Standard ECMA-109
4th Edition - December 1996

ECMA

Standardizing Information and Communication Systems

Declared Noise Emission Values of Information Technology and Telecommunications Equipment

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Brief History

Information on acoustic noise emission of information technology and telecommunications equipment is needed by users, planners, manufacturers and authorities. This information is required for comparison of the noise emissions from different products and for installation acoustics planning and may be used for relating to workplace noise immission requirements.

In order for equipment noise emission data to be useful, uniform methods are necessary for the following purposes:

- Measurement of noise emission values

  ECMA-74 specifies procedures for measuring sound power level based on ISO 3740, ISO 3741, ISO 3742, ISO 3744 and ISO 3745 (reverberation room or hemi-anechoic room) and sound pressure level based on ISO 11201. ECMA-160 specifies alternative procedures for determining sound power level based on ISO 9614-2.

- Determination of the noise emission values to be declared

  ISO 4871 gives guidelines for the preparation of standards for deriving noise emission values for declaration purposes, and ISO 7574 gives statistical methods for such determination. ECMA-109 is based upon these basic International Standards.

- Presentation of declared noise emission values

  For the presentation of declared noise emission values, it is of prime importance to declare A-weighted sound power levels L_{WA}. It is recognized, however, that users still desire information on A-weighted sound pressure levels L_{pA}. Therefore, this ECMA Standard specifies that both quantities shall be declared. In the preparation of this ECMA Standard divergences of opinion have been found between various national and international organisations as to the most useful way of presenting noise emission values. In order to avoid any misunderstanding between presentation of sound power levels in decibels re 1 pW and sound pressure levels in decibels re 20 μPa, this ECMA Standard expresses sound power level emission values in bels and sound pressure level emission values in decibels, to alleviate the divergences of opinion mentioned.

  As an option, methods for determination and presentation of subjective characteristics of noise emission are presented in annex C.

- Verification of declared noise emission values

  ISO 7574 gives methods for the verification of a declared noise emission value. In this ECMA Standard the procedure is restricted to verifying declared A-weighted sound power levels only.

The reasons for using bels for declared A-weighted sound power levels are:

i) To avoid user confusion

   In this ECMA Standard the A-weighted sound power level is the primary descriptor and will be reported in accordance with ISO 4871. Many manufacturers and users of information technology and telecommunications equipment have historically used A-weighted sound pressure levels in decibels. Since customers want both sound power and sound pressure, this ECMA Standard utilises both quantities. If both declared sound power levels and declared sound pressure levels were expressed in decibels, the user would be confused and the distinction between sound power and sound pressure would soon become lost.

ii) To avoid misapplication of data

   If declared A-weighted sound power levels were expressed in decibels, users may mistakenly compare the sound power levels with workplace regulations of sound pressure levels. In many information technology and telecommunications equipment applications, the sound power level (in decibels) of the equipment is significantly larger than the resulting sound pressure levels (in decibels) in the workplace.

iii) To promote the use of ECMA-109

   The purpose of ECMA-109 is to provide uniform methods of presenting declared noise emission values to users. Without using bels, this objective would be lost since there would be an incentive for some manufacturers to report sound **pressure** levels instead of sound **power** levels. The primary descriptor of information technology and telecommunications equipment noise is the declared A-weighted sound power level L_{WAd}. If ECMA-109 were to use

decibels for declared A-weighted sound power levels, manufacturers who do not implement this ECMA Standard would be at a competitive advantage by reporting sound pressure levels in decibels which would be lower than the declared sound power levels also in decibels. Not only would the user be confused, and unable to tell the difference, but the manufacturer who followed ECMA-109 would be at an unfair competitive disadvantage. To eliminate this confusion and disadvantage and to promote the uniform reporting of declared noise emission values, the declared A-weighted sound power levels must be reported in bels.

iv) To use a method based on successful experience

For several years, many international companies, members of ECMA, have reported A-weighted sound power levels in bels and A-weighted sound pressure levels in decibels without confusion of their customers. On the contrary, their customers have been able to distinguish easily between the important difference of sound power and sound pressure, and the users have not lost the significance of the digit after the decimal mark. Actually they have been less confused: without using bels, they would wonder: "which decibel do I compare to our specification?".

v) To be consistent with other ECMA and ISO standards

The use of bels for declared A-weighted sound power levels is consistent with ISO 4871 "Acoustics - Declaration and verification of noise emission values of machinery and equipment" and with ISO 7574-1 "Acoustics - Statistical methods for determining and verifying stated noise emission values of machinery and equipment - Part 1: General considerations and definitions". The declared A-weighted sound power level, L_{WAd}, is a statistical maximum value and corresponds to the "declared single-number noise emission value" in ISO 4871 and "labelled value" in ISO 7574-1. The definition of "declared single-number noise emission value " in ISO 4871 and "labelled value" in ISO 7574-1 has a note which states that in some cases, the labelled value may be expressed as the numerical value of sound power level in decibels divided by 10, given with one digit after the decimal mark, i.e. in bels. ECMA-109 recognizes that the sound power is **determined in decibels**, according to either ECMA-74 which is based upon ISO 3741, ISO 3742, ISO 3744 or ISO 3745 or ECMA-160 which is based upon ISO DIS 9614-2, and is then **reported** to the customers as a **declared value in bels**.

The first edition of Standard ECMA-109 was processed by ISO under the fast-track procedure and led to International Standard ISO 9296. The second edition has been adapted to the final wording of ISO 9296.

The third edition was adapted to allow for the determination of declared sound power level based on measurements made in accordance with ECMA-160 (using sound intensity) as an alternative to ECMA-74 (reverberation room or hemi-anechoic room).

This fourth edition corrects minor errors in the third edition, includes re-arrangements of the text, and clarifies the procedure when only a single machine from a batch has been measured and there is no prior knowledge of the standard deviation of production.

Adopted as 4th edition of Standard ECMA-109 by the General Assembly of December 1996.

Table of contents

1 Scope and field of application

This ECMA Standard applies to information technology and telecommunications equipment.

This ECMA Standard specifies:

- the method of determining the declared noise emission values,
- acoustical and product information to be given in technical documents supplied to users by the manufacturer,
- the method for verifying the declared noise emission values given by the manufacturers.

The uniform methods in this ECMA Standard use the noise emission data obtained in accordance with ECMA-74 or ECMA-160, and the procedures specified in ISO 4871 and ISO 7574.

The basic declared noise emission values are the declared A-weighted sound power level L_{WAd} (a statistical maximum value corresponding to L_c in ISO 7574) and the declared A-weighted sound pressure level L_{pAm} (a mean value) at the operator or bystander positions.

The declared A-weighted sound power level L_{WAd} permits comparison of noise emissions between different products and permits predictions of installation or work-place noise immission levels, as described in ECMA TR/27.

Although the most useful quantity for calculating immission levels due to one or more sound sources is usually the declared A-weighted sound power level of the individual source(s), the declared A-weighted sound pressure level L_{pAm} may be used to estimate the immission level in the immediate vicinity of an isolated piece of equipment.

To avoid confusion between sound power levels and sound pressure levels, the A-weighted sound power level is declared in bels and the A-weighted sound pressure level is declared in decibels.

2 References

ECMA-74	Measurement of airborne noise emitted by information technology and telecommunications equipment (1996).
ECMA-160	Determination of sound power levels of computers and business equipment using sound intensity measurements; scanning method in controlled rooms (1992).
ECMA TR/27	Method for the prediction of installation noise levels (1985).
ISO 4871:1996	Acoustics - Declaration and verification of noise emission values of machinery and equipment.
ISO 7574-1:1985	Acoustics - Statistical methods for determining and verifying stated noise emission values of machinery and equipment - Part 1 : General consideration and definitions.
ISO 7574-2:1985	Acoustics - Statistical methods for determining and verifying stated noise emission values of machinery and equipment - Part 2 : Methods for stated values for individual machines.
ISO 7574-4:1985	Acoustics - Statistical methods for determining and verifying stated noise emission values of machinery and equipment - Part 4 : Methods for stated values for batches of machines.

3 Definitions

For the purpose of this Standard, the following definitions apply. They are grouped in three categories, general definitions, acoustical definitions and statistical definitions.

General definitions

3.1 information technology and telecommunications equipment

Equipment for information processing and components thereof, used in homes, offices, computer installations, telecommunications installations or similar installations.

3.2 batch (lot) of equipment

A number of units of information technology or telecommunications equipment intended to perform the same function produced in quantity, manufactured to the same technical specifications and characterized by the same declared noise emission value.

NOTE

The batch may be either an entire production series or a portion thereof.

3.3 specific individually-declared machine

A single identifiable unit of information technology or telecommunications equipment, which has its own particular declared value derived from measurements of noise emission from that particular unit.

3.4 idle mode

A condition specified in ECMA-74 in which the equipment, after any necessary warm-up period, is energized but is not operating.

3.5 operating mode

A condition in which the equipment is performing its intended function(s) as specified in ECMA-74. If more than one operating mode is applicable, the mode which is typical for the majority of the applications shall be used.

Acoustical definitions

3.6 A-weighted sound power level L_{WA} in decibels

The sound power level of the equipment, determined in accordance with ECMA-74 or ECMA-160, with A-weighting. The reference sound power is 1 pW.

3.7 A-weighted sound pressure level L_{pA} in decibels

The sound pressure level of the equipment with A-weighting, determined in accordance with ECMA-74 at the operator position(s), or at the bystander positions if no operator position is specified. The reference sound pressure is 20 µPa.

3.8 measured value

The value of the A-weighted sound power level, L_{WA}, or the A-weighted sound pressure level L_{pA}, determined from measurements on an individual machine in accordance with ECMA-74 or ECMA-160. Measured values shall not be rounded.

3.9 declared noise emission values

The value of the declared A-weighted sound power level L_{WAd}, or that of the declared A-weighted sound pressure level, L_{pAm}, or both.

3.10 declared A-weighted sound power level L_{WAd} in bels

The value of the A-weighted sound power level, L_{WA}, divided by 10 declared for all equipment in a batch or declared for a specific individual machine.

- The declared value for all equipment in a batch indicates the limit below which the A-weighted sound power level, L_{WA}, divided by 10 of a specified large proportion of the A-weighted sound power levels, L_{WA}, divided by 10 of the batch of equipment are stated to lie when the machines are new.
- The declared value for a specific individual machine indicates the value below which the A-weighted sound power level, L_{WA}, divided by 10, of the specific machine is stated to lie when the machine is new.

L_{WAd} shall be rounded to 0,1 B.

NOTE

L_{WAd} corresponds to L_c in ISO 7574. The assumptions and verification procedures of clause 6 of ECMA-109 for a batch of equipment result in a 95% probability of acceptance if no more than 6,5% of the equipment in a batch has A-weighted sound power levels greater than the declared noise emission value, L_{WAd}. The assumptions and verification procedures of clause 6 for a specific individually-declared machine result in a 95% probability of acceptance.

3.11 declared A-weighted sound pressure level L_{pAm} in decibels

The value of the A-weighted sound pressure level L_{pA}, declared for the arithmetic mean of the values of the A-weighted sound pressure level, L_{pA}, for a batch of equipment, when new or declared for the A-weighted sound pressure level, L_{pA} of a specific individual machine, when new. The measurement position(s) for L_{pA} are the

operator position(s) defined in ECMA-74 or the bystander positions if no operator position is specified. L_{pAm} shall be rounded to 1 dB.

Statistical definitions

3.12 standard deviation of repeatability σ_r

The standard deviation of noise emission values obtained under repeatability conditions, that is, the repeated application of the same noise emission measurement method on the same equipment within a short interval of time under the same conditions (same laboratory, same operator, same apparatus).

NOTE

In this ECMA Standard, the symbol σ is used for a standard deviation of a population and the symbol s for a standard deviation of a sample.

3.13 standard deviation of reproducibility σ_R

The standard deviation of noise emission values obtained under reproducibility conditions, that is, the repeated application of the same noise emission measurement method on the same equipment at different times and under different conditions (different laboratory, different operator, different apparatus). The standard deviation of reproducibility, therefore, includes the standard deviation of repeatability, σ_r.

3.14 standard deviation of production σ_p

The standard deviation of noise emission values obtained on different equipment from a batch of the same family, using the same noise emission measurement method under repeatability conditions (same laboratory, same operator, same apparatus).

3.15 total standard deviation σ_t

The square root of the sum of the squares of the standard deviation of reproducibility and the standard deviation of production:

$$\sigma_t = \sqrt{\sigma_R^2 + \sigma_p^2}$$

3.16 reference standard deviation σ_M

The total standard deviation specified for information technology and telecommunications equipment which is considered typical for batches of this equipment. The reference standard deviation for L_{WA} in this ECMA Standard shall be 2,0 dB.

NOTE

The use of a fixed σ_M enables the application of a statistical method to deal with small sample sizes. If the total standard deviation σ_t is different from the reference standard deviation σ_M the manufacturer may estimate his risk of rejection on the basis of both standard deviations, σ_t and σ_M (see clause A.1).

4 Declared noise emission values

Declared noise emission values, L_{WAd} and L_{pAm}, shall be determined for one or more idle modes and one or more operating modes as defined in ECMA-74. The determination of the declared noise emission values is solely the responsibility of the manufacturer. Noise emission levels used in the determination of declared noise emission values shall be obtained in accordance to ECMA-74 or ECMA-160. See annex A for additional guidance.

4.1 Determination of the A-weighted sound power level L_{WA}

The A-weighted sound power level L_{WA}, shall be determined in accordance with ECMA-74 or ECMA-160. Measured values shall not be rounded.

4.2 Determination of the A-weighted sound pressure level L_{pA} at the operator (bystander) position(s)

The A-weighted sound pressure level, L_{pA}, at the operator positions shall be measured in accordance with ECMA-74. If no operator position is specified, L_{pA} shall be determined by energy-averaging the measured values of the bystander positions at the front, rear, right and left sides of the equipment in accordance with ECMA-74.

5 Presentation of declared noise emission values

5.1 Required information

The presentation of noise emission values for a product, determined according to this ECMA Standard, shall contain the following information.

- identification of the product with sufficient detail to determine the applicability of the declared noise emission values. If such information is not given, the declared noise emission values apply to all variations of the listed product;
- the words "Declared Noise Emission Values per ECMA-109" followed by L_{WAd} and L_{pAm} in conformance with clause 4;
- identification of whether L_{pAm} as defined in ECMA-74 refers to the operator position or bystander positions;
- if more than one operating mode according to ECMA-74 is possible, sufficient information to determine unambiguously the mode(s) used for declaration.

NOTE

Declared noise emission values should be given in technical documents or other literature supplied to the user (see annex B).

5.2 Additional information

Annex C provides optional information on describing the character of the noise emissions.

6 Verification of the declared noise emission values

6.1 General

The procedures for verifying the declared noise emission values are applicable only to declared A-weighted sound power levels L_{WAd} and are not applicable to declared A-weighted sound pressure level L_{pAm}.

Verification shall be made with noise measurements and equipment operation in accordance with ECMA-74 or ECMA-160. Furthermore, the installation and operating conditions for verification shall be as specified in clause 4 and stated by the manufacturer as specified in clause 5.

The procedure for verifying the L_{WAd} of the batch is consistent with ISO 7574-4, using the single sampling inspection procedure with a sample size of $n = 3$ and with the reference standard deviation σ_M specified as 2,0 dB.

The procedure for verifying the L_{WAd} of an equipment declared individually is consistent with ISO 7574-2.

6.2 Verification of L_{WAd} for a batch of equipment

The following procedure is designed for inspection under reproducibility conditions (see clause 3.13). It may be applied for inspection under repeatability conditions (see clause 3.12) if there is confidence that there is no significant systematic error of measurement connected with the relevant laboratory.

Take a random sample of three from the batch of new equipment under consideration. The measured values are L_{WA1}, L_{WA2} and L_{WA3} in dB, and their mean value $\bar{L}$ in dB is given by:

$$\bar{L} = \frac{1}{3}\left(L_{WA1} + L_{WA2} + L_{WA3}\right)$$

Decide on the acceptability of the declared noise emission value L_{WAd} using the following rules:

- if $\bar{L}/10 \leq (L_{WAd} - 0{,}11)$, L_{WAd} is confirmed as verified for the batch,

– if $\bar{L}/10 > (L_{WAd} - 0{,}11)$, L_{WAd} is not confirmed as verified for the batch.

6.3 Verification of L_{WAd} for a specific individually-declared machine

The measured value is L_{WA} in dB.

Decide on the acceptability of the declared noise emission value L_{WAd} for a specific individually-declared machine using the following rules:

– if $L_{WA}/10 \leq L_{WAd}$, L_{WAd} is confirmed as verified for the specific individually-declared machine,

– if $L_{WA}/10 > L_{WAd}$, L_{WAd} is not confirmed as verified for the specific individually-declared machine.

Annex A

(informative)

Guidelines for determining declared noise emission values

The determination of the declared noise emission values is solely the responsibility of the manufacturer.

A.1 Determination of the declared A-weighted sound power level L_{WAd} for a batch of equipment

To obtain the declared A-weighted sound power level L_{WAd} for a batch of equipment the manufacturer should take into account the following:

i) The uncertainty of the measurement with respect to the accuracy of the measurement method (ECMA-74 or ECMA-160), considering reproducibility. The standard deviation of reproducibility σ_R for L_{WA} is estimated to be 1,5 dB for most information technology and telecommunications equipment, as stated in ECMA-74 and ECMA-160.

ii) The production variation; i.e. measurements on many machines from the batch carried out in accordance with ECMA-74 or ECMA-160 in one laboratory under conditions as identical as possible (repeatability conditions). For each machine the mean value from two measurements is determined. These values are used to estimate the standard deviation of production for the batch.

iii) The total standard deviation σ_t for values of L_{WA} as a combination of the standard deviation of reproducibility σ_R and the standard deviation of production σ_p (see clause 3.15).

iv) The procedures for verifying the declared noise emission values as given in clause 6 which are consistent with ISO 7574-4: the single sampling inspection procedure with a sample size (n) equal to 3 and a reference standard deviation σ_M = 2,0 dB.

Take a reasonably large random sample from the batch of new equipment under consideration. Determine the measured value of L_{WAi} for each individual piece of equipment in the sample in accordance with ECMA-74 or ECMA-160. Calculate the arithmetic mean value L_{WAm}:

$$L_{WAm} = \frac{1}{n}\sum_{i=1}^{n} L_{WAi}$$

where n is the number of equipment in the sample.

Calculate the standard deviation of production s_p for the measured values L_{WAi} of the individual equipment in the sample:

$$s_p = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(L_{WAi} - L_{WAm}\right)^2}$$

Calculate the total standard deviation s_t from the standard deviation of production s_p and the standard deviation of reproducibility s_R (estimated to be 1,5 dB, see clause A.1 i):

$$s_t = \sqrt{s_R^2 + s_p^2} = \sqrt{1{,}5^2 + s_p^2}$$

NOTE

The values of L_{WAm} and s_t are estimates of the true mean value μ and the true total standard deviation σ_t of the batch.

Determine the declared A-weighted sound power level L_{WAd} , rounded to 0,1 bel, from the values L_{WAm} and s_t in decibels:

$$L_{WAd} = \frac{1}{10}\left[L_{WAm} + 1{,}5\sqrt{1{,}5^2 + s_p^2} + 0{,}564\left(2{,}0 - \sqrt{1{,}5^2 + s_p^2}\right)\right]$$

NOTE

This equation is based on ISO 7574-4 and results in a 5% risk of rejection for a verification sample of 3.

If the noise from less than 3 machines of a production series has been measured, and there is no prior knowledge of the standard deviation of production, then the manufacturer may determine the declared A-weighted sound power level, L_{WAd} , by substituting the value s_p = 2 dB in the equation above. This substitution results in

$$L_{WAd} = \frac{1}{10}\left[L_{WAm} + 3{,}5\right]$$

The value of 3,5 dB is appropriate for most information technology and telecommunications equipment for which the standard deviation (s_p) is not expected to be greater than 2 dB. Some circumstances which increase the likelihood of s_p exceeding 2.0 dB are: the product emits prominent discrete tones; there is significant structureborne noise; there is fan speed control that is sensitive at the test temperature.

A.2 Determination of the declared A-weighted sound power level L_{WAd} for a specific individually-declared machine

Determine the declared A-weighted sound power level L_{WAd} for a specific individually-declared machine from the measured A-weighted sound power level L_{WA} using the following relation:

$$L_{WAd} \geq \frac{1}{10}\left(L_{WA} + K\right)$$

The value of L_{WAd} for that individual machine is rounded to 0,1 B.

The value of K in the above equation accounts for the random measurement errors occurring under reproducibility conditions, that is, variations in measurement results among different laboratories when measuring the identical machine according to ECMA-74 or ECMA-160 (see clause 3.13). A value of K of 2,5 dB is appropriate for a 5% risk of rejection with s_R = 1,5 dB, (see clause A.1 i).

A.3 Determination of the declared A-weighted sound pressure level L_{pAm} for a batch of equipment

Determine the declared A-weighted sound pressure level L_{pAm} by calculation of the arithmetic mean of the A-weighted sound pressure level L_{pA} at the operator position or bystander positions if no operator position is specified from all the equipment measured in the batch. The value of L_{pAm} is rounded to 1 dB.

A.4 Determination of the declared A-weighted sound pressure level L_{pAm} for a specific individually-declared machine

The declared A-weighted sound pressure level L_{pAm} is the measured A-weighted sound pressure level L_{pA} at the operator position or the energy-averaged A-weighted sound pressure level at the bystander positions if no operator position is specified in accordance with ECMA-74, of the individual equipment. The value of L_{pAm} is rounded to 1 dB.

Annex B

(informative)

Examples of noise emission declarations

Example 1

Where declared noise emission values apply to all variations of a product, no operator position is specified and several printing speeds are available, of which 100 cps is the most frequently used:

Product: Printer Model XYZ

Declared Noise Emission Values per ECMA-109:	Printing/100 cps	Idle
L_{WAd}	7,4 B	5,2 B
L_{pAm} (bystander positions)	62 dB	40 dB.

Example 2

Where different declared noise emission values apply to variations of the product manufactured in different years and operator position is specified:

Product: Personal Computer Model DEF

Declared Noise Emissions Values per ECMA-109:	Operating	Idle
L_{WAd}	5,2 B	4,8 B
L_{pAm} (operator position)	41 dB	37 dB
Year of Manufacture: 1991-1992		
L_{WAd}	5,5 B	5,1 B
L_{pAm} (operator position)	44 dB	40 dB
Year of Manufacture: prior to 1991		

Example 3

Where declared noise emission values apply to a specific individually-declared unit and no operator position is specified:

Product: Custom Designed Computer, Model ABC, Serial Nr. 001

Declared Noise Emissions Value per ECMA-109:	Operating	Idle
L_{WAd}	7,1 B	7,0 B
L_{pAm} (bystander positions)	57 dB	56 dB

Annex C

(informative)

Character of noise

This annex presents optional information which may be provided in addition to the declared noise emission values. Information on the character of the noise, that is, whether the noise is considered to be impulsive noise or whether it contains prominent discrete tones, may be of interest to the user of the equipment.

National and international organisations have been working on objective methods for rating the subjective character of noise, however a final consensus on the procedure to be applied has not yet been reached. Furthermore, statistical procedures have to be specified for determining a single description for the character of the noise of batches of equipment.

C.1 Determination of the character of noise

For the specified operator or bystander position(s) it shall be determined whether the equipment emits impulsive noise and/or prominent discrete tones.

C.1.1 Impulsive noise parameter

ECMA-74 shall be used to determine whether the noise is impulsive.

C.1.2 Prominent discrete tones

ECMA-74 shall be used to determine whether a prominent discrete tone is present.

C.2 Information on impulsive noise and prominent discrete tones

The declared noise emission values may be supplemented by one of the following statements to describe the character of the noise as determined according to clause C.1:

- no impulsive noise, no prominent discrete tones,
- impulsive noise, no prominent discrete tones,
- prominent discrete tones, no impulsive noise,
- impulsive noise and prominent discrete tones.

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