

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 |
| 18.11.2018 | 1.0 | Suraj Lal Putta | Initial Draft |
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# Purpose

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

Until this point the functional safety was considered only at system level. Finally the all the safety goals have to be implemented at the hardware and the software level. The software requirements related to functional safety is derived from the technical safety requirements in this document. And these requirements should be fulfilled by the software which should be developed according to the software development process (software v – model) as specified by ISO26262.

# 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.**

**]**

## 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 | 50 ms | EPS ECU - LDW Safety Functionality | The LDW functionality is turned off and the 'LDW\_Torque\_Request' shall be set to zero. |
| 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 | EPS ECU – LDW Safety Functionality | The LDW functionality is turned off and the 'LDW\_Torque\_Request' 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 | 50 ms | EPS ECU - LDW Safety Functionality | The LDW functionality is turned off and the 'LDW\_Torque\_Request' shall be set to zero. |
| Technical  Safety  Requirement  04 | The validity and integrity of the data transmission for 'LDW\_Torque\_Request' signal shall be ensured. | C | 50 ms | EPS ECU -Data Transmission and Integrity Check | The LDW functionality is turned off and the 'LDW\_Torque\_Request' 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 | EPS ECU – Safety Startup | The LDW functionality is turned off and the 'LDW\_Torque\_Request' shall be set to zero. |

## Refined Architecture Diagram from the Technical Safety Concept

**[Instructions:**

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

**]**



Figure : Refined Architecture from Technical Safety Concept

The Figure 1 shows the refined architecture derived 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.**

**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 | 50 ms | LDW Safety Functionality | The LDW functionality is turned off and the “LDW\_torque\_Request” is set to zero. |

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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 | 50 ms | Data Transmission Integrity Check | 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 | Data Transmission Integrity Check | 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 | Data Transmission Integrity Check | 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 | 50 ms | LDW Safety | LDW torque output is set to zero |

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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 | All | N/A |
| 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 | LDW\_SAFETY\_ACTIVATION | Activation\_status = 0 (LDW function deactivated) |
| 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 | LDW\_SAFETY\_ACTIVATION | N/A |
| 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 | ALL | LDW\_Torq\_Req = 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 | LDW\_SAFETY\_ACTIVATION | Activation\_status = 0 (LDW function deactivated) |

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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 | 50 ms | LDW Safety | LDW torque output is set to zero |

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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 | Ignition Cycle | LDW torque output is set to zero |

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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 | Activation\_status = 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 | Activation\_status = 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 | Activation\_status = 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 | Activation\_status = 0 |

# 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.]**



Figure : Refined Architecture of Lane Assistance after Software Requirements

The Figure 2 shows detailed architecture of the LDW Safety software function refined after deriving software requirements. The LDW safety software function contains five components namely where three components LDW\_SAFETY\_INPUT\_PROCESSING, TORQUE\_LIMITER and LDW\_SAFETY\_OUTPUT\_GERNERATOR processes the steering torque received from the main lane assistance functionality. The E2E CALCULATION enables end to end protection for data transmission outside the LDW SAFETY function. The LDW\_SAFETY\_ACTIVATION component receives the error status of all the software components in the LDW SAFETY function and triggers the software to enable safe state in case of any errors. The SAFETY STARTUP component outside of LDW SAFETY checks for any errors in the memory during system startup and sends it status to the LDW\_SAFETY\_INPUT\_PROCESSING. The LDW SAFETY provides LDW\_Torque\_Request and activation\_status to the FINAL\_EPS\_TORQUE\_GENERATOR. The activation\_status is a redundancy to ensure the system LDW function is deactivated in case of any faults. The activation\_status is also sent to the CAR DISPLAY ECU to warn the driver.