

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 |
| 2/3/2019 | 1.0 | Vern Francisco | 1st attempt at completing the elective |
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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 froms the basis of developing Technical Safety Requirements during the product development phase. It outlines the steps needed to achieve technical safety.**

# 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 he lane departure oscillating toqrue ampliteude is below Max\_Torque\_Amplitude | C | 50ms | System is turned off |
| Functional  Safety  Requirement  01-02 | The lane keeping item shall ensure tha the lane departure oscillating torque frequency is belwo Max\_Torque\_Frequency | C | 50ms | System is turned off |
| Functional  Safety  Requirement  02-01 | The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for only a Max\_Duration | B | 500ms | System is turned off |

## 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 | Used to detect objects in the road |
| Camera Sensor ECU - Lane Sensing | Takes the signal from the camera sensor and detects the lanes. |
| Camera Sensor ECU - Torque request generator | Generates a torque request thta will be sent to the Electronic Power Steering ECU |
| Car Display | Contains the lights and guages that will be used to inform the driver of system status |
| Car Display ECU - Lane Assistance On/Off Status | Informs the driver if the Lane Assistance System is ON or OFF |
| Car Display ECU - Lane Assistant Active/Inactive | Informs the driver if the Lane Assistance System is Active or Inactive |
| Car Display ECU - Lane Assistance malfunction warning | Informs the driver if the Lane Assistance System is malfunctioning |
| Driver Steering Torque Sensor | Senses the amount of torque that is input by the driver |
| Electronic Power Steering (EPS) ECU - Driver Steering Torque | Receives the information from the Driver Steering Torque Sensor and processes it |
| EPS ECU - Normal Lane Assistance Functionality | Generates the primary LDW and LKA torque requests based on the Camera Sensor ECU |
| EPS ECU - Lane Departure Warning Safety Functionality | Determines if a lane departure is occuring and adds additional torque |
| EPS ECU - Lane Keeping Assistant Safety Functionality | Determines if the lane is not being kept and adds additional torque |
| EPS ECU - Final Torque | Sums all the torque request and creates a final torque request that will be sent to the motor |
| Motor | Creates the appropriate torque based on the final commanded torque |

# 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 Software | The LDW shall set the oscillating torque to zero |
| Technical  Safety  Requirement  02 | 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 Software | LDW torque output is set to zero |
| Technical  Safety  Requirement  03 | 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 Software | LDW torque output is set to zero |
| Technical  Safety  Requirement  04 | The validity and integrity of hte data transmission for ‘LDR\_Torque\_Request’ signal shall be ensured | C | 50ms | Data Transmission Integrity Check | N/A |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at the start up of the EPS ECU to check for any faults in memory | A | Length of vehicle ignition cycle | Safety Startup Memory Test | LDW torque output is 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 electronic power steering Torque’ component is below ‘Max\_Torque Frequency.” | C | 50ms | LDW Software | LDW torque output is set to zero |
| Technical  Safety  Requirement  02 | 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 Software | LDW torque output is set to zero |
| Technical  Safety  Requirement  03 | 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 Software | LDW torque output is set to zero |
| Technical  Safety  Requirement  04 | The validity and integrity of hte data transmission for ‘LDR\_Torque\_Request’ signal shall be ensured | C | 50ms | Data Transmission Integrity Check | N/A |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at the start up of the EPS ECU to check for any faults in memory | A | Length of vehicle ignition cycle | Safety Startup Memory Test | System is turned 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 duration of the ‘LDW\_Torque\_Request’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max\_Torque Amplitude.” | B | 50ms | LKA Software | LKA torque output is set to zero |
| Technical  Safety  Requirement  02 | As soon as a failure is detected by the LKA safety component, it shall deactivate the LKA feature and the ‘LKA\_Torque\_Request’ shall be set to zero | B | 50ms | LKA Software | LKA torque output is set to zero |
| Technical  Safety  Requirement  03 | 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 | 50ms | LKA Software | LKA torque output is set to zero |
| Technical  Safety  Requirement  04 | The validity and integrity of hte data transmission for ‘LKA\_Torque\_Request’ signal shall be ensured | B | 50ms | Data Transmission Integrity Check | N/A |
| Technical  Safety  Requirement  05 | Memory test shall be conducted at the start up of the EPS ECU to check for any faults in memory | A | Length of vehicle ignition cycle | Safety Startup Memory Test | LKA torque output is set to zero |

**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.]**



## 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 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.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Degradation Mode** | **Trigger for Degradation Mode** | **Safe State invoked?** | **Driver Warning** |
| WDC-01 | Turn off the lane departure warning function | The frequency of the oscillating torque or the magnitude of the oscillating torque have exceeded their limits | Yes | Warning Light |
| WDC-02 | Turn off the lane keeping assistance function | The max duration of driver hands off the wheel has been exceeded | Yes | Warning Light |

**Oftentimes, a technical safety analysis will lead to a more detailed warning and degradation concept. ]**