

Technical Safety Concept Lane Assistance

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# Document history

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| 10/2/2017 | 1.0 | Sumit Chhabra | Technical Safety Concept Lane Assistance |
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# Purpose of the Technical Safety Concept

Technical Safety Concept (TSC) is part of the product development phase. Though it looks similar to Functional Safety Concept but its more concrete and goes into the technical details of the item’s technology. TSC often define the signal flow and covers the general hardware and software requirements without going into the specific details.

# 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 departure oscillating torque amplitude is below Max\_Torque\_Amplitude | C | 50ms | Off |
| Functional  Safety  Requirement  01-02 | The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max\_Torque\_Frequency | C | 50ms | Off |
| Functional  Safety  Requirement  02-01 | The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max\_Duration | B | 500ms | Off |

## Refined System Architecture from 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 |  |
| Camera Sensor ECU - Lane Sensing | ECU for sensing if a vehicle is in lane or drifting toward the lines. |
| Camera Sensor ECU - Torque request generator | ECU for request torque generation to create haptic feedback or bring back the car in the center of lane, |
| Car Display | Takes the input from car display ECU and displays on/off warning sign as well as any malfunction occurred. |
| Car Display ECU - Lane Assistance On/Off Status | Shows light on and off for LA symbol if driver turn LAS on and off. |
| Car Display ECU - Lane Assistant Active/Inactive | Shows light on and off for LA symbol if LDW or LKS activated or deactivated. |
| Car Display ECU - Lane Assistance malfunction warning | Shows warning sign if LDW or LKS malfunction. |
| Driver Steering Torque Sensor | Measures the torque coming from the driver. |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Receives input from Driver Steering Torque sensor and sends required torque to ECU Final torque. |
| EPS ECU - Normal Lane Assistance Functionality | Receives the input from Camera Sensor ECU and decides for generating the request for torque for LDW and LKA functionality. |
| EPS ECU - Lane Departure Warning Safety Functionality | It is part of Safety Lane Assistance Functionality.  It gets Primary\_LDW\_Torque\_Request from Normal Lane Assistance Functionality and create LDW\_Torque\_Request to generate Final Torque. It will send LDW\_Activation\_Status to Car Display ECU, if functioning properly. It will send LDW\_Error\_Status to Car Display ECU if any malfunction occurs. |
| EPS ECU - Lane Keeping Assistant Safety Functionality | It is part of Safety Lane Assistance Functionality.  It gets Primary\_LKA\_Torque\_Request from Normal Lane Assistance Functionality and create LKA\_Torque\_Request to generate Final Torque. It will send LKA\_Activation\_Status to Car Display ECU, if functioning properly. It will send LKA\_Error\_Status to Car Display ECU if any malfunction occurs. |
| EPS ECU - Final Torque | Sends the final required torque value to the motor. |
| Motor | Takes the input from EPS ECU and applies the torque to the 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 the 'LDW\_Torque\_Request' sent to the 'Final electronic power steering Torque' component is below 'Max\_Torque\_Amplitude. | C | 50ms | LDW Safety Functionality | Off |
| Technical  Safety  Requirement  02 | 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 Functionality | Off |
| 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 Functionality | Off |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50ms | Data Transmission integrity check | Off |
| 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 | Safety startup | Off |

**[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 amplitude of the 'LDW\_Torque\_Request' sent to the 'Final electronic power steering Torque' component is below 'Max\_Torque\_Amplitude. | C | 50ms | LDW Safety Functionality | Off |
| Technical  Safety  Requirement  02 | 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 Functionality | Off |
| 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 Functionality | Off |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50ms | Data Transmission integrity check | Off |
| 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 | Safety startup | Off |

**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 'LKA\_Torque\_Request' sent to the 'Final electronic power steering Torque' component is applied for only 'Max\_Duration’ | B | 500ms | LKA Safety Functionality | Off |
| Technical  Safety  Requirement  02 | 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 | LKA Safety Functionality | Off |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature and the 'LKA\_Torque\_Request' shall be set to zero. | B | 500ms | LKA Safety Functionality | Off |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | B | 500ms | Data Transmission Integrity check | Off |
| 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 | Safety startup | Off |

**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]**

For Lane Assistance system, which includes LDW and LKA, all technical safety requirements are allocated to the Electronic Power Steering ECU.

## Warning and Degradation Concept

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | | **Trigger for Degradation Mode** | | **Safe State invoked?** | | **Driver Warning** | |
| WDC-01 | | Off | | If Torque amplitude exceeds Max\_Torque\_Amplitude or Torque frequency exceeds Max\_Torque\_Frequency | | Yes | | Warning light in car display | |
| WDC-02 | | Off | | If LKA torque applied exceeds the Max\_Duration time interval | | Yes | | Warning light in car display | |