Elektrobit

UDACITY

Software Safety Requirements and Architecture

Lane Assistance

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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]

Date	Version	Editor	Description
5/1/2019	1.0	Jiaxing Gao	First Commit

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Purpose

This document identifies the new requirements for the software components at a component level to identify potential problems on software design and architecture that could lead to a violation of safety goals. These requirements are more detail oriented than the technical safety concept requirements.

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:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State
Technical Safety Requirement 01-01-01	The Lane Departure Warning 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	Lane Departure Warning torque to zero.

Technical Safety Requirement 01-01-02	When the Lane Departure Warning is deactivated, the 'LDW Safety' software module shall send a signal to the Car Display ECU to turn on a warning signal.	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 01-01-03	When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set 'LDW_Torque_Request' to zero.	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 01-01-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Data Transmission Integrity Check	Lane Departure Warning torque to zero.

Functional Safety Requirement 01-2 with its associated system elements (derived in the functional safety concept)

ID	**Functional Safety Requirement**	**Electronic Power Steering ECU**	**Camera ECU**	**Car Display ECU**
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	X		

Technical Safety Requirements related to Functional Safety Requirement 01-02 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State
Technical Safety Requirement 01-02-01	The Lane Departure Warning safety component shall ensure the frequency of the 'LDW_Torque_Reques' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency.'	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.

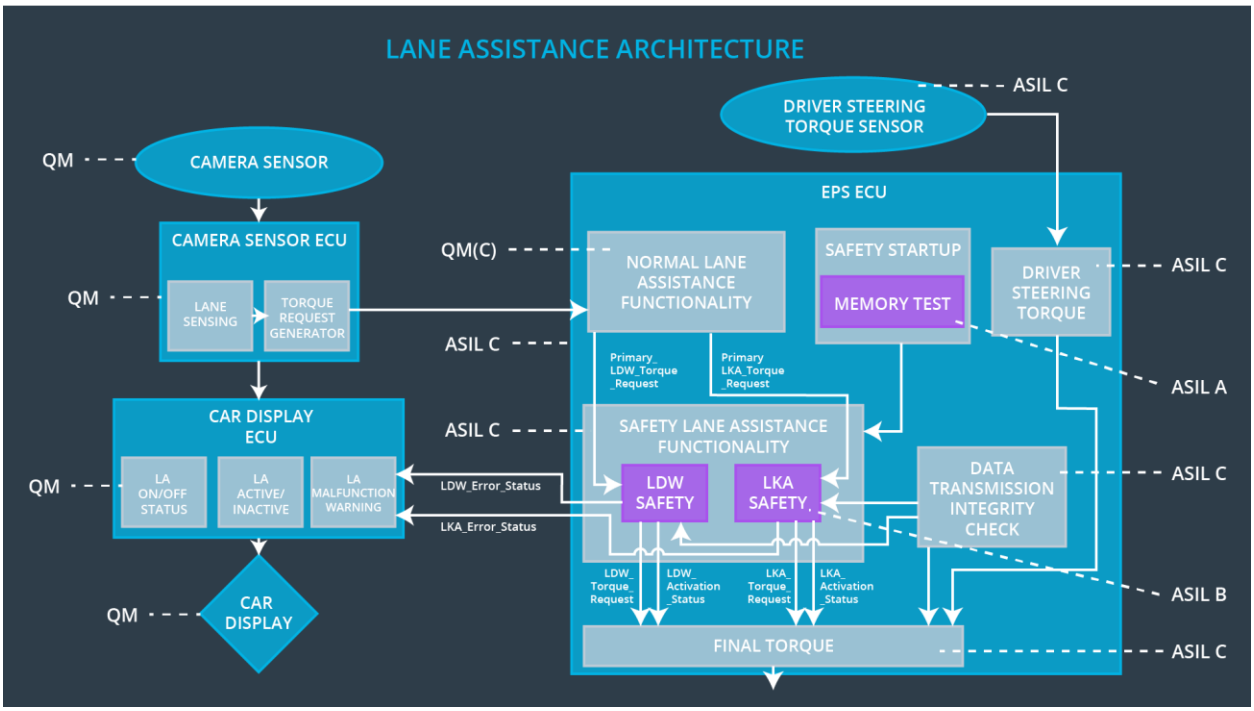
Functional Safety Requirement 01-03 with its associated system elements (derived in the functional safety concept)

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 01-03	Indicator of a ready LDW system should be added, LDW_Status, on Car Display system or other place for driver to notice			X

Technical Safety Requirements related to Functional Safety Requirement 01-03 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State
Technical Safety Requirement 01-03-01	The Car Display component shall ensure the indicator LDW_Status on green when the LDW system is ready to use	QM	50 ms	LDW Safety	Lane Departure Warning indicator turns to green.

Refined Architecture Diagram from the 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 Lane Departure Warning 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	Lane Departure Warning torque 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_SAGETY_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 zero, 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 the LDW Safety component (‘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	When the Lane Departure Warning is deactivated, the 'LDW Safety' software module shall send a signal to the Car Display ECU to turn on a warning signal.	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 02-01	Any data to be transmitted outside the LDQ Safety component ('LDW Safety') including 'LDW_Torque_Req' and 'activation_status' shall be protected by an End-2-End protection mechanism.	C	E2C Calc	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	E2E Calc	LDW_Torq_Req = 0 (Nm)

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-03	When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set 'LDW_Torque_Request' to zero.	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 03-01	Each Software element shall output a 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 Requirement 03-02	A software element shall evaluate the error status of all other software elements and in case any one of them indicates an error, it shall deactivate the Lane Departure Warning feature ('activation_status'=0)	C	LDW_SAFETY_ACTIVATION	Lane Departure Warning function deactivated ('activation_status' =0).
Software Safety Requirement 03-03	In case of a no error from the software elements, the status of the Lane Departure Warning feature shall be set to activated ('activation_status'=1).	C	LDW_SAFETY_ACTIVATION	N/A
Software	In case an error is detected by	C	All	LDW_Torq_Req = 0

Safety Requirement 03-04	any of the software elements, it shall set the value to its corresponding torque to zero so that 'LDW_Torq_Req' is set to zero			
Software Safety Requirement 03-05	Once the Lane Departure Warning functionality has been deactivated, it shall stay deactivating until the time the ignition is switched from off to on again.	C	LDW_SAFETY_ACTIVATION	Lane Departure Warning function deactivated ('activation_status' =0).

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	LDW Safety	Lane Departure Warning torque to zero.

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 04-01	When the Lane Departure Warning function is deactivated ('activation_status' set to zero), 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 01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Data Transmission Integrity Check	Lane Departure Warning torque 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 content corruption.	A	MEMORYTEST	Activation_status = 0
Software Safety Requirement 05-02	Standard RAM test 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 to 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 the error_status_input(=1) so that the Lane Departure Warning functionality is deactivated and the LDW_Torque_Req is set to zero.	A	LDW_SFETY_INPUT_PROCESSING	Activation_status = 0

Refined Architecture Diagram