



BSI Standards Publication

Road traffic noise reducing devices - Test method for determining the acoustic performance

Part 5: Intrinsic characteristics - In situ values of sound
reflection under direct sound field conditions

National foreword

This British Standard is the UK implementation of EN 1793-5:2016, incorporating corrigendum August 2018. It supersedes BS CEN/TS 1793-5:2003, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/509/6, Fences for the attenuation of noise.

A list of organizations represented on this committee can be obtained on request to its secretary.

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31 August 2018	Implementation of CEN corrigendum August 2018: Formula (4) in 5.5.1 corrected

English Version

Road traffic noise reducing devices - Test method for
determining the acoustic performance - Part 5: Intrinsic
characteristics - In situ values of sound reflection under
direct sound field conditions

Dispositifs de réduction du bruit du trafic routier -
Méthode d'essai pour la détermination de la
performance acoustique - Partie 5: Caractéristiques
intrinsèques - Valeurs in situ de réflexion acoustique
dans des conditions de champ acoustique direct

Lärmschutzvorrichtungen an Straßen - Prüfverfahren
zur Bestimmung der akustischen Eigenschaften - Teil
5: Produktspezifische Merkmale - In-situ-Werte der
Schallreflexion in gerichteten Schallfeldern

This European Standard was approved by CEN on 23 January 2016.

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This document consolidates EN 1793-5:2016 and the corrigendum EN 1793-5:2016/AC:2018.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 1793-5:2016) has been prepared under the direction of Technical Committee CEN/TC 226 “Road equipment”, by Working Group 6 “Anti-noise devices”, the secretariat of which is held by AFNOR.

This document supersedes CEN/TS 1793-5:2003.

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of an identical text or by endorsement, at the latest by September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

With respect to the superseded document, the following changes have been done:

- the rotating loudspeaker/microphone assembly has been replaced by a loudspeaker and a 9-microphone square array (the measurement grid);
- the definition of RI has been changed;
- the geometrical divergence correction factor has been changed;
- a new correction factor for sound source directivity has been introduced;
- a new correction factor for gain mismatch has been introduced;
- the impulse response alignment for signal subtraction has been described in more detail;
- the lowest reliable one-third frequency band has been better defined;
- the way to evaluate the uncertainty of the measurement method from reproducibility data has been introduced (Annex A);
- a detailed example is given (Annex B);
- information on the near-field to far-field relationship has been added (Annex C).

It should be read in conjunction with:

EN 1793-1, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 1: Intrinsic characteristics of sound absorption under diffuse sound field conditions*

EN 1793-2, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 2: Intrinsic characteristics of airborne sound insulation under diffuse sound field conditions*

EN 1793-3, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 3: Normalized traffic noise spectrum*

EN 1793-4, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 4: Intrinsic characteristics - In situ values of sound diffraction*

EN 1793-6, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 6: Intrinsic characteristics - In situ values of airborne sound insulation under direct sound field conditions*

This document includes the corrigendum EN 1793-5:2016/AC:2018 which corrects Formula (4) in 5.5.1.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This document describes a test method for determining the intrinsic characteristics of sound reflection of noise reducing devices designed for roads in non-reverberant conditions (a measure of intrinsic performance). It can be applied *in situ*, i.e. where the noise reducing devices are installed. The method can be applied without damaging the surface.

The method can be used to qualify products to be installed along roads as well as to verify the compliance of installed noise reducing devices to design specifications. Regular application of the method can be used to verify the long term performance of noise reducing devices.

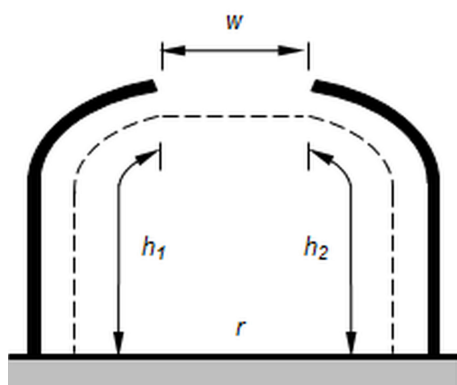
The method requires the average of results of measurements taken in different points in front of the device under test and/or for specific angles of incidences. The method is able to investigate flat and non-flat products.

The measurements results of this method for sound reflection are not directly comparable with the results of the laboratory method (e.g. EN 1793-1), mainly because the present method uses a directional sound field, while the laboratory method assumes a diffuse sound field. The test method described in the present document should not be used to determine the intrinsic characteristics of sound reflection of noise reducing devices to be installed in reverberant conditions, e.g. claddings inside tunnels or deep trenches.

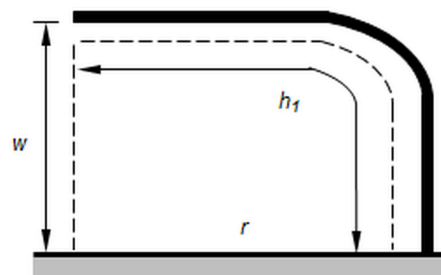
For the purpose of this document reverberant conditions are defined based on the envelope, e , across the road formed by the device under test, trench sides or buildings (the envelope does not include the road surface) as shown by the dashed lines in Figure 1. Conditions are defined as being reverberant when the percentage of open space in the envelope is less than or equal to 25 %, i.e. Reverberant conditions occur when $w/e \leq 0,25$, where $e = (w+h_1+h_2)$

This method introduces a specific quantity, called reflection index, to define the sound reflection in front of a noise reducing device, while the laboratory method gives a sound absorption coefficient. Laboratory values of the sound absorption coefficient can be converted to conventional values of a reflection coefficient taking the complement to one. In this case, research studies suggest that some correlation exists between laboratory data, measured according to EN 1793-1 and field data, measured according to the method described in the present document [7], [10], [20], [21].

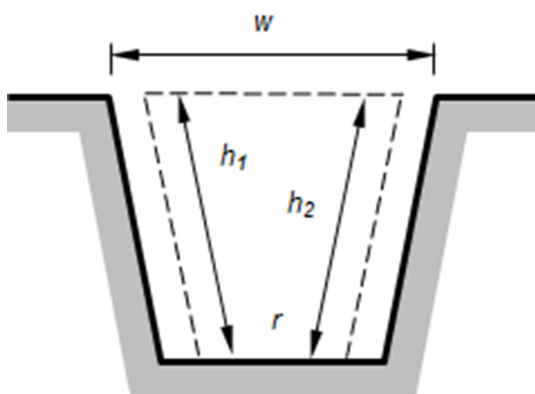
This method may be used to qualify noise reducing devices for other applications, e.g. to be installed nearby industrial sites. In this case the single-number ratings should be calculated using an appropriate spectrum.



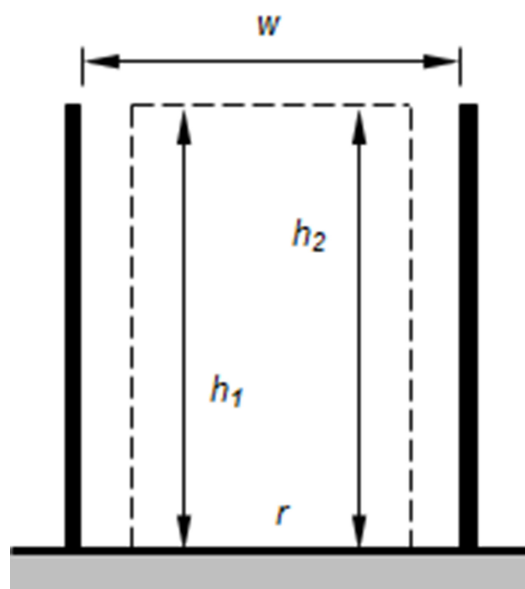
(a) Partial cover on both sides of the road; envelope, $e = w + h_1 + h_2$.



(b) Partial cover on one side of the road; envelope, $e = w + h_1$.



(c) Deep trench; envelope, $e = w + h_1 + h_2$.



(d) Tall barriers or buildings; envelope, $e = w + h_1 + h_2$.

Key

r road surface;

w width of open space

NOTE Figure 1 is not to scale.

Figure 1 — Sketch of the reverberant condition check in four cases

1 Scope

This European Standard describes a test method for measuring a quantity representative of the intrinsic characteristics of sound reflection from road noise reducing devices: the reflection index.

The test method is intended for the following applications:

- determination of the intrinsic characteristics of sound reflection of noise reducing devices to be installed along roads, to be measured either on typical installations alongside roads or on a relevant sample section;
- determination of the *in situ* intrinsic characteristics of sound reflection of noise reducing devices in actual use;
- comparison of design specifications with actual performance data after the completion of the construction work;
- verification of the long term performance of noise reducing devices (with a repeated application of the method).

The test method is not intended for the following applications:

- determination of the intrinsic characteristics of sound reflection of noise reducing devices to be installed in reverberant conditions, e.g. inside tunnels or deep trenches.

Results are expressed as a function of frequency, in one-third octave bands between 100 Hz and 5 kHz. If it is not possible to get valid measurements results over the whole frequency range indicated, the results should be given in a restricted frequency range and the reasons of the restriction(s) should be clearly reported.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1793-3, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 3: Normalized traffic noise spectrum*

EN 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications (IEC 61672-1)*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this document the following terms and definitions apply:

3.1

noise reducing device (NRD)

device that is designed to reduce the propagation of traffic noise away from the road environment. This may be a noise barrier, cladding, a road cover or an added device. These devices may include both acoustic and structural elements

3.2**noise barrier**

noise reducing device, which obstructs the direct transmission of airborne sound emanating from road traffic

3.3**acoustic element**

element whose primary function is to provide the acoustic performance of the device

3.4**structural element**

element whose primary function is to support or hold in place acoustic elements

3.5**cladding**

noise-reducing device, which is attached to a wall or other structure and reduces the amount of sound reflected

3.6**cover**

noise-reducing device, which either spans or overhangs the highway

3.7**added device**

added component that influences the acoustic performance of the original noise-reducing device (acting primarily on the diffracted energy)

3.8**roadside exposure**

the use of the product as a noise reducing device installed alongside roads

3.9**sound reflection index**

quantity, resulting from a sound reflection test, described by Formula (1)

3.10**measurement grid for sound reflection index measurements**

vertical measurement grid constituted of nine equally spaced microphones in a 3x3 squared configuration

Note 1 to entry The orthogonal spacing between two subsequent microphones, either vertically or horizontally, is $s = 0,40$ m.

Note 2 to entry See Figure 3 and 5.6.

Note 3 to entry Microphones are numbered like in Figure 3.b.

3.11**reference height**

height h_S equal to half the height, h_B , of the noise barrier under test: $h_S = h_B/2$

Note 1 to entry When the height of the device under test is greater than 4 m and, for practical reasons, it is not advisable to have a height of the source $h_S = h_B/2$, it is possible to have $h_S = 2$ m, accepting the corresponding low frequency limitation (see 5.5.7).

Note 2 to entry: See Figures 2 and 3.

3.12

(source and microphone) reference plane for sound reflection index measurements

plane facing the sound source side of the noise reducing device and touching the most protruding parts of the device under test within the tested area

Note 1 to entry See Figures 2 and 4.

3.13

source reference position

position facing the side to be exposed to noise when the device is in place, located at the reference height h_S and placed so that the horizontal distance of the source front panel to the reference plane is $d_S = 1,50$ m

Note 1 to entry See Figures 2 and 4.

3.14

measurement grid reference position

position of the measurement grid compliant with all the following conditions: i) the measurement grid is vertical; ii) the measurement grid is on the noise reducing device side to be exposed to noise when the device is in place; iii) the central microphone (microphone n. 5) is located at the reference height h_S ; iv) the horizontal distance of the central microphone to the reference plane is $d_M = 0,25$ m; v) the line passing through the centre plate of the loudspeaker and the central microphone is horizontal

Note 1 to entry See Figures 2, 3 and 4.

3.15

reference loudspeaker-measurement grid distance

distance between the front panel of the loudspeaker and the central microphone (microphone n. 5) of the measurement grid (kept in vertical position)

Note 1 to entry The reference loudspeaker-measurement grid distance is equal to $d_{SM} = 1,25$ m (see Figures 2 and 4).

3.16

free-field measurement for sound reflection index measurements

measurement taken with the loudspeaker and the measurement grid in an acoustic free field in order to avoid reflections from any nearby object, including the ground, keeping the same geometry as when measuring in front of the noise reducing device under test

Note 1 to entry See Figure 5.

3.17

maximum sampled area

surface area, projected on a front view of the noise reducing device under test for reflection index measurements, which must remain free of reflecting objects causing parasitic reflections

3.18

Adrienne temporal window

composite temporal window described in 5.5.5

3.19

background noise

noise coming from sources other than the sound source emitting the test signal

3.20

signal-to-noise ratio, S/N

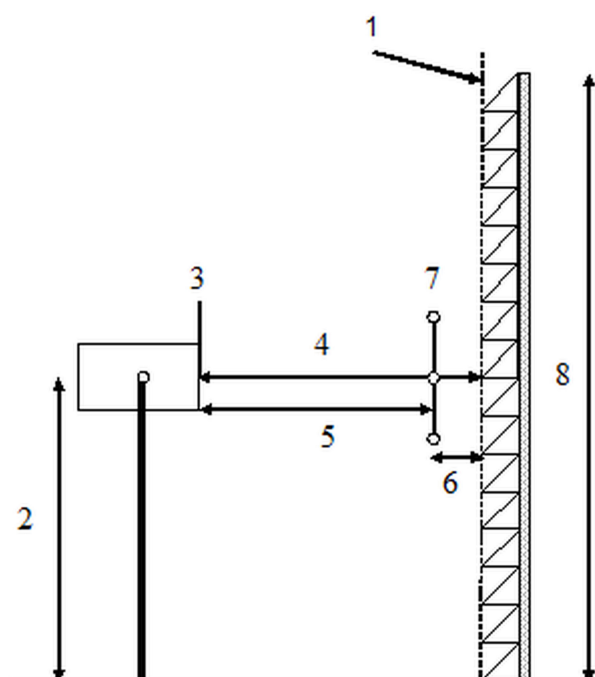
difference in decibels between the level of the test signal and the level of the background noise at the moment of detection of the useful event (within the Adrienne temporal window)

3.21

impulse response

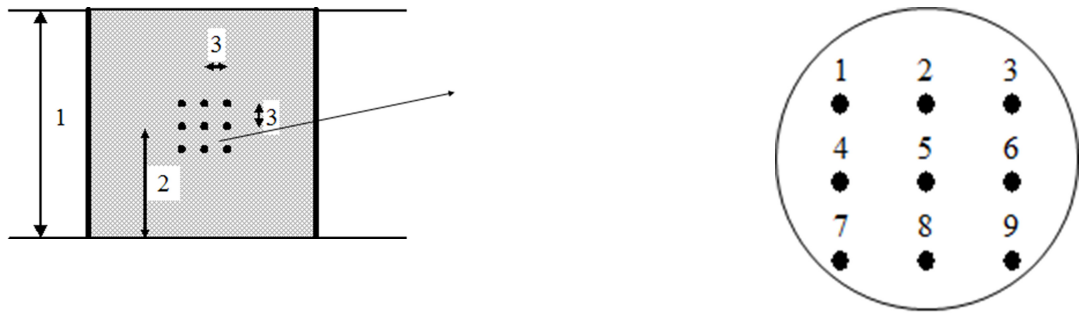
time signal at the output of a system when a Dirac function is applied to the input. The Dirac function, also called δ function, is the mathematical idealisation of a signal infinitely short in time that carries a unit amount of energy

Note 1 to entry: It is impossible in practice to create and radiate true Dirac delta functions. Short transient sounds can offer close enough approximations but are not very repeatable. An alternative measurement technique, generally more accurate, is to use a period of deterministic, flat-spectrum signal, like maximum-length sequence (MLS) or exponential sine sweep (ESS), and transform the measured response back to an impulse response.

**Key**

- | | |
|--|--|
| 1 Source and microphone reference plane | 2 Reference height h_s [m] |
| 3 Loudspeaker front panel | 4 Distance between the loudspeaker front panel and the reference plane d_s [m] |
| 5 Distance between the loudspeaker front panel and the measurement grid d_{SM} [m] | 6 Distance between the measurement grid and the reference plane d_M [m] |
| 7 Measurement grid | 8 Noise reducing device height h_B [m] |

Figure 2 — (not to scale) Sketch of the sound source and the measurement grid in front of the noise reducing device under test for sound reflection index measurements

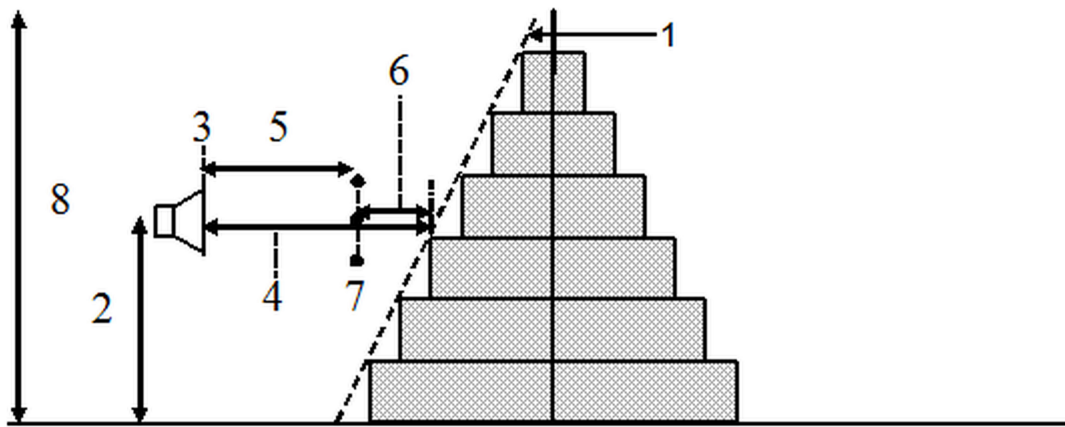


Key

- 1 Noise reducing device height h_B [m]
- 2 Reference height h_s [m]
- 3 Orthogonal spacing between two subsequent microphones s [m]

Figure 3 (a) — (not to scale) Measurement grid for sound reflection index measurements (source side).

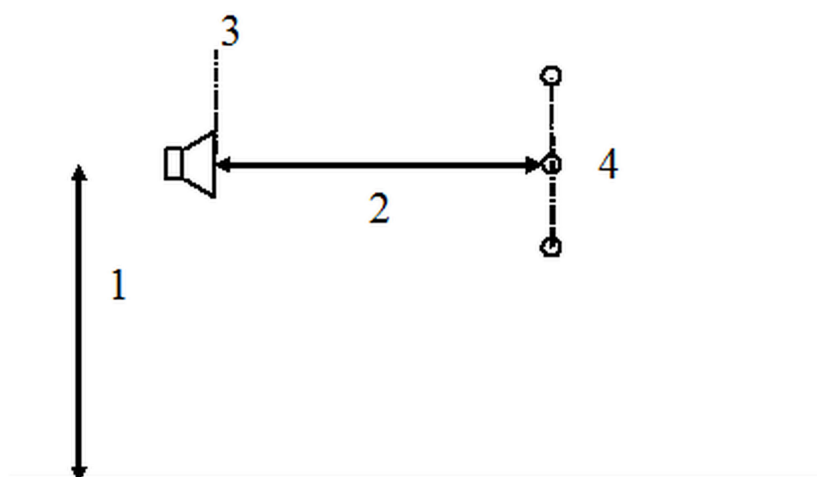
Figure 3 (b) — (not to scale) Numbering of the measurement points as seen from the sound source.



Key

- 1 Source and microphone reference plane
- 2 Reference height h_s [m]
- 3 Loudspeaker front panel
- 4 Distance between the loudspeaker front panel and the reference plane d_s [m]
- 5 Distance between the loudspeaker front panel and the measurement grid d_{SM} [m]
- 6 Distance between the measurement grid and the reference plane d_M [m]
- 7 Measurement grid
- 8 Noise reducing device height h_B [m]

Figure 4 — (not to scale) Placement of the sound source and measurement grid for sound reflection index measurement for an inclined noise reducing device (side view)



Key

- 1 Reference height h_s [m] 2 Distance between the loudspeaker front panel and the measurement grid d_{SM} [m]
 3 Loudspeaker front panel 4 Measurement grid

Figure 5 — (not to scale) Sketch of the set-up for the reference “free-field” sound measurement for the determination of the sound reflection index

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

Table 1 — Symbols and abbreviations

Symbol or abbreviation	Designation	Unit
a	major axis of the ellipsoid of revolution used to define the maximum sampled area at oblique incidence	m
a_0, a_1, a_2, a_3	Coefficient for the expression of the four-term full Blackman-Harris window	-
b_s	Depth of the surface structure of the sample under test	m
b_m	Width of a portion of material of the sample under test	m
c	Speed of sound in air	m/s
$C_{geo,k}$	Correction factor for the geometrical divergence	-
$C_{dir,k}$	Correction factor for the sound source directivity	-
$C_{gain,k}$	Correction factor for changes in the sound source gain	-
d_M	Horizontal distance from the source and microphone reference plane to the measurement grid; it is equal to $d_M = 0,25$ m	m
d_s	Horizontal distance from the front panel of the loudspeaker to the source and microphone reference plane; it is equal to: $d_s = 1,50$ m	m
d_{SM}	Horizontal distance from the front panel of the loudspeaker to the measurement grid; it is equal to: $d_{SM} = 1,25$ m	m
DL_{RI}	Single number rating of sound reflection	dB
δ_i	Any input quantity to allow for uncertainty estimates	

Δf_g	Frequency range encompassing the one-third octave frequency bands between 500 Hz and 2 kHz	Hz
Δf_j	Width of the j -th one-third octave frequency band	Hz
Δt	temporal step between the discrete points of the acquired data (linked to the given sample rate by $\Delta t = 1/f_s$)	ms
$\Delta \tau$	moving step of the free field impulse response in the adjustment procedure included in the generalized signal subtraction technique (see 5.5.4)	ms
Δt_{k5}	Time delay gap between the arrival of direct sound at microphone k ($k \neq 5$) and microphone 5	s
Δt_k	Time delay gap between the arrival of direct and reflected sound at microphone k	s
Δd_{k5}	Path length difference between the arrival of direct sound at microphone k ($k \neq 5$) and microphone 5	m
Δd_k	Path length difference between the arrival of direct and reflected sound at microphone k	m
ε_k	Tolerance on the path length difference at microphone k	m
F	Symbol of the Fourier transform	-
f	Frequency	Hz
f_{min}	Low frequency limit of sound reflection index measurements	Hz
f_s	Sample rate	Hz
f_{co}	cut-off frequency of the anti-aliasing filter	Hz
h_B	Noise reducing device height	m
h_S	Reference height	m
$h_{ik}(t)$	Incident reference component of the free-field impulse response at the k -th measurement point	-
$h_{rk}(t)$	Reflected component of the impulse response at the k -th measurement point	-
j	Index of the j -th one-third octave frequency band (between 100 Hz and 5 kHz)	-
k_p	Coverage factor	-
k_f	Constant used for the anti-aliasing filter	-
L_p	Sample period length of a non-homogeneous noise reducing device	m
n_j	Number of measurement points on which to average	-
r	Radius of the maximum sampled area at normal incidence	m
R_{sub}	Reduction factor	dB
RI_j	Sound reflection index in the j -th one-third octave frequency band	
s	Orthogonal spacing between two subsequent microphones	m
s_r	Standard deviation of repeatability	-
s_R	Standard deviation of reproducibility	-
t	Time	s
$T_{W,BH}$	Length of the Blackman-Harris trailing edge of the Adrienne temporal window	s
$T_{W,ADR}$	Total length of the Adrienne temporal window	s

u	Standard uncertainty	-
U	Expanded uncertainty	-
$w_{ik}(t)$	Reference free-field component time window (Adrienne temporal window) at the k -th measurement point	-
$w_{rk}(t)$	Time window (Adrienne temporal window) for the reflected component at the k -th measurement point	-

5 Sound reflection index measurements

5.1 General principle

The sound source emits a transient sound wave that travels past the measurement grid (microphone) position to the device under test and is then reflected on it (Figures 2 and 4). Each microphone, being placed between the sound source and the device under test, receives both the direct sound pressure wave travelling from the sound source to the device under test and the sound pressure wave reflected (including scattering) by the device under test. The direct sound pressure wave can be better acquired with a separate free field measurement (see Figure 5). The power spectra of the direct and the reflected components, gives the basis for calculating the sound reflection index.

The measurement shall take place in an essentially free field in the direct surroundings of the device, i.e. a field free from reflections coming from surfaces other than the surface of the device under test. For this reason, the acquisition of an impulse response having peaks as sharp as possible is recommended: in this way, the reflections coming from other surfaces than the tested device can be identified from their delay time and rejected.

5.2 Measured quantity

The expression used to compute the reflection index RI as a function of frequency, in one-third octave bands, is:

$$RI_j = \frac{1}{n_j} \sum_{k=1}^{n_j} \left[\frac{\int_{\Delta f_j} |F[h_{r,k}(t) \cdot w_{r,k}(t)]|^2 df}{\int_{\Delta f_j} |F[h_{i,k}(t) \cdot w_{i,k}(t)]|^2 df} \cdot C_{geo,k} \cdot C_{dir,k}(\Delta f_j) \cdot C_{gain,k}(\Delta f_g) \right] \quad (1)$$

where

- $h_{i,k}(t)$ is the incident reference component of the free-field impulse response at the k -th measurement point;
- $h_{r,k}(t)$ is the reflected component of the impulse response taken in front of the sample under test at the k -th measurement point;
- $w_{i,k}(t)$ is the time window (Adrienne temporal window) for the incident reference component of the free-field impulse response at the k -th measurement point;
- $w_{r,k}(t)$ is the time window (Adrienne temporal window) for the reflected component at the k -th measurement point;
- F is the symbol of the Fourier transform;
- j is the index of the one-third octave frequency bands (between 100 Hz and 5 kHz);
- Δf_j is the width of the j -th one-third octave frequency band;
- k is the microphone number according to Figure 3.b ($k = 1, \dots, 9$);

- n_j is the number of microphone positions on which to average ($n_j \geq 6$; see 5.6.2);
- $C_{geo,k}$ is the correction factor for geometrical divergence at the k -th measurement point;
- $C_{dir,k}(\Delta f_j)$ is the correction factor for sound source directivity at the k -th measurement point.
- $C_{gain,k}(\Delta f_g)$ is the correction factor to account for a change in the amplification settings of the loudspeaker and in the sensitivity settings of the individual microphones when changing the measurement configuration from free field to in front of the sample under test or vice versa, if any (see 5.5.1 and Formula (4));
- Δf_g is the frequency range encompassing the one-third octave frequency bands between 500 Hz and 2 kHz.

The correction factor for geometrical divergence, $C_{geo,k}$, are given by:

$$C_{geo,k} = \left(\frac{d_{r,k}}{d_{i,k}} \right)^2 \quad (2)$$

where

- $d_{i,k}$ is the distance from the front panel of the loudspeaker to the k -th measurement point;
- $d_{r,k}$ is the distance from the front panel of the loudspeaker to the source and microphone reference plane and back to the k -th measurement point following specular reflection;
- k is the microphone number according to Figure 3.b ($k = 1, \dots, 9$).

NOTE 1 For the microphone n. 5, $d_{i,5} = d_{SM} = 1,25$ m

The distances $d_{i,k}$, $d_{r,k}$ and the correction factors $C_{geo,k}$ are given in Table 2.

Table 2 — Distances $d_{i,k}$, $d_{r,k}$ and correction factors $C_{geo,k}$

k	$d_{i,k}$, m	$d_{r,k}$, m	$C_{geo,k}$
1	1,37	1,84	1,80
2	1,31	1,80	1,87
3	1,37	1,84	1,80
4	1,31	1,80	1,87
5	1,25	1,75	1,96
6	1,31	1,80	1,87
7	1,37	1,84	1,80
8	1,31	1,80	1,87
9	1,37	1,84	1,80

NOTE 2 The reflections from different portions of the surface of the device under test arrive at the microphone position at different times, depending on the travel path from the loudspeaker to the position of each test surface portion and back. The longer the travel path from the loudspeaker to a specific test surface portion and back, the greater the time delay. Thus, the amplitude of the reflected sound waves from different test surface portions, as detected at the microphone positions, is attenuated in a manner inversely proportional to the travel time. For non flat complex devices it is difficult to predict the exact travel path of each wave, considering also non specular scattering; therefore the geometrical divergence correction factors are calculated on the basis of specular reflection on an ideal flat reflecting surface.

The correction factors for sound source directivity are given by:

$$C_{dir,k}(\Delta f_j) = \frac{\int_{\Delta f_j} \left| F[h_{i,k}(t, \alpha_k) \cdot w_{i,k}(t)] \right|^2 df}{\int_{\Delta f_j} \left| F[h_{i,k}(t, \beta_k) \cdot w_{i,k}(t)] \right|^2 df} \quad (3)$$

where

- α_k is the angle between the line connecting the centre of the front panel of the loudspeaker to microphone 5 and the line connecting the centre of the front panel of the loudspeaker to microphone k (see Figure 6.a);
- β_k is the angle between the line connecting the centre of the front panel of the loudspeaker to microphone 5 and the line connecting the centre of the front panel of the loudspeaker to the specular reflection path to microphone k (see Figure 6.a);
- $h_{i,k}(t, \alpha_k)$ is the incident reference component of the free-field impulse response at the k -th measurement point;
- $h_{i,k}(t, \beta_k)$ is the incident reference component of the free-field impulse response at a point on the specular reflection path for microphone k and at distance $d_{i,k}$ from the centre of the front panel of the loudspeaker;
- $w_{i,k}(t)$ is the time window (Adrienne temporal window) for the incident reference component of the free-field impulse response at the k -th measurement point;
- F is the symbol of the Fourier transform;
- j is the index of the one-third octave frequency bands (between 100 Hz and 5 kHz);
- Δf_j is the width of the j -th one-third octave frequency band;
- k is the microphone number according to Figure 3.b ($k = 1, \dots, 9$).

When measuring the sound source directivity correction factors, the numerator and denominator of the ratio in Formula (3) shall be measured in two different points at the constant distance $d_{i,k}$ (see Table 2) from the centre of the front panel of the loudspeaker. The first point is placed at the microphone position and the second point is placed on the specular reflection travel path of the sound emitted by the loudspeaker (see Figure 6).

NOTE 3 For non flat complex devices it is difficult to predict the exact travel path of each wave, considering also non specular scattering; therefore the correction factors for sound source directivity are calculated on the basis of specular reflection on an ideal flat reflecting surface.

The sound source directivity correction factors shall be measured only once for each sound source, assuming that the source directivity patterns don't change. For the sake of accuracy they may be measured again from time to time (e.g. once a year).