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Sound system equipment – Electroacoustical transducers – Measurement of suspension parts

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOUND SYSTEM EQUIPMENT – ELECTROACOUSTICAL TRANSDUCERS – MEASUREMENT OF SUSPENSION PARTS

FOREWORD

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International Standard IEC 62459 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

This first edition cancels and replaces the IEC/PAS 62459 published in 2006. It constitutes a technical revision. The main changes are listed below:

– descriptions of the methods of measurement are adjusted to the state of the technology;
– addition of Clauses 5 to 13;
– integration of Annex A “Code of practice” at the main part of the standard;
– overall textual review.

The text of this standard is based on the following documents:

FDIS	Report on voting
100/1625/FDIS	100/1648/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of November 2011 have been included in this copy.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

The properties of the suspension parts such as spiders and surrounds have a significant influence on the final sound quality of the loudspeaker. This International Standard defines measurement methods and parameters required for development and quality-assurance by suspension-part manufacturers and loudspeaker manufacturers.

Static and dynamic methods have been developed for measuring the suspension parts at small and high amplitudes. Due to the visco-elastic properties of the suspension material (fabric, rubber, foam, paper) the measurement results depend on the measurement conditions and are not comparable between different methods. For example, the properties measured by static method significantly deviate from the dynamic behaviour of the suspension material when excited by an audio signal. This standard defines the terminology, the characteristics which should be specified and the way the results should be reported. The goal is to improve the reproducibility of the measurement, to simplify the interpretation of the results and to support the communication between manufacturers of suspension parts and complete drive units.

SOUND SYSTEM EQUIPMENT – ELECTROACOUSTICAL TRANSDUCERS – MEASUREMENT OF SUSPENSION PARTS

1 Scope

This International Standard applies to the suspension parts of electroacoustic transducers (for example, loudspeakers). It defines the parameters and measurement method to determine the properties of suspension parts like spiders, surrounds, diaphragms or cones before being assembled in the transducer. The measurement results are needed for engineering design purposes and for quality control. Furthermore, this method is intended to improve the correlation of measurements between suspension-part manufacturers and loudspeaker manufacturers.

The measurement methods provide parameters based on linear and nonlinear modelling of the suspension part and uses both static and dynamic techniques.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60268-1, *Sound system equipment – Part 1: General*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
suspension part
surround of the cone made of rubber, foam, paper and fabric and the spider which is usually made out of impregnated fabric

3.2
displacement
x
perpendicular direction at the inner rim of the suspension part

3.3
peak displacement
x_{peak}
peak value of the displacement occurring during a dynamic measurement at resonance frequency

3.4
driving force
F
total effect of the restoring force, friction and inertia of both the suspension part and the inner clamping parts at the neck of the suspension

3.5
transfer function
***H*(*f*)**
amplitude response given by

$$H(f) = \frac{|X(j\omega)|}{|F(j\omega)|} \tag{1}$$

between the displacement spectrum $X(\mathrm{j}\omega) = FT\{x(t)\}$ and the force spectrum $F(\mathrm{j}\omega) = FT\{F(t)\}$

3.6
dynamic stiffness
$K(x_{ac})$
reciprocal of the dynamic compliance $C(x_{ac})$; it is the ratio of instantaneous force F_{ac} to instantaneous displacement x_{ac}, for an a.c. excitation signal at point x_{ac}, given by the following equation

$$K(x_{ac}) = \frac{1}{C(x_{ac})} = \frac{F_{ac}}{x_{ac}} \tag{2}$$

NOTE The dynamic stiffness $K(x_{ac})$ corresponds to the secant between origin and working point defined by x_{ac} in the force-displacement curve.

3.7
incremental stiffness
$K_{inc}(x_{dc})$

reciprocal of the incremental compliance $C_{inc}(x_{dc})$; it is the ratio of a small a.c. force F_{ac} to the small a.c. displacement x_{ac} produced by it at working point x_{dc} under steady-state condition as given by the following equation

$$K_{inc}(x_{dc}) = \frac{1}{C_{inc}(x_{dc})} = \frac{F_{ac}}{x_{ac}} \tag{3}$$

NOTE The incremental stiffness $K_{inc}(x_{dc})$ corresponds to the gradient at the working point defined by x_{dc} in the force-deflection curve.

3.8
static stiffness
$K_{static}(x_{dc})$
reciprocal of the static compliance $C_{static}(x_{dc})$; it is the ratio of a d.c. force F_{dc} and the d.c. displacement x_{dc} produced by it at the working point x_{dc} under steady-state condition; the static stiffness $K_{static}(x_{dc})$ corresponds to the secant between origin and working point in the force-displacement curve, given by the following equation

$$K_{static}(x_{dc}) = \frac{1}{C_{static}(x_{dc})} = \frac{F_{dc}}{x_{dc}} \tag{4}$$

3.9
moving mass
m
defined by

$$m = \delta m_s + m_c \tag{5}$$

where
m_s is the mass of the suspension part,
m_c is the additional mass of the inner clamping parts,
δ is the clamping factor (with $0 < \delta \le 1$), describing the fraction of the suspension which contributes to the moving mass.

NOTE If factor δ is not known, the moving mass is approximated by using the total weight of the suspension part (δ = 1) and ensuring that the mass, m_c, of the inner clamping part dominates the moving mass, m ($m_c >> m_s$).

3.10
resonance frequency
***f*R**
frequency of an a.c. displacement x_{ac} at which the restoring force, $F_K = K(x_{ac})x_{ac}$ of the suspension part equals the inertia of the moving mass, m, given by the following equation

$$F_K = K(x_{ac})x_{ac} = m\frac{d^2 x_{ac}}{dt^2} \tag{6}$$

3.11
lowest cone resonance frequency
***f*0**
frequency at which the cone mass and suspension stiffness resonate

NOTE The lowest cone resonance frequency can be approximated by

$$f_0 \approx \frac{1}{2\pi}\sqrt{\frac{K(x_{off})}{\delta m_s}} \tag{7}$$

using the stiffness $K(x_{off})$ at the offset x_{off} due to gravity, the clamping factor δ and the cone mass m_s.

3.12
effective stiffness
***K*eff**
stiffness given by

$$K_{eff}(x_{peak}) = (2\pi f_R)^2 m \tag{8}$$

describing the conservative properties of the suspension part performing a vibration at the resonance frequency, f_R, using the moving mass, m

NOTE The effective stiffness, $K_{eff}(x_{peak})$, or the reciprocal, compliance, $C_{eff}(x_{peak}) = 1/K_{eff}(x_{peak})$, are integral measures of the corresponding non-linear parameters, $K(x)$ and $C(x)$, in the working range used, defined by the peak value, x_{peak}. The effective parameters are directly related to the resonance frequency and may be measured with minimal equipment. However, the effective parameters can only be compared if the measurements are made at the same peak displacement, x_{peak}.

3.13
loss factor
Q
factor estimated by the ratio

$$Q = \frac{|H(f_R)|}{|H(f_{dc})|} \tag{9}$$

between the magnitude of the transfer function, $H(f_R)$, at resonance frequency, f_R, and the magnitude of the transfer function, $H(f_{dc})$, at very low frequencies, f_{dc} (with $f_{dc} << f_r$).

NOTE If the losses are sufficiently high ($Q > 2$), the transfer function, $H(f)$, has a distinct maximum (peak) at the resonance frequency, f_R.

3.14
mechanical resistance
R
given by

$$R = \frac{2\pi f_R m}{Q} \tag{10}$$