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**Performance requirements and test methods for lane
keeping assist system of commercial vehicles**

商用车辆车道保持辅助系统

性能要求及试验方法

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Performance requirements and test methods for lane keeping assist system of commercial vehicles

1 Scope

This document specifies the terms and definitions, symbols, technical requirements, and test methods for lane keeping assist systems of commercial vehicles.

This document is applicable to vehicles of Category M₂, Category M₃, and Category N equipped with a lane keeping assist system (hereinafter referred to as the “system”) with a lane departure prevention function.

2 Normative references

The following documents contain the provisions which, through normative reference in this document, constitute the essential provisions of this document. For the dated referenced documents, only the versions with the indicated dates are applicable to this document; for the undated referenced documents, only the latest version (including all the amendments) is applicable to this document.

GB/T 3730.2-1996 Road vehicle - Masses - Vocabulary and codes

GB 5768 (All parts) Road traffic signs and markings

GB 34660 Road vehicles - Requirements and test methods of electromagnetic compatibility

GB/T 39263-2020 Road vehicles - Advanced driver assistance systems - Terms and definitions

3 Terms and Definitions

The terms and definitions defined in GB/T 39263-2020 and the following apply to this document.

3.1 lane keeping assist; LKA

It monitors the relative position of the vehicle and the lane edge in real time, controls the lateral movement of the vehicle continuously or if necessary, and keeps the vehicle in the original lane.

The position of the vehicle on the road when the intervention action is executed, which corresponds to the intervention trigger point set inside the system.

3.11 failure

Failure of system performance or function due to mechanical or electronic problems.

4 Symbols

The following symbols apply to this document.

$D_{\max}$: The maximum value that the outer edge of the front tire on the side where the vehicle deviates from is allowed to cross the lane boundary, and the unit is meter (m).

$v_{\max}$: The maximum vehicle speed that satisfies the system activation conditions, and the unit is meter per second (m/s).

$v_{\min}$: The minimum vehicle speed that satisfies the system activation conditions, and the unit is meter per second (m/s).

v : The speed of the subject vehicle, and the unit is meter per second (m/s).

5 Technical requirements

5.1 General requirements

5.1.1 The activated system shall be able to assist the driver to keep the vehicle in the original lane.

5.1.2 The electromagnetic compatibility of the system shall meet the requirements of GB 34660.

5.1.3 The system shall have a self-inspection function, and there shall be no obvious delay during the self-inspection.

5.1.4 The system can at least provide the driver with the following appropriate prompts and warning signals:

- a) The system shall use at least one signal among acoustic, tactile, and optical to prompt the intervention and exit of the system intervention action;
- b) A failure warning shall be sent out when an electronic and electrical failure occurs during system self-inspection and operation. The warning signal shall not be delayed significantly. It should be a constant yellow warning signal, which can be indicated by text or graphics; if the system has been intervened or shut down

--- If the outer edge of the front wheel on the deviated side does not exceed the boundary of the lane, the timing shall be started when the system begins to intervene, and the subject vehicle shall drive in the lane for at least 5 seconds;

- c) The lateral acceleration caused by lane keeping shall not be greater than 3 m/s^2 , and the moving average of the rate of change of lateral acceleration within 0.5 s shall not be greater than 5 m/s^3 ;
- d) The longitudinal deceleration caused by lane keeping shall not be greater than 3 m/s^2 , if the longitudinal deceleration caused by lane keeping is greater than 1 m/s^2 , the speed reduction of the vehicle shall not be greater than 5 m/s ;
- e) All 8 tests shall be passed.

5.2.2 Performance requirements for curve lane keeping

The test shall be carried out according to 6.7 and meet the following requirements:

- a) The $D_{\max}$ of N_1 vehicles is 0.40 m, and the $D_{\max}$ of M_2 , M_3 , N_2 and N_3 vehicles is 0.75 m;
- b) After the subject vehicle enters the curve, it shall run within the range of $D_{\max}$ for 5 s;
- c) The lateral acceleration caused by lane keeping shall not be greater than 3 m/s^2 , and the moving average of the rate of change of lateral acceleration within 0.5 s shall not be greater than 5 m/s^3 ;
- d) The longitudinal deceleration caused by lane keeping shall not be greater than 3 m/s^2 , if the longitudinal deceleration caused by lane keeping is greater than 1 m/s^2 , the speed reduction of the vehicle shall not be greater than 5 m/s ;
- e) All 4 tests shall be passed.

5.2.3 Performance requirements for action execution prompt

The test shall be carried out according to 6.6 and 6.7. The system shall send out an intervention action prompt signal when executing the lane departure prevention action, and the prompt signal shall meet the requirements of 5.1.4 a).

5.2.4 Performance requirements for driver intervention

The test shall be carried out according to 6.8.1, and the system shall ensure that the driver can interrupt the system intervention action through active action.

5.2.5 Performance requirements for the system that has the lane departure warning function

5.2.5.1 The test shall be carried out according to 6.6 and 6.7, the system shall automatically send out the lane departure warning signal and meet the following requirements:

- a) The system shall send out a lane departure warning signal at the warning threshold, and the warning signal shall be at least one of the auditory, tactile or optical signals, and the warning signal shall be easily distinguishable by the driver;
- b) The warning signal shall be sent out when the vehicle is at the warning threshold;
- c) The warning signal shall be sent out at the latest when the outer edge of the front wheel tire on the deviation side crosses the lane boundary by 0.3 m;
- d) The timing of sending out the warning signal shall enable the driver to respond to the lane departure and control the vehicle in time, and avoid premature or too-frequent warning to make the driver feel bored.

5.2.5.2 The test shall be carried out according to 6.8.2. The system shall ensure that the driver can interrupt the system lane departure warning through active action.

6 Test method

6.1 Vehicle conditions

The subject vehicle shall be tested separately under the conditions of the curb weight of the whole vehicle and the maximum allowable total mass. The quality description shall meet the requirements of GB/T 3730.2-1996. It is not allowed to change the conditions of the subject vehicle after the test starts. For semi-trailer tractors, the test shall be carried out under the curb weight of the combination vehicles and the maximum allowable mass of the combination vehicles, respectively.

6.2 System settings

For systems with an adjustable intervention threshold, the test shall be carried out with the system set to the latest intervention threshold. It is not allowed to change the system settings after the test starts.

6.3 Environmental conditions

The test environment conditions shall meet the following requirements:

- a) The light intensity is not less than 500 lx;
- b) Dry, flat, and clean asphalt or concrete pavement;
- c) The temperature range is -20 °C~+45 °C;

Description:

c --- The curvature, $c=1/R_{BC}$;

S_1 --- The length of variable curvature part, $S_1=c/(dc/ds)$;

S_2 --- The length of the constant curvature part;

S_3 --- The total length of the curve, $S_3 \geq v \cdot t$;

t --- The driving time of the subject vehicle within the range of $D_{\max}$ after entering the curve.

Figure 2 -- Schematic diagram of the test curve

6.5 Test equipment requirements

During the test, the test instruments and equipment shall meet the following requirements:

- a) The frequency of dynamic data sampling and storage shall be greater than or equal to 100 Hz;
- b) Accuracy requirements:
 - The accuracy of the speed shall be 0.028 m/s;
 - The horizontal and vertical position accuracy shall be 0.05 m;
 - The acceleration accuracy shall be 0.1 m/s².

6.6 Lane keeping tests on the straight roads

6.6.1 As shown in Figure 3, the initial driving direction of the subject vehicle shall be parallel to the lane line, and the deviation between the vehicle centerline and the lane centerline shall not be greater than 0.2 m.

6.6.2 The subject vehicle passes d_0 at a speed of 20.0 m/s~21.0 m/s and runs steadily to d_1 , then deviates from the lane. When the condition of $0.2 \text{ m/s} \leq v_d \leq 0.6 \text{ m/s}$ is met, the steering wheel is left in a free state.

6.6.3 After d_4 is passed, the test ends.

6.6.4 There are a total of 8 tests on straight roads, which are divided into 4 left-side deviation tests and 4 right-side deviation tests. The unilateral test shall include one test of deviating from the own lane under the condition of $0.2 \text{ m/s} \leq v_d \leq 0.4 \text{ m/s}$ test, and three tests of deviating from the lane under the condition of $0.4 \text{ m/s} < v_d \leq 0.6 \text{ m/s}$.

Appendix A

(Informative)

Functional safety requirements

A.1 General rules

When the safety-related electronic and electrical system of a vehicle malfunctions, it will lead to potential hazards (for example, during the normal driving process of a vehicle, if unexpected lateral movement occurs, it will result in the collision of vehicles). GB/T 34590^[1] clarifies the functional safety requirements that the safety-related electronic and electrical systems of vehicles shall meet during the safety life cycle, so as to avoid or reduce the risks caused by system failure.

This appendix describes the special requirements for documentation, failure strategies, and confirmation tests that the system should meet in terms of functional safety.

This appendix does not aim at the nominal performance of the system, nor does it serve as specific guidance for the development of system functional safety, but describes the methods that should be followed during the design process and the information that should be available during system verification and confirmation, so as to prove that the system can ensure the implementation of functional safety concepts in both normal operation and fault status.

A.2 Documentation

A.2.1 Requirements

The corresponding documents should be available to illustrate the functional concepts and functional safety concepts of the system, and the following requirements should be met:

- a) The functional concepts, internal and external interfaces, potential failures, risks, and safety measures of the system should be described;
- b) It should be demonstrated that the potential failure sources, including random hardware failures and systematic failures, are considered during the system design, and engineering practices in relevant fields are applied;

Example: Appendix E in GB/T 34590.5-2017 gives design practices for random hardware failures.

- c) In order to support the confirmation test, it should be explained how to check the working status of the system in normal operation and failure mode.

A.2.2 Definition of related items

A.2.2.1 It is advisable to describe the functional concepts of related items and provide a list of functional descriptions.

Note 1: In GB/T 34590.1, related items refer to a system or a group of systems that perform functions at the vehicle level; for example, the definition of related items of a system may include front camera, ECU, steering control module, driver warning system, etc.

Note 2: The functions that can be perceived from the vehicle level should be described and refined.

A.2.2.2 It is advisable to define the scope of related items, specify the systems and elements belonging to related items, and identify the external systems or elements that have interactive relationships with them.

A.2.2.3 It is advisable to define the operating conditions and constraints of related items, and specify the boundaries of the effective working range for the corresponding system functions.

Example: Common operating conditions include the power supply, the vehicle speed, etc. Common constraints include ambient temperature, humidity, vibration, etc.

A.2.2.4 A schematic diagram (for example, a module diagram) should be provided to illustrate the architecture of the relevant item and its internal and external interfaces. The relevant components, external interface systems, and internal and external interface channels should be indicated in the schematic diagram with serial numbers, and a detailed list that briefly explains the functions of each component, system and interface in the list should be provided.

Note: If a component integrates multiple functions, for clarity and ease of explanation, it can be represented by multiple modules in the schematic diagram.

A.2.2.5 It is advisable to use identification marks to clearly and unambiguously identify each component (including hardware and software) of the relevant item, and confirm its consistency with the provided documents. The identification mark should specify the version of the hardware and software. If the version change causes the function described in this document to change, the identification mark should be changed accordingly.

A.2.3 Hazard analysis and risk assessment

A.2.3.1 The functional faults of related items should be analyzed and classified.

Example: Typical analytical methods, e.g., Hazard and Operability (HAZOP).

A.2.3.2 It is advisable to give a list of potential hazards and define the corresponding

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