

Technical Safety Concept Lane Assistance

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# Document history

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| Date | Version | Editor | Description |
| 02/03/2018 | 0.1 | Michael Scharf | Initial attempt |
| 02/03/2018 | 0.2 | Michael Scharf | Fill out the sheet |
| 02/0/2018 | 1.0 | Michael Scharf | Review and smaller fixes. |
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# Purpose of the Technical Safety Concept

The Technical Safety Concept defines how the subsystems interact at the message level and describes how the ECUs communicate with each other.

# 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 oscillating torque amplitude requested by the LDW function is below Max\_Torque\_Amplitude | C | 50 ms | LDW will set the oscillating torque amplitude to 0. |
| Functional  Safety  Requirement  01-02 | the electronic power steering ECU shall ensure that the lane departure warning oscillating torque frequency is below Max\_Torque\_Frequency | C | 50 mS | LDW will set the oscillating torque frequency to 0. |
| Functional  Safety  Requirement  02-01 | the lane keeping assistance function shall be time limited and the additional steering torque shall end after a given timer interval so that the driver can not misuse the system for autonomous driving | B | 500 mS | LKA will be switched off. |

## Refined System Architecture from Functional Safety Concept



**[Instructions: Provide the refined system architecture from the functional safety concept]**

### 

### Functional overview of architecture elements

|  |  |
| --- | --- |
| **Element** | **Description** |
| Camera Sensor | Grab images for further processing in the Camera Sensor ECU. |
| Camera Sensor ECU - Lane Sensing | Identify the ego lane in images. |
| Camera Sensor ECU - Torque request generator | Depending on the car position in the ego lane, generate a torque request signal for the EPS ECU. |
| Car Display | User interface allows to indicate different states/ signals |
| Car Display ECU - Lane Assistance On/Off Status | Identifies the state of the Lane Assistance. Depending on the state, the On or Off indication is triggered on the car display |
| Car Display ECU - Lane Assistant Active/Inactive | Identifies the state of the Lane Assistance. Depending on the state, the Active or Inactive indication is triggered on the car display |
| Car Display ECU - Lane Assistance malfunction warning | Warning indication is triggered on Car Display in case that the ECU receives the signal for a malfunction. |
| Driver Steering Torque Sensor | Measure the drivers steering torque |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Identification of the drivers steering wheel torque and conversion into the EPS ECU torque range |
| EPS ECU - Normal Lane Assistance Functionality | Generate a torque amplitude and torque frequency in given borders to generate a LDW. |
| EPS ECU - Lane Departure Warning Safety Functionality | Insures that the final electronic power steering torque amplitude is below the Max\_Torque\_Amplitude. If not, the error signal is sent to the Car Display ECU. |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Insures that the max activation time of the Lane keeping function isn’t exceeded. |
| EPS ECU - Final Torque | Combine the EPS ECU torque and the ECU driver steering torque to a final electronic power steering torque. |
| Motor | Convert the final electronic power steering torque into a mechanic movement. |

# 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 LDW 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 Component | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  02 | As soon as the LDW function deactivates the LDW feature, the 'LDW Safety' software block shall send a signal to the car display ECU to turn on a warning light. | C | 50 mS | LDW Safety Component | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'LDW\_Torque\_Request' shall be set to zero. | C | 50 mS | LDW Safety Component | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50 mS | Data Transmission Integrity Check (SW) | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory. | A | Ignition cycle | Memory Test (SW) | Resulting torque amplitude 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 LDW 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 | 50 mS | LDW Safety Component | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  02 | As soon as the LDW function deactivates the LDW feature, the 'LDW Safety' software block shall send a signal to the car display ECU to turn on a warning light. | C | 50 mS | LDW Safety Component | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'LDW\_Torque\_Request' shall be set to zero. | C | 50 mS | LDW Safety Component | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50 mS | Data Transmission Integrity Check (SW) | Resulting torque amplitude is zero |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory. | A | Ignition cycle | Memory Test (SW) | Resulting torque amplitude is zero |

**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:**

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 LKA shall ensure that the ‘lane keeping assistance torque’ sent to the ‘Final electronic power steering Torque’ component is applied only ‘Max\_Duration’ | B | 500 mS | LKA Safety Component | Switch off |
| Technical  Safety  Requirement  02 | As soon as the LKA function deactivates the LKA feature, the LKA Safety' software block shall send a signal to the car display ECU to turn on a warning light. | B | 500 mS | LKA Safety Component | Switch off |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature. | B | 500 mS | LKA Safety Component | Switch off |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LKA\_Torque\_Request' signal shall be ensured. | B | 500 mS | Data Transmission Integrity Check (SW) | Switch off |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory. | A | Ignition cycle | Memory Test (SW) | Switch off |

**Lane Keeping Assistance (LKA) 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.]**

## Refinement of the System Architecture

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## Allocation of Technical Safety Requirements to Architecture Elements

The technical safety requirements will be completely full filled inside the EPS ECU.

The LDW Safety Component is in charge to detect a malfunction in LDW and triggers the transition into safe mode.

The LKA Safety Component is in charge to detect a malfunction in LKA and triggers the transition into safe mode.

Data Transmission Integrity Check SW is ensuring the validity and integrity of data transmission for LKA as well as LDW.

The Memory Test SW is checking any faults in memory during start up for LKA as well as LDW.

## Warning and Degradation Concept

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | Turn of functionality | ECU receives a vibrational torque request beyond the allowed maximum | yes | Indication of malfunction via driver dashboard |
| WDC-02 | Turn off functionality | ECU recognizes timeout of drivers interaction for lane keeping | yes | No automatic lane keeping. Eventually warning notification in drivers dashboard or hint in the manual that driver maintains responsibility for safe operation of the vehicle. |