

Technical Safety Concept Lane Assistance

**Document Version: 1.0**



# Document history

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# Purpose of the Technical Safety Concept

**[Instructions: Answer what is the purpose of a technical safety concept?]**

# 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 lane keeping item shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude | C | 50 ms | Disable system |
| Functional  Safety  Requirement  01-02 | The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max\_Torque\_Frequency | C | 50 ms | Disable system |
| Functional  Safety  Requirement  02-01 | The electronic power steering ECU shall limit lane keeping assistance torque for only Max\_Duration | B | 500 ms | Disable system. |

## Refined System Architecture from Functional Safety Concept



### 

### Functional overview of architecture elements

|  |  |
| --- | --- |
| **Element** | **Description** |
| Camera Sensor | Capture images of the road and send to the camera ECU |
| Camera Sensor ECU - Lane Sensing | Software module that processes images to determine lane and position of vehicle in lane |
| Camera Sensor ECU - Torque request generator | Software module the sends a torque request based on the lane sensing output to the power steering ECU |
| Car Display | HMI to the driver, displays light status for LKA and LDW |
| Car Display ECU - Lane Assistance On/Off Status | Indicates the status of Lane Assistance |
| Car Display ECU - Lane Assistant Active/Inactive | Indicates the activity of Lane Assistance |
| Car Display ECU - Lane Assistance malfunction warning | Indicates the functionality of Lane Assistance |
| Driver Steering Torque Sensor | Measures the steering input from the driver |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Software block that receives torque input from the driver |
| EPS ECU - Normal Lane Assistance Functionality | Software block that receives torque request from Camera Sensor ECU – Torque request block |
| EPS ECU - Lane Departure Warning Safety Functionality | Software block that constrains the torque amplitude and frequency to Max\_Torque\_Amplitude and Max\_Torque\_Frequency respectively. |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Software block that limits the LKA activity duration to Max\_Duration |
| EPS ECU - Final Torque | Software block that combines torque request from LKA, LDW and send it to the motor |
| Motor | Applies torque request 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 |  |  |  |  |  |
| Technical  Safety  Requirement  02 |  |  |  |  |  |
| Technical  Safety  Requirement  03 |  |  |  |  |  |
| Technical  Safety  Requirement  04 |  |  |  |  |  |
| Technical  Safety  Requirement  05 |  |  |  |  |  |

**[Instructions: Fill in the technical safety requirements for the lane departure warning second functional safety requirement. We have provided the associated functional safety requirement in the table below. Hint:. Most of the technical safety requirements will be the same. At least one technical safety requirement will have to be slightly modified because we are talking about frequency instead of amplitude. These requirements were not given in the lessons]**

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 |  |  |  |  |  |
| Technical  Safety  Requirement  02 |  |  |  |  |  |
| Technical  Safety  Requirement  03 |  |  |  |  |  |
| Technical  Safety  Requirement  04 |  |  |  |  |  |
| Technical  Safety  Requirement  05 |  |  |  |  |  |

**Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:**

**[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. “Validation” asks whether or not you chose the appropriate parameters. “Verification” involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]**

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

**[Instructions: Fill in the technical safety requirements for the lane keeping assistance functional safety requirement 02-01. We have provided the associated functional safety requirement in the table below. Hint:. You can reuse the technical safety requirements from functional safety requirement 01-01. But you need to change the language because we are now looking at a different system. The ASIL and Fault Tolerant Time Interval are different as well.]**

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 |  |  |  |  |  |
| Technical  Safety  Requirement  02 |  |  |  |  |  |
| Technical  Safety  Requirement  03 |  |  |  |  |  |
| Technical  Safety  Requirement  04 |  |  |  |  |  |
| Technical  Safety  Requirement  05 |  |  |  |  |  |

**Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:**

## Refinement of the System Architecture



## Allocation of Technical Safety Requirements to Architecture Elements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Technical Safety Requirement** | **Electronic Power Steering ECU** | **Camera ECU** | **Car Display ECU** |
| Technical  Safety  Requirement  01-01-01 | 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.’ | **X** |  |  |
| Technical  Safety  Requirement  01-01-02 | When the Lane Departure Warning is deactivated, the ‘LDW Safety’ software module shall send a signal to the Car Display ECU to turn on a warning signal. | **X** |  |  |
| Technical  Safety  Requirement  01-01-03 | When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set ‘LDW\_Torque\_Request’ to zero. | **X** |  |  |
| Technical  Safety  Requirement  01-01-04 | The validity and integrity of the data transmission for ‘LDW\_Torque\_Request’ signal shall be ensured. | **X** |  |  |
| Technical  Safety  Requirement  01-01-05 | Memory test shall be conducted at start up of the EPS ECU to check for any memory problems | **X** |  |  |
| Technical  Safety  Requirement  01-02-01 | The Lane Departure Warning safety component shall ensure the frequency of the ‘LDW\_Torque\_Reques’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max\_Torque\_Frequency.’ | **X** |  |  |
| Technical  Safety  Requirement  02-01-01 | The Lane Keeping Assistance safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max\_Duration | **X** |  |  |
| Technical  Safety  Requirement  02-01-02 | When the Lane Keeping Assistance function deactivates, the ‘LKA Safety’ shall send a signal to the Car Display ECU to turn on a warning light. | **X** |  |  |
| Technical  Safety  Requirement  02-01-03 | When a failure is detected, the Lane Keeping Assistance function shall deactivate and the ‘LKA\_Torque\_Request’ shall be zero. | **X** |  |  |
| Technical  Safety  Requirement  02-01-04 | The validity and integrity of the data transmission for ‘LKA\_Torque\_Request’ signal shall be ensured. | **X** |  |  |
| Technical  Safety  Requirement  02-01-05 | Memory test shall be conducted at start up of the EPS ECU to check for any memory problems | **X** |  |  |

## Warning and Degradation Concept

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | Disable LDW | Malfunction\_01,  Malfunction\_02, | Yes | LDW Malfunction Warning on Car Display |
| WDC-02 | Disable LKW | Malfunction\_03, | Yes | LKA Malfunction Warning on Car Display |