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INTERNATIONAL STANDARD

Sound system equipment –
Part 4: Microphones

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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FOREWORD

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International Standard IEC 60268-4 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

This fourth edition cancels and replaces the third edition published in 2004, and constitutes a technical revision.

The main changes with respect to the previous edition are the following:

– correction of noise measurement,
– added annex for digital microphones,
– added requirement for tolerances in data to be specified.

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

FDIS	Report on voting
100/1678/FDIS	100/1707/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.

A list of all parts of the IEC 60268 series, under the general title "*Sound system equipment*", can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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 edition of this document may be issued at a later date.

SOUND SYSTEM EQUIPMENT –

Part 4: Microphones

1 Scope

This part of IEC 60268 specifies methods of measurement for the electrical impedance, sensitivity, directional response pattern, dynamic range and external influences of sound system microphones, and also details the characteristics to be specified by the manufacturer.

It applies to sound system microphones for all applications for speech and music. It does not apply to measurement microphones, but it does apply to each audio channel of microphones having more than one channel, for example for stereo or similar use. It is also applicable to flush-mounted microphones and to the analogue characteristics of microphones with digital audio output.

For the purposes of this International Standard, a microphone includes all such devices as transformers, pre-amplifiers, or other elements that form an integral part of the microphone, up to the output terminals specified by the manufacturer.

NOTE The characteristics specified in this standard do not completely describe the subjective response of the microphone. Further work is necessary to find new definitions and measurement procedures for a later replacement by objective characteristics of at least some of the subjective descriptions used to describe microphone performance.

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 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements*
Amendment 1 (2005)

IEC 60268-1:1985, *Sound system equipment – Part 1: General*
Amendment 1 (1988)
Amendment 2 (1988)

IEC 60268-2:1987, *Sound system equipment – Part 2: Explanation of general terms and calculation methods*
Amendment 1 (1991)

IEC 60268-3:2000, *Sound system equipment – Part 3: Amplifiers*

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

IEC 60268-11:1987, *Sound system equipment – Part 11: Application of connectors for the interconnection of sound system components*
Amendment 1 (1989)
Amendment 2 (1991)

IEC 60268-12:1987, *Sound system equipment – Part 12: Application of connectors for broadcast and similar use*
Amendment 1 (1991)
Amendment 2 (1994)

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
Amendment 1 (2007)

IEC 61265:1995, *Electroacoustics – Instruments for measurement of aircraft noise – Performance requirements for systems to measure one-third-octave-band sound pressure levels in noise certification of transport-category aeroplanes*

IEC 61938:1996, *Audio, video and audiovisual systems – Interconnections and matching values – Preferred matching values of analogue signals*

ISO 354:2003, *Acoustics – Measurement of sound absorption in a reverberation room*

ITU-T Recommendation P.51:1996, *Artificial mouth*

3 General conditions

3.1 General

Special reference is made to IEC 60268-1, concerning:

- units and system of measurement;
- frequencies of measurement;
- quantities to be specified and their accuracy (see also 4.7);
- marking (see also 6.1);
- ambient conditions;
- filters, networks and measuring instruments for noise specification and measurement;
- individual specifications and type specifications;
- graphical presentation of characteristics;
- scales for graphical presentation;
- personal safety and prevention of spread of fire;
- method of producing a uniform alternating magnetic field;
- search coils for measuring the magnetic field strength,

and to IEC 61938 concerning powering of microphones.

3.2 Measurement conditions

3.2.1 General

For convenience in specifying how microphones shall be set up for measurement, a set of conditions has been defined in this recommendation under the title of "rated conditions".

Three ratings are basic to the formulation of these concepts:

– rated impedance (see 9.2);
– rated power supply (see 8.1);
– rated sensitivity (see 10.3.1).

To obtain the correct conditions for measurement, the above mentioned ratings shall be taken from the specifications supplied by the manufacturer of the equipment.

The term "rated" applied to other characteristics relates to the specification or measurement of the particular characteristic under rated conditions or under conditions unambiguously connected to them. This applies, for example, to the following two characteristics:

– rated output voltage;
– rated equivalent sound pressure level due to inherent noise.

Methods of measurement are given in this standard for electrical impedance, sensitivity, directional pattern, dynamic range and external influences. Where alternative methods are given, the chosen method shall be specified.

3.2.2 Rated conditions

The microphone is understood to be working under rated conditions when the following conditions are fulfilled:

– the microphone shall operate under no-load conditions (see 9.2);
– if the microphone needs a power supply, this shall be the rated power supply;
– the microphone (except a close-talking microphone) shall be placed in a sound field meeting the free-field conditions in 4.5.2, the waves having zero degree incidence with respect to the reference direction;
– the undisturbed sound pressure (in the absence of the microphone) in the sound field at the reference point of the microphone shall be sinusoidal and set at a level of 1 Pa (94 dB SPL);
– for close-talking microphones, the microphone shall be placed at a stated distance, no more than 25 mm from the artificial mouth complying with ITU-T P.51, and the undisturbed sound pressure in the sound field at the reference point of microphone shall be sinusoidal and set at a level of 3 Pa (104 dB SPL);
– if a special microphone needs a different measurement level, this shall be stated in the technical data together with the reason for this. Levels related to the normal reference level of 94 dB by multiples of 10 dB are preferred;
– controls, if any, shall be set to the position recommended by the manufacturer;
– in the absence of a clear reason to the contrary, the measurement frequency shall be 1 000 Hz (see IEC 60268-1);
– the ambient pressure, the relative humidity and the ambient temperature shall be within the limits given in IEC 60268-1, and shall be stated;
– measurements may be made at a sound pressure of 0,3 Pa if this is necessary due to limitations of the performance of the loudspeaker.

NOTE 1 An artificial voice which emits a signal simulating that emitted by the nose should be used for measuring pressure-gradient close-talking microphones to ensure that nasal sounds are adequately reproduced. The absence of such sounds in the reproduction may give rise to unnatural speech quality.

NOTE 2 Limitations of the measurement site or the measurement equipment may also require the use of other than the given measurement sound pressure levels. This is acceptable only if any change in performance between the level used and the reference level are known with the necessary accuracy for the relevant characteristics.

4 Particular conditions

4.1 Pre-conditioning

A microphone with preamplifier shall be switched on for the period of time specified by the manufacturer, before measurements are made, to allow the components to reach the stationary temperature for rated conditions. If the manufacturer specifies no period, a period of 10 s shall be allowed for stabilization. If the microphone contains a vacuum tube or other heating device the time shall be 10 min.

4.2 Sound source

The sound source shall be capable of producing at the microphone position the sound pressure level as defined for rated conditions. The amplitude non-linearity of the sound source shall be held to such a value that the effect on the measured response does not exceed 0,5 dB. If the conditions of measurement preclude the possibility of securing sufficiently low distortion, a narrow-band filter may be used at the microphone output terminals, which allows the response at the fundamental frequency to be measured.

For free-field calibration and calibration of performance microphones, the sound source shall be contained in an enclosure which radiates sound from one well-defined opening only, and such an opening shall be radially symmetrical with respect to the axis of the reference direction of the microphone.

4.3 Measurement of sound pressure

A calibrated reference pressure microphone shall be used to measure the sound pressure. The reference microphone should be calibrated with an accuracy of ±1 dB or better.

4.4 Voltage measuring system

The electromotive force (e.m.f.) generated by the microphone, when in a sound field, shall be determined by measuring the open-circuit voltage of the microphone using a voltmeter with an input impedance of at least 100 times the rated impedance of the microphone. If external equipment, such as a power supply, places a load on the microphone, the true e.m.f. shall be calculated by correcting for the effect of this load.

4.5 Acoustical environment

4.5.1 General

The microphone can be measured in different acoustical environments:

a) in a free field or similar with neglectable boundary effects, e.g. by using special computer-generated sound source signals:
   - spherical waves, or
   - plane waves, or
   - waves produced by a specific sound source (artificial mouth or artificial head);

b) in a diffuse field;

c) coupled to a sound source by means of a small cavity (coupler).

4.5.2 Free-field conditions

4.5.2.1 General

A free-field sound wave is normally divergent in character. In certain circumstances it can approximate an ideal plane wave.

Free-field conditions can be obtained:

– in open air, ambient noise and wind permitting, or
– in an anechoic room, or
– in a duct.

A sound source of small dimensions with respect to the wavelength produces a spherical wave in these environments. The spherical wave can be approximated to a plane wave in a region of measurement located at a sufficient distance from the source. Spherical waves can be used to measure pressure microphones but it is necessary to use almost perfect plane waves in the low frequency range for the measurement of pressure gradient microphones.

For microphones responding both to pressure and to pressure gradient, having a sufficiently flat frequency response in a plane-wave free sound field (i.e. at a sufficient distance from the source), the response as a function of frequency f of distance r from a centre of spherical diverging waves and of angle of incidence θ of the waves at the microphone, can be given in a complex form:

$$(1-B)+B\left(1+\frac{1}{\mathrm{j}kr}\right)\cos\theta$$

where

$1-B$ is the contribution of the pressure component;
B is the contribution of the pressure gradient component;
k = $2\pi/\lambda$ or $2\pi f/v$;
B = 0 for the omnidirectional pressure type;
B = 0,5 for the cardioid type;
B = 1 for the bidirectional pressure gradient type.

At low frequencies, it becomes difficult to realize plane wave conditions in an anechoic room. A plane wave at low frequencies, below the cut-off frequency of the anechoic room, can therefore be better produced under other conditions.

Free-field conditions are considered to be sufficiently realized in the region around the microphone if the following conditions are met:

– within a distance of 200 mm in front, behind, right, left, above and below the position of the microphone the sound pressure level is measured at every measuring frequency by means of a pressure transducer;
– the axis of the transducer shall point towards the reference point of the loudspeaker (see IEC 60268-5);
– the corresponding sound pressure levels on axis positioned at different distances from the loudspeaker shall not differ by more than 0,5 dB from the calculated levels in the ideal sound field;
– the values at a nearly constant distance to the sound source, right, left, above and below the microphone shall not differ by more than 1 dB from the level at the reference point of the microphone.

4.5.2.2 Spherical waves

The sound pressure generated in a free field by an omnidirectional sound source varies inversely with the distance from the acoustic centre of the sources.

The output voltage of the microphone varies inversely with the distance between the source and the microphone when the relevant dimensions of both are small compared with the wavelength, allowing the results from the measurements made at a certain distance r to be converted by calculation to results which would be obtained at the reference distance.

When either the circumference of the radiating surface of the source or the circumference of the principal acoustic entry of the microphone exceeds the wavelength, this computation applies only when the measuring distance conforms to:

$$r \geq d$$

$$r \geq d^2 / \lambda$$

where

r is the distance from the source to the measuring point;

d is the effective diameter of the sound source;

λ is the sound wavelength.

NOTE It is advisable for the distance from the source to the measuring point to exceed three times the largest dimension of the radiating surface of the source.

4.5.2.3 Plane progressive waves

A plane progressive wave can be obtained either in a duct or in a free field.

a) In a duct

In designing a duct capable of producing useful results, there are many problems to be solved such as the design of the terminating impedance, the avoidance of cross-modes, the shape of the original wavefront and the relative dimensions of the duct and the microphone.

b) In a free field

A spherical wave at a distance of at least half the wavelength from the centre of curvature at the lowest frequency of measurement is a practical approximation to a plane progressive wave.

NOTE It should be understood that for measurement of "shotgun" types and pressure zone microphones, determining the smallest permitted distance is complicated and no exact rules can be given. Therefore, in these cases the measuring distance used should be stated.

4.5.2.4 Use of an artificial mouth

In order that the conditions of test may be similar to those of actual use, it is necessary to introduce an obstacle in the shape of a human head when measuring close-talking microphones by means of an artificial mouth (see Note 1 to 3.2.2).

4.5.3 Diffuse field conditions

Some measurements can be made in a diffuse field in which sound waves are propagated with random incidence. In this case, bands of noise of third-octave width or broadband signals together with suitable filtering shall be used.

A diffuse sound field can be approximately realized in a reverberant room characterized by a sufficiently long duration of reverberation at a sufficiently large distance from the source and the walls, and above a limiting frequency (see also ISO 354).

The reverberation time T of the empty room is specified in Table 1.