Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
2018-05-22	1.0	Navin Rawther	Initial Draft

Table of Contents

Purpose of the Technical Safety Concept

A technical Safety Concept defines requirements and allocates them to the system architecture. The new requirements are more concrete and gets into the item's technology.

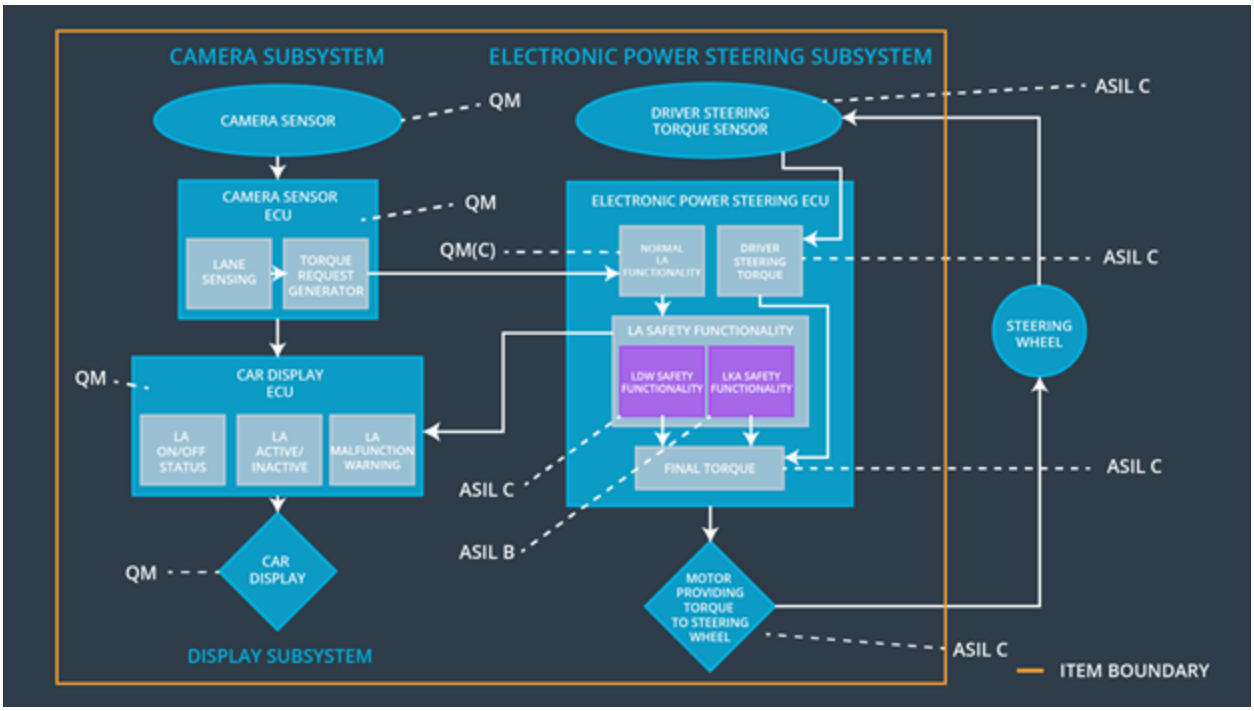
Inputs to the Technical Safety Concept

Functional Safety Requirements

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The electronic power steering ECU shall ensure that the lane departure warning oscillating torque amplitude is below Max_Torque_Amplitude	C	50ms	Lane departure warning oscillating amplitude is below Max_Torque_Amplitude
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the lane departure warning oscillating torque frequeny is below Max_Torque_Frequency	C	50ms	Lane departure warning oscillating torque 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 for only Max_Duration	B	500ms	Lane keeping assistance torque is 0 after Max_Duration

Refined System Architecture from Functional Safety Concept

The figure below shows the refined system architecture with the ASIL values:



Functional overview of architecture elements

Element	Description
Camera Sensor	Reads images of the road
Camera Sensor ECU - Lane Sensing	Computes and senses where the lane markings are on the road
Camera Sensor ECU - Torque request generator	Generates the torque request in case of vehicle reaching edge of a lane and sends it to the Electronic Power Steering Subsystem
Car Display	The display that contains the signals of the lane assistance item for the driver
Car Display ECU - Lane Assistance On/Off Status	Switches the signal corresponding to Lane Assistance to On/Off
Car Display ECU - Lane Assistant Active/Inactive	Decides whether the Lane Assistance system is active or not
Car Display ECU - Lane Assistance malfunction warning	Provides warning if the Lane Assistance system is malfunctioning by obtaining input from Electronic Power Steering Subsystem
Driver Steering Torque Sensor	Detects how much the steering wheel is already turned

Electronic Power Steering (EPS) ECU - Driver Steering Torque	Senses how much the driver is turning the steering wheel
EPS ECU - Normal Lane Assistance Functionality	Receives vibrational torque request from camera subsystem and computes the torque required to get back to the lane center
EPS ECU - Lane Departure Warning Safety Functionality	Limits the amplitude and frequency torque provided by the Normal Lane Assistance Functionality
EPS ECU - Lane Keeping Assistant Safety Functionality	Switches the Lane Keeping Assistance output torque to 0 when exceeds the Max_Duration
EPS ECU - Final Torque	Computes the final torque from the Driver Steering Torque subsystem and the Lane Assistance Safety Functionality
Motor	Provides torque to the steering wheel to obtain the required steering

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	AS	Fault Tolerant	Architecture Allocation	Safe State

		IL	Time Interval		
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 component is below Max_Torque_Amplitude	C	50ms	LDW safety block	LDW_Torque_Request Amplitude shall be set to zero
Technical Safety Requirement 02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	Data Transmission Integrity Check	LDW_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 feature and the LDW_Torque_Request shall be set to zero	C	50ms	LDW safety block	LDW_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 feature block shall send a signal to the car display ECU to turn on a warning light	C	50ms	LDW safety block	LDW_Torque_Request Amplitude shall be set to zero
Technical Safety Requirement 05	Memory test shall be conducted at the startup of the EPS ECU to check for any faults in memory	A	ignition cycle	Safety Startup	LDW_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	The lane keeping item shall ensure that the lane departure	X		

Requirement 01-02	oscillating torque frequency is below Max_Torque_Frequency			

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 LDW safety component shall ensure that the frequency of the LDW_Torque_Request sent to the Final electronic power steering component is below Max_Torque_Frequency	C	50ms	LDW safety block	LDW_Torque_Request Frequency shall be set to zero
Technical Safety Requirement 02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	Data Transmission Integrity Check	LDW_Torque_Request Frequency shall be set to zero
Technical Safety Requirement 03	As soon as a failure is detected by the LDW function, it shall deactivate the feature and the LDW_Torque_Request shall be set to zero	C	50ms	LDW safety block	LDW_Torque_Request Frequency shall be set to zero
Technical Safety Requirement 04	As soon as the LDW function deactivates the LDW feature, the LDW safety feature block shall send a signal to the car display ECU to turn on a warning light	C	50ms	LDW safety block	LDW_Torque_Request Frequency shall be set to zero
Technical Safety	Memory test shall be conducted at the startup of the EPS ECU to	A	ignition cycle	Safety Startup	LDW_Torque_R

Requirement 05	check for any faults in memory				equest Frequency 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)

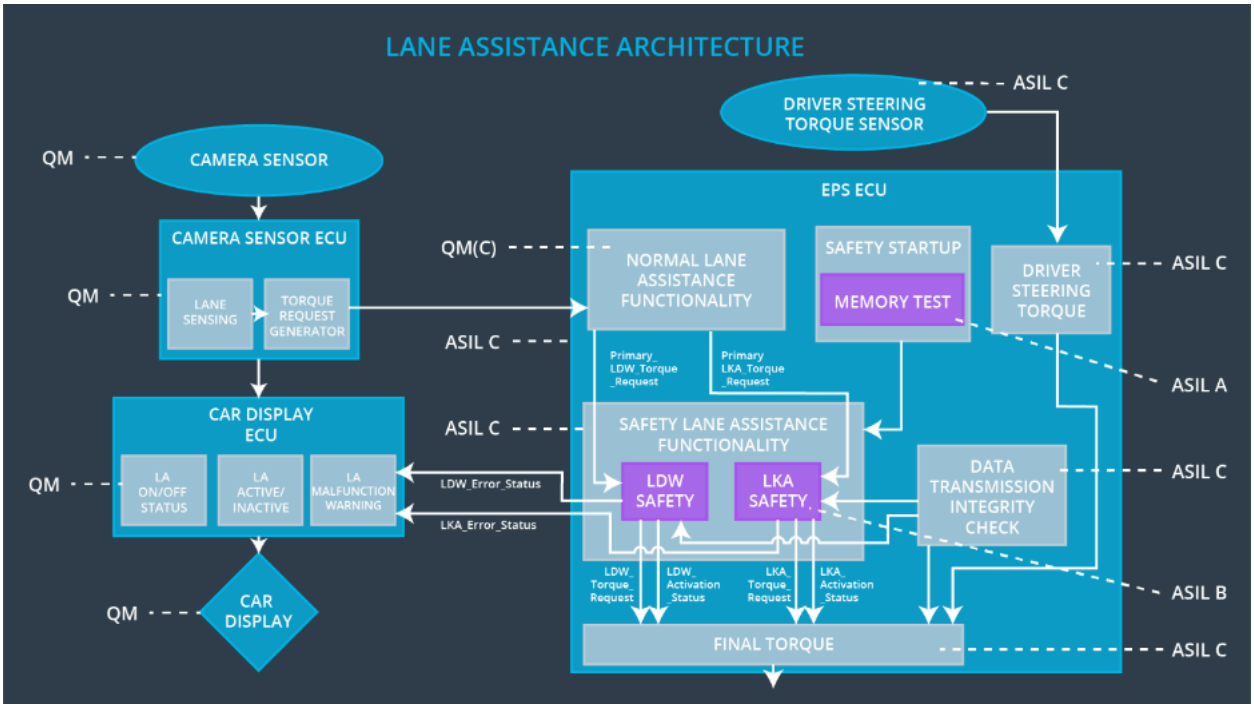
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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	The LKA safety component shall ensure that the LKA_Torque_Request is sent to the Final electronic power steering component for only Max_Duration	B	500ms	LKA safety block	LKA_Torque_Request is 0 after Max_Duration
Technical Safety Requirement 02	The validity and integrity of the data transmission for LKA_Torque_Request signal shall be ensured	B	500ms	Data Transmission Integrity Check	LKA_Torque_Request is 0 after Max_Duration
Technical Safety Requireme	As soon as a failure is detected by the LKA function, it shall deactivate the feature and the	B	500ms	LKA safety block	LKA_Torque_Request is 0 after

nt 03	LKA _Torque_Request shall be set to zero				Max_Duration
Technical Safety Requirement 04	As soon as the LKA function deactivates the LKA feature, the LKA safety feature block shall send a signal to the car display ECU to turn on a warning light	B	500ms	LKA safety block	LKA_Torque_Request is 0 after Max_Duration
Technical Safety Requirement 05	Memory test shall be conducted at the startup of the EPS ECU to check for any faults in memory	A	ignition cycle	Safety Startup	LKA_Torque_Request is 0 after Max_Duration

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	Lane Departure Warning functionality is turned off	Malfunction_01, Malfunction_02	Yes	Lane Assistance Warning light in driver dashboard turned on
WDC-02	Lane Assistance function turned off	Malfunction_03	Yes	Lane Assistance Warning light in driver dashboard turned on