

2.1 Scope

- 2.1.1. This Regulation applies to vehicles of categories M1 **equipped with an Automated Lane Keeping System (ALKS)**.

2.2. Definitions

- 2.2.0. “Automated Lane Keeping System (ALKS)” ~~for low speed application~~ is a system which is activated by the driver and which keeps the vehicle within its lane by influencing the lateral movement of the vehicle and controls the longitudinal movement of the vehicle for extended periods without further driver command.

...

- 2.2.12. A “*severe ALKS failure*” is a failure specific to the operation of the ALKS that affects the safe operation of the system and which is expected to occur less frequent than once a year per vehicle.

- 2.2.13. A “*severe vehicle failure*” is any failure in the vehicle (e.g. electrical, mechanical) that affects **the ability of the ALKS to perform** the dynamic driving task **as specified in this regulation** and would also **affect the manual operation of the vehicle** (e.g. loss of power supply, failure of the braking system, sudden loss of tire pressure).

2.3. General Requirements

- 2.3.1. The system shall have the capability to detect failures affecting the safe operation or the functionality of the ALKS

- 2.3.2. The activated system shall cope with all dynamic driving tasks and with any situation including failures or shall otherwise transition the control back to the driver offering sufficient lead time.

Any type of situation in which the vehicle will generate a transition demand to the driver shall be declared by the vehicle manufacturer and documentation shall be provided together with the documentation package required in Annex [X] [CEL].

- 2.3.3. The activated system shall comply with all relevant traffic regulations in the country of operation

2.4. Activation, Deactivation and Driver Input

- 2.4.1. The vehicle shall be equipped with a means for the driver to activate (active mode) and deactivate (off mode) the system.

- 2.4.2. The default status of the system shall be the off mode at the initiation of each new engine start/run cycle. This requirement does not apply when a new engine start/run cycle is performed automatically, e.g. by the operation of a stop/start system.

- 2.4.3. The system shall become active only upon a deliberate action by the driver and

all the following condition are met:

- The driver is in the driver seat and the driver's safety belt is fastened according to paragraph 2.6.,
- the driver is available to take over control of the dynamic driving task according to paragraph 2.6.,
- no failure affecting the safe operation or the functionality of the ALKS is present,
- DSS AD is operational,
- the environmental and infrastructural conditions allow the operation and
- the vehicle is on roads where pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions.
- [after ignition ON ~~on~~ the system has at least once detected an object at the same or a higher distance than that declared as detection range according to paragraph 2.5.6.1. **This provision does not apply when a lead vehicle is detected in a distance shorter than the detection range directly upon a new ignition run cycle e.g. in a traffic jam.**]

2.4.4. Manual Deactivation

It shall be possible to manually deactivate (off-mode) the system by an intentional action of the driver using the same means as to activate the system, as mentioned in paragraph 2.4.1. The means of deactivating shall provide protection against unintentional manual deactivation for example by requiring a single input exceeding a certain threshold of time or a double press, or two separate but simultaneous inputs. Additionally, it shall be ensured the driver is in lateral control of the vehicle at the time of the deactivation, by e.g. placing the deactivation means on the steering control or confirming the driver is holding the steering control.

2.4.5. Automatic Deactivation

The system shall not be automatically deactivated by any driver input other than those described in 2.4.5.1 and 2.4.5.2 and 2.4.5.3.

2.4.5.1. Deactivation by input to driving controls

The system shall be deactivated automatically when at least one of the following conditions is met.

- The driver maintains the vehicle in standstill for at least [1] s by any braking system.
- The driver overrides the system by steering, while holding the steering control, and this override is not suppressed, as specified in paragraph 2.4.8
- The driver is holding the steering control and overrides the system by braking or accelerating, as specified in paragraph of 2.4.8

2.4.5.2. Deactivation during an ongoing transition demand initiated by the system

In the case where a transition demand [~~initiated by the system~~] is on-going, the system shall be deactivated automatically **as soon as and only**

- **when one of the conditions of paragraph 2.4.5.1. is met or**
- upon detection that the driver has taken hold of the steering control as a response to the transition demand, provided the system confirms the driver is attentive as per 2.4.5.2.1.

~~2.4.5.2.1. Driver attentiveness shall be confirmed by at least one of the following criteria:~~

~~– Driver gaze direction is being confirmed as primarily looking at the road ahead~~

~~– Driver head movement is being confirmed as primarily directed towards the road ahead, or~~

~~alternative criteria to be defined by the manufacturer~~

~~The specification for confirming these criteria must be declared by the manufacturer and supported by documented evidence. This shall be assessed by the technical service according to Annex X (CEL).~~

~~2.4.5.3. Deactivation during an ongoing transition demand initiated by the driver input~~

~~In the case where a transition demand initiated by the driver input is on-going, the system shall be deactivated automatically upon detection that the driver has taken hold of or inputted to the steering control.~~

2.4.5.3. Deactivation during an ongoing Emergency Manoeuvre

Notwithstanding the provisions of paragraphs 2.4.5.1. and 2.4.5.2. in case of an ongoing emergency manoeuvre, the deactivation of the system may be delayed until the emergency manoeuvre is terminated.

~~2.4.6. Following a deactivation, the driver may only be supported in his driving task by any driver assistance function **providing continuous control of longitudinal and/or lateral movement of the vehicle** which only if it was active at the time of the activation of the ALKS or which if it was activated during the operation of the ALKS, [except such driver assistance functions which allow the driver make his/her hands be off from the steering control, or his/her foot be off from both the accelerator control and the braking control].~~

~~{The manufacturer shall provide evidence that suitable information is provided to the driver to ensure mode awareness when changing from ALKS to assisted driving mode.}~~

~~[Any longitudinal control that will be active after the deactivation of the ALKS shall not exceed upon [automatic] activation the speed limit valid at the time of deactivation of the ALKS.]~~

2.4.7. An automatic deactivation shall be indicated to the driver by an optical and an acoustic signal. The acoustic signal is not required when the deactivation occurs following a transition demand that contains an acoustic signal.

2.4.8. System override

- ~~2.4.8.1. A driver input to the steering control shall override the lateral control function of the system when the input exceeds a reasonable threshold (e.g. based on force and duration) designed to prevent unintentional override.~~
- ~~This threshold including a possible variation depending on parameters like speed, gaze direction of the driver, or a second deliberate action (e.g. the use of the turn indicator accompanying the steering input) and the rationale for the variation shall be provided to the Technical Service during the assessment according to Annex X (CEL).~~

2.4.8.1. A driver input to the steering control shall override the lateral control function of the system when the input exceeds a reasonable threshold designed to prevent unintentional override.

This threshold shall include a specified force and duration and vary depending on parameters that include criteria used for driver attentiveness. These thresholds shall be declared to the Technical Service during the assessment according to Annex X (CEL).

- 2.4.8.2. A driver input to the braking control resulting in a higher deceleration than that induced by the system shall override the longitudinal control function of the system.
- 2.4.8.3. A driver input to the accelerator control may override the longitudinal control function of the system. However, such an input shall not cause the system to no longer meet the requirements of this regulation, unless the driver is holding the steering control.
- [2.4.8.4. Notwithstanding the provisions laid down in paragraphs 2.4.8.1. to 2.4.8.3., the effect of the driver input on any control may be reduced or suppressed by the system in case the system has detected the risk of a collision due to this driver input.]
- 2.4.8.5. Any system override due to driver input to the accelerator or brake control shall immediately initiate a transition demand as specified in paragraph 2.7.
- 2.4.9. In case of a severe vehicle failure or a severe ALKS failure the ALKS may employ different strategies with regard to deactivation and override. These different strategies shall be declared by the manufacturer and their efficiency with regard to ensuring a safe transition of control back to the driver shall be assessed by the Technical Service.
- 2.4.10. The fulfilment of the provisions in paragraph 2.4 and its subparagraphs shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex X [CEL].
- 2.5. Dynamic Driving Task, and Sensing Capabilities
- 2.5.1. The activated system shall keep the vehicle inside its lane of travel and ensure that the vehicle does not cross any lane marking. The system shall aim to keep the vehicle in a stable lateral position inside the lane of travel to avoid confusing other road users.

- 2.5.2. The activated system shall detect a vehicle driving beside and if necessary adjust speed and/or the lateral position of the vehicle within its lane as appropriate.
- 2.5.3. The activated system shall control the speed of the vehicle.
- 2.5.3.1. The activated system shall adapt the vehicle speed to infrastructural and environmental conditions (e.g. narrow curve radii, inclement weather).
- 2.5.3.2. The activated system shall detect the distance to another road user in front located within the operating range as defined in paragraph 2.5.6. and shall adapt the vehicle speed in order to avoid collision.

While the ALKS vehicle is not at standstill, the system shall adapt the speed to adjust the distance to a vehicle in front in the same lane to be equal or greater than the minimum following distance.

In case of a lead vehicle decelerating or cutting in, there shall not be an appreciable time interval between the detection of a following distance below the required minimum distance and the start of the adjustment process.

The minimum following distance shall be calculated using the formula:

$$d_{\min} = v_{\text{ALKS}} * t_{\text{front}}$$

Where:

- d_{\min} = the minimum following distance
- v_{ALKS} = the present speed of the ALKS vehicle;
- t_{front} = minimum time gap between the ALKS vehicle and a leading vehicle in front as per the table below:

Present speed of the ALKS vehicle		Minimum time gap
km/h	m/s	
7,2	2,0	1,0
10	2,78	1,1
20	5,56	1,2
30	8,33	1,3
40	11,11	1,4
50	13,89	1,5
60	16,67	1,6

For speed values not mentioned in the table, linear interpolation shall be applied.

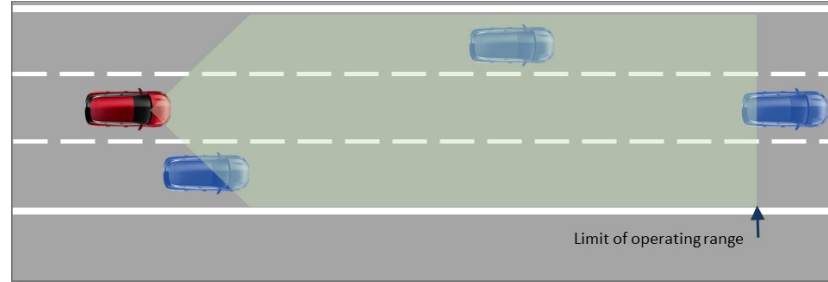
Notwithstanding the result of the formula above for present speeds below 2 m/s the minimum following distance shall never be less than 2 m.

- 2.5.4. The activated system shall be able to bring the vehicle to a complete stop behind a stationary vehicle or obstacle blocking its lane of travel. This shall be ensured up to the maximum operational speed of the system, as defined in paragraph 2.5.7.
- 2.5.5. The activated system shall detect the risk of an imminent collision e.g. with another road user ahead or beside the vehicle, due to a hard decelerating lead vehicle, a suddenly cutting in vehicle or a suddenly appearing obstacle after a

lane change of a leading vehicle and shall automatically perform an appropriate emergency manoeuvre as specified in paragraph 2.10.

2.5.6. Sensing system

The ALKS vehicle shall be equipped with a sensing system such that it can determine the driving environment (e.g. road geometry ahead, lane markings) and the traffic dynamics across its own traffic lane, the traffic lane immediately to its left and to its right up to the limit of the operating range.



Schematics of the Sensing System of the ALKS

2.5.6.1 Detection range of the sensing system to the front

The detection range of the sensing system shall be declared by the vehicle manufacturer and shall be at least [46] meters measured from the forward most point of the ALKS vehicle.

The Technical Service shall verify the distance at which the vehicle sensing system detects a leading vehicle during the relevant test in Annex [X].

The measured value shall be equal to or higher than the declared value.

2.5.6.2. The ALKS shall implement strategies to detect and cope with environmental and technical conditions which might reduce the detection range of the sensing system, e.g. prevent enabling the system, disabling the system and transferring the control back to the driver, reducing the speed when visibility is too low.

These strategies shall be described by the vehicle manufacturer and assessed according to the Annex X (CEL).

2.5.6.3. The vehicle manufacturer shall provide evidence about how the effect of wear/ageing influences the performance of the sensing system over lifetime.

2.5.7 Maximum Operational Speed

The maximum speed up to which the system is permitted to operate shall be calculated with the formula below:

$$V_{max-ALKS} = -a_{ALKS} * t_{system} + \sqrt{(a_{ALKS} * t_{system})^2 + 2a_{ALKS} * D_{range}}$$

Where:

$V_{max-ALKS}$ = Maximum operational speed of the system

- a_{ALKS} = [3.7] m/s² = feasible deceleration under wet conditions ¹
- t_{system} = System delay of 0.5s until deceleration level is reached
- D_{range} = Detection range in [m] determined according to paragraph 2.5.6.1.

The manufacturer shall declare the speed up to which the system will operate. This declared speed shall be less or equal to the value calculated by the formula above.

Notwithstanding the result of the formula above the maximum operational speed is limited to [60] km/h.

- 2.5.8 The fulfilment of the provisions of paragraph 2.5. and its subparagraphs shall be demonstrated to the technical service and tested according to the relevant tests in Annex [X].

[It is recognised that the fulfilment of the requirement in paragraph 2.5.5 may not be fully achieved in other conditions than those for the tests in Annex [X]. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with Annex [X] [CEL] of this Regulation.]

- 2.6. Driver Availability Recognition System

The system shall comprise a driver availability recognition system.

The driver availability recognition system shall detect that the driver is present in the driver seat, the safety belt of the driver is fastened and that the driver is available to take over the driving task.

- 2.6.1. Driver not present in the driver seat

A transition demand shall be initiated according to paragraph 2.7. if one of the following conditions is met:

- When the driver is detected not to be in the seat for a period of more than [1] second or
- When the driver's safety belt is unbuckled

The second level warning of the safety-belt reminder according to UN-R16 may be used instead of an acoustic warning of the Transition Demand.

- 2.6.2. Driver availability

The system shall detect if the driver is available to take over the driving task by continuously monitoring the driver.

¹Unless a higher value is declared by the manufacturer and verified during type approval to the satisfaction of and in agreement with the technical service.

2.6.2.1 Criteria for deeming Driver availability

~~{Driver availability shall be confirmed in a rolling interval of [60]s based on at least two availability criteria (e.g. input to driver-exclusive vehicle control, eye blinking, eye closure, conscious head and body movement) or by a dedicated confirmation by the driver every [180]s }~~

As soon as the system has assessed the driver to no longer be available, the system shall provide a distinctive warning until appropriate actions of the driver are detected or until a transition demand is initiated.

Latest when the system does not detect appropriate actions from the driver during the distinctive warning for a period of more than [15]s a transition demand shall be initiated according to paragraph 2.7.

2.6.3. Driver attentiveness

The system shall detect, if the driver is attentive. The driver is deemed to be attentive when at least one of the following criteria is met:

- **Driver gaze direction is confirmed as primarily looking at the road ahead,**
- **driver gaze direction is being confirmed as looking at the rear view mirrors**
- **driver head movement is confirmed as primarily directed towards the driving task.**

2.6.3. The fulfilment of the provisions of paragraph 2.6. and its subparagraphs shall be demonstrated to the technical service and tested according to the relevant tests in Annex [X].

Additionally the manufacturer shall declare to the technical service

- the vehicle's capability to detect that the driver is not in the seat,
- the vehicle's capability to detect that the driver is available to take over the driving task.
- **the specifications for confirming the driver's attentiveness criteria in paragraph 2.6.3 or equally safe criteria supported by documented evidence.**

The declarations of the manufacturer shall be assessed by the technical service according to Annex X (CEL).

2.7. Transition Demand and System Operation during Transition Phase

2.7.1. The activated system shall recognise all situations in which it needs to transition the control back to the driver.

- 2.7.2 The timing of the transition demand shall be such that sufficient time is provided for a safe transition to manual driving.
- 2.7.2.1. In case of a planned event, a transition demand shall be given latest [10] seconds before the event occurs.
- 2.7.2.2. In case of an unplanned event, a transition demand shall be given upon detection.
- 2.7.2.3 In case of any failure of the system or of any function needed for the operation, the system shall immediately initiate a transition demand upon detection.
- 2.7.3. During the transition phase the system shall continue to operate. The system may reduce the speed of the vehicle to ensure its safe operation but shall not bring it to standstill unless required by the situation (e.g. due to vehicles or obstacles obstructing the path of the vehicle).
- Once in standstill the vehicle [may] remain in this condition and shall activate the hazard warning lights within [5] s after the start of the transition demand.
- 2.7.4. A transition demand shall only be terminated once the system is deactivated or a minimum risk manoeuvre has started.
- 2.7.4.1. In case the driver is not responding to a transition demand by deactivating the system either manually as per paragraph 2.4.4. or automatically as per paragraph 2.4.5, a minimum risk manoeuvre shall be started automatically, earliest [10 s] after the start of the transition demand.
- 2.7.4.1.1. Notwithstanding paragraph 2.7.4.1. a MRM may be initiated immediately in case of a severe vehicle failure. It is recognized that in case of a severe vehicle failure the ALKS may no longer be capable of fulfilling the requirements of this Regulation, but it shall aim at enabling a safe transition of control back to the driver.
- 2.7.4.1.2. Notwithstanding paragraph 2.7.4.1., a MRM may be initiated immediately in case of a severe ALKS failure **or when a single sensor failure is accompanied by another influence affecting the safe operation of the system, e.g. unsuitable environmental conditions.**
- 2.7.4.1.3. The manufacturer shall declare the types of severe vehicle failures and severe ALKS failures that will lead the ALKS to initiate a MRM immediately.
- 2.8. Information to the driver
- 2.8.1. The following information shall be indicated to the driver:
- the system status as defined in paragraph 2.8.2.
 - any failure of the system with at least an optical signal unless the system is deactivated (off mode),

- transition demand by at least an optical and in addition an acoustic and/or haptic warning signal. The warning shall be escalated latest [4]s after the initiation.
- minimum risk manoeuvre by an optical signal and either an acoustic or a haptic warning signal and
- emergency manoeuvre by an optical signal

The optical signals above shall be in an adequate size and contrast and contain standardized symbols. The acoustic signals above shall be loud and clear.

2.8.2. System status

2.8.2.1 System unavailability indication

In case activation of the system following the deliberate action of the driver is denied by the system due to system unavailability, this shall be at least [visually/optically] displayed to the driver.

2.8.2.2 System status display when activated

Upon activation the system status (active mode) shall be displayed by an optical signal to the driver.

The optical signal shall be constant and shall contain an unambiguous indication including a steering control or a vehicle, with an additional “A” or “AUTO”, and shall contain a clearly perceptible indication in the driver’s field of view (e.g. prominent indication in the instrument cluster or on the steering control covering part of the outer rim perimeter facing towards the driver).

The optical signal shall be unambiguous and indicate the active system state until the system is deactivated (off mode).

2.8.2.3 System status display when deactivated

Upon deactivation when the system status changes from active mode to (off mode) this shall be indicated to the driver by at least an optical warning signal. This optical signal shall be realized by non-displaying the optical signal used to indicate the active mode.

Additionally, an acoustic warning signal shall be provided unless the system is deactivated either manually (according to paragraph 2.4.4) or following a transition demand which contained an acoustic signal.

2.8.3. Transition Phase and Minimum Risk Manoeuvre

During the transition phase and the minimum risk manoeuvre, the system shall instruct the driver in an intuitive and unambiguous way to take over manual control of the vehicle. The instruction shall include a pictorial information showing hands and the steering control and may be accompanied by additional explanatory text or warning symbols, as shown in the example below.



Example 1.

Example 2.

2.8.3.2. With the start of the minimum risk manoeuvre, the given signal shall change its characteristics to emphasize the urgency of an action by the driver. e.g. by red flashing of the steering control and moving hands of the pictorial information.

2.8.4. Prioritization of ALKS warnings

The warnings of an ALKS during a transition phase, a Minimal Risk Manoeuvre or an Emergency Manoeuvre may be prioritized over other warnings in the vehicle.

The prioritization of different acoustic and optical warnings during the ALKS operation shall be declared by the manufacturer to the Technical Service during Type Approval.

2.9. Minimum Risk Manoeuvre

2.9.1. During the minimum risk manoeuvre the vehicle shall be slowed down inside the lane or, in case the lane markings are not visible, remain on an appropriate trajectory taking into account surrounding traffic and road infrastructure, with a deceleration demand not greater than $[4] \text{ m/s}^2$.

Higher deceleration demand values are permissible for very short durations, e.g. as haptic warning to stimulate the driver's attention, or in case of a severe system failure.

Additionally, the hazard warning lights shall be activated [not later than $[4]$ seconds after the start of the minimum risk manoeuvre or once the vehicle comes to standstill whichever is earlier].

2.9.2. The minimum risk manoeuvre shall bring the vehicle to standstill unless the system is deactivated during the manoeuvre.

2.9.3. In case the ALKS is capable of performing lane change manoeuvres during the MRM, including to the hard shoulder, this shall only be permitted if the situation is not critical. Such lane changes are deemed critical either if there is a risk of a collision with another vehicle in the target lane, or if an approaching vehicle in the target lane would have to decelerate at a higher level than 3 m/s^2 , 0.4 seconds after the ALKS vehicle has crossed the lane marking, to ensure the distance between the two vehicles is never less than that which the ALKS vehicle travels in 1 second.

Any lane change must be indicated to other road users according to traffic regulation.

The system's safety strategies must be declared and proved with evidence by documentation to the Technical Service.

- 2.9.4. A minimum risk manoeuvre shall only be terminated once the system is deactivated or the system has brought the vehicle to a standstill.
- 2.9.5. The system shall be deactivated at the end of any minimum risk manoeuvre.
The hazard warning lights shall remain activated [unless deactivated manually] and the vehicle shall not move away after standstill without manual input.
- ~~2.9.6. Reactivation of the system after the end of any minimum risk manoeuvre shall only be possible after each new engine start/run cycle. When a new engine start/run cycle is performed automatically, e.g. by the operation of a stop/start system, it is not regarded as a new engine start/run cycle..~~
- 2.10. Emergency Manoeuvre
- 2.10.1. An emergency manoeuvre shall be carried out only in case of an imminent collision risk as described in paragraph 2.5.5.
- 2.10.2. This manoeuvre shall decelerate the vehicle up to its full braking performance if necessary and/or may perform an automatic evasive manoeuvre, **when whichever is the most** appropriate.
If failures are affecting the braking or steering performance of the system, the manoeuvre shall be carried out with the remaining performance.
During the evasive manoeuvre the ALKS vehicle shall not cross the lane marking [outer edge of the front tyre to outer edge of the lane marking] [unless the system is capable of confirming and has confirmed that no critical situation would result from this manoeuvre].
The situation is deemed critical either if there is a risk of a collision with another vehicle in the evasive path, or if a vehicle approaching from the rear in the evasive lane with the allowed or advised maximum speed would be forced to decelerate more than [4] m/s² in order to maintain a safety distance of [1]s to the ALKS vehicle once it has crossed the lane marking.
After the evasive manoeuvre the vehicle shall aim at resuming a stable position either in its original or the adjacent lane of travel.
The system shall demonstrate its capabilities to assess the criticality of an evasive manoeuvre crossing lane markings according to the relevant test in Annex X.]
- 2.10.3. An emergency manoeuvre shall only be terminated as soon as the collision risk disappeared [or in case of a system override by the driver].
- 2.10.3.1 After an Emergency Manoeuvre the system shall {continue to operate/~~initiate a transition demand~~}.
- 2.10.3.2 Once the Emergency Manoeuvre has led the vehicle to standstill, the hazard warning signal shall be activated unless the ALKS is still active.
- [2.10.4. The vehicle shall implement a logic signal indicating emergency braking as specified in UN R13H [or UN R13 as appropriate].]

