Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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05.03.2018	1.0	Qingqing Xia	First version of this document

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Purpose of the Technical Safety Concept

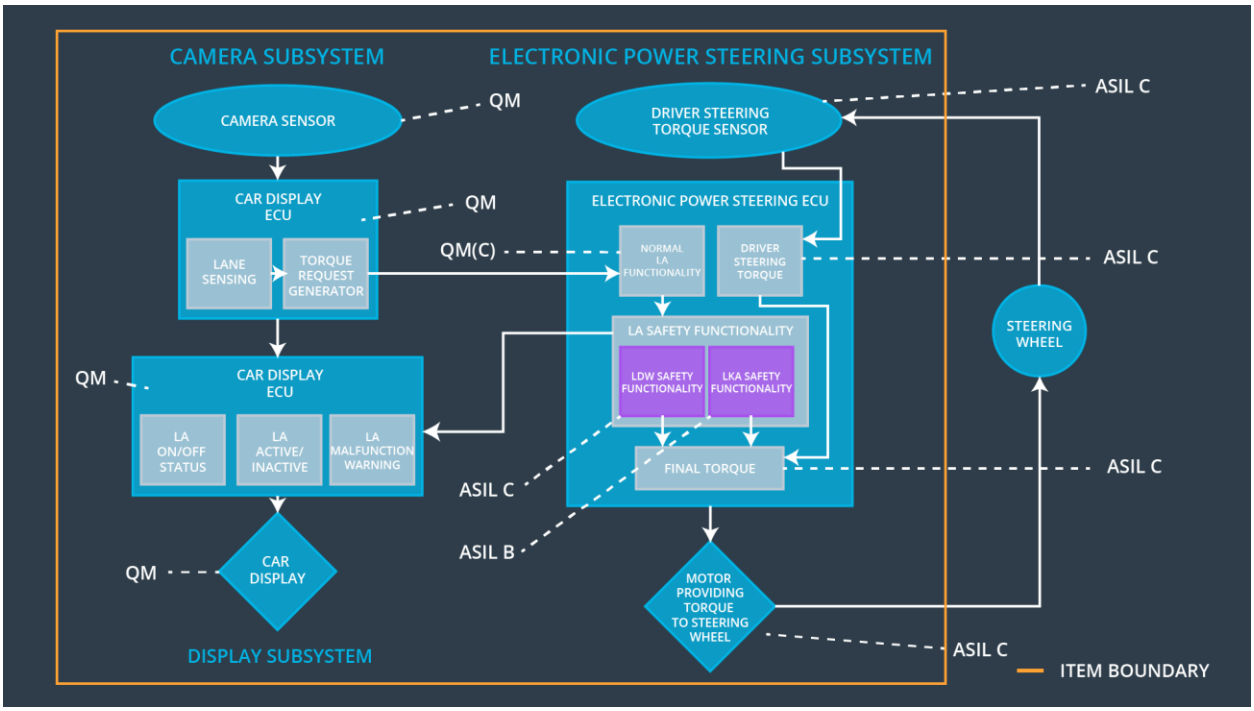
Technical safety concept is part of the product development phase. It is derived from functional safety concept and give more concrete and details of the item's technology.

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 lane departure oscillating torque amplitude 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 lane departure oscillating torque frequency is below Max_Torque_Frequency	C	50ms	Vibration frequency is below Max_Torque_Frequency.
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the Lane Keeping Assistance torque is applied only Max_Duration.	B	500ms	Lane Keeping Assistance torque is zero.

Refined System Architecture from Functional Safety Concept



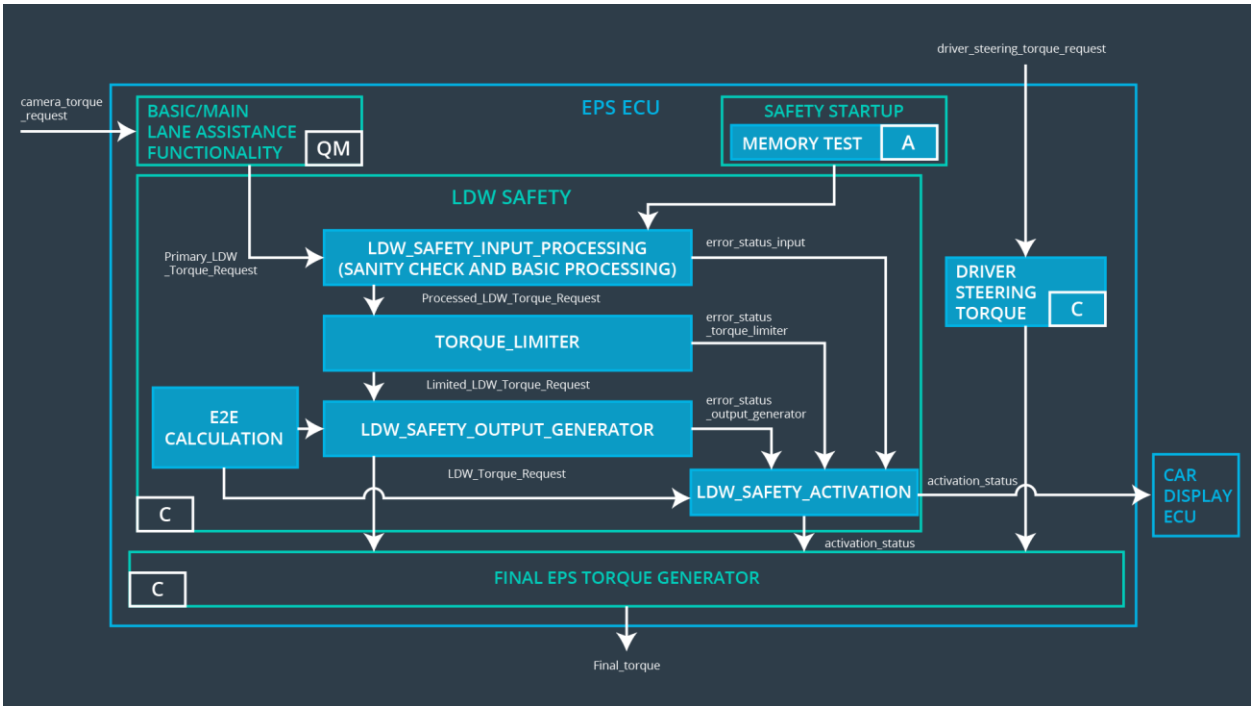
Functional overview of architecture elements

Element	Description
Camera Sensor	Deliver camera(road) images to the Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Sense where the car position in the lane
Camera Sensor ECU - Torque request generator	Calculate the torque in order to keep the car in the lane
Car Display	Show warning to the driver
Car Display ECU - Lane Assistance On/Off Status	Show the driver is the Lane Assistance is on or off
Car Display ECU - Lane Assistant Active/Inactive	Show the driver is the Lane Assistance is active or inactive
Car Display ECU - Lane Assistance malfunction warning	Show the driver is the Lane Assistance is malfunction
Driver Steering Torque Sensor	Measure the steering torque by the driver and provides it to Electronic Power Steering ECU
Electronic Power Steering (EPS) ECU -	Module receive the torque introduced by the driver

Driver Steering Torque	
EPS ECU - Normal Lane Assistance Functionality	Module receive the camera senor torque request
EPS ECU - Lane Departure Warning Safety Functionality	Module to make sure the oscillating torque amplitude is below Max_Torque_Amplitude and frequency below the Max_Torque_Frequency
EPS ECU - Lane Keeping Assistant Safety Functionality	Module to make sure the lane keeping torque applied only for a max duration defined in the
EPS ECU - Final Torque	Based on the torque request from the Lane Keeping and Lane Departure Warning Items, to calculate the final torque and deliver them to the Motor.
Motor	Applied the received final torque from EPS ECU to the 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	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	Data transmission integrity check	LDW_Activation_Status is zero
Technical Safety Requirement 02	The LDW safety component shall ensure that the amplitude of 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Amplitude'.	C	50ms	LDW Safety	LDW_Activation_Status is zero
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	LDW_Activation_Status is zero
Technical Safety Requirement 04	As soons 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	LDW_Error_Status is zero
Technical	Memory test shall be conducted	A	Ignition	Memory test	LDW_A

Safety Requirement 05	at start up of the EPS ECU to check for any faults in memory		cycle		ctivation _Status is 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	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	Data transmission integrity check	LDW_Activation_Status is zero
Technical Safety Requirement 02	The LDW safety component shall ensure that the frequency of 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency'.	C	50ms	LDW Safety	LDW_Activation_Status is zero
Technical Safety Requirement	As soon as a failure is detected by the LDW function, it shall	C	50ms	LDW Safety	LDW_Activation_Status

03	deactivate the LDW feature and the 'LDW_Torque_Request' shall be set to zero.				is 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 ECU to turn on a warning light.	C	50ms	LDW Safety	LDW_Error_Status is 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	Memory test	LDW_Activation_Status is zero

Lane Keeping Assistance (LKA) Requirements:

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

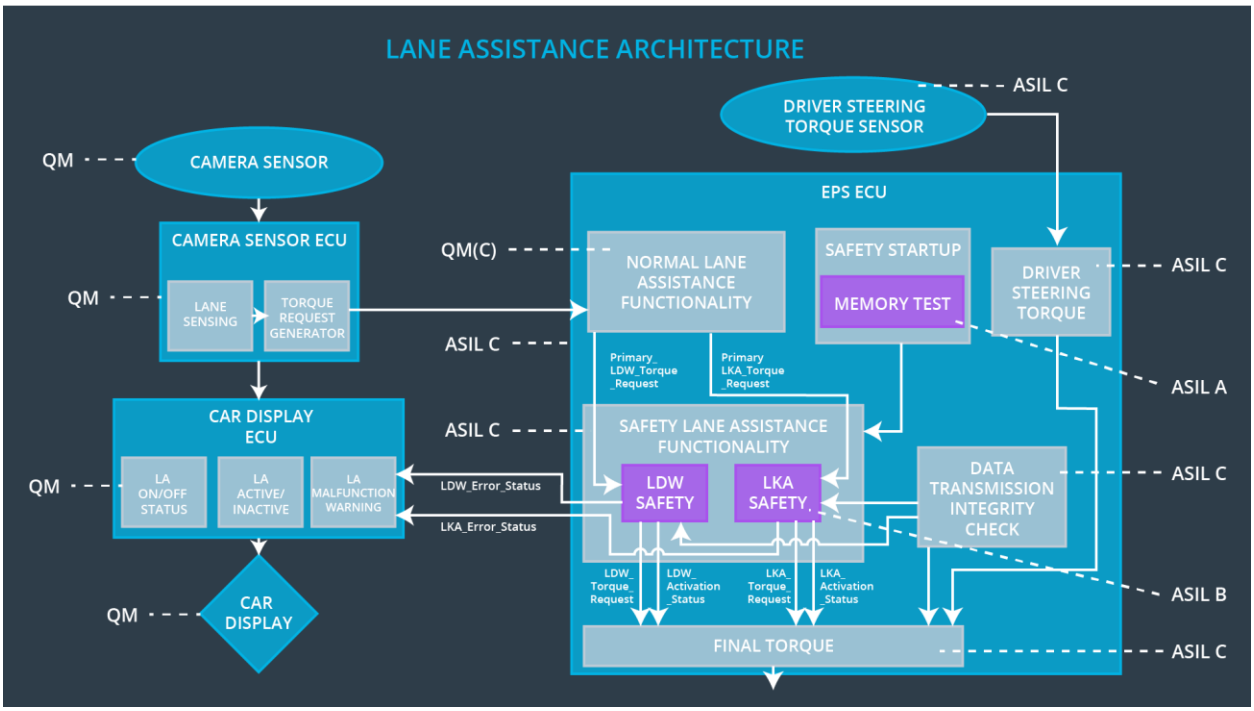
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 01	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500ms	Data transmission integrity check	LKA_Acion_Status is zero
Technical	The LKA safety component	B	500ms	LKA Safety	LKA_Activat

Safety Requirement 02	shall ensure that the duration of ‘LKA_Torque_Request’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max_Duration’.				ion_Status is zero
Technical Safety Requirement 03	As soon as a failure is detected by the LKW function, it shall deactivate the LKW feature and the ‘LKW_Torque_Request’ shall be set to zero.	B	500ms	LKA Safety	LKA_Activation_Status is zero
Technical Safety Requirement 04	As soon as the LKW function deactivates the LKW feature, the ‘LKW Safety’ software block shall send a signal to the car display ECU to turn on a warning light.	B	500ms	LKA Safety	LKA_Error_Status is zero
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory	A	cycle	Memory test	LKA_Error_Status is zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All technical safety requirements are allocated to the Electronic Power Steering ECU.

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off Lane Departure Warning functionality	Malfunction_01, Malfunction_02,	Yes	Lane Departure Warning Malfunction Warning on Car Display
WDC-02	Turn off Lane Keeping Assistance functionality	Malfunction_03	Yes	Lane Keeping Assistance Malfunction Warning on Car Display