Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
21-May-2018	0.1	Venkataraman	Initial Draft
23-May-2018	1.0	Venkataraman	First attempt

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Purpose of the Technical Safety Concept

The functional safety requirements in the functional safety concept is used to establish the Technical safety concept. These new requirements are more concrete and gets into details of the item's technology as specified by ISO 26262.

The technical safety concept involves:

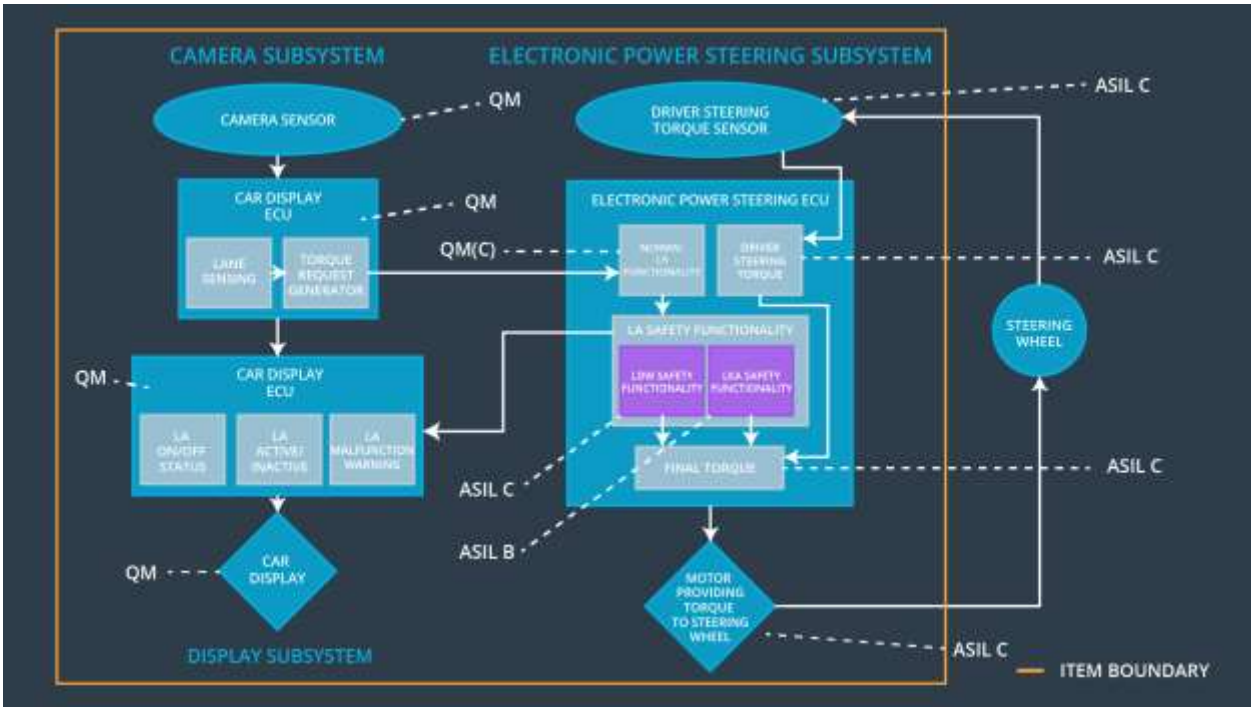
- Turning functional safety requirements into technical safety requirements
- Allocating technical safety requirements to the system architecture

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	50 ms	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	50 ms	Vibration torque Frequency below Max_Torque_Frequency.
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration	B	500 ms	Lane Assistant torque is zero
Functional Safety Requirement 02-02	The electronic power steering ECU shall be deactivated when the electronic power steering ECU detects the camera sensor is not working.	B	50 ms	Function is deactivated

Refined System Architecture from Functional Safety Concept

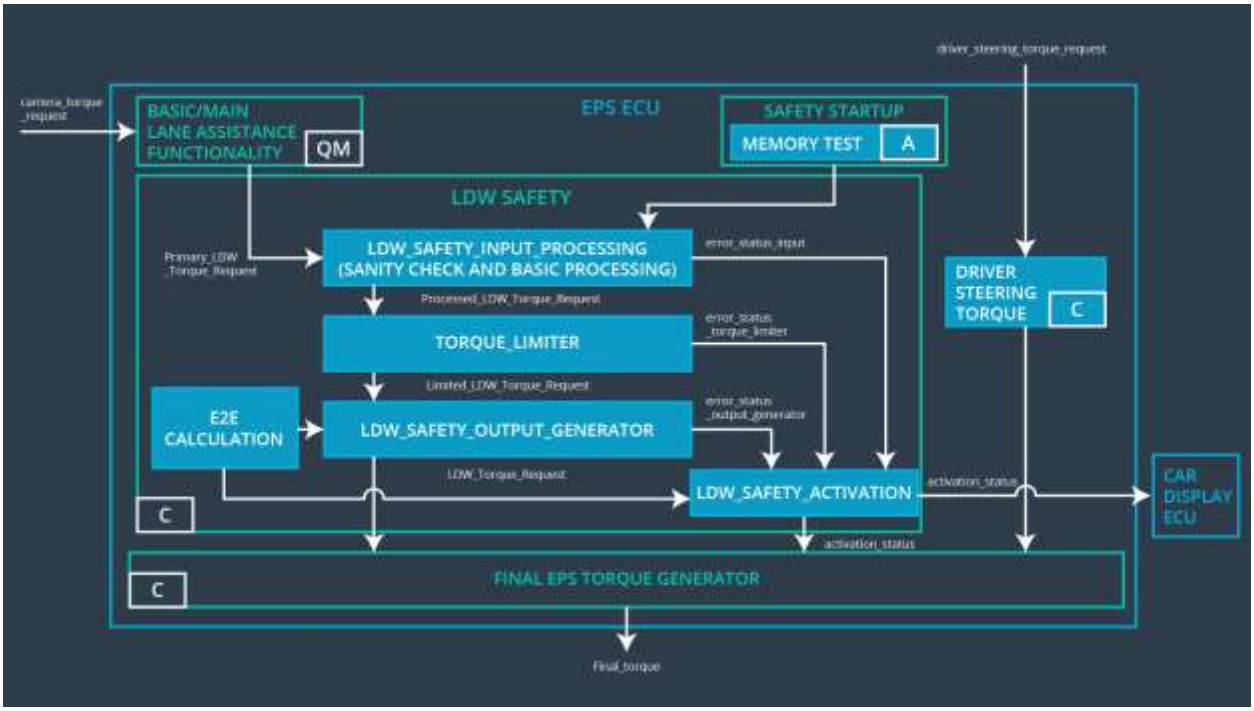


Functional overview of architecture elements

Element	Description
Camera Sensor	Sensor responsible for capturing road images and provide them to the Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Software module inside camera sensor ECU responsible for detecting the lane line positions from the Camera Sensor images.
Camera Sensor ECU - Torque request generator	Software module inside camera sensor ECU responsible for calculating additional torque for LKA and LDW function. This calculated torque will be requested to EPS ECU.
Car Display	Car Display is responsible for providing feedback to the driver about the status of lane assistant system

Car Display ECU - Lane Assistance On/Off Status	Software module responsible for displaying **On/Off** status of LDW & LKA functions.
Car Display ECU - Lane Assistant Active/Inactive	Software module responsible for displaying **Active/Inactive** status of LDW & LKA function.
Car Display ECU - Lane Assistance malfunction warning	Software module responsible for displaying warning of malfunctions in LDW & LKA function.
Driver Steering Torque Sensor	Sensor responsible for measuring the torque applied on steering wheel
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software module responsible for process data received from Driver Steering Torque Sensor.
EPS ECU - Normal Lane Assistance Functionality	Software module responsible for receiving torque request from Camera Sensor ECU and transfers to Safety Lane Assistance Functionality.
EPS ECU - Lane Departure Warning Safety Functionality	Software module ensuring the torque amplitude is below Max_Torque_Amplitude and torque frequency is below Max_Torque_Frequency.
EPS ECU - Lane Keeping Assistant Safety Functionality	Software module in EPS ECU responsible for ensuring that LKA is not activate more than Max_duration time and if camera sensor is failed, then LKA will be deactivated.
EPS ECU - Final Torque	Combine the torque request from the LKA safety and LDW safety functionalities and sends them to the Motor.
Motor	An electric motor that applies the torque indicated by the Electronic Power Steering ECU to 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	50 ms	LDW safety block	LDW_Torque_Output is set to zero
Technical Safety Requirement 01-01-02	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	C	50 ms	LDW safety block	LDW_Torque_Output is set to zero
Technical Safety Requirement 01-01-03	Once the failure in LDW is identified, The LDW feature needs to be deactivate, preventing it from taking control of the vehicle.	C	50 ms	LDW safety block	LDW_Torque_Output is set 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	Data Transmission Integrity Check	LDW_Activation_Status is zero
Technical Safety Requirement 01-01-05	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

Functional Safety Requirement 01-02 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 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	50 ms	LDW safety block	LDW_Torque_Output is set to zero

Lane Keeping Assistance (LKA) Requirements:

Functional Safety Requirement 02-01 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 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 LKA safety component shall ensure that the amplitude of the 'LKA_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Duration'.	C	50 ms	LKA safety block	LKA_Torque_Output is set to zero
Technical Safety Requirement 02-01-02	As soon as the LKA function deactivates the LKA feature, the 'LKA Safety' software block shall send a signal to the car display ECU to turn on a warning light	C	50 ms	LKA safety block	LKA_Torque_Output is set to zero
Technical Safety Requirement 02-01-03	As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature and the 'LKA_Torque_Request' shall be set to zero.	C	50 ms	LKA safety block	LKA_Torque_Output is set to zero
Technical Safety Requirement 02-01-04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	C	50 ms	Data Transmission Integrity Check	LKA_Activation_Status is zero
Technical Safety Requirement 02-01-05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Memory Test	LKA_Activation_Status is zero

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

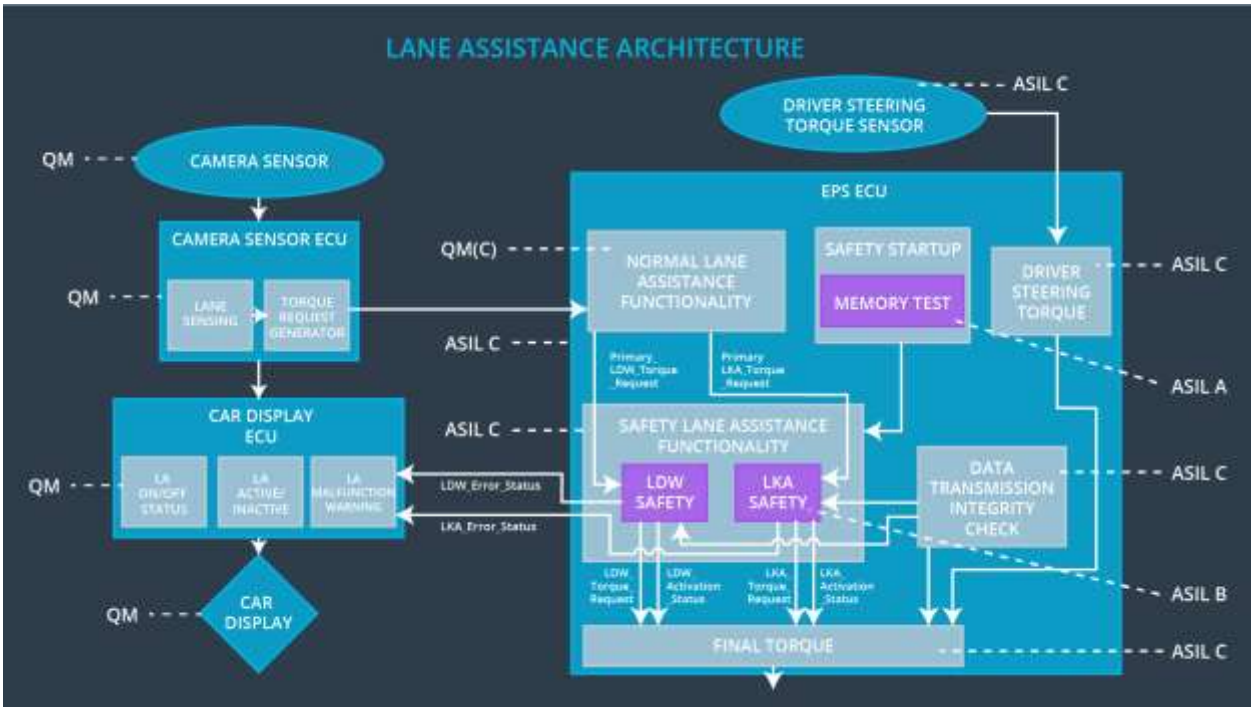
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU

Functional Safety Requirement 02-02	The electronic power steering ECU shall be deactivated when the electronic power steering ECU detects the camera sensor is not working.	X		

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

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 02-02-01	As soon as a failure is detected by the Camera Sensor, it shall deactivate the LKA feature and the 'LKA_Torque_Request' shall be set to zero.	C	50 ms	LKA safety block	LKA_Activation_Status is zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

For the Lane Assistance item, all technical safety requirements are allocated to the Electronic Power Steering ECU. For the exact allocation within EPS ECU, please refer to the technical safety requirements tables above.

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off LDW functionality	Malfunction_01, Malfunction_02	Yes	Turn on warning light of the LDW functionality
WDC-02	Turn off LKA functionality	Malfunction_03, Malfunction_04	Yes	Turn on warning light of the LKA functionality