

IVISTA

China Intelligent Vehicle Index

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Intelligent Safety Index Safety Assist Lane Support System Test Protocol

(Version 2023)

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Lane Support System Test Protocol

1 Scope

This document specifies the test methods of IVISTA China Intelligent Vehicle Index - Intelligent Safety Index - Lane Support System (ISS).

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 protocol. For undated references, the latest edition (including all amendments) applies to this protocol.

GB/T 26773-2011 Intelligent Transport Systems - Lane Departure Warning Systems - Performance Requirements and Test Procedures

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

GB/T 39323-2020 Performance Requirement and Testing Method for Lane Keeping Assist (LKA) System of Passenger Cars

Euro NCAP TEST PROTOCOL-Lane Support Systems

ISO 11270-2014 Intelligent transport systems - Lane keeping assistance systems (LKAS) - Performance requirements and test procedures

3 Terms and Definitions

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

3.1

inertial frame

the inertial frame specified in ISO 8855:2011 used in this protocol, 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

lane departure prevention; LDP

a system that monitors the relative position between the vehicle and the lane boundary lines in real time, and controls the lateral motion of the vehicle when it is about to depart from the lane, so as to assist the driver in keeping the vehicle running in the original lane

[Source: GB/T 39263-2020, 2.3.8]

3.3

lane departure warning; LDW

a system that monitors the running state of the vehicle in the original lane in real time and gives a warning in case of an unintended lane departure or an imminent unintended lane departure

[Source: GB/T 39263-2020, 2.2.2.12]

3.4

emergency lane keeping; ELK

a system that detects in real time the relative position between the vehicle and the solid lane line, road edge, or the adjacent lane for oncoming traffic or overtaking lane, and corrects the running direction of the vehicle automatically in case of emergency

3.5

subject vehicle; SV

a vehicle under test equipped with the lane support system defined in this protocol

3.6

lane boundary

the lane boundary line determined by visible lane markings or in the absence of visible lane markings, by other indicative visible road features or other means such as GPS and magnetic markers

3.7

rate of departure

the vertical component of the speed at which the vehicle departs from the lane boundary

[Source: GB/T 393233-2020, 3.4]

3.8

lane departure warning issue point

location and time when the system gives a warning

3.9

lane centering control; LCC

a system that monitors the relative position between the vehicle and the lane boundary lines in real time, and controls the lateral motion of the vehicle in a continuous and automatic manner, to keep the vehicle running in the central area of the lane

[Source: GB/T 39263-2020, 2.3.7]

3.10

test start time; T_0

the moment when the test formally starts after the SV runs in the lane, reaches the test speed and runs stably for 2 s

3.11

LDP system issue time; T_{LDP}

the moment when the LDP system starts to intervene in the case that the SV departs from the lane

3.12

LDW system issue time; T_{LDW}

the moment when the LDW system starts to send a warning signal in the case that the SV

departs from the lane

3.13

path steer time; T_{steer}

the moment when the SV enters the curved part of the test path in the straight lane test and the rate of departure reaches 0.05 m/s

4 Test Requirements

4.1 Test site and test environment

4.1.1 Requirements for test site

- a) The test road surface shall be horizontal and dry without visible moisture, and the adhesion coefficient should be above 0.8;
- b) The test road shall be flat without apparent pits, cracks and other defects, with a horizontal flatness of less than 1% and a length of 500 m at least;
- c) During the test, there shall be no vehicles, obstacles or other objects affecting the test within 3 m on both sides of the test road and 30 m in front of the TV;
- d) Signs, bridges and other objects or buildings on the test road shall be 5 m above the ground;
- e) A single test lane shall be 3.5-3.75 m wide. The lane boundary shall be determined by white visible lane markings, and the line on the departure side shall be a dotted line in accordance with GB 5768.3 4.3.
- f) The radius of the curve centerline required for the curved LDW test shall be (250 ± 10) m.

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 temperature shall be $0\text{ }^{\circ}\text{C} \sim 45\text{ }^{\circ}\text{C}$, and the wind velocity shall be less than 5 m/s;
- c) Except for nighttime scenarios, the test shall be conducted under uniform natural lighting conditions. The illuminance shall not be lower than 2000 lux, unless other lower illuminance limit is specified by the VUT manufacturer.

4.2 Test equipment

The test equipment shall meet the sampling and storage requirements for dynamic data, with a sampling and storage frequency of at least 100 Hz. The data acquisition accuracy shall not be lower than the following limits:

- a) Longitudinal speed accuracy: 0.1 km/h;
- b) Longitudinal and lateral position accuracy: 0.03 m;
- c) Heading angle accuracy: 0.1° ;
- d) Yaw rate accuracy: $0.1^{\circ}/\text{s}$;
- e) Angular velocity accuracy of steering wheel: $1.0^{\circ}/\text{s}$.

4.3 Vehicle preparation

4.3.1 System initialization

If necessary, the LSSs may be initialized prior to the test, including the calibration of sensors

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

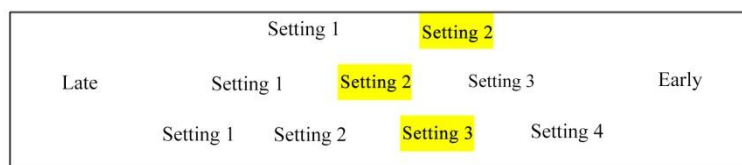
4.3.3 Functional check

Before the test, drive the SV to check whether its LSS functions can be enabled and used normally.

4.3.4 Function settings

4.3.4.1 Sensitivity setting

For LSSs with multiple system sensitivity options, the system sensitivity shall be set to the middle position before the test, or to the position earlier than the middle if there is an even number of positions.



4.4 Setting of LCC function switch

Before the test, the function switch shall be set according to the following rules:

- a) If the LDP and LCC functions of the SV have independent switches, the LCC function shall be disabled during the LSS test;
- b) If the LDP of the SV is integrated with LCC, the LCC function shall be set as follows:
 - If the LCC of the SV cannot be activated until the ACC system or ADAS is enabled, it shall not be enabled during the test;
 - If LCC is not dependent on ACC or ADAS, can be activated separately and can memorize the OFF or ON state, it can be determined whether to disable LCC function according to the VUT manufacturer's requirements.

4.5 Data recording and processing

- The vehicle speed shall be the speed on GPS, measured in km/h. The lateral and longitudinal positions shall be measured in m. Original data shall be used.
- Both the yaw rate (in $^{\circ}/s$) and steering wheel speed (in $^{\circ}/s$) shall be processed by a 12-pole phaseless Butterworth filter with a cutoff frequency of 10 Hz.

4.6 Test photos

- Before the test equipment is installed, photos shall be taken of the VUT at front left 45° and of the vehicle nameplate;
- After the test equipment is installed, photos shall be taken of the test equipment inside and outside the VUT.

5 Test Methods

5.1 General

LSS tests include LDP test, LDW test and ELK test. During the LDP function test, if the ELK function can be enabled/disabled separately, it shall be disabled; otherwise, it shall be determined whether to disable the ELK function according to the information feedback form provided by the VUT manufacturer. When the LDW test is carried out separately, it shall be determined whether to disable the LDP function according to the information feedback form provided by the VUT manufacturer. During the ELK function test, if the LDP function can be enabled/disabled separately, it shall be disabled; otherwise, it shall be determined whether to disable the LDP function according to the information feedback form provided by the VUT manufacturer.

5.2 LDP function test

On a long straight lane, if the minimum speed for activation of LDP is less than or equal to 72 km/h, the test speed shall be 72 km/h; if the minimum speed for activation of LDP is greater than 72 km/h, the test speed shall be the minimum speed for activation declared by the VUT manufacturer + 1 km/h. The test shall be carried out according to the rate of departure shown in Table 1.

The test starts from T_0 . During the period from T_0 to T_{LDP} , the SV must meet the following conditions to ensure the validity of the test:

- The speed on GPS of the SV shall be (72 ± 1) km/h, or (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1 km/h;
- When the vehicle speed is stable, the actual rate of departure shall be within ± 0.05 m/s of the specified value;
- The transverse deviation between the actual running path and the preset test path of the SV shall be ± 0.1 m;
- Until time T_{steer} , the yaw rate range is $(0 \pm 1)^{\circ}/s$;
- Until time T_{steer} , the angular velocity range of steering wheel is $(0 \pm 15)^{\circ}/s$.

Table 1 Straight LDP Test Cycle

Vehicle Speed	Rate of Departure (m/s)	Direction of Departure	Number of Tests
max $\{(72 \pm 1)$ km/h, (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1.0 km/h}	0.5 \pm 0.05	Departure to the left	2
	0.5 \pm 0.05	Departure to the right	2

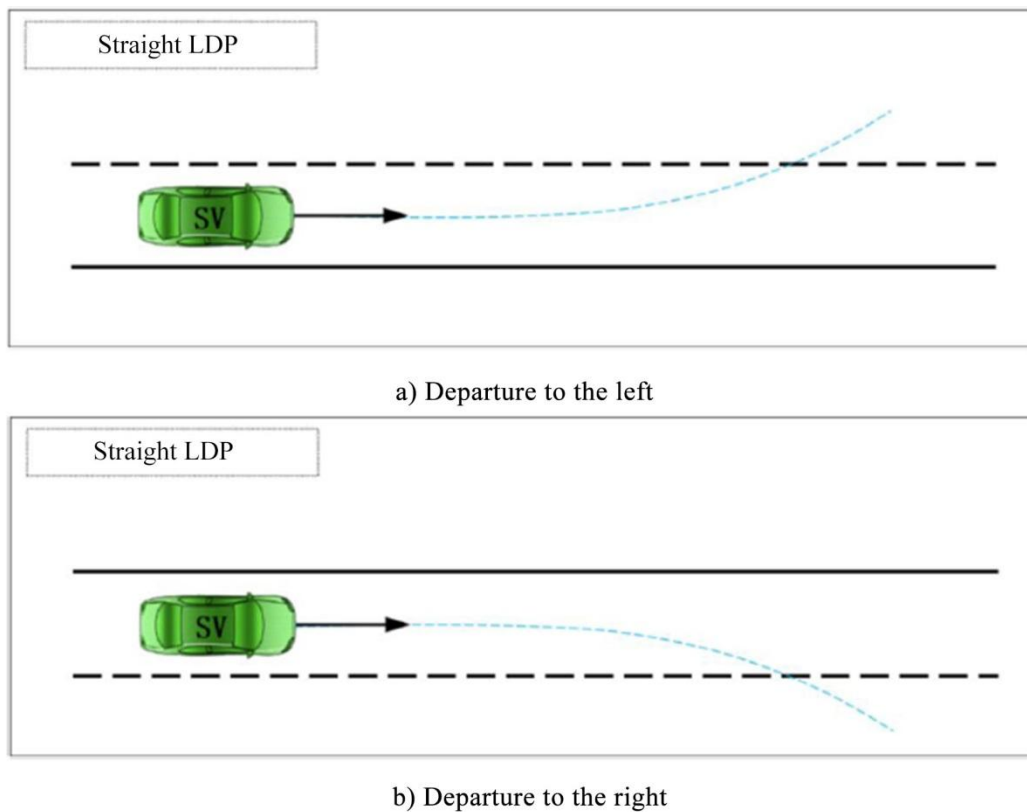


Fig. 1 Straight LDP Test Method

5.3 LDW function test

5.3.1 Straight LDW

On a long straight lane, if the minimum speed for activation of LDW is less than or equal to 72 km/h, the test speed shall be 72 km/h; if the minimum speed for activation of LDW is greater than 72 km/h, the test speed shall be the minimum speed for activation declared by the manufacturer + 1 km/h. The test shall be carried out according to the rate of departure shown in Table 2.

The test starts from T_0 . During the period of T_0-T_{LDW} , the SV must meet the following conditions to ensure the validity of the test:

- a) The speed on GPS of the SV shall be (72 ± 1) km/h, or (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1 km/h;
- b) When the vehicle speed is stable, the actual rate of departure shall be within ± 0.05 m/s of the specified value;
- c) The transverse deviation between the actual running path and the preset test path of the SV shall be ± 0.1 m;
- d) Until time T_{steer} , the yaw rate range is $(0 \pm 1)^\circ/s$;
- e) Until time T_{steer} , the angular velocity range of steering wheel is $(0 \pm 15)^\circ/s$.

Table 2 Straight LDW Test Cycle

Vehicle Speed	Rate of Departure (m/s)	Direction of Departure	Number of Tests
max $\{(72 \pm 1)$ km/h, (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1.0 km/h}	0.5 \pm 0.05	Departure to the left	2
	0.5 \pm 0.05	Departure to the right	2

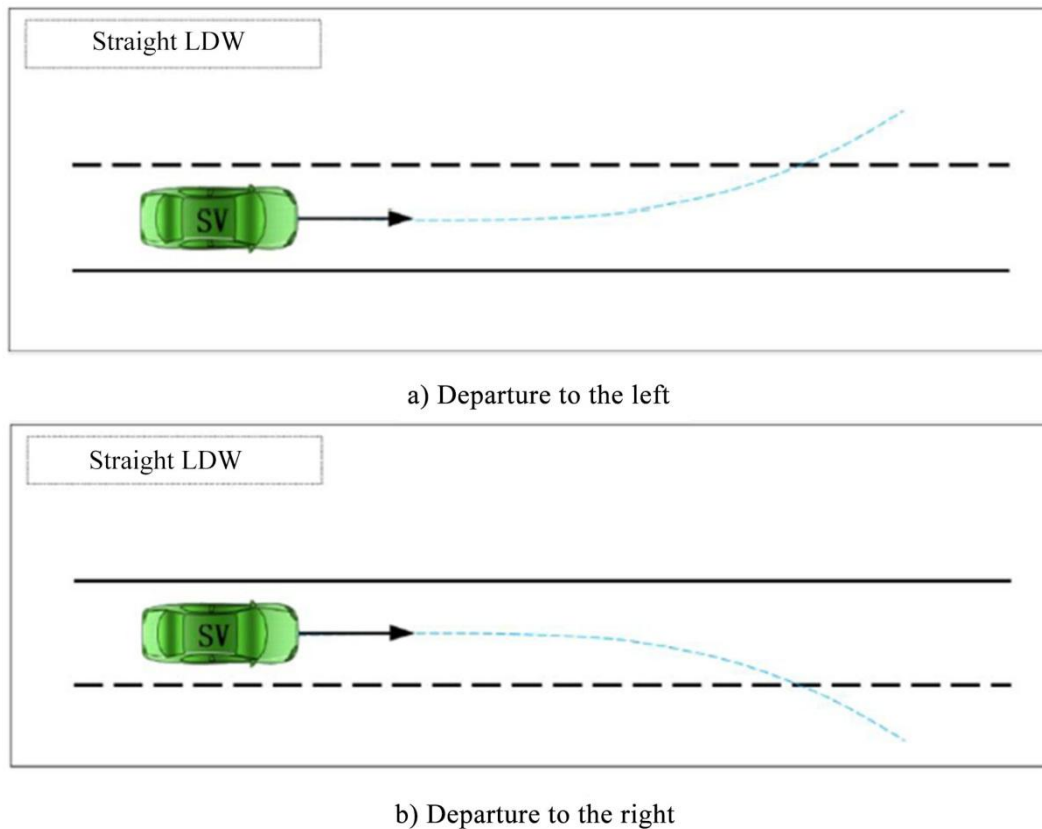


Fig. 2 Straight LDW Test Method

5.3.2 Curved LDW

On a curved lane with constant curvature and a radius of 250 m, if the minimum speed for activation of LDW is less than or equal to 72 km/h, the test speed shall be 72 km/h; if the minimum speed for activation of LDW is greater than 72 km/h, the test speed shall be the minimum speed for activation declared by the manufacturer + 1 km/h. When the SV enters the curved lane and reaches a steady state, it may gradually depart to the outside of the curve. The test is carried out according to the rate of departure shown in Table 3.

Table 3 Curved LDW Test Cycle

Vehicle Speed	Curve Direction	Direction of Departure	Number of Tests
max $\{(72 \pm 1) \text{ km/h, (the minimum speed for activation declared by the manufacturer + 1 km/h)} \pm 1.0 \text{ km/h}\}$	Right curve	Outward departure	2
	Left curve	Outward departure	2

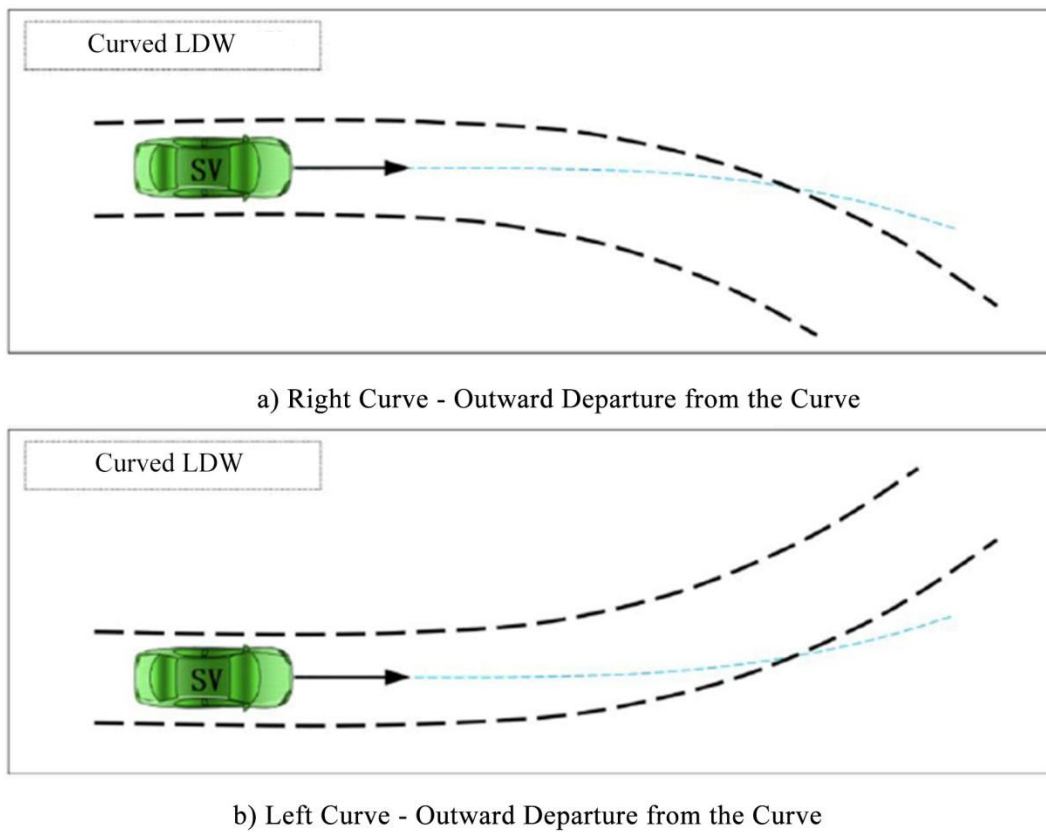


Fig. 3 Curved LDW Test Method

5.4 ELK function test

5.4.1 ELK for departure from lane line

On a long straight lane, if the minimum speed for activation of ELK is less than or equal to 72 km/h, the test speed shall be 72 km/h; if the minimum speed for activation of ELK is greater than 72 km/h, the test speed shall be the minimum speed for activation declared by the manufacturer + 1 km/h. The test shall be carried out according to the rate of departure shown in Table 4.

The test starts from T_0 . During the period of T_0-T_{LDW} , the SV must meet the following conditions to ensure the validity of the test:

- a) The speed on GPS of the SV shall be (72 ± 1) km/h, or (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1 km/h;
- b) When the vehicle speed is stable, the actual rate of departure shall be within ± 0.05 m/s of the specified value;
- c) The transverse deviation between the actual running path and the preset test path of the SV shall be ± 0.1 m;
- d) Until time T_{steer} , the yaw rate range is $(0 \pm 1)^\circ/s$;
- e) Until time T_{steer} , the angular velocity range of steering wheel is $(0 \pm 15)^\circ/s$.

Table 4 ELK Test Cycle for Departure from Lane Line

Vehicle Speed	Rate of Departure (m/s)	Direction of Departure	Number of Tests
max $\{(72 \pm 1)$ km/h, (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1.0 km/h}	0.5 \pm 0.05	Departure to the left	2

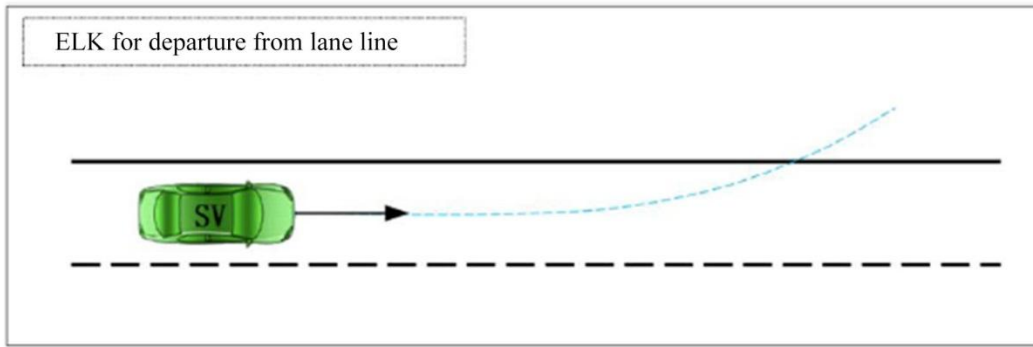


Fig. 4 ELK Test Method for Departure from Lane Line

5.4.2 ELK for heading to curb

On a long straight lane, if the minimum speed for activation of ELK is less than or equal to 72 km/h, the test speed shall be 72 km/h; if the minimum speed for activation of ELK is greater than 72 km/h, the test speed shall be the minimum speed for activation declared by the manufacturer + 1 km/h. The test shall be carried out according to the rate of departure shown in Table 5.

The test starts from T_0 . During the period of T_0 - T_{LDW} , the SV must meet the following conditions to ensure the validity of the test:

- a) The speed on GPS of the SV shall be (72 ± 1) km/h, or (the minimum speed for activation declared by the manufacturer + 1 km/h) ± 1 km/h;
- b) When the vehicle speed is stable, the actual rate of departure shall be within ± 0.05 m/s of the specified value;
- c) The transverse deviation between the actual running path and the preset test path of the SV shall be ± 0.1 m;
- d) Until time T_{steer} , the yaw rate range is $(0 \pm 1)^\circ/s$;
- e) Until time T_{steer} , the angular velocity range of steering wheel is $(0 \pm 15)^\circ/s$.

Table 5 ELK Test Cycle for Heading to Curb

Vehicle Speed	Rate of Departure (m/s)	Direction of Departure	Number of Tests
$\max \{(72 \pm 1) \text{ km/h, (the minimum speed for activation declared by the manufacturer + 1 km/h)} \pm 1.0 \text{ km/h}\}$	0.5 ± 0.05	Departure to the right	2

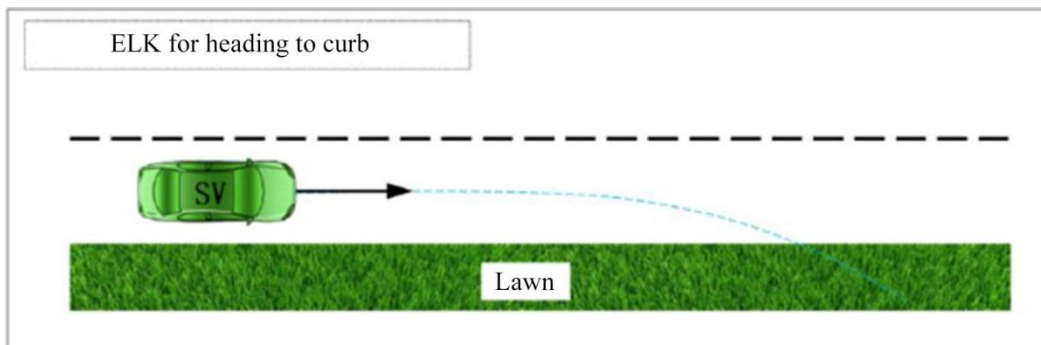


Fig. 5 ELK Test Method for Heading to Curb