Elektrobit

UDACITY

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]

Date	Version	Editor	Description
August 13,2017	1.0	Ryosuke Honda	Initial Draft
August 14,2017	2.0	Ryosuke Honda	Add description on the purpose and revised ASIL value for Lane Keeping Assistance function.

Table of Contents

[Instructions: We have provided a table of contents. If the table of contents is not showing up correctly in your word processor of choice, please update it. The table of contents should show each section of the document and page numbers or links. Most word processors can do this for you. In Google Docs, you can use headings for each section and then go to Insert > Table of Contents. Microsoft Word has similar capabilities]

Purpose

[Instructions: Answer what is the purpose of this document?]
The purpose of software safety requirements and architecture document is to identify new detailed requirements and allocate these software requirements to component level diagrams for the lane assistance functional safety project that is related to the potential malfunctions of the electrical and electronic system as defined 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:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State

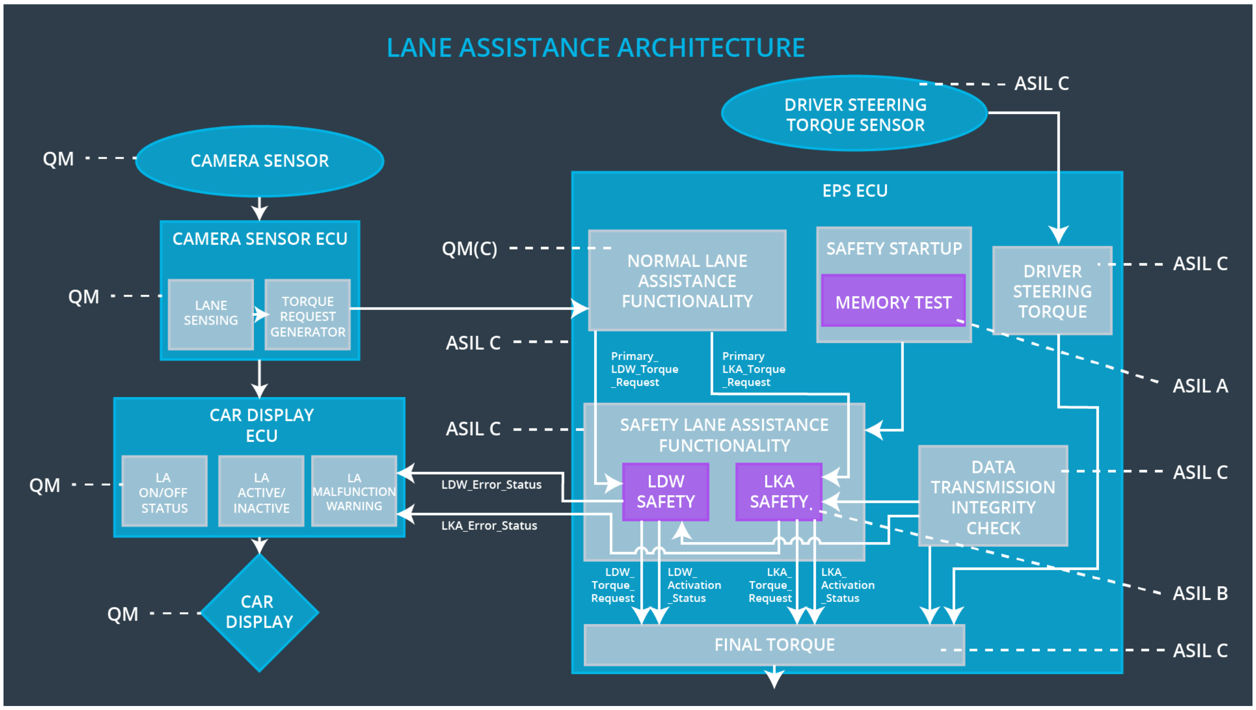
Technical Safety Requirement 01	The LDW safety components shall ensure that the amplitude of "LDW_Torque_Request" send to the "Final electronic power steering torque" components is below "Max_Torque_Amplitude"	C	50ms	LDW Safety Functionallity	LDW torque output is set to zero
Technical Safety Requirement 02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	Data Transmission integrity check	N/A
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 Functionallity	LDW torque output is 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 to turn a warning light.	C	50ms	LDW Safety Functionallity	LDW torque output is set to zero
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check any faults in memory.	A	Ignition Cycle	Safety startup memory test	LDW torque output is set to zero

Refined Architecture Diagram from the Technical Safety Concept

[Instructions:

REQUIRED: Provide the refined system architecture diagram 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.
]

ID	Technical Safety Requirement	A	Fault	Allocation to	Safe State

		SIL	**Tolerant Time Interval**	**Architecture**	
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 Functionality	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=Newton-meter)
Software Safety Requirement 01-03	The “limited_LDW_Torq_Req”shall be transformed into a signal “LDW_Torq_Req” whichis suitable to be transmitted outside of the LDW Safety	C	LDW_SAFETY_OUTPUT_GENERATOR	LDW_Torq_Req = 0 (Nm)

	component (“LDW Safety”) to the “Final EPS Torque”component. Also see SofSafReq02-01 andSofSafReq02-02			

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	Data Transmission Integrity Check	N/A

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" (seeSofSafReq03-02) shall be protected by an End2End(E2E) protection mechanism	C	E2ECalc	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	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 the LDW_Torque_Request shall be set to zero	C	50ms	LDW Safety Functionality	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 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 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 Requirement 03-03	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 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	Once the LDW functionality has	C	LDW_SAFETY_A	Activation_status = 0

Safety Requirement 03-05	been deactivated, it shall stay deactivated till the time the ignition is switched from off to on again.		CTIVATION	(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	LDW Safety Functionality	LDW torque output is set to zero

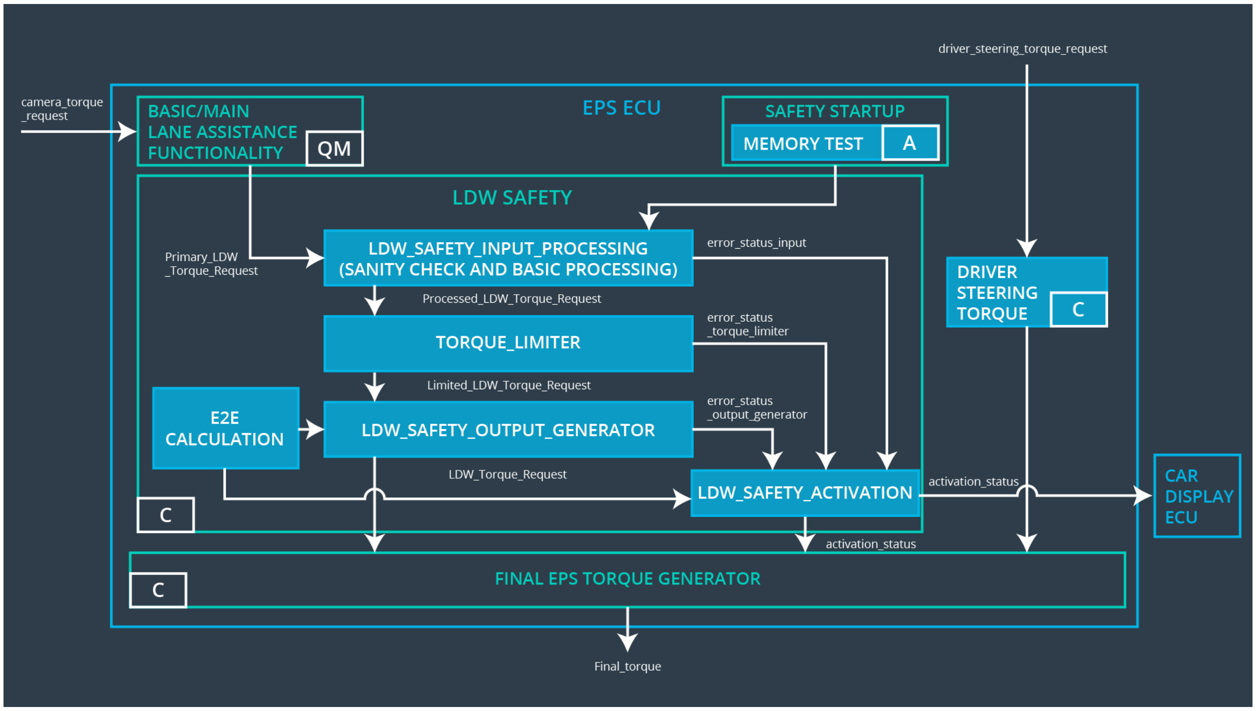
ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 04-01	When the LDW function is deactivated (activation_status set to 0), the activation_status shall be sent to the car displayECU.	C	LDW_SAFETY_ACTIVATION, CarDisplay ECU	N/A

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	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	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	MEMORYTEST	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.]


driver_steering_torque_request
camera_torque _request
BASIC/MAIN LANE ASSISTANCE FUNCTIONALITY
QM
EPS ECU
SAFETY STARTUP
MEMORY TEST
A
LDW SAFETY
Primary_LDW _Torque_Request
LDW_SAFETY_INPUT_PROCESSING (SANITY CHECK AND BASIC PROCESSING)
error_status_input
Processed_LDW_Torque_Request
TORQUE_LIMITER
error_status _torque_limiter
Limited_LDW_Torque_Request
DRIVER STEERING TORQUE
C
E2E CALCULATION
LDW_SAFETY_OUTPUT_GENERATOR
error_status _output_generator
LDW_Torque_Request
LDW_SAFETY_ACTIVATION
activation_status
CAR DISPLAY ECU
C
activation_status
C
FINAL EPS TORQUE GENERATOR
Final_torque

Lane Departure Warning (LDW) Frequency 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 frequency of the LDW_Torque_Request sent to the Final Electronic Power Steering Torque component is below Max_Torque_Frequency	C	50ms	LDW Safety Functionality	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_Frequency_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” whichis suitable to be transmitted outside of the LDW Safety component (“LDW Safety”) to the “Final EPS Torque”component. Also see SofSafReq02-01 andSofSafReq02-02	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	Data Transmission Integrity Check	N/A

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” (seeSofSafReq03-02) shall be protected by an End2End(E2E) protection mechanism	C	E2ECalc	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	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 the LDW_Torque_Request shall be set to zero	C	50ms	LDW Safety Functionality	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 signal = error_status_input(LDW_SAFETY_INPUT_PROCESSING), error_status_torque_limiter(TORQUE_LIMITER), error_status_output_gen(LDW_SA	C	All	N/A

	FETY_OUTPUT_GENERATOR)			
Software Safety Requirement 03-02	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 Requirement 03-03	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 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	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	LDW Safety Functionality	LDW torque output is set to zero

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

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	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	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	MEMORYTEST	Activation_status = 0

ID	**Technical Safety Requirement**	**ASIL**	**Fault Tolerant Time Interval**	**Allocation to Architecture**	**Safe State**
Technical Safety Requirement 01	The LKA safety component shall ensure that the duration of "LKA_Torque_Request" send to the "Final electronic power steering torque" component is below Max_Duration.	B	500ms	LKA Safety Functionallity	LKA 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_LKA_Torq_Req” shall be read and pre-processed to determine the torque request coming from the “Basic/Main LAFunctionality” SW Component. Signal“processed_LKA_Torq_Req”shall be generated at the end of the processing.	B	LKA_SAFETY_INPUT_PROCESSING	N/A
Software Safety Requirement 01-02	In case the “processed_LKA_Torq_Req” signal has a value greater duration than“Max_Duration _LKA”(maximum duration allowed safe torque), the torque signal “limited_LKA_Torq_Req” shall be set to 0, else“limited_LKA_Torq_Req” shall take the value of “processed_LKA_Torq_Req”.	B	TORQUE_LIMITER	“limited_LKA_Torq_Req” = 0(Nm=Newton-meter)
Software Safety Requirement 01-03	The “limited_LKA_Torq_Req”shall be transformed into a signal “LKA_Torq_Req” whichis suitable to be transmitted outside of the LKA Safety component (“LKA Safety”) to the	B	LKA_SAFETY_OUTPUT_GENERATOR	LKA_Torq_Req = 0 (Nm)

	“Final EPS Torque”component. Also see SofSafReq02-01 andSofSafReq02-02			

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 "LKA_Torque_Request" signal shall be ensured.	B	500ms	Data Transmission integrity check	N/A

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 02-01	Any data to be transmitted outside of the LKA Safety component (“LKA Safety”) including "LKA_Torque_Req"and “activation_status” (seeSofSafReq03-02) shall be protected by an End2End(E2E) protection mechanism	B	E2ECalc	LKA_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.	B	E2ECalc	LKA_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 LKA function, it shall deactivate the LKA feature and "LKA_Torque_Request" shall be set to zero.	B	500ms	LKA Safety Functionallity	LKA 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 signal = error_status_input(LKA_SAFETY_INPUT_PROCESSING), error_status_torque_limiter(TORQUE_LIMITER), error_status_output_gen(LKA_SAFETY_OUTPUT_GENERATOR)	B	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 1 of them indicates an error, it shall deactivate the LKA feature(“activation_status”=0)	B	LKA_SAFETY_ACTIVATION	Activation_status = 0 (LKA function deactivated)
Software Safety Requirement 03-03	In case of no errors from the software elements, the status of the LKA feature shall be set to activated (“activation_status”=1)	B	LKA_SAFETY_ACTIVATION	N/A
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 “LKA_Torq_Req” is set to 0	B	All	LKA_Torq_Req = 0
Software Safety Requirement 03-05	Once the LKA functionality has been deactivated, it shall stay deactivated till the time the ignition is switched from off to on again.	B	LKA_SAFETY_ACTIVATION	Activation_status = 0 (LKA function deactivated)

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 04	As soon as the LKA function deactivates the LKA feature, the "LKA Safety" software block shall send a signal to the car display to turn a warning light.	B	500ms	LKA Safety Functionallity	LKA torque output is set to zero

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 04-01	When the LKA function is deactivated (activation_status set to 0), the activation_status shall be sent to the car displayECU.	B	LKA_SAFETY_ACTIVATION, CarDisplay ECU	N/A

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 any faults in memory.	A	Ignition Cycle	Safety startup memory test	LKA 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	A	MEMORYTEST	Activation_status = 0

	on to check for any corruption of content.			
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_LKA_PROCESSING shall set an error on error_status_input (=1) so that the LKA functionality is deactivated and the LKA Torque is set to 0	A	MEMORYTEST	Activation_status = 0