

Technical 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 |
| 6/22/2018 | 1.0 | Jason Kang | First Draft |
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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

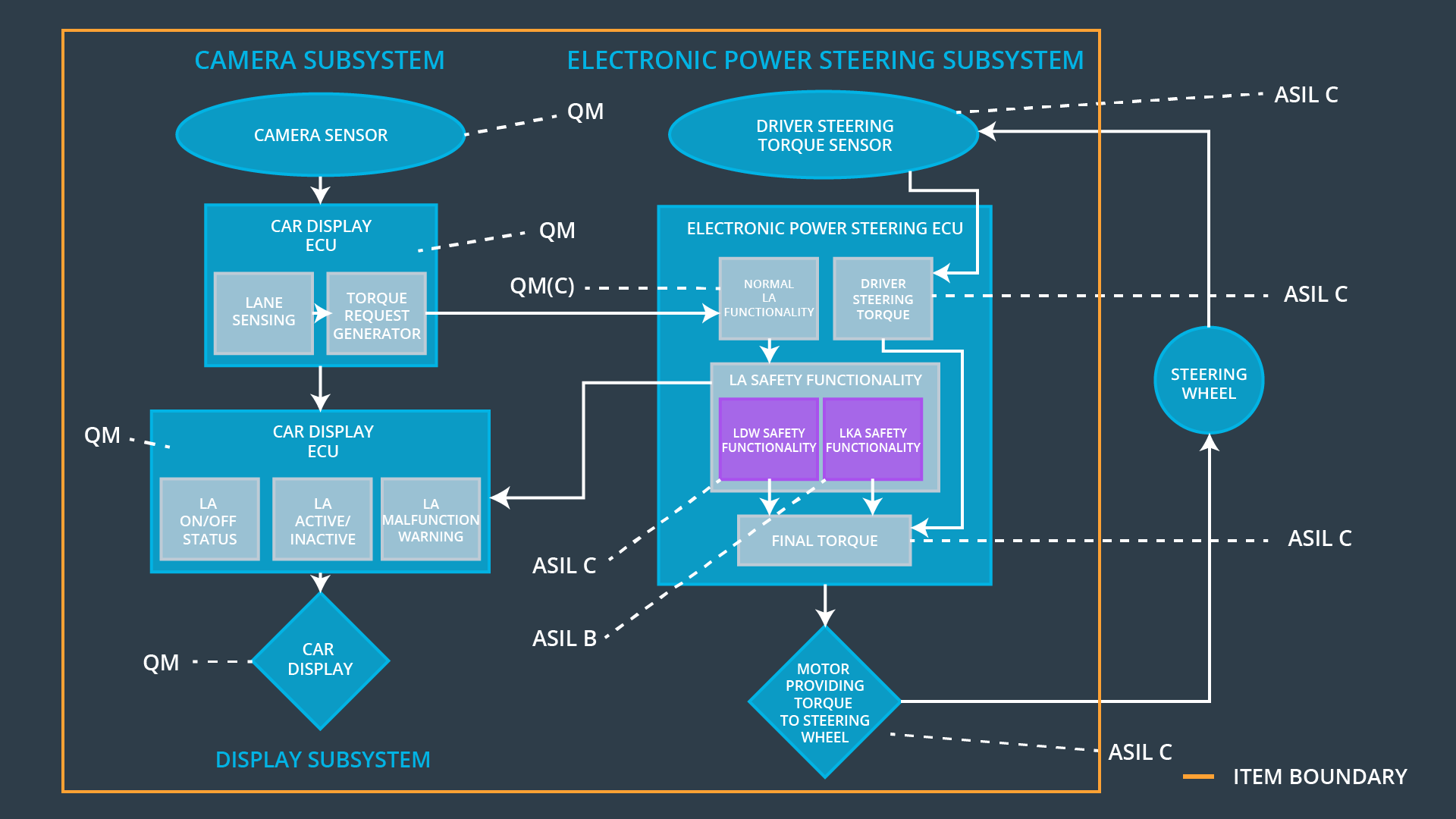
**[Instructions: Provide the functional safety requirements derived in the functional safety concept ]**

The goal of this document is to determine take the functional safety requiements defined in the Functional Safety Concept and convert them into technical safety requirements. In addtition it lists other requirements invloving detecting faults, communications between different subsystems, methods for reaching a safe state, implementing warnings, and preventing latent faults. These are more focused requirements targeting the subsystems of the overall system. Furthermore, these technical safety requirements are assigned to a specific resource in the system architecture.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 |
| 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 |

## 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 | Visualizes the road in front of the vehicle. |
| Camera Sensor ECU - Lane Sensing | Determines the edges of the lane and heading, passes this information to other ECUs. |
| Camera Sensor ECU - Torque request generator | Recognizes that the driver is departing the lane. Requests activation of lane keeping assistant. |
| Car Display | Displays warning lights |
| Car Display ECU - Lane Assistance On/Off Status | Lights up lane assistance indicator based on lane assistance state |
| Car Display ECU - Lane Assistant Active/Inactive | Lights up lane assistance indicator based on lane assistance state |
| Car Display ECU - Lane Assistance malfunction warning | Lights up if lane assistance malfunction indicator if a fault has occured. |
| Driver Steering Torque Sensor | Determines the amount of torque the driver is applying to the steering wheel |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Reads torque sensor to determine the amount of torque driver is applying |
| EPS ECU - Normal Lane Assistance Functionality | Monitors driver steering torque. Decides on whether or not to activate lane departure warning or lane keeping assistnt. |
| EPS ECU - Lane Departure Warning Safety Functionality | Decides how much vibration to apply to the steering wheel to warn of lane departure |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Figures out how much assisting torque to apply to the steering wheel to help to maintaion lane |
| EPS ECU - Final Torque | Applies final limits on vibration amplitude and frequency. |
| Motor | Applies additional torque to the steering wheel per direction of the Power Steering ECU |

# 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 electornic power steering Torque’ component is less than ‘Max\_Torque\_Amplitude’ | C | 50ms | LDW Safety | Lane Departure Warning Torque Request Amplitude shall be set to zero |
| Technical  Safety  Requirement  02 | The Validity and integrity of the data transmission fo ‘LDW\_Torque\_Request’ signal shal be ensured | C | 50ms | Data Transmission Integrity | Lane Departure Warning 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 | Lane Departure Warning Torque Request Amplitude shall be 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 ECU to turn on a warning light. | C | 50ms | LDW Safety | Lane Departure Warning Torque Request Amplitude shall be set to zero |
| 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 | Lane Departure Warning 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 electornic power steering Torque’ component is less than ‘Max\_Torque\_Frequency’ | C | 50ms | LDW Safety | Lane Departure Warning Torque Request Amplitude shall be set to zero |
| Technical  Safety  Requirement  02 | The Validity and integrity of the data transmission fo ‘LDW\_Torque\_Request’ signal shal be ensured | C | 50ms | Data Transmission Integrity | Lane Departure Warning 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 | Lane Departure Warning Torque Request Amplitude shall be 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 ECU to turn on a warning light. | C | 50ms | LDW Safety | Lane Departure Warning Torque Request Amplitude shall be set to zero |
| 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 | Lane Departure Warning Torque Request Amplitude 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:

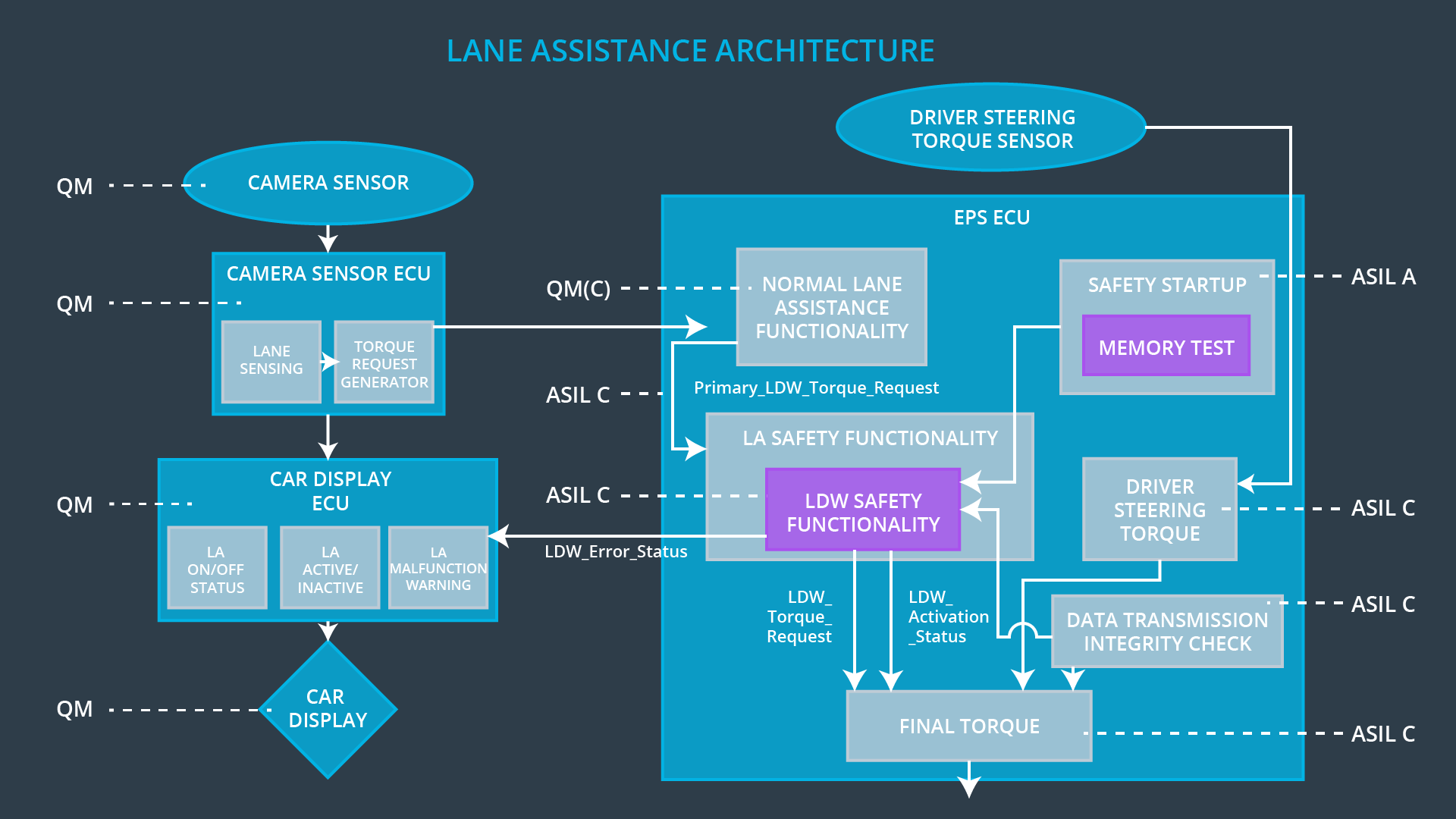
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Allocation to Architecture** | **Safe State** |
| Technical  Safety  Requirement  01 | The LKA safety component shall ensure that ‘LKA\_Time\_Activated\_ms’ is less than ‘Max\_LKA\_Time\_Acitvated\_ms’ | B | 500ms | LKW Safety | ‘LKA\_enable’ shall be set to False |
| Technical  Safety  Requirement  02 | The Validity and integrity of the timer measuring LKA\_Time\_Activated\_ms shall be ensured | B | 500ms | Timer | ‘LKA\_enable’ shall be set to False |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature shall be disabled | B | 500ms | LKW Safety | ‘LKA\_enable’ shall be set to False |
| 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 ECU to turn on a warning light. | B | 500ms | LKW Safety | ‘LKA\_enable’ shall be set to False |
| 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\_enable’ shall be set to False |

**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]**

All technial safety requirements discussed in this document 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 | 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 |