

Acoustics — Determination of sound power radiated into a duct by fans — In-duct method

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National foreword

This British Standard has been prepared under the direction of the Environmental and Pollution Standards Policy Committee. It is the English language version of EN 25136:1993 *Acoustics — Determination of sound power radiated into a duct by fans — In-duct method*, published by the European Committee for Standardization (CEN), which endorses ISO 5136:1990 *Acoustics — Determination of sound power radiated into a duct by fans — In-duct method*, incorporating Technical Corrigendum 1, published by the International Organization for Standardization (ISO).

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the EN title page, pages 2 to 28, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Descriptors: Acoustics, ventilators, pipelines, acoustic tests, acoustic measurements, sound power, noise, sound

English version

Acoustics — Determination of sound power radiated into a duct by fans — In-duct method

(ISO 5136:1990 and Technical Corrigendum 1:1993)

Acoustique — Détermination de la puissance acoustique rayonnée dans un conduit par des ventilateurs — Méthode en conduit
(ISO 5136:1990 et Rectificatif
Technique 1:1993)

Akustik — Ermittlung der von Ventilatoren in Kanäle abgestrahlten Schalleistung — Kanalverfahren
(ISO 5136:1990 und Technisches
Korrigendum 1:1993)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

Following the positive result of the CEN/CS proposal, the Technical Board of CEN(BT) decided to submit the International Standard ISO 5136:1990 *Acoustics — Determination of sound power radiated into a duct by fans — In-duct method* to the formal vote.

BT decided to approve the endorsement of ISO 5136:1990 and its Technical Corrigendum 1:1993 as a European Standard.

This European Standard has been prepared under a mandate given to CEN by the Commission of the European Communities and the European Free Trade Association, and supports essential requirements of EC Directive(s).

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 1994, and conflicting national standards shall be withdrawn at the latest by May 1994.

In accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Switzerland and United Kingdom.

1 Scope

1.1 Measurement conditions

This International Standard specifies a method for testing ducted fans to determine the sound power radiated into an anechoically-terminated duct on the inlet and/or outlet side of the equipment. It applies to fans which emit steady, broad-band, narrow-band and discrete-frequency sound. It applies to air temperatures between $-50\text{ }^{\circ}\text{C}$ and $+70\text{ }^{\circ}\text{C}$.

The test duct diameter range is from 0,15 m to 2 m. The maximum flow velocity is 30 m/s and the maximum swirl angle is 15° . An example of a method for determining the angle of swirl is given in Annex F.

The one-third octave band centre frequency range is from 50 Hz to 10 000 Hz.

NOTE The flow noise suppression of the sampling tube (see 6.2.1) may be insufficient at higher velocities and at higher angles of swirl.

1.2 Types of source

The method applies to a sound source in which a fan is usually connected to ducts on at least one side.

Examples of the ducted fans and fan equipment covered by this International Standard are

- ducted centrifugal fans;
- ducted axial flow fans;
- ducted mixed flow fans.

This International Standard may also apply to other aerodynamic sources, such as boxes, dampers and throttle devices.

This International Standard does not apply to non-ducted fans or non-ducted fan equipment.

1.3 Precision of the method of measurement

The precision of the method of measurement is given in terms of the standard deviation of the sound power level. It includes the effects of end reflections, transitions, the possible errors in computing sound power from pressure measurements, and the tolerance of the instrument calibration. The estimated standard deviations are given in Table 1.

Table 1 — Precision of the method of measurement

One-third octave band centre frequency Hz	Standard deviation dB
50	3,5
63	3
80; 100	2,5
125 to 4 000	2
5 000	2,5
6 300	3
8 000	3,5
10 000	4

The standard deviations given in Table 1 reflect the cumulative effects of all causes of measurement uncertainty, excluding variations in the sound power from machine to machine or from test to test which may be caused, for example, by changes in the mounting or operating conditions of the source.

NOTE 1 The standard deviations given in Table 1 are derived from information in [3], [5] and [19].

NOTE 2 The precision data will increase in the presence of swirling flows.

NOTE 3 If discrete frequency components are present or if measurements are not averaged over a sufficiently long period, the precision will be less than that indicated.

NOTE 4 At high frequencies, particularly above about 4 000 Hz, the precision data quoted in Table 1 may increase when the noise spectrum being measured decreases rapidly with frequency. Under these conditions, the high-frequency sound pressure levels sensed by the microphone can be of small magnitude compared with those at lower frequencies, and electrical noise, particularly from the frequency analyser, can interfere with the sound signal at these high frequencies. In order to achieve correct determinations of sound power it may be necessary to repeat the high-frequency sound measurement by passing the microphone signal through a high pass filter before it is analysed by the frequency analyser.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 266:1975, *Acoustics — Preferred frequencies for measurements*.

ISO 5221:1984, *Air distribution and air diffusion — Rules to methods of measuring air flow rate in an air handling duct*.

ISO 7235:—, *Acoustics — Measurement procedures for ducted silencers — Insertion loss, flow noise and total pressure loss*¹⁾.

IEC 225:1966, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations*.

IEC 651:1979, *Sound level meters*.

3 Definitions and symbols

For the purposes of this International Standard, the following definitions and symbols apply.

3.1

fan inlet [outlet] area, S_f

the area of the fan fitting provided for connection to attached ductwork

3.2 ducts

Any of the airways defined in 3.2.1, 3.2.2 and 3.2.3.

3.2.1

test duct

the duct in which the fan sound power is measured. It has an anechoic termination

3.2.2

terminating duct

the duct opposite to the test duct, if both sides of the fan are ducted. It has an anechoic termination

3.2.3

intermediate duct

the duct fitted on the intake side and on the discharge side of the fan to ensure desired flow conditions. It connects to the test duct or the terminating duct, if necessary by a transition section (see Figure 1)

3.3

measurement plane

the radial plane in the test duct in which the microphone diaphragm is located

3.4

sound pressure level, L_p , in decibels

ten times the logarithm to the base 10 of the ratio of the mean-square sound pressure of a sound to the square of the reference sound pressure. The width of a restricted frequency band shall be indicated, for example one-third octave band pressure level, A-weighted sound pressure level, etc. The reference sound pressure is 20 μ Pa

L_{p1} , L_{p2} , L_{p3} , are the sound pressure levels at each of the three measurement positions in the test duct

$\overline{L_{pm}}$ is the spatially averaged sound pressure level obtained from averaging over the measurement positions in the test duct. It may also be obtained from a continuous circumferential traverse (see 6.2.4)

$\overline{L_p}$ is the spatially averaged sound pressure level at the measurement plane, corrected for the combined free-field response C (see 3.9 and 7.1)

¹⁾ To be published.

3.5**sound power level, L_W** , in decibels

ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power. The width of a restricted frequency band shall be indicated, for example one-third octave band power level, A-weighted sound power level, etc. The reference sound power is 1 pW

3.6**fan sound power**

the sound power radiated into the test duct by the fan

3.7**frequency range of interest**

for general purposes, the frequency range of interest includes the one-third octave bands with centre frequencies between 100 Hz and 10 000 Hz. For special purposes, the frequency range of interest may be extended down to 50 Hz. For fans which radiate predominantly high- or low-frequency sound, the frequency range of interest may be limited in order to reduce the costs of the test facilities and procedures. The limits of the restricted frequency range shall be given in the test report

3.8**sampling tube**

a tubular windscreen to be attached to a standard microphone designed to minimize its sensitivity to flow noise

3.9 Further symbols

- C_1 correction supplied by the manufacturer to be added to the calibrated microphone response to obtain the free field response, expressed in decibels
- C_2 frequency response correction of the sampling tube of normal incidence, expressed in decibels, to be added to the calibrated microphone response [see 4.3.3 c)]
- C_3 flow velocity correction for the frequency response required by the use of the sampling tube, expressed in decibels (see Table 5)
- C_4 modal correction for the frequency response required by the use of the sampling tube, expressed in decibels (see Table 6)
- $C = C_1 + C_2 + C_3 + C_4$ combined frequency response correction, expressed in decibels
- c speed of sound in the test duct
- ρ fluid density in the test duct
- d diameter of the fan inlet, fan outlet, test duct, intermediate ducts, terminating ducts (see Figure 1)
- l length of the ducts and transitions (see Figure 1)
- r radial distance from the test duct centreline to the sampling tube centreline
- r_a pressure reflection coefficient defined as the ratio of the sound pressure amplitude of the sound wave reflected from the anechoic termination to the sound pressure amplitude of the incident wave
- b, h cross-dimensions of the rectangular fan inlet or fan outlet

4 Test facilities and instrumentation**4.1 General requirements**

The test arrangement shall consist of the fan to be tested, an intermediate duct, the test duct with anechoic termination, and the instrumentation (see Figure 1). If a fan usually used with duct work on both sides is to be tested, a termination duct with anechoic termination plus an intermediate duct shall be connected opposite to the side on which the sound power is determined.

All connections between the fan and the ducts shall be firm, unless a vibration-isolating coupling is an inherent part of the fan. The test ducts shall include provisions for mounting the microphone and sampling tube at the locations specified in 5.2.