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Intelligent transport systems — Lane keeping assistance systems (LKAS) — Performance requirements and test procedures

Systèmes intelligents de transport — Systèmes d'aide au suivi de voie — 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

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

Introduction

The main system function of a Lane Keeping Assistance System (LKAS) is to support the driver in keeping the vehicle within the current lane. LKAS acquires information on the position of the vehicle within the lane and, when required, sends commands to actuators to influence the lateral movement of the vehicle. LKAS provides status information to the driver.

Issues such as specific requirements for the detection sensor function and its performance, or the communication links for co-operative solutions, will not be considered here.

Intelligent transport systems — Lane keeping assistance systems (LKAS) — Performance requirements and test procedures

1 Scope

This International Standard 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 Lane Keeping Assistance Systems (LKAS). LKAS provide support for safe lane keeping operations by drivers and do not perform automatic driving nor prevent possible lane departures. The responsibility for the safe operation of the vehicle always remains with the driver. LKAS is intended to operate on highways and equivalent roads. LKAS consist of means for recognizing the location of the vehicle inside its lane and means for influencing lateral vehicle movement. LKAS should react consistently with the driver expectations with respect to the visible lane markings. The support at roadway sections having temporary or irregular lane markings (such as roadwork zones) is not within the scope of this International Standard. This International Standard is applicable to passenger cars, commercial vehicles, and buses.

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 2575, *Road vehicles — Symbols for controls, indicators and tell-tales*

3 Terms and definitions

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

3.1
subject vehicle
vehicle equipped with LKAS as defined herein

3.2
system states
one of several stages or phases of system operation (see Figure 1)

3.2.1
LKAS off state
system is switched off

3.2.2
LKAS on state
system is switched on

3.2.3
LKAS stand-by state
system is switched on but the activation criteria are not all met

3.2.4
LKAS active state
system is switched on and the activation criteria are met

3.3
lane
area of roadway that a vehicle would be expected to travel along in the absence of any obstruction without the driver's desire to change the path of travel

3.4
visible lane marking
delineators intentionally placed on the borderline of the lane that are directly visible to the driver while driving (e.g. not covered by snow, etc.)

3.5
incidental visible road feature
visible patterns on the road surface that were not explicitly intended to delineate the boundaries of the lane, but which are indicative of the position of the lane

Note 1 to entry: These can include such features as pavement seams or edges and curbs.

3.6
lane boundary
borderline of the lane that is determined by a visible lane marking; and in the absence of a visible lane marking, by incidental visible road features or other means such as GPS, magnetic nails, etc

Note 1 to entry: In the case of a visible lane marking, the boundary is at the center thereof.

3.7
time to line crossing
TTLC
calculated time to lane 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 lane boundary by rate of departure (*V_depart*) of the vehicle relative to the lane. ($TTLC = D/V\_depart$)

3.8
suppression request
driver request or a system feature intended to prevent an LKAS action if an intentional lane departure is detected

3.9
lane keeping actions
actions which the system performs to influence the lateral movement of the subject vehicle with the intention of helping the driver to keep the vehicle within the lane

3.10
rate of departure
V_depart
component of subject vehicle's approach velocity at a right angle to the lane boundary

3.11
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

3.12
automatic driving
system that drives the vehicle without the driver being in the vehicle control loop, e.g. without a hand on the steering wheel or feet on the pedals

3.13
failure
mechanical or electronic malfunction which causes a persistent loss of performance or function

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

3.14
straight
segment of road which curvature is less than 1/5 000 m

4 Symbols and abbreviated terms

4.1 Symbols

Table 1 — Symbols and meanings

Symbol	Meaning
D	distance between the predetermined part of the vehicle and the lane boundary
LKAS_curvature_rate_max	maximum rate of change of curvature which is allowed for the curve test track
LKAS_curve_time	minimum duration of the curve test after entering the curve
LKAS_Lat_Acel_max	maximum lateral acceleration which is allowed to be induced by a lane keeping action
LKAS_Lat_Jerk_max	maximum lateral jerk which is allowed to be induced by a lane keeping action
LKAS_Offset_max	maximum value by which the outer edges of the tyres of the vehicle are allowed to exceed the lane boundary
V_depart	rate of departure
vmax	LKAS is not required to function if the vehicle speed is larger than *vmax*
vmin	LKAS is not required to function if the vehicle speed is less than *vmin*

4.2 Abbreviated terms

TTLC time to line crossing

5 Requirements

5.1 Functionality

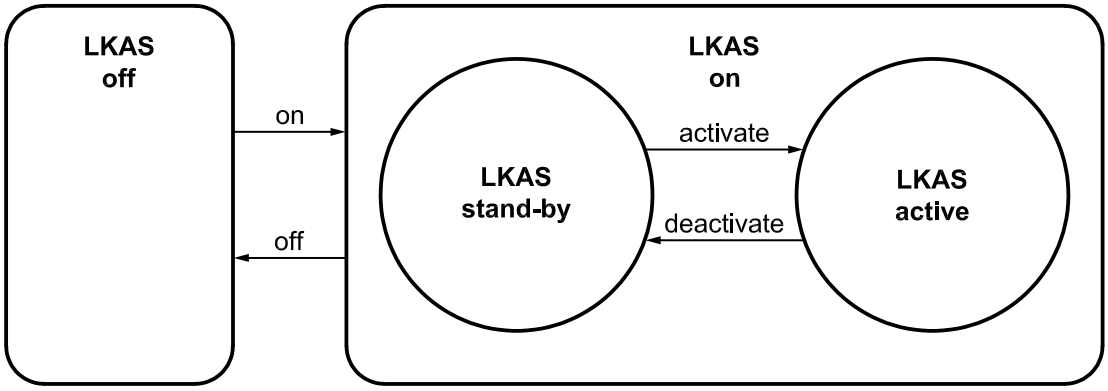

Figure 1 — LKAS states and transitions

LKAS provides support for safe lane keeping operations by drivers and do not perform automatic driving nor prevent possible lane departures. The responsibility for the safe operation of the vehicle always remains with the driver. LKAS shall, as a minimum, provide the following operations and state transitions. The following constitutes the fundamental behaviour of LKAS.

— The transition from LKAS off to LKAS on can be performed by the driver or automatically, e.g. after the ignition is switched on and no system failure has occurred. The transition from LKAS on to LKAS off can be performed by the driver or automatically, for instance after the ignition is switched off or a system failure has occurred.

— LKAS shall be operational for speeds between *vmin* and *vmax*. *vmin* = 20 m/s, *vmax* = 30 m/s, or the maximum possible vehicle speed, whichever is less. It is allowed to be operational in a wider speed range.

— In LKAS stand-by state, the system shall evaluate the activation criteria. LKAS shall not perform any lane keeping actions. One of the activation criteria shall be that the system has determined the position of the vehicle within the lane relative to the visible lane markings of its own lane. It is up to the manufacturer to decide whether it is necessary to detect one or both visible lane markings of the own lane. Other criteria to be selected by the manufacturer can be the type of the lane marking (e.g. solid or dashed), a minimum vehicle speed, driver actions, steering angle, and other vehicle conditions. If all of the selected activation criteria are met, the system shall transition from LKAS stand-by to LKAS active state. This transition can be done automatically or by a driver confirmation.

— In LKAS active state, the system shall evaluate the activation criteria. If any one of the selected activation criteria is not met, the system shall transition from LKAS active to LKAS stand-by state. In the LKAS active state, the system can perform lane keeping actions to influence the lateral movement of the subject vehicle with the intention of helping the driver to keep the vehicle within the lane when an unintended lane departure is likely. A lane keeping action influences the lateral movement of the subject vehicle with respect to the lane in such a way that the TTLC increases compared to the vehicle movement without a lane keeping action (unless the driver overrides the system). The system can detect suppression requests to minimize nuisance lane keeping actions. The suppression request can be issued, e.g. if the driver operates a turn signal.

5.2 Basic driver interface and intervention capabilities

The system shall provide the following controls and intervention capabilities:

5.2.1 Operation elements and system reactions

— The driver shall be provided with means to override the lane keeping action at any time. Such means shall include turning the steering wheel.

— Specific driver actions can be considered as a suppression request.

— The driver shall be provided with the means to transition from LKAS on to LKAS off and to keep the system in the LKAS off state. Such transition shall be possible regardless of whether the system is in the LKAS active or the LKAS stand-by state.

— The driver shall be provided with the means to transition from LKAS off to LKAS on.

— Drivers shall be informed of the conditions that result in LKAS activation and deactivation by the vehicle owner's manual.

5.2.2 Display elements

— The information about whether the LKAS is in LKAS on state shall be accessible to the driver, e.g. in a pull down menu.

— It shall be displayed whether LKAS is in LKAS active state, except if the vehicle is equipped with a combination of systems that assist the driver to keep the vehicle inside the lane, e.g. with lane

departure warning system and LKAS. In this case, it shall be displayed whether at least one of the systems is in an active state.

— If LKAS is not available due to a failure, the driver shall be informed.

5.2.3 Symbols

— If symbols are used to identify LKAS function or malfunction, standardized symbols in accordance with ISO 2575 are recommended to be employed.

5.3 Minimum functionality

To cover the main purpose to help the driver to keep the vehicle inside the lane, the LKAS shall pass the test procedure defined in Clause 6.

5.4 Operational limits

The LKAS should be designed in a way that the driver is able to use the LKAS safely in all situations. Therefore, the vehicle actions which are induced by the lane keeping actions shall be limited.

— The magnitude of the lateral acceleration which is induced by the lane keeping action shall not exceed *LKAS_Lat_Acel_max*. Also the moving average over half a second of the lateral jerk should be limited to:

  — LKAS_Lat_Jerk_max;

  — LKAS_Lat_Acel_max = 3 m/s^2;

  — LKAS_Lat_Jerk_max = 5 m/s^3.

— The lane keeping action shall not cause a longitudinal deceleration larger than 3 m/s^2. If the lane keeping action causes a longitudinal deceleration larger than 1,0 m/s^2, this shall not cause a speed reduction more than 5 m/s.

— In case of a transition from LKAS active state to LKAS stand-by state, the lane keeping action shall not end suddenly but shall be faded out smoothly.

— The vehicle owner's manual shall inform the driver that LKAS operation is not guaranteed to be the same as on a dry, flat road if it is under low traction conditions, on roads with lateral bend, super elevation, or adverse weather conditions.

— These operational limit requirements shall be fulfilled under all conditions.

5.5 Failure reactions

— Failures in the LKAS components shall result in immediate notification to the driver and LKAS shall transition to the LKAS off state. The notification shall remain active until the system is switched off.

— The reactivation of the LKAS shall be prohibited until a successful self-test, initiated by either ignition off/on or LKAS-off/on, is accomplished.