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Intelligent transport systems — Road boundary departure prevention systems (RBDPS) — Performance requirements and test procedures

Systèmes intelligents de transport — Systèmes de prévention de sortie de route (RBDPS) — Exigences de performance et modes opératoires 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

Road boundary departure means a vehicle goes off the road unintentionally (not done intentionally by the driver). Such a departure can cause a crash by colliding with an oncoming vehicle, surrounding structures, or roll-over and the mortality rate in case of such accidents is high. To address this situation, systems which are effective in lane keeping assistance have been developed. Some representative systems are lane departure warning systems (LDWS) (presented in ISO 17361) and lane keeping assistance systems (LKAS) (presented in ISO 11270). LDWS informs the driver of danger by a warning in case of a departure but doesn't have a function to control said departure. On the other hand, the main functionality of LKAS is to support driver operations to keep the vehicle within the lane while the vehicle is in the normal driving operation, not to avoid such accidents by actively preventing road departure. This document specifies road boundary departure prevention systems (RBDPS) which aim to prevent accidents caused by road departure.

RBDPS is a driving safety support system aimed at both the prevention of road departure accidents by causes such as driver negligence and the mitigation of damages when accidents actually occur. RBDPS detects or predicts road departure and activates the actuator(s) to prevent such a departure. The actuator(s) controls yaw moment and deceleration of a vehicle such that the vehicle is effectively controlled so as to remain within the road boundaries. By this mechanism, RBDPS effectively assists in the prevention of accidents and mitigates damages when accidents actually occur. This system allows driver operations to take priority over RBDPS when RBDPS is controlling the vehicle. Also, the driver is adequately informed of the operational state of RBDPS support.

In this document, a road boundary is defined as a boundary of vehicle driving lanes delimited by solid lane markers. Therefore, a dashed line, which a vehicle can cross in order to change lanes, is not a road boundary. Also, this document does not define the means used to detect road boundaries.

Intelligent transport systems — Road boundary departure prevention systems (RBDPS) — Performance requirements and test procedures

1 Scope

This document contains the basic control strategy, minimum functionality requirements, basic driver interface elements, minimum requirements for diagnostics and reaction to failure, and performance test procedures for road boundary departure prevention systems (RBDPS). RBDPS is a driving safety support system which acts on vehicles to prevent road departures. RBDPS is designed to reduce damage and accidents arising from road boundary departures.

This document is intended to be applied to systems that predict road boundary departures and maintain the vehicle within the road boundaries by both lateral acceleration control and longitudinal deceleration control. RBDPS is intended to operate on roads (well-developed and standardized freeways or highways) having solid lane markers. Roadwork zones or roads without visible road boundary markers are not within the scope of this document. RBDPS is intended for light duty passenger vehicles and heavy vehicles. RBDPS is not designed to operate continuously, but to operate automatically only when possible road boundary departures are detected or predicted. However, the driver's decision and operation takes priority at all times.

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 1176, *Road vehicles — Masses — Vocabulary and codes*

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:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
control threshold
control trigger point set in the system where RBDPS control is issued

Note 1 to entry: In the case of *TTLC* (3.20) the control threshold shifts depending on the rate of departure.

Note 2 to entry: The control threshold is placed within the control threshold placement zone (see Figure 3).

3.2
control threshold placement zone
zone between the control threshold line and the latest control lines within which the control threshold is placed

Note 1 to entry: There is one control threshold placement zone at the inner side of the lane marking and one at the outer side of the lane marking (see Figure 3).

3.3
failure
inability of a system or system component to perform a required function within specified limits, which is caused by mechanical or electronic malfunction

Note 1 to entry: Temporary performance reductions, for example, due to bad weather conditions, bad lane markings, or temporary sensor blindness, are not considered a failure.

3.4
heavy vehicle
any single vehicle or combination of vehicles defined as Category M3, M2, N3, N2 in the United Nations Economic and Social Council World Forum for Harmonization of Vehicle Regulations (WP.29) ECE/TRANS/WP.29/78/Rev.2

3.5
lane
area of roadway delimited by visible lane markers between which, in the absence of any obstruction or intention on the part of the driver to change direction, a vehicle would be expected to travel

3.6
lane departure warning
warning given to the driver in accordance with the lane departure warning condition in the absence of suppression requests

3.7
latest control line
outermost limit of the control threshold

3.8
light duty passenger vehicle
vehicle defined as category M1 and N1 in the United Nations Economic and Social Council World Forum for Harmonization of Vehicle Regulations (WP.29) ECE/TRANS/WP.29/78/Rev.2

3.9
rate of departure
subject vehicle's lateral component of the approach velocity to the road boundary at the control issue point

3.10
RBDPS action
action which the system performs to influence the lateral movement of the subject vehicle with the intention of assisting the driver to prevent departing the road boundaries

3.11
road
area for vehicular travel delineated by road boundaries

3.12
road boundary
innermost edge of visible, solid, markers between which a vehicle shall travel

Note 1 to entry: Refer to Table A.1 for a detailed definition.

3.13
road departure
situation in which the outermost edge of one of the front wheels with tyres of a vehicle or of the leading part of an articulated vehicle, or, in the case of a three-wheeled vehicle, the outside of one of the wheels on the axle with the widest track, is crossing a road boundary

Note 1 to entry: See Figure 3.

3.14
straight road
segment of road for which the curve radius is larger than 5 000 [m]

3.15
subject vehicle
vehicle equipped with RBDPS as defined herein

3.16
system states
one of several stages or phases of system operation

Note 1 to entry: See Figure 2.

3.17.1
RBDPS off state
state in which the system is switched off

3.17.2
RBDPS on state
state in which the system is switched on

3.17.3
RBDPS stand-by state
state in which the system is switched on but the activation criteria to issue intervention are not all met

3.17.4
RBDPS active state
state in which the system is switched on and the activation criteria to issue intervention are met

3.18
threshold for start timing of system support
maximum time threshold which may be set by the user for the start time of RBDPS support after the road boundary departure has started

3.19
threshold for support level of the system
maximum level of system support which may be set by the user

3.20
time to line crossing
TTLC
calculated time to the crossing of the solid line, leading to road departure

Note 1 to entry: For example, the most simple calculation method of this time (TTLC) is to divide lateral distance (D) between the predetermined part of the vehicle and the road boundary by rate of departure (*Vdepart*) of the vehicle relative to the lane (TTLC = D/*Vdepart*).

3.21
visibility
distance at which the illuminance of a non-diffusive beam of white light with a colour temperature of 2 700 K is decreased to 5 % of its original light source illuminance

4 Symbols

Table 1 — Symbols and definitions

Symbol	Definition
RBDPS_Lat_Accel_min [m/s^2]	minimum lateral acceleration which RBDPS shall be capable to achieve
RBDPS_Lat_Accel_max [m/s^2]	maximum lateral acceleration which shall be induced by a RBDPS action
RBDPS_Long_Decel_min [m/s^2]	minimum longitudinal deceleration which RBDPS shall be capable to achieve
RBDPS_Long_Decel_max [m/s^2]	maximum longitudinal deceleration which shall be induced by RBDPS action
RBDPS_Offset_max [m]	maximum allowable road departure
RBDPS_Curvature_rate_max [1/m^2]	maximum rate of change of curvature which is allowed for the curve test track
RBDPS_Lat_Jerk_max [m/s^3]	maximum lateral jerk which shall be induced by a RBDPS action
RBDPS_Active_Duration_max [s]	maximum time duration of RBDPS control
Vdepart [m/s]	rate of departure
Vmax [m/s]	maximum velocity for RBDPS operation
Vmin [m/s]	minimum velocity for RBDPS operation
SV_speed [m/s]	speed of subject vehicle

5 Specifications and requirements

5.1 System function

RBDPS shall be designed taking into consideration the functional elements shown in Figure 1. However, as regards the control methods, a manufacturer is allowed to decide which control methods are used.

As examples of the control methods, generation of vehicle yaw moment for RBDPS functionality is achieved through the use of steering or four-wheel brake distribution, and reduction of vehicle velocity is achieved through braking or braking by engine.

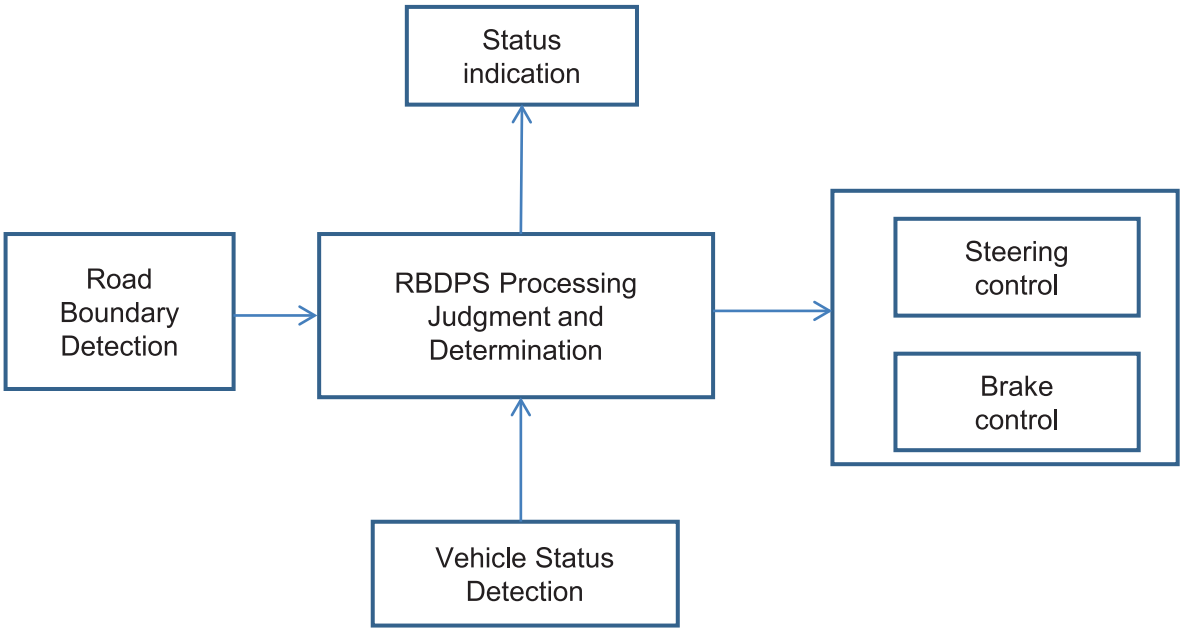


Figure 1 — RBDPS functional elements

The relationship with ISO 11270 (lane keeping assistance systems) and ISO 17361 (lane departure warning systems) is described in Annexes C and D.

5.2 Requirements

5.2.1 Functionality

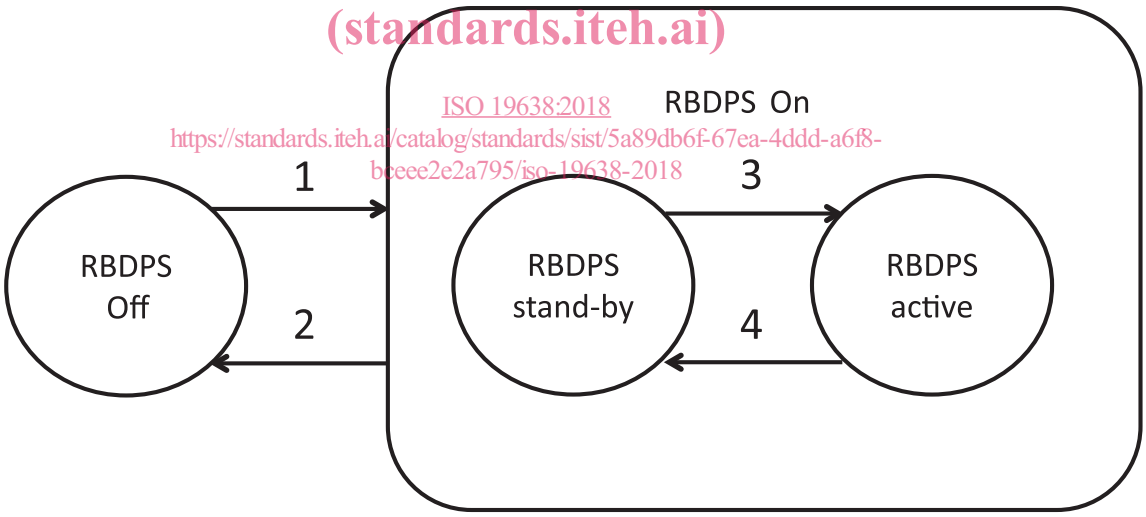
RBDPS is intended to attempt to prevent road departure crashes and minimize crash damages. The system provides driving support for prevention of road departure and does not perform automatic driving to support drivers. RBDPS shall, as a minimum, provide the following operations and state transitions. The following constitutes the fundamental behaviour of RBDPS.

As a basic functionality of RBDPS, it shall operate automatically when a road departure is predicted or detected by the system, and generate yaw moment and longitudinal deceleration to keep the vehicle within the road boundaries. Road boundaries within which RBDPS shall operate are illustrated in Table A.1. RBDPS shall react to road boundaries marked with solid lines. RBDPS may also react to other road boundaries represented by dashed lines, tar/turf transition, discrete protruding lane markings, etc.

As Table A.1 shows, for the centreline of a two-way road and the solid lane markers between the lanes in the case of a multi-lane road, RBDPS may operate.

5.2.2 State transition

RBDPS state transition is described in Figure 2. Specific implementation beyond what is illustrated below is left to the manufacturer.



Key

1 ignition ON
and no system fail
and RBDPS switch on

2 system fail
or ignition off
or RBDPS switch off

3 solid lane marker is detected
and road departure is predicted
and *Vmin* ≤ *SV_speed* ≤ *Vmax*
and no driver's corrective action detected
and other criteria specified by manufacturer

4 *SV_speed* < *Vmin*
or *SV_speed* > *Vmax*
or road departure is not predicted
or solid lane marker is not detected
or turn-signal ON or driver's corrective action
or other criteria specified by manufacturer

Figure 2 — RBDPS state transition