Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
2017-10-18	1.0	Albert Killer	First draft of technical safety concept

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Purpose of the Technical Safety Concept

The purpose of the technical safety concept is to refine the functional safety requirements established in the functional safety concept into technical safety requirements. This is a crucial step before developing reliabel hardware and software. As part of product development technical safety concept involves:

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

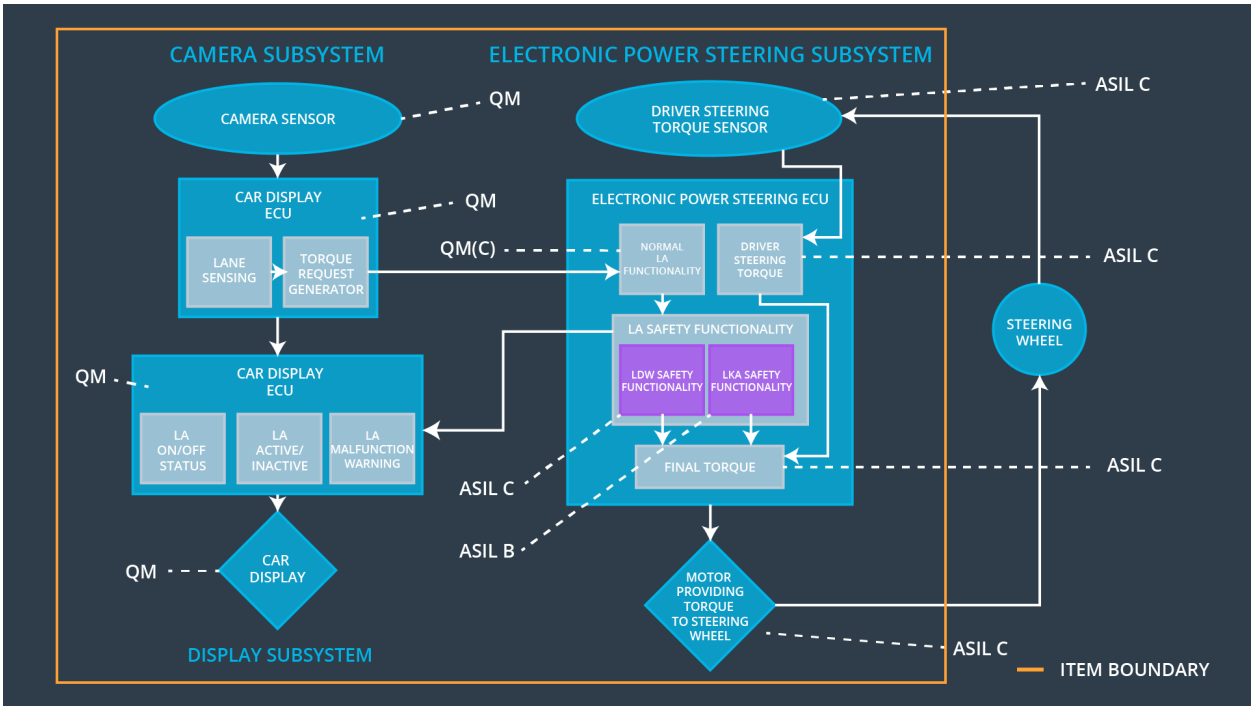
As a subsequent step technical safety requirements will be considered within software and hardware implementation.

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	Lane Assistant functionality off
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	Lane Assistant functionality off
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration.	B	500 ms	Lane Assistant functionality off

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Provides camera images to the Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Detects laneline positions from camera images.
Camera Sensor ECU - Torque request generator	Generates a torque request to the Electronic Power Steering ECU.
Car Display	Shows warning to driver.
Car Display ECU - Lane Assistance On/Off Status	Indicates if LA functionality is turned on.
Car Display ECU - Lane Assistant Active/Inactive	Indicates if LA functionality has properly detected lanes and is active at the moment.
Car Display ECU - Lane Assistance malfunction warning	Indicates fault malfunction of LA functionality.
Driver Steering Torque Sensor	Delivers steering torque intensity provided by driver to Electronic Power Steering ECU.

Electronic Power Steering (EPS) ECU - Driver Steering Torque	Processes input from Driver Steering Torque Sensor.
EPS ECU - Normal Lane Assistance Functionality	Receives torque request from Camera Sensor ECU and transfers it to Safety Lane Assistance Functionality.
EPS ECU - Lane Departure Warning Safety Functionality	Checks for malfunction of Lane Departure Warning and translates torque request into final torque output.
EPS ECU - Lane Keeping Assistant Safety Functionality	Checks for malfunction of Lane Keeping Assistant and transfers torque request to final torque output.
EPS ECU - Final Torque	Generates final torque from torque requests received from LDW and LKA safety.
Motor	Receives final torque calculated by Electronic Power Steering ECU and applies it to 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 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Amplitude'.	C	50 ms	LDW Safety	LDW_Activation_Status is zero
Technical Safety Requirement 02	As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'LDW_Torque_Request' shall e set to zero.	C	50 ms	LDW Safety	LDW_Activation_Status is zero
Technical Safety Requirement 03	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	50 ms	LDW Safety	LDW_Error_Status is zero
Technical	The validity and integrity of the	C	50 ms	Data	N/A

Safety Requirement 04	data transmission for ‘LDW_Torque_Request’ signal shall be ensured.			Transmission Integrity Check	
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in mermory.	A	ignition cycle	Memory Test	LDW_Activation_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 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	50 ms	LDW Safety	LDW_Activation_Status is zero
Technical Safety Requirement 02	As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the ‘LDW_Torque_Request’ shall e set to zero.	C	50 ms	LDW Safety	LDW_Activation_Status is zero
Technical Safety Requirement	As soons as the LDW function deactivates the LDW feature, the	C	50 ms	LDW Safety	LDW_Error_Status is

03	‘LDW Safety’ software block shall send a signal to the car display ECU to turn on a warning light.				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_Activation_Status is zero
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in mermory.	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)

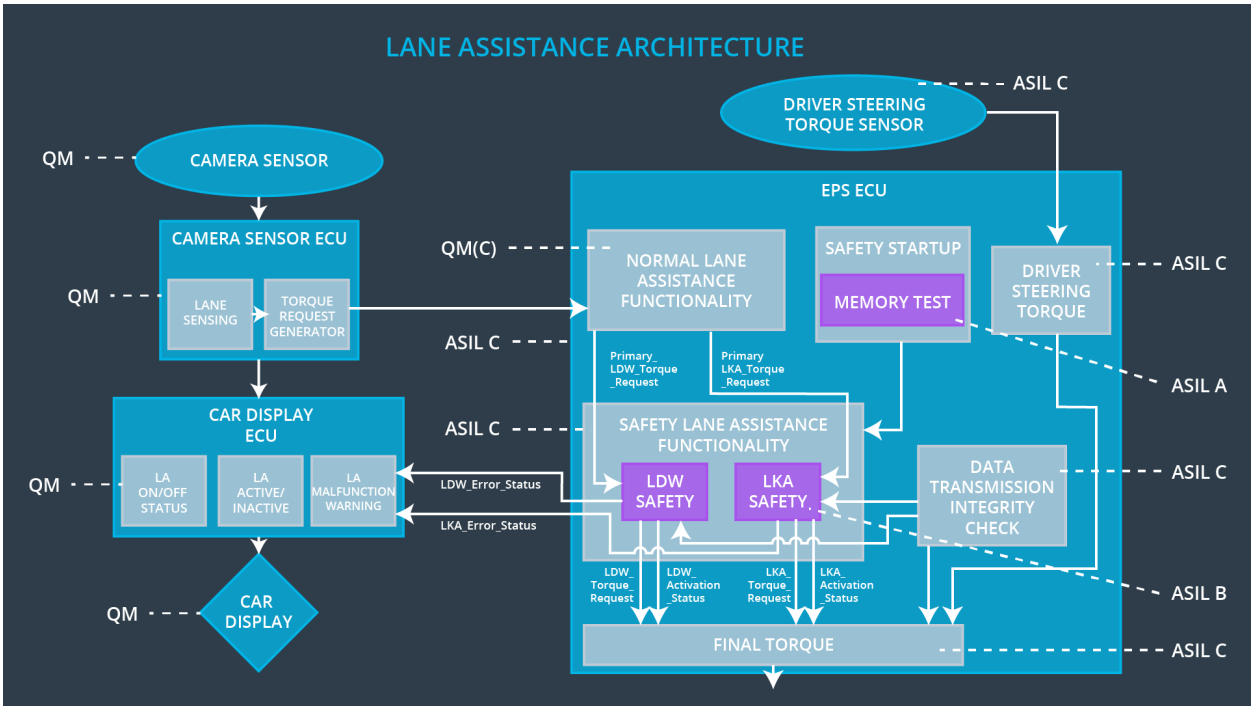
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 LKA safety component shall ensure that ‘LKA_Torque_Request’ is sent to the ‘Final electronic power steering Torque’ component for only ‘Max_Duration’.	B	500 ms	LKA Safety	LKA_Activation_Status is zero
Technical Safety Requireme	As soon as a failure is detected by the LKA function, it shall deactivate the LKA feature and	B	500 ms	LKA Safety	LKA_Activation_Status is zero

nt 02	the ‘LKA_Torque_Request’ shall e set to zero.				
Technical Safety Requirement 03	As soons 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	LKA Safety	LKA_Error_ Status is zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for ‘LKA_Torque_Request’ signal shall be ensured.	B	500 ms	Data Transmission Integrity Check	LKA_Activation_Status is zero
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in mermory.	A	ignition cycle	Memory Test	LKA_Activation_Status is zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All technical safety requirements were allocated to the Electronic Power Steering ECU. For the exact allocation within EPS ECU compare the technical requirement tables above.

Warning and Degradation Concept

For any system malfunction, the lane assistance functions will be turned off and the driver will receive a warning light indication.

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off Lane Assistant functionality	Malfunction_01	Yes	Lane Assistant Malfunction Warning on Car Display
WDC-02	Turn off Lane Assistant functionality	Malfunction_02	Yes	Lane Assistant Malfunction Warning on Car Display
WDC-03	Turn off Lane Assistant functionality	Malfunction_03	Yes	Lane Assistant Malfunction Warning on Car Display
WDC-04	Turn off Lane Assistant functionality	Malfunction_04	Yes	Lane Assistant Malfunction Warning on Car Display
WDC-05	Turn off Lane Assistant functionality	Malfunction_05	Yes	Lane Assistant Malfunction Warning on Car Display