Software Safety Requirements and Architecture

Lane Assistance

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Document history

Date	Version	Editor	Description
20/10/2018	1.0	L.R	First Submission

Table of Contents

Purpose

This document refines technical safety requirements into software safety requirements and determines the software units these requirements should be allocated to. This is more detailed look at requirements and applying them to individual software units. A software engineer should be able to write a program from the software requirements and software architecture.

Inputs to the Software Requirements and Architecture Document

Technical safety requirements

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 safety	LDW_Torque_Request amplitude shall be set to zero.
Technical Safety Requirement 02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	LDW safety	LDW_Torque_Request amplitude 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 LDW_Torque_Request shall be set to zero	C	50ms	LDW safety	LDW_Torque_Request amplitude shall be set to zero.
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	Data Transmission Integrity Check	LDW_Torque_Request amplitude shall be set to zero.
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory	A	Ignition cycle	Safety Startup	LDW_Torque_Request amplitude shall be set to zero.

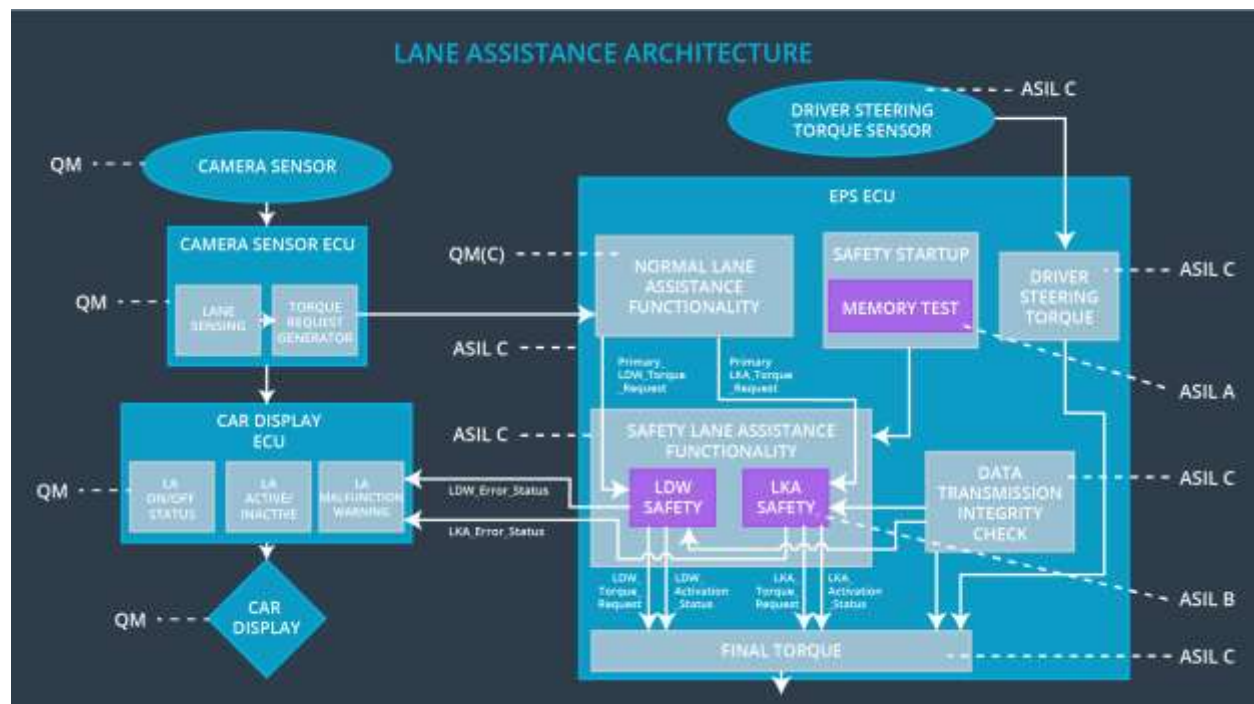# Refined Architecture Diagram from the Technical Safety Concept

Figure 1 - Lane Assistance Architecture from Technical Safety Concept

Software Requirements

Lane Departure Warning (LDW) Amplitude Malfunction Software Requirements:

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	LDW_Torque_Request amplitude shall be set to zero.

ID	Technical Safety Requirement	ASIL	Allocation Software Elements	Safe State
SoftwareSafetyRequirement01-01	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
SoftwareSafetyRequirement01-02	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)
SoftwareSafetyRequirement01-03	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)

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	LDW_Torque_Request amplitude shall be set to zero.

ID	Technical Safety Requirement	ASIL	Allocation Software Elements	Safe State
SoftwareSafetyRequirement02-01	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)
SoftwareSafetyRequirement02-02	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)

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 LDW_Torque_Request shall be set to zero	C	50ms	LDW safety	LDW_Torque_Request amplitude shall be set to zero.

ID	Technical Safety Requirement	ASIL	Allocation Software Elements	Safe State
SoftwareSafetyRequirement03-01	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
SoftwareSafetyRequirement03-02	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)
SoftwareSafetyRequirement03-03	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
SoftwareSafetyRequirem	In case an error is detected by any of the software elements, it	C	All	LDW_Torq_Req = 0

ent03-04	shall set the value of its corresponding torque to 0 so that "LDW_Torq_Req" is set to 0			
SoftwareSafetyRequirement03-05	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)

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	Data Transmission Integrity Check	LDW_Torque_Request amplitude shall be set to zero.

ID	Technical Safety Requirement	ASIL	Allocation Software Elements	Safe State
SoftwareSafetyRequirement04-01	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

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
ssTechnical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory	A	Ignition cycle	Safety Startup	LDW_Torque_Request amplitude shall be set to zero.

ID	Technical Safety Requirement	ASIL	Allocation Software Elements	Safe State
SoftwareSafetyRequirement05-01	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
SoftwareSafetyRequirement05-02	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
SoftwareSafetyRequirement05-03	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
SoftwareSafetyRequirement05-04	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	A	LDW_SAFETY_INPUT_PROCESSING	Activation_status = 0

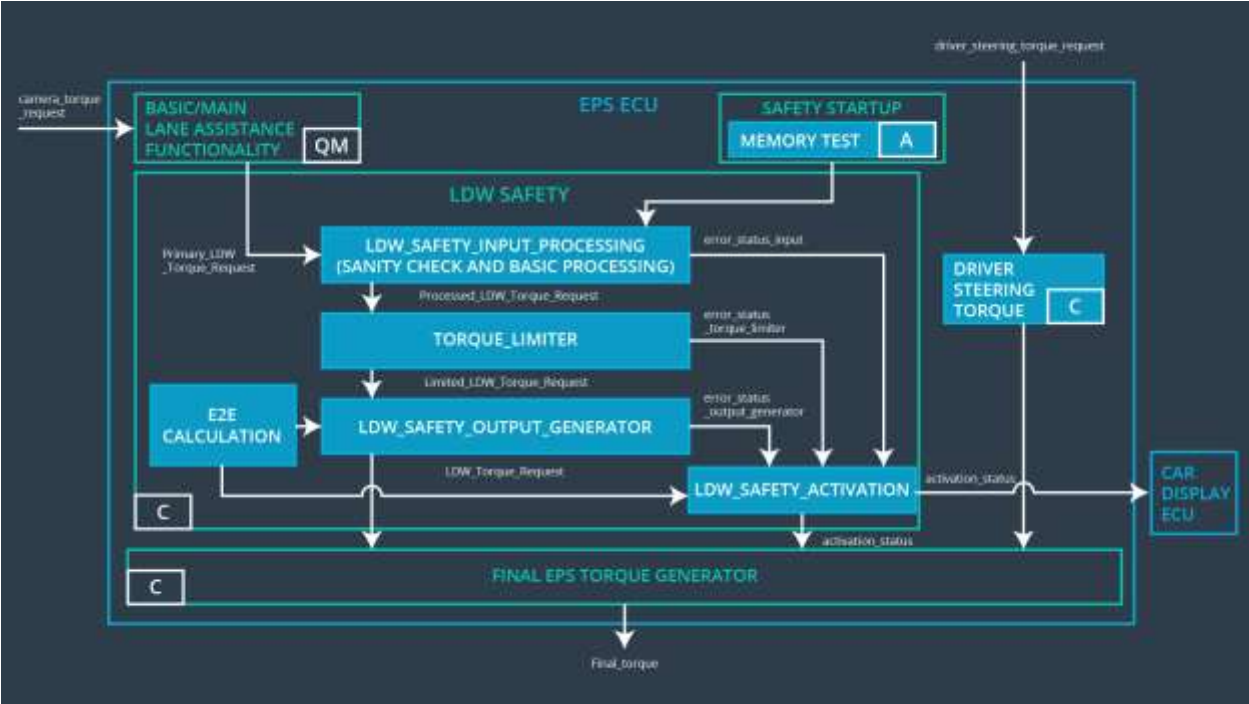|	is set to 0			

Refined Architecture Diagram

Figure 2 - Refined Architecture Diagram for software