

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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| Date | Version | Editor | Description |
| 2/23/18 | 1.0 | Anh Le | First draft |
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# Purpose of the Functional Safety Concept

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

The functional safety concept documents the system high level requirements. It looks at the general functionality without going into technical detail. The goal is to identify safety requirements. Functional safety concept will also derive safety requirements. It will also prove the system meets the requirements.

# 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 Keep Assistance function shall be limited by reducing time activated |

## 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 | Provides images to the Camera Sensor ECU |
| Camera Sensor ECU | Detects the lane line positions and if a requirement is fulfilled, sends a request to the Car Display ECU and Electronic Power Steering ECU |
| Car Display | Displays warning |
| Car Display ECU | Generates warning signal when Camera Sensor ECU requests it |
| Driver Steering Torque Sensor | Measure the torque applied to the steering wheel |
| Electronic Power Steering ECU | From the Camera Sensor ECU request and driver steering torque sensor, requests the necessary torque from the motor |
| Motor | Applies torque requested by Electronic Power Steering ECU 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 LDW function applies an oscillating torque above the amplitude limit |
| Malfunction\_02 | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback | More | THE LDW function applies an oscillating torque above the frequency limit |
| Malfunction\_03 | Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane | NO | The LKA function is not time limited leading to misuse |

## 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 lane departure warning item shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude | C | 50 ms | Lane Assistance off |
| 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 | Lane Assistance 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 | Validate Max\_Torque\_Amplitude chosen is adequate through trials with multiple drivers | Verify the system does turn off LDW if Max\_Torque\_Amplitude is exceeded |
| Functional  Safety  Requirement  01-02 | Validate Max\_Torque\_Frequency chosen is adequate through trials with multiple drivers | Verify the system does turn off LDW if Max\_Torque\_Frequency is exceeded |

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

Lane Keeping Assistance (LKA) Requirements:

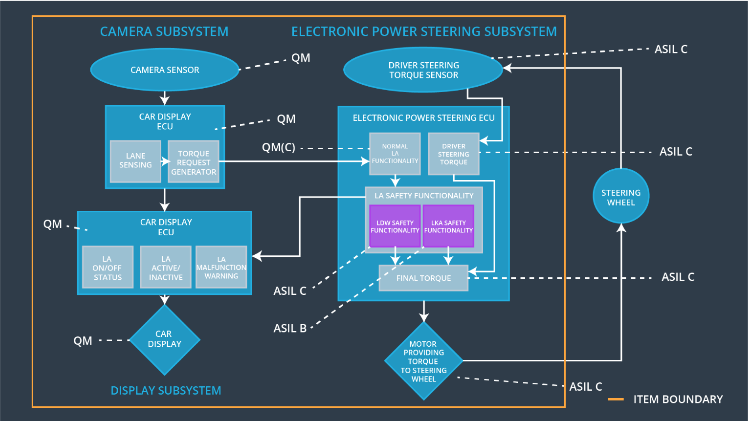
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Safe State** |
| Functional  Safety  Requirement  02-01 | The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for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

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 | Validate the Max\_Duration chosen will dissuade the driver from using the feature as a self-driving car | Verify the system turns off if LKA duration exceeds 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 lane departure warning item shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude | **x** |  |  |
| Functional  Safety  Requirement  01-02 | The lane departure warning item shall ensure that the lane departure 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 | Turn off LDW | Malfunction\_01,  Malfunction\_02,  Malfunction\_04 | Yes | LDW Malfunction warning on car display |
| WDC-02 | Turn off LKA | Malfunction\_03,  Malfunction\_05 | Yes | LKA Malfunction warning on car display |