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Intelligent transport systems — Bicyclist detection and collision mitigation systems (BDCMS) — Performance requirements and test procedures

Systèmes de transport intelligents — Systèmes de détection des cyclistes et d'atténuation des collisions (BDCMS) — Exigences de performance et procédures d'essai

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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).

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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 204, *Intelligent transport systems*.

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

Bicyclist detection and collision mitigation systems (BDCMS) reduce the severity of collisions between a human-driven vehicle and bicyclists that cannot be avoided and may reduce the likelihood of such collisions by automatically activating emergency braking (EB). BDCMS assist in slowing the subject vehicle (SV) when a collision is likely.

BDCMS functions may be used as a stand-alone system or might be part of a driver assistance system. As depicted in Figure 1, the BDCMS will provide information to the driver and perform SV actuation in the form of longitudinal control.

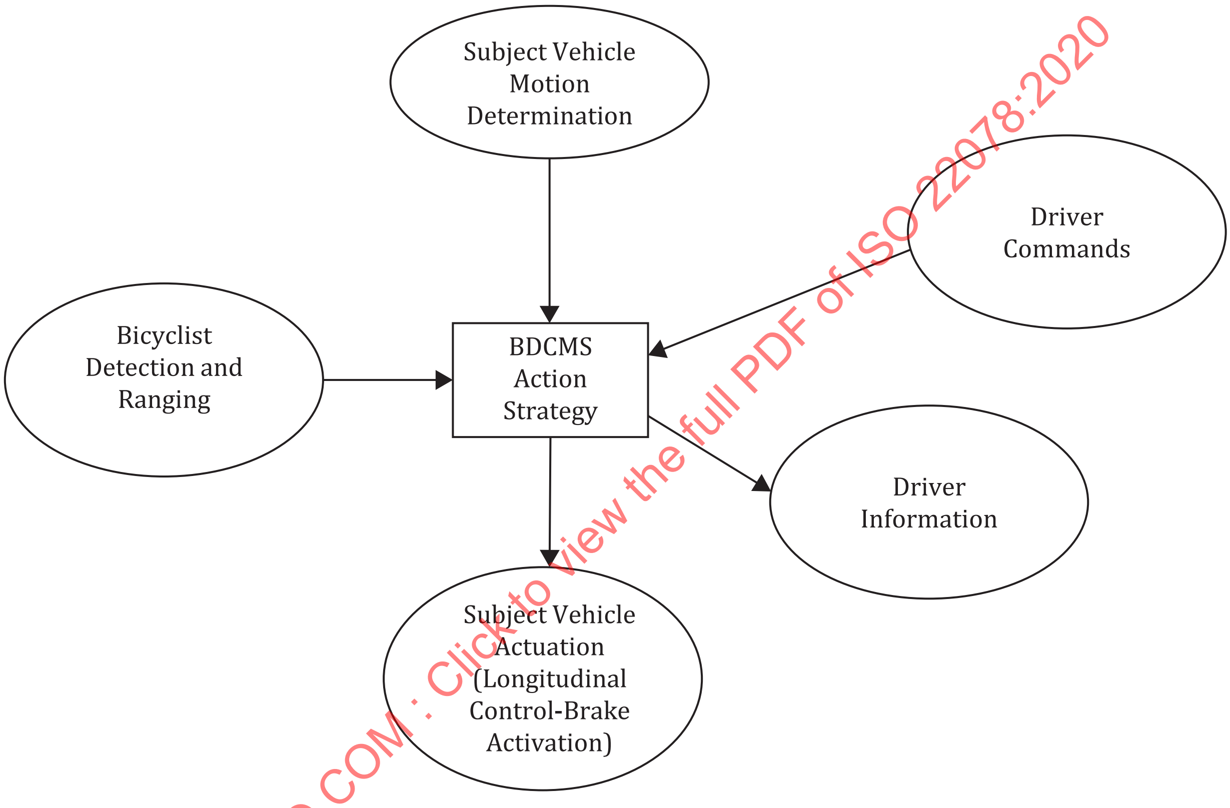


Figure 1 — BDCMS functional elements

Intelligent transport systems — Bicyclist detection and collision mitigation systems (BDCMS) — Performance requirements and test procedures

1 Scope

This document specifies the concept of operation, minimum functionality, system requirements, system interfaces, and test procedures for bicyclist detection and collision mitigation systems (BDCMS). It also defines the system test criteria necessary to verify that a given implementation meets the requirements of this document. Implementation choices are left to system designers, wherever possible.

BDCMS are fundamentally intended to provide emergency braking (EB) of equipped vehicles in order to mitigate collision severity between the subject vehicle (SV) and a bicyclist. BDCMS detect bicyclists forward of the SV, determine if the detected bicyclists are in a hazardous situation with respect to the SV, and initiate EB if a hazardous situation exists and a collision is imminent. Systems that include other countermeasures such as evasive steering are outside the scope of this document.

This document defines two types of BDCMS (based on operation in different ambient illuminance) and two classes of BDCMS (based on operation on different vehicle size classes), as depicted in Table 1. This document does not apply to motorcycles. The operational design domain is public roads. BDCMS is not intended for off-road use.

Table 1 — Types and classes of BDCMS

	BDCMS class I	BDCMS class II
BDCMS type I	Daytime only Light vehicles only	Daytime only Heavy vehicles only
BDCMS type II	Daytime, twilight, and night-time Light vehicles only	Daytime, twilight, and night-time Heavy vehicles only

Responsibility for the safe operation of the vehicle remains with the driver.

Licensable motor vehicles intended for use on public roads (i.e. motorcycles, cars, light trucks, buses, motor coaches), and other heavy vehicles as hazards are outside the scope of this document and are covered under ISO 22839.

Pedestrians are outside the scope of this document and are covered under ISO 19237.

Annex A contains informative information relative to BDCMS.

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

ISO 19206-4:—[1)], *Road vehicle — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions —Part 4: Requirements for bicyclist targets*

ISO/CIE 19476, *Characterization of the performance of illuminance meters and luminance meters*

1) Under preparation. Stage at the time of publication: ISO/DIS 19206-4:2020.

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 http://www.electropedia.org/

3.1
bicyclist
human-vehicle combination consisting of a human riding on top of a two-wheel frame (bicycle) with a steering mechanism, brakes, two pedals for propulsion (optionally with motor-assisted pedalling) that does not require a licence for use on public roads

3.2
bicyclist collision
collision between the *subject vehicle (SV)* (3.12) and a *bicyclist* (3.1)

3.3
daytime
condition where the ambient illuminance is greater than 2 000 lx

3.4
driver override
driver-initiated suppression of an *emergency braking (EB)* (3.5) or collision warning (CW) countermeasure

3.5
emergency braking
EB
bicyclist detection and collision mitigation systems (BDCMS) countermeasure that responds to the detection of a hazardous situation by automatically activating braking, and optionally issuing a collision warning (CW), to quickly reduce the *subject vehicle* (*SV)* (3.12) velocity

3.6
hazardous situation
condition whereby the position and orientation of a detected *bicyclist* (3.1), in relation to the position and orientation of the *subject vehicle* (*SV)* (3.12), will result in an imminent collision

3.7
heavy vehicle
single vehicle or combination of vehicles equipped with a pneumatic braking system, defined as category 1-2 or category 2 in the United Nations Economic and Social Council World Forum for Harmonization of Vehicle Regulations ECE/TRANS/WP.29/1045

3.8
impact point
relative position, from the *subject vehicle* (*SV)* (3.12) point of view, where a collision with a *bicyclist* (3.1) is expected in a hazardous situation, defined as the relative position where the *SV* will contact the bicyclist

3.9
light vehicle
vehicle defined as category 1-1 in the United Nations Economic and Social Council World Forum for Harmonization of Vehicle Regulations ECE/TRANS/WP.29/1045

3.10
night-time
condition where the ambient illuminance is less than 1 lx

3.11
off-road
road surface conditions (i.e. unpaved) not intended for vehicular traffic or governed by normal traffic laws

3.12
subject vehicle
SV
vehicle equipped with bicyclist detection and collision mitigation systems (BDCMS)

3.13
twilight
condition where the ambient illuminance is 3-400 lx

Note 1 to entry: Generally, twilight occurs during civil twilight, from when the geometric centre of the sun's disk dips below the horizon until the geometric centre of the sun's disk is less than 6 ° below the horizon.

4 Symbols

v_B	velocity of the bicyclist
$v_{B_{max}}$	maximum bicyclist speed for the BDCMS operation
$v_{B_{min}}$	minimum bicyclist speed for the BDCMS operation
v_{SV}	velocity of the SV
$v_{SV_{max}}$	maximum SV speed for the BDCMS operation
$v_{SV_{min}}$	minimum SV speed for the BDCMS operation
W_{SV}	width of the SV

5 Requirements

5.1 Minimum enabling capabilities

Vehicles equipped with BDCMS shall able to:

— detect the hazardous situation;

— determine the SV velocity;

— initiate appropriate BDCMS countermeasures (optionally CW) and generate at least the minimum required BDCMS speed reduction;

— activation and modulation of the brakes whether or not the driver is already braking.

— enhancement of the driver control based on brakes with a yaw stability capability and a capability to manage longitudinal wheel slip, by utilizing an electronic stability control (ESC) system;

— management of permission of the driver's ability to increase the deceleration to any higher value up to the maximum possible vehicle deceleration after EB has been initiated;

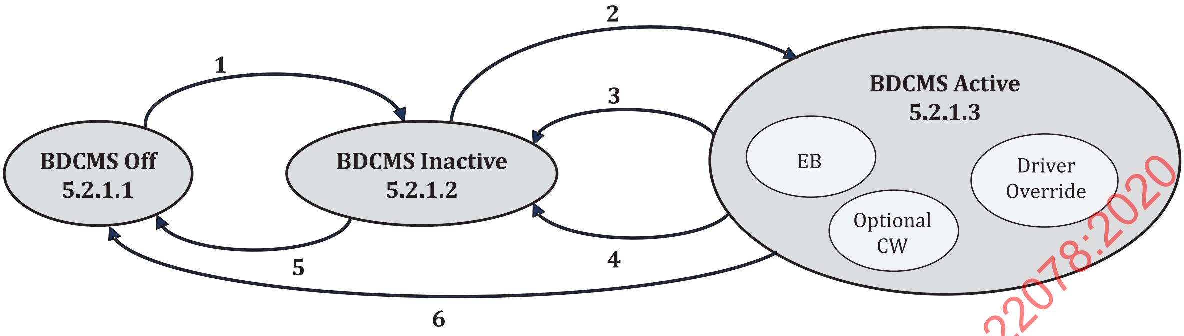
— management of permission of the driver's ability to override commands at any time;

— provision of information about system availability to the driver.

5.2 Operating model — State transition diagram

5.2.1 General

The BDCMS shall function according to the state transition diagram in Figure 2. Specific implementation, beyond what is illustrated in Figure 2, of the state transitions is left to the manufacturer.



Key

1 ignition on or (optional) ignition on and driver turn on

2 SV speed ≥ $v_{SV_{min}}$ and SV speed ≤ $v_{SV_{max}}$

3 failure detected (automatic deactivation possible)

4 SV speed < $v_{SV_{min}}$ or SV speed > $v_{SV_{max}}$, exception: when SV speed falls below $v_{SV_{min}}$ or exceeds $v_{SV_{max}}$, while EB is active, EB continues to be operational as long as the command is being issued

5 fail self-test, ignition off or (optional) driver turn off

6 fail self-test, ignition off or (optional) driver turn off

Figure 2 — BDCMS state transition diagram including optional features

5.2.2 State functional descriptions

5.2.2.1 General

The BDCMS state descriptions address the functional requirements of BDCMS, identifying which functions shall be performed in each state.

5.2.2.2 BDCMS off state

No countermeasures are performed in the BDCMS off state. Upon turning the ignition to the off position, BDCMS shall transition to the BDCMS off state. Whenever the self-test function determines that BDCMS are not able to deliver adequate performance, or when the driver manually turns off the BDCMS (optional), it shall transition to the BDCMS off state. BDCMS may be in the BDCMS off state when the vehicle is on.

5.2.2.3 BDCMS inactive state

In the BDCMS inactive state, BDCMS shall monitor vehicle speed and determine if it is appropriate to activate the system.

BDCMS shall enter the BDCMS inactive state from the BDCMS off state if the ignition on sequence has been completed and the engine is running. BDCMS shall enter inactive state from the active state if the conditions for activating are not met, for example, if the vehicle speed drops below $v_{SV_{min}}$. If a manufacturer-defined failure mode is encountered for which an automatic recovery (optional) is possible, the BDCMS shall transition from the BDCMS active state to the BDCMS inactive state. Based on the results of a diagnostic self-test, functions of all or some of the countermeasures may be restored. Once the recovery occurs, the system may transition back to the BDCMS active state. Finally, if the driver manually turns on BDCMS (optional), then it shall transit from the BDCMS off state to the BDCMS inactive state.

5.2.2.4 BDCMS active state

BDCMS shall enter this state if the vehicle speed is greater than or equal to $v_{SV_{min}}$ and less than $v_{SV_{max}}$. In the BDCMS active state, it shall monitor for triggering conditions resulting in the selection of EB and decide to activate countermeasures or optionally override if so instructed by the operator. BDCMS may optionally provide a CW to the driver.

If a system failure is detected or there is an inability to perform a countermeasure, BDCMS shall transfer to the BDCMS inactive state if automatic recovery from the failure is possible. If the system fails, and a self-test results in a case where automatic recovery without driver intervention is not possible, BDCMS shall transfer to the BDCMS off state. Means of notification of these failures to the driver is left up to the manufacturer.

5.3 System types

There are two types of BDCMS:

— type 1: BDCMS is capable of daytime activation;

— type 2: BDCMS is capable of daytime, twilight and night-time activations.

5.4 System classes

There are two classes of BDCMS:

— class 1: BDCMS operate on light vehicles only;

— class 2: BDCMS operate on heavy vehicles only.

5.5 Performance requirements

5.5.1 General

BDCMS shall, at a minimum, provide an EB countermeasure based on determination of a hazardous situation.

5.5.2 Hazardous situation

BDCMS shall monitor the area forward of the SV, whenever it is in the active state, to determine if a hazardous situation exists.

Typical hazardous situations such as longitudinal and crossing ones are shown in Figure 3. BDCMS shall determine if a hazardous situation exists for any relative bicyclist approach angle and size of bicyclist.

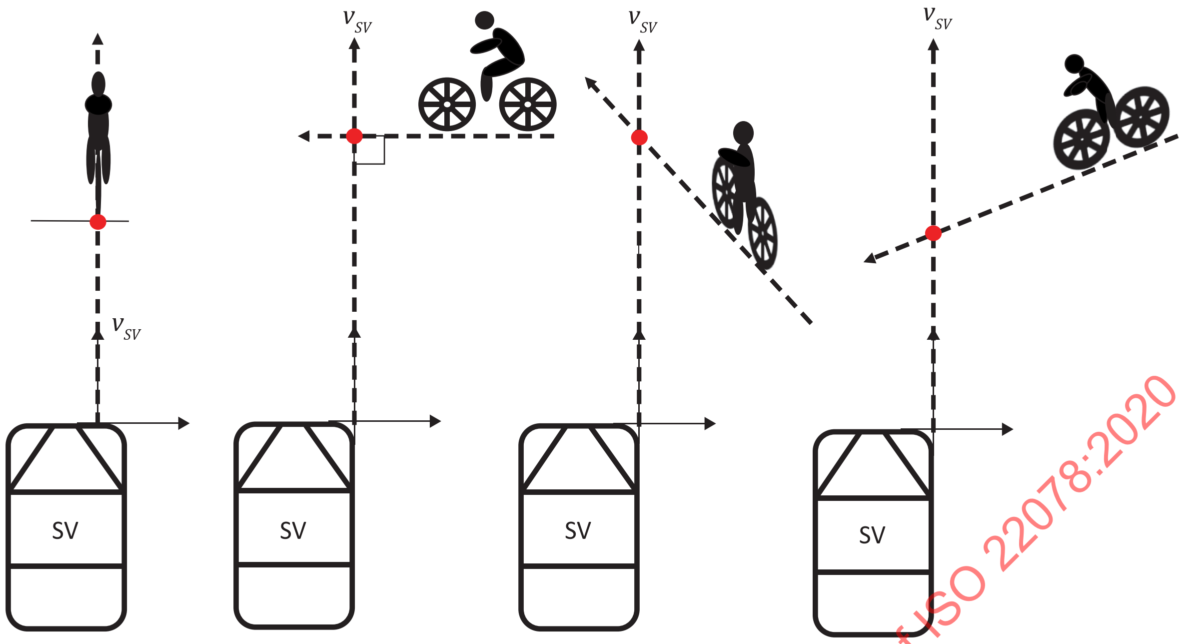


Figure 3 — Bicyclist longitudinal and crossing hazardous situations

BDCMS may optionally detect bicycles when a pedestrian is present next to the bicycle. Performance limitations are given by bad weather conditions (e.g. fog, rain, and snow), illumination (e.g. glaring by backlighting), occlusions and abnormal shapes of bicyclists (e.g. special clothing, large transported items).

BDCMS shall not initiate emergency countermeasures when a bicyclist is detected forward of the SV when the situation is determined not to be hazardous (i.e. when the bicyclist and SV trajectory are such that a collision is not imminent).

BDCMS shall determine a hazardous situation on roads with a horizontal curve radius of 500 m or greater (see 5.5.3 and A.1).

5.5.3 Operating speed

5.5.3.1 General

BDCMS shall operate with an SV speed between 4,2 m/s (15 km/h) and 15,3 m/s (55 km/h) and shall address bicyclists with a speed between 2,8 m/s (10 km/h) and 5,6 m/s (20 km/h). Beyond these operating speed ranges, the upper and lower speed limits of BDCMS operation for the SV and the upper and lower speed limits for bicyclists, regardless of the direction of motion of bicyclists, may be exceeded by the manufacturer. Operating speeds are absolute values.

5.5.3.2 Minimum SV speed ($v_{SV_{min}}$)

All BDCMS shall have a value of $v_{SV_{min}}$ of 4,2 m/s (15 km/h) or less.

BDCMS shall enter the inactive state if the SV speed drops below $v_{SV_{min}}$ (or the OEM set value if it is lower than 4,2 m/s [15 km/h]) and EB is not in process.

5.5.3.3 Maximum SV speed ($v_{SV_{max}}$)

All BDCMS shall have a value of $v_{SV_{max}}$ of 15,3 m/s (55 km/h) or greater.

5.5.3.4 Minimum bicyclist speed ($v_{B_{min}}$)

All BDCMS shall have a value of $v_{B_{min}}$ of 2,8 m/s (10 km/h) or less.

5.5.3.5 Maximum bicyclist speed ($v_{B_{max}}$)

All BDCMS shall have a value of $v_{B_{max}}$ of 5,6 m/s (20 km/h) or greater.

5.5.4 Horizontal curve radius capability

All BDCMS systems shall operate along curves of radii at and above 500 m.

5.5.5 Countermeasure requirements

5.5.5.1 General

The following requirements represent minimum functionality as defined for BDCMS operation. Manufacturers may exceed this minimum functionality at their discretion.

5.5.5.2 Provision of EB

All BDCMS shall provide EB based on determination of a hazardous situation.

5.5.5.3 Class I — Light vehicles

5.5.5.3.1 Initiation of EB

EB shall not be initiated if the situation is determined not to be hazardous.

5.5.5.3.2 Minimum speed reduction in EB

BDCMS shall activate the EB countermeasure upon determination of a hazardous situation. It is the intent of this document that the SV EB countermeasure provides as much speed reduction as possible to mitigate a hazardous situation; however, as current state-of-the-art sensors have limitations, the detection area for crossing bicyclists is also limited. For example, only bicycles with certain speeds can be detected in certain crossing scenarios. Additionally, certain BDCMS implementations may be combined with an automated evasion countermeasure which could lead to different approaches to mitigating the hazardous situation. For example, certain longitudinal bicyclist positions near the edges of the SV trajectory may lead to a reduced speed reduction. In these circumstances, while the minimum speed reduction may not be fully achieved, BDCMS shall begin the EB countermeasure upon the determination of a hazardous situation so that some speed reduction is realized. Considering these limitations, BDCMS shall achieve at least the specified minimum speed reduction as defined in the basic validation tests of Clause 6.

5.5.5.3.3 Termination of EB

BDCMS may deactivate if the situation is determined to be no longer hazardous.

5.5.5.4 Class II — Heavy vehicles

5.5.5.4.1 Initiation of EB

EB shall not be initiated if the situation is determined not to be hazardous.

5.5.5.4.2 Minimum speed reduction in EB

BDCMS shall activate the EB countermeasure upon determination of a hazardous situation. It is the intent of this document that the the SV EB countermeasure provides as much speed reduction as possible to mitigate a hazardous situation; however, as current state-of-the-art sensors have limitations, the detection area for crossing bicyclists is also limited. For example, only bicycles with certain speeds can be detected in certain crossing scenarios. Additionally, certain BDCMS implementations may be combined with an automated evasion countermeasure which could lead to different approaches to mitigating the hazardous situation. For example, certain longitudinal bicyclist positions near the edges of the SV trajectory may lead to a reduced speed reduction. In these circumstances, while the minimum speed reduction may not be fully achieved, BDCMS shall begin the EB countermeasure upon the determination of a hazardous situation so that some speed reduction is realized. Considering these limitations, BDCMS shall achieve at least the specified minimum speed reduction as defined in the basic validation tests in Clause 6.

5.5.5.4.3 Termination of EB

BDCMS may deactivate if the situation is determined to be no longer hazardous.

5.5.5.5 Driver-commanded enhancement of EB

BDCMS shall allow a driver-initiated increase in braking force unless the SV is already braking at its maximum capability.

5.5.5.6 Driver initiated override of EB

BDCMS may optionally permit the driver to override EB by driver actions in a manner to be defined by the manufacturer. After EB has been activated and the driver has overridden it, EB may again activate after the driver override has ended.

5.5.5.7 Braking with reduced traction

EB shall not lead to locked wheels for periods longer than the anti-lock brake system (ABS) or ESC devices would allow.

5.5.6 Driver controls and human interface

5.5.6.1 System limitation information

The driver shall at least be informed of BDCMS operating limitations by means of the owner's manual or equivalent alternative.

5.5.6.2 BDCMS fault indication

The driver shall be provided with an indication of system failure. Specific implementation of the indication is left to the manufacturer.

5.5.6.3 BDCMS state indication

The driver shall be provided with an indication of the BDCMS off-state. Specific implementation of the indication is left to the manufacturer.

6 Test procedures

6.1 General

Test procedures defined in Clause 6 are not intended to be used as exhaustive conformity tests. They are basic validation tests for use by the manufacturer. More extensive tests may be performed, at the discretion of the manufacturer, to ensure BDCMS conformity to the functional requirements of this document.

Low-beam light shall be used for the test.

All BDCMS shall at a minimum be tested against the two scenarios defined in 6.4 and 6.5. For the crossing scenario, without mitigation, the impact point would be at the centre of the SV and the centre of the bottom bracket of the bicycle, assuming no position tolerance.

BDCMS type 1 systems shall at minimum be tested under type 1 illumination as defined in 6.3.5.2. BDCMS type 2 systems shall be tested under both type 1 and type 2 illuminations, as defined in 6.3.5.2 and 6.3.5.3, respectively.

6.2 Bicyclist test target specification

6.2.1 Test target physical characteristics

Bicyclist test targets should provide a surface profile, shape, and reflectivity representative of a bicyclist. Bicyclist test targets, shall be compliant to the adult (50 percentile male) size in ISO 19206-4.

6.2.2 Detectability specifications

Detectability requires testing devices that exhibit the ability to detect characteristics of representative bicyclists in relevant environments. For the purposes of these test procedures, the wheels on the bicyclist target shall rotate; pedalling is optional for the test procedures.

6.3 Environmental conditions

6.3.1 General

The following subclauses describe environmental conditions that shall exist when the functionalities according to this document are tested. To avoid incorrect measurements, these conformance tests need to be performed in an environment where no objects or structures are interfering with the sensor systems. These specific environmental conditions are not meant to be exhaustive or restrictive in assessing the overall system performance. This test specification does not preclude manufacturers from testing during additional conditions.

6.3.2 Driving surface

Tests shall be conducted on a dry (i.e. no visible moisture on the surface), uniform, solid-paved surface with a consistent slope between level and 1,5 %. The test surface shall be a smooth road surface, no rougher than road class A as defined in ISO 8608.

6.3.3 Ambient air temperature

Ambient temperature range during test execution shall be above 5 °C and below 40 °C.

6.3.4 Horizontal visibility

Horizontal visibility shall be greater than 1 km.

6.3.5 Ambient illumination

6.3.5.1 General

Testing shall be performed for daytime, twilight and/or night-time conditions depending upon the type of BDCMS. For test simplicity, testing is divided into two types according to illumination conditions. Type 1 is for bright conditions and type 2 is for both bright and dark conditions. Testing shall be performed under daytime conditions for type 1. Testing shall be performed under both daytime, twilight and/or night-time conditions for type 2 systems.

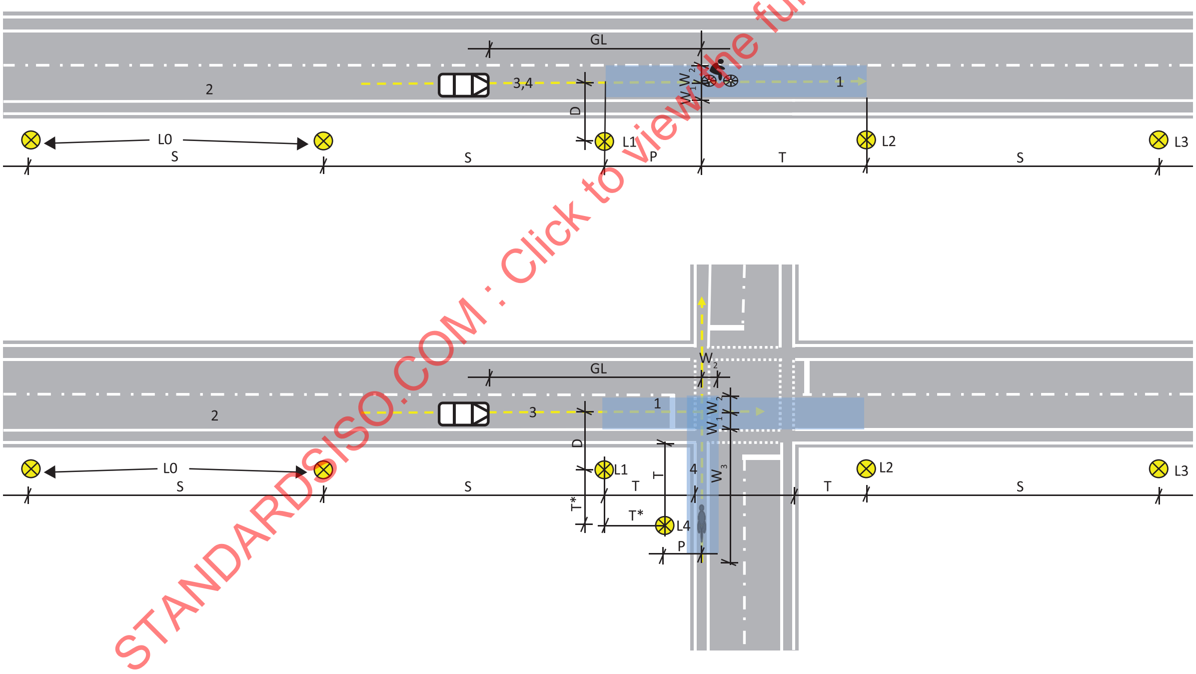
6.3.5.2 Type 1 illumination

Illumination shall be higher than 2 000 lx.

6.3.5.3 Type 2 illumination

6.3.5.3.1 General

Testing for type 2 systems shall be performed for both bright and dark conditions. For bright conditions, refer to 6.3.5.2. Ambient illumination for dark conditions shall be less than 1 lx, when all the lamps of the test vehicle and installed lights for the test are off. Figure 4 provides a representative test setup for the night-time test. The parameters listed in the key are representative of a lamp placement that will provide illumination conditions as specified in 6.3.5.5.



Key

1	illuminance measurement area	3	vehicle path
2	test car start side	4	bicyclist path
L0 to L4	installed street lamps at different positions	H_L	lamp height

NOTE Example values of the variables given in this figure are as follows:

— 4,5 m ≥ H_L ≥ 12,0 m

— S = 25,0 m ± 0,1 m

— 8,5 m ± 0,1 m ≥ T ≥ 10,0 m ± 0,1 m

— 8,5 m ± 0,1 m ≥ T_1 ≥ 10,0 m ± 0,1 m

— $P \geq 2,5$ m

— $D \geq 4,0$ m ± 0,1 m

— $W_1 = 4,0$ m ± 0,1 m

— $W_2 = 3,0$ m ± 0,1 m

— $W_3 = 12,0$ m ± 0,1 m

— GL = 60,0 m ± 0,5 m

Figure 4 — Type 2 ambient illumination example test lighting

6.3.5.3.2 Lamp installation requirements

The lamp installation requirements are given below.

— There shall be a sufficient number of street lamps installed along the test course to ensure the illumination values specified in 6.3.5.5. The number of street lamps represented by L0 in Figure 4 will change according to the value of S.

— As represented by L3 in Figure 4, there shall be one lamp installed beyond the illuminance measurement area (see 6.3.5.3.2) to avoid an unrealistic dark area in front of the SV.

— The installed lamps along the vehicle path used in the test shall be the same type, have the same height with the deviation of less than 0,2 m, and be equally spaced with the deviation of less than 1,0 m.

— The position of the centre of the lamps shall be within 2 m of the lamppost in the direction towards the vehicle path.

— The colour temperature of the lamps shall be 4 500 K ± 1 000 K.

— Lampposts, or any other test equipment, installed for the test setup shall not present occlusion between the SV and bicyclist during the test.

6.3.5.3.3 Illuminance measurement area and points

— The illuminance measurement area is defined by the length and width given below:

  — The length is equal to the distance between L1 and L2 in Figure 4.

  — The width is equal to W1 plus W3 along the vehicle path in Figure 4.

— The vehicle path (and bicyclist path for longitudinal scenario) runs parallel to the lamps and at least 4,0 m (and represents D in Figure 4) away from the base of the lamppost. A minimum 11 measurement points are distributed equally along the segment between L1 and L2 on the vehicle path. Both L1 and L2 locations are included in the minimum 11 measurement points.

— The bicyclist path for crossing scenario runs in between L1 and L2. A minimum seven measurement points are distributed equally along the segment between the collision point and the location W3+W1 from the collision point. Both collision point and W3+W1 from the collision point are included in the minimum seven measurement points.

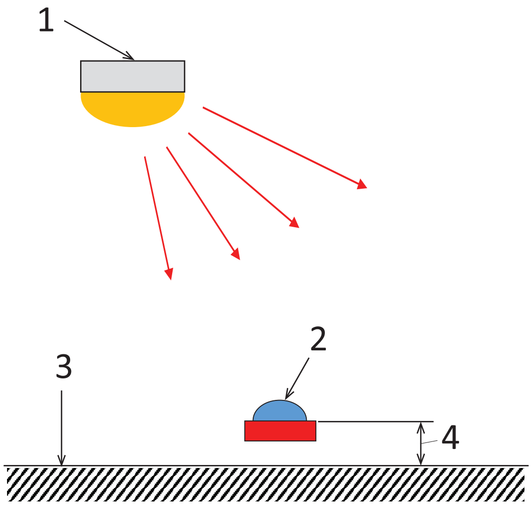
6.3.5.4 Illuminance measurement methods

To measure illumination, an illuminance meter that meets the requirements of ISO/CIE 19476 shall be used.

As shown in Figure 5, the illuminance meter shall be positioned horizontally (i.e. the measuring direction is vertical upwards).

For the measurement points over the vehicle path, the height of measurement shall be <0,2 m.

For the bicyclist path, the height of measurement shall be both ≤0,2 m and 1,5 ± 0,1 m above the ground.



Key

1 installed lamps along the test course

2 illuminance meter

3 ground surface

4 height of measurement

Figure 5 — Illumination measurement methods

6.3.5.5 Illuminance values

Table 2 specifies illuminance requirements for dark condition testing. Exact lamp placement and test environment design is left up to the manufacturer as long as the required average illuminance is in accordance with Table 2.

Table 2 — Required illuminance values

Measurement points	Required illuminance
Vehicle path	15 lx to 35 lx (average)
Bicyclist path (both heights ≤0,2 m and ≤1,5 m, separately averaged)	15 lx to 35 lx (average)

Ratio factor (RF) of the illuminance of the brightest and the darkest points of the measurement points at a height <0,2 m within the illuminance measurement area shall be less than 10.

Glare on the sensor system shall not occur anywhere on the illuminance measurement area. Specifically, the lamps shall not be tilted towards the approaching vehicle, as this may create a glare that negatively affects sensor performance.

At least for the area within 60 m from the collision point to the direction of the test vehicle start point, the same level of illuminance, RF and glare avoidance shall be ensured.

6.4 Test procedure for longitudinal scenario (limited dynamic-test)

The longitudinal scenario dynamic test consists of one test scenario, repeated twice as depicted in Figure 6. The system shall be presented with a bicyclist test target positioned at two different test positions. The first test position, TP_1, is in a location that represents a clear hazardous situation (i.e.

in the forward trajectory of the SV as statically oriented, a collision would occur). For the purpose of this manufacture validation test, TP_1 shall be positioned along the centreline of the SV. The second test position, TP_2, is 2,0 m (±0,1 m) from the edge of the vehicle mirror as measured from the edge of the handlebar of the bicyclist closest to the SV. The system shall determine that this is not a hazardous situation and not activate EB countermeasures. The lateral and longitudinal position tolerances in this test shall remove any ambiguity such that TP_1 clearly represents a hazardous situation and TP_2 clearly does not represent a hazardous situation to the SV taking into consideration whether the SV is equipped with a combination of BDCMS and some other automated evasion systems.

Table 3 — BDCMS longitudinal scenario test parameters

Dimensions in m/s

SV speed	Bicyclist speed	Minimum speed reduction
11,1 (±0,25)	4,2 (±0,25)	5,5

At the start of each test iteration, the SV velocity and the bicyclist test target constant velocity shall be as defined in Table 3. At the start of the test, the bicyclist test target is 50 m, or greater, in front of the SV. The longitudinal distance from the front of the SV to the nearest point on the bicyclist test target is 50 m or greater, and the bicyclist test target is travelling in the same direction as the SV. The SV approaches the bicyclist test target, and the BDCMS EB countermeasure is activated for the TP_1 test but is not activated for the TP_2 test.

Pass criteria for this test are achieved if v_{SV} is reduced by the amount as defined in Table 3, at the impact point or if the SV drops below the bicyclist speed before the impact point for the TP_1 test and if no EB occurs for the TP_2 test.

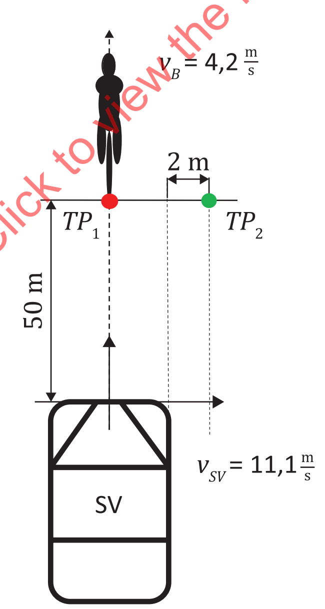


Figure 6 — Longitudinal scenario (limited dynamic-test)

6.5 Test procedure for crossing scenario (limited dynamic-test)

The crossing scenario dynamic test consists of three test scenarios, as depicted in Figure 7. The three test scenarios parameters are specified in Table 4.

Table 4 — BDCMS crossing scenario test parameters

	SV speed m/s	Bicyclist speed m/s	Distance from SV to impact point m	Distance from bicyclist to impact point m	Minimum speed reduction m/s
Test 1	8,3 +/ 0,14	3,0 ± 0,06	41,5 ± 0,05	15 ± 0,05	5,5
Test 2	11,1 +/ 0,14	4,2 ± 0,06	39,64 ± 0,05	15 ± 0,05	7,0
Test 3	13,9 +/ 0,14	4,2 ± 0,06	49,64 ± 0,05	15 ± 0,05	4,0

At the start of the test, the bicyclist test target is 15 m (±0,05 m), from the impact point. The longitudinal distance from the front of the SV to the impact point is as shown in Table 4, and the bicyclist test target is travelling roughly perpendicular to the SV (90° ± 2°). The SV approaches the bicyclist test target, and the BDCMS EB countermeasure is activated.

Pass criteria for this test are achieved if v_{SV} is reduced by the amount specified in Table 4 at the impact point, or if the SV comes to a stop before the impact point or the collision is completely avoided (e.g. when the bicycle has passed in front of the SV without being hit).

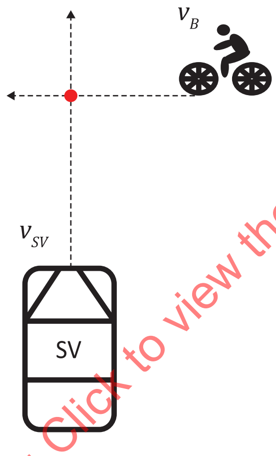


Figure 7 — Crossing scenario (limited dynamic-test)