

TEST PROTOCOL – LANE SUPPORT SYSTEMS

VERSION 1.0



**ASEAN NCAP
PROTOCOL**
2026-2030

Preface

Where text is contained within square brackets, this denotes that the procedure being discussed is currently being trialled in ASEAN NCAP. Its incorporation in the Test Protocol will be reviewed at a later date.

During the test preparation, vehicle manufacturers are encouraged to liaise with the laboratory and to check that they are satisfied with the way cars are set up for testing. Where a manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Manufacturers are forbidden from making changes to any parameter that will influence the test, such as dummy positioning, vehicle setting, laboratory environment, etc.

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of ASEAN NCAP. Where a disagreement exists between the laboratory and manufacturer, the ASEAN NCAP secretariat should be informed immediately to pass final judgement. Where the laboratory staff suspect that a manufacturer has interfered with any of the setup, the manufacturer's representatives should be warned that they are not allowed to do so themselves. They should also be informed that if another incident occurs, they will be asked to leave the test site.

Where there is a recurrence of the problem, the manufacturer's representatives will be told to leave the test site and the Secretariat should be immediately informed. Any such incident may be reported by the Secretariat to the manufacturer and the persons

concerned may not be allowed to attend further ASEAN NCAP tests.

DISCLAIMER: ASEAN NCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the technical decisions taken by the organization. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, ASEAN NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

In addition to the settings specified in this protocol, the following information will be required from the manufacturer of the car being tested in order to facilitate vehicle preparation. A vehicle handbook should be provided to the test laboratory prior to the assessment.

TEST PROTOCOL – LANE SUPPORT SYSTEMS

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**NEW CAR ASSESSMENT PROGRAM FOR
SOUTHEAST ASIAN COUNTRIES
(ASEAN NCAP)**

TEST PROTOCOL – LANE SUPPORT SYSTEMS

1 INTRODUCTION

Road departure is one of the main causes of single vehicle and frontal crashes. By implementing lateral support systems, a significant amount of these accidents can be avoided. Typical accidents are normally occurring due to unintentional lane departure where the driver drifts towards and across the line identifying the edge of the lane. Very often, the driver will be unaware that the car is in a potentially dangerous situation until the situation is critical: the wheels of the car may be on the grass or gravel at the side of the road, or, in extreme cases, the car may find itself in the path of an oncoming or overtaking traffic. This sudden, late realisation by the driver may prompt a panic response: the driver loses control of the car, and a crash is often the result. Injury severities are usually high, but this type of accident is relatively easy to avoid with a lateral support system resulting in potentially large safety improvements.

This protocol specifies the Lateral Support Systems test procedure, which are part of the Safety Assist assessment. Lane Keep Assist and Lane Departure Warning systems are tested, if applicable. To be eligible to score points for LSS, the vehicle must be equipped with an ESC system meeting the regulatory requirements.

2 DEFINITIONS

Throughout this protocol the following terms are used:

Peak Braking Coefficient (PBC) – the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre, measured using the American Society for Testing and Materials (ASTM) E1136-10 (2010) standard reference test tyre, in accordance with ASTM Method E 1337-90 (reapproved 1996), at a speed of 64.4km/h, without water delivery. Alternatively, the method as specified in UNECE R13-H.

Lane Keeping Assist (LKA) – heading correction that is applied automatically by the vehicle in response to the detection of the vehicle that is about to drift beyond a delineated edge line of the current travel lane.

Lane Departure Warning (LDW) – a warning that is provided automatically by the vehicle in response to the vehicle that is about to drift beyond a delineated edge line of the current travel lane.

Vehicle under test (VUT) – means the vehicle tested according to this protocol with a Lane Keep Assist and/or Lane Departure Warning system.

Euro NCAP Vehicle Target (EVT) - vehicle target used in this protocol that replicates the visual, radar, LIDAR and PMD attributes of a typical M1 passenger vehicle, and is impactable at

differential speeds up to 50 km/h without causing damage to the VUT or EVT.

Vehicle width – the widest point of the vehicle ignoring the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground.

Time To Collision (TTC) – means the remaining time before the VUT strikes the EVT, assuming that the VUT and EVT would continue to travel with the speed it is travelling.

Lane Edge – means the inner side of the lane marking or the road edge.

Distance To Lane Edge (DTLE) – means the remaining lateral distance (perpendicular to the Lane Edge) between the Lane Edge and most outer edge of the tyre, before the VUT crosses Lane Edge, assuming that the VUT would continue to travel with the same lateral velocity towards it.

Driver Intention Monitoring system – means a system that is effective at distinguishing intentional from unintentional lane crossing and suppressing undesired interventions.

3 REFERENCE SYSTEM

3.1 Convention

3.1.1 For the VUT use the convention specified in ISO 8855:1991 in which the x-axis points towards the front of the vehicle, the y-axis towards the left and the z-axis upwards (right hand system), with the origin at the most forward point on the centreline of the VUT for dynamic data measurements as shown in Figure 3.1.

3.1.2 Viewed from the origin, roll, pitch and yaw rotate clockwise around the x, y and z axes respectively. Longitudinal refers to the component of the measurement along the x-axis, lateral the component along the y-axis and vertical the component along the z-axis.

3.1.3 This reference system should be used for both left and right hand drive vehicles tested.

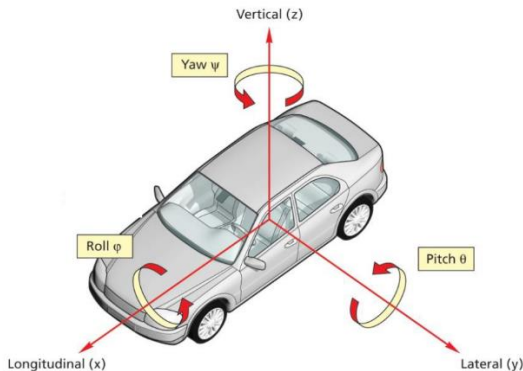


Figure 3.1: Coordinate system and notation

3.2 Lateral Path Error

3.2.1 The lateral path error is determined as the lateral distance between the centre of the front axle of the VUT when measured in parallel to the intended path as shown in the figure below. This measure applies during both the straight line approach and the curve that establishes the lane departure.

Lateral Deviation from Path = YVUT error

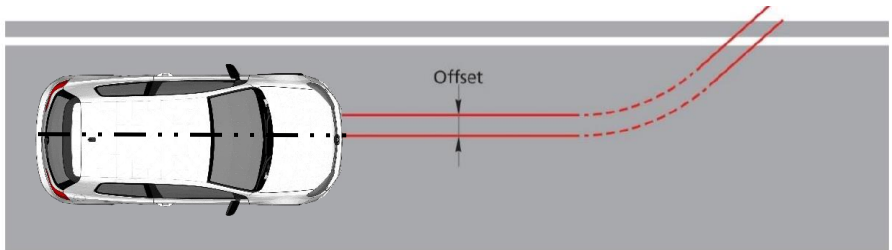


Figure 3.2: Lateral Path Error

4 MEASURING EQUIPMENT

4.1 Sample and record all dynamic data at a frequency of at least 100Hz.

4.2 Measurements and Variables

4.2.1	Time	T
	• T_0 , time where manoeuvre starts with 2s straight path	T_0
	• T_{LDW} , time where LDW activates	T_{LDW}
	• T_{steer} , time where VUT enters in curve segment	T_{steer}

	• T_{crossing} , time where VUT crosses the line or road edge	T_{crossing}
4.2.2	Position of the VUT during the entire test	$X_{\text{VUT}}, Y_{\text{VUT}}$
4.2.3	Speed of the VUT during the entire test	$V_{\text{long}}, V_{\text{UT}}$ $V_{\text{lat}}, V_{\text{UT}}$
4.2.4	Yaw velocity of the VUT during the entire test	Ψ_{VUT}
4.2.5	Steering wheel velocity of the VUT during the entire test	Ω_{VUT}

4.3 Measuring Equipment

4.3.1 Equip the VUT with data measurement and acquisition equipment to sample and record data with an accuracy of at least:

- VUT and EVT longitudinal speed to 0.1 km/h;
- VUT and EVT lateral and longitudinal position to 0.03 m;
- VUT heading angle to 0.1° ;
- VUT and EVT yaw rate to $0.1^\circ/\text{s}$;
- VUT longitudinal acceleration to 0.1 m/s^2 ;
- VUT steering wheel velocity to $1.0^\circ/\text{s}$.

4.4 Data Filtering

4.4.1 Filter the measured data as follows:

4.4.1.1 Position and speed are not filtered and are used in their raw state.

4.4.1.2 Acceleration, yaw rate, steering wheel torque and steering wheel velocity with a 12-pole phaseless Butterworth filter with a cut-off frequency of 10 Hz.

5 TEST CONDITIONS

5.1 Test Track

5.1.1 Conduct tests on a dry (no visible moisture on the surface), uniform, solid-paved surface with a maximum slope of 1% in the longitudinal direction, < 2% for half a lane width either side of the centreline and < 3% for the outer half of the test lane in lateral direction.

5.1.2 The test surface shall have a minimal peak braking coefficient (PBC) of 0.9, must be paved and may not contain any irregularities (e.g. large dips or cracks, manhole covers or reflective studs) within a lateral distance of 3.0 m to either side of the centre of the test lane and with a longitudinal distance of 30m ahead of the VUT from the point after the test is complete.

5.1.3 Lane Markings and Road Edge

5.1.3.1 The tests described in this document require the use of two different types of lane markings conforming to one of the lane markings as defined in UNECE Regulation 130 to mark a lane with a width of 3.5 to 3.7m when measured from the inside edge of the lane marking and a road edge:

1. Dashed line with a width between 0.10 and 0.25 m (0.10 and 0.15 m for centerlines)

2. Solid line with a width between 0.10 and 0.25 m
3. Road Edge consisting of grass and/or gravel or any other approved surrogate

The inner edge of the lane marking shall be at 0.20 to 0.30 m from the road edge (transition between paved test surface and road edge material), where applicable.

The lane markings and/or road edge should be sufficiently long to ensure that there is at least 20 m of marking remaining ahead of the vehicle after the test is complete.

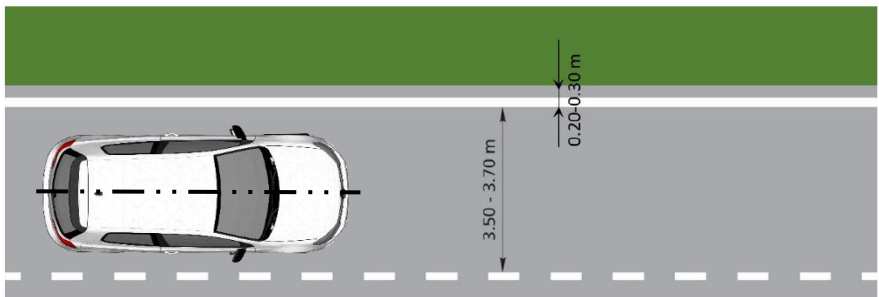


Figure 5.1: Layout of the lane markings

5.1.4 Weather conditions

5.1.4.1 Conduct tests in dry conditions with ambient temperature above 5 °C and below 40 °C.

5.1.4.2 No precipitation shall be falling and horizontal visibility at ground level shall be greater than 1km. Wind speeds shall be below 10m/s to minimise VUT disturbance.

5.1.4.3 Natural ambient illumination must be homogenous in the test area and in excess of 2000 lux for daylight testing with no strong shadows cast across the test area other than those caused by the VUT. Ensure testing is not performed driving towards, or away from the sun when there is direct sunlight.

5.1.4.4 Measure and record the following parameters preferably at the commencement of every single test or at least every 30 minutes:

- a) Ambient temperature in °C;
- b) Track Temperature in °C;
- c) Wind speed in m/s;
- d) Wind direction in azimuth ° and/or compass point direction (monitoring);
- e) Ambient illumination in Lux.

5.2 VUT Preparation

5.2.1 System Settings

5.2.1.1 Set any driver configurable elements of the system (e.g. the timing of the Lane Departure Warning or the Lane Keep Assist if present) to the middle setting or midpoint and then next poorer performing setting similar to the examples shown in Figure 5.2. Lane Centering functions should be turned OFF.

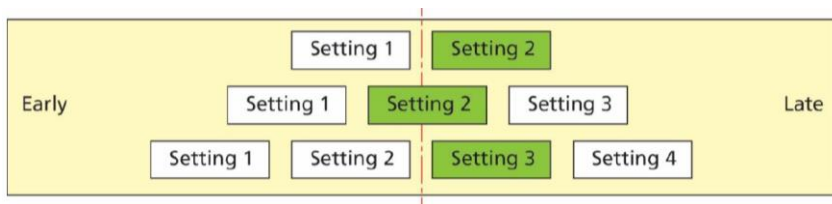


Figure 5.2: System setting for testing

5.2.2 Tyres

Perform the testing with new original fitment tyres of the make, model, size, speed and load rating as specified by the vehicle manufacturer. It is permitted to change the tyres which are supplied by the manufacturer or acquired at an official dealer representing the manufacturer if those tyres are identical make, model, size, speed and load rating to the original fitment. Use inflation pressures corresponding to the least loading normal condition.

Run-in tyres according to the tyre conditioning procedure specified in 6.1.3. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

5.2.3 Wheel Alignment Measurement

The vehicle should be subject to a vehicle (in-line) geometry check to record the wheel alignment set by the OEM. This should be done with the vehicle in kerb weight.

5.2.4 Unladen Kerb Mass

5.2.4.1 If applicable, fill up the tank with fuel to at least 90% of the tank's capacity of fuel.

5.2.4.2 Check the oil level and top up to its maximum level if necessary. Similarly, top up the levels of all other fluids to their maximum levels if necessary.

5.2.4.3 Ensure that the vehicle has its spare wheel on board, if fitted, along with any tools supplied with the vehicle. Nothing else should be in the car.

5.2.4.4 Ensure that all tyres are inflated according to the manufacturer's instructions for the least loading condition.

5.2.4.5 Measure the front and rear axle masses and determine the total mass of the vehicle. The total mass is the 'unladen kerb mass' of the vehicle. Record this mass in the test details.

5.2.4.6 Calculate the required ballast mass, by subtracting the mass of the test driver and test equipment from the required 200 kg interior load.

5.2.5 Vehicle Preparation

5.2.5.1 Fit the on-board test equipment and instrumentation in the vehicle. Also fit any associated cables, cabling boxes and power sources.

5.2.5.2 Place weights with a mass of the ballast mass. Any items added should be securely attached to the car.

5.2.5.3 With the driver in the vehicle, weigh the front and rear axle loads of the vehicle.

5.2.5.4 Compare these loads with the ‘unladen kerb mass’.

5.2.5.5 The total vehicle mass shall be within $\pm 1\%$ of the sum of the unladen kerb mass, plus 200kg. The front/rear axle load distribution needs to be within 5% of the front/rear axle load distribution of the original unladen kerb mass plus full fuel load. If the vehicle differs from the requirements given in this paragraph, items may be removed or added to the vehicle which has no influence on its performance. Any items added to increase the vehicle mass should be securely attached to the car.

5.2.5.6 Repeat paragraphs 5.2.5.3 and 5.2.5.4 until the front and rear axle loads and the total vehicle mass are within the limits set in paragraph 5.2.5.5. Care needs to be taken when adding or removing weight in order to approximate the original vehicle inertial properties as close as possible. Record the final axle loads in the test details. Record the axle weights of the VUT in the ‘as tested’ condition.

5.2.5.7 Vehicle dimensional measurements shall be taken. For purposes of this test procedure, vehicle dimensions shall be represented by a two-dimensional polygon defined by the lateral and longitudinal dimensions relative to the centroid of the vehicle using the standard ISO 8855 coordinate system. The corners of the polygon are defined by the lateral and longitudinal locations where the plane of the outside edge of each tyre makes contact with the road. This plane is defined by running a perpendicular line from the outer most edge of the tyre to the ground at the wheelbase, as illustrated in Figure 5.3.

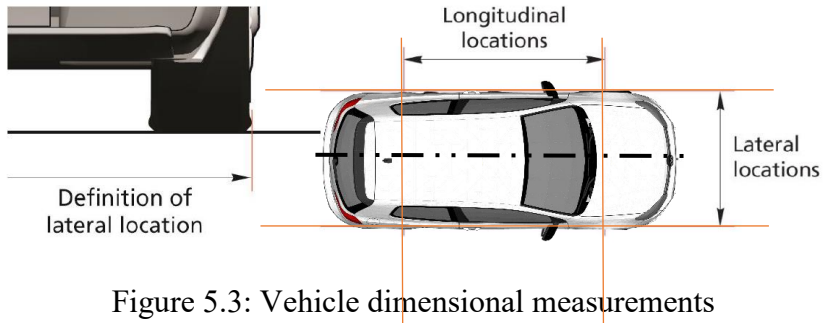


Figure 5.3: Vehicle dimensional measurements

5.2.5.8 The vehicle's wheelbase and the lateral and longitudinal locations shall be measured and recorded.

6 TEST PROCEDURE

6.1 VUT Pre-test Conditioning

6.1.1 General

6.1.1.1 A new car is used as delivered to the test laboratory; however a car may have been used for other ASEAN NCAP active safety tests.

6.1.1.2 If requested by the vehicle manufacturer and where not already performed for other tests, drive a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to 'calibrate' the sensor system. Avoid harsh acceleration and braking.

6.1.2 Brakes

6.1.2.1 Condition the vehicle's brakes in the following manner, if it has not been done before or in case the lab has not performed a 100 km of driving:

- Perform twenty stops from a speed of 56 km/h with an average deceleration of approximately 0.5 to 0.6 g.
- Immediately following the series of 56 km/h stops, perform three additional stops from a speed of 72 km/h, each time applying sufficient force to the pedal to operate the vehicle's antilock braking system (ABS) for the majority of each stop.
- Immediately following the series of 72 km/h stops, drive the vehicle at a speed of approximately 72 km/h for five minutes to cool the brakes.

6.1.3 Tyres

6.1.3.1 Condition the vehicle's tyres in the following manner to remove the mould sheen, if this has not been done before for another test or in case the lab has not performed a 100 km of driving:

- Drive around a circle of 30m in diameter at a speed sufficient to generate a lateral acceleration of approximately 0.5 to 0.6 g for three clockwise laps followed by three anticlockwise laps.
- Immediately following the circular driving, drive four passes at 56 km/h, performing ten cycles of a sinusoidal steering input in each pass at a frequency of 1 Hz and amplitude sufficient to generate a peak lateral acceleration of approximately 0.5 to 0.6 g.

- Make the steering wheel amplitude of the final cycle of the final pass double that of the previous inputs.

6.1.3.2 In case of instability in the sinusoidal driving, reduce the amplitude of the steering input to an appropriately safe level and continue the four passes.

6.1.4 System Check

6.1.4.1 Before any testing begins, perform a maximum of ten runs, to ensure proper functioning of the system.

6.2 Test Scenarios

The performance of the VUT LSS is assessed in different scenarios that are applicable to the system:

- Lane Keep Assist
- Lane Departure Warning

6.2.1 Tests in all scenarios will be performed with 0.1 m/s incremental steps within the lateral velocities specified for the test scenarios.

6.2.2 For testing purposes, assume an initial straight-line path followed by a fixed radius as specified for the test scenarios, followed again by a straight line, hereby known as the test path. Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.

6.2.2.1 The vehicle manufacturer shall provide information describing the location when the closed loop path and/or speed control shall be ended so as not to interfere with the system intervention for each test. Otherwise for each lateral velocity, two calibration runs shall be performed in order to determine when the system activates. Compare steering wheel torque, vehicle speed or yaw rate of both runs and determine where there is a notable difference that identifies the location of intervention.

Run 1: Complete the required test path with the system turned OFF and measure the control parameter

Run 2: Complete the required test path with the system turned ON and measure the control parameter

6.2.2.2 Complete the tests while ending the closed loop control before system activation as defined in 6.2.2.1 In the case of calibration runs the release of steering control should occur on the test path and no less than 5 m longitudinally before the location of intervention.

6.2.2.3 When the closed loop path ends, the driver's hands or the control will remain passive on the steering wheel without applying deliberate force but reflecting the behaviour of an inattentive driver holding the steering wheel.

6.2.3 The following parameters should be used to create the test paths.

Vlat,VUT [m/s]	R [m]	ψ VUT [°]	d1 [m]	d2 [m]
0.2	1200	0.57	0.06	0.70
0.3		0.86	0.14	0.90
0.4		1.15	0.24	0.80
0.5		1.43	0.38	0.75
0.6		1.72	0.54	0.60
0.7		2.01	0.74	0.53

Where the lateral offset d from the lane marking or road edge:

$$d = d1 + d2 + \text{Half of the vehicle width (m)}$$

With:

d1: Lateral distance travelled during curve establishing yaw angle (m)

d2: Lateral distance travelled during Vlat steady state (m)

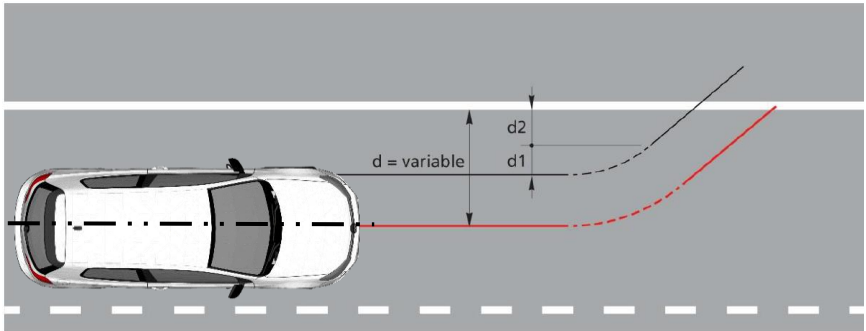


Figure 6.1: Vehicle paths definition

6.2.5 Lane Keep Assist tests

6.2.5.1 Dashed line tests

LKA Dashed line tests will be performed with 0.1 m/s incremental steps within the lateral velocity range of 0.2 to 0.6 m/s for departures at both sides of the vehicle.

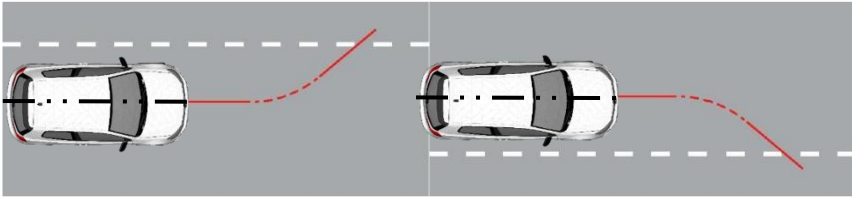


Figure 6.2: LKA Dashed line scenarios

6.2.5.2 Solid line tests

LKA Solid line tests will be performed with 0.1 m/s incremental steps within the lateral velocity range of 0.2 to 0.6m/s for departures at both sides of the vehicle.

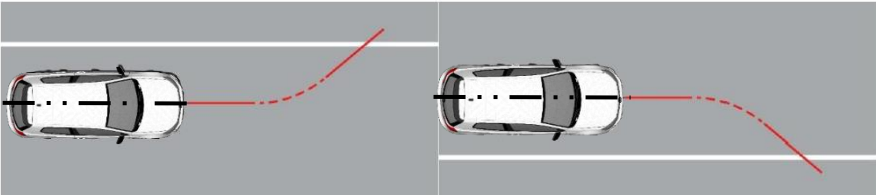


Figure 6.3: LKA solid line scenarios

6.2.6 Lane Departure Warning tests

Perform the LKA single line tests within the lateral velocity range of 0.6 to 0.7 m/s.

6.3 Test Conduct

6.3.1 Before every test run, drive the VUT around a circle of maximum diameter 30 m at a speed less than 10 km/h for one clockwise lap followed by one anticlockwise lap, and then manoeuvre the VUT into position on the test path. If requested by the OEM an initialisation run may be included before every test run.

6.3.2 For vehicles with an automatic transmission select D. For vehicles with a manual transmission select the highest gear where the RPM will be at least 1500 at the test speed.

Between tests, manoeuvre the VUT at a maximum speed of 50 km/h and avoid riding the brake pedal and harsh acceleration, braking or turning unless strictly necessary to maintain a safe testing environment.

6.4 Test Execution

6.4.1 Accelerate the VUT to 72 km/h.

6.4.2 Where applicable accelerate the target vehicle to 72km/h or 80km/h depending on the test scenario.

6.4.3 The test shall start at T0 and is valid when all boundary conditions are met between T0 and TLKA/TLDW:

LKA and LDW scenarios:

- Speed of VUT (GPS-speed): 72 ± 1.0 km/h
- Lateral deviation from test path VUT: 0 ± 0.05 m
- Steady state lane departure lateral velocity: ± 0.05 m/s

- Yaw velocity of VUT (up to TSTEER): 0 ± 1.0 °/s
- Steering wheel velocity (up to TSTEER): 0 ± 15.0 °/s

6.4.3.1 Steer the vehicle as appropriate to achieve the lateral velocity in a smooth controlled manner and with minimal overshoot.

6.4.4 The end of an LDW test is considered as when the warning commences.

6.4.5 The end of an LKA test is considered complete 2 seconds after one of the following occurs:

- The LKA system fails to maintain the VUT within the permitted lane departure distance.
- The LKA system intervenes to maintain the VUT within the permitted lane departure distance, such that a maximum lateral position is achieved that subsequently diminishes causing the VUT to turn back towards the lane.

6.4.6 The subsequent lateral velocity for the next test is incremented with 0.1 m/s.

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