



Software Safety Requirements and Architecture

Lane Assistance

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Document history

Date	Version	Editor	Description
07-11-2017	1.0	S.Chonavel	First draft

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Purpose

The purpose of this document is to translate technical Safety Requirements into Software Safety requirement, by identifying those requirements and allocating them to component level diagrams for the “Lane Assistance project as defined by ISO 26262 standard.

Inputs to the Software Requirements and Architecture Document

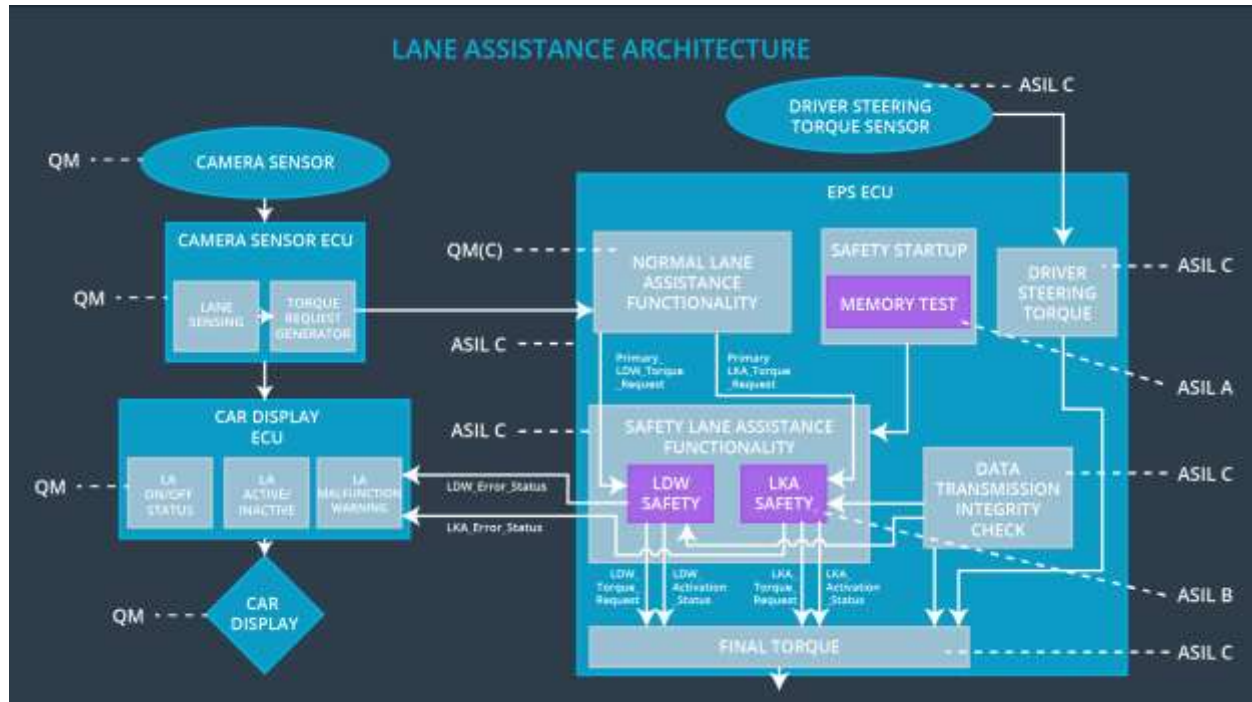
Technical safety requirements

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 01-01-01	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 block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety Requirement 01-01-02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety Requirement 01-01-03	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 block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety Requirement 01-01-04	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 block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety	Memory test shall be conducted at startup of the	A	Ignition cycle	Safety Startup	Set LDW to zero.

Requirement 01-01-05	EPS ECU to check for any faults in memory			block	Warn user of LDW malfunction
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Refined Architecture Diagram from the Technical Safety Concept



Software Requirements

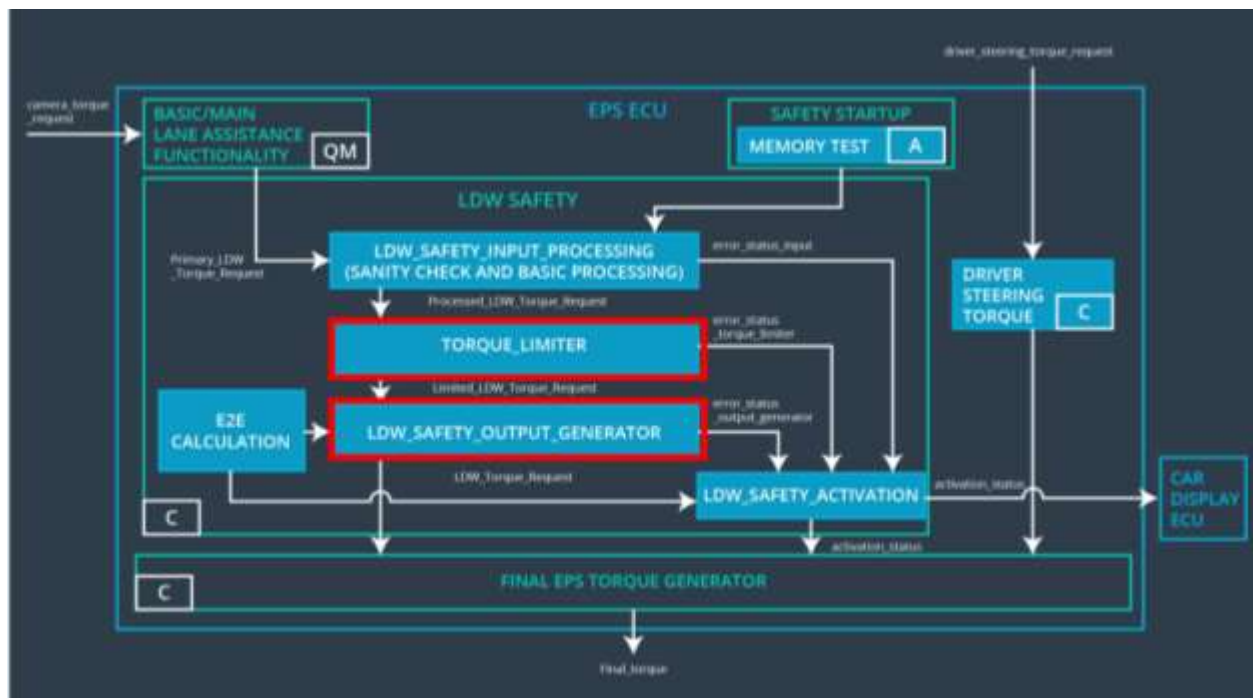
Note :

LDW Software requirements is done

LKA Software requirements is TBD

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 01-01-01	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 block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

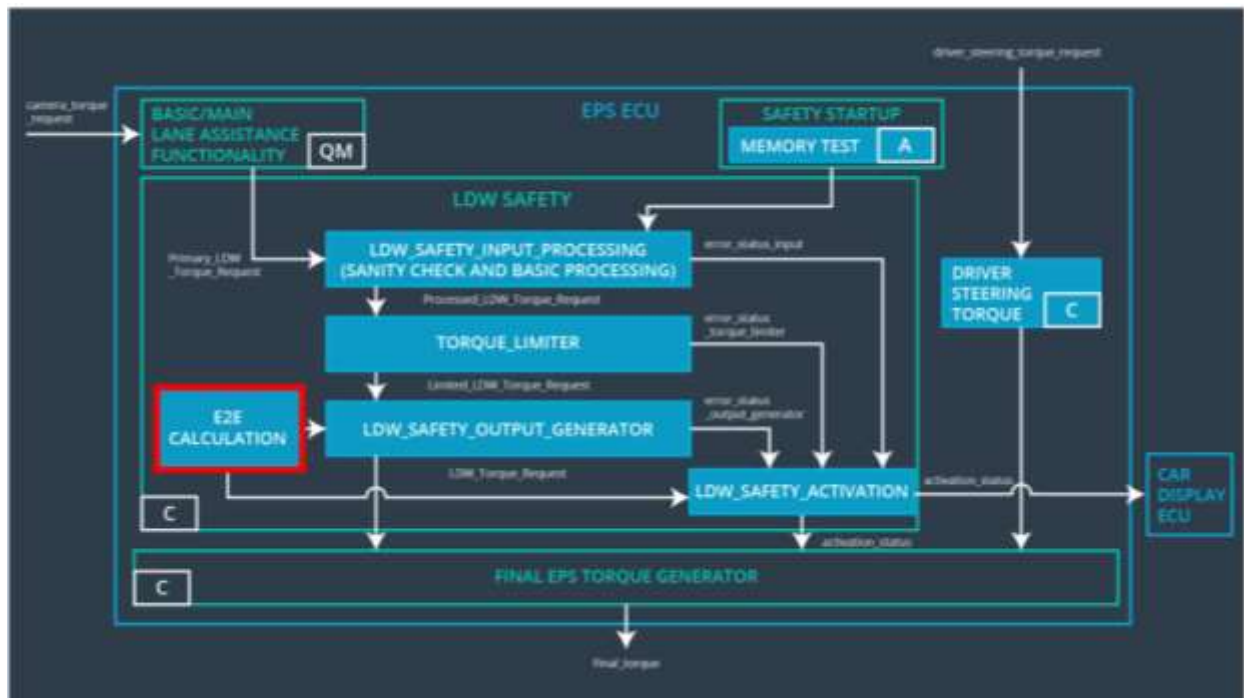


Software Safety Requirements related to Technical Safety Requirement 01-01-01 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
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		I L		
Software Safety Requirement 01-01-01-01	The input signal “Primary_LDW_Torq_Req” shall be read and pre-processed to determine the torque request coming from the “Basic/Main LAF 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 01-01-01-02	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 01-01-01-03	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)

ID	Technical Safety Requirement	A S I L	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-01-02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

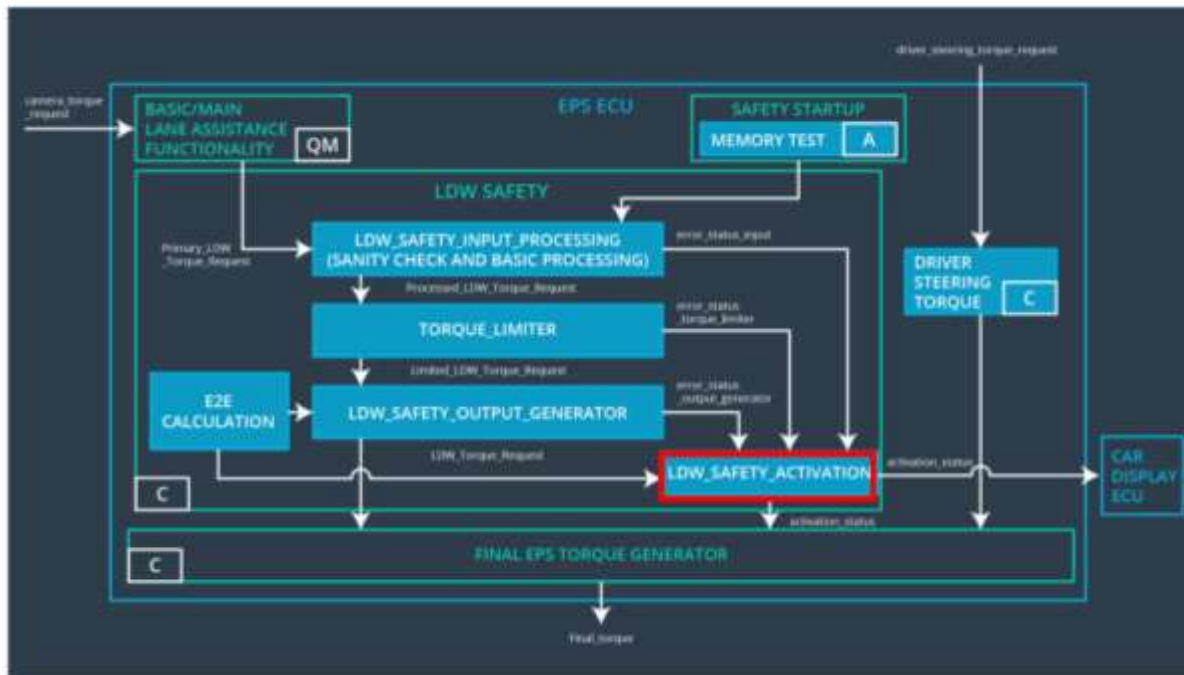


Software Safety Requirements related to Technical Safety Requirement 01-01-02 are:

ID	Software Safety Requirement	A S I L	Allocation Software Elements	Safe State
Software Safety Requirement 01-01-02-01	Any data to be transmitted outside of the LDW Safety component ("LDW Safety") including "LDW_Torque_Req" and	C	E2E Calc	LDW_Torque_Req = 0 (Nm)

	<p>“activation_status” (see SofSafReq03-02) shall be protected by an End2End(E2E) protection mechanism</p>			
<p>Software Safety Requirement 01-01-02-02</p>	<p>The E2E protection protocol shall contain and attach the control data: alive counter (SQC) and CRC to the data to be transmitted.</p>	C	E2E Calc	LDW_Torq_Re q= 0 (Nm)

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-01-03	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 block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

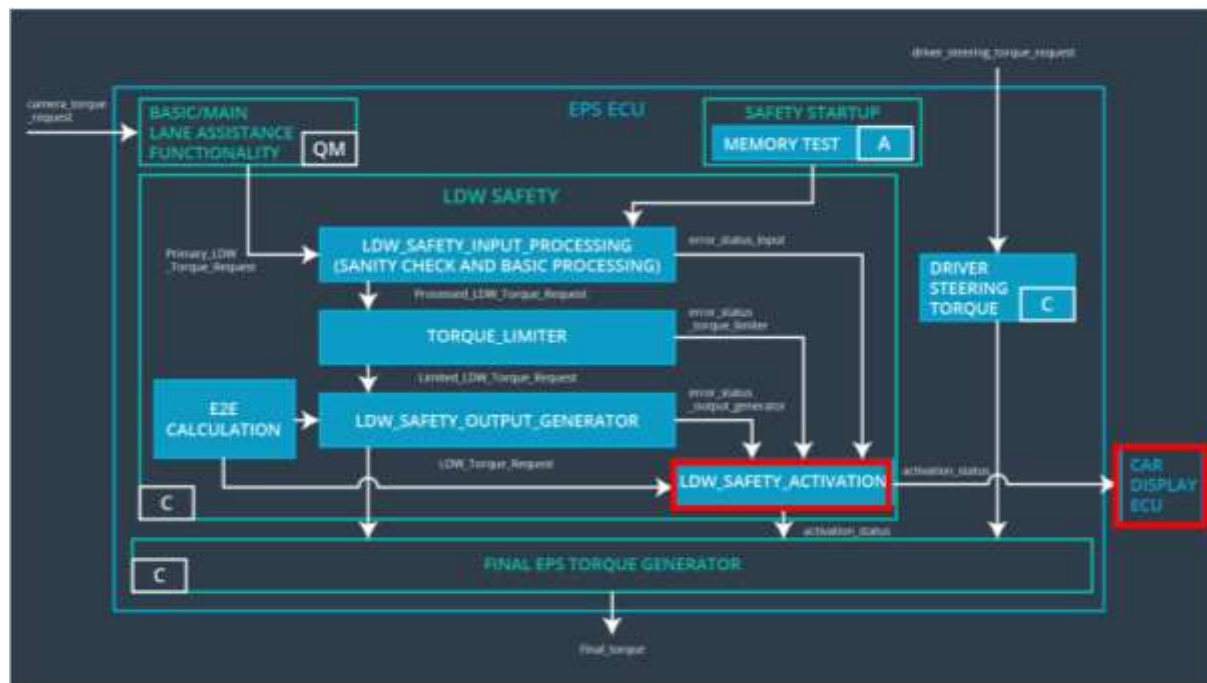


Software Safety Requirements related to Technical Safety Requirement 01-01-03 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-01-03-01	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),	C	All	N/A

	error_status_torque_limiter(TORQUE_LIMITER), error_status_output_gen(LDW_SAFETY_OUTPUT_GENERATOR)			
Software Safety Requirement 01-01-03-02	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 01-01-03-03	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 01-01-03-04	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 01-01-03-05	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)

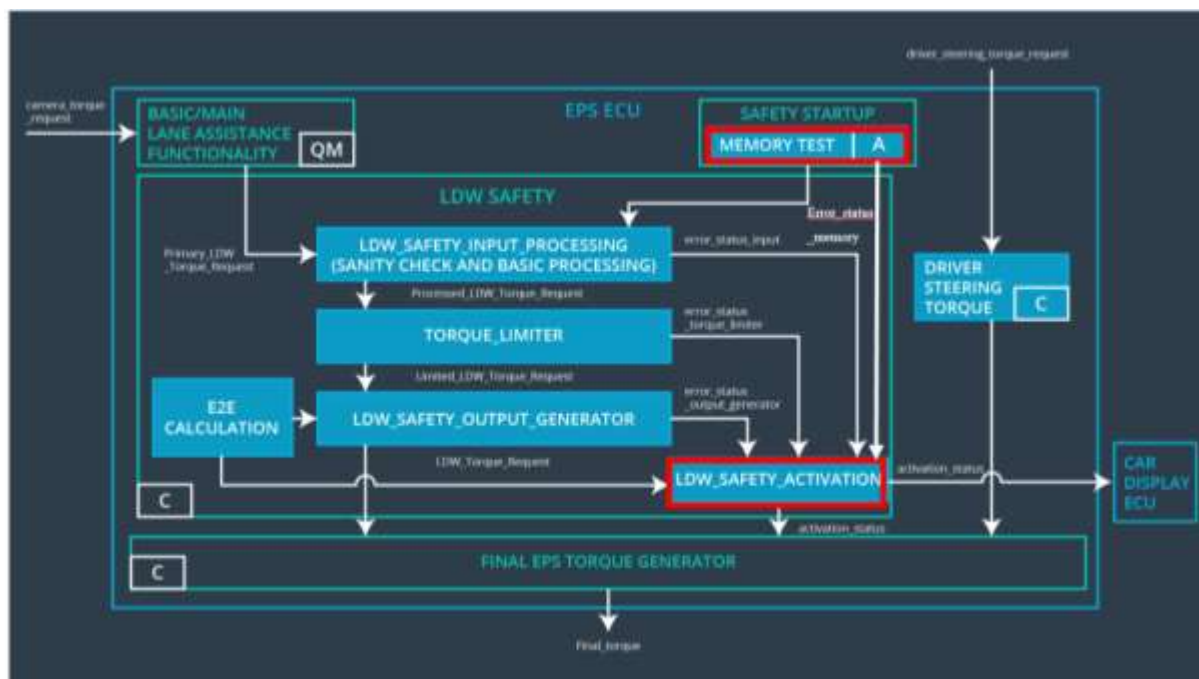
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-01-04	As soon as the LDW function deactivates the LDW feature, the LDW Safety software block shall send a signal to the car display ECU to turn on a warning light	C	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction



Software Safety Requirements related to Technical Safety Requirement 01-01-04 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-01-04-01	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, CarDisplay ECU	N/A

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory	A	Ignition cycle	Safety Startup block	Set LDW to zero. Warn user of LDW malfunction



Software Safety Requirements related to Technical Safety Requirement 01-01-05 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-01-05-01	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

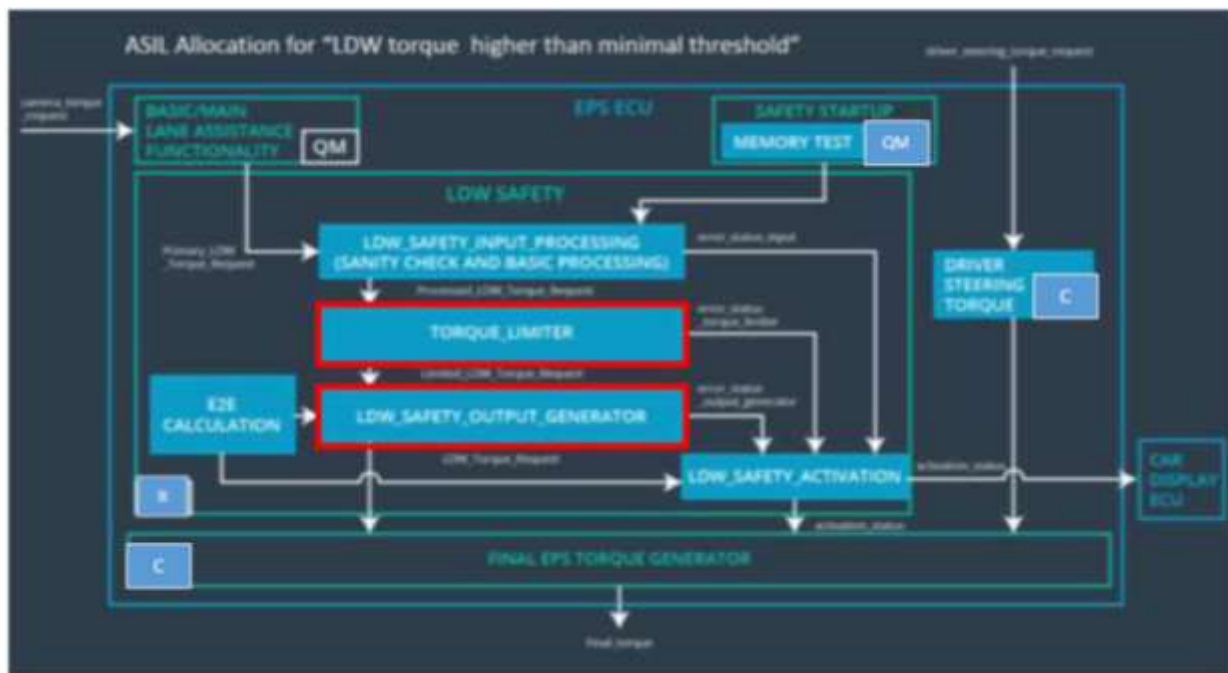
Software Safety Requirement 01-01-05-02	Standard RAM tests to check the data bus, address bus and device integrity shall be done every time the ignition is switched from off to on (E.g.walking 1s test, RAM pattern test. Refer RAM and processor vendor recommendations)	A	MEMORYTEST	Activation_status = 0
Software Safety Requirement 01-01-05-03	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 01-01-05-04	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 LDWTorque is set to 0	A	LDW_SAFETY_INPUT_PROCESSING	Activation_status = 0

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-01-05-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory	A	Ignition cycle	Safety Startup block	Set LDW to zero. Warn user of LDW malfunction

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

ID	Technical Safety Requirement	A S I L	Fault Tolerant Time Interval	Architectu re Allocation	Safe State
Technical Safety Requirem ent 01-02-01	The LDW safety component shall ensure that the amplitude of the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is above 'Min_Torque_Amplitude.	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety Requirem ent 01-02-02	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 on	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety Requirem ent 01-02-03	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.	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction
Technical Safety Requirem ent 01-02-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-02-01	The LDW safety component shall ensure that the amplitude of the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is above 'Min_Torque_Amplitude'.	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

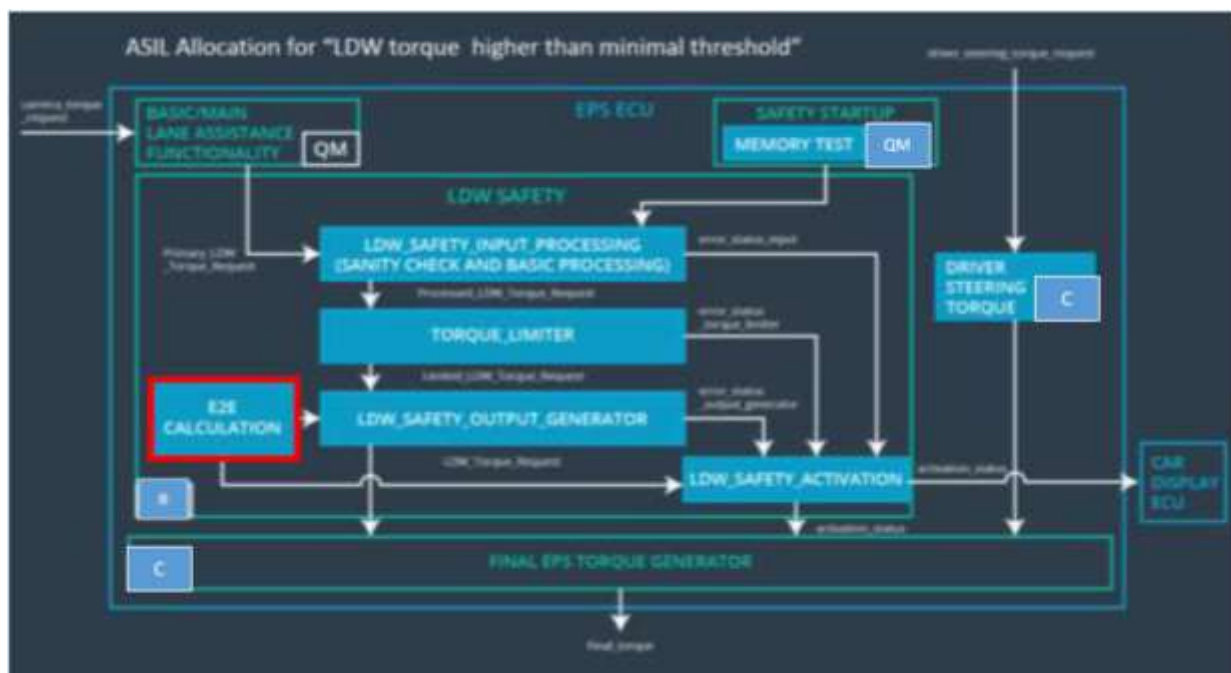


Software Safety Requirements related to Technical Safety Requirement 01-02-01 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-02-01-01	The input signal "Primary_LDW_Torq_Req" shall be read and pre-processed to	B	LDW_SAFETY_INPUT_PROCESSING	N/A

	<p>determine the torque request coming from the “Basic/Main LAF functionality” SW Component.</p> <p>Signal “processed_LDW_Torq_Req” shall be generated at the end of the processing.</p>			
<p>Software Safety Requirement 01-02-01-02</p>	<p>In case the “processed_LDW_Torq_Req” signal has a value lower than “Min_Torque_Amplitude_LDW” (minimum detectable 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”.</p>	B	TORQUE_LIMITER	<p>“limited_LDW_Torq_Req” = 0 (Nm=Newton-meter)</p>
<p>Software Safety Requirement 01-02-01-03</p>	<p>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</p>	B	LDW_SAFETY_OUTPUT_GENERATOR	<p>LDW_Torq_Req = 0 (Nm)</p>

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-02-02	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 on	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

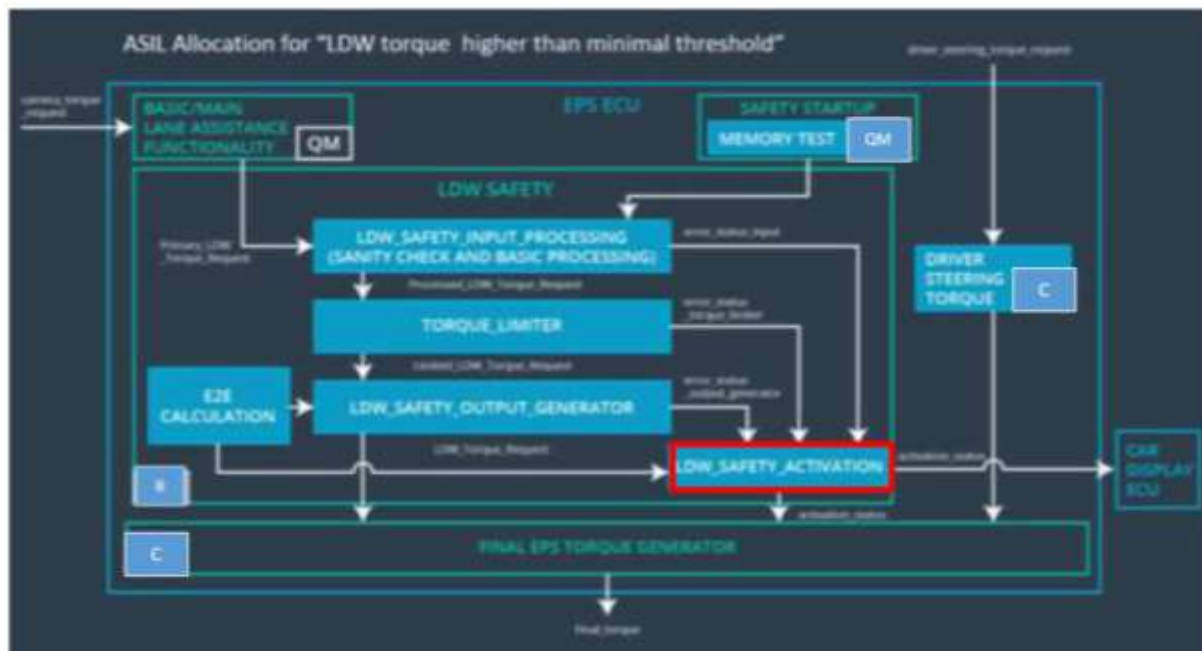


Software Safety Requirements related to Technical Safety Requirement 01-02-02 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-02-02-01	Any data to be transmitted outside of the LDW Safety component ("LDW Safety") including "LDW_Torque_Req" and "activation_status" (see SofSafReq03-02) shall	B	E2E Calc	LDW_Torq_Req = 0 (Nm)

	be protected by an End2End(E2E) protection mechanism			
Software Safety Requirement 01-02-02-02	The E2E protection protocol shall contain and attach the control data: alive counter (SQC) and CRC to the data to be transmitted.	B	E2E Calc	LDW_Torq_Request = 0 (Nm)

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-02-03	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.	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction

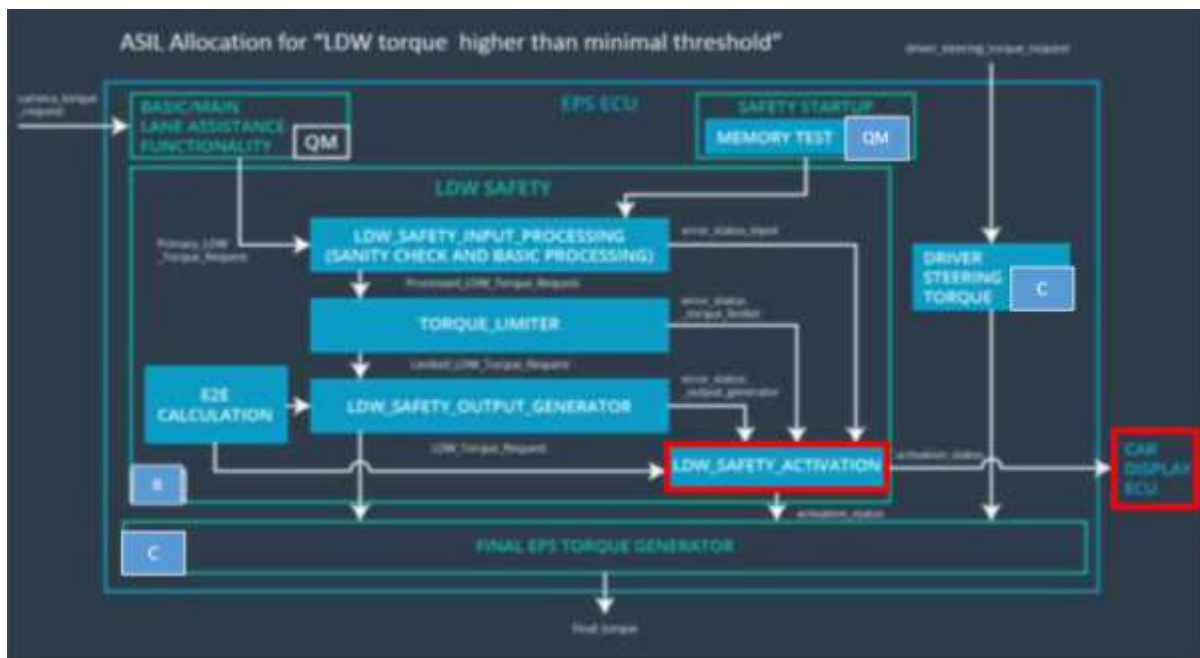


Software Safety Requirements related to Technical Safety Requirement 01-02-03 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-02-03-01	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(TO	B	All	N/A

	RQUE_LIMITER), error_status_output_gen(LDW _SAFETY_OUTPUT_GENERA TOR)			
Software Safety Requirement 01-02-03-02	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 theLDW feature(“activation_status”=0)	B	LDW_SAFETY _ACTIVATION	Activation_status = 0 (LDW function deactivated)
Software Safety Requirement 01-02-03-03	In case of no errors from the software elements, the status of the LDW feature shall be set to activated (“activation_status”=1)	B	LDW_SAFETY _ACTIVATION	N/A
Software Safety Requirement 01-02-03-04	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	B	All	LDW_Torq_Req = 0
Software Safety Requirement 01-02-03-05	Once the LDW functionality has been deactivated, it shall stay deactivated till the time the ignition is switched from off to on again.	B	LDW_SAFETY _ACTIVATION	Activation_status = 0 (LDW function deactivated)

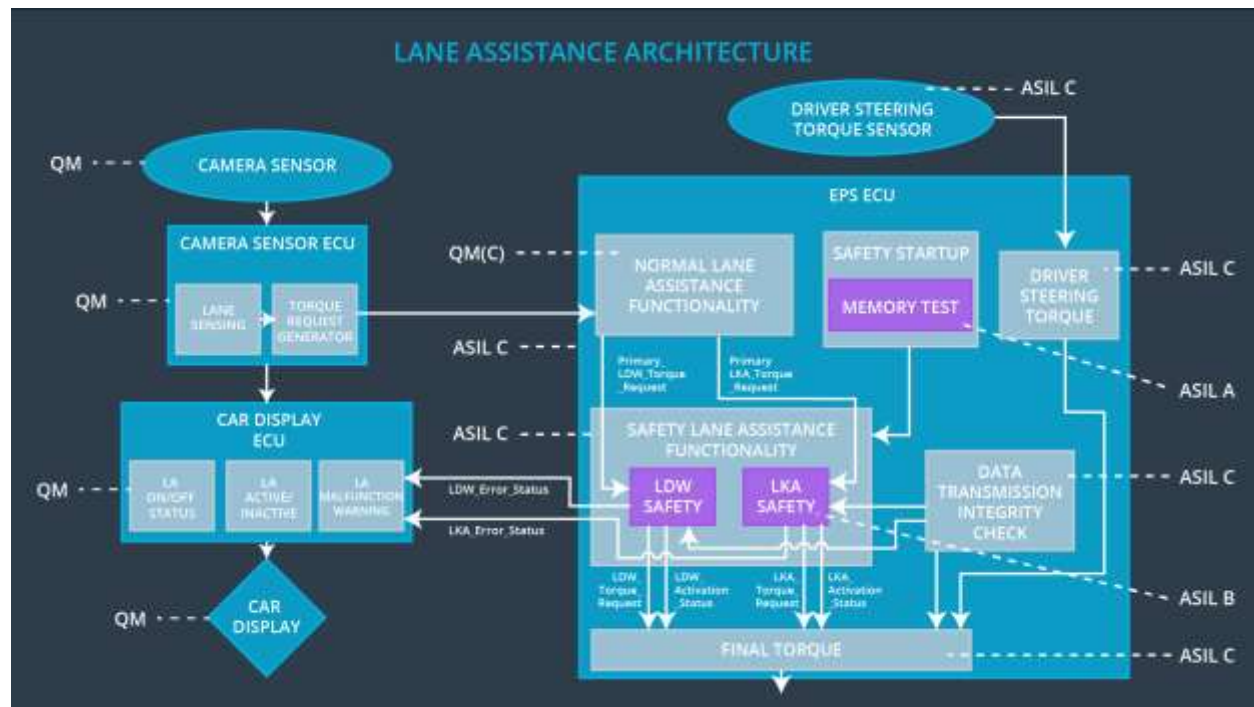
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01-02-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	B	50ms	LDW Safety block	Set vibration torque amplitude to zero. Warn user of LDW malfunction



Software Safety Requirements related to Technical Safety Requirement 01-02-04 are:

ID	Software Safety Requirement	ASIL	Allocation Software Elements	Safe State
Software Safety Requirement 01-02-04-01	When the LDW function is deactivated (activation_status set to 0), the activation_status shall be sent to the car displayECU.	B	LDW_SAFETY_ACTIVATION, CarDisplay ECU	N/A

Refined Architecture Diagram



Note: combining the various software Safety requirement leads to the following ASIL architecture allocation:

