SWEDISH STANDARDS INSTITUTE

# SVENSK STANDARD
# SS-EN ISO 5136

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Utgåva 1

**Akustik – Bestämning av ljudeffektnivåer från fläktar i ventilationsanläggningar – Mätning i kanal** (ISO 5136:2003)

**Acoustics – Determination of sound power radiated into a duct by fans and other air-moving devices – In-duct method** (ISO 5136:2003)

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The European Standard EN ISO 5136:2003 has the status of a Swedish Standard. This document contains the official English version of EN ISO 5136:2003.

This standard supersedes the Swedish Standard SS-EN 25136, edition 1.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN ISO 5136

April 2003

ICS 17.140.20; 23.120

Supersedes EN 25136:1993

English version

## Acoustics - Determination of sound power radiated into a duct by fans and other air-moving devices - In-duct method (ISO 5136:2003)

Acoustique - Détermination de la puissance acoustique rayonnée dans un conduit par des ventilateurs et d'autres systèmes de ventilation - Méthode en conduit (ISO 5136:2003)

Akustik - Bestimmung der von Ventilatoren und anderen Strömungsmaschinen in Kanäle abgestrahlten Schallleistung - Kanalverfahren (ISO 5136:2003)

This European Standard was approved by CEN on 11 March 2003.

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Ref. No. EN ISO 5136:2003 E

## Contents

# Foreword

This document (EN ISO 5136:2003) has been prepared by Technical Committee ISO/TC 43 "Acoustics" in collaboration with Technical Committee CEN/TC 211 "Acoustics", the secretariat of which is held by DS.

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of an identical text or by endorsement, at the latest by October 2003, and conflicting national standards shall be withdrawn at the latest by October 2003.

This document supersedes EN 25136:1993.

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

**NOTE FROM CMC** The foreword is susceptible to be amended on reception of the German language version. The confirmed or amended foreword, and when appropriate, the normative annex ZA for the references to international publications with their relevant European publications will be circulated with the German version.

## Endorsement notice

The text of ISO 5136:2003 has been approved by CEN as EN ISO 5136:2003 without any modifications.

# Introduction

This International Standard describes a procedure for the measurement of sound pressure levels in the inlet or outlet ducts of a fan and a method to use these sound pressure levels to calculate the sound power levels radiated by the fan to the duct system.

Annex A lists values of coefficients for the determination of the combined mean flow velocity and modal correction. Annex B specifies two procedures for the determination of the signal-to-noise ratio of sound versus turbulence. A computational procedure for the calculation of the A-weighted sound power level from one-third-octave band levels is given in Annex C. Annex D shows an example of the calculation of the combined mean flow velocity and modal correction.

The sound power radiated into a duct by a fan or other air-moving device depends to some extent on the type of duct, characterized by its acoustical impedance. For a measurement method, the test duct has, therefore, to be clearly specified. In this International Standard, the test duct is of circular cross-section and terminated anechoically. Details of typical anechoic terminations are given in Annex E. The sound power obtained under these special conditions is a representative value for actual applications, as the anechoic termination forms an impedance about midway between the higher and lower impedances found in practice. The sound power radiated in actual applications can, in theory, be estimated from data on air-moving devices and duct impedances. Since this information is at present incomplete, these effects are not usually considered in acoustical calculations.

In order to suppress the turbulent pressure fluctuations at the microphone, the use of a long cylindrical windscreen (“sampling tube”) is preferred. The microphone, with the sampling tube, is mounted at a radial position such that the sound pressure is well related to the sound power by the plane wave formula to an acceptable extent, even in the frequency range in which higher-order acoustic modes are possible.

The uncertainty of measurement (see Clause 4) is given in terms of the standard deviation to be expected if the measurements were repeated in many different laboratories.

The procedures for measuring the operating conditions (performance measurements) are not specified in detail in this International Standard. The operating conditions are specified in ISO 5801.

This International Standard is one of a series specifying different methods for determining the sound power levels of fans and other air-moving devices.

In general, the sound powers radiated from a fan inlet or outlet into free space and into a duct are different because of the reflection of sound energy at the fan inlet or outlet plane when there is no connected duct. The in-duct method according to this International Standard is suitable for determining the sound power radiated into a duct by a fan inlet or outlet. The sound power radiated into free space by a fan inlet or outlet should be determined using the a reverberation room method (ISO 3741, ISO 3743), a free-field method (ISO 3744, ISO 3745, ISO 3746) or a sound intensity method (ISO 9614).

# Acoustics — Determination of sound power radiated into a duct by fans and other air-moving devices — In-duct method

## 1 Scope

### 1.1 General

This International Standard specifies a method for testing ducted fans and other air-moving devices to determine the sound power radiated into an anechoically terminated duct on the inlet and/or outlet side of the equipment.

NOTE 1 For the sake of brevity, wherever the term "fan" occurs in the text, it means "fan or other air-moving device".

The method is applicable to fans which emit steady, broad-band, narrow-band and discrete-frequency sound and to air temperatures between – 50 °C and + 70 °C. The test duct diameter range is from 0,15 m to 2 m. Test methods for small ($d < 0{,}15$ m) and large ($d > 2$ m) test ducts are described in the informative Annexes H and I, respectively.

The maximum mean flow velocity at the microphone head for which the method is suitable depends on the type of microphone shield used, and is as follows:

— foam ball 15 m/s;

— nose cone 20 m/s;

— sampling tube 40 m/s.

Above these values the suppression of turbulent pressure fluctuations by the microphone shield (see 3.9) may be insufficient.

It is expected that sound power tests will be conducted in conjunction with airflow performance tests in accordance with ISO 5801. The ducting arrangement will therefore normally incorporate a "star" type flow straightener on the outlet side of the fan which will minimize swirl (see 7.3). Where it is permissible to delete the straightener as, for example, with large fans to installation category C according to ISO 5801:1997, the method is limited to a swirl angle of 15°. (An example of a method for determining the angle of swirl is given in Annex J.)

NOTE 2 The installation categories defined in ISO 5801 imply that the fan is either ducted on the outlet side only (category B), on the inlet side only (category C) or on both sides (category D).

### 1.2 Types of sound source

The method described in this International Standard is applicable to a sound source in which a fan is connected to ducts on at least one side. It is also applicable to other fan/attenuator combinations or equipment incorporating fans which can be considered as "black boxes".

Examples of fans and other equipment covered by this International Standard are

— ducted centrifugal fans,

— ducted axial flow fans,

- ducted mixed-flow fans,
- ducted air-handling units,
- ducted dust-collection units,
- ducted air-conditioning units, and
- ducted furnaces.

This International Standard is also applicable to other aerodynamic sources such as boxes, dampers and throttle devices provided that a quiet air flow delivered by an auxiliary fan is available, and the signal-to-noise ratio of sound pressures to turbulent pressure fluctuations in the test duct is at least 6 dB (see 7.2.1).

An alternative method to determine the sound power level of the flow-generated noise of such aerodynamic sound sources, which does not require the measurement of sound pressure in a flow environment, is described in ISO 7235. The method was originally devised for the determination of the flow noise level of ducted silencers. The sound power is determined in a reverberation room connected to the test duct via a transition element.

In the case of ducted fans with closely coupled attenuators, the signal-to-noise ratio of sound pressures to turbulent pressures may be insufficient when using the in-duct method. Therefore the method described in ISO 7235 is recommended for such fan/attenuator combinations.

This International Standard is not applicable to non-ducted fans or equipment.

## 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.

ISO 266, *Acoustics — Preferred frequencies*

ISO 5801:1997, *Industrial fans — Performance testing using standardized airways*

IEC 60651:2001, *Sound level meters*

IEC 60942:1997, *Electroacoustics — Sound calibrators*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

## 3 Terms, definitions and symbols

For the purpose of this document, the following terms and definitions apply. The symbols are given in Table 1.

**3.1**
**fan inlet area**
$S_{f1}$
surface plane bounded by the upstream extremity of the fan

NOTE 1 The inlet area is, by convention, taken as the gross area in the inlet plane inside the casing. No deduction is made for motors, fairings or other obstructions.

NOTE 2 Where motors, fairings or other obstructions extend beyond an inlet or outlet flange at which the performance for ducted installation is to be determined, the casing should be extended by a duct of the same size and shape as the inlet or outlet and of sufficient length to cover the obstruction. The test airway dimensions should be measured from the plane through the outermost extension of the obstruction as if this were the plane of the inlet or outlet flange.

NOTE 3 The fan inlet area is expressed in square metres ($m^2$).

NOTE 4 Adapted from ISO 5801:1997.

**3.2**
**fan outlet area**
$S_{f2}$
surface plane bounded by the downstream extremity of the fan

NOTE 1 The outlet area is, by convention, taken as the gross area in the outlet plane inside the casing. No deduction is made for motors, fairings or other obstructions.

NOTE 2 Some free-outlet fans without casings have no well-defined outlet area. For the purpose of determining the fan's dynamic pressure, a nominal area may then be defined and stated, e.g. the area within the ring of a propeller wall fan or the circumferential outlet area of an open-running centrifugal impeller. The corresponding fan dynamic pressure and fan pressure will also be nominal and should be so described.

NOTE 3 The fan outlet area is expressed in square metres ($m^2$).

NOTE 4 Adapted from ISO 5801:1997.

**3.3**
**ducts**
any of the airways defined in 3.3.1, 3.3.2 and 3.3.3

**3.3.1**
**test duct**
duct in which the fan sound power is measured

NOTE The test duct has an anechoic termination.

**3.3.2**
**terminating duct**
duct opposite to the test duct, if both sides of the fan are ducted

NOTE The terminating duct has an anechoic termination.

**3.3.3**
**intermediate duct**
duct fitted on the intake side and on the discharge side of the fan to ensure desired flow conditions

NOTE The intermediate duct connects to the test duct or the terminating duct, if necessary by a transition section (see Figure 7).

**3.4**
**measurement plane**
radial plane in the test duct in which the microphone diaphragm is located

**3.5**
**sound pressure level**
$L_p$

$$L_p = 10 \lg \frac{p^2}{p_0^2} \text{ dB} \quad (1)$$

where $p$ is the root mean square value of the sound pressure and the reference sound pressure $p_0$ is equal to 20 μPa

NOTE 1 The width of a restricted frequency band should be indicated, for example, octave-band sound pressure level, one-third-octave-band sound pressure level.

NOTE 2 $L_{p1}$, $L_{p2}$ and $L_{p3}$ 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 7.2.4).

$\overline{L_p}$ is the spatially averaged sound pressure level at the measurement plane, corrected for the combined free-field response $C$ (see Table 1 and 8.1).

NOTE 3 The sound pressure level is expressed in decibels (dB).

### 3.6
### sound power level
$L_W$

$$L_W = 10 \lg \frac{P}{P_0} \text{ dB} \tag{2}$$

where $P$ is the sound power and the reference sound power $P_0$ is equal to 1 pW

NOTE 1 The width of a restricted frequency band should be indicated, for example, octave-band sound power level, one-third-octave-band sound power level.

NOTE 2 The sound power level is expressed in decibels (dB).

### 3.7
### fan sound power
sound power radiated into the test duct by the fan

### 3.8
### frequency band range of interest
one-third-octave bands with centre frequencies between 50 Hz and 10 000 Hz

NOTE For information only, the frequency range of interest may be extended up to 20 000 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.

### 3.9
### microphone shield
device designed to protect a microphone placed in a moving airstream from self-generated wind noise and turbulent pressure fluctuations

NOTE 1 See Clause 4, Note 5.

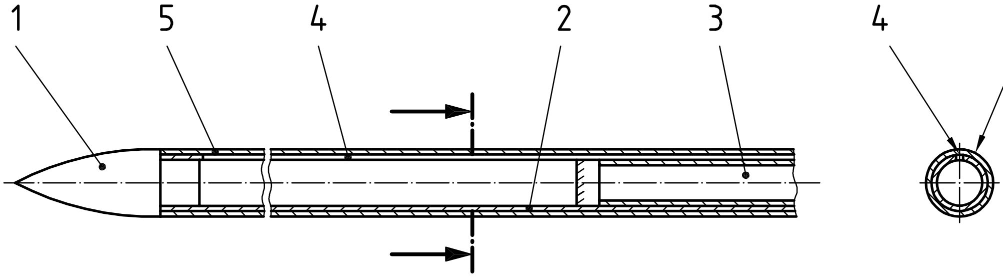
NOTE 2 The three types are listed in order of preference in 3.9.1, 3.9.2 and 3.9.3.

#### 3.9.1
#### sampling tube
#### turbulence screen
metal tube with a longitudinal slit, covered by a porous material within which the microphone is positioned, designed to reduce the response of the microphone to self-induced wind noise and to turbulent pressure fluctuations of the air pressure within the duct

See Figure 1.

NOTE 1 The sampling tube is the preferred microphone shield for measurements according to this International Standard.

NOTE 2 To minimize self-induced wind noise, the outer surface of the tube should be smooth and free of any discontinuities (see Figure 1). The slit and covering of the sampling tube should be designed to reduce the response of the microphone to turbulent pressure fluctuations in the air stream emanating from the fan being tested.




**Key**

1 nose cone
2 slit-tube
3 microphone
4 slit
5 porous material

**Figure 1 — Schematic of a sampling tube for a 13 mm (1/2 inch) microphone**

**3.9.2**
**nose cone**
microphone shield designed to substitute the normal protection grid of the microphone and used in high-velocity air flows with low turbulence and little swirl having a streamlined shape with the least possible resistance to airflow and a fine wire mesh around its periphery allowing sound pressure transmission to the microphone diaphragm, whilst a truncated cone behind the mesh reduces the air volume in form of the diaphragm

See Figure 2.

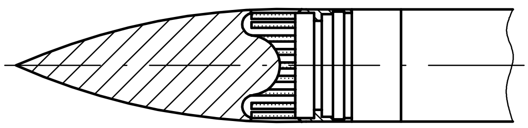


**Figure 2 — Schematic of a nose cone**

**3.9.3**
**foam ball**
ball of open-pored foam with a cylindrical hole of appropriate diameter for insertion of the microphone and preamplifier, designed not to affect the directivity of the microphone

See Figure 3.

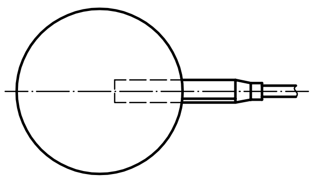


**Figure 3 — Schematic of a foam ball**