

Technical Safety Concept Lane Assistance

**Document Version: [Version]**

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



# 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

**[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 | The lane keeping item shall ensure that the lane depature oscillating torque amplitude is below Max\_Torque\_Amplitude | C | 50ms | Set vibration torque amplitude to zero |
| Functional  Safety  Requirement  01-02 | The lane keeping item shall ensure that the lane depature oscillating torque frequency torque is below Max\_Torque\_Frequency | C | 50ms | Set vibration torque frequency to zero |
| Functional  Safety  Requirement  02-01 | The lane keeping assistance function shall be time limited and additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving | B | 500ms | Set lane keeping assistance torque to zero |

## Refined System Architecture from Functional Safety Concept

**[Instructions: Provide the refined system architecture from the 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 | responsible for capturing vehicle driving condition including detectable lane lines |
| Camera Sensor ECU - Lane Sensing | responsible for measuring the distance from the lane line |
| Camera Sensor ECU - Torque request generator | responsible for getting the distance from ECU-Lane Sensing and generating torque request towards EPS ECU- Normal Lane Assistance Functionality. |
| Car Display | responsible for warning drivers whether lane assistance is malfunction or misused. |
| Car Display ECU - Lane Assistance On/Off Status | If Lane Assistance is inactive or malfunction, it will transmit “On” signal to Car Display. Otherwise, it will send “Off” signal to Car Display. |
| Car Display ECU - Lane Assistant Active/Inactive | responsible for getting a signal from LA Safety Functionality. if LDW or LKA function is deactivated, it will get “activation\_status\_set = 0” Otherwise, it will get ”activation\_status\_set = 1”. |
| Car Display ECU - Lane Assistance malfunction warning | responsible for getting a signal of whether or not turning on a warning light from LDW or LKA Safety Functionality software when a failure is detected. |
| Driver Steering Torque Sensor | responsible for measuring driver steering torque. |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | responsible for receiving steering torque from Driver Steering Torque Sensor and transmit it to the EPS-ECU -Final Torque |
| EPS ECU - Normal Lane Assistance Functionality | This element is a redundant element for “EPS ECU LDW and LKA Safety Functionality” and responsible for receiving torque request from “Camera Sensor ECU -Torque request generator”. |
| EPS ECU - Lane Departure Warning Safety Functionality | responsible for getting a torque request from “EPS ECU- Normal Lane Assistance Functionality”. If the torque request is below Max\_Torque\_Request, the torque request is delivered to “EPS ECU -Final Torque” But if the torque request is beyond “Max\_Torque\_Request”, the “EPS ECU -Lane Departure Warning Safety Functionality” will transmit a signal toward “Car Display ECU -Lane Assistance malfunction warning” to turn on a warning light and also transmit torque request which is set to zero to “EPS ECU -Final Torque”. |
| EPS ECU - Lane Keeping Assistant Safety Functionality | responsible for getting a torque request from “EPS ECU- Normal Lane Assistance Functionality”. If the torque request is below Max\_Torque\_Request, the torque request is delivered to “EPS ECU -Final Torque” But if the torque request is beyond “Max\_Torque\_Request”, the “EPS ECU -Lane Keeping Warning Safety Functionality” will transmit a signal toward “Car Display ECU -Lane Assistance malfunction warning” to turn on a warning light and also transmit torque request which is set to zero to “EPS ECU -Final Torque”. |
| EPS ECU - Final Torque | responsible for receiving driver steering torque and torque request from “EPS ECU Lane Departure Warning Safety Functionality” and ”EPS ECU Lane Keeping Assistant Safety Functionality” and then trasmit the torque to “Motor” only when those torque values are below maximum. If those torque values are above maximum, it will transmit zero torque request to “Motor”. |
| Motor | responsible for providing torque request from"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 "LDW\_Torque\_Request" send to the "Final electronic power steering torque" component is below "Max\_Torque\_Amplitude" . | C | 50ms | LDW Safety Functionallity | LDW torque output is set to zero |
| Technical  Safety  Requirement  02 | 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  03 | As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and "LDW\_Torque\_Request" shall be set to zero. | C | 50ms | LDW Safety Functionallity | LDW torque output is set to zero |
| Technical  Safety  Requirement  04 | As soon as the LDW function deactivates the LDW feature, the "LDW Safety" software block shall send a signal to the car display to turn a warning light. | C | 50ms | LDW Safety Functionallity | LDW torque output is set to zero |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at startup of the EPS ECU to check any faults in memory. | A | Ignition Cycle | Safety startup memory test | LDW torque output is 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 "LDW\_Torque\_Request" send to the "Final electronic power steering torque" component is below "Max\_Torque\_Frequency" . | C | 50ms | LDW Safety Functionallity | LDW torque output is set to zero |
| Technical  Safety  Requirement  02 | 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  03 | As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and "LDW\_Torque\_Request" shall be set to zero. | C | 50ms | LDW Safety Functionallity | LDW torque output is set to zero |
| Technical  Safety  Requirement  04 | As soon as the LDW function deactivates the LDW feature, the "LDW Safety" software block shall send a signal to the car display to turn a warning light. | C | 50ms | LDW Safety Functionallity | LDW torque output is set to zero |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at startup of the EPS ECU to check any faults in memory. | A | Ignition Cycle | Safety startup memory test | LDW torque output is 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 duration of "LKA\_Torque\_Request" send to the "Final electronic power steering torque" component is below Max\_Duration. | B | 500ms | LKA Safety Functionallity | LKA torque output is set to zero |
| Technical  Safety  Requirement  02 | 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  03 | As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature and "LKA\_Torque\_Request" shall be set to zero. | B | 500ms | LKA Safety Functionallity | LKA torque output is set to zero |
| Technical  Safety  Requirement  04 | As soon as the LKA function deactivates the LKA feature, the "LKA Safety" software block shall send a signal to the car display to turn a warning light. | B | 500ms | LKA Safety Functionallity | LKA torque output is set to zero |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at startup of the EPS ECU to check any faults in memory. | A | Ignition Cycle | Safety startup memory test | LKA torque output is 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.]**

## 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]**

All technical safety requirements for Lane Departure warning and Lane Keeping Assistance are allocated to 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 | Trun off the LDW functionality | Maximum torque is beyond Max\_Torque\_Amplitude | Yes | Car Display |
| WDC-02 | Trun off the LDW functionality | Maximum torque is beyond Max\_Torque\_Freqency | Yes | Car Display |
| WDC-03 | Trun off the LKA functionality | Maximum duration is beyond Max\_Duration | Yes | Car Display |