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ISO 22839

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Intelligent transport systems — Forward vehicle collision mitigation systems — Operation, performance, and verification requirements

Systèmes intelligents de transport — Systèmes d'atténuation de collision de véhicule frontale — Exigences de fonctionnement, de performance et de vérification

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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. www.iso.org/directives

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The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

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Introduction

Forward Vehicle Collision Mitigation Systems (FVCMS) reduce the severity of forward vehicle collisions that cannot be avoided, and may reduce the likelihood of collision with forward vehicles. FVCMS require information about range to forward vehicles, motion of forward vehicles, motion of the subject vehicle, driver commands and driver actions. FVCMS detect vehicles ahead, determine if detected vehicles represent a hazardous condition, and warn the driver if a hazard exists. They estimate if the driver has an adequate opportunity to respond to the hazard. If there is inadequate time available for the driver to respond, and if appropriate criteria are met, FVCMS determine that a collision is imminent. Based upon this assessment, the FVCMS will activate vehicle brakes to mitigate collision severity.

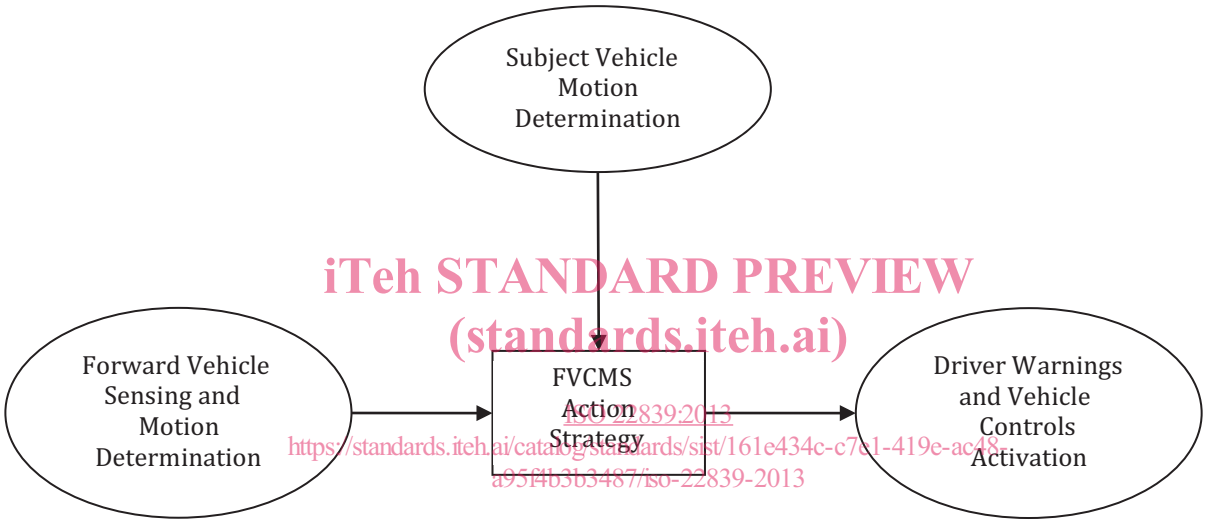

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Figure 1 — Forward Vehicle Collision Mitigation Systems (FVCMS) Functional Elements

System designers and other users of this International Standard may apply it to stand-alone FVCMS or to the integration of the FVCMS functions into other driving assistance and support systems.

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Intelligent transport systems — Forward vehicle collision mitigation systems — Operation, performance, and verification requirements

1 Scope

This International Standard specifies the concept of operation, minimum functionality, system requirements, system interfaces, and test methods for Forward Vehicle Collision Mitigation Systems (FVCMS). It specifies the behaviours that are required for FVCMS, and the system test criteria necessary to verify that a given implementation meets the requirements of this International Standard. Implementation choices are left to system designers, wherever possible.

FVCMS mitigate rear-end collisions. By reducing the collision energy, FVCMS reduce the degree of property damage, personal injury, or the likelihood of fatality. They supplement crashworthiness systems such as airbags, seatbelts and other energy-absorbing systems by reducing the impact energy that must be isolated from the occupants. By automatically activating collision mitigation braking after a Collision Warning occurs, FVCMS assist in slowing the vehicle when a collision is likely. While collision avoidance is not required, this International Standard permits collision avoidance to be attempted by a system that conforms to FVCMS. Responsibility for the safe operation of the vehicle remains with the driver.

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With the exceptions of single-track vehicles and trucks with dual or triple trailers, FVCMS are for use on road vehicles intended for public and non-public roadways. These systems are not intended for off-road use.

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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 15622, *Intelligent transport systems — Adaptive Cruise Control systems — Performance requirements and test procedures*

ISO 15623, *Transport information and control systems — Forward vehicle collision warning systems — Performance requirements and test procedures*

ISO 22179, *Intelligent transport systems — Full speed range adaptive cruise control (FSRA) systems — Performance requirements and test procedures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
adaptive cruise control
ACC
enhancement to conventional cruise control systems which allows the subject vehicle to follow a forward vehicle at an appropriate distance by controlling the engine and/or power train and optionally the brake

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Note 1 to entry: See ISO 15622.

3.2
adjacent lane
lane of travel sharing one lane boundary with the lane in which the subject vehicle is traveling, and having the same direction of travel as the subject vehicle

3.3
articulated vehicle
any road vehicle with more than two wheels that is configured for normal road use with at least two segments, and for which each adjacent pair of segments is connected by a joint, and for which propulsion is provided by at least one segment

3.4
brakes
components which generate the forces opposing the movement of the vehicle

EXAMPLES Friction brakes (when the forces are generated by friction between two parts of the vehicle moving relative to one another); electrical brakes (when the forces are generated by electro-magnetic action between two parts of the vehicle moving relatively but not in contact with one another); fluid brakes (when the forces are generated by the action of a fluid situated between two parts of the vehicle moving relatively to one another); or engine brakes (when the forces are derived from an artificial increase in the braking action, transmitted to the wheels, of the engine).

3.5
braking distance
distance the vehicle will travel from the point where its brakes are applied to where it comes to a complete stop

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3.6
clearance
$x_c\,(t)$
distance $x_c\,(t)$ from the target vehicle trailing surface to the subject vehicle leading surface

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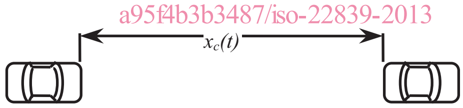

3.7
Collision Warning
CW
information that FVCMS gives to the driver to indicate the need for urgent action to avoid a collision

Note 1 to entry: This warning is issued to warn the driver of the need to perform an emergency manoeuvre in order to avoid a collision.

3.8
conventional cruise control
system capable of maintaining the speed of a vehicle as set by the driver

3.9
countermeasure action point
CAP
value of pre-collision urgency parameter (PUP), relative to an expected collision, for which FVCMS initiates a countermeasure

3.10
driver disengage
driver initiated transition from FVCMS Active or Inactive state to FVCMS Off state

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3.11
enhanced time to collision
ETTC
time that it will take a subject vehicle to collide with the target vehicle assuming the relative acceleration between the subject vehicle (SV) and target vehicle (TV) remains constant, as given in the following equation:

$$ETTC = \frac{\left[-(v_{TV} - v_{SV}) - \sqrt{(v_{TV} - v_{SV})^2 - 2*(a_{TV} - a_{SV})*x_c}\right]}{(a_{TV} - a_{SV})}$$

3.12
forward adjacent vehicle
vehicle not in the path of the subject vehicle (SV), and entirely ahead of a line touching the SV front bumper at only one point and perpendicular to the longitudinal axis of the SV

3.13
forward ranging sensor
component which detects objects in at least part of the region entirely ahead of the front bumper

3.14
forward vehicle
FV
vehicle in front of the subject vehicle (SV), which is moving in the same direction and traveling in the same path, or which is oriented in the same direction if it is not moving

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3.15
forward vehicle collision
collision between the subject vehicle (SV) and a forward vehicle (FV)

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3.16
Forward Vehicle Collision Mitigation Systems
FVCMS
vehicle systems meeting the requirements of ISO 22839 that assess the likelihood of a collision between the front of the subject vehicle (SV) and the rear of a target vehicle (TV), and when such a collision is very likely, activates the brakes automatically to reduce the relative speed at which the SV and TV may collide

3.17
Forward Vehicle Collision Warning Systems
FVCWS
systems capable of warning the driver of a potential collision with another vehicle in the forward path of the subject vehicle, excluding conditions where the subject and forward vehicle are not in the same direction of travel

Note 1 to entry: See ISO 15623.

3.18
heavy vehicle
any single vehicle or combination of vehicles defined as Category 1-2 or Category 2 in the United Nations Economic and Social Council World Forum for Harmonization of Vehicle Regulations (WP.29) TRANS/WP.29/1045

3.19
jerk
third derivative with respect to time of the position of an object, equivalently the rate of change of the acceleration of an object, considered a measure of the harshness of vehicle motion

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3.20
lateral offset
lateral distance between the longitudinal centerlines of a subject vehicle (SV) and a target vehicle (TV), measured as a percentage of the width of the SV, such that if the centers of the two vehicles are aligned, the value is zero

3.21
light vehicle
any single vehicle or combination of vehicles defined as Category 1-1 in the United Nations Economic and Social Council World Forum for Harmonization of Vehicle Regulations (WP.29) TRANS/WP.29/1045

3.22
mitigation braking
MB
FVCMS countermeasure that responds to the detection of a very likely rear-end collision by automatically activating braking to quickly reduce the relative velocity, within the minimum requirements

3.23
minimum countermeasure action point
MCAP
value of PUP, relative to an expected collision, for which initiation of a specific countermeasure shall be required

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3.24
minimum FVCMS deceleration
minimum FVCMS deceleration that the system must achieve while mitigation braking (MB) is active, measured on smooth, dry, clean pavement

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3.25
minimum velocity
V_{min}
minimum subject vehicle (SV) speed for which FVCMS must be capable of activating a countermeasure

3.26
override
driver initiated suppression of an MB, SRB, or CW countermeasure

3.27
pre-collision urgency parameter
PUP
real-time parameter that signifies the urgency of a potential future collision

3.28
rear-end collision
forward vehicle collision in which the front of the subject vehicle strikes the rear of the forward vehicle

3.29
relative velocity
$v_r(t)$
difference in longitudinal velocity between the subject vehicle (SV) and the target vehicle (TV), $v_r(t)$, given by the equation with a positive value signifying that the target vehicle is moving faster than the subject vehicle, and therefore the clearance is increasing with time

$$v_r(t) = v_{TV}(t) - v_{SV}(t)$$

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3.30
required deceleration
minimum deceleration that, if constant, would enable the subject vehicle to match the velocity of the target vehicle without contacting the target vehicle and thus prevent a collision

3.31
single track vehicle
vehicle that leaves a single ground track as it moves forward

Note 1 to entry: Single track vehicles usually have little to no lateral stability when stationary but develop it when moving forward or controlled.

3.32
speed reduction braking
SRB
FVCMS countermeasure that reduces the subject vehicle speed by activating the brakes allowing the driver time to analyse and respond to a potential collision, which may have the additional effect of drawing driver attention to hazards ahead of the subject vehicle (SV)

3.33
subject vehicle
SV
vehicle equipped with FVCMS as defined herein

3.34
target vehicle
TV
forward vehicle that is within the effective range of the subject vehicle (SV)'s forward ranging sensor

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3.35
time gap
value calculated from vehicle speed and clearance by: Time Gap = Clearance / Vehicle Speed

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3.36
time to collision
TTC
time that it will take a subject vehicle to collide with the target vehicle assuming the relative velocity remains constant, as given in the following equation:

$$TTC = -\frac{x_c}{v_r}$$

3.37
truck-tractor
heavy single-chassis vehicle providing propulsion, control, and crew (driver) accommodation, with the primary purpose of controlling and transporting one or more separate load-carrying trailers

3.38
unit truck
heavy single-chassis vehicle providing its own propulsion, control, and crew (driver) accommodation, with a significant cargo or other payload section

3.39
warning braking
WB
action in which FVCMS respond to detection of a possible rear-end collision by automatically activating the brake to provide a warning to the driver

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4 Symbols (and abbreviated terms)

a_{TV}	Acceleration of the TV
a_{SV}	Acceleration of the SV
ABS	Anti-lock Brake System
ACC	Adaptive Cruise Control
CAP	Countermeasure Action Point
CTT	Coefficient for Test Target
CW	Collision Warning
D_{TV}	Deceleration of target vehicle
D_{SV}	Deceleration of subject vehicle
d_{max}	Maximum detectable distance
d_1	Minimum detectable distance for a laterally offset vehicle
d_2	Minimum distance with distance measuring
d_0	Minimum detectable distance without distance measuring
h	Upper limit of detectable zone, from ground
h_1	Lower limit of detectable zone, from ground
ESC	Electronic Stability Control
ETTC	Enhanced Time to Collision
FV	Forward Vehicle
FVCWS	Forward Vehicle Collision Warning Systems
FVCMS	Forward Vehicle Collision Mitigation Systems
MB	Mitigation Braking
$MCAP_{MB}$	Minimum Countermeasure Action Point for Mitigation Braking
$MCAP_{SRB}$	Minimum Countermeasure Action Point for Speed Reduction Braking
$MCAP_{CW}$	Minimum Countermeasure Action Point for Collision Warning
PUP	Pre-collision Urgency Parameter
RCS	Radar Cross Section
RSC	Roll Stability Control
SRB	Speed Reduction Braking
SV	Subject Vehicle
TTC	Time to Collision
TV	Target Vehicle
V_{min}	Minimum SV path velocity for FVCMS operation
$v_{SV}(t)$	Subject vehicle path velocity
$v_r(t)$	Relative path velocity between SV and TV
$v_{TV}(t)$	Target vehicle path velocity
V_{max}	Maximum SV path velocity for FVCMS operation
WB	Warning Braking
W_v	Width of subject vehicle

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W_l Width of lane

$x_c(t)$ Distance between SV and TV

5 Classifications

This Clause provides introductory information that explains the different classifications of FVCMS that are covered by this International Standard. This Clause is not intended to define requirements. All requirements of this International Standard appear in Clauses 6 and 7.

5.1 System classification by curve radius capability

Systems are classified according to curve radius capability as shown in Table 1.

Table 1 — System classifications

Class	Horizontal curve radius capability
I	curve radius greater than or equal to 500 m
II	curve radius greater than or equal to 250 m
III	curve radius greater than or equal to 125 m

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Class I systems shall have the capability to detect forward obstacle vehicles in the subject vehicle's trajectory along curves of radii down to 500 meters.

Class II systems shall have the capability to detect forward obstacle vehicles in the subject vehicle's trajectory along curves of radii down to 250 meters.

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Class III systems shall have the capability to detect forward obstacle vehicles in the subject vehicle's trajectory along curves of radii down to 125 meters.

5.2 Classification by countermeasure types included

FVCMS may be classified based on the countermeasures that are provided. Classification is based on the minimum countermeasures and on additional countermeasures that may be provided. Each countermeasure has an associated minimum countermeasure action point (MCAP). FVCMS activate a countermeasure when the pre-collision urgency parameter (PUP) is at least equal to the minimum countermeasure action point for that countermeasure.

5.2.1 Collision Warning (CW) countermeasure

Collision Warning is a warning based on some combination of audible, visual and tactile or haptic sensory modes, meeting the requirements of ISO 15623 for the operation range of FVCMS as depicted in Figure 4.

A Collision Warning countermeasure shall occur no later than the initiation of SRB or MB.

5.2.2 Speed Reduction Braking (SRB) countermeasure

Speed reduction braking is an automatic braking function, intended to reduce subject vehicle velocity. SRB affords the driver an improved opportunity to apply manual emergency braking, to make an emergency lane change, or to determine that no hazard is present and to disengage SRB. Any of these actions could prevent MB from activating. To assist the occupants to prepare for this braking event, SRB actuation is preceded by a Collision Warning countermeasure.

SRB will not be initiated if MB is active.

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