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Standards Secretariat
Acoustical Society of America
335 East 45th Street
New York, New York 10017

AMERICAN NATIONAL STANDARD Specification for Acoustical Calibrators

ABSTRACT

This standard specifies performance requirements for coupler-type acoustical calibrators. For each microphone type that may be used with the calibrator, requirements include the sound pressure level in the coupler, the frequency of the sound, and the determination of the influence of atmospheric pressure, temperature, humidity, and magnetic fields on the pressure level and frequency of the sound produced by the calibrator. Specifications are to be met within stated tolerances at each frequency and sound pressure level of operation.

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AMERICAN NATIONAL STANDARDS ON ACOUSTICS

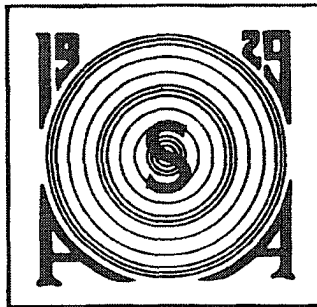
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These standards are developed as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

This standard was approved by the American National Standards Institute as ANSI S1.40-1984 on 23 March 1984.

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FOREWORD

[This Foreword is for information only and is not part of Accredited Standard Specification for Acoustical Calibrators S1.40-1984 (ASA Catalog No. 40-1984)]

This standard was developed under the jurisdiction of Accredited Standards Committee S1 using the American National Standards Institute (ANSI) Standards Committee Procedure.

Accredited Standards Committee S1 had the following scope:

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

At the time this standard was submitted to Accredited Standards Committee S1 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 the Standards Secretariat, Acoustical Society of America, 335 East 45th Street, New York, NY 10017.

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American National Standard

Specification for Acoustical Calibrators

0 INTRODUCTION

0.1 Acoustical calibrators that meet the performance requirements of this standard normally include a sound source which generates a known sound pressure level in a coupler into which a microphone is inserted. A diaphragm or piston inside the coupler is driven sinusoidally and generates a specified sound pressure level and frequency within the coupler. The calibrator presents to the inserted microphone of a sound level meter or other sound measuring system a reference or known acoustic signal so one can verify the system sensitivity or set the system to indicate the correct sound pressure level at some frequency.

0.2 Many acoustical calibrators provide two or more nominal sound pressure levels and operate at two or more nominal frequencies. Multiple levels and multiple frequencies are useful for checking the linearity and, in a limited way, the frequency response of a sound measuring system. An acoustical calibrator that produces multiple frequencies may also be used to determine a single-number composite calibration for a broadband sound through calibration at several frequencies. Additional signals such as tonebursts may be provided for use in checking some important electroacoustical characteristics of sound level meters and other acoustical instruments. Such signals may also be useful in checking performance characteristics of instruments to measure sound exposure level or time-period average sound level. Adaptors may be provided to accommodate microphones having different diameters or construction than the microphone for which the calibrator coupler was designed.

1 SCOPE AND PURPOSE

This standard specifies performance requirements for coupler-type acoustical calibrators. For each microphone type that may be used with the calibrator, requirements include the sound pressure level in the coupler, the frequency of the sound, and the determination of the influence of atmospheric pressure, temperature, humidity, and magnetic fields on the pressure level and frequency of the sound produced by the calibrator. Specifications are to be met within stated tolerances at each frequency and sound pressure level of operation.

This standard specifies performance requirements of acoustical calibrators and provides information for the user to determine how he should expect an acoustical calibrator to perform.

2 APPLICATIONS

This standard applies to acoustical calibrators of the coupler type that are used to check or adjust the sensitivity of sound measuring instruments and systems including conventional and integrating-averaging sound level meters and personal noise dosimeters. Acoustical calibrators specified in the document produce a sinusoidal signal with a specified sound pressure level at a specified frequency in a closed coupler. Coupler-type acoustical calibrators are not intended for freefield calibration. The calibrator shall be capable of producing a pressure calibration of a microphone as defined in ANSI S1.10-1966 (R1976) at one or more selected frequencies.

3 STANDARDS RELEVANT TO THIS DOCUMENT

3.1 American National Standards

[When the following American National Standards are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply.]

- (1) American National Standard Specification for Sound Level Meters S1.4-1983
- (2) American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements S1.6-1984
- (3) American National Standard Method for the Calibration of Microphones S1.10-1966 (R1976)
- (4) American National Standard Specifications for Laboratory Standard Microphones S1.12-1967 (R1977)
- (5) American National Standard Specification for Personal Noise Dosimeters S1.25-1978

3.2 International Standards

[When the following publications are superseded by an approved revision, the revision shall apply.]

- (1) International Electrotechnical Commission Publication 651: Sound Level Meters (1979).
- (2) International Electrotechnical Commission Publication 327: Precision method for pressure calibration of one-inch standard condenser microphones by the reciprocity technique (1971).

(3) International Electrotechnical Commission Publication 486: Simplified method for pressure calibration of one-inch standard condenser microphones by the reciprocity technique (1972).

(4) International Organization for Standardization Publication R266: Preferred Frequencies for Acoustical Measurements (1975).

4 PERFORMANCE REQUIREMENTS

4.1 General

An acoustical calibrator of the coupler type shall satisfy the requirements of this section. The waveform of the calibration signal shall be sinusoidal. Users of the standard should refer to ANSI S1.10-1966 (R1976) for a description of procedures to perform precision calibration of a microphone.

4.2 Nominal Sound Pressure Level

The nominal design center sound pressure level in the coupler of a single-level acoustical calibrator shall be 94, 104, 114, or 124 decibels *re*: 20 micropascals. The nominal sound pressure levels produced by a multilevel acoustical calibrator shall include 94 decibels.

4.2.1 Reference Conditions

The nominal sound pressure level(s) produced by the calibrator shall apply for those microphones of specified effective volumes, or for specified combinations of microphone and adaptor. The nominal sound pressure level(s) shall apply for an atmospheric pressure of 101.3 kilopascals, an air temperature of 20° Celsius, and relative humidity of 65%.

4.2.2 Measurement of Sound Pressure Level in the Coupler

Whenever possible, coupler-type calibrators shall be designed to accept a type L or type M laboratory standard microphone and the procedures of 4.2.2(a) or 4.2.2(b) shall be used to measure the sound pressure level produced by the calibrator. The sound pressure level produced by the acoustical calibrator shall meet the tolerance limits shown in Table I and shall be measured as follows:

- (a) The sound pressure level produced by coupler-type calibrators having the capability of being coupled (with or without adaptors) to a type L laboratory standard microphone specified in ANSI S1.12-1967 (1977) shall be determined by use of a calibrated type L standard microphone (in an exposed diaphragm configuration) using the insert method to determine the microphone output voltage as described in ANSI S1.10-1966 (R1976).
- (b) The sound pressure level produced by coupler-type calibrators not capable of being used with a type L laboratory standard microphone but capable of being used with a type M laboratory standard microphone specified in ANSI S1.12-1967 (R1977) shall be determined by use of a calibrated type M laboratory standard microphone (in an exposed diaphragm configuration) using the insert method to determine the microphone output voltage.
- (c) The sound pressure level produced by a special purpose coupler-type calibrator not accommodating a type L or type M laboratory standard microphone (with or without adaptors) shall be determined by a transfer method using a transfer microphone and a reference calibrator. A transfer microphone is one that will be accepted by the special-purpose calibrator and will also be accepted (with an adaptor) by a reference calibrator that accepts a type L or type M laboratory standard microphone. The procedure is as follows: The sound pressure response level of the transfer microphone is first determined by comparing its output voltage to that of a calibrated standard microphone when each is inserted in the reference calibrator. Then the transfer microphone is inserted in the special-purpose calibrator and the sound pressure level generated can be verified or adjusted.

4.2.3 Effective Volume of Microphones

The manufacturer shall provide in the Instruction Manual (a) the effective volumes of those microphones specified for the calibrator, and (b) information for determining the actual sound pressure level developed in the coupler, at any frequency of operation, with a microphone of different effective volume. If the protective grid over the microphone's diaphragm can be removed, the manufacturer shall supply the information on effective volume, both with the grid in place and removed.

4.3 Sound Pressure Level Tolerance Limits

For the reference conditions of 4.2.1, tolerance limits on the total sound pressure level (fundamental plus harmonics) actually generated shall be within the values shown in Table I for frequencies of 1000 hertz or lower produced by the calibrator. Exceptions to the tolerances are permitted on multi-frequency calibrators above 1000 hertz provided they are stated by the manufacturer.

Removal of any access covers which are an integral part of a calibrator shall not affect the accuracy of the sound pressure level produced by the calibrator.

4.4 Frequency of Sound in the Coupler

The design-center frequency of the sound produced by a single frequency calibrator may be in the range from 200 to 1000 hertz. The preferred frequency for a single-frequency calibrator is 1000 hertz. For multiple-frequency calibrators, the design-center frequencies shall be selected from the preferred frequencies in ANSI S1.6-1984 or ISO R266. One of the frequencies shall be 1000 hertz. The frequency of the sound generated in the coupler shall be within $\pm 3\%$ of the design-center frequency for the reference atmospheric pressure, air temperature, and humidity given in 4.2.1. Correction tables or charts shall be provided if the frequency of the sound is not within $\pm 3\%$ of the design-center frequency over the operating range specified by the manufacturer for atmospheric pressure, air temperature, and relative humidity.

TABLE I. Tolerance limits for sound pressure levels produced by acoustical calibrators.

Situation	Tolerance limits
1. The calibrator used directly with a Type L laboratory standard microphone	± 0.3 dB
2. The calibrator, with an adaptor, used with a Type L laboratory standard microphone	± 0.4 dB
3. The calibrator, with or without an adaptor, used with a Type M laboratory standard microphone	± 0.4 dB
4. The calibrator is a special-purpose type with a coupler having non-standard dimensions and cannot be adapted to a Type L or Type M laboratory standard microphone.	± 0.5 dB

4.5 Atmospheric Pressure Sensitivity

The sound pressure level produced in the coupler of an acoustical calibrator is likely to depend on atmospheric pressure. The manufacturer shall use the reference atmospheric pressure given in 4.2.1 for demonstrating compliance with the tolerance limits on sound pressure level. A correction curve or other means shall be provided in the Instruction Manual for correcting the nominal sound pressure level at the frequencies produced by the calibrator over the atmospheric pressure range from 108 to 65 kilopascals [-600 to $+4000$ meters (-2000 to $+13\,000$ feet) altitude reference to mean sea level]. A procedure for determining the sensitivity to atmospheric pressure changes may be found in Sec. 2.2 of Ref. 1.

4.6 Temperature Sensitivity

The effect of air temperature on the sound pressure level produced in the coupler shall not exceed ± 0.05 dB/ $^{\circ}\text{C}$, and shall be specified over the temperature range from at least -10°C to $+50^{\circ}\text{C}$.

4.7 Magnetic Field Sensitivity

The effects of magnetic fields on the sound pressure level produced by a calibrator shall be minimized. The complete coupler-type calibrator shall be tested in a magnetic field strength of 80 amperes per meter at frequencies of 50 or 60 hertz and 400 hertz. The manufacturer shall state any change in the sound pressure level and harmonic content of the sound produced by the calibrator in the presence of the specified magnetic field.

4.8 Humidity Sensitivity

For any air temperature between -10°C and $+50^{\circ}\text{C}$, the manufacturer shall state the range of relative humidity over which the calibrator is intended to operate with any of the specified microphones. The manufacturer shall state the effect of humidity on sound pressure level and on harmonic content of the sound field in the coupler of the calibrator over a range of 5% to 90% relative humidity at an air temperature of 40°C .

4.9 Timed Tonebursts

If a timed toneburst output is provided, the manufacturer shall specify the frequency, sound pressure level, and on and off time of the burst. The accuracy of the duration, frequency, and sound pressure level of the burst shall also be specified. Tolerance on the duration and frequency of the timed toneburst shall be $\pm 3\%$ of the nominal values specified by the manufacturer. The toneburst signals shall start and stop at zero crossings of the pressure waveform.

4.10 Distortion

The total harmonic distortion of the sound in the coupler shall not exceed 3% at each nominal frequency and each nominal sound pressure level.

4.11 Battery and Battery Indicator

If the calibrator is battery operated, the manufacturer shall determine that the above performance requirements for the sound pressure level and the frequency are met under all specified environmental conditions when the calibrator is powered by a recommended type battery supplying a voltage within design limits. Preferred battery types shall be marked on the calibrator case.

Means shall be provided to determine that the battery is operating within its normal or recommended range of output voltage.

5 VERIFICATION AND RECALIBRATION

5.1 Verification of Sound Pressure Level

The sound pressure level in the coupler shall be verified by using a measurement procedure specified in 4.2.2(a), 4.2.2(b), or 4.2.2(c), as appropriate.

5.2 Recalibration of Calibrators

An acoustical calibrator should be recalibrated at least annually by the instrument manufacturer or an acoustical test laboratory qualified to perform the calibration.

6. NAMEPLATE DATA AND INSTRUCTION MANUAL INFORMATION

6.1 Nameplate Data

The nameplate panel or outer case on an instrument that complies with this standard shall be marked "Acoustical Calibrator, ANSI S1.40-1984." The nameplate shall also contain the name of the manufacturer and the model and unique serial number of the calibrator. The nominal sound pressure level (see Sec. 4.2.2) and the nominal sound pressure level for the microphone for which the calibrator was designed shall be indicated at each frequency and sound pressure level setting at reference atmospheric conditions.

6.2 Instruction Manual Information

The manufacturer shall provide with each coupler-type calibrator an Instruction Manual containing, as a minimum, the following information:

- (a) Instructions on how the calibrator is to be used, with specific information on how to insert the microphone into the coupler to avoid leakage or damage to the microphone diaphragm.
- (b) Nominal values of sound pressure levels in decibels, *re*: 20 micropascals, and tolerances for the sound pressure level in the coupler under reference atmosphere conditions at each setting of nominal frequency and nominal sound pressure level for each microphone and microphone adaptor combination for which the calibrator was designed.
- (c) Effect of barometric pressure (altitude) on the sound pressure level produced by the calibrator.
- (d) Effect of air temperature on the sound pressure level produced by the calibrator.
- (e) Effect of humidity on the sound pressure level produced by the calibrator.
- (f) Effect of magnetic fields on the sound pressure level produced by the calibrator.
- (g) Preferred or recommended battery types.
- (h) Microphone types to be used, adaptors needed, and corrections at each frequency for each microphone or microphone and adaptor used.
- (i) Effective volumes of those microphones at each frequency, and information for calculating the actual sound pressure level in the coupler when the effective volume of the microphone differs from the nominal.

- (j) Instructions on how to operate the calibrator for every microphone type for which the calibrator was designed.
- (k) A description of the measurement procedures used to initially determine the actual sound pressure level and tolerance relative to the nominal sound pressure level.
- (l) Recommendation that the acoustical calibrator be recalibrated at least annually and a description of the recommended calibration procedure.
- (m) A recommended method for packing the acoustical calibrator to prevent damage during shipping and storage.

7 REFERENCES

- (1) "Environmental Effects on Microphones and Type II Sound Level Meters," National Bureau of Standards, Technical Note 931, National Bureau of Standards, Washington, DC 20234 (October 1976).

ACOUSTICAL SOCIETY OF AMERICA STANDARDS SECRETARIAT

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Standards are produced in four broad areas: physical acoustics, mechanical shock and vibration, bioacoustics, and noise, and are reaffirmed or revised every five years. The latest information on current ANSI standards as well as those under preparation is available from the Standards Secretariat.

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Erratum to American National Standard S1.40-1984(ASA 40-1984)

**American National Standard
Specification for Acoustical Calibrators**

Correction to the first sentence of paragraph 4.2 of ANSI S1.40-1984:

The preferred nominal design center sound pressure level in the coupler of a single-level acoustical calibrator is 94, 104, 114, or 124 decibels *re*: 20 micropascals.

