Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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14.07.2018	1.1	Ankith Manjunath	

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Purpose of the Technical Safety Concept

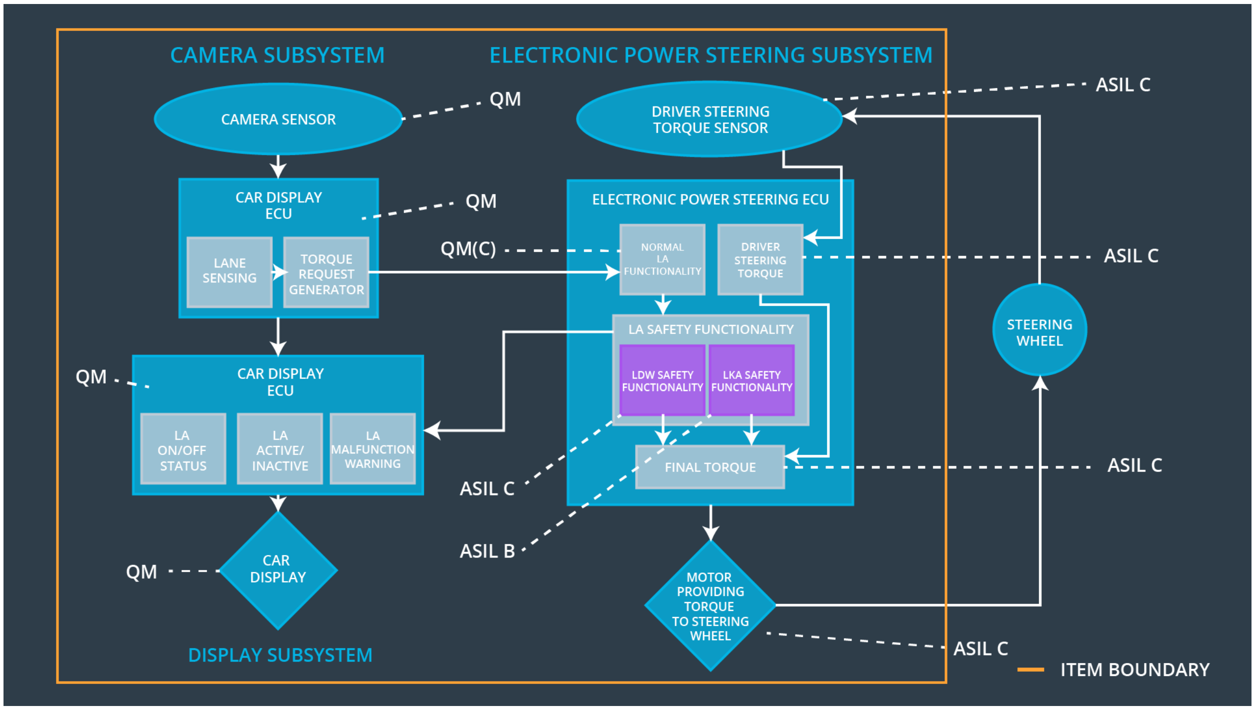
The functional safety concept follows the ISO26262 standards to specifiy safety requirements on a system level ignoring the technical details. Technical safety concept introduces more technical specific requirements into the system.

Inputs to the Technical Safety Concept

Functional Safety Requirements

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The lane keeping item shall ensure that the torque amplitude by lane departure warning system is below MAX_TORQUE_AMPLITUDE	C	50ms	Vibration torque amplitude below Max_Torque_Amplitude.
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the torque frequency by the lane departure warning is below MAX_TORQUE_FREQUENCY	C	50ms	Vibration torque amplitude below Max_Torque_Frequency.
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the steering torque TIME_FOR_TORQUE is applied for a limited period of time .	B	500ms	Lane Keeping Assistance torque is zero.

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	**Description**
Camera Sensor	Captures Frames of the road environment from a video feed
Camera Sensor ECU - Lane Sensing	Detects the lane on the road and the distance of the center of the car from the lane on either side
Camera Sensor ECU - Torque request generator	Estimates the amount of torque required to keep the car in the center of the lane
Car Display	HMI to the driver
Car Display ECU - Lane Assistance On/Off Status	HMI indication to indicate if Lane assistance is on or off
Car Display ECU - Lane Assistant Active/Inactive	HMI indicaion to indicate if Lane assistance item is working properly or not
Car Display ECU - Lane Assistance malfunction warning	HMI indication to alert the driver for a handover
Driver Steering Torque Sensor	Sensor to detect the amount of torque applied by the driver
Electronic Power Steering (EPS) ECU - Driver Steering Torque	ECU receiving the torque from the steering torque sensor
EPS ECU - Normal Lane Assistance Functionality	ECU calculating the amount of torque needed for lane assitance
EPS ECU - Lane Departure Warning Safety Functionality	ECU to provide driver with a haptic feedback(Vibration) to alert the driver of lane departure warning
EPS ECU - Lane Keeping Assistant Safety Functionality	ECU calculating the amount of extra torque needed to keep the vehicle in the lane
EPS ECU - Final Torque	ECU to send the torque request to the motor
Motor	Motor used to steer the steering wheel

Technical Safety Concept

Technical Safety Requirements

Lane Departure Warning (LDW) Requirements:

Functional Safety Requirement 01-01 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 01-01	The lane keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude	X		

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	Set LDW_Torque_request to zero
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	Set LDW_Torque_request to zero
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	Set LDW_Torque_request to zero
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	Set LDW_Torque_request to zero
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	Data transmission Integrity check	Set LDW_Torque_request 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 subsyste ensures that the LDW_Torque_request is less than the Max_Torque_Frequency	C	50ms	LDW safety	Set LDW_Torque_request to zero
Technical Safety Requirement 01-02-02	On lane departure warning malfunction, the lane departure warning safety system shall deactivate and set Max_Torque_Frequency to zero	C	50ms	LDW safety	Set LDW_Torque_request to zero
Technical Safety Requirement 01-02-03	When LDW is deactivated the LDW safety module shall send a signal to car display ECU to display a warning	C	50ms	LDW safety	Set LDW_Torque_request to zero
Technical Safety Requirement 01-02-04	The integrity of LDW_Torque_request shall be ensured	C	50ms	LDW safety	Set LDW_Torque_request to zero
Technical Safety Requirement 01-02-05	Memory tests shall be conducted on EPS ECU to check for memory problems	A	Ignition cycle	Data transmission Integrity check	Set LDW_Torque_request to zero

Lane Keeping Assistance (LKA) Requirements:

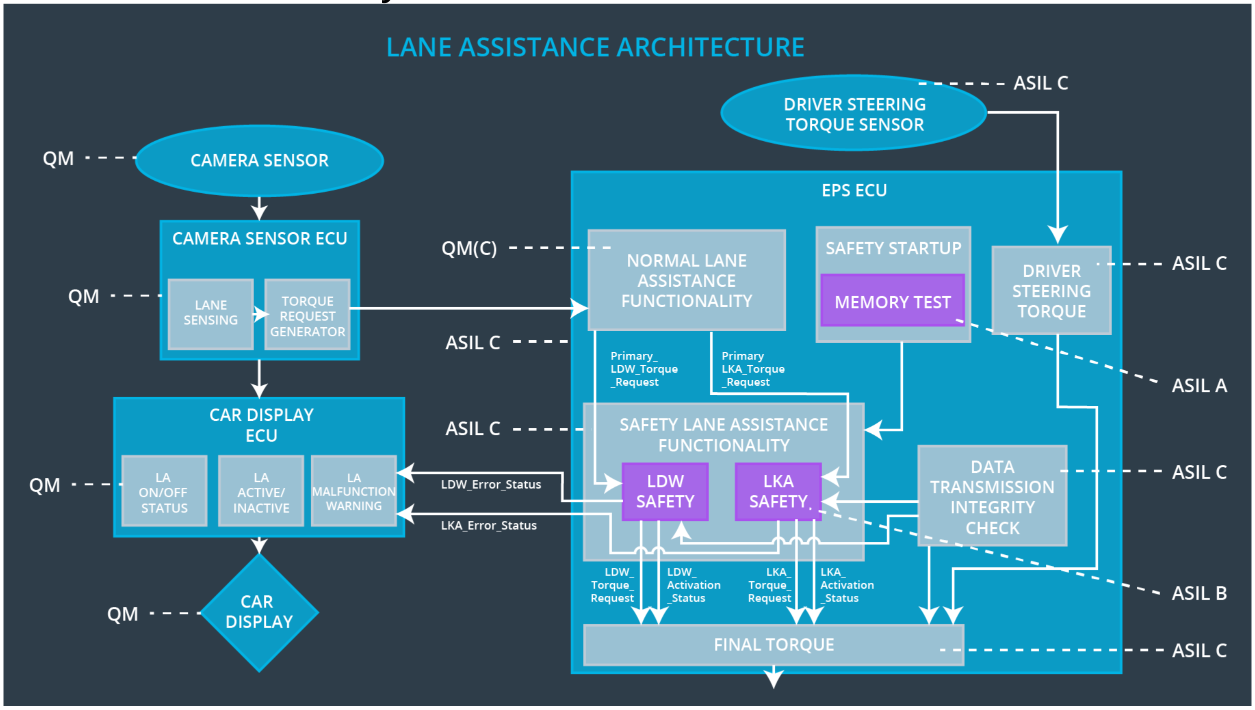
Functional Safety Requirement 02-1 with its associated system elements
(derived in the functional safety concept)

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 02-01-01	The lane keep assistance safety function shall apply lane keeping assistance torque for a duration less than Max_Duration	B	500ms	LKA safety	LKA_Torque_request set to zero
Technical Safety Requirement 02-01-02	When lane keeping assitance is deactivated the LKA safety module shall send a signal to car display ECU to display a warning	B	500ms	LKA safety	LKA_Torque_request set to zero
Technical Safety Requirement 02-01-03	On lane keeping assistance malfunction, the lane keeping assistance safety system shall deactivate and set LKA_Torque_request to zero	B	500ms	LKA safety	LKA_Torque_request set to zero
Technical Safety Requirement 02-01-04	The integrity of LKA_Torque_request shall be ensured	B	500ms	LKA safety	LKA_Torque_request set to zero
Technical Safety Requirement 02-01-05	Memory tests shall be conducted on EPS ECU to check for memory problems	A	Ignition cycle	Data transmission Integrity check	LKA_Torque_request set to zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

ID	**Technical Safety Requirement**	**Electronic Power Steering ECU**	**Camera ECU**	**Car Display ECU**
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	X		
Technical Safety Requirement 01-01-02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	x		
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	x		
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	x		
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	x		
Technical Safety Requirement 01-02-01	The lane departure warning safety subsyste ensures that the LDW_Torque_request is less than the Max_Torque_Frequency	x		
Technical Safety Requirement 01-02-02	On lane departure warning malfunction, the lane departure warning safety system shall deactivate and set Max_Torque_Frequency to zero	x		
Technical Safety	When LDW is deactivated the LDW safety module shall send a	x		

Requirement 01-02-03	signal to car display ECU to display a warning			
Technical Safety Requirement 01-02-04	The integrity of LDW_Torque_request shall be ensured	x		
Technical Safety Requirement 01-02-05	Memory tests shall be conducted on EPS ECU to check for memory problems	x		
Technical Safety Requirement 02-01-01	The lane keep assistance safety function shall apply lane keeping assistance torque for a duration less than Max_Duration	x		
Technical Safety Requirement 02-01-02	When lane keeping assitance is deactivated the LKA safety module shall send a signal to car display ECU to display a warning	x		
Technical Safety Requirement 02-01-03	On lane keeping assistance malfunction, the lane keeping assistance safety system shall deactivate and set LKA_Torque_request to zero	x		
Technical Safety Requirement 02-01-04	The integrity of LKA_Torque_request shall be ensured	x		
Technical Safety Requirement 02-01-05	Memory tests shall be conducted on EPS ECU to check for memory problems	x		

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off functionality	Malfunction_01 Malfunction_02	Yes	LDW warning on the screen
WDC-02	Turn off functionality	Malfunction_03	Yes	LKA warning on the screen, Driver to take over the car