
**Road vehicles — Test method
to evaluate the performance of
autonomous emergency braking
systems —**

**Part 1:
Car-to-car**

*Véhicules routiers — Méthode d'essai pour évaluer la performance
des systèmes automatiques de freinage d'urgence —*

Partie 1: Voiture à voiture

ISO 22733-1:2021

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Foreword

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. 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).

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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.

This document was prepared by Technical Committee ISO/TC 22, *Road Vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

A list of all parts in the ISO 22733 series can be found on the ISO website.

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.

Introduction

The capacity to avoid or mitigate a collision during potential accident is an important part of the performance of an autonomous emergency braking system. This document is intended to assess performance of an autonomous emergency braking system under defined test scenario only.

NOTE Moreover, insufficient knowledge is available concerning the relationship between overall vehicle dynamic properties and accident avoidance. (A substantial amount of work is necessary to acquire enough and reliable data on the correlation between accident avoidance and vehicle dynamic properties in general and the results of these tests in particular.)

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Road vehicles — Test method to evaluate the performance of autonomous emergency braking systems —

Part 1: Car-to-car

1 Scope

This document specifies a method to evaluate the behaviour of a vehicle equipped with an autonomous emergency braking system (AEBS), or dynamic brake support (DBS) during several accident scenarios. Those accidents occur during a straight-line driving when the vehicle under test (VUT) approaches another vehicle in the same lane. Both vehicles are aligned in longitudinal axis to each other.

The most important part of the vehicle behaviour during these accidents scenarios is the capacity to avoid or mitigate the collision.

Systems requiring driver intervention are not in the scope of this document.

NOTE Depending on accidentology, only a part of the scenarios can be used for an evaluation of performance. AEB system evaluation based upon this document is limited to longitudinal accident scenarios.

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.

ISO 8855:2011, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary* 22733-1-2021

ISO 15037-1:2019, *Road vehicles — Vehicle dynamics test methods — Part 1: General conditions for passenger cars*

ISO 19206-1, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 1: Requirements for passenger vehicle rear-end targets*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8855, ISO 15037-1 and the following 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

AEB

autonomous emergency braking

braking applied automatically by the vehicle in response to the detection of a likely collision to reduce the vehicle speed and potentially avoid the collision

3.2

CCRs

car-to-car rear stationary

collision in which a vehicle travels forward towards another stationary vehicle and the frontal structure of the vehicle strikes the rear structure of the stationary vehicle

3.3

CCRm

car-to-car rear moving

collision in which a vehicle travels forward towards another vehicle travelling at constant speed and the frontal structure of the vehicle strikes the rear structure of the leading vehicle

3.4

CCRb

car-to-car rear braking

collision in which a vehicle travels forward towards another vehicle travelling at constant speed and then decelerates, and the frontal structure of the vehicle strikes the rear structure of the leading vehicle

3.5

DBS

dynamic brake support

system that further amplifies the driver braking demand in response to the detection of a likely collision to achieve a greater deceleration

3.6

EVT

equivalent vehicle target

vehicle target as defined in ISO 19206-1

3.7

FCW

forward collision warning

audiovisual warning provided automatically by the vehicle in response to the detection of a likely collision to alert the driver

3.8

peak braking coefficient

PBC

measure of tyre-to-road surface friction based on the maximum deceleration of a rolling tyre

Note 1 to entry: Measured using ASTM E1136-10, at a speed of 64,4 km/h, without water delivery.

3.9

TTC

time-to-collision

remaining time before the VUT strikes the EVT (3.6), assuming that the VUT and EVT travel at constant speed

3.10

VUT

vehicle under test

vehicle tested with a pre-crash collision mitigation or avoidance system on board

3.11

T_{AEB}

time when the AEB (3.1) system activates

Note 1 to entry: Activation time is determined by identifying the last data point where the filtered acceleration signal is below -1 m/s^2 , and then going back to the point in time where the acceleration first crossed $-0,3 \text{ m/s}^2$.

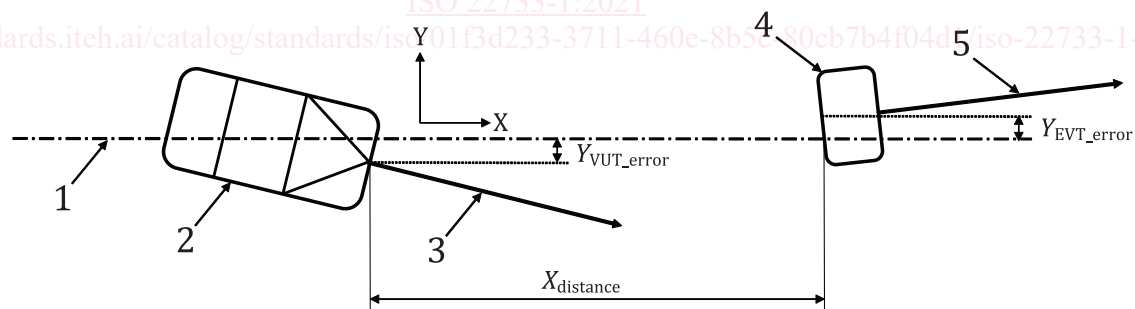
3.12 T_{FCW} time when the audible warning of the *FCW* (3.7) starts

Note 1 to entry: The starting point is determined by audible analysis or video analysis.

3.13 V_{impact} vehicle velocity at which the VUT hits the *EVT* (3.6)**3.14** $V_{\text{rel_impact}}$ relative speed at which the VUT hits the *EVT* (3.6) by subtracting the velocity of the *EVT* from V_{impact} (3.13) at the time of collision**4 Variables****4.1 Reference system**

The reference earth frame according to ISO 8855:2011, 2.8 is defined as:

- X axis: intended straight line path projected on the ground to front;
- Y axis: perpendicular to X axis on the ground to left;
- Z axis: perpendicular to the ground to the top.

4.2 Lateral offsetThe lateral offset is determined as the lateral distance between the centre of the front of the VUT and the centre of the rear of the EVT when measured in parallel to the intended straight-lined path as shown in [Figure 1](#).**Key**

- 1 intended straight-lined path
- 2 VUT
- 3 VUT path
- 4 EVT
- 5 EVT path

Figure 1 — Coordinate system and notationThe lateral offset is defined as $Y_{\text{VUT_error}} + Y_{\text{EVT_error}}$.The origin is an arbitrary point on X axis. The Y_{VUT} and $Y_{\text{target_error}}$ are measured in the reference frame and the $Y_{\text{target_error}}$ is identical to $Y_{\text{EVT_error}}$.

4.3 Variables to be measured

[Table 1](#) lists all relevant variables to be measured. All dynamic data shall be sampled and recorded at a frequency of at least 100 Hz. EVT and VUT data shall be synchronized by using the differential GPS (DGPS) time stamp of the EVT.

Table 1 — Variables to be measured

	Variable	Symbol
Time	CCRs and CCRm: T_0 equals TTC = 4 s	T_0
	CCRB: T_0 when EVT starts decelerating	
	T_{AEB} , time when AEB activates	T_{AEB}
	T_{FCW} , time when FCW activates	T_{FCW}
	T_{impact} , time when VUT impacts EVT	T_{impact}
Position	Position of the VUT during the entire test	X_{VUT}, Y_{VUT}
	Position of the EVT during the entire test	X_{EVT}, Y_{EVT}
Speed	Speed of the VUT during the entire test:	V_{VUT}
	— V_{impact} , speed when VUT impacts EVT	V_{impact}
	— V_{rel_impact} , relative speed when VUT impacts EVT	V_{rel_impact}
	Speed of the EVT during the entire test	V_{EVT}
Yaw velocity	Yaw velocity of the VUT during the entire test	$\dot{\psi}_{VUT}$
	Yaw velocity of the EVT during the entire test	$\dot{\psi}_{EVT}$
Acceleration	Acceleration of the VUT during the entire test	A_{VUT}
	Acceleration of the EVT during the entire test	A_{EVT}

An example of a test report is given in [Annex B](#).

5 Equivalent vehicle target

The equivalent vehicle target (EVT) shall meet the requirements as defined in ISO 19206-1.

6 Measuring equipment and data processing

6.1 General

The test conditions on measurement equipment and data processing shall be in accordance with ISO 15037-1:2019, Clause 6, unless otherwise specified below.

6.2 Description

VUT and EVT shall be equipped with data measurement and acquisition equipment to sample and record data with an accuracy of at least:

- VUT and EVT speed to 0,1 km/h;
- VUT and EVT lateral and longitudinal position to 0,03 m;
- VUT and EVT yaw rate to 0,1°/s;
- VUT and EVT longitudinal acceleration to 0,1 m/s²;
- steering wheel velocity to 1,0°/s.