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Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions —

Part 3: Requirements for passenger vehicle 3D targets

Véhicules routiers — Dispositifs d'essai pour véhicules cibles, usagers de la route vulnérables et autres objets, pour l'évaluation de fonctions de sécurité active —

Partie 3: Exigences pour cibles de véhicules particuliers 3D

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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.

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).

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.

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 19206 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

ADAS (advanced driver assistance systems) and active safety systems are designed to support decision-making for the driver, extend the driver's awareness of the traffic situation with advanced warnings, improve the behaviour of the vehicle, and even take over vehicle control in an emergency situation. The goal is to completely avoid an accident or at least reduce the severity of an accident.

The surrogate target is an essential component in the evaluation of ADAS/active safety functions and different levels of automated driving systems, in all situations where a collision with the target may occur.

The characteristics of targets must be trustworthy and a vehicle target must be recognized as a real vehicle by the various sensing technologies.

This document addresses the specification of vehicle 3D test targets.

It is important that a surrogate vehicle target represents a real vehicle in terms of detectability and movement from all directions. It should also provide safety for the subject vehicle and test operators if contact is made between the subject vehicle and the target. Crashworthiness and durability requirements for the vehicle target require that the material and construction of the vehicle target are adapted to fit the purposes.

Test cases usually address both stationary and moving targets and, as such, the physical construction of the target accommodates a target carrier system capable of mimicking realistic motions. This document includes requirements on the target carrier system as applicable.

Targets described in the ISO 19206 series can be used for system development or applied in conjunction with existing standards, or standards under development, for assessment of ADAS and active safety functions of vehicles.

Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions —

Part 3: Requirements for passenger vehicle 3D targets

1 Scope

This document specifies performance requirements for surrogate targets used to assess the system detection and performance of active safety systems.

This document specifies the properties of an omni-directional multi-purpose vehicle target for assessment of interaction in a variety of traffic scenarios.

This document specifies the properties of a vehicle target that will allow it to represent a passenger vehicle in terms of size, shape, reflection properties, etc. for testing purposes. This document addresses the detection requirements for a vehicle target in terms of sensing technologies commonly in use at the time of publication of this document, and where possible, anticipates future sensing technologies. It also addresses methodologies to verify the target response properties to these sensors, as well as performance requirements for the target carrier.

The vehicle targets specified in this document reflect passenger cars and, in particular, the smaller and more common B and C segment cars.

This document does not address the test procedures in terms of speeds, positions, or timing of events. Performance criteria for the active safety system are also not addressed.

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, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

ISO 8608, *Mechanical vibration — Road surface profiles — Reporting of measured data*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8855 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 http://www.electropedia.org/

3.1
subject vehicle
SV
vehicle with active safety system to be tested

3.2
vehicle target
VT
test device representing a vehicle, whose purpose is to activate sensor systems

Note 1 to entry: Vehicle target consists of a *target structure* (3.2.1) and optionally a *target carrier* (3.2.2).

Note 2 to entry: This document addresses test devices representing a vehicle having the necessary features to be recognised from any direction (3D vehicle target).

3.2.1
target structure
physical structure whose purpose is to maintain the shape and provide the relevant sensor signature representing a vehicle

3.2.2
target carrier
mechanical or electro-mechanical system used to move and/or support the *target structure* (3.2.1) according to a test protocol

Note 1 to entry: Target carrier may be self-contained within, or supporting the target structure or external devices connected with cables, beams, or similar structures. It can also be a self-propelled carrier.

Note 2 to entry: Target structure and target carrier may be integrated.

Note 3 to entry: Target structure fixation is included in the target carrier.

3.3
target axis system
axis system fixed in the reference frame of the target, so that the X_t axis is substantially horizontal and forward (with the target at rest), and is parallel to the target's longitudinal plane of symmetry, and the Y_t axis is perpendicular to the target's longitudinal plane of symmetry and points to the left with the Z_t axis pointing upward

Note 1 to entry: See Figure 2 for further explanation of the target axes X_t, Y_t, Z_t.

3.4
target coordinate system
coordinate system based on the *target axis system* (3.3) with the origin located at the *target reference point* (3.5)

Note 1 to entry: The position of the vehicle in the target coordinate system is described by coordinates x_t, y_t, z_t.

3.5
target reference point
point whose location relative to the external dimensions of the target, in its initial condition, remains constant

Note 1 to entry: to entry:

$x = 0, y = 0$ at the centroid of the area defined by a horizontal projection of the plan view of the target;

$z = 0$ at the ground plane.

3.6
measurement equipment
equipment used to record the position and motions of the *vehicle target* (3.2) relative to the *subject vehicle* (3.1)

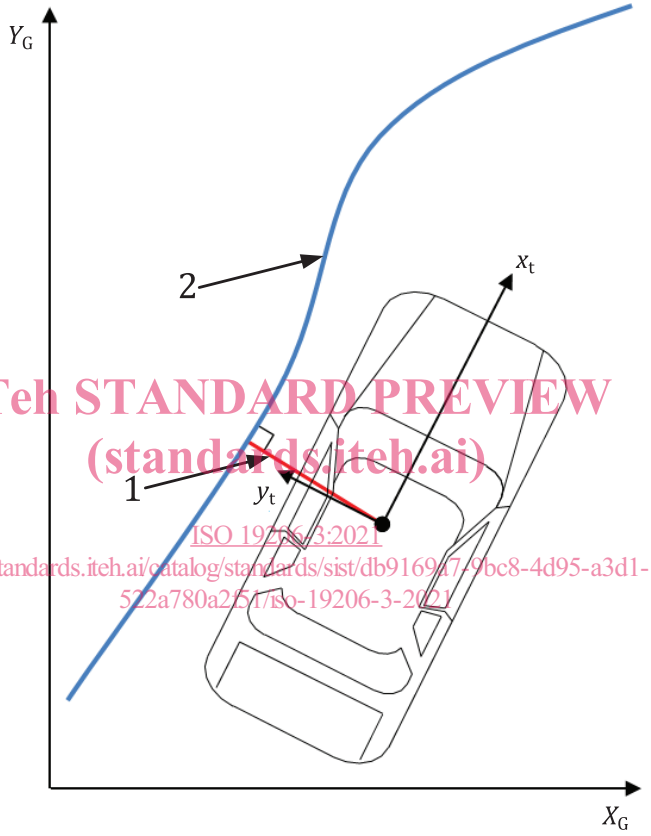
Note 1 to entry: The measurement equipment is used to ensure that the test protocol is followed within prescribed tolerances and to record data documenting the function of the active safety system and allowing its performance to be assessed.

3.7
planned path
X, Y coordinates that define the desired trajectory of the target vehicle

3.8
lateral path deviation
position error of the target vehicle relative to the *planned path* (3.7) measured perpendicular from the planned path direction

Note 1 to entry: See illustration in Figure 1.

Note 2 to entry: Y_G and X_G are the ground (fixed) coordinate axes in which the planned path is defined.



Key
1 lateral path deviation
2 planned path

Figure 1 — Lateral path deviation

4 Abbreviated terms

CCD charge-coupled device

CMOS complementary metal oxide semiconductor

FIR far infrared

LIDAR light detection and ranging

NIR near infrared

PMD photonic mixer device

RCS radar cross section

SV subject vehicle

VT vehicle target

5 Vehicle target specifications

5.1 Vehicle classes and target applicability

The vehicle targets specified in this document reflect passenger cars and in particular the smaller and more common B and C segment cars. See Annex A for more information.

The test devices described in this document are intended for testing of systems designed to mitigate or avoid collisions in which the subject vehicle approaches the target vehicle from any direction.

5.2 Reference dimensional measurements

Reference measurements for the vehicle target should come from a representative sample of vehicles from the B/C segment that were manufactured within five years prior to the publication date of this document.

General dimensions of the vehicle fleet are given in Annex A.

5.3 Safety considerations

Drivers of the subject vehicle shall not be exposed to any substantial risk of personal injury. The vehicle target and its components should not cause more than cosmetic damage to the subject vehicle when struck at a relative velocity of 60 km/h. The conditions specified by the test procedure application shall be taken into consideration.

NOTE Test procedures for specific applications typically indicate what measures are taken to reduce the risk of injury and vehicle damage. These measures can include instructions to disable subject vehicle systems such as supplementary occupant restraints, seatbelt pre-tensioners, vulnerable user protection systems, etc.

5.4 Repairability and robustness

The vehicle target should be easily reassembled or repaired after contacts. Field repairs should be possible to perform with standard hand tools. The sensor-specific characteristics shall be met also after re-assembly and repair. The time for reassembly is affected by the handling efficiency of the users and should be as short as possible. As a guideline the reassembly should be possible with two persons and should take less than 15 minutes. The target requirements should be fulfilled after at least fifty crashes with a relative velocity of 60 km/h with a vehicle of category M1.

NOTE 1 This requirement does not apply to disposable and single impact targets.

NOTE 2 Category M1: vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat. (Source: UN consolidated resolution R.E.3 and Directive 2007/46/EC).

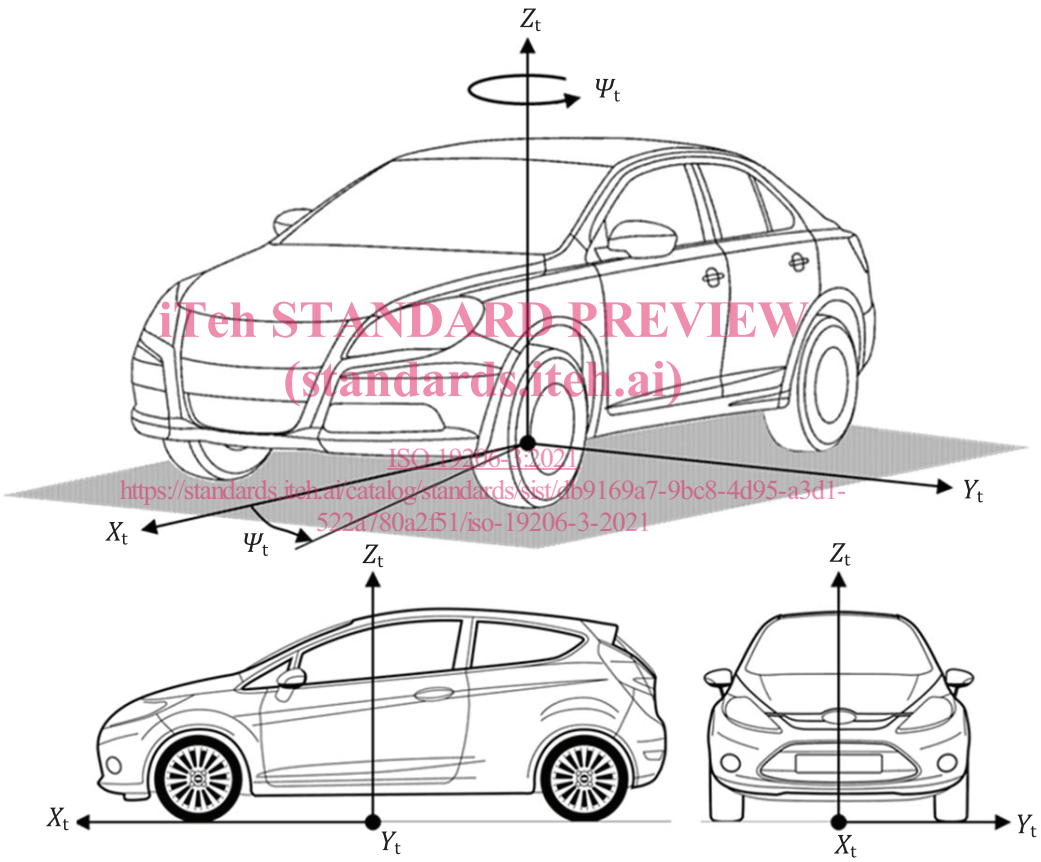
5.5 Environmental conditions

The vehicle target shall fulfil all requirements in an ambient temperature range of -5 °C to +40 °C. The vehicle target shall not deteriorate under storage temperatures in the range of -40 °C to +80 °C when properly stored.

NOTE The specified temperature range recognises that there are substantial technical challenges achieving a cost-effective target fulfilling the requirements at lower temperatures than -5 °C.

5.6 Reference coordinate system

The reference coordinate system in this document essentially adopts the coordinate system given in ISO 8855, adapting it to the purpose of the target vehicle movement. The target coordinate system, which uses the target axis system located at the target reference point, is shown in Figure 2.



NOTE ψ_t is the rotation about the Z_t axis.

Figure 2 — Reference coordinate system

5.7 Speed classes

The following speed classes are applicable according to this document, see Table 1.

Table 1 — Speed classes

Speed class	Description
SC50	Operational speed up to 50 km/h (13,9 m/s)
SC80	Operational speed up to 80 km/h (22,2 m/s)
SC80+	Operational speed up to and greater than 80 km/h (22,2 m/s)

6 Vehicle target response to sensing technologies

6.1 General

Requirements related to sensing technologies commonly in use at the time of publication of this document are listed in 6.2, 6.3 and 6.4. A vehicle target intended for use with a specific set of sensing technologies only needs to meet the requirements of those technologies.

6.2 Optical requirements

6.2.1 General

Sensors operating on optical principles include CCD and CMOS camera sensors, stereo camera sensors, photonic mixer devices (PMD) and light detection and ranging (LIDAR). These systems cover visible and near infrared light frequency spectra. PMD and LIDAR are more reliant on infrared reflectivity of the target surface.

6.2.2 Reference measurements

When technology-specific measurements are required, information of the type of sensor used, environmental conditions during measurements, and date of measurement shall be provided with the description of the vehicle models. The version of the vehicle target and the target carrier shall be traceable to manufacturing drawings or supplier specifications.

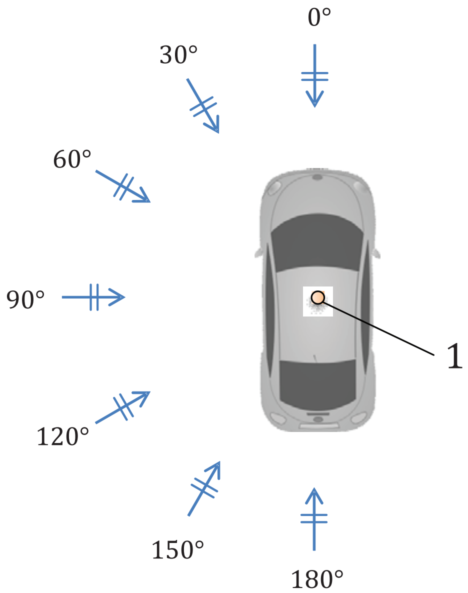
General dimensions of the vehicle fleet are given in Annex A.

6.2.3 Stability of dimensions for optical recognition

Target surface shall not flutter or vibrate unrealistically due to aerodynamic effects for the applicable speed class and a side wind of up to 5 m/s. Local fluttering should not exceed 10 mm perpendicularly from the reference surface. Distortion of the vehicle shape should not exceed 25 mm in any direction.

6.2.4 Viewing angles

Main angles for recognition are shown in Figure 3.



Key

1 target reference point

Figure 3 — Viewing angles

6.2.5 Features related to optical requirements

The visual difference between the VT and a passenger vehicle of the B/C segment size should be as small as possible. The contours of the VT should be representative of a real middle-sized passenger car. It should demonstrate a high level of symmetry about the x-z plane.

The wheels, consisting of tire and rim, shall be round and of realistic dimensions.

The windows (windscreen, side windows, rear window) should give the impression of being transparent. The interior of a real car (seat, steering wheel, rear view mirror, driver) may be indicated.

Features representing the rear lights, reflectors, and registration plate are required.

NOTE General requirements for the size and position of these features are available in 407/2011/EC[10], UN-ECE Regulation 3[11], UN-ECE Regulation 48[12] and FMVSS 108[9].

Lighter colours of vehicle targets shall be used. High contrast to background should be considered.

Features necessary for the optical recognition as specified in Annex B shall be followed.

6.3 Radar requirements

6.3.1 Reference measurements of radar properties

At the time of publication of this document, automotive applications of radar are using 24 GHz and (76 – 81) GHz.

6.3.2 Reference measurements

Reference measurements for the vehicle target should come from a representative sample of vehicles from the B/C segment that were manufactured within five years prior to the publication date of this document.

When technology-specific measurements are required, information of the type of sensor used, environmental conditions during measurements, and date of measurement shall be provided with the description of the vehicle models. The version of the vehicle target and the target carrier shall be traceable to manufacturing drawings or supplier specifications.

6.3.3 Radar cross section, static measurements and requirements

Measurement of radar cross section as described in Annex C shall be followed.

6.3.4 Radar recognition features of vehicle target

Features necessary for radar recognition as specified in Annex C shall be followed.

6.3.5 Stability of dimensions for radar recognition

Local fluttering due to aerodynamic effects should not cause radar signature to vary, including micro-Doppler effects, for the applicable speed class and a side wind of up to 5 m/s.

6.4 Thermal requirements for Far Infrared vision systems

6.4.1 General

The vehicle target is defined as possessing the optical characteristics according to 6.2 with features added to provide response to thermal sensing. Inclusion of passive thermal sensor requirements is optional.

Far infrared (FIR) vision systems can provide information to active safety systems in conditions of low light or otherwise limited visibility. A thermal camera detects far-infrared electromagnetic radiation with a wavelength in the range of 8 µm to 14 µm. Imaging is provided by means of an appropriate camera.

6.4.2 Reference measurements

When technology-specific measurements are required, information of the type of sensor used, environmental conditions during measurements, and date of measurement shall be provided with the description of the measured subjects and/or target. The version of the target and the target carrier shall be traceable to manufacturing drawings or supplier specifications.

6.4.3 Thermal characteristics

Vehicle targets commonly in use at the time of publication of this document do not feature vehicle-specific FIR characteristics. Developers of vehicle targets that incorporate such characteristics should ensure that the characteristics are comparable to typical vehicles represented by the target.

Characterization of these properties should follow the steps below:

1) measurement of typical vehicles,

2) establishment of boundaries,

3) verification that the vehicle target FIR measurements are within the specified boundaries.

6.5 Calibration

The vehicle target manufacturer shall provide a certificate detailing which test information has been used to verify the product performance and which sensor technologies it conforms to. Target should comply to this document with a certificate.

Calibration shall be based on representative characteristics of the applied detection technology as described in 6.2, 6.3 and 6.4, and the related annexes.

6.6 Field verification

For field verification of vehicle target functionality, see Annex E.

7 Motion and positioning during test for VT including target carrier system

7.1 General requirements

The target carrier system shall be capable of positioning the target within tolerances required by the test procedure application. Repeatable test performance requires that subject and vehicle target relative speed and position be consistent between test repetitions. Unless more stringent requirements are needed by a specific test procedure, the positioning requirements outlined in this section are the minimum requirements for the vehicle target. Recommendations for measurement equipment are given in Annex D.

The following requirements should be fulfilled by the target carrier system.

— All visible parts of the target carrier system should be coloured to minimize the contrast with background, e.g. grey, to approximate the test area road surface. In case of a uniform background the colour shade of the background can be used.

— The target carrier system and resulting motion of the vehicle target shall minimally affect target characteristics (radar, optical signature, etc).

— The target carrier shall accelerate and decelerate in a smooth manner, except for actions intended to avoid impact or damage.

The requirements in this clause are applicable to all speed ranges. The positioning requirements in 7.2 and 7.3 are with reference to a coordinate system oriented with the vehicle target. The longitudinal axis is parallel with the direction of travel, see Figure 2.

7.2 Longitudinal positioning

7.2.1 Speed range for operation

The steady state speed control accuracy shall be ± 1 km/h (± 0,3 m/s) for the speed classes in Table 1.

7.2.2 Accelerations

Deceleration/braking of at least 6 m/s^2 is required. Acceleration of at least 1 m/s^2 is recommended.

7.3 Lateral positioning

7.3.1 General

The vehicle target shall be able to meet the lateral positioning requirements in 7.3.2 and 7.3.3 while operating in the speed range defined in 7.2.1 over a smooth road surface no rougher than road class A as defined in ISO 8608.

7.3.2 Yaw rate

When using a self-propelled target carrier, the vehicle target shall be capable of maintaining a straight-line path with a filtered yaw rate of ±1°/s.