Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
1/06/2018	1.0	Pratul Singh	1st attempt
1/07/2018	2.0	Pratul Singh	Fix as per reviews
01/08/2018	3.0	Pratul Singh	Fix as per reviews

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Purpose of the Technical Safety Concept

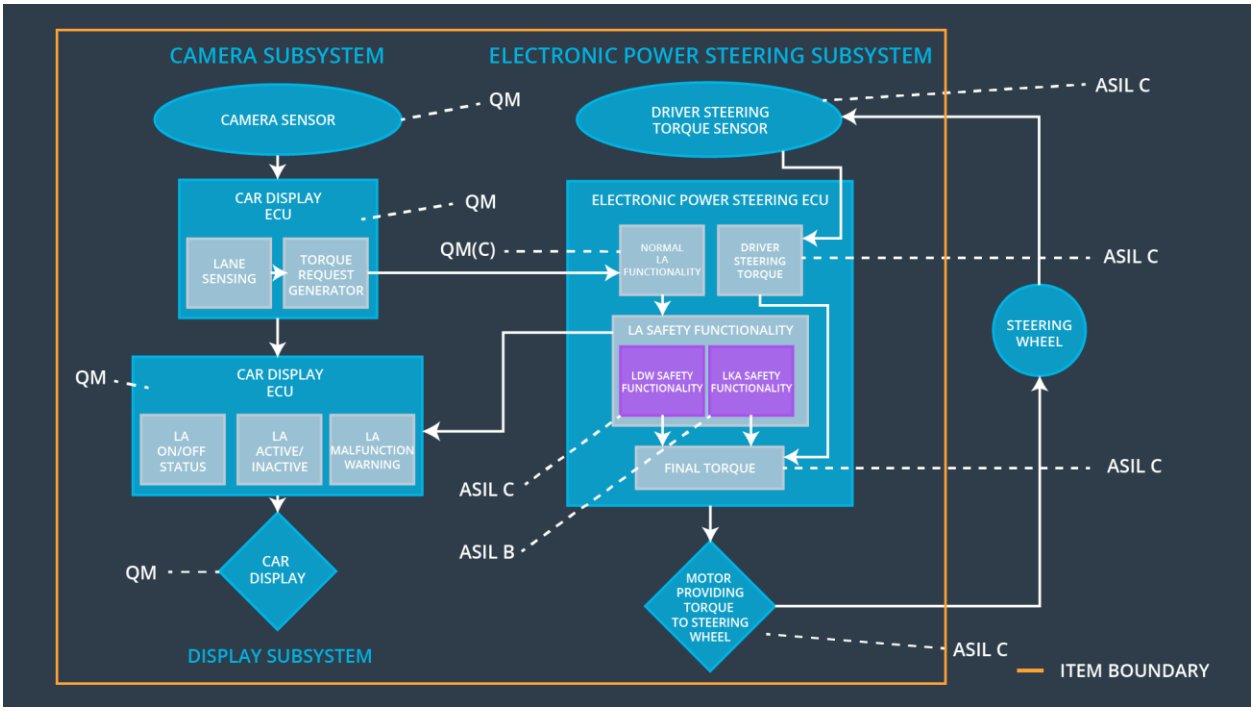
A technical safety concept is like a functional safety concept in the sense that it defines requirements and allocates them to subsystems. While a functional safety concept provides a bird's eye view of the system, a technical safety concept goes deeper into the technical details of the system. Technical safety requirements are derived from functional safety requirements.

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 electronic power steering ECU shall ensure that the lane departure warning oscillating torque amplitude is below Max_Torque_Amplitude	C	50 ms	Set vibration torque amplitude to zero
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the lane departure warning oscillating torque frequency is below Max_Torque_Frequency	C	50 ms	Set vibration torque frequency to zero
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	50 ms	Set lane keeping assistance torque amplitude to zero

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Sensor responsible for capturing vehicle driving condition including detectable lane lines.
Camera Sensor ECU - Lane Sensing	Software Module in the Camera Sensor ECU responsible for detecting lane lines and determining when the vehicle leaves the lane by mistake.
Camera Sensor ECU - Torque request generator	Software Module in the Camera Sensor ECU responsible for calculating and sending the additional torque for the LDW and LKA functions.
Car Display	Visual display responsible to displaying warning of lane departures and LKA and LDW activation and deactivations.
Car Display ECU - Lane Assistance On/Off Status	Visual display responsible to displaying LKA and LDW ON/OFF status.
Car Display ECU - Lane Assistant Active/Inactive	Visual display responsible to displaying warning of lane departures, LKA and LDW activation and

	deactivations.
Car Display ECU - Lane Assistance malfunction warning	Visual display responsible to displaying warning of LKA and LDW malfunctions.
Driver Steering Torque Sensor	Sensor responsible for measuring how much force (steering torque) the driver is applying to the steering wheel.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software Module in the electronic power steering ECU responsible for receiving the Camera Sensor ECU torque requests.
EPS ECU - Normal Lane Assistance Functionality	Software Module in the electronic power steering ECU responsible for receiving the Driver Steering torque sensor input from the steering wheel.
EPS ECU - Lane Departure Warning Safety Functionality	Software Module in the electronic power steering ECU responsible for keeping the lane departure oscillating torque amplitude and frequency below MAX_Torque_Amplitude and MAX_Torque_Frequency respectively
EPS ECU - Lane Keeping Assistant Safety Functionality	Software Module in the electronic power steering ECU responsible for ensuring the application of the lane keeping assistance torque does not ever exceeded Max_Duration and if lane detection is lost, the LKA function is deactivated.
EPS ECU - Final Torque	Software Module in the electronic power steering ECU responsible for ensuring the LDW, LKA and the driver’s steering torque requests are combined and sent to the Motor.
Motor	Actuator responsible for applying requested torque to the steering column by the Electronic Power Steering ECU for either the LKA or the LDW functions.

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 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	The lane departure warning torque request amplitude shall be set to zero

Technical Safety Requirement 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	Data Transmission Integrity Check	The lane departure warning torque request amplitude shall be set to zero
Technical Safety Requirement 03	As soon as a failure is detected by the LDW function, it shall eactivate the LDW feature and the 'LDW_Torque_Request' shall be set to zero	C	50 ms	LDW Safety Block	The lane departure warning torque request amplitude shall be set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	LDW Safety Block	The lane departure warning torque request amplitude shall be set to zero
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	Separate External block with Memory test code	The lane departure warning torque request amplitude shall be set 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	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 Component	The lane departure warning torque request amplitude shall be set to zero
Technical Safety Requirement 02	Validity and Integrity of the data transmission for the LDW_Torque_Request signal shall be ensured	C	50ms	Data Transmission Integrity Check	The lane departure warning torque request amplitude shall be set to 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 Component	The lane departure warning torque request amplitude shall be 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 ECU to turn on a warning light.	C	50ms	LDW Safety Component	The lane departure warning torque request amplitude shall be set to zero
Technical Safety	Memory test shall be conducted at the startup of EPS ECU to check	A	Iginition Cycle	Separate External block	The lane departure warning torque request amplitude shall be set to zero

Lane Keeping Assistance (LKA) Requirements:

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

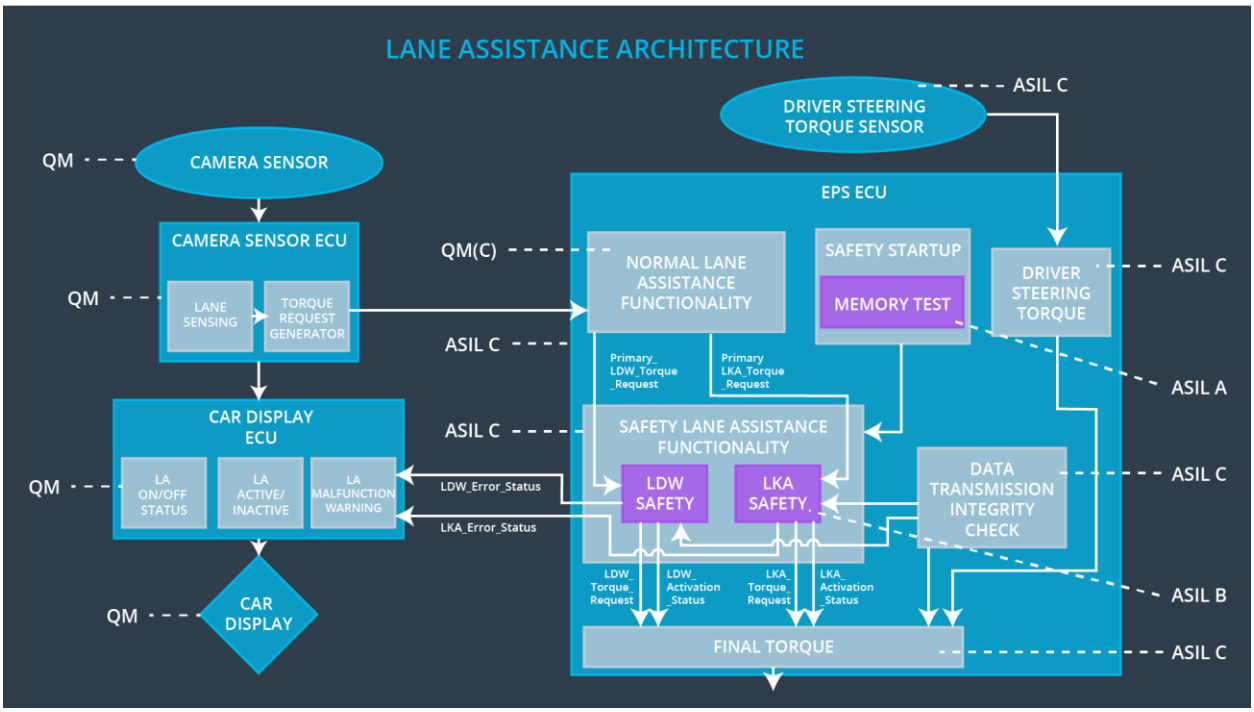
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 01	LKA safety component shall ensure that the duration of the LKA_torque_request sent to the Final Electronic Power Steering Torque component is below Max_torque_duration	B	500ms	LKA safety component	The lane departure warning torque request amplitude shall be set to zero
Technical Safety Requirement 02	Validity and Integrity of the data transmission for the LKA_Torque_Request signal shall be ensured	B	500ms	Data Transmission Integrity Check	The lane departure warning torque request amplitude shall be set to zero

Technical Safety Requirement 01	LKA safety component shall ensure that the duration of the LKA_torque_request sent to the Final Electronic Power Steering Torque component is below Max_torque_duration	B	500ms	LKA safety component	The lane departure warning torque request amplitude shall be set to zero
Technical Safety Requirement 02	Validity and Integrity of the data transmission for the LKA_Torque_Request signal shall be ensured	B	500ms	Data Transmission Integrity Check	The lane departure warning torque request
Technical Safety Requirement 01	LKA safety component shall ensure that the duration of the LKA_torque_request sent to the Final Electronic Power Steering Torque component is below Max_torque_duration	B	500ms	LKA safety component	The lane departure warning torque request amplitude shall be set to zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

Ignore this item as all technical safety requirements are allocated to the Electronic Power Steering ECU

Warning and Degradation Concept

The warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements.

Warning	Warning light displayed to the driver on the dashboard
Degradation	Turn off functionality