Software Safety Requirements and Architecture

Lane Assistance

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Document history

Date	Version	Editor	Description
12/27/2017	1.0	Daniel Prado	Initial Version

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Purpose

The Software Safety Requirements document is part of the safety process of ISO 26262 for the treatment of potential malfunctions in electrical and electronic systems.

Its purpose is to refine the architecture identifying new detailed software requirements and allocate them to component level diagrams of the system. In addition, it provides the metrics to be used to verify the functional safety of the item under development.

Inputs to the Software Requirements and Architecture Document

Technical safety requirements

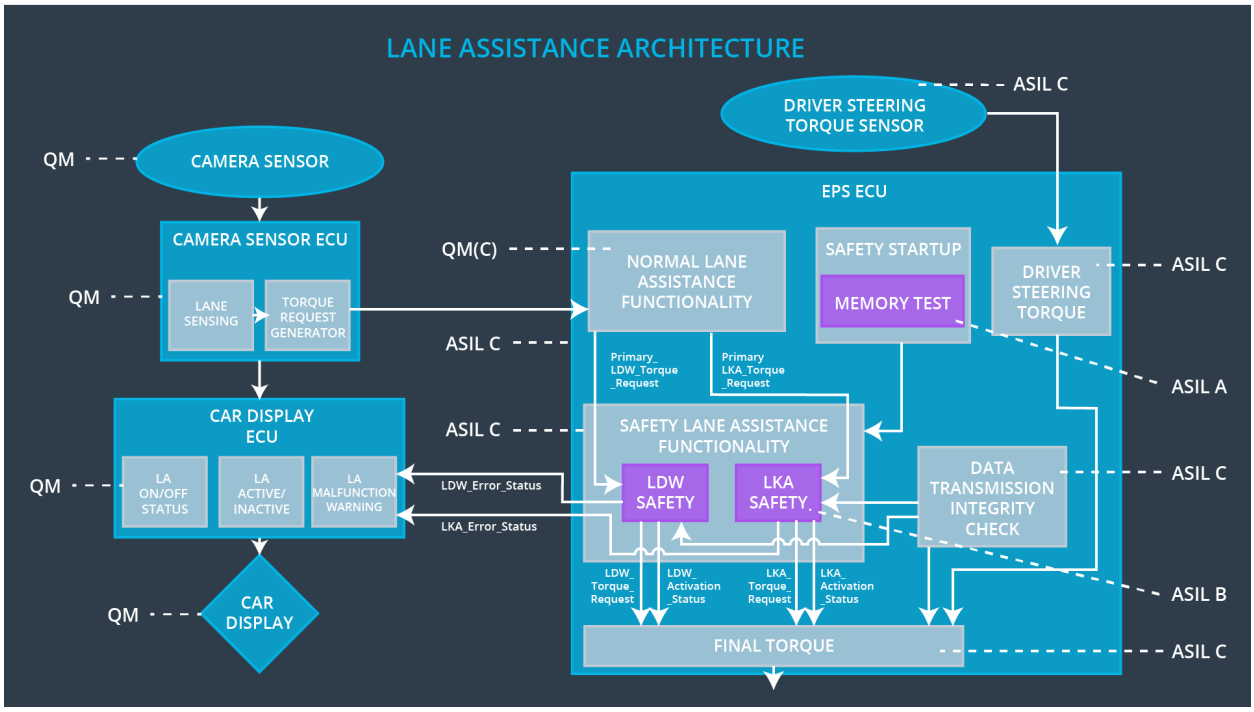
Technical Safety Requirements related to Functional Safety Requirement 01-01 are:

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	EPS ECU - LDW Safety Component	LDW torque output is 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	50ms	EPS ECU - LDW Safety Component	LDW torque output is set to zero.
Technical Safety Requirement	As soon as a failure is detected by the LDW function, it shall deactivate	C	50ms	EPS ECU - LDW Safety Component	LDW torque output is set to zero.

03	the LDW feature 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	50ms	EPS ECU – Data Transmission Integrity Check	LDW torque output is 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	EPS ECU – Safety Startup Memory Test	LDW torque output is set to zero.

Refined Architecture Diagram from the Technical Safety Concept

The following images shows the refined system architecture:



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	EPS ECU - LDW Safety Component	LDW torque output is set to zero.

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_Ampltide_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

Software Safety Requirement 01-03	The “limited_LDW_Torq_Req”shall be transformed into a signal “LDW_Torq_Req” whichis suitable to be transmittedoutside of the LDW Safetycomponent (“LDW Safety”) to the “Final EPS Torque”component.	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	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	EPS ECU - LDW Safety Component	LDW torque output is set to zero.

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

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	EPS ECU - LDW Safety Component	LDW torque output is set to zero.

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 03-01	Each of the SW elements shall output a signal to indicate any error which is detected by the element. Error signals: 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 Requirement 03-02	A software element shall evaluate the error status of all the other software elements and in case any one 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 Requirement 03-03	In case of no errors from the software elements, the status of the LDW feature shall be set to activated.	C	LDW_SAFETY_ACTIVATION	N/A

	(“activation_status”=1)			
Software Safety Requirement 03-04	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 Requirement 03-05	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	The validity and integrity of the data transmission for ‘LDW_Torque_Request’ signal shall be ensured.	C	50ms	EPS ECU – Data Transmission Integrity Check	LDW torque output is set to zero.

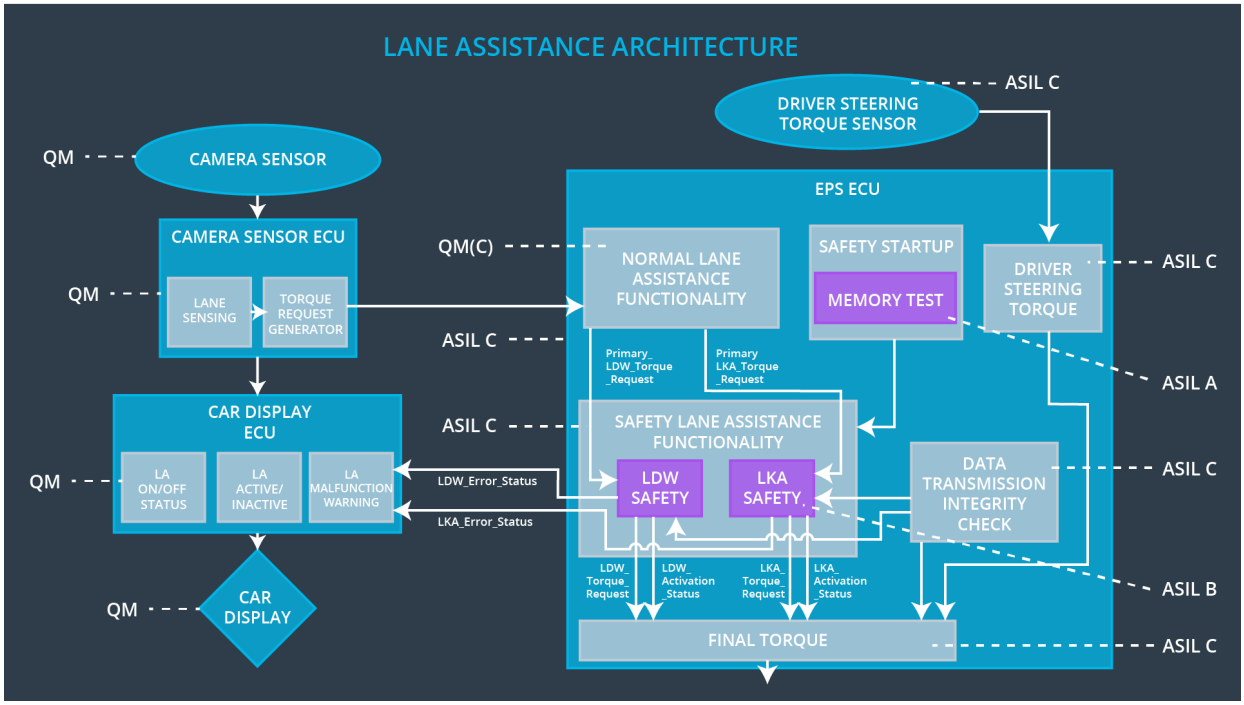
ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 04-01	Any data to be transmitted outside of the LDW Safety component (“LDW Safety”) including "LDW_Torque_Req" and “activation_status” shall be protected by an End2End (E2E) protection mechanism.	C	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)

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
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	EPS ECU – Safety Startup Memory Test	LDW torque output is set to zero.

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	MEMORY TEST	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	MEMORY TEST	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	MEMORY TEST	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

Refined Architecture Diagram

The refined architecture diagram is presented in the following figures:
For the whole L.A. System Architecture:



And for the LDW safety component of the EPS ECU: