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

Part 4:
Requirements for bicyclist 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 4: Exigences pour cibles de cyclistes

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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,* Working Group 16 *Active safety test equipment*.

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.

Testing of active safety systems requires documentation of test equipment, test environment, testing procedures, and performance criteria. This document series addresses the specification of test target objects for traffic scenarios representing vehicles, vulnerable road users and other objects in the forward path of the tested vehicle.

This document addresses the specification of bicyclist test targets. The bicyclist targets specified are representative of adult and child sizes.

A bicyclist test target needs to represent the characteristics of the rider and bicycle yet provide safety for the subject vehicle and test operators in the event that contact is made between the tested vehicle and the bicyclist target. Crashworthiness and durability requirements for the bicyclist target require that the material and construction of the bicyclist target are adapted to fit the purposes.

Test cases may address both stationary and moving targets and, as such, the physical construction of the target may accommodate a target carrier system capable of mimicking the motions of a human bicyclist. This document includes applicable requirements for the target carrier system.

Targets described in this document series may 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 4: Requirements for bicyclist targets

1 Scope

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

This part of ISO 19206 specifies the properties of bicyclist targets (BT) that represent a human bicyclist in terms of shape, movement, reflection properties, etc. for testing purposes.

The document addresses the detection requirements for a BT in terms of sensing technologies commonly in use at the time of publication of this document, and where possible, anticipated future sensing technologies. It also addresses methodologies to verify the target response properties to these sensors, as well as some performance requirements for the target carrier.

The BT according to this document is also representative for electrically assisted pedal bicycles (pedal electric cycle, pedelec).

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

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.

ISO 8608:1995, *Mechanical vibration — Road surface profiles — Reporting of measured data*

ISO 19206-2, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 2: Requirements for pedestrian targets*

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 http://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
bicyclist target
BT
test device representing a bicyclist on a bicycle used to test active safety systems

3.2.1
BT bicycle
part of the bicyclist target consisting of the bicycle only

3.2.2
BT rider
part of the bicyclist target consisting of the rider only

3.3
target carrier
mechanical or electro-mechanical system used to move the target 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.

Note 2 to entry: Target structure fixation is included in the target carrier.

3.4
measurement equipment
equipment used to record the position of the bicyclist target relative to the subject vehicle to ensure that the test protocol is followed within prescribed tolerances and record data documenting the function of the active safety system and allowing its performance to be assessed

4 Symbols and abbreviated terms

BT	Bicyclist Target
CCD	Charge-Coupled Device
FIR	Far Infrared
LIDAR	Light Detection and Ranging
NIR	Near Infrared
PMD	Photonic Mixer Device
RCS	Radar Cross Section
SV	Subject Vehicle

5 Bicyclist target specifications

5.1 Bicyclist target size

The bicyclist targets specified in this document are representative for adult and child sizes. References for subsequent requirements are based on sample measurements of different demographics and compiled into categories. The following human bicyclist sizes are relevant for this document:

— Adult: 50 %-ile male

— Child: 6-7 year old

5.2 Dimensions of the BT rider

Annex A, Tables A.1 and A.2 provide the information for a 50%-ile male adult and a 6-7 year old child.

5.3 Safety considerations

Drivers of the subject vehicle shall not be exposed to any substantial risk of personal injury resulting from impact of the BT by the SV. The BT 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 BT should be easily reassembled or repaired after contacts up to a relative speed of 60 km/h. Field repairs should be possible with standard hand tools. After repair, the target body and/or target carrier system shall be verified according to clause 6.5.

NOTE The repairability requirement does not apply to disposable targets.

After a collision, the correctness of the BT posture and dimension shall be verified before start of a new test.

5.5 Environmental conditions

The BT shall fulfil all requirements in a temperature range of -5 °C to +40 °C. The BT shall not deteriorate under storage temperatures in the range of -20 °C to +80 °C when properly stored.

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

5.6 Postures and articulation

5.6.1 General

BT rider postures can be of static (non-pedalling type) or articulated (pedalling type). Both variants are recognised according to this document.

The BT shall be a full 3D representation of a human bicyclist with bicycle, and shall have rotating wheels (synchronized to speed) or other means of producing the 3D visual and micro-Doppler effects as described in 6.3.4.

5.6.2 Static posture

The BT described in this document represents an average human adult bicyclist on an average standard adult utility bike (Figure 1) in relation to the vulnerable road users (VRU) detection sensors used in vehicles. The requirements relate, unless not specified otherwise, to the BT including a target carrier.

The torso angles according to Table A.1 (10° and 30°) shall be implemented. Optional torso angles may be implemented using a range of 0° to 50°.

Figure 1 — Bicyclist target with different BT rider torso angles

6 Bicyclist 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 BT intended for use with a specific set of sensing technologies needs only 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 Mixing 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 BT. The version of the BT and the target carrier shall be traceable to manufacturing drawings or supplier specifications. For more information, see Annex C.

6.2.3 Colours and clothing

Skin surface parts of BT rider shall be non-reflective and skin-coloured. Hair may be represented by a securely attached hairpiece or integrated in the head design by other means.

It is recommended to use a long-sleeved t-shirt and trousers in different, non-reflective, colours. A black t-shirt and blue jeans are recommended. Clothing shall be loose fitting, but fluttering shall be avoided. Specific requirements given in Annex B, clause B.2, shall be followed.

6.3 Radar requirements

6.3.1 General

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

6.3.2 Reference measurements

Reference measurement setups for human bicyclist subjects to be used for verification are provided in Annex C, clause C.3.

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 reference subject(s). The version of the BT and the target carrier shall be traceable to manufacturing drawings or supplier specifications.

6.3.3 Radar cross section measurement of BT

The radar reflective characteristics of the BT should be comparable to a human bicyclist of the same size. Recommendations on the radar properties are given in Annex B, clause B.3.

For every radar frequency relevant for the BT, a set of radar cross section measurements shall be made. The main steps are as follows:

1) Measurement of human bicyclist reference subjects and RCS standard targets,

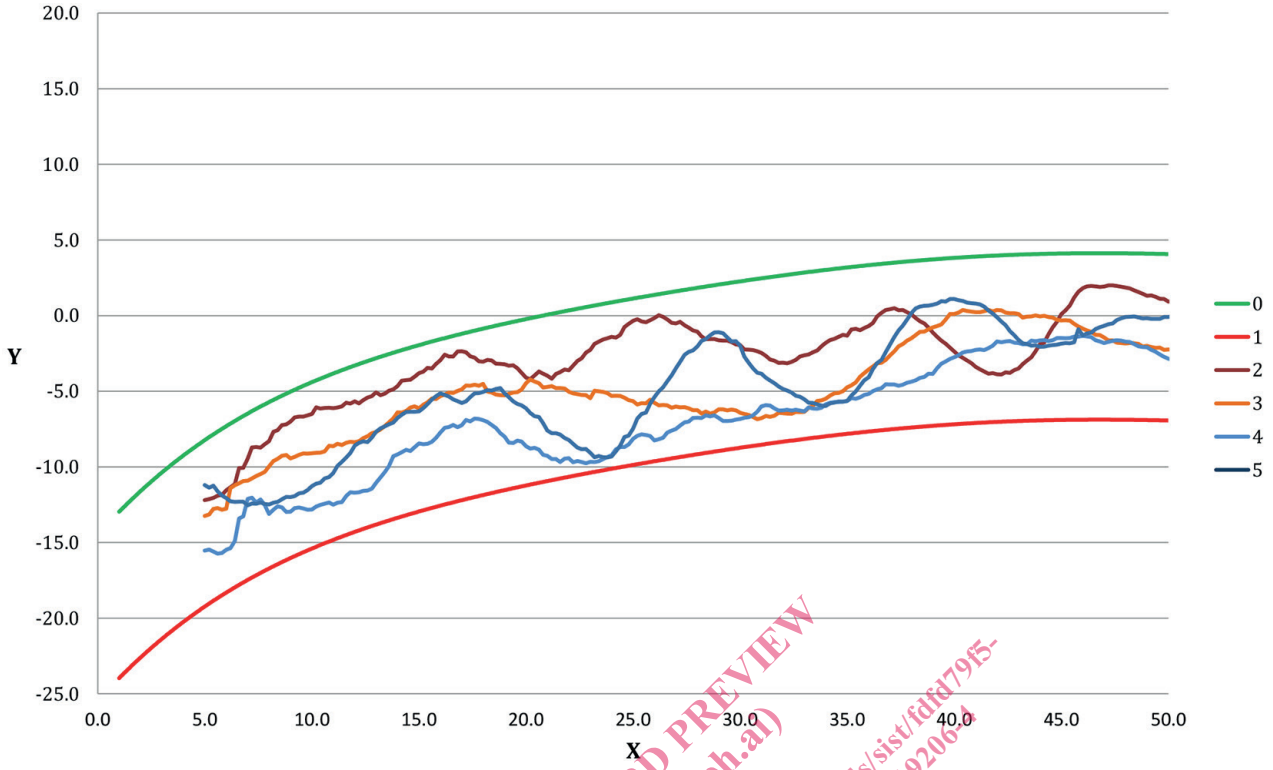
2) Establishment of boundaries,

3) Verification that the BT Radar Cross Section (RCS) measurements are within the boundaries.

The following scenario is described in Annex C, clause C.3.3:

— Static BT approached by moving vehicle or moving fixture, to check for inconsistencies at different distances and different BT orientation angles.

An example of the results of this process is illustrated in Figure 2, showing RCS measurements on human bicyclist reference subjects and two BT versions at 77 GHz (static measurements).



Key

X Distance [m]
Y RCS [dBsm]
0 Upper Boundary RCS
1 Lower Boundary RCS
2 Average RCS Real GAZELLE 180°
3 Average RCS Real KTM 180°
4 Average RCS commercially available BT A 180°
5 Average RCS commercially available BT B 180°

NOTE Boundary definitions are given in Annex B, clause B.3.

Figure 2 — Radar cross-section measurement, example for human adult bicyclists and BTs

6.3.4 Micro-Doppler effect for rotating wheels and pedalling of the BT

State of the art radar sensor technology can measure and detect the relative velocities of rotating wheels and pedalling legs on the bicyclist. This characteristic of moving parts will be referenced as micro-Doppler in the specifications. For more information, see Annex D.

Figure 3 shows an example of the distribution of relative velocities for a transversal moving human bicyclist, measured by radar (77 GHz sensor, 1 GHz bandwidth).

The plot shows a snapshot at a distinct time from the approach. Due to the chosen reference coordinate system, relative speeds show negative values (approach towards sensor). A typical H-shape of relative velocities is depicted, with reflections in the centre emerging from non-rotating parts (travel speed of bicycle), and two horizontal lines representing the two rotating wheels (double the travel speed of bicycle for upper parts of wheels, zero relative velocity for part of wheels touching ground). The pedalling motion shows additional relative speed information minor to the rotating wheels.