

Software Safety Requirements and Architecture

Lane Assistance

**Document Version: [Version]**

**Template Version 1.0, Released on 2017-06-21**



# 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 |
| 9/22/2018 | 1.0 | George V. Paul | First draft |
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# Purpose

**[Instructions: Answer what is the purpose of this document?]**

The purpose of this document is to develop the requirements and metrics against which the item can be verified. This will ensure that the system software achieves functional safety.

# Inputs to the Software Requirements and Architecture Document

**[Instructions:**

**REQUIRED:**

**You are only required to develop this document for the LDW (lane departure warning) amplitude malfunction. So here, provide the technical safety requirements for the LDW amplitude malfunction as well as the refined system architecture diagram from the technical safety concept.**

**OPTIONAL:**

**Expand this document to include software safety requirements for the LDW frequency malfunction as well. Go even further and document software safety requirements for the Lane Keeping Assistance (LKA) function as well.**

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## Technical safety requirements

Technical Safety Requirements related to Functional Safety Requirement 01-01 are:

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| **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 | 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 | 50ms | LDW Safety | 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 | 50ms | LDW Safety | 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 | 50ms | LDW Safety | LDW will set the oscillating torque amplitude to 0. |
| 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 | LDW Safety | LDW will set the oscillating torque amplitude to 0. |

## Refined Architecture Diagram from the Technical Safety Concept

**[Instructions:**

**REQUIRED: Provide the refined system architecture diagram from the technical safety concept**

**]**



# Software Requirements

**Lane Departure Warning (LDW) Amplitude Malfunction Software Requirements:**

**[Instructions: Fill in the software safety requirements for the LDW amplitude malfunction technical safety requirements. We have provided the associated technical safety requirements. Hint: The software safety requirements were discussed in the text from the software and hardware lesson.**

The LDW safety component has three blocks.

The first block will get the torque request from Basic/Main Lane Assistance functionality component. That first block will do any pre-processing needed. Then the block sends the results out to a torque limiter block that will check if the torque is beyond the allowed maximum amplitude. If the limit is reached, the torque request is set to zero. Finally, we'll add a third block that gets the signal ready for transmitting to the final torque generator.

**OPTIONAL:**

**CHALLENGE ONE**

**Develop software safety requirements for the Lane Departure Warning (LDW) frequency function and modify the system architecture as needed.**

**CHALLENGE TWO**

**Develop software safety requirements for the Lane Keeping Assistance (LKA) function and modify the system architecture as needed.**

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| **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\_Torque\_Amplitude | C | 50ms | LDW Safety | The default LDW\_Torque\_Request is set to 0. |

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| ID | Software Safety Requirement | ASIL | Allocation Software Elements | Safe State |
| Software  Safety  Requirement  01-01 | The input signal “Primary\_LDW\_Torq\_Req” shall be read and pre-processed to determine the torque request coming from the “Basic/Main LAFunctionality” SW Component. Signal “processed\_LDW\_Torq\_Req” shall be generated at the end of the processing. | C | LDW\_SAFETY\_INPUT\_PROCESSING | N/A |
| Software Safety Requirement 01-02 | In case the “processed\_LDW\_Torq\_Req” signal has a value greater than “Max\_Torque\_Amplitude\_LDW” (maximum allowed safe torque), the torque signal “limited\_LDW\_Torq\_Req” shall be set to 0, else “limited\_LDW\_Torq\_Req” shall take the value of “processed\_LDW\_Torq\_Req”. | C | TORQUE\_LIMITER | “limited\_LDW\_Torq\_Req” = 0 (Nm=Newton-meter) |
| Software Safety Requirement 01-03 | The “limited\_LDW\_Torq\_Req” shall be transformed into a signal “LDW\_Torq\_Req” which is suitable to be transmitted outside of the LDW Safety component (“LDW Safety”) to the “Final EPS Torque”component. Also see SofSafReq02-01 and SofSafReq02-02 | C | LDW\_SAFETY\_OUTPUT\_GENERATOR | LDW\_Torq\_Req= 0 (Nm) |

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| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Allocation to Architecture** | **Safe State** |
| Technical  Safety  Requirement  02 | The validity and integrity of the data transmission for LDW\_Torque\_Request signal shall be ensured | C | 50ms | LDW Safety | N/A |

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| **ID** | **Software Safety Requirement** | **ASIL** | **Allocation Software Elements** | **Safe State** |
| Software Safety Requirement 02-01 | Any data to be transmitted outside of the LDW Safety component (“LDW Safety”) including "LDW\_Torque\_Req" and “activation\_status” (see SofSafReq03-02) shall be protected by an End2End(E2E) protection mechanism | C | E2ECalc | LDW\_Torq\_Req=0 (Nm) |
| Software Safety Requirement 02-02 | The E2E protection protocol shall contain and attach the control data: alive counter (SQC) and CRC to the data to be transmitted | C | E2ECalc | LDW\_Torq\_Req=0 (Nm) |

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| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Allocation to Architecture** | **Safe State** |
| 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 | LDW torque output is set to 0. |

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| **ID** | **Software Safety Requirement** | **ASIL** | **Allocation Software Elements** | **Safe State** |
| Software Safety Requirement03-01 | Each of the SW elements shall output a signal to indicate any error which is detected by the element. Error signal = error\_status\_input(LDW\_SAFETY\_INPUT\_PROCESSING), error\_status\_torque\_limiter(TORQUE\_LIMITER), error\_status\_output\_gen(LDW\_SAFETY\_OUTPUT\_GENERATOR) | C | 50ms | Set the (“activation\_status”=0) |
| Software Safety Requirement03-02 | A software element shall evaluate the error status of all the other software elements and in case any 1 of them indicates an error, it shall deactivate the LDW feature (“activation\_status”=0) | C | 50ms | Set the (“activation\_status”=0) |
| Software Safety Requirement03-03 | In case of no errors from the software elements, the status of the LDW feature shall be set to activated (“activation\_status”=1 | C | 50ms | Set the (“activation\_status”=0) |
| Software Safety Requirement03-04 | In case an error is detected by any of the software elements, it shall set the value of its corresponding torque to 0 so that “LDW\_Torq\_Req” is set to 0 | C | 50ms | Set the (“activation\_status”=0) |
| Software Safety Requirement03-05 | Once the LDW functionality has been deactivated, it shall stay deactivated till the time the ignition is switched from off to on again. | C | 50ms | Set the (“activation\_status”=0) |

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| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Allocation to Architecture** | **Safe State** |
| 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 | LDW torque output is set to 0. |

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| **ID** | **Software Safety Requirement** | **ASIL** | **Allocation Software Elements** | **Safe State** |
| Software Safety Requirement 04-01 | When the LDW function is deactivated (activation\_status set to 0), the activation\_status shall be sent to the car displayECU. | C | LDW\_SAFETY\_ACTIVATION, CarDisplay ECU | N/A |

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| **ID** | **Technical Safety Requirement** | **ASIL** | **Fault Tolerant Time Interval** | **Allocation to Architecture** | **Safe State** |
| 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 | LDW torque output is set to 0. |

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| **ID** | **Software Safety Requirement** | **ASIL** | **Allocation Software Elements** | **Safe State** |
| Software Safety Requirement 05-01 | A CRC verification check over the software code in the Flash memory shall be done every time the ignition is switched from off to on to check for any corruption of content. | A | MEMORYTEST | LDW torque output is set to 0. |
| Software Safety Requirement 05-02 | Standard RAM tests to check the data bus, address bus and device integrity shall be done every time the ignition is switched from off to on (E.g.walking 1s test, RAM pattern test. Refer RAM and processor vendor recommendations ) | A | MEMORYTEST | LDW torque output is set to 0. |
| Software Safety Requirement 05-03 | The test result of the RAM or Flash memory shall be indicated to the LDW\_Safety component via the “test\_status” signal | A | MEMORYTEST | LDW torque output is set to 0. |
| Software Safety Requirement 05-04 | In case any fault is indicated via the “test\_status” signal the INPUT\_LDW\_PROCESSING shall set an error on error\_status\_input (=1) so that the LDW functionality is deactivated and the LDWTorque is set to 0 | A | LDW\_SAFETY\_INPUT\_PROCESSING | LDW torque output is set to 0. |

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# Refined Architecture Diagram

**[Instructions: Include the refined system architecture. Hint: The refined system architecture should include the system architecture from the end of the software and hardware lesson, including all of the ASIL labels.]**

