

Software Safety Requirements and Architecture

Lane Assistance

**Document Version: 1.0**



# Document history

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| Date | Version | Editor | Description |
| 13/9/2018 | 1.0 | Ajinkya Bhave | Software Safety Requirements and Architecture for the Lane Assistance Item |
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# Table of Contents

[Document history 2](#_Toc524621757)

[Table of Contents 2](#_Toc524621758)

[Purpose 2](#_Toc524621759)

[Inputs to the Software Requirements and Architecture Document 3](#_Toc524621760)

[Technical safety requirements 3](#_Toc524621761)

[Refined Architecture Diagram from the Technical Safety Concept 4](#_Toc524621762)

[Software Requirements 5](#_Toc524621763)

[Refined Architecture Diagram 10](#_Toc524621764)

# Purpose

The purpose is to derive the detailed software safety requirements for each technical safety requirement defined in the Technical Safety Concept, refine the architecture to the level of software units, and allocate each software safety requirement to a software unit.

# Inputs to the Software Requirements and Architecture Document

**[REQUIRED:**

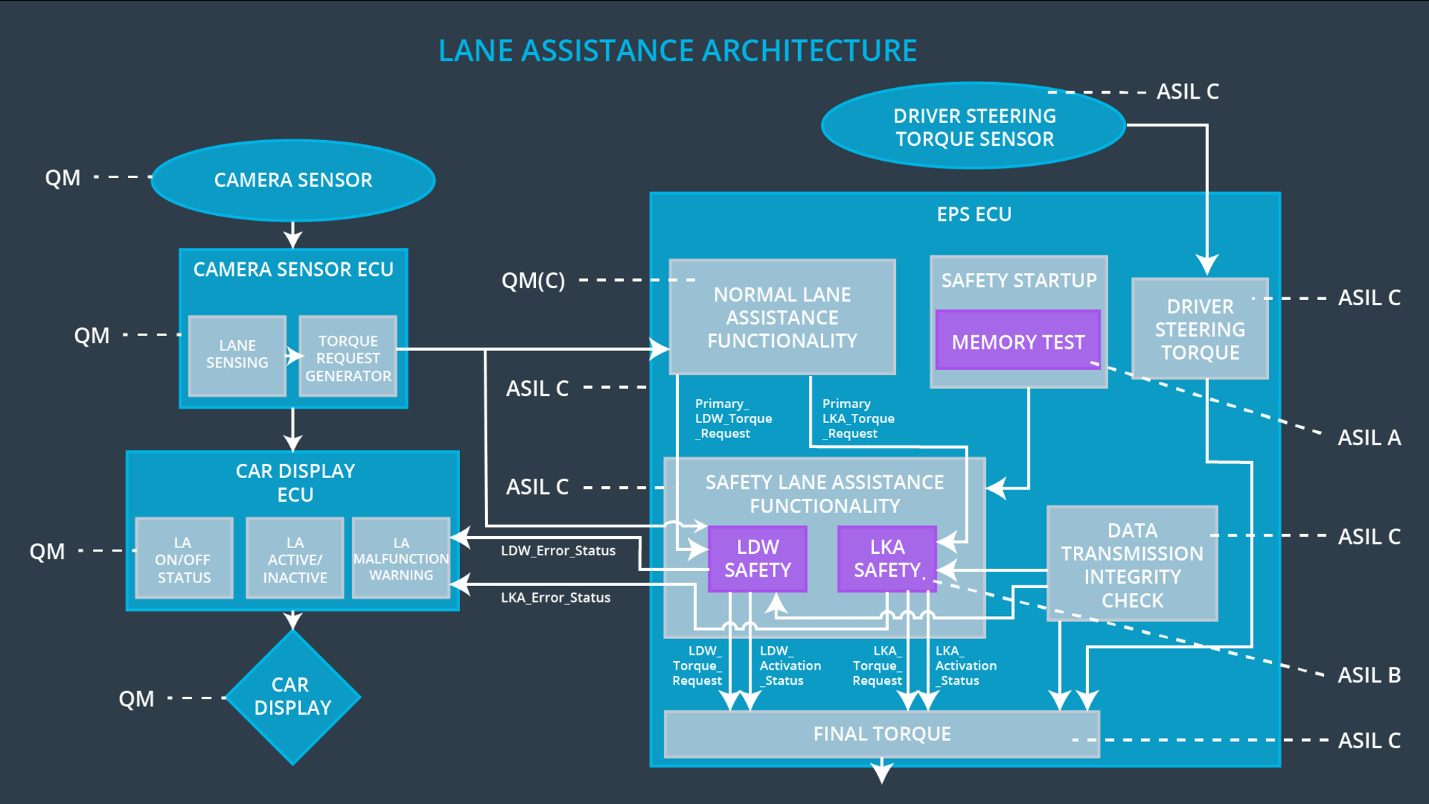
**You are only required to develop this document for the LDW (lane departure warning) amplitude malfunction. So here, provide the technical safety requirements for the LDW amplitude malfunction as well as the refined system architecture diagram from the technical safety concept.]**

## 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 Torque* component is below *Max\_Torque\_Amplitude* | C | 50 ms | LDW Safety | *LDW\_Torque\_Request* is set to zero |
| Technical  Safety  Requirement  02 | As soon as the LDW function deactivates the LDW feature, the *LDW Safety* component shall send a signal to the car display ECU to turn on a warning light | C | 50 ms | LDW Safety | *LDW\_Torque\_Request* is 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 | LDW Safety | *LDW\_Torque\_Request* is 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 | Data Transmission Integrity Check | *LDW\_Torque\_Request* is 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 | Memory Test | *LDW\_Torque\_Request* is set to zero |

## Refined Architecture Diagram from the Technical Safety Concept

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# Software Requirements

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

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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 | *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 LA Functionality” 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 | As soon as the LDW function deactivates the LDW feature, the *LDW Safety* component shall send a signal to the car display ECU to turn on a warning light | C | 50 ms | LDW Safety | *LDW\_Torque\_Request* is set to zero |

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| **ID** | **Software Safety Requirement** | **ASIL** | **Allocation Software Elements** | **Safe State** |
| Software Safety Requirement 02-01 | When the LDW function is deactivated (activation\_status set to 0), the activation\_status shall be sent to the car display ECU | C | LDW\_SAFETY\_ACTIVATION,  Car Display ECU | N/A |

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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\_Request* 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 | The validity and integrity of the data transmission for *LDW\_Torque\_Request* signal shall be ensured | C | 50 ms | Data Transmission Integrity Check | *LDW\_Torque\_Request* is set to zero |

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| **ID** | **Software Safety Requirement** | **ASIL** | **Allocation Software Elements** | **Safe State** |
| Software Safety Requirement 04-01 | 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 04-02 | 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  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\_Request* 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 LDW\_Torque is set to 0 | A | LDW\_SAFETY\_INPUT\_PROCESSING | Activation\_status = 0 |

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# Refined Architecture Diagram

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