

**ISO/FDIS 5128:2023(E)**

**ISO TC 43/SC 1/~~WG 42~~**

**Secretariat: DIN**

**Date: 2023-05-06~~xx~~**

**Acoustics — Measurement of interior vehicle noise**

*Acoustique — Mesurage du bruit intérieur des véhicules*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be involved in the subject of a patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) — see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 5128:1980), which has been technically revised.

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The main changes are as follows:

- new technology neutral test method;
- updated test equipment;
- updated facility descriptions;
- new evaluation principle (instead  $L_{\max}$  to  $L_{A,eq}$ )

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This measurement procedure for interior vehicle noise as presented by this document has been completely revised to better match the application needs.

The interior noise of modern vehicles has such improved, that hearing damages even under high engine speeds and loads are unlikely. Assessments on the application of the document reveal a changed focus on protection of drivers and passenger in a direction of long-term exposure in a sense of working place protection.

In most countries provisions exist, which regulate the noise burden on workers on a basis of a noise exposure over a period of 8 hours per day, a full working week over a work life of 35 years. In addition, aspects of driver distraction and fatigue have become a stronger emphasis. In order to match this application, it is no longer given to determine the maximum sound level from a set of measurements, as was provided by the previous release.

The target of this edition is to determine a time average interior sound level, which is representative for the typical driving and use of a vehicle. Therefore, in-use driving statistics were reviewed and new in-use driving data generated by the group members. A strong focus was put on the WLTP, WHVC and VECTO statistics <sup>[1][2][3]</sup> which so far provides the biggest source of statistical information.

However, it should be kept in mind that the sound inside a vehicle is strongly influenced by external factors. These factors are different for various vehicle categories. During normal driving for passenger cars at low engine speeds and loads, the sound inside the cabin comes mainly from tyre rolling sound transferred via structure- and air paths. The excitation of the tyre is dependent on the structure of the surface and the characteristics of the tyre, such as the hardness of the rubber and the tyre dimension. This standard cannot cover all eventual excitation models for smooth and rough roads or soft and hard tyres. For reproducibility a road texture has been chosen, which is commonly used in test centre.

For heavy commercial vehicles with large cabin, wind noise can become very dominant at speeds beyond 60 km/h. The wind direction, especially as lateral wind, can be very changeable.

The driving cycles differ strongly with regard to vehicle categories, the used speeds and accelerations dependent on the area, where the vehicles are used. The document provides individual cycles for urban, suburban, rural and motorway conditions, all four applicable to light duty vehicles and three of them for heavy duty vehicles. In urban and rural areas, the interior sound of a vehicle is a mixture of powertrain and tyre rolling sound components. For countryside and motorway conditions the influence of powertrain is reduced but wind noise provides a stronger contribution, especially for large trucks and buses.

The combination of the cycles is very much dependent on the typical use of a vehicle. A large variation may exist for the same product. This document focuses on a typical use for vehicle categories, but it has to be kept in mind, that a substantially different use, may lead to other results. A standardized data processing for a given vehicle category will allow benchmarking of products. The availability of the individual cycle results enables as well an estimation of the interior sound for other conditions of use.

Another important factor is the total driving time within the concept of a working day. While it appears obvious that long haulage trucks are driven many hours per day, a delivery service in a town will have a mix between driving and loading/unloading work. Where test results of this document are used with regard to occupational noise exposure standards, it is essential to consider the time contribution according to the typical use of a vehicle. Again, a large variability should be kept in mind. The test results of this document allow as well the calculation for conditions, other than selected by this document.

All definitions in this document are based on design neutral parameters – as far as practically possible – to enable an application for all kind of vehicle technologies, inclusive of hybrid vehicles and pure electric vehicles.

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The test procedures and calculation schemes are engineering methods and compromise between precision, repeatability, feasibility and simplicity.

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## Acoustic — Measurement of interior vehicle noise

### 1 Scope

This document specifies an engineering method for measuring the interior sound of road vehicles of categories M and N under typical driving conditions. It does not apply to agricultural tractors and field machinery.

It specifies the conditions for obtaining reproducible and comparable measurements of sound pressure levels inside a vehicle.

These measurements are used to obtain a representative average sound level during a typical driving cycle to enable assessment of adverse effects on human health.

The results can be used for

- standardized assessment of interior sound for comparisons (e.g. benchmark, consumer information programs);
- verification tests, to decide whether or not the sound inside the vehicle is in accordance with specifications;
- regulatory purposes, for example for evaluation of sound in relation to labour or for general health standards; and
- monitoring tests, in order to check that the sound inside the vehicles has not changed since delivery, or between individual units of a consignment of vehicles.

This document does not evaluate the exposure to interior sound of vehicles in a way as it is commonly used for scientific effects on human health.

It does not assess maximum interior sound of a vehicle under extreme driving situations, as today's measured maximum sound pressure levels inside vehicles are far away from the risk to create instantaneous hearing damages.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

~~<std>ISO 10844, Acoustics — Specification of test tracks for measuring sound emitted by road vehicles and their tyres</std>~~

~~<std>ISO 26101-1, Acoustics — Test methods for the qualification of the acoustic environment</std>~~

~~<std>ISO 10844, Acoustics — Specification of test tracks for measuring sound emitted by road vehicles and their tyres~~

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[ISO 26101-1, Acoustics — Test methods for the qualification of the acoustic environment](#)

[ISO 13473-1, Characterization of pavement texture by use of surface profiles — Part 1: Determination of mean profile depth](#)

~~[ISO 13473-3, Characterization of pavement texture by use of surface profiles — Part 3: Specification and classification of profilometers](#)~~

~~[IEC 61672-1, Electroacoustics — Sound level meters — Part 1: Specifications](#)~~

~~[IEC 61672-3, Electroacoustics — Sound level meters — Part 3: Periodic tests](#)~~

~~[IEC 60942, Electroacoustics — Sound calibrator](#)~~

~~[ISO/IEC Guide 98-3, Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement \(GUM:1995\)](#)~~

~~[IEC 61672-1, Electroacoustics — Sound level meters — Part 1: Specifications](#)~~

[IEC 61672-3, Electroacoustics — Sound level meters — Part 3: Periodic tests](#)

[IEC 60942, Electroacoustics — Sound calibrator](#)

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

[EN 13036-7, Road and airfield surface characteristics — Test methods — Part 7: Irregularity measurement of pavement courses: the straightedge test](#)

~~[EN 13043, Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas](#)~~

[EN 13043, Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas](#)

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### 3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

#### 3.1

##### Mass

##### 3.1.1

###### kerb mass

mass of the vehicle, with its fuel tank(s) filled to at least 90 % of its or their ~~capacity/ies~~ capacities, including the mass of the driver, of the fuel and liquids, fitted with the standard equipment in accordance



with the manufacturer's specifications and, when they are fitted, the mass of the bodywork, the cabin, the coupling and the spare wheel(s) as well as the tools

[SOURCE: ISO 1176:1990, 4.6, modified — extended based on the today's applied principles used in regulations for sound emission of vehicles (see UN R51.03)]

**3.1.2**  
~~maximum authorized mass~~  
~~kerb mass (3.1.1) plus the maximum allowable payload~~

~~3.1.2~~  
**test mass**  
 $m_t$   
mass of the vehicle subject to testing inclusive all equipment and payload

~~3.1.4~~  
~~3.1.3~~  
**driver mass**  
 $m_d$   
nominal mass of a driver that shall be 75 kg (subdivided into 68 kg occupant mass at the seat and 7 kg luggage mass)

Note 1 to entry: According to ISO 2416.

**3.2**  
**test cycle**  
test conditions comprising acceleration, deceleration, steady speed and standstill to establish typical operation of a vehicle under either urban, suburban, rural or motorway condition

**3.3**  
~~Total~~**total power**  
 $P_n$   
sum of net power of all available propulsion sources

Note 1 to entry: According to ISO 1585, for vehicles with combustion engine only,  $P_n$  is the net power of the combustion engine expressed in kilowatt.

Note 2 to entry: According to UN R85, for vehicles with electric propulsion only,  $P_n$  is the net power over a time period of 5 minutes, expressed in kilowatt.

Note 3 to entry: According to UN R51, for vehicles with hybrid drive line,  $P_n$  is the sum of the net power of all available propulsion sources, expressed in kilowatt.

**3.4**  
**rated engine speed,  $S$**   
 $S$   
engine speed at which the combustion engine develops its rated maximum net power as stated by the manufacturer

Note 1 to entry: If the rated maximum net power is reached at several engine speeds,  $S$  used in this document is the highest engine speed at which the rated maximum net power is reached.

Note 2 to entry: ISO 80000-3 defines this term as "rated engine rotational frequency". The term "rated engine speed" was retained due to its common understanding by practitioners and its use in government regulations.

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### 3.5

#### active sound system

system that is installed to a vehicle for producing exterior or interior sound, such as but not limited to sound actuators, regardless of its mounting position

### 3.6

#### modes

distinct driver-selectable condition which does affect powertrain and transmission setup, such that the emitted sound of the vehicle may vary, including distinct driver-selectable modes which can affect the sound emitted by sound enhancement systems

### 3.7

#### Irregularities

#### 3.7.1

##### irregularity

maximum distance of a surface from the measurement edge of the *straightedge* between two contact points of the *straightedge* when placed perpendicular to the surface

Note 1 to entry: Measured in accordance with EN 13036-7.

#### 3.7.2

##### longitudinal irregularity

*irregularity* (3.7.1) in the direction parallel to the longitudinal axis of the track

#### 3.7.3

##### transverse irregularity

*irregularity* (3.7.1) in the direction perpendicular to the longitudinal axis of the track

### 3.8

#### mean profile depth

##### MPD

average value of the height difference between the profile and a horizontal line through the highest peak (the peak level) over a 100-mm long baseline

### 3.9

#### maximum aggregate size

aggregate upper sieve size (D) based on all-in aggregate grading category of GA90

Note 1 to entry: According to EN 13043.

### 3.10

#### Vehicle category M

#### 3.10.1

##### category M1

vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat

#### 3.10.2

##### category M2

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vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat and having a maximum mass not exceeding 5 000 kg

~~Note 1 to entry: In this definition, "maximum mass" is equivalent to "maximum authorized mass" used elsewhere in this document.~~

**3.10.3 category M3**

vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat and having a maximum mass exceeding 5 000 kg

~~Note 1 to entry: In this definition, "maximum mass" is equivalent to "maximum authorized mass" used elsewhere in this document.~~

**3.11 Vehicle category N**

**3.11.1 category N1**

vehicles used for the carriage of goods and having a ~~kerb mass (3.1.1) plus the maximum authorized mass~~ allowable payload not exceeding 3 500 kg

**3.11.2 category N2**

vehicles used for the carriage of goods and having a ~~kerb mass (3.1.1) plus the maximum authorized mass~~ allowable payload exceeding 3 500 kg but not exceeding 12 000 kg

**3.11.3 category N3**

vehicles used for the carriage of goods and having a ~~kerb mass (3.1.1) plus the maximum authorized mass~~ allowable payload exceeding 12 000 kg

**3.11.4 light duty vehicle LDV**

vehicle primarily used to transport passengers and cargo (e.g., cars, vans, SUVs, pickup trucks), with category M1 and N1 and N2 with  $m \leq 4536$  kg and  $P_n \geq 150$  kW may be deemed as LDV. (i.e., Class 1 through Class 2 Vehicles, as designated by the U.S. Department of Transportation)

**3.11.5 Heavy Duty Vehicles-heavy duty vehicle HDV**

vehicle other than defined in ~~clause 3.11.4~~ with a maximum allowable payload of more than 4 536 kg

**4 Tables of symbols and abbreviated terms**

Table 1 lists the symbols, terms, and abbreviated terms in the order where they are used for the first time.

**Table 1 — Symbols and abbreviated terms used and corresponding clauses**

Symbol	Unit	Subclause	Explanation
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$P_e$	kW	3.3	Total power. Sum of net power of all available propulsion sources.
$m_t$	kg	7.5	Test mass of the vehicle
$m_{kerb}$	kg	7.5	Kerb mass of the vehicle
$m_{load}$	kg	7.5	Extra loading for vehicles of category N2 and N3
$m_{target}$	kg	7.5	Target mass of the vehicle for vehicles of category N2 and N3
$m_{ra\ load\ unladen}$	kg	7.5	Unladen rear axle load for vehicles of category N2 and N3
$m_{fa\ load\ unladen}$	kg	7.5	Unladen front axle load for vehicles of category N2 and N3
$m_d$	kg	7.5	Mass of driver Driver mass
$L_{Aeq,TC}$	dB(A)	8.4.1	A-weighted equivalent continuous sound pressure level for the different test conditions. Index TC means either ACC, CST, DEC, DEC AB, CRS STAT, AC MAX and AC LOW
$L_{Aeq,ACC}$	dB(A)	8.4.2.1	A-weighted equivalent continuous sound pressure level for the acceleration test
$L_{Aeq,DEC}$	dB(A)	8.4.2.2.1	A-weighted equivalent continuous sound pressure level for the deceleration test without any braking applied
$L_{Aeq,DEC,AB}$	dB(A)	8.4.2.2.2	A-weighted equivalent continuous sound pressure level for the deceleration test with auxiliary brake device activated
$L_{Aeq,CRS}$	dB(A)	8.4.2.3	A-weighted equivalent continuous sound pressure level for the steady speed test
$L_{Aeq,STAT}$	dB(A)	8.4.3	A-weighted equivalent continuous sound pressure level for the standstill test
$L_{Aeq,AC,MAX}$	dB(A)	8.4.3	A-weighted equivalent continuous sound pressure level for the standstill test with air conditioning on and ventilation at highest operation level for maximum cooling
$L_{Aeq,AC,LOW}$	dB(A)	8.4.3	A-weighted equivalent continuous sound pressure level for the standstill test with air conditioning off and ventilation speed at lowest operation level
$\alpha_{STAT}$	%	8.5	Weighting factor for the representative sound pressure level at standstill condition
$\alpha_{CRS}$	%	8.5	Weighting factor for the representative sound pressure level at steady speed condition
$\alpha_{ACC}$	%	8.5	Weighting factor for the representative sound pressure level at acceleration condition
$\alpha_{CST}$	%	8.5	Weighting factor for the representative sound pressure level at deceleration condition
$L_{Aeq,CYCLE}$	dB(A)	8.5	Representative sound pressure level for the vehicle per cycle component
URBAN		8.5	Cycle component for urban condition
SUBURBAN		8.5	Cycle component for suburban condition
RURAL		8.5	Cycle component for rural condition
MOTORWAY		8.5	Cycle component for motorway condition

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$L_{Aeq,CST}$	dB(A)	8.5.1	A-weighted equivalent continuous sound pressure level for the deceleration test, weighted combination of deceleration tests with and without auxiliary brake device applied
$L'_{TEST}$	dB(A)	8.5.1	Representative sound pressure level for the driving cycle without time weighting
$L_{TEST}$	dB(A)	8.5.1	Representative sound pressure level for the driving cycle inclusive time weighting
$t_{exp}$	h	8.5.2	Annual average use time of a vehicle per working day
$L_{Aeq,INTERIOR}$	dB(A)	8.5.3	Representative interior sound level for a vehicle according to this standard

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## 5 Test equipment

### 5.1 Instrumentation for acoustic measurement

#### 5.1.1 General

The apparatus used for measuring the sound pressure level shall be a sound level meter, or single microphones connected to a data acquisition system or equivalent measurement systems, meeting the requirements of class 1 instruments. These requirements are described in IEC 61672-1.

The entire measurement system shall be checked and adjusted by means of a sound calibrator that fulfils the requirements of class 1 sound calibrators in accordance with IEC 60942.

When no general statement or conclusion can be made about conformance of the sound level meter model to the full specifications of IEC 61672-1, the apparatus used for measuring the sound pressure level shall be a sound level meter or equivalent measurement system meeting the requirements of Class 1 instruments as described in IEC 61672-3.

The instruments shall be maintained and calibrated in accordance with the instructions of the instrument manufacturer.

#### 5.1.2 Calibration

At the beginning of every measurement session, the entire acoustic measurement system shall be checked and adjusted by means of a sound calibrator as described in 5.1.1. At the end of every measurement session, the entire acoustic measurement system shall be checked by means of a sound calibrator as described in 5.1.1. Without any further adjustment, the difference between the readings at the beginning and the end shall be less than or equal to 0,5 dB. If this value is exceeded, the results of the measurements obtained after the previous satisfactory check shall be discarded.

The checking and adjustment described in 5.1.2 does not invalidate the compliance conformity of IEC 61672-1 described in 5.1.3 for the purpose of this standard document.

A bi-yearly IEC 61672-3 calibration permits the use of a daily sensitivity check and adjustment.

~~Note~~-NOTE The purpose of the check at the beginning of the measurement session is twofold: 1)

a) To insure the measurement system is in good working order, and 2)

b) To adjust the level consistent with the environmental conditions of the day.

The purpose of the check at the end of the measurement session is also twofold: 1)

== To insure the measurement system remains in good working order, and 2)

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