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Electroacoustics—Sound level meters—Part 1: Specifications

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from Institute of Noise Control Engineering Japan (INCE/J)/Japanese Standards Association (JSA), with a draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Consequently JIS C1502 : 1990 and JIS C1505 : 1988 are withdrawn and replaced with this Standard and JIS C1509-2.

This Standard has been made based on IEC 61672-1 : 2002 *Electroacoustics—Sound level meters—Part 1: Specifications* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

At the time of publication of this Standard, JIS C 1509 series was scheduled to consist at least of the following 3 parts under the general title “*Electroacoustics—Sound level meters*”:

Part 1: Specifications

Part 2: Pattern evaluation tests

Part 3: Periodic tests

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the original JIS is to be the final authority.

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Electroacoustics—Sound level meters

—Part 1: Specifications

Introduction This Japanese Industrial Standard has been prepared based on the first edition of IEC 61672-1 *Electroacoustics—Sound level meters—Part 1: Specifications* published in 2002 without modifying the technical contents of the original International Standard.

The portions given dotted underlines are the matters not stated in the original International Standard.

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.

Information 1 In this Standard, the term “sound level” is used for the frequency-weighted sound pressure level, and when the frequency-weighted characteristic is specified, it is used with the characteristic attached before the term.

2 In this Standard, only when the distinction among the three kinds of sound level meters mentioned above is needed, a sound level meters is called with the word “time-weighted”, “integrating-averaging”, or “integrating” added to it. When the distinction is not needed, it is called simply “sound level meter”.

3 A sound level meter is also called a noise meter.

4 A-weighted sound level is also called noise level.

5 A-weighted time-average sound level is also called equivalent continuous noise level.

6 A-weighted sound exposure level is also called noise exposure level.

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. See annex B.

Information : Numbers in square brackets refer to the bibliography

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.

1.6 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.

Remarks : The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT(identical), MOD(modified), and NEQ(not equivalent) according to ISO/IEC Guide 21.

IEC 61672-1 : 2002 *Electroacoustics—Sound level meters—Part 1: Specifications* (IDT)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. If the indication of the year of coming into effect/publication is given to these referred standards, only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter do not apply. The normative references without the indication of the year of coming into effect/publication apply only to the most recent editions (including amendments).

JIS C 1515 *Electroacoustics—Sound calibrators*

Remarks : IEC 60942 *Electroacoustics—Sound calibrators* is identical with the said standard.

JIS C 61000-4-2 *Electromagnetic compatibility (EMC)—Part 4: Testing and measurement techniques—Section 2: Electrostatic discharge immunity test*

Remarks : IEC 61000-4-2 *Electromagnetic compatibility (EMC)—Part 4-2: Testing and measurement techniques—Electrostatic discharge immunity test* is identical with the said standard.

JIS C 61000-6-2 : 2003 *Electromagnetic compatibility (EMC)—Part 6: Generic standards—Section 2: Immunity for industrial environments*

Remarks : IEC 61000-6-2 *Electromagnetic compatibility (EMC)—Part 6-2: Generic standards—Immunity for industrial environments* is equivalent to the said standard.

JIS Z 8106 *International electrotechnical vocabulary Chapter 801: Acoustics and electroacoustics*

Remarks : IEC 60050(801) *International Electrotechnical Vocabulary (IEV)—Chapter 801: Acoustics and electroacoustics* is identical with the said standard.

CISPR 16-1:1999 *Specification for radio disturbance and immunity measuring apparatus and methods—Part 1: Radio disturbance and immunity measuring apparatus*

Information : In English, CISPR stands for International Special Committee on Radio Interference.

ISO/IEC GUIDE EXPRESS : 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 Definitions For the purpose of this Standard, the definitions given in JIS Z 8106, JIS C 61000-6-2, ISO/IEC GUIDE EXPRESS, ISO Publication and the following definitions 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 .

Information : In this Standard, the level of sound pressure which is filed quantity is defined using the expression of 20 times the common logarithm according to the original International Standard, IEC 60027-3 *Letter symbols to be used in electrical technology, Part 3: Logarithmic quantities and units*. On the other hand, in many Japanese Industrial Standards in which the sound measurement method, etc. are specified based on ISO, it is defined as "10 times the common logarithm of ratio of the square of effective value of sound pressure to the square of reference sound pressure".

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

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

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.

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

$$L_{A\tau}(t) = 20 \log_{10} \left\{ \left(\frac{1}{\tau} \right) \int_{-\infty}^t p_A^2(\xi) e^{-(t-\xi)/\tau} d\xi \right\}^{1/2} / p_0 \dots\dots\dots (1)$$

where

τ : the exponential time constant for time weighting F or S (s)

ξ : 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

$p_A(\xi)$: the A-weighted instantaneous sound pressure

p_0 : 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 .

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

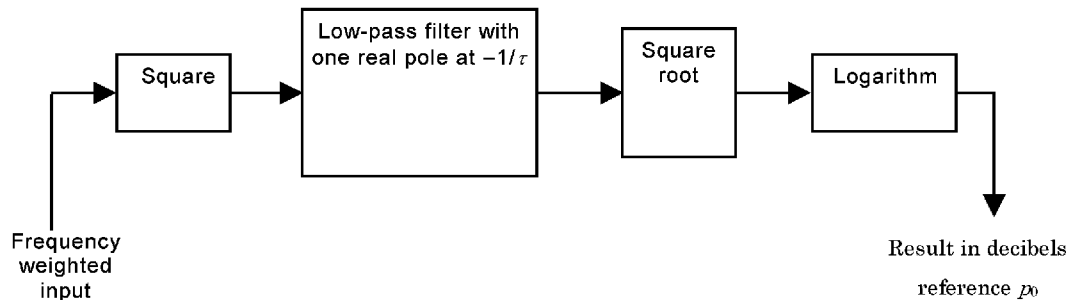


Figure 1 Principal steps involved in forming an exponential-time-weighted sound level

Information 1 In this Standard, only when the distinction between time-weighted sound level and time-average sound level is needed, sound level is called with the word “time-weighted”, “time-average” added to it. When the distinction is not needed, it is called simply “sound level”.

2 A- or C-weighted sound level is also called A- or C-weighted sound pressure level, respectively. Generally, “noise level” is called A-weighted sound level.

3 In this Standard, although sound level is defined using the expression of 20 times common logarithm according to the original International Standard, as is the case with sound pressure (3.2), generally it is often expressed in the form of 10 times the common logarithm. In that case, the formula (1) is expressed as follows:

$$L_{A\tau}(t) = 10 \log_{10} \left\{ \left[\frac{1}{\tau} \int_{-\infty}^t P_A(\xi) e^{-(t-\xi)/\tau} d\xi \right] / p_0^2 \right\} \dots\dots\dots (1')$$

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

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

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

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

- 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

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

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

$$L_{AT} = L_{AeqT} = 20 \log_{10} \left\{ \left[(1/T) \int_{t-T}^t p_A^2(\xi) d\xi \right]^{1/2} / p_0 \right\} \dots\dots\dots (2)$$

where

ξ : a dummy variable of time integration over the averaging time interval ending at the time of observation t

T : the averaging time interval

$p_A(\xi)$: the A-weighted instantaneous sound pressure

p_0 : 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 .

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

Information 1 Generally, “equivalent continuous noise level” is also called A-weighted time-average sound level.

- 2 In this Standard, although equivalent continuous noise level is defined using the expression of 20 times the common logarithm according to the original International Standard, as is the case with sound pressure (3.2), generally it is often expressed in the form of 10 times the common logarithm. In that case, the formula (2) is expressed as follows:

$$L_{AT} = L_{AeqT} = 10 \log_{10} \left\{ (1/T) \int_{t-T}^t p_A^2(\xi) d\xi / p_0^2 \right\} \dots\dots\dots (2')$$

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

NOTES 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.

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

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

where $p(t)$ 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 (Pa^2s) if A-weighted sound pressure is in pascals and running time is in seconds.

- 3 Sound exposure in pascal-squared hours (Pa^2h) 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

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

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

$$\begin{aligned} L_{AE} &= 10 \log_{10} \left\{ \left[\int_{t_1}^{t_2} p_A^2(\xi) d\xi \right] / p_0^2 \right\} = 10 \log_{10} (E_A / E_0) \\ &= L_{AT} + 10 \log_{10} (T / T_0) \dots\dots (4) \end{aligned}$$

where

E_A : the A-weighted sound exposure in pascal-squared seconds [see equation (3)]

E_0 : 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; reference time interval

T : $t_2 - t_1$ is the time interval for measurement, in seconds, for sound exposure level and time-average sound level

- 3 Time-average, A-weighted sound level (equivalent continuous 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

$$E_A = (p_0^2 T)(10^{0.1 L_{AT}}) \dots\dots\dots (5a)$$

or

$$L_{AT} = 10 \log_{10}[E_A / (p_0^2 T)] = L_{AE} - 10 \log_{10}(T/T_0) \dots\dots\dots (5b)$$

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.

Information : An a.c. d.c or digital output alone is not a display device (see NOTE of 5.1.11).

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] (the texts of JIS C 1502 and JIS C 1505 correspond to this International Standard) and in IEC 60804 [4] (the annexes of JIS C 1502 and JIS C 1505 correspond to this International Standard) 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 JIS C 1515. For class 2 sound level meters, the sound calibrator shall