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(JSA)

**Electroacoustics—
Random incidence and diffuse
field calibration of sound level
meters**

ICS 17.140.50

Descriptors : noise (environmental), acoustic measurement, measuring instruments,
absorption (waves), diffusion (waves), calibration

Reference number : JIS C 1508 : 2000 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from the Japanese Standards Association (JSA), with a draft of Industrial Standard based on the provision of Clause 1, Article 12 of the Industrial Standardization Law.

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In the event of any doubts arising as to the contents,
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Electroacoustics— Random incidence and diffuse field calibration of sound level meters

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **IEC 61183** *Electroacoustics—Random-incidence and diffuse-field calibration of sound level meters* published in 1994 without modifying the technical contents.

“Information” underlined with dots is the matter not stated in the original International Standard.

1 Scope

1.1 This Standard describes a free-field calibration method for determining random-incidence sensitivity levels of sound level meters. Additionally, this Standard describes a diffuse-field calibration method for determining diffuse-field sensitivity levels.

1.2 For the purpose of this Standard, diffuse-field sensitivity level may be used interchangeably with random-incidence sensitivity level. Selection of calibration method depends on the facility available.

1.3 Results of calibrations conducted in accordance with this Standard depend upon which components of a sound level meter are exposed to the sound field.

1.4 For the purpose of this Standard, a sound level meter is considered to be a conventional sound level meter, an integrating-averaging sound level meter, or any other sound measuring system.

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

2.1 Japanese Industrial Standards

JIS C 1502 *Sound level meters*

JIS C 1505 *Precision sound level meters*

NOTE : The items cited from **IEC 60651** *Sound level meters* and **IEC 60804** *Integrating-averaging sound level meters* are equivalent to the corresponding matters of **JIS C 1502** and **JIS C 1505**.

JIS C 1514 *Octave-band and fractional-octave-band filters* (to be published)

NOTE : **IEC 61260** *Electroacoustics—Octave-band and fractional-octave-band filters* is identical with the said standard.

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

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

JIS Z 8732 *Acoustics—Determination of sound power levels of noise sources using sound pressure—Precision methods for anechoic and hemi-anechoic rooms*

NOTE : **ISO 3745** *Acoustics—Determination of sound power levels of noise sources—Precision methods for anechoic and semi-anechoic rooms* is identical with the said standard.

JIS Z 8734 *Acoustics—Determination of sound power levels of noise sources using sound pressure—Precision methods for reverberation rooms*

NOTE : **ISO 3741** *Acoustics—Determination of sound power levels of noise sources—Precision methods for broad-band sources in reverberation rooms* is identical with the said standard.

2.2 International Standards

IEC 61094-1 *Measurement microphones—Part 1 : Specifications for laboratory standard microphones*

Information : There is **JIS C 5515** as a Japanese Industrial Standard corresponding to the above **IEC**, but the portions cited in this Standard (**JIS C 1508**) are different in both **JISs**, therefore this International Standard is adopted as the normative reference.

ISO 266 *Acoustics—Preferred frequencies for measurements*

3 Definitions

3.1 For the definitions of terms used in this Standard, reference should be made to **JIS Z 8106**. Certain additional terms are defined below for the purpose of this Standard.

3.2 reference direction The direction of sound incidence specified by the manufacturer for testing the free-field sensitivity level and directional characteristics of a sound level meter.

3.3 random incidence sound field At a given location and for a given frequency or frequency band centred on that frequency, a sound field consisting of free sound waves arriving successively from all directions with equal probability and level.

3.4 diffuse sound field At a given location and for a given frequency or frequency band centred on that frequency, a sound field consisting of sound waves arriving more or less simultaneously from all directions with equal probability and level.

3.5 random-incidence sensitivity level In decibels, of a sound level meter, for a given frequency or frequency band centred on that frequency, the time-average sound pressure level indicated by the instrument due to a random incidence sound field, minus the time-average sound pressure level at the position of the acoustical centre of the microphone, due to sound waves from the same sound source and in the absence of the instrument.

3.6 diffuse-field sensitivity level In decibels, of a sound level meter, for a given frequency or frequency band centred on that frequency, the time-average sound pressure

level indicated by the instrument due to a diffuse sound field minus the time-average sound pressure level of the sound field at the position of the acoustical centre of the microphone and in the absence of the instrument.

3.7 free-field sensitivity level In decibels, of a sound level meter, for a given frequency or frequency band centred on that frequency, the sound pressure level indicated by the instrument due to a free sound-field incident from a specified direction minus the sound pressure level of the sound field at the position of the acoustical centre of the microphone and in the absence of the instrument.

3.8 pressure sensitivity level In decibels, of a sound level meter, for a given frequency or frequency band centred on that frequency, the sound pressure level indicated by the instrument due to a sound pressure uniformly applied over the surface of the diaphragm of the microphone minus the actual sound pressure level at the diaphragm.

4 Calibration method based on free-field measurements

4.1 For each frequency or frequency band centred on that frequency, the random-incidence sensitivity level G_{RI} of a sound level meter shall be calculated, in decibels, from

$$G_{RI} = G_F - 10 \log_{10} \gamma \dots\dots\dots (1)$$

where

- γ is the directivity factor of the sound level meter and is a measure of the deviation from an ideal omni-directional response with equal sensitivity at all possible angles of sound incidence on the microphone;
- G_F is the free-field sensitivity level, in decibels, of the sound level meter for the reference direction of sound incidence and equal to $L_{rd} - L_0$;
- L_{rd} is the sound pressure level, in decibels, indicated by the sound level meter when exposed to a plane progressive sound wave arriving at the microphone from the reference direction of sound incidence;
- L_0 is the sound pressure level, in decibels, of the same plane progressive sound wave in the absence of the sound level meter.

4.2 While $G_F = L_{rd} - L_0$ will usually vary for individual sound level meters, the directivity factor γ depends only on dimensions and geometry and is therefore the same for all instruments of the same model.

4.3 For determination of the directivity factor γ , consider the sound level meter located with the acoustical centre of the microphone at the origin of a reference coordinate system. The reference direction of the sound level meter coincides with the X-axis of the coordinate system. Sounds from different directions are incident on the sound level meter from a sound source located at a position on the surface of the sphere defined by a vector $\vec{r}$ from the origin; see Fig. 1.

4.4 The directivity factor γ is calculated from the following equation:

$$\gamma = \frac{4\pi}{\int_s 10^{-0.1[L_{rd}-L(\bar{r})]} d\Omega} \dots\dots\dots (2)$$

where

$L(\bar{r})$ is the sound pressure level, in decibels, indicated by the sound level meter when exposed to a plane progressive wave arriving at the microphone from the direction of $\bar{r}$;

L_{rd} is the sound pressure level, in decibels, indicated by the sound level meter when exposed to a plane progressive wave arriving at the microphone from the reference direction;

$d\Omega$ is the elemental solid angle associated with source position $\bar{r}$ in steradians.

The integral is taken over all possible angles of incidence from locations over the surface of the surrounding sphere.

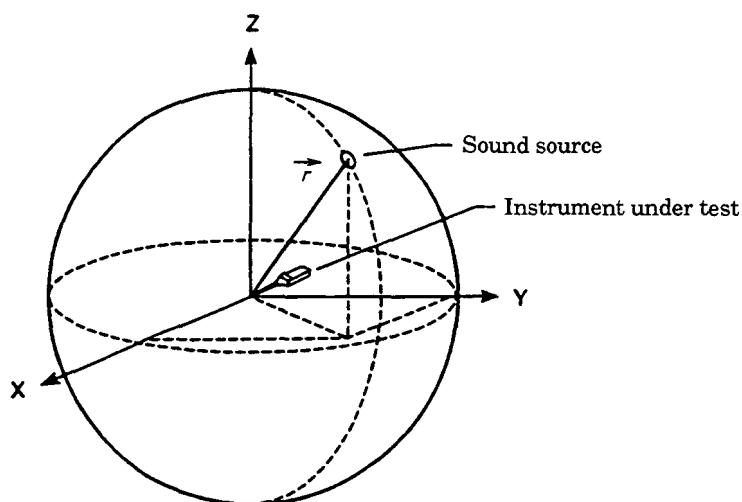


Fig. 1 Reference coordinate system for random-incidence sensitivity level calibration based on free-field measurements

4.5 For the purpose of practical measurements, it is convenient to describe the position of the sound source by means of a sound incidence angle ϕ , measured from the X-axis, and an angle α measured in a plane perpendicular to the X-axis as shown in Fig. 2. The directivity factor γ is then given by:

$$\gamma = \frac{4\pi}{\int_0^{\phi=2\pi} \int_0^{\alpha=\pi} 10^{-0.1[L_{rd}-L(\phi,\alpha)] |\sin \phi| d\alpha d\phi} \dots\dots\dots (3)$$

4.6 For a practical determination of random-incidence sensitivity level, the number of sound-incidence directions has to be limited. Sound pressure levels indicated by the sound level meter for particular directions are considered representative of directions near those selected.