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Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment

Acoustique — Mesurage du bruit aérien émis par les équipements liés aux technologies de l'information et aux télécommunications

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This fourth edition cancels and replaces the third edition (ISO 7779:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

— Clause 3:
  — Updates of many items in 3.1 and 3.2 to be consistent with basic standards, such as ISO/TR 25417, ISO 3744, etc.
  — Addition of new 3.3 corresponding to new Clause 9.
— Clause 6:
  — In 6.4.6, the microphone calibration procedures were amended to be consistent with those of industrial counterpart, ECMA-74.
— Clause 7:
  — In 7.3 (7.3.1), the procedure for test environment qualification was amended to clarify that any frequency bands, typically low in frequency, not significantly affecting A-weighted sound power level need not meet the hemi-anechoic room qualification criteria for the purposes of determining A-weighted sound power level.

  - In 7.4.6, the microphone calibration procedures were amended to be consistent with those of industrial counterpart, ECMA-74.

- Clause 8:
  - In 8.6, new 8.6.1 was inserted to clarify the method of defining operator position and bystander positions.

- Clause 9:
  - Clause 9 was newly inserted.
  - In relation to Clause 9, 3.3 was also added, and the descriptions of Tables 1, 5 and 6 (in 6.2, 7.2 and 8.2 respectively) were amended.

- Annex B:
  - B.2.2 and B.2.3 were amended to clarify the section of size and microphone positions on the cylindrical measurement surface, respectively.

- Annex D:
  - In D.1, D.8, D.9.5, D.10.3 and D.10.4, descriptions were amended to clarify that Annex D permits to use FFT data below 89,1 Hz and above 11 200 Hz to calculate tone-to-noise ratio and prominence ratio.
  - In D.9.7 and D.10.7, notes were added to mention that new metrics for detecting prominent discrete tone, (1) total tone-to-noise ratio and (2) total prominence ratio are under development.

- Annex E:
  - The measurement method stated in Annex E became out of date and was removed. But the annex structure is still maintained for the possible development of a new method (the title of the annex was amended accordingly).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document specifies methods for the measurement of airborne noise emitted by information technology and telecommunications (ITT) equipment. Hitherto, a wide variety of methods have been applied by individual manufacturers and users to satisfy particular equipment or application needs. These diverse practices have, in many cases, made comparison of noise emission difficult. This document simplifies such comparisons and is the basis for the declaration of the noise emission levels of ITT equipment.

In order to ensure accuracy, validity and acceptability, this document is based on the basic International Standards for determination of the sound power level and for determination of the emission sound pressure level at the operator position and bystander positions. Furthermore, implementation is simplified by conformity with these International Standards.

In many cases, free-field conditions over a reflecting plane are realised by hemi-anechoic rooms. These rooms can be particularly useful during product design to locate and to improve individual contributing noise sources. Reverberation test rooms can be more economical for production control and for obtaining sound power levels for noise emission declaration purposes.

The method for measuring the emission sound pressure level at the operator or bystander positions (based on ISO 11201) is specified in a separate clause, as this level is not considered to be primary noise emission declaration information. The measurements can, however, be carried out in conjunction with those for sound power determination in a free field over a reflecting plane.

For comparison of similar equipment, it is essential that the installation conditions and mode of operation be the same. In Annex C, these parameters are standardized for many categories of equipment.

This document is based on ECMA-74.

Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment

1 Scope

This document specifies procedures for measuring and reporting the noise emission of information technology and telecommunications equipment.

NOTE 1 This document is considered part of a noise test code (see 3.1.2) for this type of equipment and is based on basic noise emission standards (see 3.1.1) ISO 3741, ISO 3744, ISO 3745, ISO 9295 and ISO 11201.

The basic emission quantity is the A-weighted sound power level, which can be used for comparing equipment of the same type but from different manufacturers, or for comparing different equipment.

Three basic noise emission standards for determination of the sound power levels are specified in this document in order to avoid undue restriction on existing facilities and experience. ISO 3741 specifies comparison measurements in a reverberation test room; ISO 3744 and ISO 3745 specify measurements in an essentially free field over a reflecting plane. Any of these three basic noise emission standards can be selected and used exclusively in accordance with this document when determining sound power levels of a machine.

The A-weighted sound power level is supplemented by the A-weighted emission sound pressure level determined at the operator position or the bystander positions, based on basic noise emission standard ISO 11201. This sound pressure level is not a level of noise immission at a work station (see 3.2.12), but it can assist in identifying any potential problems that could cause annoyance, activity interference or hearing damage to operators and bystanders.

Methods for determination of whether the noise emission includes prominent discrete tones are specified in Annex D.

This document is suitable for type tests and provides methods for manufacturers and testing laboratories to obtain comparable results.

The methods specified in this document allow the determination of noise emission levels for a functional unit (see 3.1.4) tested individually.

The procedures apply to equipment which emits broad-band noise, narrow-band noise and noise which contains discrete-frequency components, or impulsive noise.

The sound power and emission sound pressure levels obtained can serve noise emission declaration and comparison purposes (see ISO 9296[3]).

NOTE 2 The sound power levels and emission sound pressure levels obtained are not intended to be considered as installation noise immission levels; however, they can be used for installation planning (see ECMA TR/27[11]).

If sound power levels obtained are determined for a number of functional units of the same production series, they can be used to determine a statistical value for that production series (see ISO 9296[3]).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 3741, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms*

ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

ISO 3745, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic rooms and hemi-anechoic rooms*

ISO 6926, *Acoustics — Requirements for the performance and calibration of reference sound sources used for the determination of sound power levels*

ISO 9295, *Acoustics — Determination of high-frequency sound power levels emitted by machinery and equipment*

ISO 11201, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 11203, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61183, *Electroacoustics — Random-incidence and diffuse-field calibration of sound level meters*

IEC 61260-1, *Electroacoustics — Octave-band and fractional-octave-band filters — Part 1: Specifications*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

ECMA-74[1)], *Measurement of airborne noise emitted by information technology and telecommunications equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3744, ISO 11201 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General definitions

3.1.1
basic noise emission standard
B-type standard
standard which specifies a procedure for determining the noise emission of machinery and equipment in such a way as to obtain reliable, reproducible results with a specified degree of accuracy

[SOURCE: ISO 12001:1996, 3.1]

1) Available [viewed 2017-04-07] at: http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-74.pdf

3.1.2
noise test code
C-type standard
standard that is applicable to a particular class, family or type of machinery or equipment which specifies all the information necessary to carry out efficiently the determination, declaration and verification of the noise emission characteristics under standardized conditions

Note 1 to entry: This document, together with ISO 9296[3], comprises the noise test codes for ITT equipment.

[SOURCE: ISO 12001:1996, 3.2, modified — Note 1 to entry was added.]

3.1.3
information technology and telecommunications equipment
ITT equipment
equipment for information processing, and components thereof, used in homes, offices, server installations, telecommunications installations or similar environments

3.1.4
functional unit
unit of information technology and telecommunications equipment, either with or without its own end-use enclosure, that is tested or intended to be tested in accordance with the procedures of this document

Note 1 to entry: A functional unit can comprise more than one unit of ITT equipment when such units are to be tested together in accordance with the methods of this document. A functional unit can also comprise one or more units of ITT equipment coupled to one or more units of non-ITT equipment, such as power modules, water pumps, or refrigeration units, when such equipment is necessary for the normal operation of the ITT equipment.

Note 2 to entry: Functional units of ITT equipment can take on a wide range of forms, including commercially available products, prototype units under development or sub-assemblies and components thereof.

3.1.5
work station
operator position
position in the vicinity of the equipment under test which is intended for the operator

Note 1 to entry: This term does not refer to a computer “workstation”, which denotes a high-performance, single-user computer.

3.1.6
operating mode
condition in which the equipment being tested is performing its intended function(s)

3.1.7
idle mode
one or more steady-state conditions in which the equipment being tested is energized but is not operating

3.1.8
floor-standing equipment
functional unit which is intended to be installed on the floor

3.1.9
table-top equipment
functional unit which has a complete enclosure and which is intended to be installed or used on a table, desk or separate stand

3.1.10
wall-mounted equipment
functional unit which is normally mounted against or in a wall and which does not have a stand of its own

3.1.11
sub-assembly
functional unit, generally without its own end-use enclosure, intended to be installed in another unit of ITT equipment or assembled together with other sub-assemblies or units of ITT equipment into a single end-use enclosure

3.1.12
rack-mountable unit
functional unit that is designed to be installed in an end-use enclosure in the form of a rack, frame, or cabinet, either fully enclosed, partially enclosed, or open frame

3.1.13
rack-enclosed system
functional unit in the form of a rack, frame, or cabinet containing one or more rack-mountable units

Note 1 to entry: Rack-enclosed systems represent a wide variety of ITT equipment, depending on the particular configuration of the rack-mountable units in the rack or enclosure. These can be server systems, storage systems, I/O systems, networking systems or "integrated" systems of these or other types of rack-mountable units.

3.1.14
hand-held equipment
functional unit, generally small and lightweight, intended to be supported in one's hand(s) during operation

3.1.15
standard test table
rigid table having a top surface of at least 0,5 m^2 and length of the top plane not less than 700 mm

Note 1 to entry: The design for the standard test table is shown in A.1.

3.2 Acoustical definitions

3.2.1
emission
noise emission

airborne sound radiated by a well-defined noise source (e.g. the equipment under test)

Note 1 to entry: Noise emission descriptors can be incorporated into a product declaration and/or product specification. The basic noise emission descriptors are the sound power level of the source itself and the emission sound pressure levels at an operator position (work station) and/or at bystander positions (if no operator position is defined) in the vicinity of the source.

3.2.2
sound pressure
p
difference between instantaneous total pressure and static pressure

Note 1 to entry: Sound pressure is expressed in pascals.

Note 2 to entry: The symbol *p* for instantaneous sound pressure is often used without modification to represent a root-mean-square (RMS) sound pressure.

Note 3 to entry: See ISO 80000-8.

3.2.3
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure, p, to the square of a reference value, p_0, expressed in decibels

$$L_p = 10 \lg \frac{p^2}{p_0^2} \text{ dB}$$

where the reference value, p_0, is 20 µPa

[SOURCE: ISO/TR 25417:2007, 2.2, modified — Notes to entry were removed.]

3.2.4
time-averaged sound pressure level
$L_{p,T}$
ten times the logarithm to the base 10 of the ratio of the time average of the square of the sound pressure, p, during a stated time interval of duration, T (starting at t_1 and ending at t_2), to the square of a reference value, p_0, expressed in decibels

$$L_{p,T} = 10 \lg \left[\frac{\frac{1}{T} \int_{t_1}^{t_2} p^2(t) \mathrm{d}t}{p_0^2} \right] \text{ dB}$$

where the reference value, p_0, is 20 µPa

Note 1 to entry: Because of practical limitations of the measuring instruments, p^2 is always understood to denote the square of a frequency-weighted and frequency-band-limited sound pressure. If a specific frequency weighting as specified in IEC 61672-1 and/or specific frequency bands are applied, this should be indicated by appropriate subscripts; e.g. $L_{p,\mathrm{A},10\ \mathrm{s}}$ denotes the A-weighted time-averaged sound pressure level over 10 s.

Note 2 to entry: $L_{p,T}$ can be interpreted as the sound pressure level of a stable and permanent noise that will have the same average energy as the noise under study.

3.2.5
emission sound pressure level
L_p
sound pressure level at a specified position near a machine, when the machine is in operation under specified operating and mounting conditions on a reflecting plane surface, but excluding the effects of background noise as well as the effect of reflections other than those from the plane or planes permitted for the purpose of the test

Note 1 to entry: The emission sound pressure level is expressed in decibels with a reference value, p_0, of 20 µPa (20×10^{-6} Pa).

Note 2 to entry: Clause 8 specifies the method for determination of emission sound pressure level.

[SOURCE: ISO 11205:2003, 3.6, modified — Note 1 to entry was elaborated and Note 2 to entry was added.]

3.2.6
time-averaged emission sound pressure level
$L_{\mathrm{peq}T}$
emission sound pressure level of a continuous steady sound that, within a measurement time interval, T, has the same mean-square sound pressure as a sound under consideration which varies with time

$$L_{\mathrm{peq}T} = 10\,\lg\left[\frac{\frac{1}{T}\int_0^T p^2(t)\,\mathrm{d}t}{p_0^2}\right]\,\mathrm{dB}$$

Note 1 to entry: The time-averaged emission sound pressure level is expressed in decibels with a reference value, p_0, of 20 µPa (20 × 10^{-6} Pa).

Note 2 to entry: The emission sound pressure level is determined at the specified position(s) required by the noise test code (i.e. this document, for specific families of ITT equipment).

Note 3 to entry: Clause 8 of this document specifies the method for the determination of time-averaged A-weighted emission sound pressure level, $L_{p\mathrm{A}}$, for ITT equipment defined in 3.1.3.

Note 4 to entry: In general, the subscripts "eq" and "T" are omitted since time-averaged emission sound pressure levels are necessarily determined over a certain measurement time interval.

3.2.7
C-weighted peak emission sound pressure level
$L_{p\mathrm{C,peak}}$
highest instantaneous value of the C-weighted emission sound pressure level determined over an operational cycle

Note 1 to entry: The C-weighted peak emission sound pressure level is expressed in decibels with a reference value, p_0, of 20 µPa (20 × 10^{-6} Pa).

3.2.8
sound power
P
through a surface, product of the sound pressure, p, and the component of the particle velocity, u_n, at a point on the surface in the direction normal to the surface, integrated over that surface

Note 1 to entry: Sound power is expressed in watts.

Note 2 to entry: The symbol, P, is often used without modification for the mean value (over time) of the sound power.

Note 3 to entry: The quantity relates to the rate per unit time at which airborne sound energy is radiated by a source.

[SOURCE: ISO/TR 25417:2007, 2.8]

3.2.9
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the sound power of a source, P, to a reference value, P_0, expressed in decibels

$$L_W = 10\,\lg\frac{P}{P_0}\,\mathrm{dB}$$

where the reference value, P_0, is 1 pW

Note 1 to entry: If a specific frequency weighting as specified in IEC 61672-1 and/or specific frequency bands are applied, this is indicated by appropriate subscripts; e.g. $L_{W\mathrm{A}}$ denotes the A-weighted sound power level.

Note 2 to entry: Clauses 6 and 7 of this document specify the method for the determination of the A-weighted sound power level, $L_{W\mathrm{A}}$, for *ITT equipment* (3.1.3).

