IVISTA

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Intelligent Cruise Index
Cruise Assist System Test Protocol

(Version 2023)

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Cruise Assist System Test Protocol

1 Scope

This document specifies the test methods of IVISTA China Intelligent Vehicle Index - Intelligent Cruise Index - Cruise Assist System.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute indispensable provisions of this document. For dated references, only the dated edition applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB 5768.2-2022 Road Traffic Signs and Markings - Part 2: Road Traffic Signs

GB 5768.3-2009 Road Traffic Signs and Markings - Part 3: Road Traffic Markings

GB 5768.5-2017 Road Traffic Signs and Markings - Part 5: Speed Limit

GB/T 23826-2009 Light-emitting Diode Changeable Speed Limit Signs of Expressway

GB/T 15089 Classification of Power-driven Vehicles and Trailers

GB/T 18385-2005 Electric Vehicles - Power Performance - Test Method

GB/T 20608-2006 Intelligent Transportation Systems - Adaptive Cruise Control Systems - Performance Requirements and Test Procedures

GB/T 39263-2020 Road Vehicles - Advanced Driver Assistance Systems - Terms and Definitions

GB/T 40429-2021 Taxonomy of Driving Automation for Vehicles

ISO 11270 Intelligent transport systems - Lane keeping assistance systems (LKAS) - Performance requirements and test procedures

ISO 15622 Intelligent transport systems - Adaptive cruise control systems - Performance requirements and test procedures

ISO NP 21717 Intelligent transport systems - Partially automated in lane driving systems (PADS) - Performance requirements and test procedures

ISO 22179 Intelligent transport systems - Full speed range adaptive cruise control (FSRA) systems - Performance requirements and test procedures

3 Terms and Definitions

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

3.1

inertial frame

the inertial frame specified in ISO 8855:2011, in which the X axis points towards the front of the vehicle, the Y axis towards the left side of the driver and the Z axis upwards (right-hand coordinate system)

Viewed from the origin to the positive directions of X, Y and Z axes, roll, pitch and yaw rotate clockwise around the x, y and z axes respectively. This frame is used for both left-hand and right-hand drive vehicles.

3.2

cruise assist; CA

control system that realizes horizontal and longitudinal (or longitudinal) control of the vehicle by controlling the powertrain, transmission system, brakes and steering gear to assist the driver in driving the vehicle, including Level 1 or Level 2 driving automation systems such as adaptive cruise control, traffic jam assist and highway assist

3.3

adaptive cruise control; ACC

a system that is capable of monitoring the driving environment in front of the vehicle in real time, and automatically adjusting the driving speed within the set range, to adapt to the changes in the driving environment resulting from the vehicle ahead and/or road conditions

[Source: GB/T 39263-2020, 2.3.10]

3.4

traffic jam assist; TJA

a system that is capable of monitoring the driving environment of adjacent lanes and in front of the vehicle in real time, and automatically controlling the vehicle laterally and longitudinally (the use of some functions needs to be confirmed by the driver) when a vehicle passes through a traffic jam section at a low speed

[Source: GB/T 39263-2020, 2.3.12]

3.5

subject vehicle; SV

a vehicle, equipped with the CA system, which is used for test

3.6

target vehicle 1; TV1

the target vehicle which is closest to the SV and is the first object targeted by the vehicle with CA system in operation

3.7

target vehicle 2; TV2

the forward vehicle which is the second closest to the SV on the forward traveling trajectory of the SV and is the second object targeted by the vehicle with CA system in operation

3.8

express tricycle target vehicle

an express tricycle test device designed for the test of CA system

3.9

clearance

distance between the rear of TV and the head of SV, expressed by X0(t)

3.10

time gap

time interval required for the SV to pass through the clearance between continuous vehicles, calculated as follows

$$\tau = X_0(t) / V_{SV}(t)$$

Where, τ - time gap, in s

$V_{SV}(t)$ - current speed, in m/s

$X_0(t)$ - clearance, in m

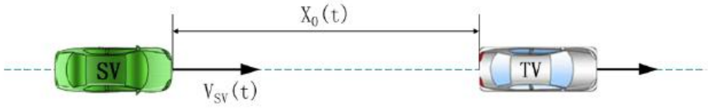

Fig. 1 Time Gap

3.11

set speed

expected GPS speed of the vehicle under CA control

3.12

steady state

vehicle state in which relevant parameters do not change along with time and clearance

3.13

time to collision; TTC

the remaining time before a collision between two vehicles traveling on the same path, assuming that the relative velocity remains unchanged, calculated as per the following formula, provided that the relative velocity is not zero

The value may be estimated through dividing the clearance between the SV and TV by the relative velocity. If the calculation condition is not met or the calculated TTC is negative, the collision is impossible under the above-mentioned assumed conditions.

$$\mathrm{TTC} = \frac{X_0(t)}{V_r(t)}$$

Where, TTC - time to collision, in s

$V_r(t)$ - relative velocity, in m/s

$X_0(t)$ - clearance, in m

3.14

lateral offset

distance from the front axle center point of SV and the rear axle center point of TV to the planned path

When the centerlines of both the SV and TV coincide with the planned path, the lateral offset is zero. When there is no TV, the lateral offset is the distance from the front axle center point of SV to the planned path.

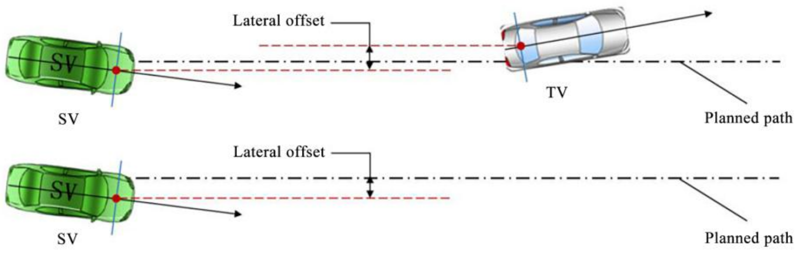

Fig. 2 Lateral Offset

3.15

longitudinal offset

distance from the center point of the SV's head to the TV on the planned path of the SV

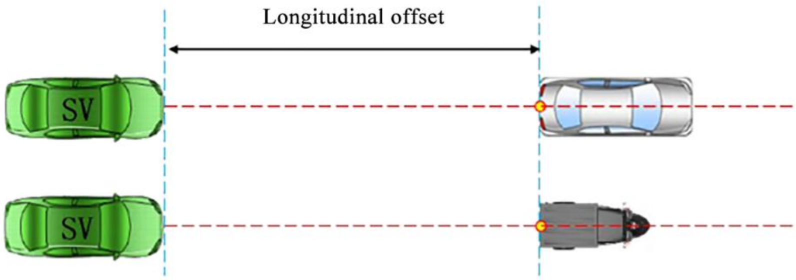

Fig. 3 Longitudinal Offset

3.16

lateral overlap

a percentage of the width overlap between the TV and the SV to the VUT's width

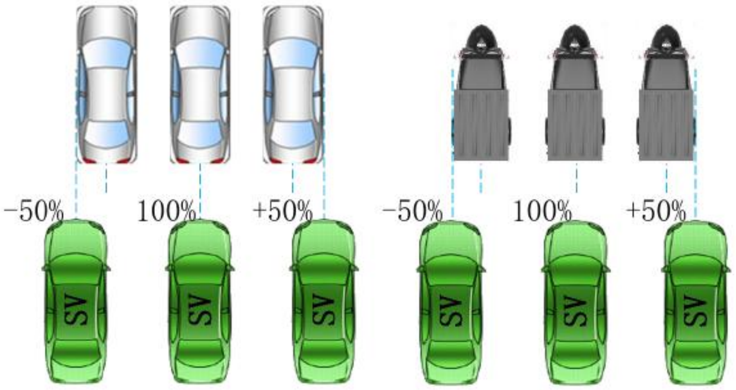

Fig. 4 Lateral Overlap

4 Test Requirements

4.1 Proving ground and test environment

4.1.1 Requirements for test site

The requirements for test site are as follows:

a) The test road shall be dry and flat, without defects such as obvious pits and cracks, and its slope shall be less than 1%. It shall be at least 500 m long, and the adhesion coefficient of the pavement should be above 0.8;

b) A single test lane shall be 3.5~3.75 m wide, and the lane markings shall be white or yellow solid or dashed lines as specified in Table 1 (excluding Nos. 5, 6 and 13) of GB 5768.3;

c) The test road for the curve test shall consist of a straight section and a curved section whose length shall ensure that the vehicle can run for at least 5 s. The curved section shall consist of two parts: the constant curvature part and the variable curvature part. The curvature of the constant curvature part is given in Table 1. The variable curvature part connects the straight section and the constant curvature part, and its curvature shows a linear change along with the length of the curved section, gradually increasing from 0 to C, and with the curvature change rate (dc/ds) not exceeding 4×10-5 m-2, as shown in Fig. 5.

Table 1 Relation between Curve Radius and Curvature

Curve Radius R/m	250	500
Curvature C/m^{-1}	0.004	0.002

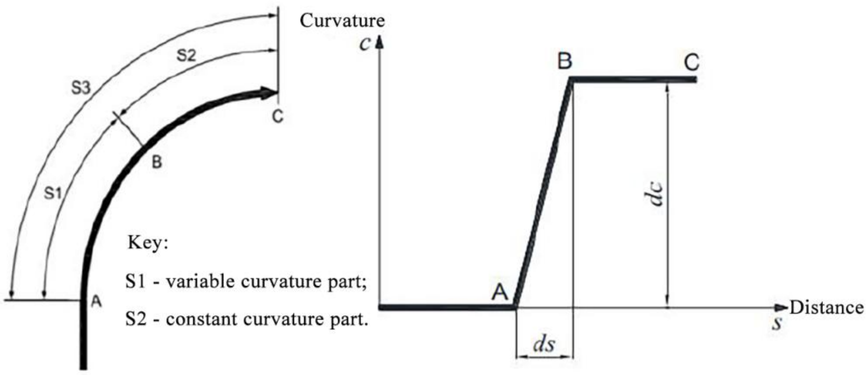

Fig. 5 Curvature at the Curve

4.1.2 Requirements for test environment

a) The weather shall be good, without any bad weather such as rain, snow and dust except for special scenarios;

b) The ambient temperature shall be 0 °C ~ 45 °C, and the wind velocity shall be less than 5 m/s;

c) Except for nighttime and rainy day scenarios, the test shall be conducted under uniform natural illumination conditions. The illuminance shall not be lower than 2000 lux, unless any other lower illuminance limit is specified by the SV manufacturer;

d) The running direction of the vehicle shall not be parallel to the direction of direct sunlight.

4.2 Test equipment

4.2.1 Target

a) The passenger car target vehicle shall be a mass-produced M1 passenger car, or a flexible target that has surface characteristic parameters representative of M1 passenger cars and can adapt to the sensor system. For specific requirements, see ISO 19206-3.

Fig. 6 Appearance of Flexible Passenger Car Target

a) The express tricycle target vehicle shall be a mass-produced express tricycle, or a flexible target that has surface characteristic parameters representative of express tricycles and can adapt to the sensor system. The current main dimensional requirements are given in table 2.

Fig. 7 Appearance of Flexible Express Tricycle Target

Table 2 Main Dimensions of Flexible Express Tricycle Target

Dimensions	Value (mm)
Total vehicle length	2905
Total vehicle width	1100
Total vehicle height	1490
Wheel track	1950
Compartment height	1150
Compartment width	1000

Note 1: For flexible targets, after relevant national standards are published, the requirements of those national standards will prevail.

Note 2: If the manufacturer of the VUT believes that the flexible target does not meet the requirements of the VUT sensor for the target, please contact the IVISTA Management Center.

4.2.2 Speed limit sign

Speed limit signs shall be provided according to GB 5768.5-2017, and LED variable speed limit signs shall meet the technical requirements of GB 23826-2009. Fig. 8 shows the appearance of speed limit signs.

Fig. 8 Appearance of Speed Limit Sign

4.2.3 Requirements for data acquisition equipment and accuracy

The data acquisition equipment and accuracy in the closed field shall meet the following requirements:

a) The sampling and storage frequency of dynamic data shall not be less than 100 Hz, and DGPS time shall be used for data synchronization between the SV and the target;

b) Speed accuracy of SV and targets: ±0.1 km/h;

c) Longitudinal acceleration accuracy of SV and targets: ±0.1 m/s^2;

d) Lateral and longitudinal position accuracy of SV and target: ±0.03 m.

4.3 Vehicle preparation

4.3.1 System initialization

If necessary, the CA system can be initialized prior to the test, including the calibration of sensors such as radars and cameras.

4.3.2 Vehicle status confirmation

a) The VUT shall be new with a traveled mileage of not more than 5000 km;

b) The VUT shall be equipped with the original new tires designated by the VUT manufacturer. The tires shall be inflated to the standard cold tire pressure recommended by the VUT manufacturer, or to the pressure corresponding to the least loading condition if more than one tire pressure value is recommended;

c) The VUT shall be refueled to not less than 90% of the fuel tank capacity, with other fluids such as oil and water (e.g. coolant, brake fluid, and engine oil) added at least to the minimum indicated position. During the test, the fuel may decrease but shall not be lower than 50% of the fuel tank capacity;

d) The active hood system of VUT, if equipped, shall be disabled before the test equipment is installed;

e) The mass of the VUT shall lie between the complete vehicle curb mass plus the total mass of the driver and test equipment (with the total mass of the driver and test equipment not exceeding 200 kg) and the maximum allowable total mass. No change shall be made to the conditions of the VUT after the test starts;

f) For off-vehicle-chargeable new energy vehicles, the traction battery shall be fully charged according to 5.1 of GB/T 18385-2005. For non-off-vehicle-chargeable new energy vehicles, the test shall be prepared in their normal operation states. During the test, the power of the vehicle may decrease, but it shall not be less than 50% SOC.

4.3.3 Functional check

Before the test, it shall be checked whether the CA functions, buttons, instruments and on-board central control screen of the VUT work properly.

4.3.4 Function settings

4.3.4.1 Time gap

Unless otherwise specified, the time gap for CA shall be set to the middle level throughout the test. If there is an even number of time gap levels for CA, the time gap shall be set to the higher level immediately after the middle level, as shown in Fig. 9.

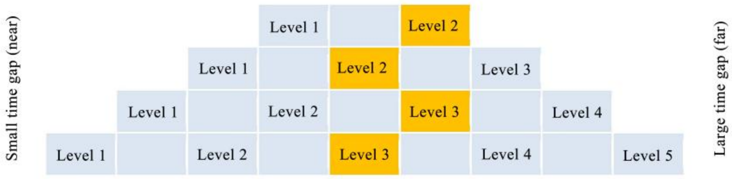

Fig. 9 Time Gap Level Setting

4.3.4.2 Driving mode

If the SV is provided with multiple driving modes, unless otherwise specified, it shall be set to the standard mode throughout the test.

4.3.4.3 System alarm level

a) If the alarm level of the AEB and/or FCW system(s) of the SV is settable, it shall be set to the middle level before the test starts. If there is an even number of alarm levels, it shall be set to the next earlier level, as shown in Fig. 10.

Fig. 10 Alarm Levels

b) If the SV is provided with LDW and/or LDP alarm function(s) and the alarm level is settable, the alarm level shall be set to the middle alarm sensitivity level before the test starts. If there is an even number of alarm levels, the sensitivity level shall be set to the next higher level, as shown in Fig. 11.

Fig. 11 LDW/LDP Alarm Level Settings

4.4 Data recording and processing

4.4.1 Requirements for data recording

The following data shall be recorded in the closed field test:

a) Software version information of the SV's CA system;

b) Longitudinal and lateral positions of the SV;

c) Longitudinal and lateral speeds of the SV;

d) Longitudinal and lateral accelerations of the SV;

e) Position and motion data of the target.

4.4.2 Requirements for data processing

The data processing methods and requirements for the closed field test are as follows:

a) For the longitudinal and lateral positions and deviation distances of the SV, the original data shall be used, in m;

b) The SV speed shall be GPS speed (in km/h), and original data shall be used;

c) The longitudinal deceleration data (in m/s^2) of the SV shall be filtered by a 12-pole phaseless Butterworth filter with a cutoff frequency of 6 Hz, and the average value taken every 2 s;

d) The longitudinal deceleration change rate data (in m/s^3) of the SV shall be filtered by a 12-pole phaseless Butterworth filter with a cutoff frequency of 6 Hz, and the average value taken every 1 s;

e) The lateral acceleration data (in m/s^2) of the SV shall be filtered by a 12-pole phaseless Butterworth filter with a cutoff frequency of 6 Hz, and the average value taken every 2 s.

4.5 Test photos

The requirements for taking photos in the closed field test are as follows:

a) Before the test equipment is installed, photos shall be taken of the VUT at front left 45° and of the vehicle nameplate;

b) After the test equipment is installed, photos shall be taken of the test equipment inside and outside the VUT.

5 Test Methods

5.1 Basic requirements

The basic requirements for the closed field test are as follows:

a) A maximum of three tests are performed for each test cycle. If the safety index requirements are met in 2 of the 3 tests, it is deemed that the test is passed for the test cycle, and the experience indexes are scored based on the better results of one of the two tests. If requirements are met in the first two tests, the third test will not be performed;

b) In all test scenarios, the settings shall not be changed unless otherwise specified. If the driver needs to operate the accelerator pedal and the brake pedal and perform manual assisted steering, the driver shall intervene before the lateral function exits due to hands-off driving, so that the exit of lateral control function can be avoided.

5.2 CCRs scenario

5.2.1 Scenario description

The TV keeps stationary in the middle of the lane and the SV cruises at different set speeds respectively. The SV, after its speed becomes stable, gradually approaches the TV.

Table 3 Test Cycle for CCRs Scenario

No.	SV Speed (km/h)	TV Speed (km/h)	Clearance at the Start of Test (m)
1	60	0	200
2	80	0	200
3	100	0	200

5.2.2 Test method

This test is used to rate the ability of the SV to detect the stationary TV ahead and decelerate for collision avoidance, as shown in Fig. 12. The test steps are as follows:

a) Keep the TV stationary in the middle of the test road;

b) Turn on ACC of the SV at a set speed of 60 km/h;

c) Run the SV to gradually approach the TV, record valid data from the time when the clearance between the two vehicles is 200 m until the SV is braked to zero; or end the test when the SV collides with the TV, or with the TTC between the SV and the TV being 2.5 s, the SV is not braked and the driver actively departs from the lane to avoid collision;

d) Increase the set speed of the SV by 20 km/h to proceed with the next test;

e) End the test scenario when the speed of SV goes beyond the speed range given in Table 3, or the SV collides with the TV, or the driver actively departs from the lane to avoid collision.

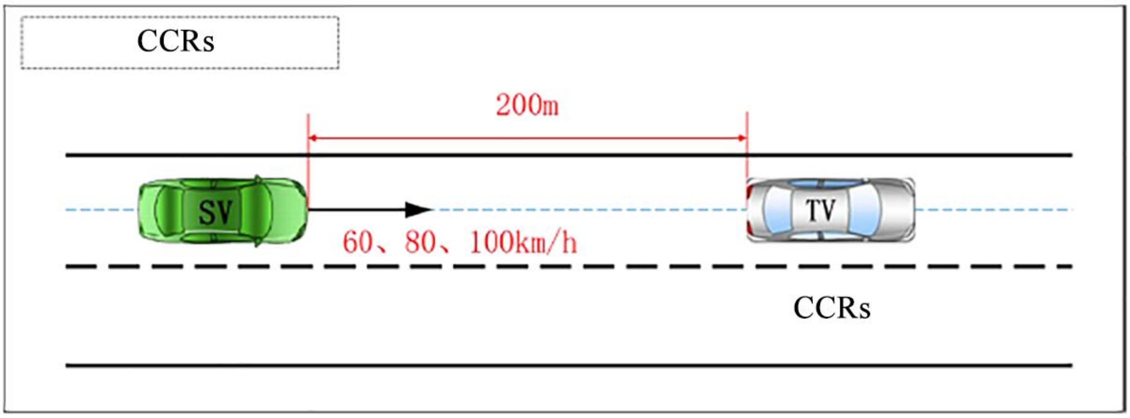

Fig. 12 CCRs Scenario

5.2.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test (from the start of the test when the clearance between SV and TV is 200 m to the end of the test):

a) The lateral offset between the longitudinal axis of TV and the centerline of lane marking does not exceed ± 0.2 m;

b) If the driver controls the direction of the SV, the lateral offset between the longitudinal axis of SV and the centerline of lane marking does not exceed ± 0.2 m.

5.3 CCRm scenario

5.3.1 Scenario description

The TV runs at a constant speed of 30 km/h, and the SV cruises at different set speeds respectively. The SV, after its speed becomes stable, gradually approaches the TV.

Table 4 Test Cycle for CCRm Scenario

No.	SV Speed (km/h)	TV Speed (km/h)	Clearance at the Start of Test (m)
1	90	30	200
2	100	30	200
3	110	30	200
4	120	30	200

5.3.2 Test method

This test is used to rate the ability of the SV to detect the low-speed TV ahead and decelerate to follow the TV, as shown in Fig. 13. The test steps are as follows:

a) Run the TV straightly in the middle of the test road at a constant speed of 30 km/h;

b) Turn on ACC of the SV at a set speed of 90 km/h;

c) Run the SV to gradually approach the TV, record valid data from the time when the clearance between the two vehicles is 200 m until the SV is braked to follow the TV; or end the test when the SV collides with the TV, or with the TTC between the SV and the TV being 2.5 s, the SV is not braked and the driver actively departs from the lane to avoid collision;

d) Increase the set speed of the SV by 10 km/h to proceed with the next test;

e) End the test scenario when the speed of SV goes beyond the speed range given in Table 4, or the SV collides with the TV, or the driver actively departs from the lane to avoid collision.

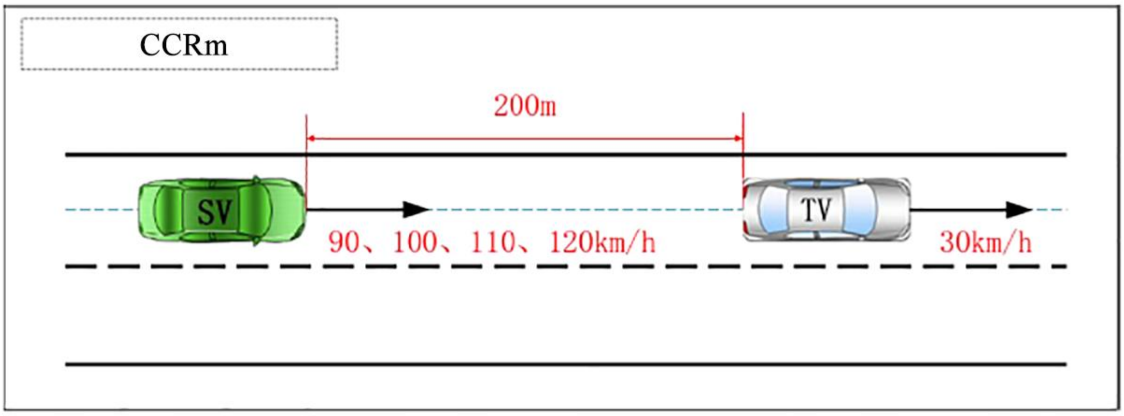

Fig. 13 CCRm Scenario

5.3.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test (from the start of the test when the clearance between SV and TV is 200 m to the end of the test):

a) The speed error of the TV does not exceed ±1 km/h;

b) The lateral offset between the longitudinal axis of TV and the centerline of lane marking does not exceed ± 0.2 m;

c) If the driver controls the direction of the SV, the lateral offset between the longitudinal axis of SV and the centerline of lane marking does not exceed ± 0.2 m.

5.4 CCRb Scenario

5.4.1 Scenario description

The SV follows the TV at a set speed of 120 km/h, and the TV runs at a constant speed of 70 km/h. After the vehicle following state becomes stable, the TV is braked at different decelerations until its speed is zero.

Table 5 Test Cycle for CCRb Scenario

No.	Set Speed of SV (km/h)	TV Speed (km/h)	Deceleration of TV (m/s^2)
1	120	70	-3
2	120	70	-4

5.4.2 Test method

This test is used to rate the ability of the SV to follow the forward TV to brake and stop when the forward TV decelerates, as shown in Fig. 14. The test steps are as follows:

a) Run the TV straightly in the middle of the test road at a constant speed of 70 km/h;

b) Turn on ACC of the SV at a set speed of 120 km/h to follow the TV;

c) After the SV stably follows the forward TV for at least 2 s, brake the TV at a deceleration of -3 m/s^2 until its speed is zero;

d) End the test when the SV decelerates, follows and stops along with the TV, or the SV collides with the TV, or with the TTC between the SV and the TV being 2.5 s, the SV is not braked by CA and the driver actively departs from the lane to avoid collision;

e) Increase the deceleration of TV to -4m/s^2 to proceed with the next test;

f) End the test scenario when the deceleration of TV goes beyond the speed range given in Table 5, or the SV collides with the TV, or the driver departs from the lane to avoid collision.

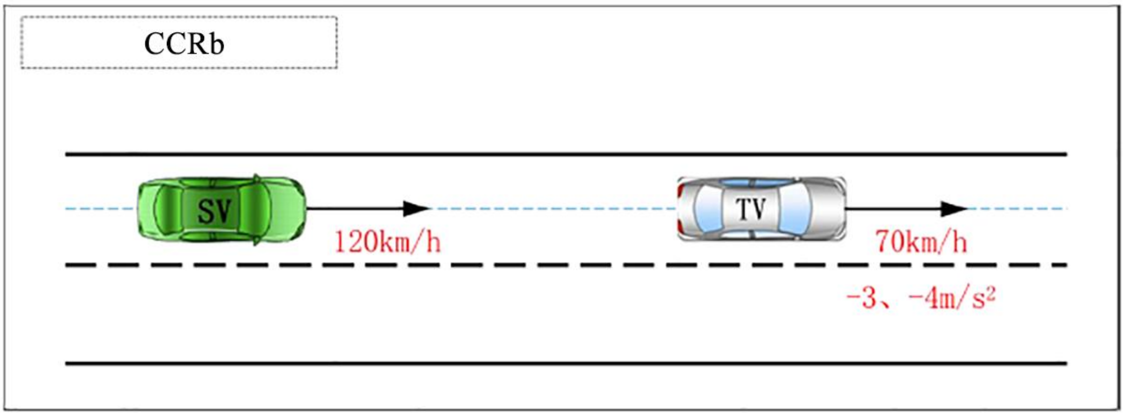

Fig. 14 CCRb Scenario

5.4.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test (from the moment when the SV stably follows the TV to the end of the test):

a) In the stage with stable speed, the speed error of the TV does not exceed ±1 km/h;

b) The lateral offset between the longitudinal axis of TV and the centerline of lane marking does not exceed ± 0.2 m;

c) If the driver controls the direction of the SV, the lateral offset between the longitudinal axis of SV and the centerline of lane marking does not exceed ± 0.2 m;

d) The TV reaches the target deceleration of -3 m/s^2 or -4 m/s^2 within 1 s until the test ends, with the error not exceeding ± 0.25 m/s^2.

5.5 TV cut-out scenario

5.5.1 Stationary TV2 scenario

5.5.1.1 Scenario description

The SV cruises in a straight lane at different set speeds with its ACC on. TV1 runs in front of the SV at the same speed in the same lane and TV2 keeps stationary in front of TV1 in the middle of the SV lane. When TV1 approaches TV2, TV1 cuts out from the lane of the SV to an adjacent lane, and the SV heads for TV2.

Table 6 Test Cycle for Stationary TV2 Scenario

No.	Speed of SV, Vsv (km/h)	Speed of TV1, V_{tv1} (km/h)	Cut-out Time, TTC (s)	Cut-out Direction
1	40	40	2.0	Left or right
2	60	60	3.0	Left or right

5.5.1.2 Test method

This test is used to rate the ability of the SV's ACC function to detect the forward TV2 and decelerate for collision avoidance when the forward TV1 cuts out. During the test as shown in Fig. 15, the TV1 cut-out path is set as defined in Fig. 16, and either left or right side is selected as the TV1 cut-out direction for the test. The test steps are as follows:

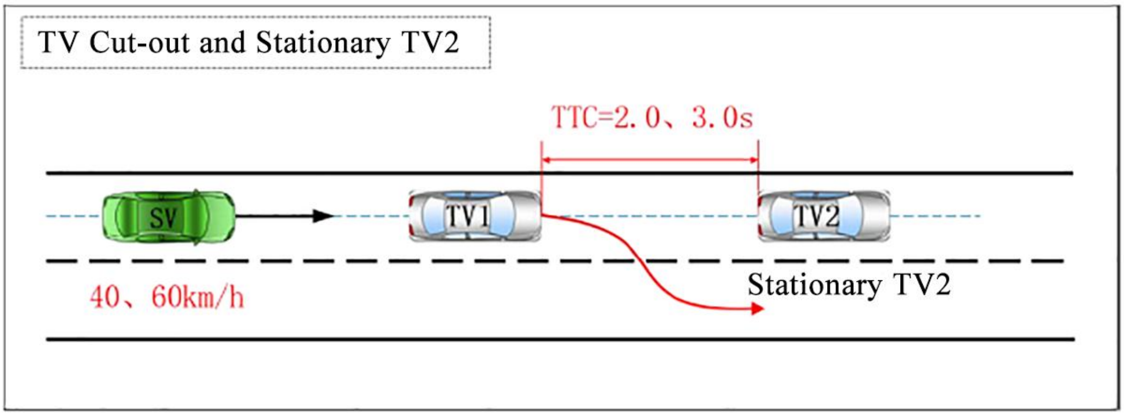

Fig. 15 TV1 Cut-out and Stationary TV2 Scenarios

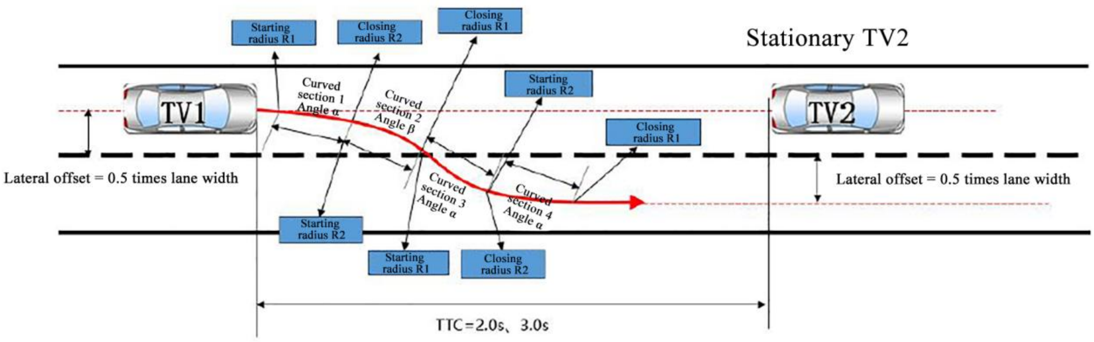

Fig. 16 TV1 Cut-out Path

a) Run the SV at a set speed of 40 km/h, run TV1 at the same speed as the SV in the middle of the road, with the longitudinal axes of the vehicles parallel to the lane markings, and perform test as per the test cycle given in Table 7;

b) Run the SV to follow TV1 and gradually approach TV2, record valid test data from the time when the clearance between TV1 and TV2 is 150 m. Cut TV1 out of the SV path according to the trajectory specified in Fig. 16 and Table 7 when the TTC between TV1 and TV2 reaches the set value in Table 6. End the test when the SV decelerates and stops behind TV2, or the SV collides with TV2, or with the TTC between SV and TV2 being 1.5 s, the SV is not braked by CA and the driver actively departs from the lane to avoid collision;

c) Increase the set speed of SV and TV1 by 20 km/h to proceed with the next test;

d) End the test scenario when the speed of SV goes beyond the speed range given in Table 6, or the SV collides with the stationary TV2, or the driver actively departs from the lane to avoid collision.

Table 7 Parameters of TV1 Cut-out Path

Speed of TV1	Curved section 1			Curved section 2			Curved section 3			Curved section 4		
	Starting Radius R1/m	Ending Radius R2/m	Angle α/°	Starting Radius R2/m	Ending Radius R1/m	Angle β/°	Starting Radius R1/m	Ending Radius R2/m	Angle β/°	Starting Radius R2/m	Ending Radius R1/m	Angle α/°
40km/h	1000	25	1	25	1000	13.1	1000	25	13.1	25	1000	1
60km/h	1000	50	1	50	1000	9.2	1000	50	9.2	50	1000	1

5.5.1.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test:

a) The speed error of TV1 does not exceed ± 1 km/h;

b) The error between TTC of TV1 and the value specified in Table 6 does not exceed 10%;

c) The lateral offset between the longitudinal axis of SV and the centerline of lane marking does not exceed ± 0.2 m.

5.5.2 Low-speed TV2 scenario

5.5.2.1 Scenario description

The SV cruises in a straight lane at different set speeds with its ACC on. TV1 runs in front of the SV at the same speed in the same lane. The express tricycle TV2 is in front of TV1 and runs at a constant speed with a lateral overlap of -50% with the SV. When TV1 approaches the express tricycle TV2, TV1 cuts out from the lane of the SV to the left adjacent lane, and the SV heads for the express tricycle TV2.

Table 8 Test Cycle for Low-speed TV2 Scenario

No.	Speed of SV, V_{sv}, and Speed of TV1, V_{tv1} (km/h)	Speed of Express Tricycle TV2, V_{tv2} (km/h)	Cut-out Time, TTC (s)	Cut-out Direction
1	40	15	2.0	Left
2	60	10	3.0	Left

5.5.2.2 Test method

This test is used to rate the ability of the SV's ACC function to detect the forward low-speed express tricycle TV2 and decelerate to follow it when TV1 cuts out. During the test as shown in Fig. 17, the TV1 cut-out path is set as defined in Fig. 18, and the left side is selected as the TV1 cut-out direction for the test. The test steps are as follows:

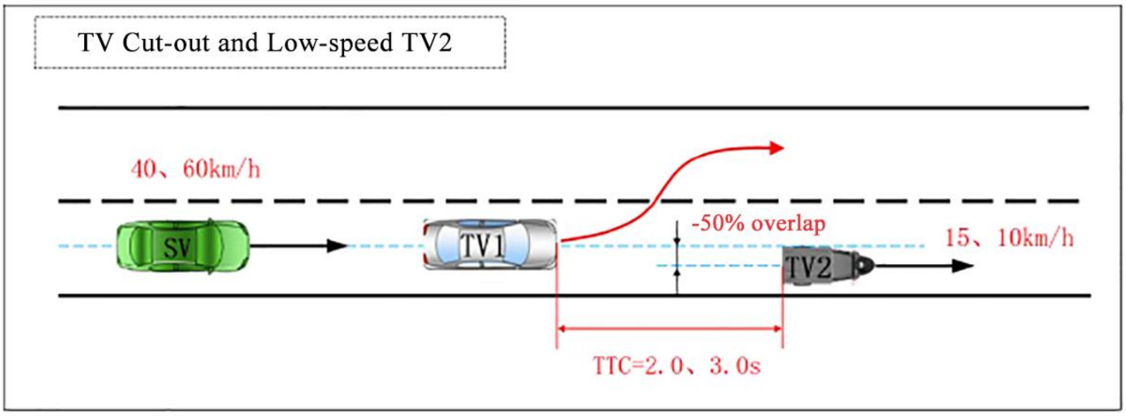

Fig. 17 TV1 Cut-out and Low-speed TV2 Scenarios

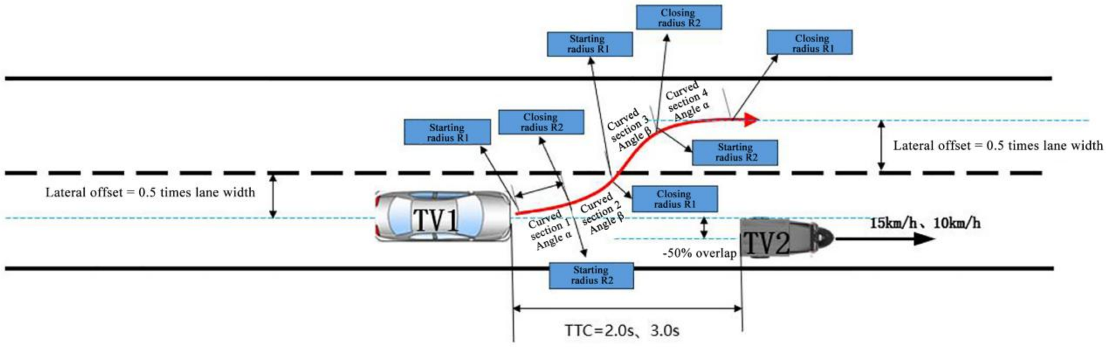

Fig. 18 TV1 Cut-out Path

a) Run the SV at a set speed of 40 km/h, TV1 at the same speed as the SV, and the express tricycle TV2 at a constant speed of 15km/h with a lateral overlap of -50% with the SV. Keep the SV and TV1 running in the middle of the road, with the longitudinal axes of the vehicles parallel to the lane markings, and perform test as per the test cycle given in Table 8;

b) Run the SV to follow TV1 and gradually approach express tricycle TV2, record valid test data from the time when the clearance between TV1 and express tricycle TV2 is 150 m. Cut TV1 out to the left adjacent lane according to the trajectory specified in Fig. 18 and Table 9 when the TTC between TV1 and TV2 reaches the set value in Table 8. End the test when the SV decelerates and runs stably following express tricycle TV2, or the SV collides with express tricycle TV2, or with the TTC between SV and express tricycle TV2 being 1.5 s, the SV is not braked by CA and the driver actively departs from the lane to avoid collision;

c) Increase the set speed of SV and TV1 by 20 km/h to proceed with the next test;

d) End the test scenario when the speed of SV goes beyond the speed range given in Table 8, or the SV collides with express tricycle TV2, or the driver actively departs from the lane to avoid collision.

Table 9 Parameters of TV1 Cut-out Path

Speed of TV1	Curved section 1			Curved section 2			Curved section 3			Curved section 4		
	Starting	Ending	Angle	Starting	Ending	Angle	Starting	Ending	Angle	Starting	Ending	Angle

	Radius R1/m	Radius R2/m	α/°	Radius R2/m	Radius R1/m	β/°	Radius R1/m	Radius R2/m	β/°	Radius R2/m	Radius R1/m	α/°
40km/h	1000	25	1	25	1000	13.1	1000	25	13.1	25	1000	1
60km/h	1000	50	1	50	1000	9.2	1000	50	9.2	50	1000	1

5.5.2.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test:

a) The speed error of TV1 and express tricycle TV2 does exceed ± 1 km/h;

b) The error between TTC of TV1 and the value specified in Table 8 does not exceed 10%;

c) If the driver controls the direction of the SV, the lateral offset between the longitudinal axis of SV and the centerline of lane marking does not exceed ± 0.2 m.

5.6 Straight-to-curve scenario

5.6.1 Straight-to-curve (without vehicle in the curve) scenario

5.6.1.1 Scenario description

The SV, with its CA system on, cruises at different set speeds. After 5 s of stable running in the straight section, the SV enters the curved section as described in Table 10.

Table 10 Test Cycle for Straight-to-curve (without Vehicle in the Curve) Scenario

No.	SV Speed (km/h)	Curve Radius, R (m)	Curve Direction
1	100	250	Left or right curve
2	110	500	
3	120		

5.6.1.2 Test method

This test is used to rate the ability of the SV to keep running in the middle when it moves from a straight section to a curved section, as shown in Fig. 19. The curve is of the type described in 4.1.1, and either the left or the right curve may be selected as the curve for this test scenario, and the test steps are as follows:

a) Run the SV, with its CA on, in the middle of the straight section at a speed of 100 km/h, and start recording valid data when the SV is 200 m away from the curved section and the speed reaches a steady state;

b) After the SV enters the curved section from the straight section, run it in the curved section for at least 5 s or operate it to depart from the curved section to end the test;

c) Increase the speed of the SV by 10 km/h to proceed with the next test according to the test cycle given in Table 10;

d) End the test scenario when the speed of SV goes beyond the speed range given in Table 10, or the SV departs from the curved section. Different curve radii represent different scenarios.

Note: The SV departing from the curved section means that any running wheel of the SV crosses the lane marking of the current running curved section on either side.

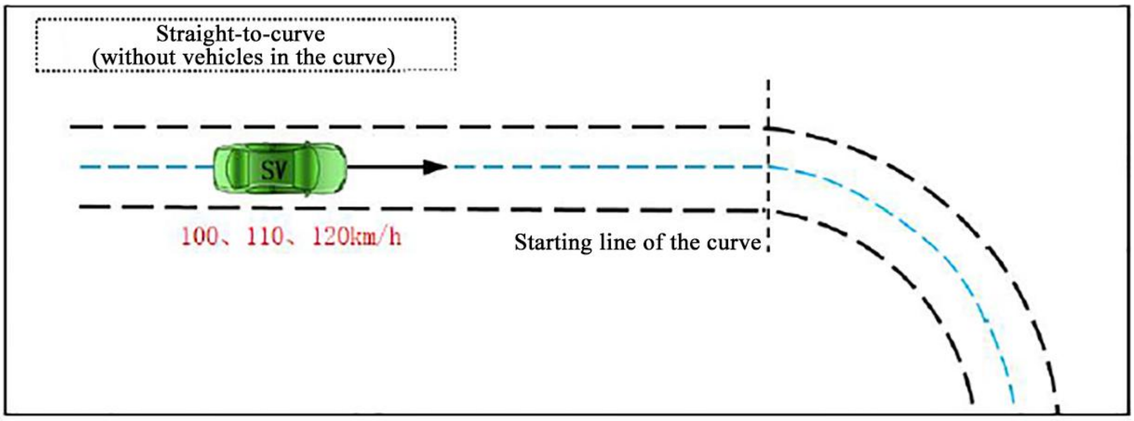

Fig. 19 Straight-to-curve (without Vehicle in the Curve) Scenario

5.6.2 Straight-to-curve (with vehicle in the curve) scenario

5.6.2.1 Scenario description

The SV, with its CA on, cruises at different set speeds. In the scenario as shown in Fig. 20, after 5 s of stable running in the straight section, the SV heads for the stationary TV1 in the middle of the curved section as described in Table 11, with the tail of the stationary TV1 100 m from the starting line of the curve.

Table 11 Test Cycle for Straight-to-curve (with Vehicle in the Curve) Scenario

No.	SV Speed (km/h)	Curve Radius, R (m)	Curve Direction
1	60	250	Left or right curve
2	80		

5.6.2.2 Test method

This test is used to rate the ability of the SV to detect and respond to the stationary TV1 in the curve. During the test performed according to the information shown in Fig. 20 and Table 11, either the left or the right curve may be selected as the curve for this test scenario, and the test steps are as follows:

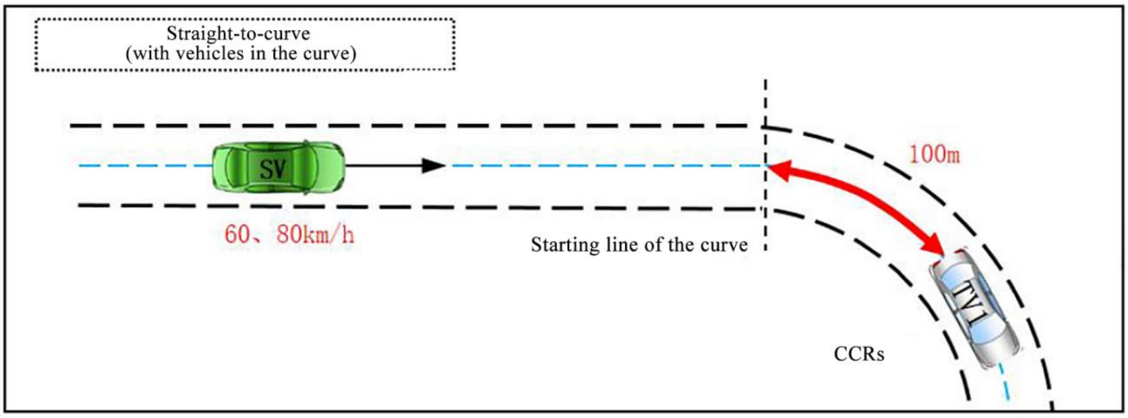

Fig. 20 Straight-to-curve (with Vehicle in the Curve) Scenario

a) Run the SV, with its CA system on, in the middle of the straight section at a speed of 60 km/h, and start recording valid data when the SV is 200 m away from the starting line of the curve and the speed reaches a steady state;

b) After the SV enters the curved section from the straight section, run it to the stationary TV. End the test when the SV decelerates and stops behind the stationary TV, or the SV collides with TV, or the SV departs form the curved section, or with the TTC between SV and TV1 being 2 s, the SV is not braked by CA and the driver actively departs from the lane to avoid collision;

c) Adjust the set speed of the SV to proceed with the next test;

d) End the test scenario when the speed of SV goes beyond the speed range given in Table 11, or the SV collides with the stationary TV, or the driver actively departs from the lane to avoid collision.

Note: The SV departing from the curved section means that any running wheel of the SV crosses the lane marking of the current running curved section on either side.

5.7 Lane change assist scenario

5.7.1 Scenario of lane change without vehicle in blind spot

5.7.1.1 Scenario description

In a lane with clear lane markings, with the SV's CA on, if the driver inputs a lane change instruction, the SV can correctly perform lane change according to its surrounding environment.

Table 12 Condition without Vehicle in Blind Spot

No.	Set Speed of SV (km/h)	TV Speed (km/h)	Lane Change Direction
1	90	-	Left or right

5.7.1.2 Test method

This test is used to rate the lane change assist of the SV. The test is performed according to Fig. 21, and the test steps are as follows:

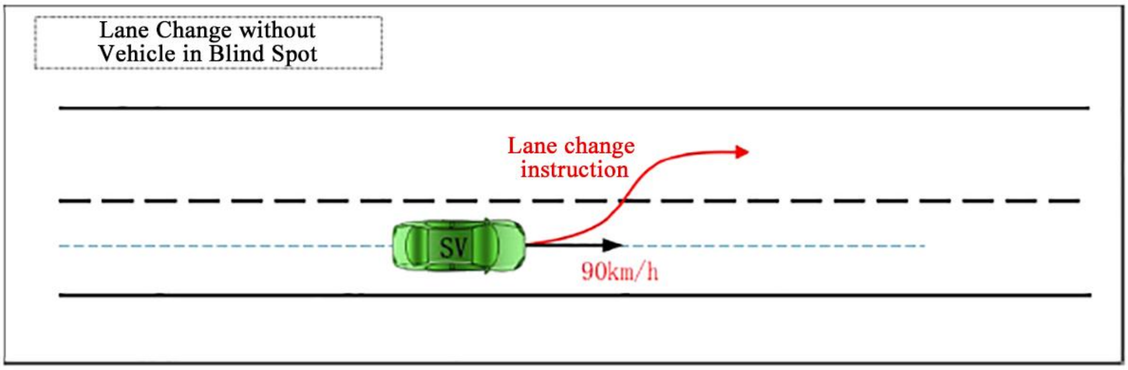

Fig. 21 Scenario of Lane Change without Vehicle in Blind Spot

a) The SV, with its CA on, runs stably in the straight section at a set speed of 90 km/h for more than 5 s, as shown in Fig. 21;

b) The driver inputs the lane change intention (e.g., turning on turn signals) according to the requirements in the owner's manual of the vehicle to test whether the SV can correctly perform lane change.

5.7.2 Scenario of lane change with vehicle in blind spot

5.7.2.1 Scenario description

In the case of any vehicle in the blind spot of the adjacent lane of the SV, the driver inputs a lane change instruction to test whether the SV can correctly perform/prevent the lane change action according to its surrounding environment. In the case of no vehicle in the blind spot, if the SV can perform the lane change assist function, the test for the scenario of lane change with vehicle in blind spot will be performed; otherwise, the test will not be performed.

Table 13 Test Cycle for Scenario with Vehicle in Blind Spot

No.	Set Speed of SV (km/h)	TV Speed (km/h)	Lane Change Direction
1	90	90	Left or right

5.7.2.2 Test method

This test is used to rate the lane change assist function. The test is carried out according to Fig. 22, and the test steps are as follows:

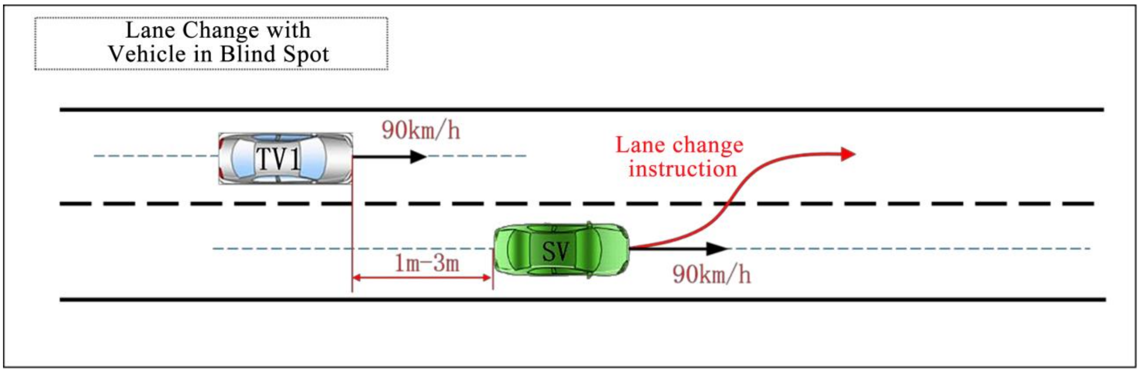

Fig. 22 Scenario of Lane Change with Vehicle in Blind Spot

a) With the set speeds of SV and TV being 90 km/h and the CA system turned on, the TV runs in the blind spot of the left adjacent lane of the SV and the two vehicles keep stable running for more than 5 s, as shown in Fig. 22;

b) The driver inputs the lane change intention (e.g., turning on turn signals) according to the requirements in the owner's manual of the vehicle to test whether the SV prevents lane change, gives an alarm or successfully changes the lane after avoiding the TV.

Note: Successful lane change means that all driving wheels of the SV enter the adjacent lane.

5.7.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test:

a) The lateral offset between the longitudinal axis of TV and the centerline of lane marking does not exceed ± 0.5 m.

5.8 Speed limit sign response scenario

5.8.1 Scenario description

The SV, with its CA on, runs in the middle of the lane and approaches two speed limit signs 200 m apart, as shown in Fig. 23.

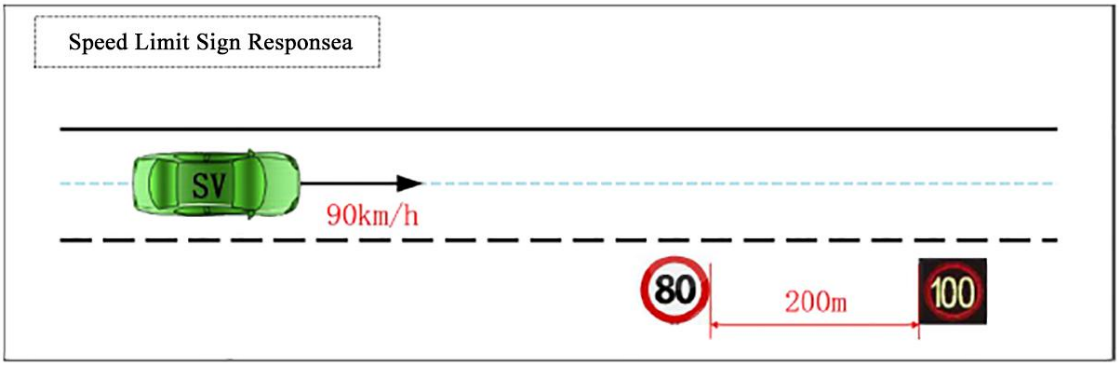

Fig. 23 Speed Limit Sign Response Scenario

5.8.2 Test method

This test is used to rate the ability of the SV to identify and respond to speed limit signs. The test is performed according to the scenario shown in Fig. 21, and the test steps are as follows:

a) Run the SV, with its CA system and speed limit sign assist system (including overspeed alarm function) on, at a set speed of 90 km/h;

b) Run the SV to gradually approach the first ordinary speed limit sign. Start recording valid data when the plane of the SV's head is 200 m away from the plane where the first speed limit sign is located;

c) After the speed of the SV is stabilized, pass through the first ordinary speed limit sign that reads 80 km/h;

d) Keep the SV at the original set speed and pass the second LED electronic speed limit sign that reads 100 km/h;

e) End the test scenario 3 s after the SV's tail passes through the plane where the second speed limit sign is located.

5.8.3 Test validity requirements

To ensure the validity of the test, the following items need to be guaranteed during the whole test:

a) The speed limit signs are provided on the roadside, and the lower edge of each sign is (200±5) cm above the pavement;

b) The included angle between the vertical line of the speed limit sign face and the road centerline shall be within 0°~10°.

5.9 Rating of associated functions

5.9.1 Head-up display (HUD)

The HUD, if equipped, can display the CA related information in the driver's field of view during normal driving, including but not limited to vehicle speed, system state and other information.

5.9.2 C-V2X

The C-V2X, if provided, can realize communication between vehicles or communication between vehicle and infrastructure, such as identification of speed limit signs, identification of electronic traffic lights, and vehicle-to-vehicle communication.

5.9.3 Driver monitoring system (DMS)

The DMS, if equipped, can realize real-time monitoring of the driver status. In two groups of function verification tests, the DMS gives an audible or tactile alarm in the driver statuses of eye close and head down.

5.10 Review of owner's manual

The review is to check whether the description, warning and prompt information about the ICA function of L2 driving automation system provided in the user manual are complete and unambiguous. The main contents to be checked include:

Table 14 Review Contents of Owner's Manual

No.	Contents to Be Checked	Remarks
1	Definition of CA system	Definition clear or not
2	Description of driver's responsibility	Description clear or not
3	Description of service conditions for the CA function of L2 driving automation system	Clear or not
4	Description of limitations on the CA function of L2 driving automation system (warning information)	Clear or not

Note: The form of the owner's manual is not limited to textual content, but may also include the human-machine interaction learning process, safety education video or animation before the vehicle user uses the vehicle, and other forms that are easy for the vehicle driver to understand the use method and functional boundary of the CA system.