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**Intelligent transportation systems - Forward vehicle collision
warning systems - Performance requirements and test
procedures**

智能运输系统 车辆前向碰撞预警系统 性能要求和测试规程
(ISO 15623:2013, Transport information and control systems - Forward vehicle
collision warning systems - Performance requirements and test procedures,
NEQ)

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Intelligent transportation systems - Forward vehicle collision warning systems - Performance requirements and test procedures

1 Scope

This Standard specifies performance requirements and test procedures for forward vehicle collision warning systems (hereinafter referred to as FVCWS).

This Standard covers operations on roads with radius of curvature over 125 m, and motor vehicle including cars, trucks, buses and motorcycles.

Note: Responsibility for the safe operation of the vehicle remains with the driver.

2 Normative references

The following referenced documents are indispensable for the application 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.

GB 7247.1-2012, Safety of laser products - Part 1: Equipment classification and requirements

GB/T 20608-2006, Intelligent transportation systems - Adaptive cruise control systems - Performance requirements and test procedures

JTG B01-2014, Technical Standard of Highway Engineering

3 Terms and definitions

The following terms and definitions are applicable to this document.

3.1

collision warning

Information that the system gives to the driver indicating the need for urgent action to avoid a collision.

No warning is performed in the FVCWS off state. It is optional to provide a driver-selected means of placing FVCWS in this state, other than the Ignition key (for example: on/off Switch).

Upon turning the ignition to the off position, the FVCWS transitions to the FVCWS off state. Whenever the Self-Test function determines that the FVCWS is not able to deliver adequate performance, a fault condition is set and FVCWS transitions to the FVCWS off state.

● FVCWS standby (2)

No warning is performed in the FVCWS standby state. In this state, FVCWS monitors the vehicle velocity and the gear position. If the subject vehicle velocity comes within the FVCWS operating range and the gear select is in forward position (all gear positions except reverse and park), the system transitions from the standby state to the active state. FVCWS enters the FVCWS standby state from the FVCWS off state if the ignition cycle has been completed and the engine is running, or if the engine is running and the driver manually turns on the switch. If the subject vehicle velocity value is outside the FVCWS operation range (hysteresis δ is added), reverse gear is selected, or park is selected, FVCWS enters standby state from the active state.

● FVCWS active (3)

The warning is performed in the FVCWS active state whenever the warning conditions are met. FVCWS enters this state if gear select is in any forward position and the vehicle velocity value is in the FVCWS operation range.

4.3.3 Operational limits

The value of the minimum velocity V_{\min} shall be at most 11.2 m/s when the system works. The value of the maximum velocity V_{\max} shall be at least 27.8 m/s or the maximum vehicle operating velocity when the system works. The minimum value of the relative velocity shall not be higher than 4.2 m/s, and the maximum value shall not be lower than 20 m/s.

4.4 Warning functionality

4.4.1 Warning target object

Forward vehicle collision warning systems shall provide warnings for moving (including “has been detected as moving by the sensor and now stopped”) obstacle vehicles. Providing warnings for stationary obstacle vehicles is optional.

4.4.2 Monitoring distance and relative velocity between obstacle vehicle and subject vehicle

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

- a) The collision warning shall include a visual warning and an audible and/or tactile warning, wherein the tactile warning can be realized by means of seat belt warning;
- b) The preliminary collision warning shall include visual or auditory warning or a combination of the two; a tactile form can be selected as a supplement;
- c) If the driver of the subject vehicle is taking a braking operation, it is recommended not to warn the driver in the form of braking warning;
- d) If the subject vehicle is automatically applying the braking force, the collision warning and preliminary collision warning can be taken in the form of braking warning;
- e) The duration of the braking warning shall not exceed 1 s; the resulting deceleration shall not exceed 0.5 g; the range of vehicle velocity drop generated during the warning process shall not exceed 2 m/s. At the same time, in order to ensure the effectiveness of the braking warning, the average deceleration shall not be less than 0.1 g, and the duration shall not be less than 100 ms;
- f) Audible warning tone shall be selected such that it can be easily heard and discriminated from warnings unrelated to forward direction threats (e.g., lateral threat warnings).

4.5.3 Required deceleration threshold

The required deceleration thresholds involved in the forward vehicle collision warning system shall meet the following requirements:

- a) If the required deceleration a_{req} exceeds its threshold range, the forward vehicle collision warning system shall issue a collision warning; under dry road and warm climate conditions, the a_{req} threshold shall not exceed 0.68 g (taking into account the response time value of 4.5.4);
- b) If the timing of warning of the forward vehicle collision warning system can be adjusted by the driver, at least one of the settings shall be able to meet the previous threshold requirements for the required deceleration a_{req} ;
- c) FVCWS may issue a preliminary collision warning at a lower required deceleration.
- d) The required deceleration threshold for collision warning and preliminary collision warning may be adapted based on the detected road condition, environmental and driver state conditions, driver behavior and different driving scenarios.

4.5.4 Response time

The value of the response time involved in the forward vehicle collision warning system shall meet the following requirements:

- a) In the calculation of the warning range, the driver's response time to the warning T_{resp} shall be incorporated. The T_{resp} value shall not be less than 0.8 s;
- b) The braking system response time T_b shall be incorporated in the calculation of the required deceleration. The selection of the braking system response time value is left to the FVCWS designer;
- c) In case when automatic braking is applied in the subject vehicle, the driver's response time to warning T_{resp} and the braking system response time T_b may be set to zero.

4.5.5 No Warning requirements

The FVCWS warning shall be suppressed or delayed under the following conditions:

- a) The FVCWS shall not issue any type of warnings if the subject vehicle deceleration is greater than or equal to the threshold of required deceleration a_{req} .
- b) The FVCWS shall not issue any type of warnings for a forward vehicle that is not in the lane of the subject vehicle on roads with radius of curvature defined for each class in Table 1;
- c) It is recommended that that FVCWS does not issue any type of warnings for a faster forward vehicle that cuts in front of the subject vehicle;
- d) The FVCWS warning may be suppressed or delayed if the subject vehicle driver is applying the brakes;
- c) The FVCWS warning may be suppressed or delayed if the time to collision TTC is greater than 4.0 s;
- f) The FVCWS warning may be suppressed or delayed if the subject vehicle is detected to be performing a lane change or high dynamic maneuvering, or if the subject vehicle driver is overriding the automatic braking by applying throttle, or if an ACC maximum braking warning is active;
- g) The FVCWS warning may be suppressed or delayed if the situation is beyond the operational limits as defined in 4.3.3.

4.5.6 Warning distance range calculation example

The minimum expected warning distance can be calculated using Formula (5). It can be assumed that the driver's response time to warning is $T_{\text{resp}} = 0.8$ s, and the required deceleration as defined in 3.22 is $a_{\text{req}} = 6.67$ m/s².

Appendix C

(Normative)

Sensor performance requirements and test target requirements

C.1 General

The forward vehicle collision warning system needs to obtain the information of the forward vehicle (such as relative distance, relative velocity, etc.) through sensors. When different sensors are used, certain safety performance requirements shall be met; for systems using different types of sensors, there are also certain requirements for the test target in performance test.

C.2 Safety performance of the sensor

C.2.1 Optical radar

The optical radar shall be in accordance with the provisions of the first class of lasers in GB 7247.1-2012.

C.2.2 Radio wave radar

The radio wave radar shall comply with the regulations on vehicle ranging radar issued by the Ministry of Industry and Information Technology [2005] No. 423^[3].

C.3 Test target requirements

C.3.1 Optical radar

C.3.1.1 The test target shall be determined according to the CTT (Test Target Coefficient) representing the reflectivity of the vehicle. CTT shall be $2 \text{ m}^2/\text{sr}$.

C.3.1.2 CTT describes the performance of the reflector. A corner reflector (reducing a flat surface to a point) is required during testing. Large flat reflectors can also be used, as long as their reflectivity does not exceed the value specified in C.3.1.1.

C.3.2 Radio wave radar

The test target is determined by the typical radar cross section (RCS) of the motor vehicle. The RCS value is 3 m^2 .

Note: In actual use, it is difficult to obtain plane waves on scatterers. In actual use, the radar cross-sectional area is determined by the measured value.

C.3.3 Visual sensor

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