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COMMISSION IMPLEMENTING REGULATION (EU) 2021/646

of 19 April 2021

laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of motor vehicles with regard to their emergency lane-keeping systems (ELKS)

(Text with EEA relevance)

(OJ L 133, 20.4.2021, p. 31)

Corrected by:

►**C1** Corrigendum, OJ L 145, 28.4.2021, p. 42 (2021/646)

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(Text with EEA relevance)

Article 1

Administrative provisions and technical specifications for the type-approval of motor vehicles with regard to the emergency lane-keeping systems

1. The information document, submitted in accordance with Article 24(1)(a) of Regulation (EU) 2018/858 with the application for type-approval of a type of vehicle with regard to the emergency lane-keeping system, shall consist of the information relevant for that system as contained in Part 1 of Annex I.

2. The type-approval of motor vehicles with regard to emergency lane-keeping systems shall be subject to the technical specifications set out in Part 2 of Annex I.

3. Where motor vehicles with hydraulic power assisted steering are equipped, instead of emergency lane-keeping systems, with lane departure warning systems as defined in Article 3(9) of Regulation (EU) 2019/2144, those lane departure warning systems shall comply with the relevant technical specifications set out in Part 2 of Annex I.

4. The EU type-approval certificate for a type of vehicle with regard to the emergency lane-keeping system, as referred to in Article 28(1) of Regulation (EU) 2018/858, shall be drawn up in accordance with Part 3 of Annex I.

Article 2

Safety audit

Procedures for verification of the safety aspects of electronic control systems of the emergency lane-keeping systems by the approval authorities or technical services and for the assessment of the technical documentation provided by the manufacturers are laid down in Annex II.

Article 3

Entry into force and application

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

It shall apply from 6 July 2022.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

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ANNEX I

PART 1

Information document for EU type-approval of vehicles with regard to their emergency lane-keeping systems

MODEL

Information document No … relating to the EU type-approval of a type of vehicle with regard to the emergency lane-keeping system.

The following information shall be supplied in triplicate and include a list of contents. Any drawings or pictures shall be supplied in appropriate scale and in sufficient detail on size A4 or on a folder of A4 format. Photographs, if any, shall show sufficient detail.

If the systems, referred to in this information document have electronic controls, information concerning their performance shall be supplied.

0. GENERAL

0.1. Make (trade name of manufacturer):

0.2. Type:

0.2.1. Commercial name(s) (if available):

0.3. Means of identification of type, if marked on the vehicle/component/separate technical unit:

0.3.1. Location of that marking:

0.4. Category of vehicle:

0.5. Company name and address of manufacturer:

0.8. Name(s) and address(es) of assembly plant(s):

0.9. Name and address of the manufacturer's representative (if any):

1. GENERAL CONSTRUCTION CHARACTERISTICS

1.1. Photographs and/or drawings of a representative vehicle/component/separate technical unit:

1.8. Hand of drive: left/right

2. MASSES AND DIMENSIONS

(in kg and mm) (Refer to drawing where applicable)

2.6. Mass in running order

(a) Minimum and maximum for each variant:

(b) Mass of each version (a matrix must be provided):

4. TRANSMISSION

4.5. Gearbox

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4.5.1. Type: Manual/Automatic/CVT(continuously variable transmission)/ Fixedratio/Automised/Other/Wheel hub

4.7. Maximum vehicle design speed (in km/h):

6.6.1. Tyre/wheel combination(s)

6.6.1.1. Axles

6.6.1.1.1. Axle 1:

6.6.1.1.1.1. Tyre size designation	6.6.1.1.1.2. Load-capacity index	6.6.1.1.1.3. Speed category symbol	6.6.1.1.1.4. Wheel rim size (s)	6.6.1.1.1.5. Wheel off-set(s)	6.6.1.1.1.6. Rolling resistance coefficient (RRC)

6.6.1.1.2. Axle 2:

6.6.1.1.2.1. Tyre size designation	6.6.1.1.2.2. Load-capacity index	6.6.1.1.2.3. Speed category symbol	6.6.1.1.2.4. Wheel rim size (s)	6.6.1.1.2.5. Wheel off-set(s)	6.6.1.1.2.6. Rolling resistance coefficient (RRC)

etc.

6.6.1.2. Spare wheel, if any:

7.4. Emergency lane-keeping system (ELKS)

7.4.1. Technical description and drawing of the system:

7.4.2. Means to manually deactivate the ELKS:

7.4.3. Description of the automatic deactivation (if fitted):

7.4.4. Description of the automatic suppression (if fitted):

7.5. Lane Departure Warning System (LDWS)

7.5.1 Speed range of the LDWS:

7.5.2. Technical description and drawing of the LDWS):

7.6. Corrective Directional Control Function (CDCF)

7.6.1 Speed range of the CDCF:

7.6.2. Technical description and drawing of the system (in particular if the system uses steering or braking):

Explanatory note:

This information document comprises the information relevant for the emergency lane keeping system and shall be completed in accordance with the template laid down in Annex I to Commission Implementing Regulation (EU) 2020/683.

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PART 2

Technical specifications

1. Definitions

For the purpose of the Annexes, the following definitions shall apply:

1.1. ‘vehicle type with regard to its emergency lane-keeping system’ means a category of vehicles which do not differ in such essential aspects as:

(1) vehicle features which significantly influence the performances of the emergency lane-keeping system;

(2) the type and design of the emergency lane-keeping system;

1.2. ‘corrective directional control function (CDCF)’ means a control function within an electronic control system whereby, for a limited duration, changes to the steering angle of one or more wheels and/or braking of individual wheels may result from the automatic evaluation of signals initiated on-board the vehicle optionally enriched by data provided off-board the vehicle, in order to correct lane departure, e.g. to avoid crossing lane markings, leaving the road;

1.3. ‘subject vehicle’ means the vehicle being tested;

1.4. ‘distance to lane marking (DTLM)’ means the remaining lateral distance (perpendicular to the lane marking) between the inner side of the lane marking and most outer edge of the tyre before the subject vehicle crosses the inner side of the lane marking;

1.5. ‘flat road’ means a road with a slope less than 1 % in the longitudinal direction and for the lateral direction, less than 2 % for half a lane width either side of the centreline and less than 3 % for the outer half of the lane;

1.6. ‘dry road’ means a road with a nominal peak braking coefficient of 0,9;

1.7. ‘The System’ means the electronic control system and complex electronic control systems that provide or form part of the control transmission of the emergency lane-keeping system, including the transmission links to or from other vehicle systems that act on the emergency lane-keeping system;

1.8. ‘units’ means the smallest divisions of system components which will be considered, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement;

1.9. ‘transmission links’ means any electric, mechanic, pneumatic or hydraulic equipment used for inter-connecting distributed units for the purpose of conveying signals, operating data or energy supply;

1.10. ‘electronic control system’ means a combination of units, designed to cooperate in the production of a vehicle control function by electronic data processing;

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1.11. ‘complex electronic vehicle control system’ means an electronic control system in which a function controlled by an electronic system or the driver may be over-ridden by a higher level electronic control system/function, thus becoming part of the complex system, as well as any overriding of the system, including the transmission links to and from the overriding systems/function outside of the scope of this Regulation;

1.12. ‘control strategy’ means a strategy to ensure robust and safe operation of the function(s) of an electronic control system in response to a specific set of ambient and/or operating conditions (such as road surface condition, traffic intensity and other road users, adverse weather conditions, etc.), which may include the automatic deactivation of a function or temporary performance restrictions (e.g. a reduction in the maximum operating speed, etc.);

1.13. ‘safety concept’ means a description of the measures designed into the system, for instance within the electronic units, so as to address system integrity and ensure safe operation under fault and non-fault conditions, including in the event of an electrical failure. The possibility of a fallback to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.

2. General requirements

2.1. An emergency lane-keeping system (ELKS) shall comprise a lane departure warning system (LDWS) and a corrective directional control function (CDCF).

2.1.1. The LDWS shall meet the requirements of points of 3.1 to 3.4 and point 3.5.

2.1.2. The CDCF shall meet the requirements of points of 3.1 to 3.4 and point 3.6.

2.2. ELKS lane departure warnings and interventions

Subject to specific requirements below the system shall be designed to minimise warnings and interventions for driver intended manoeuvres.

3. Specific requirements

3.1. ELKS failure warning

A warning shall be provided when there is a failure in the ELKS that prevents the requirements of this Regulation of being met.

3.1.1. The failure warning shall be a constant visual warning signal.

3.1.1.1. There shall not be an appreciable time interval between each ELKS self-check (an integrated function that checks for a system failure on a continuous basis at least while the system is active), and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.

3.1.1.2. Upon detection of any non-electrical failure condition (e.g. sensor misalignment), the warning signal as defined in point 3.1.1 shall be activated.

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3.1.2. If the vehicle is equipped with a means to deactivate the ELKS a warning shall be given when the system is deactivated according to point 3.2. This shall be a constant visual warning signal. The failure warning signal specified in point 3.1.1. may be used for this purpose.

3.2. ELKS deactivation

3.2.1. Manual deactivation

When a vehicle is equipped with a means to manually deactivate the ELKS function, either partially or fully, the following conditions shall apply as appropriate:

3.2.1.1. The full ELKS function shall be automatically and fully reinstated upon each activation of the vehicle master control switch.

3.2.1.2. The manual deactivation of the full ELKS shall not be possible with less than two deliberate actions, e.g. press and hold on a button, or select and confirm on menu option. It shall be possible to easily suppress acoustic warnings of the LDWS, but such action shall not at the same time deactivate the LDWS or the CDCF.

3.2.1.3. The manual deactivation capability shall be tested in accordance with the relevant vehicle test(s) specified in point 3.

3.2.2. Automatic deactivation

If the vehicle is equipped with a means to automatically deactivate the ELKS function, either partially or fully, for instance in situations such as off-road use, being towed, a trailer being hitched to the vehicle or the electronic stability control (ESC) being deactivated, the following conditions shall apply as appropriate:

3.2.2.1. As part of the safety audit, the vehicle manufacturer shall provide a list of situations and corresponding criteria where the ELKS function is automatically deactivated which shall be annexed to the test report.

3.2.2.2. The ELKS function shall be automatically and fully reactivated as soon as the conditions that led to the automatic deactivation are not present anymore.

3.2.3. A constant visual warning signal shall inform the driver that the ELKS function has been deactivated. The failure warning signal specified in point 3.1.1 above may be used for this purpose.

3.3. Automatic suppression

3.3.1. For driver intended manoeuvres

As part of the safety audit, the manufacturer shall provide a documentation package which gives access to the basic design and logic of the system for detection of likely driver intended manoeuvres and automatic suppression of the ELKS. This package shall include a list of parameters detected and a basic description of the method used to decide that the system should be suppressed, including limit values where possible. For both the CDCF and LDWS, the Technical Service shall assess the documentation package to show that driver unintentional manoeuvres, within the scope of the lane keep test parameters (in particular lateral departure velocity), will not result in automatic suppression of the system.

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3.3.2. Automatic suppression of the ELKS is also permitted in situations when other driver assist or automated steering functions, (i.e. Automatically commanded steering function, emergency steering function or automated lane keeping), are controlling the lateral movement of the vehicle or other safety related functions (i.e. that is capable of changing the dynamic behaviour of the vehicle such as AEBS, ESC, etc.) are intervening. These situations shall be declared by the manufacturer as part of the safety audit.

3.4. Provisions for periodic roadworthiness tests

3.4.1. For the purpose of periodic roadworthiness tests of vehicles, it shall be possible to verify the following features of the ELKS:

(a) Its correct operational status, by visible observation of the failure warning signal status following the activation of the vehicle master control switch and any bulb check. Where the failure warning signal is displayed in a common space (the area on which two or more information functions/symbols may be displayed, but not simultaneously), it must be checked first that the common space must be observed to be functional prior to the failure warning signal status check;

(b) Its correct functionality and the software integrity, by the use of an electronic vehicle interface, such as the one laid down in point I.(14) of Annex III of Directive 2014/45/EU of the European Parliament and of the Council ([1]), where the technical characteristics of the vehicle allow for it and the necessary data is made available. Manufacturers shall ensure to make available the technical information for the use of the electronic vehicle interface in accordance with Article 6 of Commission Implementing Regulation (EU) 2019/621 ([2]).

3.4.2. At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined as part of the safety audit in Annex II. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the ELKS is available.

3.5. LDWS requirements

3.5.1. Speed range

The LDWS shall be active at least within the vehicle speed range between 65 km/h and 130 km/h (or the maximum vehicle speed if it is lower than 130 km/h) and at all vehicle load conditions, unless deactivated as per point 3.2.

3.5.2. Lane departure warning

When activated and operated within the prescribed speed range, the LDWS shall be able to warn the driver at the latest if the vehicle crosses over a visible lane marking for the lane in which it is running by more than a DTLM of – 0,3 m:

([1]) Directive 2014/45/EU of the European Parliament and of the Council of 3 April 2014 on periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC (OJ L 127, 29.4.2014, p. 51).

([2]) Commission Implementing Regulation (EU) 2019/621 of 17 April 2019 on the technical information necessary for roadworthiness testing of the items to be tested, on the use of the recommended test methods, and establishing detailed rules concerning the data format and the procedures for accessing the relevant technical information (OJ L 108, 23.4.2019, p. 5).

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(a) for lateral departure velocities in the range of the 0,1 m/s to 0,5 m/s;

(b) on straight, flat and dry roads;

(c) for solid line and dashed lane markings in line with one of those described in Annex 3 (Visible lane marking identification) to Regulation No 130 of the United Nations Economic Commission for Europe (UNECE) – Uniform provisions concerning the approval of motor vehicles with regard to the Lane Departure Warning System ([1]) and other markings expected on EU roads;

(d) with the markings being in good condition and of a material conforming to the standard for visible markings of that contracting party;

(e) in all illumination conditions without blinding of the sensors (e.g. direct blinding due to sunlight) and with activated passing-beam (dipped-beam) headlamps if necessary;

(f) in absence of weather conditions affecting the visibility of lane markings (e.g. no fog).

It is recognised that the performance required may not be fully achieved in other conditions than those listed above. However, the system shall not unreasonably switch the control strategy in these other conditions.

The lane departure warning capability shall be tested in accordance with the relevant vehicle test(s) specified in point 4.

3.5.3. LDWS warning indication

3.5.3.1. The lane departure warning referred to in point 3.5.2 shall be noticeable by the driver and be provided by:

(a) at least two warning means out of visual, acoustic and haptic; or

(b) one warning means out of haptic and acoustic, with spatial indication about the direction of unintended drift of the vehicle.

The warning mentioned above may be suppressed when there is a driver action which indicates an intention to depart from the lane;

3.5.3.1.1. Where a visual signal is used for the lane departure warning, it may use the failure warning signal as specified in point 3.1.1 above in a flashing mode.

3.5.3.1.2. When there is a lane keep intervention by the CDCF, this shall be considered a haptic warning according to point 3.5.3.1.

3.5.3.2. The LDWS visual warning signal shall be activated following a vehicle master control switch ‘power-ON’. This requirement does not apply to warning signals shown in a common space.

3.5.3.3. The LDWS visual warning signals shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver’s seat.

([1]) OJ L 178, 18.6.2014, p. 29.

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3.5.3.4. The visual warning signal shall be tested in accordance with the relevant vehicle test(s) specified in point 4.

3.6. CDCF performance requirements

3.6.1. Speed range

The CDCF shall be active at least between 70 km/h and 130 km/h (or the maximum vehicle speed if it is below 130 km/h) and at all vehicle load conditions, unless deactivated as per point 3.2. However, in the case that the vehicle reduces its speed from above 70 km/h to below 70 km/h, the system shall be active at least until the vehicle speed reduces below 65 km/h.

3.6.2. Lane keep

In the absence of conditions leading to deactivation or suppression of the system, the CDCF shall be able to prevent lane departure by crossing of visible lane markings in the scenarios shown in the following table by more than a DTLM of – 0,3 m:

(a) for lateral departure velocities in the range of the 0,2 m/s to 0,5 m/s for vehicle speeds up 100 km/h and for lateral departure velocities in the range of 0,2 m/s to 0,3 m/s for vehicle speeds greater than 100 km/h and up to 130 km/h (or the maximum vehicle speed if it is below 130 km/h);

(b) on straight, flat and dry roads;

(c) for solid lane markings in line with one of those described in Annex 3 (Visible lane marking identification) to UN Regulation No 130;

(d) with the markings being in good condition and of a material conforming to the standard for visible markings of that contracting party;

(e) in all illumination conditions without blinding of the sensors (e.g. direct blinding sunlight) and with activated passing-beam (dipped-beam) headlamps if necessary;

(f) in absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 5 °C) or the visibility of lane markings (e.g. no fog).

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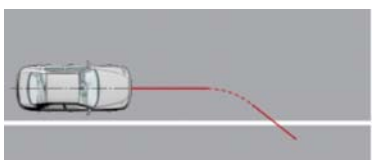
No	Scenario description
1.	Solid line – Departure to right side of the vehicle 

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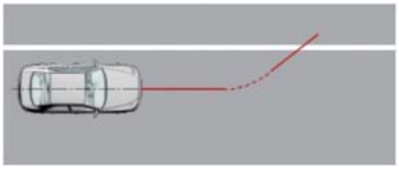
No	Scenario description
2.	Solid line – Departure to left side of the vehicle 

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It is recognised that the performances required for the scenarios in this table may not be fully achieved in other conditions than those listed above. However, the system shall not unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with the safety audit.

The lane keep capability shall be tested in accordance with the relevant vehicle test(s) specified in point 5.

3.6.3. Steering override

3.6.3.1. The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N. Significant loss of steering support once overridden shall not happen suddenly.

3.6.3.2. For CDCF systems which do not act on the steering itself (e.g. differential braking type CDCF), the steering input shall not exceed 25 degrees.

3.6.3.3. The steering override control effort shall be tested in accordance with the relevant vehicle test(s) specified in point 5.

3.6.4. CDCF warning indication

3.6.4.1. Every CDCF intervention shall immediately be indicated to the driver by a visual warning signal which is displayed for at least 1 second or as long as the intervention exists, whichever is longer. The visual signal may be the flashing of the failure warning signal specified in point 3.1.1.

3.6.4.1.1. In the case of an intervention longer than 10 seconds, an acoustic warning signal shall be provided until the end of the intervention unless there is a driver action which indicates an intention to depart from the lane.

3.6.4.1.2. In the case of two or more consecutive interventions within a rolling interval of 180 seconds and in the absence of a steering input by the driver during this intervention, an acoustic warning signal shall be provided by the system during the second and any further intervention within a rolling interval of 180 seconds. Starting with the third intervention (and subsequent interventions) the acoustic warning signal shall continue for at least 10 seconds longer than the previous warning signal.

3.6.4.2. The requirements in points 3.6.4.1.1 and 3.6.4.1.2 shall be tested in accordance with the relevant vehicle test(s) specified in point 5.

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4. Test requirements for LDWS

4.1. General provisions

Vehicles fitted with LDWS shall fulfil the appropriate tests requirements of this point

4.2. Testing conditions

The tests shall be performed:

(a) On a flat and dry asphalt or concrete road type surface, which 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 30 m ahead of the subject vehicle from the point after the test is complete.

(b) In ambient illumination conditions of at least 2 000 lux without blinding of the sensors (e.g. direct blinding sunlight) and with activated low beam head lamps if necessary.

(c) In ambient air temperatures between 5 °C and 45 °C.

(d) In the absence of weather conditions affecting the visibility of lane markings, e.g. fog.

At the manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above (e.g. at lower ambient air temperatures).

4.2.1. Lane markings

The solid line and dashed lane markings on the road used for the tests shall be in line with one of those described in Annex 3 (Visible lane marking identification) to UN Regulation No 130. The markings shall be in good condition and of a material conforming to the standard for visible lane markings. The lane-marking layout used for the tests shall be recorded in the test report.

The width of the lane (measured between the lane markings) shall be a minimum of 3,5 m for the purpose of the tests of this point. The vehicle manufacturer shall demonstrate, through the use of documentation, compliance with all other lane markings identified in Annex 3 (Visible lane marking identification) to UN Regulation No 130. Any of such documentation shall be appended to the test report.

4.2.2. Subject vehicle conditions

4.2.2.1. Test mass

The subject vehicle shall be tested in a load condition agreed between the manufacturer and the Technical Service. No load alteration shall be made once the test procedure has begun. The vehicle manufacturer shall demonstrate, through the use of documentation, that the system works at all load conditions.

4.2.2.2. The subject vehicle shall be tested at the tyre pressures recommended by the vehicle manufacturer.

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4.2.2.3. Where the LDWS is equipped with a user-adjustable warning threshold, the tests specified in point 4.3 shall be performed with the warning threshold set at its maximum lane departure setting. No alteration shall be made once the test procedure has begun.

4.2.2.4. Pre-test conditioning

If requested by the vehicle manufacturer the vehicle can be driven to calibrate the sensor system up to a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture.

4.3. Test procedures

4.3.1. Visual warning signal verification test

With the vehicle stationary check that the visual warning signal(s) comply with the requirements of point 3.5.3.2.

4.3.2. Lane departure warning test

4.3.2.1. Drive the vehicle at a speed of 70 km/h +/– 3 km/h into the centre of the test lane in a smooth manner so that the attitude of the vehicle is stable.

Maintaining the prescribed speed, gently drift the vehicle, either to the left or the right, with a lateral departure velocity of between 0,1 and 0,5 m/s so that the vehicle crosses the lane marking.

Repeat the test at a different rate of departure within the range 0,1 and 0,5 m/s. Repeat the above tests drifting in the opposite direction.

4.3.2.2. The test requirements are fulfilled if the LDWS provides the lane departure warning indication mentioned in point 3.5.3.1 above at the latest when the DLTM is – 0,3 m.

4.3.2.3. In addition, the vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements for the whole speed range and lateral departure velocity range are fulfilled. This may be achieved on the basis of appropriate documentation appended to the test report.

4.3.3. Manual deactivation test

4.3.3.1. If the vehicle is equipped with means to manually deactivate the ELKS (LDWS), turn the vehicle master control switch to the ‘Power ON’ position and deactivate the ELKS (LDWS). The warning signal specified in point 3.2.3 shall be activated.

Turn the master control switch to the ‘Power OFF’ position. Turn the vehicle master control switch to the ‘Power ON’ position and verify that the previously activated warning signal is not reactivated, thereby indicating that the ELKS (LDWS) has been reinstated as specified in point 3.2.1.1.

5. Test requirements for CDCF

5.1. General provisions

Vehicles fitted with CDCF shall fulfil the appropriate tests requirements of this point.

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5.2. Testing conditions

The tests shall be performed:

(a) On a flat and dry asphalt or concrete road type surface, which 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 30 m ahead of the subject vehicle from the point after the test is complete.

(b) In ambient illumination conditions of at least 2 000 lux without blinding of the sensors (e.g. direct blinding sunlight) and with activated low beam head lamps if necessary.

(c) In ambient air temperatures between 5 °C and 45 °C.

(d) In the absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 5 °C) or the visibility of lane markings (e.g. fog).

At the manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above (e.g. at lower ambient air temperatures).

5.2.1. Lane markings

The solid lane marking on the road used for the tests shall be in line with one of those described in Annex 3 (Visible lane marking identification) to UN Regulation No 130. The marking shall be in good condition and of a material conforming to the standard for visible lane markings. The lane-marking used for the tests shall be recorded in the test report.

The solid lane marking shall be a minimum of 3,5 m distance from any other lane markings, for the purpose of the tests of this point. The vehicle manufacturer shall demonstrate, through the use of documentation, compliance with all other solid lane markings identified in Annex 3 (Visible lane marking identification) to UN Regulation No 130. Any of such documentation shall be appended to the test report.

5.2.2. Subject vehicle conditions

5.2.2.1. Test mass

The subject vehicle shall be tested in a load condition agreed between the manufacturer and the Technical Service. No load alteration shall be made once the test procedure has begun. The vehicle manufacturer shall demonstrate, through the use of documentation, that the system works at all load conditions.

5.2.2.2. The subject vehicle shall be tested at the tyre pressures recommended by the vehicle manufacturer.

5.2.2.3. Where the CDCF is equipped with a user-adjustable timing threshold, the test specified in point 5.3.3 shall be performed with the timing threshold set at its latest setting for system intervention. No alteration shall be made once the test procedure has begun.

5.2.2.4. Pre-test conditioning

If requested by the vehicle manufacturer the vehicle can be driven to calibrate the sensor system up to a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture.

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5.3. Tests procedures

5.3.1. Warning Indication test

5.3.1.1. The subject vehicle shall be driven with an activated CDCF on a road with solid lane markings on at least one side of the lane.

The test conditions and the subject vehicle test speed shall be within the operating range of the system.

During the test, the duration of the CDCF interventions and of the visual and acoustic warning signals shall be recorded.

In the case referred to in point 3.6.4.1.1, the subject vehicle shall be driven such that it attempts to leave the lane and causes CDCF intervention to be maintained for a period longer than 10 seconds. If such a test cannot be practically achieved due to e.g. the limitations of the test facilities, with the consent of the Type Approval Authority this requirement may be fulfilled through the use of documentation.

The test requirements are fulfilled if the acoustic warning is provided no later than 10 seconds after the beginning of the intervention.

In the case referred to in point 3.6.4.1.2., the subject vehicle shall be driven in such a way that it attempts to leave the lane and causes at least three interventions of the system within a rolling interval of 180 seconds.

The test requirements are fulfilled if all the following conditions are met:

(a) a visual warning signal is provided for each intervention, as long as the intervention exists;

(b) an acoustic warning signal is provided at the second and third intervention;

(c) the acoustic warning signal at the third intervention is at least 10 s longer than the one at the second intervention.

5.3.1.2. In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in points 3.6.4.1.1 and 3.6.4.1.2 are fulfilled in the whole range of CDCF operation. This may be achieved on the basis of appropriate documentation appended to the test report.

5.3.2. Steering override test

5.3.2.1. The subject vehicle shall be driven with an activated CDCF on a road with solid lane markings on each side of the lane.

The test conditions and the subject vehicle test speed shall be within the operating range of the system.

The vehicle shall be driven such that it attempts to leave the lane and causes CDCF intervention. During the intervention, the driver shall apply the steering control effort necessary to override the intervention.

The force and steering input applied by the driver on the steering control to override the intervention shall be recorded.

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The test requirements are fulfilled if:

(a) The force applied by the driver on the steering control to override the intervention does not exceed 50 N.

(b) There is no sudden loss of significant steering support once CDCF is overridden.

(c) For ELKS that do not act on the steering itself (e.g. differential braking type CDCF), the steering input does not exceed 25 degrees.

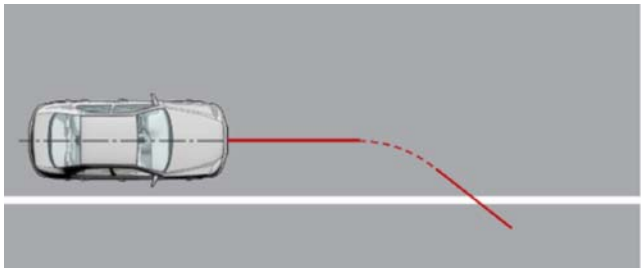
5.3.2.2. In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in paragraph 3.6.4 are fulfilled in the whole range of CDCF operation. This may be achieved on the basis of appropriate documentation appended to the test report.

5.3.3. Lane keep test

5.3.3.1. The CDCF shall be tested for test scenarios No 1 and No 2 described in point 3.6.2.

5.3.3.1.1. Tests for all scenarios shall be performed with lateral velocities of 0,2 m/s and 0,5 m/s.

5.3.3.1.2. A test path shall be driven which consists of an initial straight path parallel to the solid lane marking being tested, followed by a fixed radius curve to apply a known lateral velocity and yaw to the subject vehicle, followed again by a straight path without any force applied on the steering control (e.g. by removing the hands from the steering control).



5.3.3.1.3. The subject vehicle speed during the test up to the point of system intervention shall be 72 km/h +/– 1 km/h.

The curve of fixed radius driven to apply the lateral velocity required shall have a radius 1 200 m or more.

The lateral velocity required shall be achieved to a tolerance of +/– 0,05 m/s.

The vehicle manufacturer shall provide information describing the radius of the curve to be driven and the location when the closed loop path and/or speed control shall be ended so as to ensure a free drifting in order not to interfere an automatic suppression according to point 3.3.1.

5.3.3.2. The test requirements are fulfilled if the subject vehicle does not cross the lane marking by a DTLM of more than – 0,3 m.

5.3.3.3. In addition, the vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements for the whole speed range and lateral departure velocity range are fulfilled. This may be achieved on the basis of appropriate documentation appended to the test report.

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PART 3

EU TYPE-APPROVAL CERTIFICATE (VEHICLE SYSTEM)

Communication concerning *granting*/*extension*/*refusal*/*withdrawal* ([1]) of type-approval of a type of vehicle with regard to its emergency lane-keeping system in accordance with the requirements laid down in Commission Implementing Regulation (EU) 2021/646 ([2]) *[PO: this Regulation]*, as last amended by Regulation (EU) No 2021/646

Number of the EU type-approval certificate:

Reason for *extension*/*refusal*/*withdrawal* ([1]):

SECTION I

0.1. Make (trade name of manufacturer):

0.2. Type:

0.2.1. Commercial name(s) (if available):

0.3. Means of identification of type, if marked on the vehicle:

0.3.1. Location of that marking:

0.4. Category of vehicle:

0.5. Name and address of manufacturer:

0.8. Name(s) and address(es) of assembly plant(s):

0.9. Name and address of the manufacturer's representative (if any):

SECTION II

1. Additional information (where applicable): see Addendum.

2. Technical service responsible for carrying out the tests:

3. Date of test report:

4. Number of test report:

5. Remarks (if any): see Addendum.

6. Place:

7. Date:

8. Signature:

([1]) Delete where not applicable.

([2]) Commission Implementing Regulation (EU) 2021/646 of 19 April 2021 laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of motor vehicles with regard to their emergency lane-keeping systems (ELKS) (OJ L 133, 20.4.2021, p. 31).

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Addendum

to EU type-approval certificate number

1. Additional information

1.1. Description of the system

1.2. Means to manually deactivate the ELKS

1.3. Description of the automatic deactivation (if fitted).

1.4. Description of the automatic suppression (if fitted)

1.5. Lane Departure Warning System (LDWS)

1.5.1 Speed range of the LDWS

1.5.2. Technical description and drawing of the LDWS)

1.6. Corrective Directional Control Function (CDCF)

1.6.1 Speed range of the CDCF

1.6.2. Description of the system (in particular if the system uses steering or braking)

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ANNEX II

SAFETY AUDIT

1. General

1.1. This Annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of electronic control system(s) and complex electronic vehicle control system(s) of the emergency lane-keeping system.

1.1.1. Electronic control systems are commonly controlled by software and are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements.

1.2. This Annex does not specify the performance criteria for the 'The System' covered by this Regulation but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes.

1.3. This information shall show that 'The System' respects, under non-fault and fault conditions, all the appropriate performance requirements specified in Part 2 of Annex I and that it is designed to operate in such a way that it does not induce safety critical risks.

2. Documentation

2.1. Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of 'The System' and the means by which it is linked to other vehicle systems or by which it directly controls output variables. The function(s) of 'The System', including the control strategies, and the safety concept, as laid down by the manufacturer, shall be explained. Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved. For periodic roadworthiness tests, the documentation shall describe how the current operational status of 'The System' can be checked.

The Technical Service shall assess the documentation package to show that 'The System':

(a) is designed to operate, under non-fault and fault conditions, in such a way that it does not induce safety critical risks;

(b) respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation; and

(c) was developed according to the development process/method declared by the manufacturer and that this includes at least the steps listed in point 2.4.4.

2.1.1. Documentation shall be made available in two parts:

(a) The formal documentation package for the approval, containing the material listed in point 2. (with the exception of that of point 2.4.4.) which shall be supplied to the Technical Service at the time of submission of the type approval application. This documentation package shall be used by the Technical Service as the basic reference for the verification process set out in point 3. The Technical Service shall ensure that this documentation package remains available for a period determined in agreement with the Approval Authority. This period shall be at least 10 years counted from the time when production of the vehicle is definitely discontinued.

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(b) Additional material and analysis data of point 2.4.4. which shall be retained by the manufacturer, but made open for inspection at the time of type approval. The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued.

2.2. A description shall be provided which gives a simple explanation of all the functions including control strategies of 'The System' and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

Any described function that can be over-ridden shall be identified and a further description of the changed rationale of the function's operation provided.

2.2.1. A list of all input and sensed variables shall be provided and the working range of these defined, along with a description of how each variable affects system behaviour.

2.2.2. A list of all output variables which are controlled by 'The System' shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle system. The range over which 'The System' is likely to exercise control on each output variable shall be defined.

2.2.3. Limits defining the boundaries of functional operation (i.e. the external physical limits within which the system is able to maintain control) shall be stated where appropriate to system performance.

2.3. System layout and schematics.

2.3.1. Inventory of components.

A list shall be provided, collating all the units of 'The System' and mentioning the other vehicle systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination, shall be provided with both the equipment distribution and the interconnections made clear.

2.3.2. Functions of the units

The function of each unit of 'The System' shall be outlined and the signals linking it with other units or with other vehicle systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

2.3.3. Interconnections within 'The System' shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages. The transmission links both to and from other systems shall also be shown.

2.3.4. There shall be a clear correspondence between transmission links and the signals carried between units. Priorities of signals on multiplexed data paths shall be stated wherever priority may be an issue affecting performance or safety.

2.3.5. Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

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Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used. The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

2.3.5.1. The identification defines the hardware and software version and, where the latter changes such as to alter the function of the Unit as far as this Regulation is concerned, this identification shall also be changed.

2.4. Safety concept of the manufacturer

2.4.1. The manufacturer shall provide a statement which affirms that the strategy chosen to achieve 'The System' objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

2.4.2. In respect of software employed in 'The System', the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall show evidence of the means by which they determined the realisation of the system logic, during the design and development process.

2.4.3. The manufacturer shall provide the Technical Service with an explanation of the design provisions built into 'The System' so as to generate safe operation under fault conditions. Possible design provisions for failure in 'The System' are for example:

(a) fall-back to operation using a partial system;

(b) change-over to a separate back-up system;

(c) removal of the high level function.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the ignition (run) switch to 'off', or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

2.4.3.1. If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

2.4.3.2. If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

2.4.3.3. If the chosen provision selects the removal of the higher level electronic control function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

2.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any of those hazards or faults which will have a bearing on vehicle control performance or safety.

The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the Technical Service at the time of the type approval.

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The Technical Service shall perform an assessment of the application of the analytical approach(es). The assessment shall include:

(a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of:

(i) interactions with other vehicle systems;

(ii) malfunctions of the system, within the scope of this Regulation;

(iii) for the functions referred to in point 2.2.:

— situations when a system free from faults may create safety critical risks (e.g. due to a lack of or wrong comprehension of the vehicle environment),

— reasonably foreseeable misuse by the driver,

— intentional modification of the system.

This approach shall be based on a hazard/risk analysis appropriate to system safety.

(b) Inspection of the safety approach at the system level. This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety.

(c) Inspection of the validation plans and results. This shall include validation testing appropriate for validation, for example, Hardware in the Loop (HIL) testing, vehicle on-road operational testing, or any other testing appropriate for validation.

The assessment shall consist of spot checks of selected hazards and faults to establish that argumentation supporting the safety concept is understandable and logical and validation plans are suitable and have been completed.

The Technical Service may perform or may require to perform tests as specified in point 3. to verify the safety concept.

2.4.4.1. This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined in point 2.4.4., the warning signal to be given to the driver and/or to service/technical inspection personnel.

2.4.4.2. This documentation shall describe the measures in place to ensure the 'The System' does not prejudice the safe operation of the vehicle when the performance of 'The System' is affected by environmental conditions e.g. climatic, temperature, dust ingress, water ingress, ice packing.

3. Verification and test

3.1. The functional operation of 'The System', as laid out in the documents required in point 2., shall be tested as follows:

3.1.1. Verification of the function of 'The System'

The Technical Service shall verify 'The System' under non-fault conditions by testing a number of selected functions from those described by the manufacturer in point 2.2.

For complex electronic systems, these tests shall include scenarios whereby a declared function is overridden.

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3.1.1.1. The verification results shall correspond with the description, including the control strategies, provided by the manufacturer in point 2.2.

3.1.2. Verification of the safety concept of point 2.4.

The reaction of 'The System' shall be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit. The Technical Service shall conduct this check for at least one individual unit, but shall not check the reaction of 'The System' to multiple simultaneous failures of individual units.

The Technical Service shall verify that these tests include aspects that may have an impact on vehicle controllability and user information (HMI aspects).

4. Reporting by Technical Service

Reporting of the assessment by the Technical Service shall be performed in such a manner that allows traceability, e.g. versions of documents inspected are coded and listed in the records of the Technical Service.

An example of a possible layout for the assessment form from the Technical Service to the Type Approval Authority is given in the Appendix.

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Appendix

Model assessment form for ELKS

Test report No:

1. Identification.

1.1. Vehicle make:

1.2 Type

1.3 Means of identification of type if marked on the vehicle:

1.4. Location of that marking:

1.5. Manufacturer's name and address:

1.6. If applicable, name and address of manufacturer's representative:

1.7. Manufacturer's formal documentation package:

Documentation reference No:

Date of original issue:

Date of latest update:

2. Test vehicle(s)/system(s) description

2.1. General description:

2.2. Description of all the control functions of 'The System', and methods of operation:

2.3. Description of the components and diagrams of the interconnections within 'The System':

2.4. General description:

2.5. Description of all the control functions of 'The System', and methods of operation:

2.6. Description of the components and diagrams of the interconnections within "The System

3. Manufacturer's safety concept

3.1. Description of signal flow and operating data and their priorities:

3.2. Manufacturer's declaration:

The manufacturer(s)..... affirm(s) that the strategy chosen to achieve 'The System' , objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

3.3. Software outline architecture and the design methods and tools used:

3.4. Explanation of design provisions built into 'The System' under fault conditions:

3.5. Documented analyses of the behaviour of 'The System' under individual hazard or fault conditions:

3.6. Description of the measures in place for environmental conditions:

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3.7. Provisions for the periodic roadworthiness test of ‘The System’:

3.8. Results of ‘The System’ verification test, referred to in point 3.1.1. of Annex II to Commission Implementing Regulation (EU) 2021/646 ([1]).

3.9. Results of safety concept verification test, referred to in point 3.1.2. of Annex II to Implementing Regulation (EU) 2021/646.

3.10. Date of test:

3.11. This test has been carried out and the results reported in accordance with Regulation (EU) 2021/646, as last amended by Regulation (EU) 2021/646

Technical Service carrying out the test

Signed: ..... Date: .....

3.12. Comments:

([1]) Commission Implementing Regulation (EU) 2021/646 of 19 April 2021 laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of motor vehicles with regard to their emergency lane-keeping systems (ELKS) (OJ L 133, 20.4.2021, p. 31).