

Technical Safety Concept Lane Assistance

**Document Version: V1.0**



# Document history

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| 2020/09/15 | V1.0 | Mohamed Ayman | First submission |
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# Table of Contents

[Document history](#_1t3h5sf)

[Table of Contents](#_ktt3lgighckp)

[Purpose of the Technical Safety Concept](#_fulgh8sf1ocg)

[Inputs to the Technical Safety Concept](#_757cx6xm46zb)

[Functional Safety Requirements](#_2f9rjqxbsp2)

[Refined System Architecture from Functional Safety Concept](#_qp3s9pvua9mt)

[Functional overview of architecture elements](#_cqb49updinx4)

[Technical Safety Concept](#_mx8us8onanqo)

[Technical Safety Requirements](#_lnxjuovv6kca)

[Refinement of the System Architecture](#_74udkdvf7nod)

[Warning and Degradation Concept](#_4w6r8buy4lrp)

# Purpose of the Technical Safety Concept

Technical Safety Concept gets into details of the item Technology and build more concrete requirements.

# Inputs to the Technical Safety Concept

## Functional Safety Requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Safe State** |
| Functional  Safety  Requirement  01-01 | The Electronic power steering ECU shall ensure that the lane departure oscillating torque amplitude is below Max\_toruque\_amplitude. | C | 50ms | the lane departure oscillating torque amplitude is below Max\_toruque\_amplitude |
| Functional  Safety  Requirement  01-02 | The Electronic power steering ECU shall ensure that the lane departure oscillating torque frequency is below Max\_toruque\_frequency | C | 50ms | the lane departure oscillating torque frequency is below Max\_toruque\_frequency |
| Functional  Safety  Requirement  01-03 | The Electronic power steering ECU shall ensure that the lane departure oscillating torque amplitude is upper Min\_toruque\_amplitude | A | 500ms | the lane departure oscillating torque amplitude is upper Min\_toruque\_amplitude |
| Functional  Safety  Requirement  01-04 | The Electronic power steering ECU shall ensure that the lane departure oscillating torque frequency is upper Min\_toruque\_frequency | A | 500ms | the lane departure oscillating torque frequency is upper |
| Functional  Safety  Requirement  02-01 | Electronic power steering ECU shall be time limited and the additional steering torque shall end after a given timer interval so that the driver cannot misuse the system for autonomous driving | C | 50ms | lane keeping assistance function shall be time limited |
| Functional  Safety  Requirement  02-02 | Lane keeping assistance function shall be deactivated in case of the camera can't work under some environmental condition | C | 50ms | Lane keeping assistance function shall be deactivated in some environmental conditions |

## Refined System Architecture from Functional Safety Concept



### 

### Functional overview of architecture elements

|  |  |
| --- | --- |
| **Element** | **Description** |
| Camera Sensor | Take images for the road and provide it to the Camera ECU |
| Camera Sensor ECU - Lane Sensing | Detect the lane lines and the position of the car according to Lane line. |
| Camera Sensor ECU - Torque request generator | Calculate the torque and send it to the electronic power steering ECU |
| Car Display | Display warnings and the status of the system |
| Car Display ECU - Lane Assistance On/Off Status | Display the status of the Lane assistance if it is on or off |
| Car Display ECU - Lane Assistant Active/Inactive | Display the status of the Lane assistance if it is active and inactive |
| Car Display ECU - Lane Assistance malfunction warning | Display warnings of malfunctions |
| Driver Steering Torque Sensor | Measure the torque that applied to the steering wheel |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Receive the driver steering torque from camera sensor ECU |
| EPS ECU - Normal Lane Assistance Functionality | Receive the torque amplitude and frequency from the Camera sensor ECU |
| EPS ECU - Lane Departure Warning Safety Functionality | Receive the torque amplitude and frequency from the Camera sensor ECU |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Ensure that the torque is limited and doesn't exceed the maximum limit |
| EPS ECU - Final Torque | Receive the torque and send it to the motor |
| Motor | Apply the torque to the steering wheel |

# 

# Technical Safety Concept

## Technical Safety Requirements

**Lane Departure Warning (LDW) Requirements:**

Functional Safety Requirement 01-01 with its associated system elements

(derived in the functional safety concept)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **Electronic Power Steering ECU** | **Camera ECU** | **Car Display ECU** |
| Functional  Safety  Requirement  01-01 | The lane keeping item shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude | X |  |  |

Technical Safety Requirements related to Functional Safety Requirement 01-01 are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Architecture Allocation** | **Safe State** |
| Technical  Safety  Requirement  01 | The Lane Departure Warning safety component shall ensure that the amplitude of the ‘LDW\_Torque\_Request’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max\_Torque\_Amplitude. | C | 50ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  02 | The validity and integrity of the data transmission for LDW\_Torque\_Request signal shall be ensured. | C | 50ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  03 | The Lane Departure Warning safety component shall ensure that if there is any fault , the amplitude of the ‘LDW\_Torque\_Request’ sent to the ‘Final electronic power steering Torque’ component should return back to the safe state | C | 50ms | LDW Safety | Lane Departure Warning torque to zero. |

Functional Safety Requirement 01-2 with its associated system elements

(derived in the functional safety concept)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **Electronic Power Steering ECU** | **Camera ECU** | **Car Display ECU** |
| Functional  Safety  Requirement  01-02 | The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max\_Torque\_Frequency | X |  |  |

Technical Safety Requirements related to Functional Safety Requirement 01-02 are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Architecture Allocation** | **Safe State** |
| Technical  Safety  Requirement  01 | The Lane Departure Warning safety component shall ensure that the frequency of the ‘LDW\_Torque\_Request’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max\_Torque\_frequency. | C | 50ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  02 | The validity and integrity of the data transmission for LDW\_Torque\_Request signal shall be ensured. | C | 50ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  03 | The Lane Departure Warning safety component shall ensure that if there is any fault , the amplitude of the ‘LDW\_Torque\_Request’ sent to the ‘Final electronic power steering Torque’ component should return back to the safe state | C | 50ms | LDW Safety | Lane Departure Warning torque to zero. |

**Lane Keeping Assistance (LKA) Requirements:**

Functional Safety Requirement 02-1 with its associated system elements

(derived in the functional safety concept)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **Electronic Power Steering ECU** | **Camera ECU** | **Car Display ECU** |
| Functional  Safety  Requirement  02-01 | The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max\_Duration | X |  |  |

Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Allocation to Architecture** | **Safe State** |
| Technical  Safety  Requirement  01 | The Lane Keeping Assistance shall ensure that the duration of applying the torque is less than the Max\_Duration | C | 50ms | LKA Safety | Lane keeping assistance torque to zero |
| Technical  Safety  Requirement  02 | The Lane Keeping Assistance shall set the torque to zero if there is a fault | C | 50ms | LKA Safety | Lane keeping assistance torque to zero |
| Technical  Safety  Requirement  03 | The Lane Keeping Assistance shall warn the car display and turn on the warning light if there is a malfunction | C | 500ms | LKA Safety | Lane keeping assistance torque to zero |

## Refinement of the System Architecture



## Warning and Degradation Concept

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | turn off the lane departure functionality | Malfunction\_1  Malfunction\_2  Malfunction\_5 | Yes | Lane departure warning work on car display |
| WDC-02 | turn off the lane keeping assistance functionality | Malfunction\_3  Malfunction\_4 | Yes | Lane keeping assistance warning work on car display |