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Transport information and control systems — Forward vehicle collision warning systems — Performance requirements and test procedures

Systèmes de commande et d'information des transports — Systèmes d'avertissement de collision frontale — Exigences de performance et modes opératoires

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15623 was prepared by Technical Committee ISO/TC 204, *Transport information and control systems*.

Annexes A, B, C, and D form a normative part of this International Standard.

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Introduction

The main system function of a Forward Vehicle Collision Warning System (FVCWS) is to warn the driver when the subject vehicle encounters the situation when a forward vehicle in the subject vehicle's trajectory becomes a potential hazard. This is done by using information about: (1) the range to forward vehicles, (2) the time to a potential collision and (3) the grade of warnings provided to the driver (see Figure 1). Based upon the information acquired, the controller identified as "FVCWS warning strategy" in Figure 1 produces the warning to the driver.
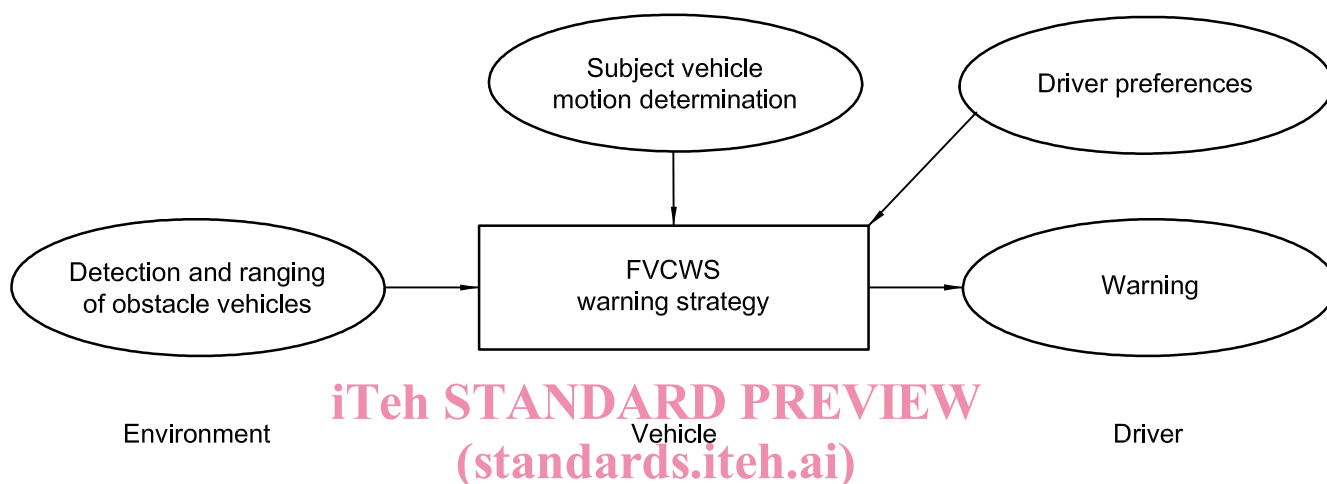
Figure 1 — Functional forward vehicle collision warning system's elements

Automobile manufacturers and component suppliers throughout the world have been vigorously pursuing the development and commercialization of these FVCWS systems. Systems of this type have already been introduced onto the market in some countries. Thus the standardization efforts began in 1994 amongst interested countries. This International Standard is composed to address only the basic performance requirements and test procedures for the FVCWS type systems. This International Standard may be used as a basis by other advanced standards for systems which have more advanced features and may extend beyond this International Standard.

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Transport information and control systems — Forward vehicle collision warning systems — Performance requirements and test procedures

1   Scope

This International Standard specifies performance requirements and test procedures for systems capable of warning the driver of short inter-vehicle distance and closing speed which may cause a rear-end collision with other vehicles, including motor cycles, ahead of the subject vehicle while it is operating at ordinary speed.

This International Standard is applicable to operations on roads with curve radii over 125 m as well as higher radius curves.

2   Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60825-1:2001, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide* (consolidated edition)

3   Terms and definitions

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

3.1
collision warning
information that the system gives to the driver indicating the need for urgent action to avoid a collision

NOTE   This warning is issued in the advanced stages of a dangerous situation to warn the driver of the need to perform emergency braking, lane changing or other emergency manoeuvres in order to avoid a collision.

3.2
coefficient of test target
CTT
coefficient representing the optical radar reflectivity of the target which is defined as the coefficient of radiated intensity, measured in front of the receiver surface, divided by the intensity of irradiation out of the transmitter

NOTE   See clause C.4.

3.3
forward vehicle
vehicle in front of and moving in the same direction and travelling on the same roadway as the subject vehicle

1

3.4
forward vehicle collision warning system
system capable of warning the driver of a potential collision with another vehicle in the forward path of the subject vehicle, but excluding intersections

3.5
obstacle vehicles
vehicles, both moving and stationary, considered potential hazards that can be detected by this system

NOTE   Vehicles include motor vehicles only, that is cars, trucks, buses, and motorcycles.

3.6
preliminary collision warning
information that the system gives to the driver indicating the presence of a forward obstacle vehicle

NOTE   This warning is issued in the early stages of a potentially dangerous situation, caused by such circumstances as driver's inattention/daydreaming, or the sudden change in movement of a preceding vehicle, which may result in a collision.

3.7
radar cross section
RCS
measure of the reflective strength of a radar target expressed in square meters, and defined as 4π times the ratio of the power per unit solid angle scattered in a specified direction to the power per unit area in a radio wave incident on the scatterer from a specified direction

3.8
visibility
distance which the illuminance of a non-diffusive beam of white light with the colour temperature of 2 700 K is decreased to 5 % of its original light source illuminance

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4   Symbols

$a_{lateral\_max}$ Maximum allowed lateral acceleration in curves

a_{min} Minimum deceleration of the subject vehicle's emergency braking

CTT   Coefficient for Test Target for infrared reflector

d_0 Minimum detectable distance without distance measuring capability

d_1 Minimum detectable distance with distance measuring capability

d_2 Minimum detection distance for a cut-in vehicle

d_{max} Maximum detectable distance

h Upper detection height from ground

h_1 Lower detection height from ground

T_{max} Maximum driver's brake reaction time after the warning

T_{min} Minimum driver's brake reaction time after the warning

RCS   Radar Cross Section

V_{circle_start} Speed of the test vehicles at the start of the test

V_{max} Maximum vehicle speed at which the system is capable of operating

V_{min} Minimum vehicle speed at which the system is capable of operating

W_L Lane width

W_V Subject vehicle width

5 Specifications and requirements

5.1 Warnings

5.1.1 General

Forward vehicle collision warning systems shall provide warnings in accordance with the following functions.

5.1.2 Monitoring distance and relative speed between obstacle vehicle and subject vehicle

A forward obstacle vehicle is sensed by obstacle detecting devices such as optical radar, radio wave radar, and image processing systems.

5.1.3 Judging the timing of collision

The timing of a potential collision is judged by the results of evaluating the subject vehicle speed, the distance to the obstacle vehicle, and the relative speed between the subject vehicle and the obstacle vehicle. When the system detects multiple obstacle vehicles at the same time, the one in the subject vehicle's expected trajectory that the subject vehicle will reach the soonest[1] shall be selected.

5.1.4 Preliminary collision warning and collision warning (see annex A)

Forward vehicle collision warning systems shall provide at least two separate warnings: a preliminary collision warning and a collision warning. The purpose of the preliminary collision warning is to inform the driver of the presence of a forward obstacle vehicle. In this case the driver should prepare to take the necessary action to avoid a collision. The purpose of the collision warning is to inform the driver of the need to take action in order to avoid a collision.

Warnings consist of independent or combined use of visual, audible and/or tactile senses. However in the case of a collision warning, audible and/or tactile means of warning shall be used and visual means may be used in addition to the aforementioned means.

Warnings are issued depending on the relative speed between the subject vehicle and the obstacle vehicle, the subject vehicle speed, the inter-vehicle distance, the free running (driver's brake reaction) time and the deceleration.

When the subject vehicle is approaching an obstacle vehicle, the warning distance should be decided according to criteria with respect to time to collision threshold values.

5.1.5 Fault indicator

If a fault is detected during system start up or during system operation, the driver shall be informed.

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1) "Soonest" means the smallest time to collision.

5.2   System classification

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 $\geqslant$ 500 m
II	curve radius $\geqslant$ 250 m
III	curve radius $\geqslant$ 125 m

— 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 m.

— 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 m.

— 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 m.

5.3   Obstacle vehicle detection area and performance

5.3.1   Obstacle vehicle detection area

5.3.1.1   Minimum detection area (Class I, II and III)

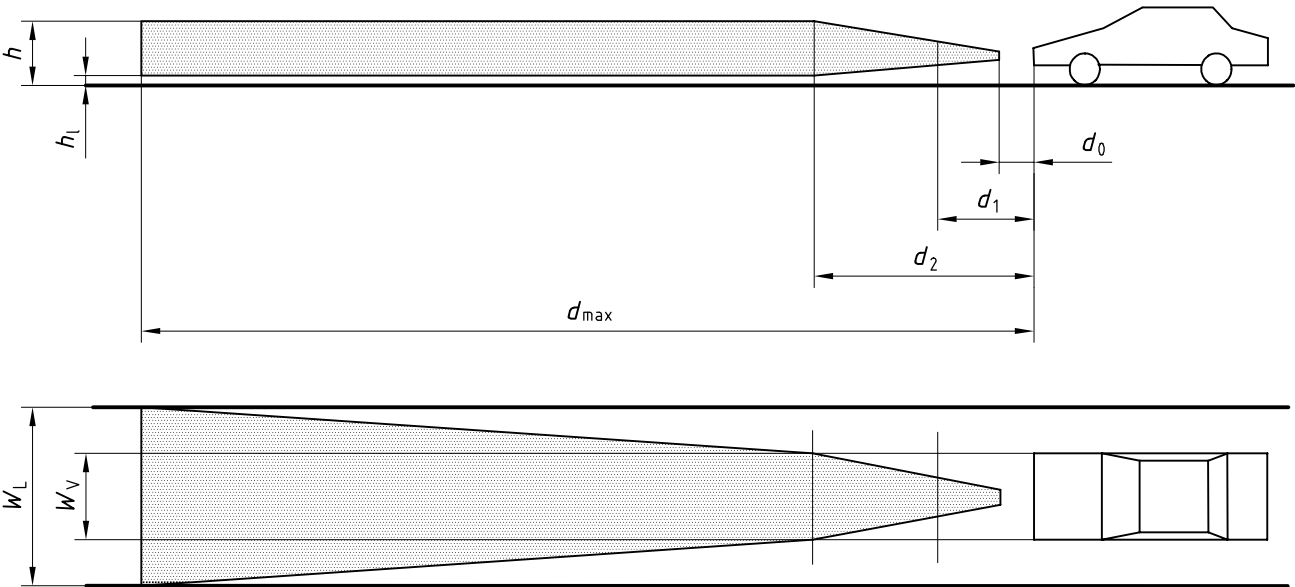The minimum detection area is illustrated in Figure 2.

Figure 2 — Detection area

5.3.1.1.1   Detection range

Detection range requirements are specified in Table 2.

Table 2 — Detection range requirements

Distance	Formula or value	Meaning
d_{max}	$V_{max} \times T_{max} + V_{max}^2 / 2a_{min}$	The maximum detectable distance.
d_2	Less than or equal to 10 m for Class I Less than or equal to 7,5 m for Class II Less than or equal to 5 m for Class III	The minimum detection distance for a cut-in vehicle (which crosses the line of the subject vehicle's trajectory by the width of the subject vehicle and is thus possible to disturb the subject vehicle's ordinary driving).
d_1	$T_{min} \times V_{min}$	The system's minimum distance with distance measuring capability.
d_0	Less than or equal to 2 m	The minimum detectable distance without distance measuring capability.

where

V_{max} is the maximum vehicle speed at which the system is capable of operating, in metres per second (m/s);

V_{min} is the minimum vehicle speed at which the system is capable of operating, in metres per second (m/s);

T_{max} is the maximum driver's brake reaction time after the warning, in seconds (s);

T_{min} is the minimum driver's brake reaction time after the warning, in seconds (s);

a_{min} is the minimum deceleration of the subject vehicle's emergency braking, in metres per square second (m/s^2).

V_{max} and V_{min} are the design parameters for actual systems, which will be decided by the vehicle manufacturer, while T_{max}, T_{min} and a_{min} are the design parameters (see Annex A) and following values should be used to calculate the d_{max} and d_1.

T_{max} = 1,5 s

T_{min} = 0,4 s

a_{min} = 3,6 m/s^2

5.3.1.1.2 Detection width and detection height

Table 3 — Detection width and detection height requirements

Distance	Minimum detection width	Minimum detection height
d_{max}	W_L, metres	$h_1 = 0,2$ m and $h = 1,1$ m
d_2	W_V, metres	$h_1 = 0,2$ m and $h = 1,1$ m
d_1	not specified	not specified
d_0	not specified	not specified

5.3.1.2 Detection range for horizontal curve radius

The width of the detection range for horizontal curve radius shall be extended in relation to the curve's radius (see Annex B).

5.3.2 Warning distance accuracy

Warning distance accuracy, which is defined as the difference between the warning distance where the system produces the warning at the test and the system design warning distance, shall be the maximum system design warning distance, with a relative tolerance of ± 1 m or ± 5 %. Both distances are calculated by evaluating the inter-vehicle distance, the relative speed, the time to collision, the subject vehicle speed and so on.

5.3.3 Target discrimination ability

5.3.3.1 Longitudinal discrimination

If there are two or more obstacle vehicles in the detection range from a distance d_1 to d_{max} from the subject vehicle's front end, the system shall be capable of clearly selecting the soonest one in the subject vehicle's trajectory and shall give appropriate warnings.

5.3.3.2 Lateral discrimination

If there are two or more obstacle vehicles in the subject vehicle's trajectory or in an adjacent position, the system shall be capable of clearly selecting the vehicle in the subject vehicle's trajectory and shall give appropriate warnings.

5.3.3.3 Overhead discrimination

If there are obstacles at overhead of the road such as overhead sign, etc., the system shall be capable of avoiding nuisance warnings.

5.4 User safety requirements

5.4.1 Optical radar

The optical radar shall satisfy the requirements for Class 1 lasers as defined in IEC 60825-1.

5.4.2 Radio wave radar

No International Standard giving the relevant requirements currently exists.

5.5 Human interface requirements

5.5.1 Warning output specification

Visual, audible warnings shall correspond to the characteristics given in Table 4.