
AMERICAN NATIONAL STANDARD

Specifications and Verification Procedures for Sound Calibrators

ANSI S1.40-2006

Accredited Standards Committee S1, Acoustics

Standards Secretariat
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Secretariat

Acoustical Society of America

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American National Standards Institute, Inc.

Abstract

This Standard specifies performance requirements for coupler-type sound calibrators. It replaces ANSI S1.40-1984 American National Standard Specifications for Acoustical Calibrators, and is technically equivalent (except for the absence of requirements for radio-frequency emissions) to International Standard IEC 60942:2003, *Electroacoustics—Sound calibrators*. The standard specifies performance requirements for the sound pressure level, frequency, and total distortion generated by a sound calibrator. It also provides requirements for the influence of environmental conditions, for electromagnetic compatibility, and for instrument marking and documentation. The standard gives details of the tests necessary to verify that a model of sound calibrator conforms to all the requirements, as well as details of the method for periodic testing of a sound calibrator. The tests require the determination of the actual uncertainties of measurement which are to not exceed the maximum uncertainties allowed for laboratory measurements.

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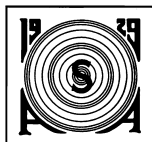
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Foreword

[This Foreword is for information only, and is not an integral part of the American National Standard ANSI S1.40—2006 American National Standard Specifications and Verification Procedures for Sound Calibrators.]

This Standard comprises a part of a group of definitions, standards, and specifications for use in acoustics. It was developed and approved by Accredited Standards Committee S1 Acoustics, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S1 is as follows:

Standards, specifications, methods of measurement and test, and terminology in the field of physical acoustics, including architectural acoustics, electroacoustics, sonics and ultrasonics, and underwater sound, but excluding those aspects which pertain to biological safety, tolerances, and comfort.

This Standard replaces ANSI S1.40-1984 (R2001), American National Standard Specifications for Acoustical Calibrators.

This Standard is technically equivalent (except for the absence of requirements regarding radio-frequency emissions from calibrators) to International Standard IEC 60942:2003, Electroacoustics – Sound calibrators.

This Standard includes two normative annexes that are considered to be integral parts of this Standard.

At the time this Standard was submitted to Accredited Standards Committee S1, Acoustics for approval, the membership was as follows:

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Suggestions for improvements of this Standard will be welcomed. They should be sent to Accredited Standards Committee S1, Acoustics, in care of the Standards Secretariat of the Acoustical Society of America, 35 Pinelawn Road, Suite 114E, Melville, New York 11747-3177. Telephone: 631-390-0215; FAX: 631-390-0217; E-mail: asastds@aip.org

American National Standard

Specifications and Verification Procedures for Sound Calibrators

1 Scope

Sound calibrators generate known sound pressure levels at one or more frequencies in a coupler into which a specified model of microphone is inserted in a specified configuration.

NOTE An example of a specified configuration may be with or without a grid.

This Standard specifies performance requirements and verification procedures for three classes of coupler-type sound calibrators:

- Class LS: Laboratory Standard calibrator with the smallest tolerance limits.
- Class 1: Sound calibrators that are generally intended for field use with class 1 sound level meters and similar instruments.
- Class 2: Sound calibrators that are generally intended for field use with class 2 sound level meters, dosimeters, and similar instruments.

For class LS calibrators, the Standard requires the use of a laboratory standard microphone as specified in ANSI S1.15-1997/Part 1. For class 1 and class 2 calibrators, the Standard requires the use of a working standard microphone as specified in IEC 61094-4:1995.

Tolerance limits in this Standard include maximum permitted expanded uncertainties of measurement as well as the tolerance limits allowed for design and manufacturing.

This Standard applies to sound calibrators that are used to check or adjust the sensitivity of sound measuring instruments and systems including conventional, integrating-averaging and integrating sound level meters, and personal noise dosimeters.

This Standard does not include requirements for the Instruction Manual to provide data for use in adjusting a sound level indicated by a sound level meter, or equivalent instrument, in response to application of a sound calibrator to the equivalent free-field or random-incidence sound level.

Sound calibrators may provide two or more sound pressure levels and operate at two or more frequencies. These multiple-level / multiple-frequency calibrators have a single class designation for all combinations of levels and frequencies for which the Instruction Manual states conformance to the requirements of this Standard.

Additional useful functions such as tonebursts may be provided. Requirements for these additional functions are not included in this Standard.

2 Normative references

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

ANSI S1.1-1994 (R 2004), American National Standard Acoustical Terminology.

ANSI S1.6-1984 (R 2006), American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements.

ANSI S1.15-1997/Part 1 (R 2006), American National Standard Measurement Microphones – Part 1: Specifications for Laboratory Standard Microphones

ANSI S1.15-2005/Part 2, American National Standard Measurement Microphones – Part 2: Primary Method for Pressure Calibration of Laboratory Standard Microphones by the Reciprocity Technique.

IEC 61094-4:1995, Measurement microphones - Part 4: Specifications for working standard microphones

IEC 61094-5:2001, Measurement microphones - Part 5: Methods for pressure calibration of working standard microphones by comparison

IEC 61000-4-2:1995, Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test. Basic EMC Publication

IEC 61000-4-3:1998, Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test, Edition 1.1

IEC 61000-6-1:1997, Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 1: Immunity for residential, commercial and light-industrial environments

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

CISPR 22:1997, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

Guide to the expression of uncertainty in measurement: 1995, ISBN: 9267101889

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in ANSI S1.1-1994, and the following apply.

3.1

sound calibrator

device that generates a sinusoidal sound pressure of specified sound pressure level and frequency when coupled to specified models of microphone in specified configurations

3.2**specified sound pressure level**

sound pressure level(s) generated under reference environmental conditions for use with a particular microphone model and configuration, valid for either an individual sound calibrator (in the case of a class LS sound calibrator) or all sound calibrators of the same model (in the case of a class 1 or class 2 calibrator)

3.3**nominal sound pressure level**

close approximation to the specified sound pressure level(s), valid for all sound calibrators of the same model, rounded to the nearest decibel (intended for marking)

3.4**specified frequency**

frequency(ies) of the sound generated by the sound calibrator under reference environmental conditions, valid for either an individual sound calibrator (in the case of a class LS calibrator) or all sound calibrators of the same model (in the case of a class 1 or class 2 calibrator)

3.5**nominal frequency**

close approximation to the specified frequency, often rounded according to ANSI S1.6-1984 (intended for marking)

3.6**principal sound pressure level**

sound pressure level specified in the Instruction Manual as principal

NOTE Principal sound pressure level is used during demonstration of conformance of the sound calibrator to the requirements of this Standard.

3.7**principal frequency**

frequency specified in the Instruction Manual as principal

NOTE Principal frequency is used during demonstration of conformance of the sound calibrator to the requirements of this Standard.

3.8**replication**

repeat of a measurement involving coupling the microphone to the sound calibrator and then completely removing the microphone from the sound calibrator

3.9**total distortion**

ratio in percent of the root-mean-square of the total distortion components of a nominally sinusoidal signal to the root-mean-square of the entire signal

3.10**reference orientation**

orientation of a sound calibrator such that the principal axis of the opening of the cavity (the axis along which the microphone is inserted into the cavity) coincides with the principal direction of an emitter or receiver of radio-frequency fields

3.11

reference plane

plane of contact between the microphone and the sound calibrator

3.12

effective load volume of a microphone

volume of air at reference environmental conditions that has the same acoustic compliance as the cavity bounded by the reference plane, the microphone diaphragm and the outer cylindrical surface of the microphone at the reference plane, including the equivalent volume of the microphone (see ANSI S1.15-1997/Part 1)

NOTE The effective load volume of a microphone is typically expressed in cubic millimeters.

4 Reference environmental conditions

The reference environmental conditions are:

- Temperature: 23 °C
- Static pressure: 101.325 kPa
- Relative humidity: 50 %

5 Requirements

5.1 General

5.1.1 A sound calibrator conforming to the requirements of this Standard shall have the characteristics described in this clause. Adapters may be provided to accommodate more than one model of microphone. For the purpose of this Standard, any such adapter is an integral part of the sound calibrator.

5.1.2 The sound calibrator shall conform to the requirements of this Standard for one or more of the sound pressure level and frequency combinations available. All the combinations conforming to the requirements given in this Standard shall conform to the requirements for the same class designation. Conformance to the requirements of this Standard shall not be stated for sound pressure level and frequency settings for which this Standard provides no tolerance limits.

5.1.3 Class LS sound calibrators shall be supplied with an individual calibration chart containing the information required by 6.2. For class 1 and class 2 sound calibrators, the specified sound pressure level(s) and specified frequency(ies) shall be given in the Instruction Manual.

5.1.4 Class LS and class 1 sound calibrators that require corrections for the influence of static pressure to conform to the specifications for the appropriate class shall have the letter 'C' added to their class designation. Class LS and class 1 sound calibrators shall not require corrections for any of the other environmental conditions to conform to the specifications for the appropriate class. Class 2 sound calibrators that require corrections for any of the environmental conditions to conform to the specified requirements shall have the letter 'C' added to their class designation. Where appropriate, the class designation shall be described as class LS/C, class 1/C, or class 2/C. Where corrections are

permitted, and are necessary to conform to the specified requirements as an environmental condition varies, these corrections shall be stated in the Instruction Manual.

5.1.5 Class 1 sound calibrators that require a correction for the influence of static pressure to conform to the specifications of this Standard shall be supplied with a barometer. The barometer shall enable the static pressure to be measured such that the ability of a sound calibrator to conform to the requirements for the class is not affected. Class 2 sound calibrators that require a correction for the influence of static pressure to conform to the specifications of this Standard shall be supplied with a barometer (which shall enable the static pressure to be measured such that the ability of a sound calibrator to conform to the requirements for the class is not affected), unless the corrections are sufficiently small that, for any change in static pressure of ± 6.0 kPa, the uncorrected measured sound pressure levels conform to the specifications of this Standard. In this case the corrections to be applied for the influence of variations in static pressure shall be stated in the Instruction Manual, together with information on how to calculate the relevant correction when operating the sound calibrator at different elevations above sea level.

NOTE 1 A class LS sound calibrator is normally used only in the laboratory where a suitable device should be available for measuring static pressure if the sound calibrator has a class 'C' designation. Hence there is no requirement to supply a barometer for this class.

NOTE 2 The barometer may provide the data directly in the form to be used to correct measured sound pressure levels for deviations from the reference static pressure.

5.1.6 When a class 2 sound calibrator that requires a correction for the influence of temperature or relative humidity to conform to the specifications of this Standard is supplied with the means to measure the relevant environmental condition, the supplied means shall enable the condition to be measured such that the ability of a sound calibrator to conform to the requirements for the class is not affected.

5.1.7 The design of the sound calibrator and the materials used in the construction should be such as to provide long-term stability for the operation of the sound calibrator.

5.1.8 If a specific orientation of the sound calibrator is to be used to conform to the requirements of this Standard, this orientation shall either be indicated on the sound calibrator, or the indication on the sound calibrator shall refer to the Instruction Manual, which shall state the required orientation.

5.1.9 All performance requirements relate to the operation of the sound calibrator following stabilizing of the coupling of the microphone and sound calibrator, and after the sound pressure level and frequency have stabilized. The elapsed time necessary for stabilization of the sound pressure level and frequency, which begins once the sound calibrator is switched on with the microphone coupled to it, shall be stated in the Instruction Manual, and shall not exceed 30 s for any applicable combination of environmental conditions specified in 5.4. The sound calibrator and microphone shall be allowed to reach equilibrium with the prevailing environmental conditions before coupling.

NOTE The stabilization time required following the coupling of the microphone to the sound calibrator may vary considerably depending on the model of microphone and sound calibrator in use.

5.1.10 Seals or marks shall protect those components of a sound calibrator that are not intended to be accessible to a user or test laboratory.

5.1.11 Tolerance limits in this Standard include the associated expanded uncertainty 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:1995. For testing laboratories the maximum permitted expanded uncertainties of measurement are stated in Annex A and Annex B of this document. Sound calibrator manufacturers may calculate the proportion of the tolerance limits available for design and manufacturing purposes by subtracting the maximum permitted expanded uncertainties of measurement from the appropriate tolerance limit.

5.1.12 Conformance to the requirements of this Standard is demonstrated when the result of a measurement or the absolute value of the difference between the result and the design goal, as appropriate, extended by the actual expanded uncertainty of measurement of the testing laboratory, shall not exceed the specified tolerance limits for the appropriate class.

5.1.13 If the actual expanded uncertainty of a measurement performed by the test laboratory exceeds the maximum permitted expanded uncertainty value given in Annex A and Annex B, the measurement shall not be used to demonstrate conformance to the requirements of this Standard.

5.2 Sound pressure level

5.2.1 General

5.2.1.1 All specified sound pressure level(s) generated shall be stated in the Instruction Manual with a resolution better than, or equal to, 0.1 dB.

5.2.1.2 All the requirements and tolerance limits specified in this Standard relate to the level of the sound pressure produced at the diaphragm of the inserted microphone.

5.2.1.3 The principal sound pressure level of the sound calibrator shall be at least 90 dB (re 20 μ Pa) when the sound calibrator is applied to the models of microphone in the configurations specified in the Instruction Manual.

5.2.2 Generated sound pressure level

The sound pressure level generated by the sound calibrator shall be measured as an average over 20 s of operation. For sound calibrators with letter 'C' designation the measured level shall be corrected, if necessary, to the reference environmental conditions given in Clause 4. The absolute value of the difference between the measured sound pressure level and the corresponding specified sound pressure level, extended by the expanded uncertainty of measurement, shall not exceed the tolerance limits given in Table 1 for the class of sound calibrator. These tolerance limits apply to measurements made at and around reference environmental conditions within the following ranges: 97 kPa to 105 kPa, 20 °C to 26 °C and 40 % relative humidity to 65 % relative humidity.

5.2.3 Short-term level fluctuation

Fluctuation in the sound pressure level shall be measured with time-weighting F (nominal time constant of 125 ms), by making a minimum of ten measurements at regular intervals during a period of 20 s of operation of the sound calibrator. One-half of the difference between the maximum and minimum levels measured, extended by the actual expanded uncertainty of measurement, shall not exceed the short-term level fluctuation limits given in Table 1 for the class of sound calibrator. These short-term level fluctuation limits apply to measurements made at and around reference environmental conditions within the following ranges: 97 kPa to 105 kPa, 20 °C to 26 °C and 40 % relative humidity to 65 % relative humidity.

5.2.4 Sound pressure level over range of supply voltage

The absolute value of the difference between the sound pressure level generated by the sound calibrator, determined according to 5.2.2 over the range of supply voltages specified in the Instruction Manual, and the sound pressure level measured at the nominal supply voltage at and around reference environmental conditions, extended by the actual expanded uncertainty of measurement, shall not exceed the tolerance limits given in Table 2 for the class of sound calibrator. Also, the tolerance limits given in Table 1 for the absolute value of the difference between the measured sound pressure level and the specified sound pressure level shall not be exceeded for any supply voltage within the range.

Table 1 — Tolerance limits for sound pressure level and short-term level fluctuation, at and around reference environmental conditions

Range of nominal frequencies (Hz)	Sound pressure level tolerance limits (dB)			Short-term level fluctuation limits (dB)		
	Class LS	Class 1	Class 2	Class LS	Class 1	Class 2
31.5 to <160	...	0.50	...	...	0.20	...
160 to 1,250	0.20	0.40	0.75	0.05	0.10	0.20
>1,250 to 4,000	...	0.60	...	...	0.10	...
>4,000 to 8,000	...	0.80	...	...	0.10	...
>8,000 to 16,000	...	1.00	...	...	0.10	...
NOTE 1 Sound pressure level tolerance limits are for the absolute value of the difference between the sound pressure level generated by the sound calibrator and the specified sound pressure level, extended by the actual expanded uncertainty of measurement.						
NOTE 2 Short-term level fluctuation limits are for the corresponding measured short-term level fluctuation, extended by the actual expanded uncertainty of measurement.						
NOTE 3 For a class LS or class 2 sound calibrator the '...' symbols in the table indicate ranges of nominal frequency for which this Standard provides no tolerance limits.						

Table 2 — Tolerance limits for the influence of supply voltage on sound pressure level, at and around reference environmental conditions

Tolerance limits (dB)		
Class LS	Class 1	Class 2
0.05	0.10	0.20
NOTE Tolerance limits are for the absolute value of the difference between the sound pressure level generated by the sound calibrator over the range of operating voltage, and the sound pressure level measured at the nominal supply voltage, extended by the actual expanded uncertainty of measurement.		