

Technical 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 |
| 01/23/2019 | 1.0 | Rouzbeh Shirvani | First attempt |
| 01/27/2019 | 1.1 | Rouzbeh Shirvani | Second attempt |
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# Purpose of the Technical Safety Concept

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

**The technical safety concept defines how the sub-systems interact at the system level and describes how the ECUs communicate with each other.**

# 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 electronic power steering ECU shall ensure that the oscillating torque aplitude requested by the LDW function is below max\_torque\_amplitude | C | 50 ms | LDW will set the oscillating torque amplitude to 0 |
| Functional  Safety  Requirement  01-02 | The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max\_Torque\_Frequency | B | 50ms | LDW will set the oscillating frequency 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 | Safe state would be a state that the driver takes control of the wheel and does not rely on the system. Deactivating the system so that the driver takes control. |

## 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 | The camera system reads images from the road |
| Camera Sensor ECU - Lane Sensing | The camera system ECU identifies when the vehicle accidentally departds its lane and sends the approprate messages to the car display ECU and the electronic power steering ECU |
| Camera Sensor ECU - Torque request generator | The camera system ECU checks whether appropriate torque request has been generated in order to steer the vehcile in the right direction |
| Car Display | Car Displays system visualizes information and provides feedback for driver about the Lane Assistance system among other display functionality |
| Car Display ECU - Lane Assistance On/Off Status | Car Display ECU checks whether the lane assitance system is on or off so that it can generate the right signal in order to show to the driver. |
| Car Display ECU - Lane Assistant Active/Inactive | Car Display ECU makes sure whether the driver is in charge or the lane assitance is active currently. |
| Car Display ECU - Lane Assistance malfunction warning | In case of malfunctioning Car Display ECU provides appropriate feedback for the driver in order to be aware of the situation. |
| Driver Steering Torque Sensor | Driver Steering Torque Sensor senses how much torque is applied to the steering wheel and sends it to the power steering ECU |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Electronic power Steering ECU senses the steering torque generated by the driver for further processes. For example making sure that the driver is providing right amount of steering power. |
| EPS ECU - Normal Lane Assistance Functionality | EPS ECU makes sure that the Lane Assistance system is working under normal situation and sends appropriate signal to the driver |
| EPS ECU - Lane Departure Warning Safety Functionality | EPS ECU makes sure that the Lane Departure torque amplitude and frequency are in the safe range and potentially set to zero in case of missuse |
| EPS ECU - Lane Keeping Assistant Safety Functionality | EPS ECU makes sure that lane keeping assitance has a time limit |
| EPS ECU - Final Torque | EPS ECU makes sure that enough torque is applied in order to keep the vehicle on the path |
| Motor | The motor provides required force in order to move the steering wheel in the appropriate direction. |

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# 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 | 50 ms | LDW Safety block | LDW will set the oscillating torque amplitude to 0 |
| 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 | 50 ms | LDW safety block | LDW will set the oscillating torque amplitude to 0 |
| 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 | 50 ms | LDW safety block | LDW will set the oscillating torque amplitude to 0 |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50 ms | Data Transmission integrity check | N/A |
| 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 | Driver should be warned to stop the engine. |

**[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\_Frequency\_Request' sent to the 'Final electronic power steering Torque' component is below 'Max\_ Frequency \_Amplitude. | B | 50 ms | LDW Safety block | LDW will set the oscillating torque amplitude to 0 |
| 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. | B | 50 ms | LDW safety block | LDW will set the oscillating torque amplitude to 0 |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'LDW\_ Frequency \_Request' shall be set to zero. | B | 50 ms | LDW safety block | LDW will set the oscillating torque amplitude to 0 |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_ Frequency \_Request' signal shall be ensured. | B | 50 ms | Data Transmission integrity check | N/A |
| 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 | Driver should be warned to stop the engine. |

**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 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\_Duration | C | 50 ms | LDW Safety block | LDW will set the duration to 0 |
| 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 | 50 ms | LDW safety block | LDW will set the duration to 0 |
| Technical  Safety  Requirement  03 | As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the Max\_Duration shall be set to zero. | C | 50 ms | LDW safety block | LDW will set the duration to 0 |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for Max\_Duration signal shall be ensured. | C | 50 ms | Data Transmission integrity check | N/A |
| 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 | Driver should be warned to stop the engine. |

**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]**

## 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. ]**