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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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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.

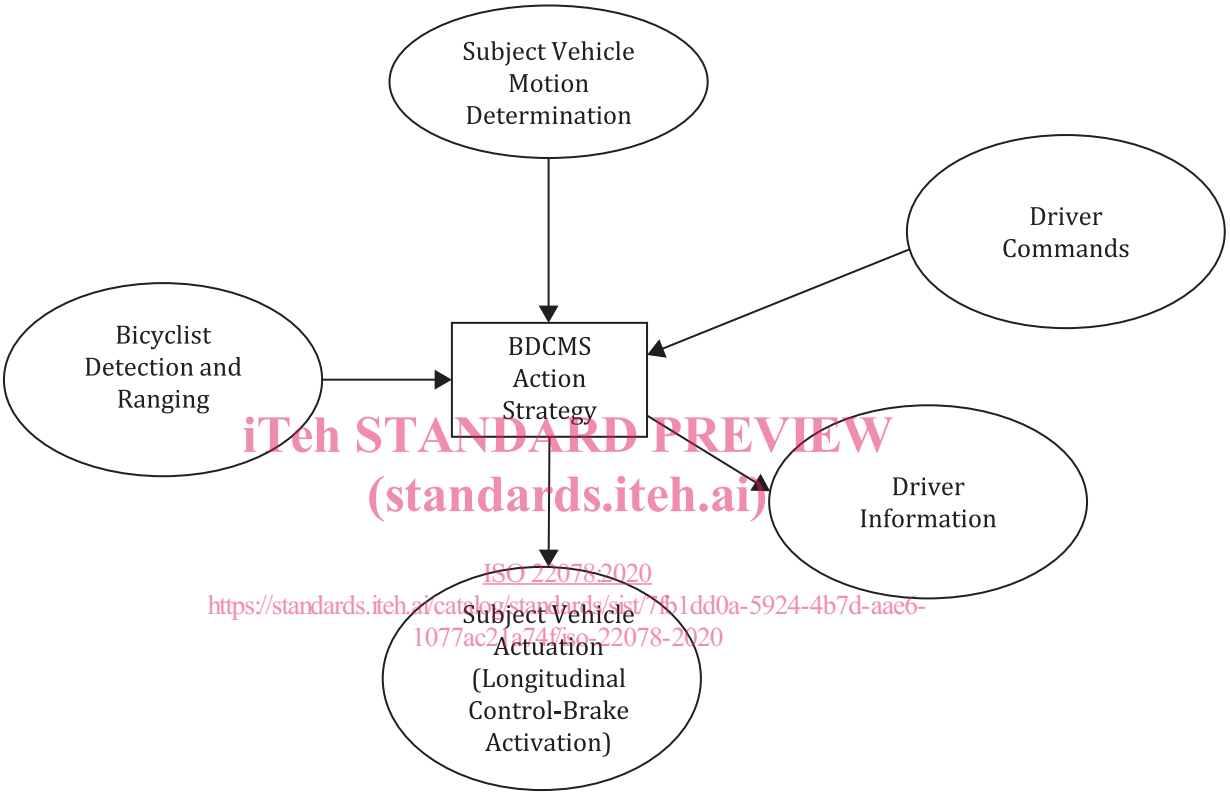


Figure 1 — BDCMS functional elements

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;

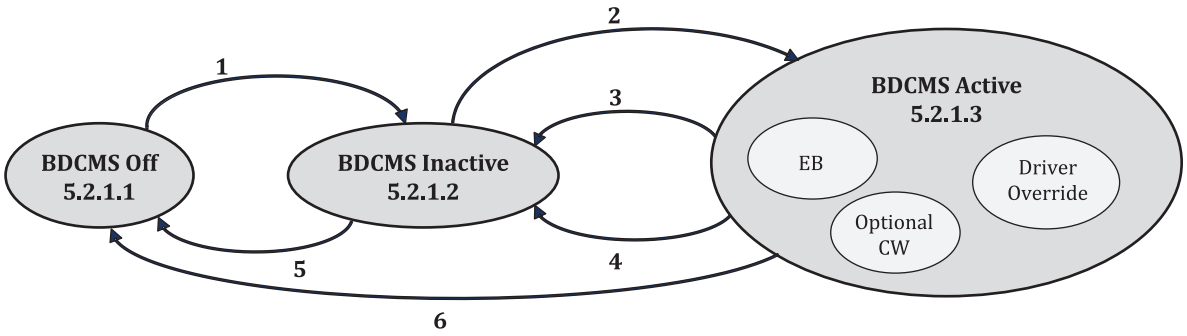
— management of permission of the driver's ability to override commands at any time;

— 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 $\geq v_{SV_{min}}$ and SV speed $\leq v_{SV_{max}}$

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.