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colour inside

Sound system equipment – Electroacoustical transducers – Measurement of large signal parameters

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOUND SYSTEM EQUIPMENT – ELECTROACOUSTICAL TRANSDUCERS – MEASUREMENT OF LARGE SIGNAL PARAMETERS

FOREWORD

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International Standard IEC 62458 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

This first edition cancels and replaces IEC/PAS 62458 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 4 to 15;
– integration of Annex A in the main body of the standard;
– overall textual review.

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

FDIS	Report on voting
100/1624/FDIS	100/1647/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- withdrawn,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.

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

Electro-mechanical-acoustical transducers such as loudspeaker drive units, loudspeaker systems, headphones, micro-speakers, shakers, and other actuators behave in a nonlinear manner at higher amplitudes. This limits the acoustical output and generates nonlinear signal distortion. Linear models fail in describing the large signal behaviour of such transducers and extended models have been developed which consider dominant nonlinearities in the motor and suspension. The free parameters of the large signal model have to be measured on the particular transducer by using static or dynamic methods. The large signal parameters show the physical cause of the signal distortion directly and are very important for the objective assessment of sound quality and failure diagnostics in development and manufacturing. Furthermore, the model and parameters identified for a particular transducer are the basis for predicting the maximum output and signal distortion for any input signal. The close relationship between causes and symptoms simplifies the interpretation of the harmonic and intermodulation distortion measured according to IEC 60268-5. Large signal parameters are valuable input data for the synthesis of loudspeaker systems and the development of electrical control systems dedicated to loudspeakers.

SOUND SYSTEM EQUIPMENT – ELECTROACOUSTICAL TRANSDUCERS – MEASUREMENT OF LARGE SIGNAL PARAMETERS

1 Scope

This International Standard applies to transducers such as loudspeaker drive units, loudspeaker systems, headphones, micro-speakers, shakers and other actuators using either an electro-dynamical or electro-magnetic motor coupled with a mechanical suspension. The large signal behaviour of the transducer is modelled by a lumped parameter model considering dominant nonlinearities such as force factor, stiffness and inductance as shown in Figure 1. The standard defines the basic terms and parameters of the model, the methods of measurements and the way the results should be reported.

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.

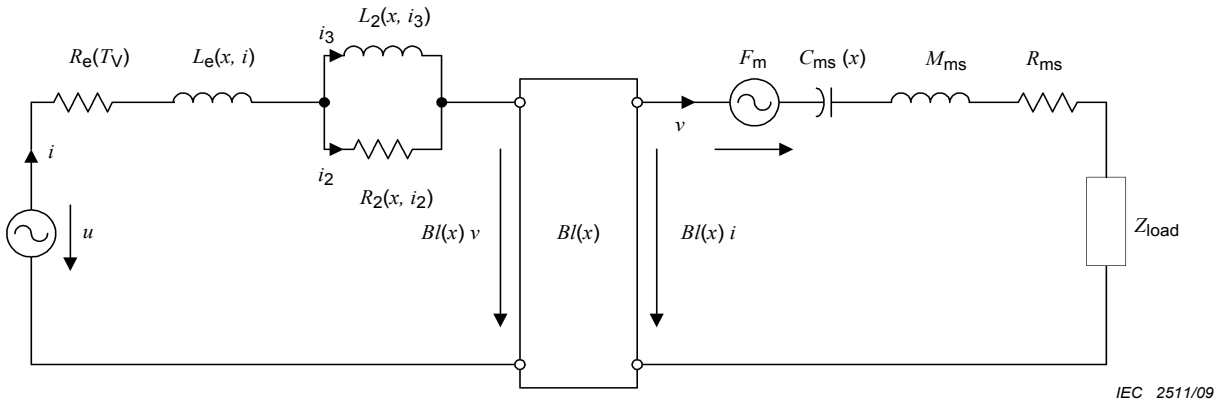
IEC 60268-1, *Sound system equipment – Part 1: General*

IEC 60268-5:2003, *Sound system equipment – Part 5: Loudspeakers*
Amendment 1 (2007)

3 Terms and definitions

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

3.1
electro-mechanical equivalent circuit
electrical circuit of an electro-dynamical transducer, as shown in Figure 1



NOTE 1 This Figure shows an example of a lumped parameter model of an electro-dynamical transducer considering the dominant nonlinearities.

NOTE 2 Other equivalent circuits can be applied. Contrary to the results of linear modelling some parameters of the lumped elements are not constant but depend on instantaneous state variables (such as displacement x, velocity v, current i).

Figure 1 – Electro-dynamical transducer

3.2
input current and voltage
i, u
electrical state variables at the terminals of the transducer

3.3 displacement
x
deflection of the voice coil from the rest position

3.4
velocity
v
time derivative of displacement x

3.5
d.c. resistance
R_e
electrical impedance $Z_e(s)$ at very low frequencies where the effect of the back EMF can be neglected

NOTE Electrical impedance can be used for measuring the d.c. resistance R_e of the voice coil. The d.c. resistance R_e depends on the mean voice coil temperature T_V.

3.6
nonlinear inductance and losses
nonlinear elements to model the effect of the magnetic a.c. field, the losses in the magnetic material, and the losses caused by eddy currents where the equivalent circuit in Figure 1 uses the LR-2 model comprising the inductance $L_e(x, i)$, the inductance $L_2(x, i_2)$ and additional resistance $R_2(x, i_3)$

3.7
nonlinear force factor
$Bl(x)$
dependency of instantaneous force factor $Bl(x)$ on voice coil displacement x defined by the integral of magnetic flux density B versus the voice-coil conductor of length l

NOTE The product of force factor $Bl(x)$ and velocity v is the back EMF generated on the electrical side in an equivalent circuit as shown in Figure 1. The product of force factor $Bl(x)$ and input current i gives the electro-dynamical driving force of the mechanical system.

3.8
reluctance force
F_m
additional electro-magnetic driving force caused by the displacement varying inductances $L_e(x, i)$ and $L_2(x, i_2)$

3.9
stiffness, $K_{ms}(x)$, of the suspension
ratio between the instantaneous restoring force $F(x)$ and the displacement x as given by

$$K_{ms}(x) = \frac{F(x)}{x} \tag{1}$$

NOTE The nonlinear compliance $C_{ms}(x) = 1/K_{ms}(x)$ is the reciprocal quantity of the mechanical stiffness.

3.10
mechanical mass
M_{ms}
total moving mass including the mass of the moving assembly and the reactive part of the air load on both sides of the diaphragm

3.11
mechanical resistance
R_{ms}
non-electrical losses of the driver, due to suspension, turbulences and radiation

3.12
mechanical impedance
Z_{load}
mechanical impedance which may represent any additional load caused by mechanical elements (cone, panel) or acoustical elements (such as a vented enclosure or horn)

4 Test signals

4.1 General

The measurement of the large signal parameters requires an electrical, mechanical or acoustical stimulus. Depending on the method used for the measurement of the large signal parameters different kind of test signals are used as stimulus for the excitation of the transducer. Since the loudspeaker behaves as a time-varying system the stimulus may cause a permanent or temporary change of the loudspeaker properties. Thus, the properties of the stimulus (spectral bandwidth, crest factor, proability density function) shall be statet. The same stimulus should be used if the numerical values of the results should be compared from two measurements.

4.2 Large d.c. signal

A constant d.c. voltage or d.c current of defined magnitude and sufficient duration is supplied to the electrical terminals to measure the steady-state response of the transducer. If the transducer is mounted in a sealed enclosure a difference between the static air pressures inside and outside the enclosure may be used as d.c. stimulus.

4.3 Large d.c. signal and small a.c. signal

A constant d.c. signal of defined magnitude and sufficient duration (see 4.2) superimposed with a small a.c. signal is used as stimulus. The a.c. signal (such as noise, sinusoidal sweep, impulsive test signals) should have sufficient bandwidth to identify all parameters of the loudspeaker model.

4.4 Broadband noise signal

One of the noise signals defined in IEC 60268-1 or any other noise having sufficient bandwidth and amplitude may be used as stimulus. The crest factor of the noise should be less than 4 to reduce clipping in the amplifier.

4.5 Music

Ordinary music, speech of sufficient bandwidth and amplitude may be used as a stimulus.

NOTE The dynamic methods need a stimulus which provides persistent excitation of the loudspeaker to identify the parameters correctly. The stimulus should have enough spectral components at least one octave below resonance frequency f_s and one decade above f_s.