

Technical Safety Concept Lane Assistance

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# Document history

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| 18/5/2018 | 1 | Aakash Gupta | First draft of Technical Safety Concept |
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# Purpose of the Technical Safety Concept

The purpose of the technical safety concept is to refine the functional safety requirements established in the functional safety concept into technical safety requirements. This is a crucial step before developing reliabel hardware and software. As part of product development technical safety concept involves:

* Turning functional safety requirements into technical safety requirements
* Allocating technical safety requirements to the system architecture

As a subsequent step technical safety requirements will be considered within software and hardware implementation.

# 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 Departure Warning item shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude. | C | 50 ms | Vibration torque amplitude below Max\_Torque\_Amplitude. |
| Functional  Safety  Requirement  01-02 | The Lane Departure Warning item shall ensure that the lane departure oscillating torque frequency is below Max\_Torque\_Frequency. | C | 50 ms | Vibration frequency is below Max\_Torque\_Frequency. |
| Functional  Safety  Requirement  02-01 | The electronic power steering ECU shall ensure that the Lane Keeping Assistance torque is applied only Max\_Duration. | B | 500 ms | Lane Keeping Assistance torque is zero. |

## Refined System Architecture from Functional Safety Concept



### 

### Functional overview of architecture elements

**[Instructions: Provide a description for each functional safety element; what is each element's purpose in the lane assistance item? ]**

|  |  |
| --- | --- |
| **Element** | **Description** |
| Camera Sensor | Capture road images and provide them to the Camera Sensor ECU. |
| Camera Sensor ECU - Lane Sensing | Software module detecting the lane line positions from the Camera Sensor images. |
| Camera Sensor ECU - Torque request generator | Software module calculating the necessary torque to be requested to the Electronic Power Steering ECU. |
| Car Display | Display warning for the driver. |
| Car Display ECU - Lane Assistance On/Off Status | Indicate the status of the Lane Assistance functionality (On/Off.) |
| Car Display ECU - Lane Assistant Active/Inactive | Indicate if the Lane Assistance functionality is properly functioning (Active/Inactive.) |
| Car Display ECU - Lane Assistance malfunction warning | Indicate a malfunction on the Lane Assistance functionality. |
| Driver Steering Torque Sensor | Measure the torque applied to the steering wheel by the driver. |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Software module receiving the driver’s torque request from the steering wheel. |
| EPS ECU - Normal Lane Assistance Functionality | Software module receiving the Camera Sensor ECU torque request. |
| EPS ECU - Lane Departure Warning Safety Functionality | Software module ensuring the torque amplitude is below Max\_Torque\_Amplitude and torque frequency is below Max\_Torque\_Frequency. |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Software module ensuring the Lane Keeping Assistance functionality application is not activate more than Max\_duration time. |
| EPS ECU - Final Torque | Combine the torque request from the Lane Keeping and Lane Departure Warning functionalities and sends them to the Motor. |
| Motor | Applies the required torque to the steering wheels. |

# 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 | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  02 | 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. | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  03 | 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. | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for ‘LDW\_Torque\_Request’ signal shall be ensured. | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at start up of the EPS ECU to check for any memory problems | A | Ignition cycle | Data Transmission Integrity Check | LWD\_Activation\_Status is 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 the frequency of the ‘LDW\_Torque\_Reques’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max\_Torque\_Frequency.’ | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  02 | 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. | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  03 | 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. | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for ‘LDW\_Torque\_Request’ signal shall be ensured. | C | 50 ms | LDW Safety | Lane Departure Warning torque to zero. |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at start up of the EPS ECU to check for any memory problems | A | Ignition cycle | Data Transmission Integrity Check | LWD\_Activation\_Status is 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 safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max\_Duration | C | 500 ms | LKA Safety | Lane Keeping Assistance torque to zero. |
| Technical  Safety  Requirement  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. | C | 500 ms | LKA Safety | Lane Keeping Assistance torque to zero. |
| Technical  Safety  Requirement  03 | When a failure is detected, the Lane Keeping Assistance function shall deactivate and the ‘LKA\_Torque\_Request’ shall be zero. | C | 500 ms | LKA Safety | Lane Keeping Assistance torque to zero. |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for ‘LKA\_Torque\_Request’ signal shall be ensured. | C | 500 ms | LKA Safety | Lane Keeping Assistance torque to zero. |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at start up of the EPS ECU to check for any memory problems | A | Ignition cycle | Data Transmission Integrity Check | Lane Departure Warning torque to zero. |

## Refinement of the System Architecture



## Allocation of Technical Safety Requirements to Architecture Elements

**For LDW and LKA the technical requirements are mentioned in the tables above. All of these technical safety requirements are allocated to the Electronic Power Steering ECU.**

## Warning and Degradation Concept

WDC-01: lane departure warning function

WDC-02: lane keeping assistance function

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | Turn off functionality | When oscillating time is greater than **Max\_Allowed\_Time** | Yes | Driver will see a warning light on the dashboard when the system malfunctions |
| WDC-02 | Turn off functionality | When oscillating toque amplitude is higher than **Max\_Torque\_Amplitude and** When oscillating toque frequency is more than **Max\_Torque\_Frequncy** | Yes | Driver will see a warning light on the dashboard when the system malfunctions |