2 + f_4^2\right)}\right] - C_{1000} \qquad (6)$$

The A-weighting $A(f)$ shall be calculated from

$$A(f) = 20 \ \lg\left[\frac{f_4^2 f^4}{\left(f^2 + f_1^2\right)\left(f^2 + f_2^2\right)^{1/2}\left(f^2 + f_3^2\right)^{1/2}\left(f^2 + f_4^2\right)}\right] - A_{1000} \qquad (7)$$

where $C_{1\,000}$ and $A_{1\,000}$ are normalization constants, in decibels, representing the electrical gain needed to provide frequency weightings of zero decibels at 1 kHz.

The Z-weighting $Z(f)$ shall be calculated from

$$Z(f) = 0.$$

5.4.9 Pole frequencies f_1 and f_4 shall be determined, in hertz, from the solution of a bi-quadratic equation that yields

$$f_1 = \left[\frac{-b-\sqrt{b^2-4c}}{2}\right]^{1/2} \tag{9}$$

and

$$f_4 = \left[\frac{-b+\sqrt{b^2-4c}}{2}\right]^{1/2} \tag{10}$$

Constants b and c shall be determined from

$$b = \left(\frac{1}{1-D}\right)\left[f_r^2 + \frac{f_L^2 f_H^2}{f_r^2} - D\left(f_L^2 + f_H^2\right)\right] \tag{11}$$

and

$$c = f_L^2 f_H^2 \tag{12}$$

and where D^2, f_r, f_L, and f_H are given in 5.4.6, and $D = +\sqrt{D^2}$

5.4.10 With the cutoff frequency f_A from 5.4.6, the poles in the response at frequencies f_2 and f_3, that are required to implement the additional high-pass filters for the A-weighting characteristic, shall be determined, in hertz, from

$$f_2 = \left(\frac{3-\sqrt{5}}{2}\right) f_A \tag{13}$$

and

$$f_3 = \left(\frac{3+\sqrt{5}}{2}\right) f_A \tag{14}$$

NOTE 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; see 5.4.6.

5.4.11 Approximate values for frequencies f_1 to f_4 in equations (6) and (7) are:

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

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.

5.4.12 If a sound level meter provides one or more optional frequency responses, the instruction manual shall state the design-goal frequency response and the tolerance 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. Tolerance limits shall include the applicable maximum expanded uncertainties of measurement given in annex A for frequency weightings.

5.4.13 For an optional FLAT frequency response, the 0 dB design goal for the response to sound waves shall extend from less than 31,5 Hz to greater than 8 kHz. At each frequency in table 2, tolerance limits around the design goal shall be not greater than those given in table 2 for the appropriate performance class. Separate tolerance limits may be stated for acoustical and electrical input signals. Tolerance limits shall include the applicable maximum expanded uncertainties of measurement given in annex A for frequency weightings.

5.4.14 For a steady sinusoidal electrical signal at 1 kHz, the difference between the indicated level of any C-weighted, Z-weighted, or FLAT-response measurement quantity and the indicated level of the corresponding A-weighted measurement quantity, extended by the expanded uncertainty of measurement, shall not exceed ±0,4 dB. This requirement applies at the reference sound pressure level on the reference level range. It does not apply to indications of peak C sound level.

5.5 Level linearity

5.5.1 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-average sound levels, and sound exposure levels.

5.5.2 Tolerance limits on level linearity errors apply for electrical signals inserted through the applicable device.

5.5.3 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 error shall be the indication of the reference sound pressure level.

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

5.5.5 The level linearity error, extended by the expanded uncertainty of measurement, shall not exceed ±1,1 dB for class 1 and ±1,4 dB for class 2 sound level meters.

5.5.6 Any 1 dB to 10 dB change in the level of the input signal shall cause the same change in the displayed sound level. Deviations from this design goal, extended by the expanded uncertainty of measurement, shall not exceed ±0,6 dB for class 1 and ±0,8 dB for class 2 sound level meters.

5.5.7 The specifications in 5.5.5 and 5.5.6 apply over the total range for any frequency within the frequency range of the sound level meter and for any frequency weighting or frequency response provided.

NOTE 1 In principle, the requirements for level linearity error 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.

NOTE 2 If level linearity error 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. At 16 Hz, the ripple is approximately 0,2 dB.

5.5.8 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-average sound levels or sound exposure levels.

5.5.9 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 limits of the linear operating ranges over which sound levels can be measured without display of under-range or overload. Linear operating ranges shall be stated in the instruction manual for frequencies of 31,5 Hz, 1 kHz, 4 kHz, 8 kHz, and 12,5 kHz for class 1 sound level meters and for frequencies of 31,5 Hz, 1 kHz, 4 kHz, and 8 kHz for class 2 sound level meters.

NOTE The frequencies required for the specification in 5.5.9 were selected to minimize the data to be provided in the instruction manual and the cost of pattern evaluation tests.

5.5.10 For the frequencies specified in 5.5.9, the instruction manual shall state the starting point at which to begin tests of level linearity error on a specified level range.

5.5.11 For a sound level meter that uses a display device with a range less than the linear operating range, a means shall be described in the instruction manual to test level linearity error beyond the limits of the display range.

5.6 Self-generated noise

5.6.1 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 self-generated noise level anticipated for each model of microphone specified for use on the sound level meter.

5.6.2 Levels of self-generated noise shall be stated in the instruction manual as time-weighted sound levels or as time-average sound levels, as applicable.

5.6.3 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.

5.6.4 The sound levels stated in the instruction manual for self-generated noise shall be for reference environmental conditions. Levels of self-generated noise shall be stated for all available frequency weightings.

5.6.5 The instruction manual shall describe procedures for measuring low-level sounds with consideration of the influence of self-generated noise.

5.7 Time weightings F and S

5.7.1 Design-goal time constants are 0,125 s for time-weighting F (Fast) and 1 s for time-weighting S (Slow). Time weightings that are provided shall be described in the instruction manual.

5.7.2 For time-weighted sound levels, the decay time constant is specified from the response to sudden cessation of a steady 4 kHz sinusoidal electrical input signal. Following cessation, the rate of the decrease in the displayed sound level, extended by the expanded uncertainty of measurement, shall be at least 25 dB/s for time-weighting F and between 3,4 dB/s and 5,3 dB/s for time-weighting S. This requirement applies for any level range.

5.7.3 For a steady sinusoidal electrical signal at 1 kHz, the deviation of the indication of both A-weighted sound level with time-weighting S and A-weighted time-average sound level, if available, from the indication of A-weighted sound level with time-weighting F, extended by the expanded uncertainty of measurement, shall not exceed ±0,3 dB. This requirement applies at the reference sound pressure level on the reference level range.

5.8 Toneburst response

5.8.1 The specification for measurement of the sound level for a transient signal is given in terms of 4 kHz tonebursts. Specifications for toneburst response apply for electrical input signals.

5.8.2 For the A and optional C and Z weightings, the reference toneburst response to a single 4 kHz toneburst shall be as given in column 2 of table 3 for maximum F or maximum S sound levels, and in column 3 for sound exposure levels. The deviation of a measured toneburst response from the corresponding reference toneburst response, extended by the expanded uncertainty of measurement, shall be within the applicable tolerance limits over the range of toneburst durations.

5.8.3 The reference toneburst responses and tolerance limits of table 3 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 from a measurement of time-average sound level by use of equation (4). The averaging time T shall be that displayed by the sound level meter and shall include the toneburst.

5.8.4 For a toneburst duration between two consecutive toneburst durations in table 3, the reference toneburst response shall be determined from equation (15) or (16), as applicable. The applicable tolerance limits are those for the shorter toneburst duration where limits are given.

5.8.5 Reference toneburst responses and corresponding tolerance limits apply for any toneburst duration within the ranges specified in table 3 and on the reference level range over a range of steady input signals. 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 limit of the linear operating range down to an input equivalent to a display at 10 dB above the specified lower limit. Toneburst responses shall be within the specified tolerance limits as long as the toneburst response can be observed on the display device and produces an indication at least 10 dB greater than the specified noise level caused by the inherent noise from the microphone and electronic elements within the sound level meter.

5.8.6 There shall be no overload indication during any measurement of toneburst response over the range of signal levels specified in 5.8.5.

Table 3 – Reference 4 kHz toneburst responses and tolerance limits including maximum expanded uncertainty of measurement

Toneburst duration, T_b ms	Reference 4 kHz toneburst response, δ_{ref}, relative to the steady sound level dB		Tolerance limits dB Class	
	$L_{AFmax} - L_A$ $L_{CFmax} - L_C$ and $L_{ZFmax} - L_Z$; Eq. (15)	$L_{AE} - L_A$ $L_{CE} - L_C$ and $L_{ZE} - L_Z$; Eq. (16)	1	2
1 000	0,0	0,0	±0,8	±1,3
500	−0,1	−3,0	±0,8	±1,3
200	−1,0	−7,0	±0,8	±1,3
100	−2,6	−10,0	±1,3	±1,3
50	−4,8	−13,0	±1,3	+1,3; −1,8
20	−8,3	−17,0	±1,3	+1,3; −2,3
10	−11,1	−20,0	±1,3	+1,3; −2,3
5	−14,1	−23,0	±1,3	+1,3; −2,8
2	−18,0	−27,0	+1,3; −1,8	+1,3; −2,8
1	−21,0	−30,0	+1,3; −2,3	+1,3; −3,3
0,5	−24,0	−33,0	+1,3; −2,8	+1,3; −4,3
0,25	−27,0	−36,0	+1,3; −3,3	+1,8; −5,3
	$L_{ASmax} - L_A$ $L_{CSmax} - L_C$ and $L_{ZSmax} - L_Z$; Eq. (15)			
1 000	−2,0		±0,8	±1,3
500	−4,1		±0,8	±1,3
200	−7,4		±0,8	±1,3
100	−10,2		±1,3	±1,3
50	−13,1		±1,3	+1,3; −1,8
20	−17,0		+1,3; −1,8	+1,3; −2,3
10	−20,0		+1,3; −2,3	+1,3; −3,3
5	−23,0		+1,3; −2,8	+1,3; −4,3
2	−27,0		+1,3; −3,3	+1,3; −5,3

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

$$\delta_{ref} = 10 \ \lg\left(1 - e^{-T_b/\tau}\right) \qquad (15)$$

where

T_b is a specified duration of a toneburst in seconds,

τ is a standard exponential time constant specified in 5.7.1, and

e is the base of the natural logarithm.

Equation (15) 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 frequency-weighted sound exposure levels is determined from the following approximation

$$\delta_{ref} = 10 \ \lg\left(T_b / T_0\right) \qquad (16)$$

where

T_b is a specified duration of a toneburst in seconds, and

T_0 = 1 s is the sound-exposure reference duration.

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

5.9 Response to repeated tonebursts

5.9.1 The specification for the response to repeated electrical tonebursts applies for the A weighting and the C and Z weightings, where provided, and for any sequence of 4 kHz tonebursts of equal amplitude and equal duration. The deviation of a time-average sound level from the time-average sound level calculated for the toneburst sequence, extended by the expanded uncertainty of measurement, shall be within the applicable tolerance limits of table 3 for the sound-exposure-level toneburst response. This specification 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 limit of the linear operating range down to an input equivalent to a display at 10 dB above the specified lower limit.

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

$$\delta_{\mathrm{ref}} = 10\ \lg\left(NT_{\mathrm{b}} / T_{\mathrm{m}}\right) \tag{17}$$

where

T_b is a toneburst duration and

T_m is the total measurement duration, both in seconds.

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

5.10 Overload indication

5.10.1 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.

5.10.2 An overload condition shall be displayed before the tolerance limits for steady level linearity or toneburst response are exceeded for sound levels above the upper limit 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.

5.10.3 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, the difference between the input signal levels that first cause an overload indication, extended by the expanded uncertainty of measurement, shall not exceed 1,8 dB.

5.10.4 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.

5.10.5 When time-average 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. These requirements also apply to measurements of maximum time-weighted sound level, peak C sound level, and other quantities calculated during, or displayed after, the measurement interval.

5.11 Under-range indication

5.11.1 If any measurement of time-weighted sound level, time-average sound level, or sound exposure level is less than the specified lower limit of a linear operating range at a given frequency, an under-range condition shall be displayed before the tolerance limits on level linearity error are exceeded. The under-range display shall be presented 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 the under-range indications.

5.11.2 For the more-sensitive level ranges, the under-range display need not be activated if the lower limit for level linearity error is caused by the inherent noise from the microphone and electronic elements within the sound level meter.

5.12 Peak C sound level

5.12.1 Class 1 and class 2 sound level meters may display peak C sound levels. On each level range, the instruction manual shall state the nominal range of peak C sound levels that are measured within the applicable tolerance limits. On at least the reference level range, the extent of the peak level range shall be at least 40 dB for indications of peak C sound levels. Within the specified ranges, peak C sound levels shall be indicated without display of an overload condition.

NOTE Peak Z or peak FLAT sound levels are not the same as peak C sound levels.

5.12.2 Indications of peak C sound levels are specified 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 electrical signals and applied to the specified electrical input facility. Complete cycles and half-cycles shall start and stop on zero crossings.

5.12.3 The deviation of an indication of a peak C sound level (L_{Cpeak}), minus the corresponding indication of the C-weighted sound level of the steady signal (L_C), from the corresponding difference given in table 4, extended by the expanded uncertainty of measurement, shall not exceed the applicable tolerance limits given in table 4.

Table 4 – Peak C sound levels and tolerance limits including maximum expanded uncertainty of measurement

Number of cycles in test signal	Frequency of test signal Hz	$L_{Cpeak} - L_C$ dB	Tolerance limits dB	
			Class	
			1	2
One	31,5	2,5	±2,4	±3,4
One	500	3,5	±1,4	±2,4
One	8 000	3,4	±2,4	±3,4
Positive half cycle	500	2,4	±1,4	±2,4
Negative half cycle	500	2,4	±1,4	±2,4

5.13 Reset

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

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

5.14 Thresholds

If user-selectable thresholds are provided for an integrating-averaging or an integrating sound level meter, their performance and method of operation shall be stated in the instruction manual for measurements of time-average sound levels or sound exposure levels.

5.15 Display

5.15.1 For sound level meters that can display more than one measurement quantity, a means shall be provided to indicate the quantity that is being displayed.

5.15.2 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 appropriate. The indication may be by means of a suitable letter symbol or abbreviation. Examples of appropriate letter symbols are given with the definitions, equations, and tables in this standard.

5.15.3 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 the display range of at least 60 dB.

NOTE Sound level meters with an analogue display device may implement the 60 dB display range in two portions.

5.15.4 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 explained in the instruction manual.

5.15.5 If a digital indicator is provided, the instruction manual shall state the display update rate and the conditions after initiating a measurement when the first indication is displayed.

5.15.6 For integrating-averaging and integrating sound level meters, the instruction manual shall state the time interval after completion of integration before a reading is displayed.

5.15.7 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.

5.15.8 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 conformance to the performance specifications in this clause and the applicable environmental specifications of clause 6.

5.16 Analogue or digital output

5.16.1 If an analogue or digital output is provided, the characteristics of the output signals shall be described in the instruction manual. The characteristics shall include the frequency weighting, the range of output signals, the internal electrical impedance at the output, and the recommended range of load impedances.

5.16.2 Connecting a passive impedance without stored electrical energy, including a short circuit, to an analogue output shall not affect any measurement in progress by more than 0,2 dB.

5.16.3 If an analogue or digital output is not provided for general applications, an output shall be provided for testing the characteristics of a class 1 sound level meter and may be provided for a class 2 sound level meter. Changes in the levels of the signal at the analogue or digital output in response to changes in the sound pressure at the microphone, or to changes in the electrical input signal, shall be identical, to a tenth of a decibel, to changes in the signal levels indicated on the display devices.

5.17 Timing facilities

5.17.1 A class 1 sound level meter that indicates time-average 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 pre-set an integration time interval may also be provided. Time of day may also be displayed. If applicable, the instruction manual shall describe the procedure to pre-set an integration time interval and to set the time of day.

NOTE 1 Recommended pre-set integration time intervals are 10 s, 1 min, 5 min, 10 min, 30 min, 1 h, 8 h, and 24 h.

NOTE 2 If the sound level meter can display the time of day, the nominal drift in the displayed time over a 24 h period should be stated in the instruction manual.

5.17.2 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-average sound levels and sound exposure levels, respectively.

5.18 Radio frequency emissions and disturbances to a public power supply

5.18.1 If the sound level meter allows the connection of interface or interconnection cables, the instruction manual shall state the lengths and types (for example, shielded or unshielded) of typical cables and the characteristics of all devices to which the cables are expected to be attached.

5.18.2 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 field strength 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 highest radio frequency emissions.

5.18.3 For group Y and group Z sound level meters, the maximum disturbance conducted to the public supply of electric power shall be within the quasi-peak and average voltage-level limits given in table 5 at an a.c. power port. If the sound level meter conforms to the limit on the average voltage of conducted disturbances when using a quasi-peak measuring device, the sound level meter shall be deemed to conform to the quasi-peak and average voltage limits.

Table 5 – Limits for conducted disturbance to the voltage of a public supply of electric power including maximum expanded uncertainty of measurement

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

NOTE 1 See 4.1.2 of CISPR 16-1:1999 for the characteristics of quasi-peak-measuring receivers.

NOTE 2 Lower limits for voltage levels apply at the transition frequencies.

NOTE 3 Voltage level limits decrease linearly with the logarithm of the frequency in the range from 0,15 MHz to 0,50 MHz.

5.19 Crosstalk

5.19.1 Crosstalk, or leakage of signals between pairs of channels, is a concern for multi-channel sound level meters.

5.19.2 At any frequency within the range of a class 1 or class 2 multi-channel sound level meter system, the difference between the level indicated on the display device, in response to a steady electrical signal applied to the electrical input facility of one channel and adjusted to indicate the upper limit of the applicable linear operating range, and the signal level indicated for any other channel shall be at least 70 dB. Termination devices, as stated in the instruction manual, shall be installed in place of the microphones on the other inputs.

5.20 Power supply

5.20.1 An indication shall be provided to confirm that the power supply is sufficient to operate the sound level meter within the specifications of this standard.

5.20.2 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 change in the displayed sound level, extended by the expanded uncertainty of measurement, shall not exceed ±0,3 dB for class 1 sound level meters and ±0,4 dB for class 2 sound level meters when the supply voltage is reduced from the maximum to the minimum.

5.20.3 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. The instruction manual shall also 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.

5.20.4 For battery-powered sound level meters 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.

5.20.5 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 tolerance limits.

6 Environmental, electrostatic, and radio frequency criteria

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 of 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 125 Hz to 1 250 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 tested for conformance with these specifications.

6.2 Static pressure

6.2.1 Over the range of static pressure from 85 kPa to 108 kPa, the deviation of the displayed sound level from the sound level displayed at the reference static pressure, extended by the expanded uncertainty of measurement, shall not exceed ±0,7 dB for class 1 sound level meters or ±1,0 dB for class 2 sound level meters.

6.2.2 Over the range of static pressure from 65 kPa to less than 85 kPa, the deviation of the displayed sound level from the sound level displayed at the reference static pressure, extended by the expanded uncertainty of measurement, shall not exceed ±1,2 dB for class 1 sound level meters or ±1,9 dB for class 2 sound level meters.

NOTE The frequency response of the microphone may 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. The instruction manual should provide guidance and procedures to use the sound level meter at locations or under conditions where the static pressure is less than 85 kPa.

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 The deviation of the sound level displayed at any temperature from the sound level displayed at the reference air temperature, extended by the expanded uncertainty of measurement, shall not exceed ±0,8 dB for class 1 sound level meters or ±1,3 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 The level linearity error at 1 kHz over the stated linear operating range on the reference level range shall remain within the tolerance limits given in 5.5. 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

The deviation of the sound level displayed at any relative humidity from the sound level displayed at the reference relative humidity, extended by the expanded uncertainty of measurement, shall not exceed ±0,8 dB for class 1 sound level meters or ±1,3 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 AC 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 greatest susceptibility (least immunity) to a.c. power frequency and radio frequency fields.

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

6.6.3 The specification for exposure to a.c. power frequencies applies to the orientation of the sound level meter that is stated in the instruction manual to have greatest susceptibility (least immunity) to a.c. power frequency fields.

6.6.4 The specification for susceptibility to radio frequency fields shall apply for exposure 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.

NOTE A sound level meter may conform to the specifications of this standard at unmodulated root-mean-square electric field strengths greater than 10 V/m. If so, the applicable field strengths should be stated in the instruction manual.

6.6.5 Immunity of a sound level meter 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-average sound level. The sound level shall be displayed on the level range for which the lower limit is closest to, but not greater than, 70 dB, if more than one level range is provided.

NOTE If the sound level meter only displays sound exposure level, the equivalent time-average sound level should be calculated by means of equation (5b).

6.6.6 The deviation of a displayed sound level from the sound level displayed in the absence of an a.c. power frequency or radio frequency field, extended by the expanded uncertainty of measurement, shall not exceed ±1,3 dB for class 1 sound level meters or ±2,3 dB for class 2 sound level meters.

6.6.7 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 80 % amplitude modulated by a 1 kHz sinusoidal signal. 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 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 61000-6-2:1999. The additional specification given in table 4 of IEC 61000-6-2:1999 also applies for immunity to voltage dips, voltage interruptions, and voltage surges.

6.6.8 For group Z sound level meters with signal or control ports, the requirements of table 2 in IEC 61000-6-2:1999 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 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 61000-6-2:1999.

6.6.9 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, the sound level meter shall conform within the applicable tolerance 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 1 dB, shall apply to all modes of operation of the 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 microphone preamplifier or between the microphone 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 average effect of optional accessories supplied by the manufacturer of the sound level meter shall be stated in the instruction manual. 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. Data shall be provided for the typical effect, in the absence of wind, of any recommended windscreen 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 the specifications for the original performance class when an optional accessory is installed, the instruction manual shall state whether the sound level meter conforms to the specifications for another class or that it no longer conforms to the requirements for either class 1 or class 2.

7.4 If internal or external bandpass filters are provided for the 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 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 the effects, if any, of such devices on the 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 reference number and year of publication of this standard. The marking shall indicate the name or mark of the supplier responsible for the technical specifications applicable to the complete sound level meter. In addition, the marking shall include the model designation, serial number, and performance class of the complete sound level meter in accordance with the specifications of this standard.

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.

8.3 Suitable seals or marks shall be used to protect those components of a sound level meter that are accessible to a user and which might affect the electroacoustical performance.

9 Instruction manual

9.1 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 of this clause.

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 document in one or more parts.

9.2 The instruction manual shall contain the following operational information as appropriate 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 susceptibility 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 and class 2.

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 appropriate. 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 a microphone extension device or cable that may be needed for a particular sound level meter to conform to the specifications of this standard for the 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 in a free field or with random incidence, as appropriate.

d) If a microphone 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.

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-average sound level, and sound exposure level, separately or in combinations, along with explanations of all abbreviations and letter symbols that are displayed.

b) Optionally, detailed tabular descriptions, as functions of sound incidence angle and frequency, of the relative free-field response to sinusoidal plane waves for the sound level meter in the configuration for the normal mode of operation.

c) A description of the frequency weightings that conform to the specifications of this standard, and the optional Z-weighting and FLAT frequency response, if included.

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

e) Identification of the level ranges by the nominal A-weighted sound levels 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 level that can be measured at 1 kHz within applicable tolerance limits.

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

j) A unique identification of all computer program software that is needed to operate the sound level meter and the procedure for its installation and use.

k) Information about the design-goal characteristics and the tolerance 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 within 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 voltage and frequency of the supply and the acceptable tolerance limits around the nominal values.

9.2.4 Adjustments to indicated levels

a) Identifioation of the model(s) of sound calibrator(s) that may be used to check and maintain the correct indication of the sound level meter.

b) The calibration check frequency.

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

d) At environmental conditions close to reference environmental conditions and at the frequencies and under the test conditions specified in 5.2.4 and 5.2.5, for microphones of all models that are stated to be for use on the sound level meter, the combination of corrections for deviations of the average free-field microphone frequency response from a uniform frequency response and for the average effects of reflections from the case of the instrument and diffraction around the microphone. The information shall also include the corrections for the average effects of a windscreen, if a windscreen is an integral part of the configuration of the sound level meter for the normal mode of operation or if the sound level meter is stated to conform to the specifications of this standard with a windscreen around the microphone.

NOTE The information may be given as separate data for the average free-field microphone frequency response and the average effects of reflections, diffraction, and windscreen.

9.2.5 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) Recommendations for selecting the optimum level range for measurements of sound level or sound exposure level.

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

e) 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.

f) For integrating-averaging and integrating sound level meters, the time interval after completion of a measurement before a reading is displayed.

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

h) The minimum and maximum integration times for measurement of time-average sound levels and sound exposure levels.

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

j) The operation of the reset facility for measurements of time-average sound level, sound exposure level, maximum time-weighted sound level, and the optional peak C 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.

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

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

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

n) 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.

o) For the more-sensitive level ranges and for each available frequency weighting and frequency response, and for reference environmental conditions, the time-weighted and time-average sound levels, as appropriate, corresponding to the highest level of self-generated noise. The self-generated noise shall be that anticipated from the combination of a microphone of any specified model and the other components of the sound level meter. The averaging time for time-average sound level shall be stated and shall be at least 30 s.

p) 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.

9.2.6 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. 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 microphone 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.

9.2.7 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-average 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 include a specification for the frequency of the a.c. power field.

9.3 The instruction manual shall contain the following information for testing, as appropriate to a sound level meter.

a) The reference sound pressure level.

b) The reference level range.

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

d) For the A-weighted sound levels displayed in response to the sound pressure produced by a calibrated multi-frequency sound calibrator, or in response to simulation of sound pressure by an electrostatic actuator, adjustment data to obtain A-weighted sound levels equivalent to the response to plane sinusoidal sound waves incident from the reference direction and at least at the frequencies required for periodic testing. The model of sound calibrator or electrostatic actuator, for which the adjustment data are valid, shall be identified.

e) Tables of the nominal A-weighted sound levels at the upper and lower limits of the linear operating ranges on each level range. Sound levels shall be tabulated at frequencies of 31,5 Hz, 1 kHz, 4 kHz, 8 kHz, and 12,5 kHz for class 1 sound level meters and at frequencies of 31,5 Hz, 1 kHz, 4 kHz, and 8 kHz for class 2 sound level meters.

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

g) For each specified model of microphone, a description of the electrical design goal, and applicable tolerance limits, for the input device, or the means, to insert electrical signals into the electrical input facility.

h) For each model of microphone for which the sound level meter is stated to conform to the specifications, the time-weighted and time-average sound levels, as appropriate, corresponding to the highest anticipated self-generated noise produced when the sound level meter is placed in a low-level sound field and when a specified electrical input device, or the specified means, is installed in place of the microphone and terminated in a specified manner. The sound levels shall be stated for the more-sensitive level ranges and for each available frequency weighting and frequency response.

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

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

k) For sound level meters that have a display device with an extent less than the linear operating range on any level range, the recommended means to test level linearity error beyond the limits of the display range.

l) The typical time interval needed to stabilize after changes in environmental conditions.

m) If applicable, the unmodulated root-mean-square electric field strength greater than 10 V/m 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 greatest susceptibility (least immunity) 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 a field.

Annex A
(normative)

Maximum expanded uncertainties of measurement

A.1 Tolerance limits for electroacoustical performance characteristics in this standard include allowances for the expanded uncertainties of measurement. This annex gives the maximum values of expanded uncertainties permitted for tests to demonstrate conformance of a sound level meter to the specifications of this standard.

A.2 The tolerance limits in this standard include the associated expanded uncertainties of measurement calculated for a coverage factor of 2 corresponding to a level of confidence of approximately 95 %, in accordance with the guidelines given in the *Guide to the expression of uncertainty in measurement*. The maximum expanded uncertainties of measurement for the relevant specifications are given in table A.1. Manufacturers of sound level meters may calculate the tolerance limits available for design and manufacturing by subtracting the maximum permitted expanded uncertainties of measurement from the appropriate tolerance limits given in this Part 1 of IEC 61672.

Table A.1 – Maximum expanded uncertainties of measurement

Requirement	Subclause or table	Maximum expanded uncertainty of measurement dB
Directional response	table 1; 250 Hz to 1 kHz	0,3
Directional response	table 1; >1 kHz to 4 kHz	0,5
Directional response	table 1; >4 kHz to 8 kHz	1,0
Directional response	table 1; >8 kHz to 12,5 kHz	1,5
Frequency weightings A, C, Z, FLAT	table 2, 5.4.13; 10 Hz to 200 Hz	0,5
Frequency weightings A, C, Z, FLAT	table 2, 5.4.13; >200 Hz to 1,25 kHz	0,4
Frequency weightings A, C, Z, FLAT	table 2, 5.4.13; >1,25 kHz to 10 kHz	0,6
Frequency weightings A, C, Z, FLAT	table 2, 5.4.13; >10 kHz to 20 kHz	1,0
A vs C, Z, or FLAT at 1 kHz	5.4.14	0,2
Level linearity error	5.5.5	0,3
1 dB to 10 dB change in level	5.5.6	0,3
F and S decay rates	5.7.2	2 dB/s for F; 0,4 dB/s for S
F vs S level at 1 kHz	5.7.3	0,2
Toneburst response	5.8.2, table 3	0,3
Repeated tonebursts	5.9.1, table 3	0,3
Overload indication	5.10.3	0,3
Peak C sound levels	5.12.3, table 4	0,4
Electrical output	5.16.2	0,1
Power supply voltage	5.20.2	0,2
Static pressure influence	6.2.1; 6.2.2	0,3
Air temperature influence	6.3.3	0,3
Humidity influence	6.4	0,3
AC and radio frequency fields	6.6.6	0,3

Annex B
(informative)

AU weighting

B.1 The AU weighting, specified in [1] in the Bibliography, is intended for applications where it is desired to measure the audible component of a sound in the presence of ultrasound. The relative response and tolerance limits of the AU weighting are specified for frequencies at nominal one-third-octave intervals from 10 Hz to 40 kHz.

B.2 When a sound level meter is equipped with the AU weighting, the result of a measurement is designated an AU-weighted sound level.

B.3 The design goals for the AU weighting and the associated tolerance limits are consistent with the design goals and tolerance limits given in table 2 of this standard for A weighting over the frequency range from 10 Hz to 20 kHz. A measurement of a sound level with AU weighting is also a measurement of a sound level with A weighting.

B.4 If AU-weighted sound level is to be measured, the sound level meter should conform within the tolerance limits to the applicable specifications of this standard as well as the specifications in [1] for the AU weighting. A different microphone may be needed from the microphone required for the sound level meter to conform just to the specifications of this standard.

Annex C
(informative)

Specifications for time-weighting I (impulse)

C.1 Introduction

C.1.1 Various investigations[3] have concluded that time-weighting I is not suitable for rating impulsive sounds with respect to their loudness. Time-weighting I is also not suitable for assessing the risk of hearing impairment, nor for determining the 'impulsiveness' of a sound. Because of the possibility of obtaining misleading results, time-weighting I is not recommended for the purposes described above.

C.1.2 Nevertheless, time-weighting I is referenced in some documents and hence, for historical reasons, time-weighting I is included in this informative annex. Recommendations given here are from IEC 60651 [3], except that the frequency of the electrical toneburst signals is 4 kHz for consistency with this standard instead of 2 kHz as in IEC 60651.

C.1.3 For this annex, the tolerance limits allowed for design and manufacturing were extended by the maximum permitted expanded uncertainties of measurement of 0,3 dB. Actual expanded uncertainties should be calculated by the testing laboratory for a level of confidence of 95 %, using the necessary coverage factor.

NOTE Generally a coverage factor of 2 approximates to a level of confidence of 95 %, unless the contributions are such that it is necessary to use a different coverage factor to maintain the 95 % level of confidence.

C.1.4 For the optional I time weighting, testing laboratories should not perform tests to demonstrate conformance to the recommendations of this annex if their actual expanded uncertainties of measurement exceed 0,3 dB.

C.1.5 Conformance to the recommendations of this annex is demonstrated when the measured deviations from the design goals, extended by the actual expanded uncertainties of measurement of the testing laboratory, lie fully within the specified tolerance limits. Uncertainties of measurement should be determined in accordance with the *Guide to the expression of uncertainty in measurement.*

C.2 General requirements for time-weighting I

C.2.1 Specifications for time weighting I are similar to those for time-weightings F and S except that the time constant is different and a special signal detector is introduced after the signal is squared and time weighted. For time weighting I, the design goal of 35 ms for the time constant is the same for signals that increase or decrease with time. The detector acts to store the signal fed to it for a sufficient time to allow the I-time-weighted signal to be displayed.

---

[3] For example by ISO Technical Committee 43 (Subcommittee 1, Study Group B).

C.2.2 The onset time constant of the special signal detector is small compared with the 35 ms time constant. The design-goal decay rate of the detector is 2,9 dB/s with tolerance limits of ±0,8 dB/s and ±1,3 dB/s for class 1 and class 2 sound level meters, respectively. The design-goal decay rate and the tolerance limits for design and manufacture correspond approximately to a decay time constant of 1 500 ms ± 250 ms and 1 500 ms ± 500 ms for class 1 and class 2 sound level meters, respectively.

C.2.3 Sound level meters with time-weighting I should respond to single sinusoidal tonebursts and to sequences of sinusoidal tonebursts in accordance with the tests given in C.3.

C.2.4 For steady sinusoidal electrical input signals with frequencies from 315 Hz to 8 kHz, sound levels measured with time-weightings F and I should be the same within 0,4 dB. For a single short toneburst, the sound level displayed with time-weighting I generally is greater than the sound level displayed with time-weightings F or S.

C.3 Tests of I-time-weighted sound level

C.3.1 For single 4 kHz sinusoidal electrical tonebursts of specified durations, table C.1 gives the corresponding design goals for the highest A-frequency-weighted, I-time-weighted sound level relative to the A-weighted sound level displayed for the steady signal. Measured deviations from the design goals, extended by the actual expanded uncertainties of measurement, should be within the applicable tolerance limits. Tonebursts should be extracted from the steady 4 kHz input signal that produces a display of the A-frequency-weighted sound level stated in the instruction manual for the upper limit of the reference level range.

Table C.1 – Design goals for the relative response of A-frequency-weighted, I-time-weighted sound level to single 4 kHz tonebursts, with tolerance limits

Toneburst duration T_b ms	Highest response to a toneburst minus the response to a steady signal[a] dB	Tolerance limits, dB Class 1	Tolerance limits, dB Class 2
20	−3,6	±1,8	±2,3
5	−8,8	±2,3	±3,3
2	−12,6	±2,3	...

[a] Calculated from $10 \lg(1 - e^{-T_b/\tau})$,
where
T_b is the specified toneburst duration in seconds; and
τ is the 0,035 s time constant for time-weighting I.

C.3.2 For class 1 sound level meters, when the level of a 2 ms, 4 kHz toneburst is changed by 10 dB, the display of the A-frequency-weighted, I-time-weighted sound level should change by 10 dB ± 1,3 dB. For class 2 sound level meters, when the level of a 5 ms, 4 kHz toneburst is changed by 5 dB, the display of the A-frequency-weighted, I-time-weighted sound level should change by 5 dB ± 1,3 dB.

C.3.3 For sequences of 5 ms, 4 kHz sinusoidal electrical tonebursts at the repetition frequencies given in table C.2, table C.2 gives the corresponding design goals for the highest A-frequency-weighted, I-time-weighted sound level relative to the A-weighted sound level displayed for the steady signal. Measured deviations from the design goals, extended by the actual expanded uncertainty of measurement, should be within the applicable tolerance limits. Tonebursts should be extracted from a steady 4 kHz input signal that produces a display of the A-frequency-weighted sound level stated in the instruction manual for the upper limit of the reference level range.

Table C.2 – Design goals for the relative response of A-frequency-weighted, I-time-weighted sound level to sequences of 5 ms, 4 kHz tonebursts, with tolerance limits

Repetition frequency Hz	Highest response to a sequence of tonebursts minus the response to a steady signal dB	Tolerance limits dB Class 1	Tolerance limits dB Class 2
100	−2,7	±1,3	±1,3
20	−7,6	±2,3	±2,3
2	−8,8	±2,3	±3,3

C.3.4 For the sequence of tonebursts at a repetition frequency of 2 Hz, when the signal level is increased by 5 dB, the display of A-frequency-weighted, I-time-weighted sound level should increase by 5 dB ± 1,3 dB.

C.3.5 The decay rate for the special signal detector associated with time-weighting I should be tested by suddenly turning off a steady 4 kHz sinusoidal electrical signal and observing that the decay of A-frequency-weighted, I-time-weighted sound level is within the applicable tolerance limits given in C.2.2. The steady signal should be adjusted to initially display the A-weighted sound level stated in the instruction manual for the upper limit of the reference level range.

C.3.6 A sound level meter should conform to the recommendations of C.3.1 and C.3.3 at 10 dB intervals from the A-weighted sound level stated in the instruction manual for the upper limit of the reference level range down to the lowest signal level that can be displayed.

(*Continued from second cover*)

The concerned Technical Committee responsible for the preparation of this standard has reviewed the provisions of the following International Standards and has decided that these are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO Publication-ISBN 92-67-01075-1	International vocabulary of basic and general terms in metrology
ISO/IEC Guide Expres : 1995	Guide to the expression of uncertainty in measurement
IEC 60050 (801) (1994)	International Electrotechnical Vocabulary — Chapter 801 : Acoustics and electroacoustics
CISPR-16-1 : 1999	Specification for radio disturbance and immunity measuring apparatus and methods — Part 1 : Radio disturbance and Immunity measuring apparatus

Only the English language text in the International Standard has been retained while adopting it in this standard.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc: No. LTD 5 (2023).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *website* : www.bis.org.in

Regional Offices:		Telephones
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	260 3843 260 9285
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	2832 9295, 2832 7858 2832 7891, 2832 7892

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. NALAGARH. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at Simco Printing Press, Delhi