Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
11/04/2018	1.0	BM	First version of the document

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Purpose of the Technical Safety Concept

The purpose of the technical safety concept is to further refine the functional safety concept, in a sense that the technical safety concept provides a more detailed description of the technical requirements to achieve functional safety of the product. The technical safety concept assigns

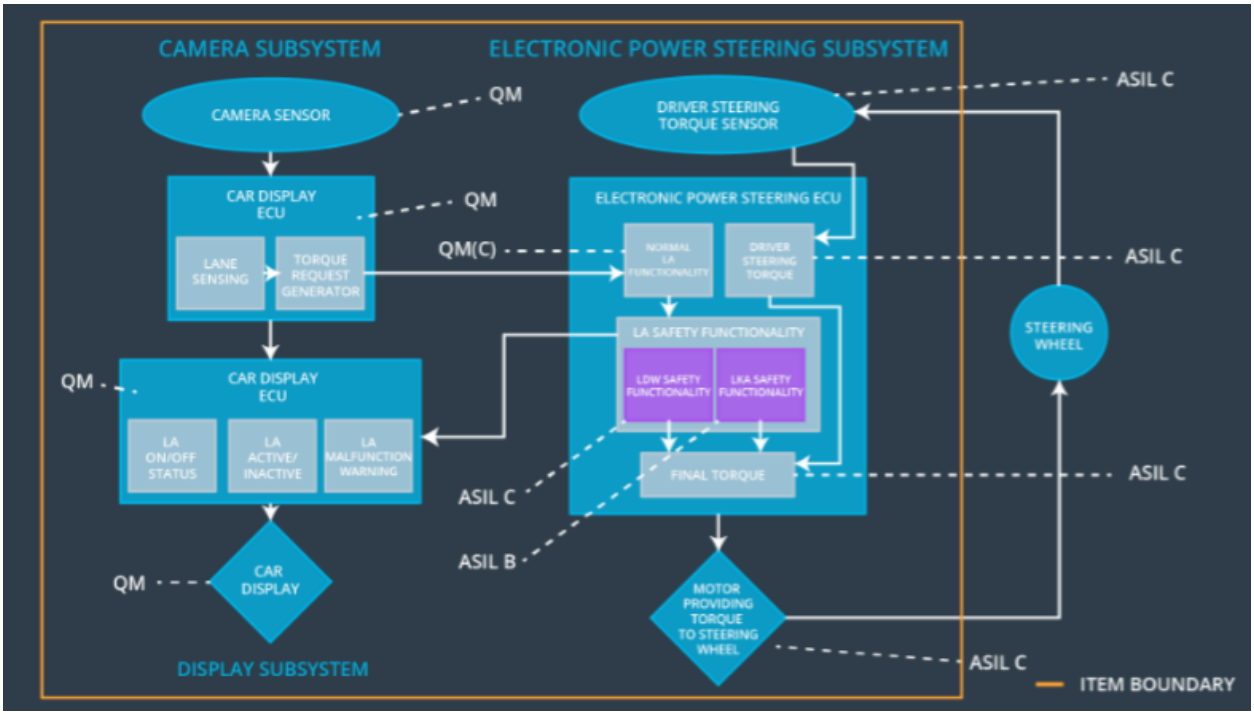
functional safety requirements to the overall system architecture, and as such, the technical safety concept influences software and hardware development directly.

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	Test different values of Max_Torque_Amplitude to ensure that the proper value is chosen for driver's comfort while still preserving meaningful functionality.	C	50 ms	Function is deactivated.
Functional Safety Requirement 01-02	Test different values of Max_Torque_Frequency to ensure that the proper value is chosen for driver's comfort while still preserving meaningful functionality.	C	50 ms	Function is deactivated.
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the torque for the Lane Keeping Assistance function is applied for no longer than Max_Duration time interval.	B	500 ms	Function is deactivated.

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Provides images to the camera sensor ECU
Camera Sensor ECU - Lane Sensing	Calculates the position of the ego vehicle with respect to the center of the ego lane
Camera Sensor ECU - Torque request generator	Calculates the necessary torque request based on lane sensing and sends it to the electronic power steering ECU
Car Display	Displays information to the driver
Car Display ECU - Lane Assistance On/Off Status	Indicates the status of the Lane Assistance System (on or off)

Car Display ECU - Lane Assistant Active/Inactive	Indicates whether or not the Lane Assistance System is currently active
Car Display ECU - Lane Assistance malfunction warning	Turns on in case of the Lane Assistance System malfunction
Driver Steering Torque Sensor	Senses the torque that the driver is currently applying to the steering wheel
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Processes the output of the driver steering torque sensor
EPS ECU - Normal Lane Assistance Functionality	Software module providing the regular Lane Assistance System functionality
EPS ECU - Lane Departure Warning Safety Functionality	Software module ensuring that the torque amplitude and the torque frequency are below the maximum values allowed
EPS ECU - Lane Keeping Assistant Safety Functionality	Software module ensuring that the Lane Keeping Assistant function is active not more that the maximum allowed time, to prevent usage as self-driving capability
EPS ECU - Final Torque	Software module that generates the final torque value based on the LDW and LKA functions
Motor	Applies the final value of the 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 maximum amplitude of the “LDW_Torque_Request” value, which is sent to the “Final electronic power steering Torque” component, is below the maximum allowed value “Max_Torque_Amplitude”	C	50 ms	LDW safety	LDW_Torque_Request is set to zero
Technical Safety Requirement 02	When the LDW function is deactivated, the LDW safety component shall send a signal to the car display ECU to turn on a warning signal.	C	50 ms	LDW safety	LDW_Torque_Request is set to zero
Technical	When the LDW safety	C	50 ms	LDW safety	LDW_Torque_Request

Safety Requirement 03	component detects a failure, it shall deactivate the LDW function and permanently set “LDW_Torque_Request” to zero.				is 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 is set to zero
Technical Safety Requirement 05	Memory test shall be conducted at start up of the electronic power steering ECU, to check for any memory problems	A	Ignition cycle	Memory check	LDW_Torque_Request is 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	AS	Fault Tolerant	Architecture	Safe

	Requirement	IL	Time Interval	Allocation	State
Technical Safety Requirement 01	The LDW safety component shall ensure that the maximum frequency of the “LDW_Torque_Request” value, which is sent to the “Final electronic power steering Torque” component, is below the maximum allowed value “Max_Torque_Frequency”	C	50 ms	LDW safety	LDW_Torque_Request is set to zero
Technical Safety Requirement 02	When the LDW function is deactivated, the LDW safety component shall send a signal to the car display ECU to turn on a warning signal.	C	50 ms	LDW safety	LDW_Torque_Request is set to zero
Technical Safety Requirement 03	When the LDW safety component detects a failure, it shall deactivate the LDW function and permanently set “LDW_Torque_Request” to zero.	C	50 ms	LDW safety	LDW_Torque_Request is 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 is set to zero
Technical Safety Requirement 05	Memory test shall be conducted at start up of the electronic power steering ECU, to check for any memory problems	A	Ignition cycle	Memory check	LDW_Torque_Request is set to zero

Lane Keeping Assistance (LKA) Requirements:

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

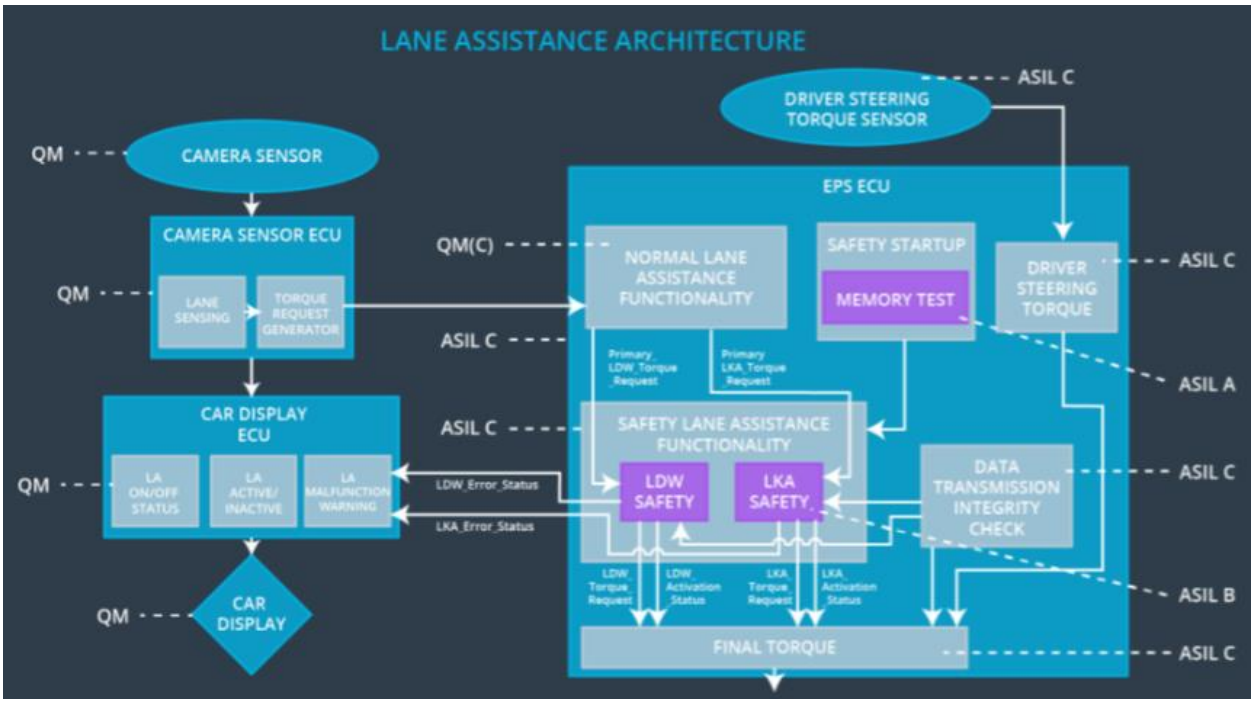
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 duration of the “LKA_Torque_Request” value, which is sent to the “Final electronic power steering Torque” component, is below the maximum allowed value “Max_Duration”	B	500 ms	LKA safety	LKA_Torque_Request is set to zero
Technical Safety Requirement 02	When the LKA function is deactivated, the LKA safety component shall send a signal to the car display ECU to turn on a warning signal.	B	500 ms	LKA safety	LKA_Torque_Request is set to zero

Technical Safety Requirement 03	When the LKA safety component detects a failure, it shall deactivate the LKA function and permanently set “LKA_Torque_Request” to zero.	B	500 ms	LKA safety	LKA_Torque_Request is set to 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 test	LKA_Torque_Request is set to zero
Technical Safety Requirement 05	Memory test shall be conducted at start up of the electronic power steering ECU, to check for any memory problems	A	Ignition cycle	Memory check	LKA_Torque_Request is set to zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

[Instructions: We already included the allocation as part of the technical requirement tables. Here you can state that for this particular item, 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	Turn off Lane Assistance System	Malfunction_01	Yes	Lane Assistance System malfunction warning on car display

WDC-02	Turn off Lane Assistance System	Malfunction_02	Yes	Lane Assistance System malfunction warning on car display
WDC-03	Turn off Lane Assistance System	Malfunction_03	Yes	Lane Assistance System malfunction warning on car display
WDC-04	Turn off Lane Assistance System	Malfunction_04	Yes	Lane Assistance System malfunction warning on car display
WDC-05	Turn off Lane Assistance System	Malfunction_05	Yes	Lane Assistance System malfunction warning on car display