Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

Document Version: [Version]

Template Version 1.0, Released on 2017-06-21

Document history

Date	Version	Editor	Description
27.02.2020	1.0	Uwe Ehmann	Initial Document

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Purpose of the Technical Safety Concept

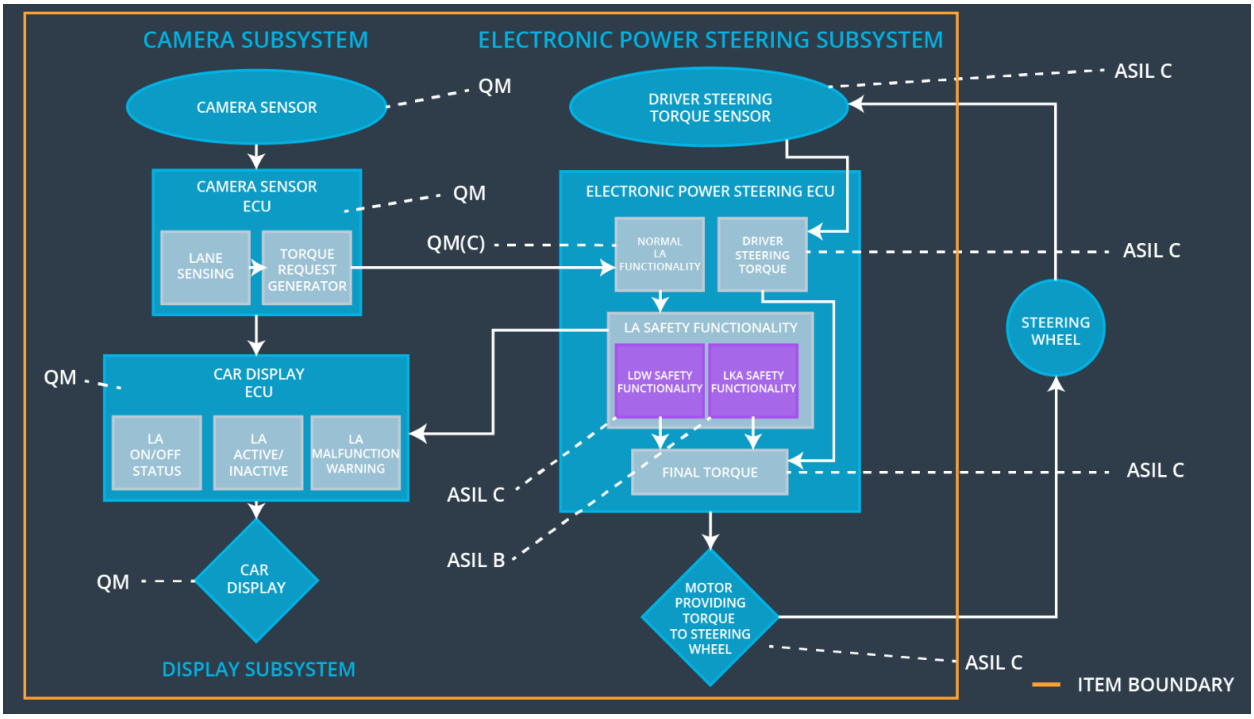
The technical safety concept is similar to the functional safety concept. New requirements are defined and allocated to the system architecture. The technical safety requirements are more concrete and get more into details of the item technology.

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	50 ms	LDW torque request amplitude is set to zero.
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	LDW torque request frequency is set 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	500 ms	LKA torque is set to zero

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Provides environment images to the camera ECU.
Camera Sensor ECU - Lane Sensing	Detects lane lines from camera images
Camera Sensor ECU - Torque request generator	Generates a torque request to the Electronic Power Steering ECU
Car Display	Displays a lane departure warning.
Car Display ECU - Lane Assistance On/Off Status	Shows the status of the lane assistance functionality.
Car Display ECU - Lane Assistant Active/Inactive	Shows whether the function is turned on or off.
Car Display ECU - Lane Assistance malfunction warning	Show whether the system has detected a malfunction of the function.

Driver Steering Torque Sensor	Measures the steering torque of the driver and provides it to the Electronic Power Steering ECU.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Takes signals from the sensor ECUs and derives a steering torque to be applied.
EPS ECU - Normal Lane Assistance Functionality	Receives signals from sensor ECU and derives a steering torque to be applied.
EPS ECU - Lane Departure Warning Safety Functionality	Limits the torque request from the normal lane assistance functionality to a defined value. Signals the car display ECU in case of malfunctioning.
EPS ECU - Lane Keeping Assistant Safety Functionality	Limits the time the LKA is available to the driver. Signals the car display ECU in case of malfunctioning.
EPS ECU - Final Torque	Computes the final torque that needs to be applied to the steering wheel
Motor	Physically applies the requested torque 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	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	EPS ECU – LDW Safety	LDW Torque Request Frequen cy 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	EPS ECU – LDW Safety	LDW Torque Request Frequen cy 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	50 ms	EPS ECU – LDW Safety	LDW Torque Request Frequen cy 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	Data transmission integrity check	LDW Torque Request Frequen cy shall be set to zero
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	C	Ignition cycle	Safety startup - Memory test	LDW Torque Request Frequen cy 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	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	EPS ECU – LKA Safety	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	50 ms	EPS ECU – LKA Safety	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 LDW feature and the LDW_TORQUE_REQUEST shall be set to zero.	C	50 ms	EPS ECU – LKA Safety	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' software block shall send a signal to the car display ECU to turn on a warning light.	C	50 ms	Data transmission integrity check	LDW Torque Request Frequency shall be set to 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	EPS ECU – LKA Safety	LDW Torque Request 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)

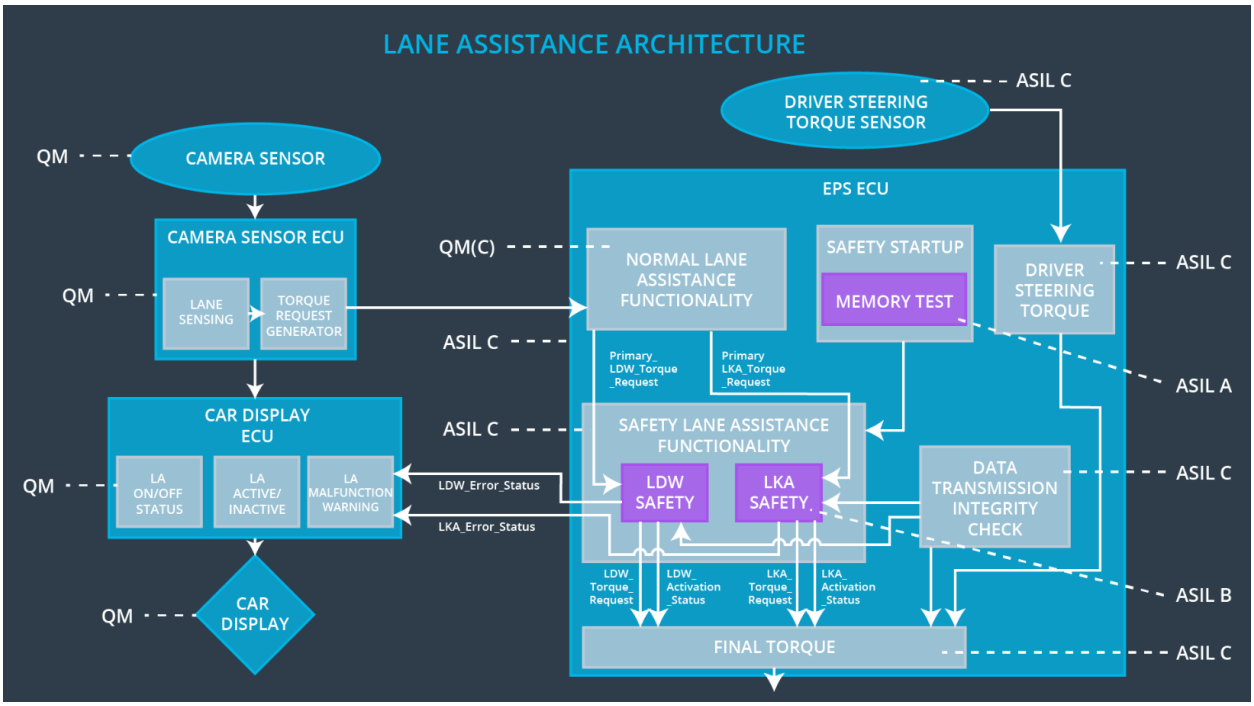
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 sent to the 'Final electronic power steering Torque' component is applied for only MAX_DURATION.	B	500 ms	EPS ECU – LKA Safety	LKA Torque Request shall be set to zero.

Technical Safety Requirement 02	The validity and integrity of the data transmission for LKA_TORQUE_REQUEST signal shall be ensured.	B	500 ms	EPS ECU – LKA Safety	LKA Torque Request shall be set to zero.
Technical Safety Requirement 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.	B	500 ms	EPS ECU – LKA Safety	LKA Torque Request shall be set to zero.
Technical Safety Requirement 04	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.	B	500 ms	Data transmission integrity check	LKA Torque Request shall be set to zero.
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	A	500 ms	Safety startup - Memory test	LKA Torque Request shall be set to zero.

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All derived 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 functionality	Malfunction_01 Malfunction_02	Yes	The car display signals degraded functionality
WDC-02	Turn off functionality	Malfunction_03	Yes	The car display signals degraded functionality