

Technical Safety Concept Lane Assistance

**Document Version: [Version]**

**Template Version 1.0, Released on 2017-06-21**



# Document history

**[Instructions: Fill in the date, version and description fields. You can fill out the Editor field with your name if you want to do so. Keep track of your editing as if this were a real world project.**

**For example, if this were your first draft or first submission, you might say version 1.0. If this is a second submission attempt, then you'd add a second line with a new date and version 2.0]**

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| --- | --- | --- | --- |
| Date | Version | Editor | Description |
| Mar. 30, 18 | 0.1 | L. Chen | Initial version |
| Mar. 31, 18 | 0.2 | L. Chen | Minor correction |
| Mar. 31, 18 | 0.3 | L. Chen | Minor correction |
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# Purpose of the Technical Safety Concept

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

The purpose of a technical safety concept is to analyze the item on system level and allocate technical safety requirements to system elements

# Inputs to the Technical Safety Concept

## Functional Safety Requirements

**[Instructions: Provide the functional safety requirements derived in the functional safety concept ]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Safe State** |
| Functional  Safety  Requirement  01-01 | Electric Power Steering ECU shall ensure that the torque amplitude provided by LDW shall not exceed max\_torque\_amplitude | C | 50ms | Off (set vibration torque to zero) |
| Functional  Safety  Requirement  01-02 | Electric Power Steering ECU shall ensure that the torque frequency provided by LDW shall not exceed max\_torque\_frequency | C | 50ms | Off (set vibration torque to zero) |
| Functional  Safety  Requirement  02-01 | Electric Power Steering ECU shall ensure that the time of LKA torque application is limited to max\_duration | B | 500ms | Off (function turned off) |

## Refined System Architecture from Functional Safety Concept

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

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### 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 | Perception of current road environment |
| Camera Sensor ECU - Lane Sensing | Process image of camera sensor and calculate lane and ego vehicle’s position and orientation within the lane |
| Camera Sensor ECU - Torque request generator | Calculate the torque needed to keep vehicle in the lane based on camera image |
| Car Display | Display information of lane assistance item |
| Car Display ECU - Lane Assistance On/Off Status | Display whether lane assistance function is on or off |
| Car Display ECU - Lane Assistant Active/Inactive | Display whether lane assistance function is active or inactive |
| Car Display ECU - Lane Assistance malfunction warning | Display warnings from lane assistance item |
| Driver Steering Torque Sensor | Measure steering torque of driver |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Process measurement of driver steering torque sensor data and add measurement to final torque calculation |
| EPS ECU - Normal Lane Assistance Functionality | Receive torque request generated by camera sensor ECU and forward this to calculate LDW and LKA torque |
| EPS ECU - Lane Departure Warning Safety Functionality | Receive torque request form normal lane assistance functionality and limit amplitude and frequency of this torque request |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Receive torque request from normal lane assistance functionality and limit application time of this torque request |
| EPS ECU - Final Torque | Add driver steering torque and torque request of the lane assistance function and calculate output torque of the motor |
| Motor | apply torque calculated in EPS ECU – Final torque to steering wheel |

# Technical Safety Concept

## Technical Safety Requirements

**[Instructions: Fill in the technical safety requirements for the lane departure warning first functional safety requirement. We have provided the associated functional safety requirement in the first table below. Hint: The technical safety requirements were discussed in the lesson videos. The architecture allocation column should contain element names such as LDW Safety block, Data Transmission Integrity Check, etc. Allocating the technical safety requirements to the "EPS ECU" does not provide enough detail for a technical safety concept.]**

**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 | 50ms | LDW safety | LDW Torque Request Amplitude shall be set to zero |
| lTechnical  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 | 50ms | LDW safety | LDW Torque Request Amplitude shall be set to 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 | 50ms | LDW safety | LDW Torque Request Amplitude shall be set to zero |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50ms | Data transmission integrity check | N/A |
| 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 | LDW Torque Request Amplitude shall be set to zero |

**[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 | 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 | 50ms | LDW safety | LDW Torque Request Frequency shall be set to 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 | 50ms | LDW safety | LDW Torque Request Frequency shall be set to 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 | 50ms | LDW safety | LDW Torque Request Frequency shall be set to zero |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50ms | Data Transmission Integrity Check | N/A |
| 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 | LDW Torque Request Frequency shall be set to 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:**

**[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 | The LKA safety component shall ensure that the 'LKA\_Torque\_Request' sent to the 'Final electronic power steering Torque' component is time limited to ‘Max\_Duration’ | B | 500ms | LKA safety | LKA Torque Request Amplitude shall be set to zero |
| 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 | 500ms | LKA safety | LKA Torque Request Amplitude shall be set to zero |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature and the 'LKA\_Torque\_Request' shall be set to zero. | B | 500ms | LKA safety | LKA Torque Request Amplitude shall be set to zero |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LKA\_Torque\_Request' signal shall be ensured. | B | 500ms | Data Transmission Integrity Check | N/A |
| 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 | LKA Torque Request Amplitude shall be set to zero |

**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

**[Instructions: Include the refined system architecture. Hint: The refined system architecture should include the system architecture from the end of the technical safety lesson, including all of the ASIL labels.]**

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## Allocation of Technical Safety Requirements to Architecture Elements

**[Instructions: We already included the allocation as part of the technical requirement tables. Here you can state that for this particular item, all technical safety requirements are allocated to the Electronic Power Steering ECU]**

For the lane assistance item, all technical safety requirements are allocated to LDW/LKA safety functionality, which is part of the Electronic Power Steering ECU

## Warning and Degradation Concept

**[Instructions: We've already identified that for any system malfunction, the lane assistance functions will be turned off and the driver will receive a warning light indication. The technical safety requirements have not changed how functionality will be degraded or what the warning will be.**

**So in this case, the warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements. You can copy the functional safety warning and degradation concept here.**

**Oftentimes, a technical safety analysis will lead to a more detailed warning and degradation concept. ]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | LDW\_Activation\_Status = inactive  LDW\_Torque\_Request = 0 | LDW\_Torque\_Request amplitude > Max\_Torque\_Amplitude | Yes | Warning light on the car display |
| WDC-02 | LDW\_Activation\_Status = inactive  LDW\_Torque\_Request = 0 | LDW\_Torque\_Request frequency > Max\_Torque\_Frequency | Yes | Warning light on the car display |
| WDC-03 | LKA\_Activation\_status = inactive  LKA\_Torque\_Request = 0 | LKA\_Activation\_Time > Max\_Duration | Yes | Warning light on the car display |