

Annex X

Test Specifications for Automated Lane Keeping Systems (ALKS)

1. Introduction

This annex defines tests with the purpose to verify the technical requirements on Automated Lane Keeping Systems (ALKS).

Pass- and Fail-Criteria for tests are derived solely from the technical requirements in section 2 of the regulation. These requirements are worded in a way that they allow the derivation of pass-fail-criteria not only for a given set of test parameters, but for any combination of parameters in which the system is designed to work (e.g. operating speed range, operating lateral acceleration range, curvature range as contained in the system boundaries).

The test specifications in this document are meant to be a minimum set of tests, the technical service authorities may perform any other test within the system boundaries and may then compare the measured results against the requirements (concrete: expected test outcome).

2. Definitions

For the purposes of this annex,

- 2.1. “*Time to Collision*” (TTC) : means the value of time obtained by dividing the longitudinal distance (in the direction of travel of the subject vehicle) between the subject vehicle and the target by the longitudinal relative speed of the subject vehicle and the target, at any instant in time
- 2.2. “*Offset*” means the distance between the vehicle’s and the respective target’s longitudinal median plane in driving direction, measured on the ground, normalized by the half the vehicle width excluding devices for indirect vision and corrected by adding 50 %.
- 2.3. “*Pedestrian Target*” : means a soft target that represents a pedestrian
- 2.4. “*Vehicle Target*” : means a target that represents a vehicle
- 2.6. “*Powered Two-Wheeler Target*”: means a combination of a motorcycle and motorcyclist, a test device according to ISO [CD] 19206-5. The reference point for the location of the motorcycle shall be the most backward point on the centreline of the motorcycle

3. General Principles

3.1. Test conditions

- 3.1.1. The tests shall be performed under conditions (e.g. environmental, road geometry) that allow the activation of the ALKS.
- 3.1.2. If system modifications are required in order to allow testing, e.g. road type assessment criteria or road type information (map data), it shall be ensured that

these modifications don't have an effect on the relevant system performance under test. These modifications shall in principle be documented and annexed to the test report.

- 3.1.3. The test surface shall afford at least the adhesion required by the scenario in order to achieve the expected test result.
- 3.1.4. Test Targets
 - 3.x.x.1. The target used for the vehicle detection tests shall be a regular high volume series production passenger car of Category M₁ AA saloon or alternatively a "soft target" representative of such a vehicle in terms of its identification characteristics applicable to the sensor system of the AEBS under test according to ISO 19206-1:2018. The reference point for the location of the vehicle shall be the most rearward point on the centreline of the vehicle.
 - 3.x.x.x. The target used for the Powered-Twowheeler tests shall be a combination of a motorcycle and motorcyclist, a test device according to ISO [CD] 19206-5:xxxx. The reference point for the location of the motorcycle shall be the most backward point on the centreline of the motorcycle
 - 3.x.x.x. The target used for the pedestrian detection tests shall be an adult "articulated soft target" and be representative of the human attributes applicable to the sensor system of the AEBS under test according to ISO 19206-2:2018.
 - 3.x.x.x. Details that enable the target(s) to be specifically identified and reproduced shall be recorded in the vehicle type approval documentation.
- 3.2. Test parameter variation

The manufacturer shall declare the system boundaries to the Technical Service. The Technical Service shall define at least 3 different combinations of test parameters (e.g. present speed of the ALKS vehicle, type and offset of target, curvature of lane) for each of the test scenarios listed under paragraph 4.

If a collision cannot be avoided for all test parameters, the manufacturer shall demonstrate either by documentation or if possible by [verification/testing] that the system doesn't change its control strategy.
- 4. Test scenarios to assess the performance of the system with regard to the dynamic driving task
 - 3.1. Lane Keeping
 - 3.1.1. The test shall demonstrate that the ALKS does not leave its lane and maintains a stable position inside its ego lane across the speed range and different curvatures within its system boundaries.
 - 3.1.2. The test shall be executed at least:
 - minimum test duration?
 - 3.2. Stopping for a traffic participant or blocked lane

- 3.2.1. The test shall demonstrate that the ALKS avoids a collision with a stationary vehicle, road user or blocked lane up to the maximum specified speed of the system.
- 3.2.2. This test shall be executed at least
- with an stationary vehicle target
 - with a stationary adult pedestrian target
 - with a target representing a blocked lane
 - on a curved section of road
- 3.3. Following a vehicle
- 3.3.1. The test shall demonstrate that the ALKS is able to maintain and restore the required safety distance to a vehicle in front and is able to avoid a collision with a lead vehicle which decelerates up to its maximum deceleration.
- 3.3.2. This test shall be executed at least:
- across the entire speed range of the ALKS
 - for constant and varying lead vehicle velocities
 - for straight and curved sections of road
 - with a deceleration of the lead vehicle of at least 6m/s^2 mean fully developed deceleration
- Lateral offset?
- 3.4. Lane change of another vehicle into lane
- 3.4.1. The test shall demonstrate that the ALKS is capable of avoiding a collision with a vehicle cutting into the lane of the ALKS vehicle up to a certain criticality of the cut-in maneuver.
- 3.4.2. The criticality of the cut-in maneuver shall be determined according to TTC, longitudinal distance between rear-most point of the cutting in vehicle and front-most point of the ALKS vehicle, the lateral velocity of the cutting-in vehicle and the longitudinal movement of the cutting-in vehicle, as defined in Paragraph 5.2.5. of this regulation.
- 3.4.3. This test shall be executed at least for the following variations of cut-in parameter:

Test Case	1	2	3	4	5
v_{Vehicle} [km/h]	50	60	60	30	45
v_{Target} [km/h]	10	50	10	15	40
Lateral acceleration	0,5	1,5	3	3	1

of target [m/s ²]					
Lane Width [m]	3,5	3,5	3,5	3,5	3,5
$t_{ic,0}$ [s]	3	2,5	2,6	2,5	1,5

- 3.5. Stationary obstacle after lane change of the lead vehicle
- 3.5.1. The test shall demonstrate that the ALKS is capable of avoiding a collision with a stationary vehicle, road user or blocked lane that becomes visible after a preceding vehicle avoided a collision by an evasive maneuver.
- 3.5.2. The test shall be executed at least:
- with a stationary vehicle target centered in lane
4. Additional verification
- 4.1. The Technical Service shall assess the detection areas of the ALKS to the side and to the front according to paragraphs x.x.x. of this regulation.
- 4.2. Compliance with the following provisions shall be demonstrated by the manufacturer and assessed by the Technical Service at the time of type approval:

6.2.1	Dedicated means to activate and deactivate
6.2.2.	Default status of new engine start/run
6.2.3a	System active if driver is in driver seat & belt is fastened
6.2.3b	System active if driver is available
6.2.3c	System active if no failure
6.2.3d	System active if DSSAD is operational
6.2.4a	Same dedicated means to activate and deactivate manually
6.2.4b	Means of deactivating protected against unintentional action
6.2.4c	At time of deactivation driver must be in lateral control
	Means to override the system
6.2.5.1	Deactivation by input to driving controls
6.2.5.2	Deactivation during an ongoing transition demand
6.2.5.4	Desactivation in case of severe failure
6.1.2.	Driver presence
6.1.3.1.	Criteria for deeming driver available
6.3.1.1.	Driver attentiveness
6.1.4.	Other activities than driving task
	System behaviour during a transition demand
	System behaviour during a Minimal Risk Manoeuvre

- 4.3. Additional other test cases (e.g. Y-split of highway lanes, vehicles entering or exiting the highway, partially blocked ego lane, tunnel) may be assessed if it is deemed justified by the Technical Service.
- 4.4. The Technical Service shall assess the ALKS behaviour during a mandatory real-road test drive.

- 4.4.1. This test drive shall have a minimum duration of X min where the ALKS was active.
- 4.4.2. This test drive shall at least aim to include a qualitative assessment of the following provisions:
- planned transition
 - ...?