

Functional Safety Concept Lane Assistance

**Document Version: [Version]**

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# 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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# Purpose of the Functional Safety Concept

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

# Inputs to the Functional Safety Concept

## Safety goals from the Hazard Analysis and Risk Assessment

**[Instructions:**

**REQUIRED:**

**Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.**

**OPTIONAL:**

**If you expanded the hazard analysis and risk assessment to include other safety goals, include them here.**

**]**

|  |  |
| --- | --- |
| **ID** | **Safety Goal** |
| Safety\_Goal\_01 | The oscillating steering torque from the lane departure warning function  shall be limited |
| Safety\_Goal\_02 | The lane keeping assistance function shall be time limited and the  additional steering torque shall end after a given time interval so that the  driver cannot misuse the system for autonomous driving |

## Preliminary Architecture

**[Instructions: Provide a preliminary architecture for the lane assistance item. Hint: See Lesson 3: Item Definition]**



### Description of architecture elements

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

|  |  |
| --- | --- |
| **Element** | **Description** |
| Camera Sensor | Captures the images |
| Camera Sensor ECU | Image Processing for determining lane departure |
| Car Display | Display the information of lane assistance  system |
| Car Display ECU | Control the car display based on the inforamtion from Camera ECU |
| Driver Steering Torque Sensor | Measure the torque provided by the steering wheel |
| Electronic Power Steering ECU | Adjust final steering torque output. |
| Motor | Provides torque to the steering wheel |

# Functional Safety Concept

The functional safety concept consists of:

* Functional safety analysis
* Functional safety requirements
* Functional safety architecture
* Warning and degradation concept

## Functional Safety Analysis

**[Instructions: Fill in the functional safety analysis table below.]**

|  |  |  |  |
| --- | --- | --- | --- |
| **Malfunction ID** | **Main Function of the Item Related to Safety Goal Violations** | **Guidewords (NO, WRONG, EARLY, LATE, MORE, LESS)** | **Resulting Malfunction** |
| Malfunction\_01 | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback | MORE | The lane departure  warning function  applies an oscillating  torque with very high  torque amplitude  (above limit) |
| Malfunction\_02 | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback | MORE | The lane departure  warning function  applies an oscillating  torque with very high  torque frequency  (above limit)" |
| Malfunction\_03 | Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane | NO | The lane keeping  assistance function is  not limited in time  duration which leads  to misuse as an  autonomous driving  function |

## Functional Safety Requirements

**[Instructions: Fill in the functional safety requirements for the lane departure warning ]**

Lane Departure Warning (LDW) 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 lane departure warning  oscillating torque amplitude is below  Max\_Torque\_Amplitude | C | 50ms | Off |
| Functional  Safety  Requirement  01-02 | The electronic power steering ECU shall  ensure that the lane departure warning  oscillating torque frequeny is below  Max\_Torque\_Frequency | C | 50ms | Off |

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

|  |  |  |
| --- | --- | --- |
| **ID** | **Validation Acceptance**  **Criteria and Method** | **Verification Acceptance**  **Criteria and Method** |
| Functional  Safety  Requirement  01-01 | Testing how drivers  react to different torque amplitudes and  chosing the comfortable one | Verify that lane assistance output is  zero within the 50ms fault tolerant time  interval for the chosen  Max\_Torque\_Amplitude |
| Functional  Safety  Requirement  01-02 | Testing how drivers  react to different torque frequencies and  chosing the comfortable one | Verify that lane assistance output is  zero within the 50ms fault tolerant time  interval for the chosen  Max\_Torque\_Frequency |

**[Instructions: Fill in the functional safety requirements for the lane keeping assistance]**

Lane Keeping Assistance (LKA) Requirements:

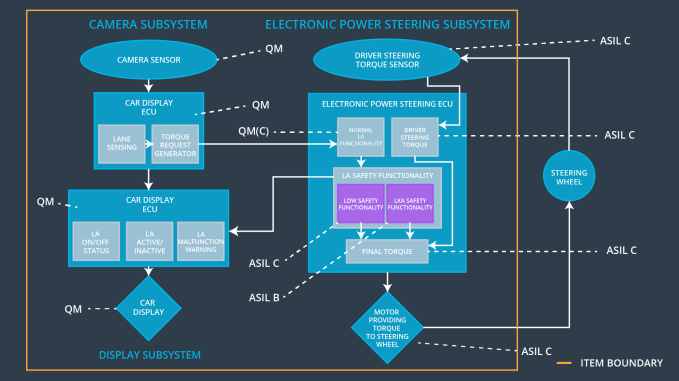
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Safe State** |
| Functional  Safety  Requirement  02-01 | The electronic power steering ECU shall  ensure that the lane keeping assistance  torque is applied for only Max\_Duration | B | 500ms | Lane keeping  assistance  torque is 0 every exceeded  max\_duration |

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

|  |  |  |
| --- | --- | --- |
| **ID** | **Validation Acceptance**  **Criteria and Method** | **Verification Acceptance**  **Criteria and Method** |
| Functional  Safety  Requirement  02-01 | Test that the max\_duration chosen  really does dissuade drivers from  taking their hands off the wheel | Verify that the system  really does turn off if the lane keeping  assistance every exceeded  max\_duration |

## 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 functional safety lesson including all of the ASIL labels.]**



## Allocation of Functional Safety Requirements to Architecture Elements

**[Instructions: Mark which element or elements are responsible for meeting the functional safety requirement. Hint: Only one ECU is responsible for meeting all of the requirements.]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **Electronic Power Steering ECU** | **Camera ECU** | **Car Display ECU** |
| Functional  Safety  Requirement  01-01 | The electronic power steering  ECU shall ensure that the  oscillating torque amplitude is  below Max\_Torque\_Amplitude | **X** |  |  |
| Functional  Safety  Requirement  01-02 | The electronic power steering  ECU shall ensure that the  oscillating torque frequency is  below Max\_Torque\_Frequency | **X** |  |  |
| Functional  Safety  Requirement  02-01 | The electronic power steering  ECU shall ensure that the lane  keeping assistance torque is  applied for only Max\_Duration | **X** |  |  |

## Warning and Degradation Concept

**[Instructions: Fill in the warning and degradation concept.]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | Off | Malfunction\_01 | Yes | Lane Assistance  Warning on Display |
| WDC-02 | Off | Malfunction\_02 | Yes | Lane Assistance  Warning on Display |