Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
22/05/2018	1.0	Ashith Raghunath	Compiled Technical Safety Concept

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Purpose of the Technical Safety Concept

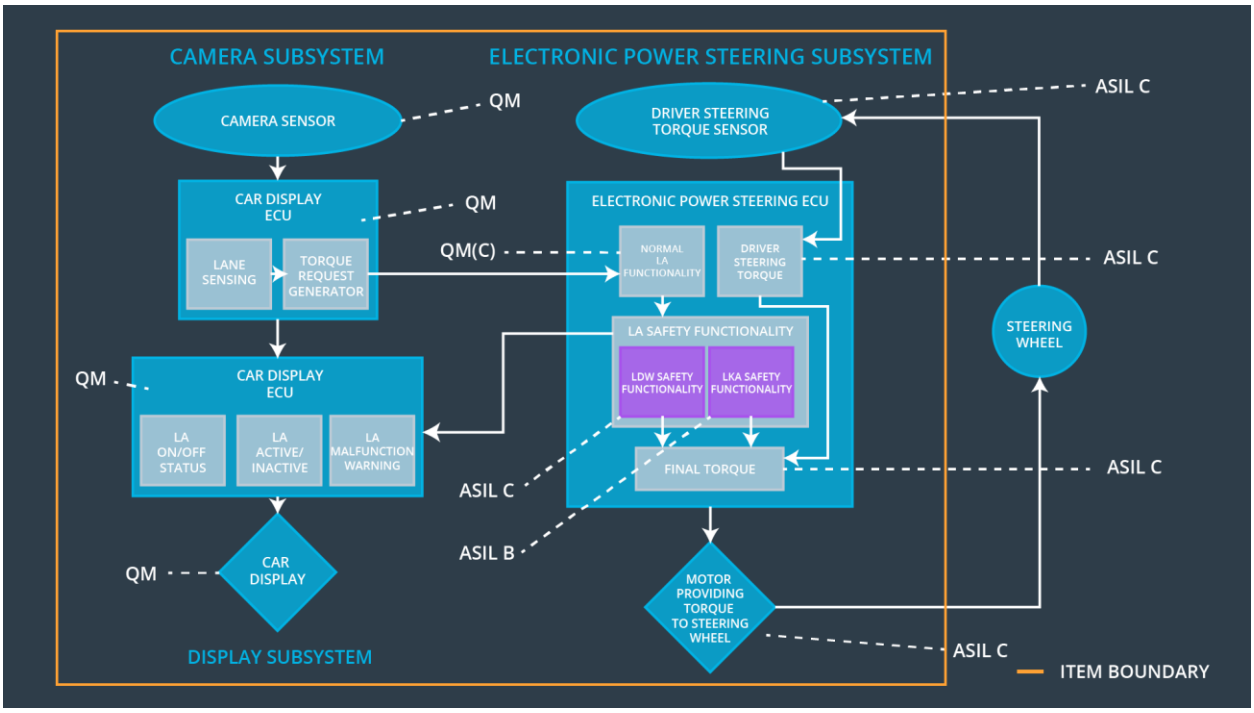
The purpose of the technical safety concept is to be a more concrete version of the Functional Safety Concept and get into the details of the item's technology. While the functional safety concept is in the concept phase, the technical safety concept is part of the product development phase.

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 max amplitude is below Max_Torque_Amplitude	C	50ms	Limit the torque below Max_Torque_Amplitude
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque max frequency is below Max_Torque_Frequency	C	50ms	Limit the torque below Max_Torque_Frequency
Functional Safety Requirement 02-01	lane keeping assistance function shall be time limited and the additional steering torque shall end after a given timer interval (MAX_DURATION)so that the driver cannot misuse the system for autonomous driving	B	500ms	Turn off the lane keeping assistance function

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	It is used to capture the images of the road ahead and pass it on to the Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Use OpenCV methods to analyze the input images and Localize the car with respect to the lane lines.
Camera Sensor ECU - Torque request generator	It calculates the torque necessary to center the vehicle in the lane.
Car Display	Provide visual display for warnings related to any of the functions such as lane departure warning.
Car Display ECU - Lane Assistance On/Off Status	Indicate whether the Lane Assistance Functionality is turned on or off.
Car Display ECU - Lane Assistant Active/Inactive	Indicate if the Lane Assistance Functionality is currently activated or not.

Car Display ECU - Lane Assistance malfunction warning	Indicate if the Lane Assistance Functionality is malfunctioning.
Driver Steering Torque Sensor	Measures the amount of torque applied to the steering wheel by the driver.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Receives the driver steering torque measured by the Driver Steering Torque Sensor
EPS ECU - Normal Lane Assistance Functionality	Receives the torque request from camera ECU and implements the Lane Keeping assist and Lane Departure Warning Functionalities
EPS ECU - Lane Departure Warning Safety Functionality	Safety module that makes sure that the applied torque amplitude and frequency are within the threshold values.
EPS ECU - Lane Keeping Assistant Safety Functionality	Safety module that makes sure that the torque is applied only for a Max_Duration time interval and automatically switches off Lane Keeping Assistant
EPS ECU - Final Torque	Combines the torque requests from Lane Keeping Assist and Lane Departure Warning to generate the appropriate torque and sends them to the Motor
Motor	Applies the required torque received from the Electronic Power Steering ECU 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	The lane keeping item shall	X		

Safety Requirement 01-01	ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude			

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 validity and integrity for 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 02	As soon as 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	LDW_Safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 03	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	LDW_Safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 04	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory	A	ignition cycle	Safety Startup	LDW_Torque_Request is set to zero.
Technical Safety Requirement 05	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 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 Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State
Technical Safety Requirement 01	The validity and integrity for 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 02	As soon as 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	LDW_Safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 03	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	LDW_Safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 04	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory	A	ignition cycle	Safety Startup	LDW_Torque_Request is set to

					zero.
Technical Safety Requirement 05	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	LDW_Safety	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)

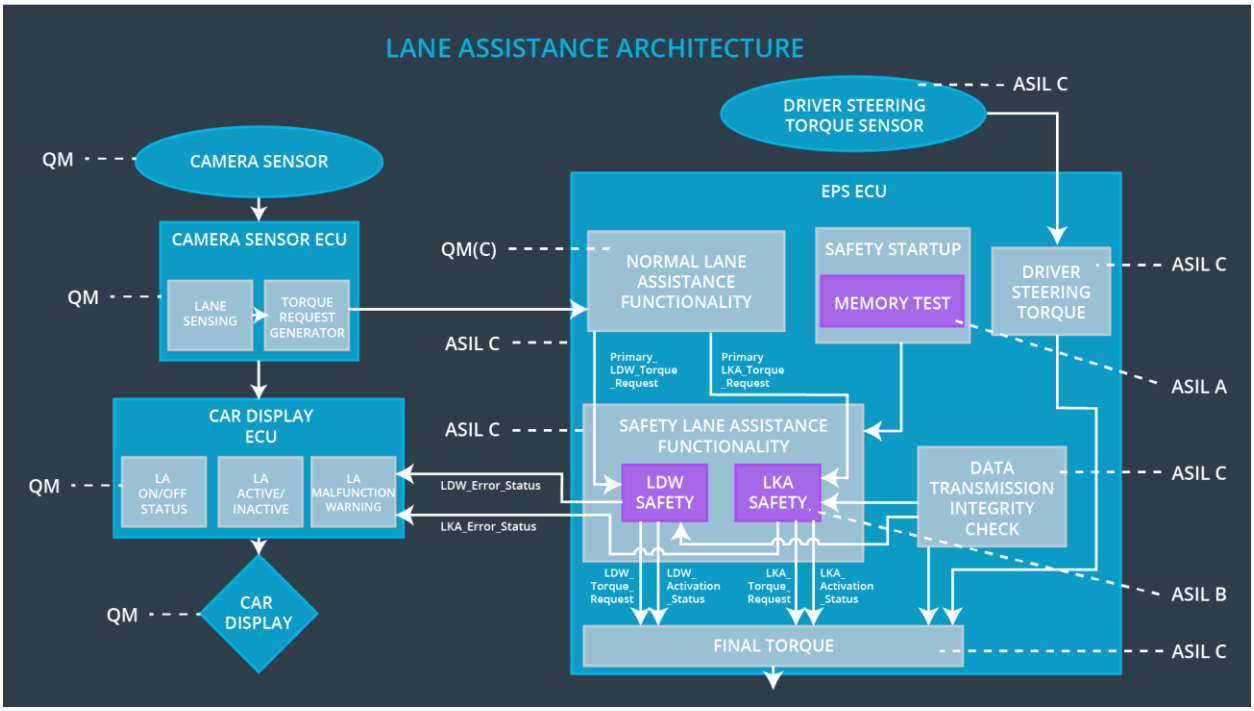
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 validity and integrity for the data transmission for 'LKA_Torque_Request' signal shall be ensured	B	500 ms	Data Transmission Integrity Check	LKA_Torque_Request is set to zero.
Technical Safety Requirement 02	The LKA safety component shall ensure that the duration of the 'LKA_Torque_Request' sent to the 'Final electronic power steering Torque' component is	B	500 ms	LKA_Safety	LKA_Torque_Request is set to zero.

	below ‘Max_DURATION’				
Technical Safety Requirement 03	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory	A	ignition cycle	Safety Startup	LKA_Torque_Request is 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	LKA_Safety	LKA_Torque_Request is set to zero.
Technical Safety Requirement 05	As soon as 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	LKA_Safety	LKA_Torque_Request is set to zero.

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	Turn off the functionality	Malfunction_01 Malfunction_02	Yes	Display a Lane Departure Warning Malfunction warning on Car Display
WDC-02	Turn off the functionality	Malfunction_03	Yes	Display a Lane Keeping Assistance Malfunction warning on Car Display