

Functional Safety Concept Lane Assistance

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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 |
| 6/21/2018 | 1.0 | Jason Kang | First Deaft |
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# Purpose of the Functional Safety Concept

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

The goal of this document is to determine which subsystems in the vehicle can be used to meet each functional safety goal. It is meant to discuss implementation from a high level as opposed to the technical details.

# 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 system shall be limited |
| Safety\_Goal\_02 | The lane keeping assistance function shall be time limited and additional steering torque shall end after 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 | Visualizes the road in front of the vehicle. |
| Camera Sensor ECU | Determines the edges of the lane and heading, passes this information to other ECUs. |
| Car Display | Displays warning lights |
| Car Display ECU | Decides which lights to light up on the display based on camera sensor ECU’s data |
| Driver Steering Torque Sensor | Determines the amount of torque the driver is applying to the steering wheel |
| Electronic Power Steering ECU | Figures out how much assisting torque to apply to the steering wheel to help to maintaion lane |
| Motor | Applies additional torque to the steering wheel per direction of the Power Steering ECU |

# 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 Max\_Torque\_Amplitude)" |
| 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 Max\_Torque\_Frequency)" |
| 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 power steering ECU shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude | C | 50ms | Set Vibration Torque to 0 |
| Functional  Safety  Requirement  01-02 | The power steering ECU shall ensure that the lane departure oscillating torque frequency is below Max\_Torque\_Frequency | C | 50ms | Set Vibration Torque to 0 |

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 | Test with 20 drivers to make sure that Max\_Torque\_Amplitude doe not result in lack of control | Use camera ECU to request a torque above Max\_Torque\_Amplitude. Ensure that Power Steering ECU limits it. |
| Functional  Safety  Requirement  01-02 | Test with 20 drivers to make sure that Max\_Torque\_Frequency does not result in lack of control | Use camera ECU to request a torque above Max\_Torque\_Frequency. Ensure that Power Steering ECU limits it. |

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

Lane Keeping Assistance (LKA) Requirements:

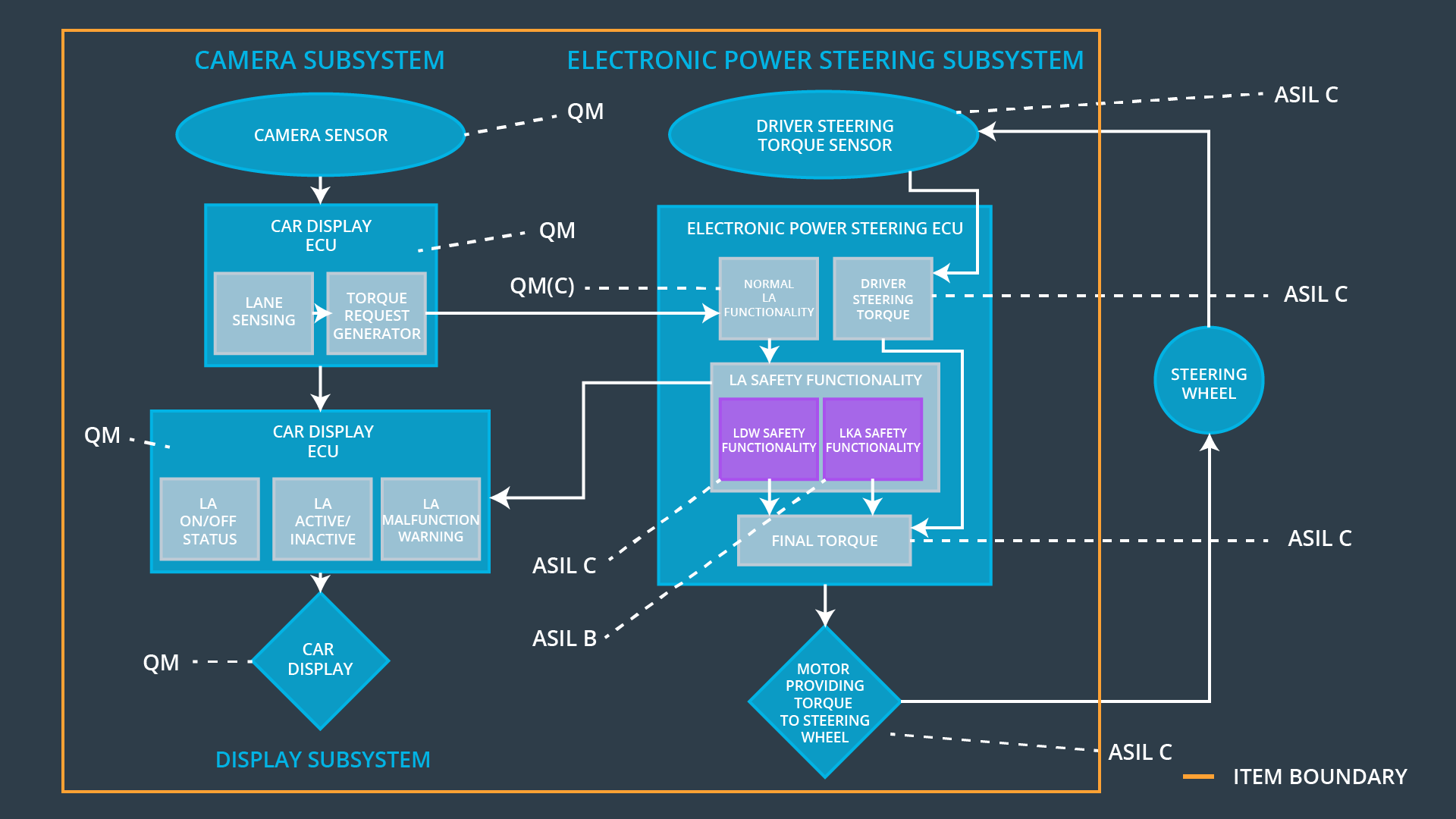
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Functional Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Safe State** |
| Functional  Safety  Requirement  02-01 | The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for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

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 | Using 20 drivers observe if disabling lane keeping assistance after Max\_Duration ms does infact reduce desire to use as self-driving function. | Stray from lane for more than Max\_Duration ms. The function should become disabled. |

## 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 power steering ECU shall ensure that the lane departure oscillating torque amplitude is below Max\_Torque\_Amplitude |  | **x** |  |
| Functional  Safety  Requirement  01-02 | The power steering ECU 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 | Amplitude exceeds Max\_Torque\_Amplitude or frequency exceeds Max\_Torque\_Frequency | Yes | Light on Display |
| WDC-02 | Turn off | Torque applied for longer than Max\_Duration | Yes | Note in user’s manual |