Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
9/23/2017	1.0	Martin Pfeifle	First draft of technical safety concept

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Purpose of the Technical Safety Concept

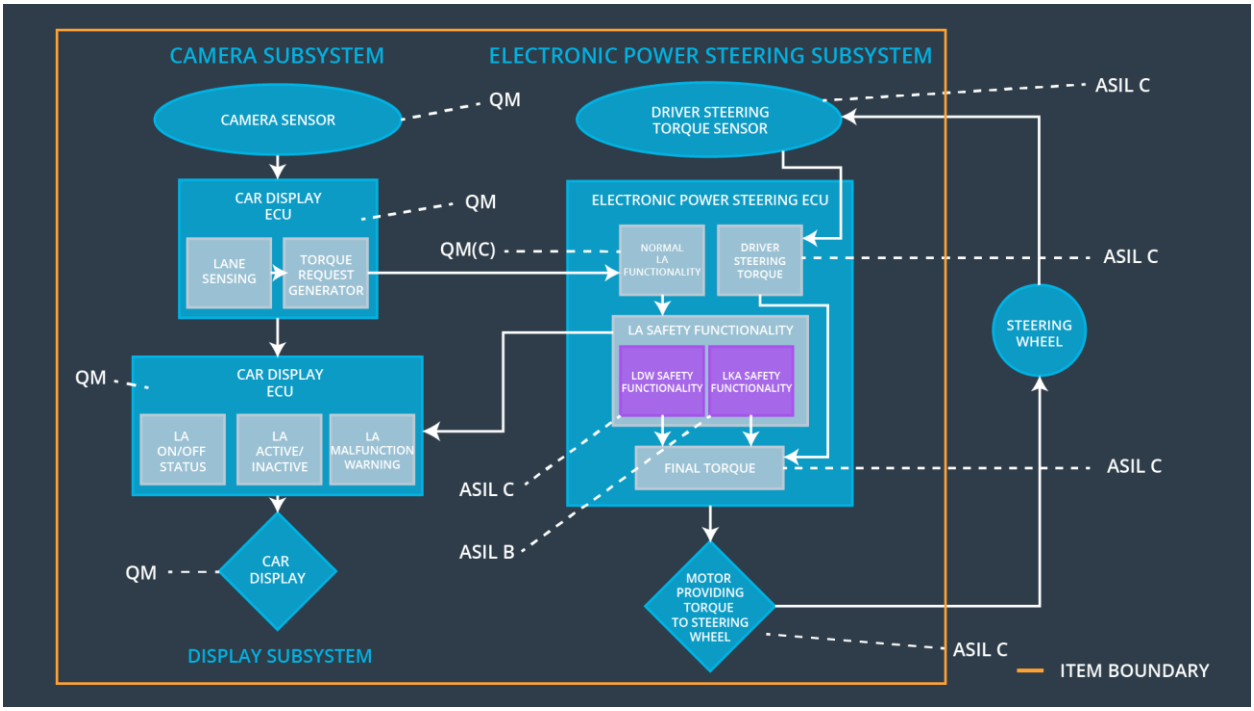
The technical safety concept defines how the subsystems interact at a message level and describes how the ECUs communicate with each other.

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 will set the oscillating torque to 0
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Frequency	C	50 ms	Lane keeping item output torque = 0
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 keeping item output torque = 0

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	A sensor that outputs a front-facing image
Camera Sensor ECU - Lane Sensing	A control module software feature that processes an image and identifies the lane markings for the current lane in the car coordinate system
Camera Sensor ECU - Torque request generator	A control module software feature that processes the vehicles position and trajectory with respect to the position and trajectory of the ego lane, and issues a torque request to alert the driver or correct the vehicle trajectory in case the car's trajectory deviates from the center line of the ego lane.
Car Display	An actuator that displays information and messages to the driver via warning lamps and LCD display
Car Display ECU - Lane Assistance On/Off Status	A control module that displays whether the lane assistance feature is currently on or off

Car Display ECU - Lane Assistant Active/Inactive	A control module feature that displays whether the lane assistance feature is currently active or inactive
Car Display ECU - Lane Assistance malfunction warning	A control module feature that displays a warning message if the lane assistance feature has experienced a malfunction
Driver Steering Torque Sensor	A sensor that outputs the torque that the driver is applying to the steering wheel
Electronic Power Steering (EPS) ECU - Driver Steering Torque	A control module that calculates the amount of steering torque being applied by the driver via the steering wheel
EPS ECU - Normal Lane Assistance Functionality	A control module that calculates the nominal amount of torque to apply, based on the driver steering torque and torque request from the camera sensor ECU
EPS ECU - Lane Departure Warning Safety Functionality	A control module that monitors the frequency and amplitude of the torque request for the LDW feature and limits both to a maximum; moreover, the feature will indicate a malfunction if the limits are exceeded
EPS ECU - Lane Keeping Assistant Safety Functionality	A control module that monitors the duration of the torque request for the LKA feature and limits it to a maximum; moreover, the feature will indicate a malfunction if the limit is exceeded
EPS ECU - Final Torque	A control module that applies the final torque
Motor	An actuator that adds torque to the steering

Technical Safety Concept

Technical Safety Requirements

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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	LDW_Torque_Request = 0
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	50ms	Electronic Power Steering ECU - LDW Safety Functionality	LDW_Torque_Request = 0
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	Electronic Power Steering ECU - LDW Safety Functionality	LDW_Torque_Request = 0
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	Electronic Power Steering ECU – Data transmission integrity check	LDW_Torque_Request = 0
Technical Safety Requirem	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Electronic Power Steering ECU	LDW_Torque_Request = 0

ent 05				– Safety Startup	

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	50ms	Electronic Power Steering ECU - LDW Safety Functionality	LDW_Torque_Request = 0
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	50ms	Electronic Power Steering ECU - LDW Safety Functionality	LDW_Torque_Request = 0
Technical Safety	As soon as a failure is detected by the LDW function, it shall deactivate	C	50ms	Electronic Power	LDW_Torque_R

Requirement 03	the LDW feature and the 'LDW_Torque_Request' shall be set to zero.			Steering ECU - LDW Safety Functionality	equest = 0
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	Electronic Power Steering ECU – Data transmission integrity check	LDW_Torque_Request = 0
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	Electronic Power Steering ECU – Safety Startup	LDW_Torque_Request = 0

Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:

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:

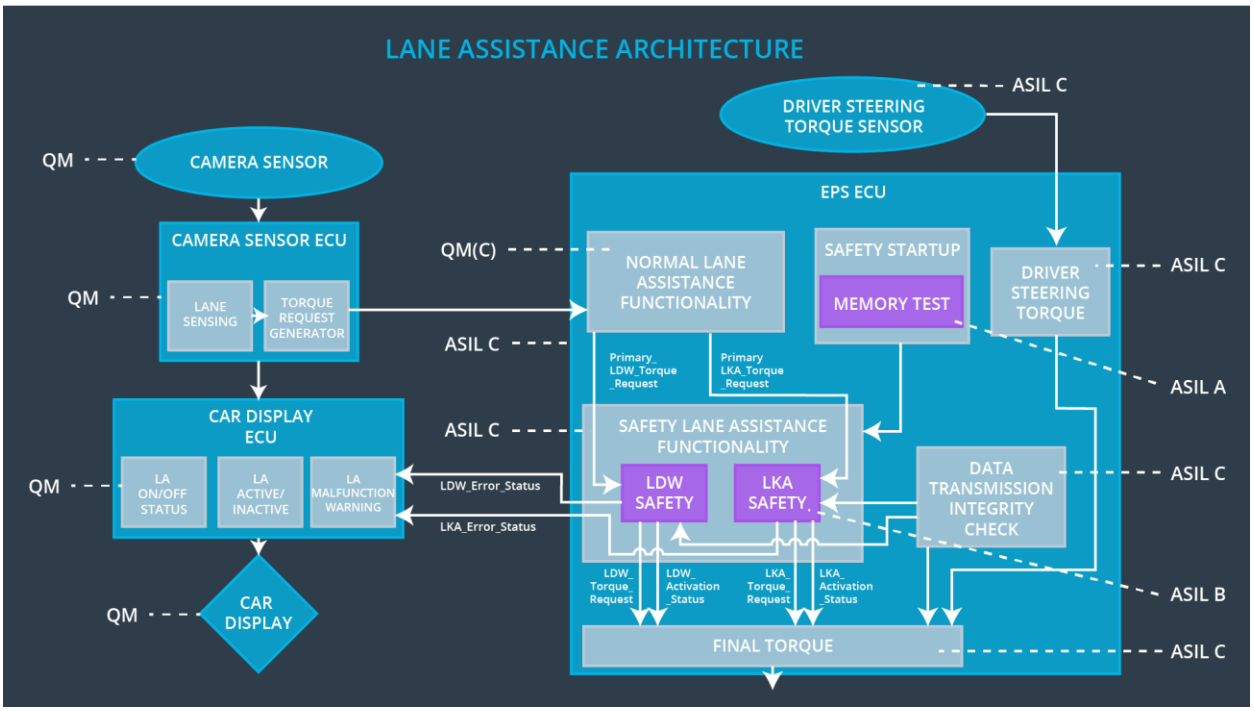
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State

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 greater than 0 for no more than 'Max_Duration.	B	500ms	Electronic Power Steering ECU - LKA Safety Functionality	LKA_Torque_Request = 0
Technical Safety Requirement 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.	B	500ms	Electronic Power Steering ECU - LKA Safety Functionality	LKA_Torque_Request = 0
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	500ms	Electronic Power Steering ECU - LKA Safety Functionality	LKA_Torque_Request = 0
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500ms	Electronic Power Steering ECU – Data transmission integrity check	LKA_Torque_Request = 0
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	Electronic Power Steering ECU – Safety Startup	LKA_Torque_Request = 0

Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. “Validation” asks whether or not you chose the appropriate parameters. “Verification” involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

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	Functionality is turned off	Malfunction_01	Yes, immediately	audible warning signal combined with a pop-up message on instrument cluster
WDC-02	Functionality is turned off	Malfunction_02	Yes, immediately	audible warning signal combined

				with a pop-up message on instrument cluster