Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
2017/12/10	1.0	Dongmin Kim	First attempt

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Purpose of the Technical Safety Concept

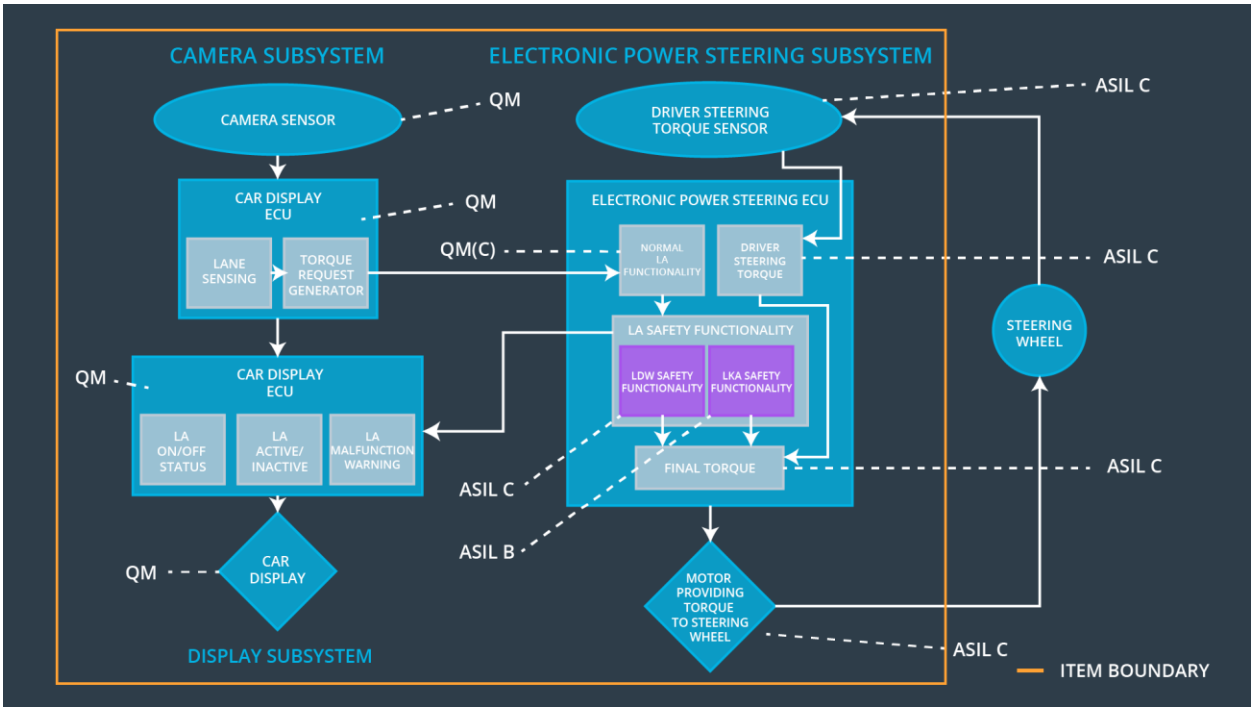
Purpose of the Technical Safety Concept is to turn functional safety requirements into technical safety requirements and to allocate technical safety requirements to the system architecture.

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	50ms	LDW is turned off and warning icon is displayed on the car display.
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency.	C	50ms	LDW is turned off and warning icon is displayed on the car display.
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	500ms	LKA is turned off and warning icon is displayed on the car display.

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	The camera sensor reads in images from the road.
Camera Sensor ECU - Lane Sensing	The camera sensor ECU is to detect lane lines and determine when the vehicle leaves the lane by mistake.
Camera Sensor ECU - Torque request generator	The camera sensor ECU determines the extra torque necessary to steer the vehicle and send request to EPS ECU.
Car Display	The car display shows information about lane assistance system.
Car Display ECU - Lane Assistance On/Off Status	Car display ECU confirms status about lane assistance On/Off status and send that information to car display.
Car Display ECU - Lane Assistant Active/Inactive	Car display ECU confirms status about lane assistance active/inactive and send that information to car display.

Car Display ECU - Lane Assistance malfunction warning	If malfunction is happened, car display ECU send malfunction warning information to car display.
Driver Steering Torque Sensor	The driver steering torque sensor is sensing the steering torque.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	EPS ECU get inputs from the driver steering torque sensor, process the data and send that to final torque part.
EPS ECU - Normal Lane Assistance Functionality	EPU ECU gets inputs from camera ECU's torque request and sends the output to motor. This torque cannot exceed Max_Torque.
EPS ECU - Lane Departure Warning Safety Functionality	EPU ECU assures that the amplitude and frequency do not exceed Max_Torque_Amplitude and Max_Torque_Frequency and sends the output to final torque part.
EPS ECU - Lane Keeping Assistant Safety Functionality	EPU ECU assures that the amplitude and frequency do not exceed Max_Duration and sends the output to final torque part.
EPS ECU - Final Torque	EPU ECU calculates final torque and sends the output to motor.
Motor	The motor provides torque 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 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 Functionality	LDW is turned off and warning icon is displayed on the car display.
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 Functionality	LDW is turned off and warning icon is displayed on the car display.
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 Functionality	LDW is turned off and warning icon is displayed on the car display.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	EPS ECU – Data Transmission Integrity Check	LDW is turned off and warning icon is displayed on the car display.
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	EPS ECU – Memory test	LDW is turned off and warning icon is displayed on the car display.

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 amplitude of the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency'.	C	50 ms	EPS ECU – LDW Safety Functionality	LDW is turned off and warning icon is displayed on the car display.
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 Functionality	LDW is turned off and warning icon is displayed on the car display.
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 Functionality	LDW is turned off and warning icon is displayed on the car display.

Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	EPS ECU – Data Transmission Integrity Check	LDW is turned off and warning icon is displayed on the car display.
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	EPS ECU – Memory test	LDW is turned off and warning icon is displayed on the car display.

Lane Keeping Assistance (LKA) Requirements:

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

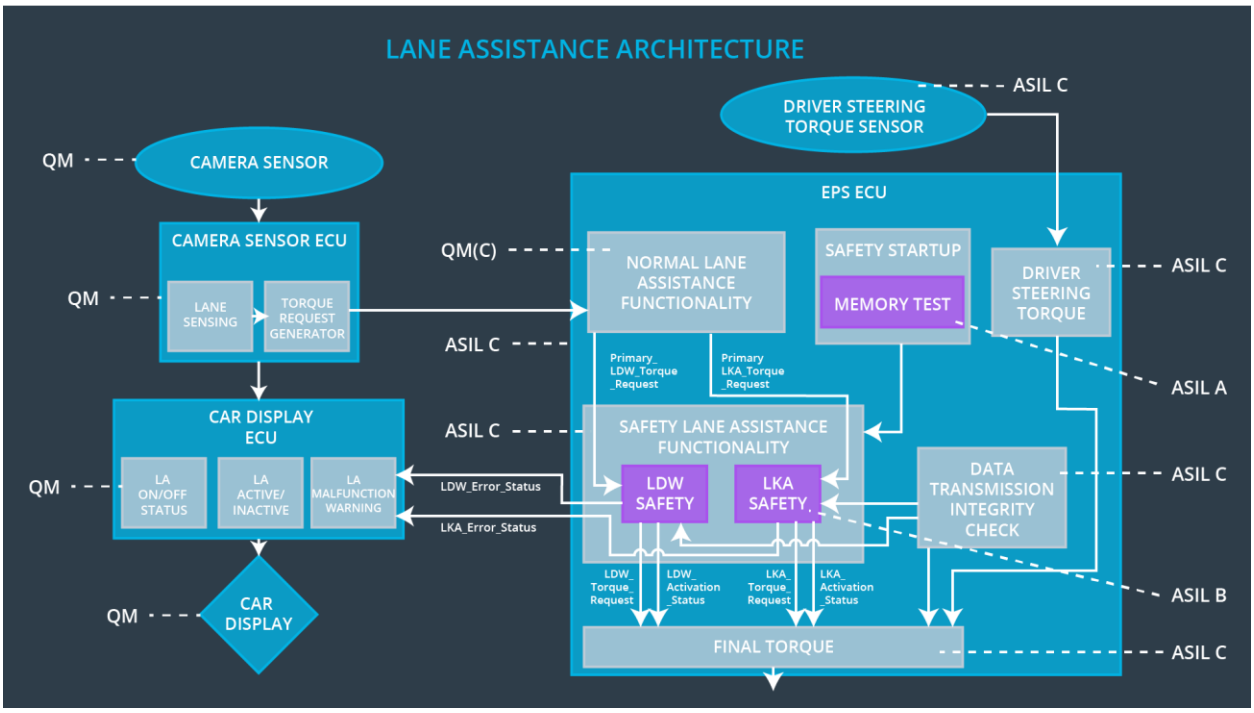
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 lane assistance torque is applied for only Max_Duration.	B	500 ms	EPS ECU – LKA Safety Functionality	LKA is turned off and warning icon is displayed on the car display.

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	500 ms	EPS ECU – LKA Safety Functionality	LKA is turned off and warning icon is displayed on the car display.
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 Functionality	LKA is turned off and warning icon is displayed on the car display.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500 ms	EPS ECU – Data Transmission Integrity Check	LKA is turned off and warning icon is displayed on the car display.
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	EPS ECU – Memory test	LKA is turned off and warning icon is displayed on the car display.

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	LDW is turned off and warning icon is displayed on the car display.	The LDW torque crosses Max_Torque_Amplitude or Max_Toque_Frequency.	YES	Warning icon is displayed on the car display.
WDC-02	LKA is turned off and warning icon is displayed on the car display.	LKA is activated longer than Max_Duration.	YES	Warning icon is displayed on the car display.