Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

Document Version: [Version]

Template Version 1.0, Released on 2017-06-21

Document history

Date	Version	Editor	Description
23/05/2018	1.0	Trijeet	Initial Draft

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Purpose of the Technical Safety Concept

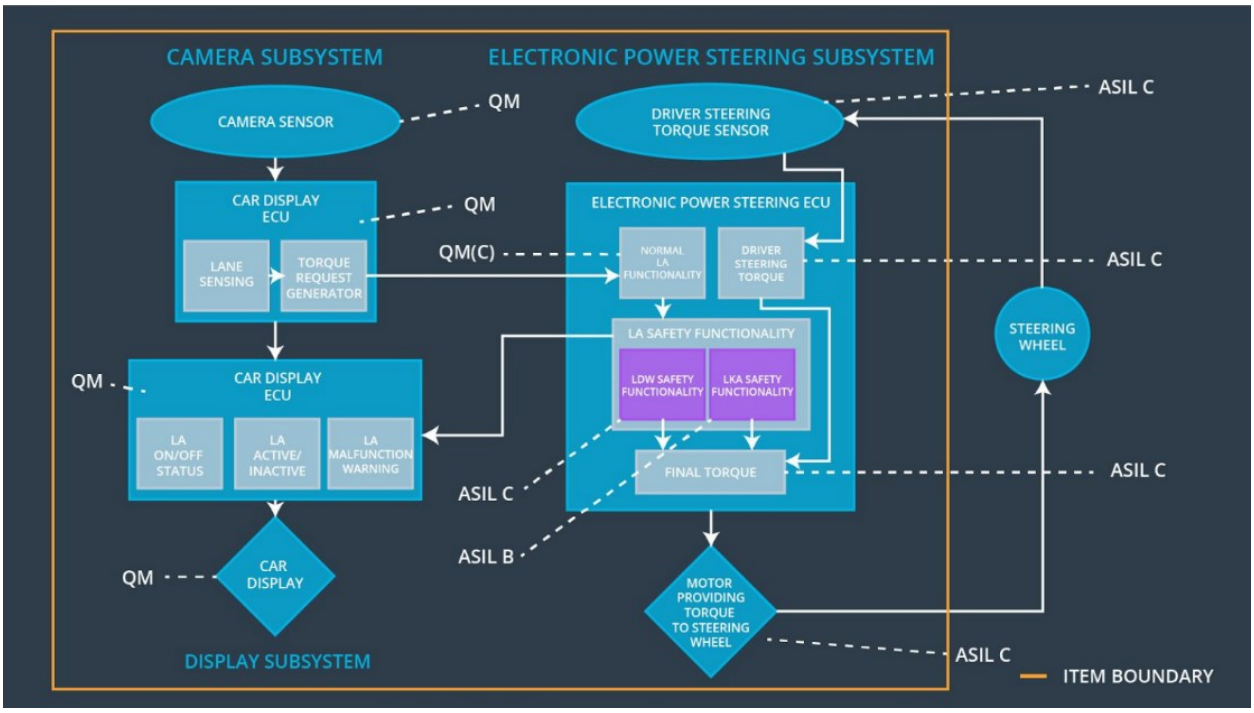
The purpose of the functional safety concept is to identify the high level system requirements without diving deep into the technical aspects. Different parts of the item architecture are allocated with the responsibility of fulfilling these requirements. The result of this leads to construction of the technical safety requirements from it. Validation and verification instructions for these requirements are also laid down in this. Finally, these requirements will be considered while hardware and software implementation of the system.

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 assistance function shall ensure that the lane departure oscillating torque amplitude stays below Max_Torque_Amplitude	C	50 ms	Oscillation torque amplitude maintained below Max_Torque_Amplitude
Functional Safety Requirement 01-02	The lane keeping assistance function shall ensure that the lane departure oscillating torque frequency stays below Max_Torque_Frequency	C	50 ms	Oscillation torque amplitude maintained below Max_Torque_Frequency
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for no more than Max_Duration so that the driver cannot misuse the system for autonomous driving	B	500 ms	Disable the lane keeping assistance function

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Captures the scene in front of the car and feeds the image to the Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Detects the lane lines in the image from the Camera Sensor feed.
Camera Sensor ECU - Torque request generator	Calculates the amount of torque required and requests the same to the Electronic Power Steering ECU.
Car Display	Displays warning notifications as fed from Car Display ECU
Car Display ECU - Lane Assistance On/Off Status	Indicates whether the Lane Assistance is turned on or off.
Car Display ECU - Lane Assistant Active/Inactive	Indicates whether the Lane Assistance is currently being used (active) or not (inactive).
Car Display ECU - Lane Assistance malfunction warning	Indicates whether the Lane Assistance has malfunctioned.
Driver Steering Torque Sensor	Detects the amount of torque being applied by the driver on the steering wheel.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Receives the torque applied by the driver as detected by the Driver Steering Torque Sensor.
EPS ECU - Normal Lane Assistance Functionality	Receives the torque request from the Camera Sensor ECU - Torque request generator and provides Lane Keeping Assistance and Lane Departure Warnings
EPS ECU - Lane Departure Warning Safety Functionality	Ensures that the torque amplitude and frequency are below Max_Torque_Amplitude and Max_Torque_Frequency respectively.
EPS ECU - Lane Keeping Assistant Safety Functionality	Ensures that the torque request is not active for more than Max_Duration.
EPS ECU - Final Torque	Computes the effective torque required by combining the torque request from the Lane Departure Warning and Lane Keeping Assistance functions.
Motor	Applies the necessary torque as computed by EPS ECU - Final Torque onto 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 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.
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	C	50 ms	LDW Safety	LDW_Torque_Request is set to zero.

	display ECU to turn on a warning light				
Technical Safety Requirement 04	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 05	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.

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	50 ms	LDW Safety	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	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 05	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.

Lane Keeping Assistance (LKA) Requirements:

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

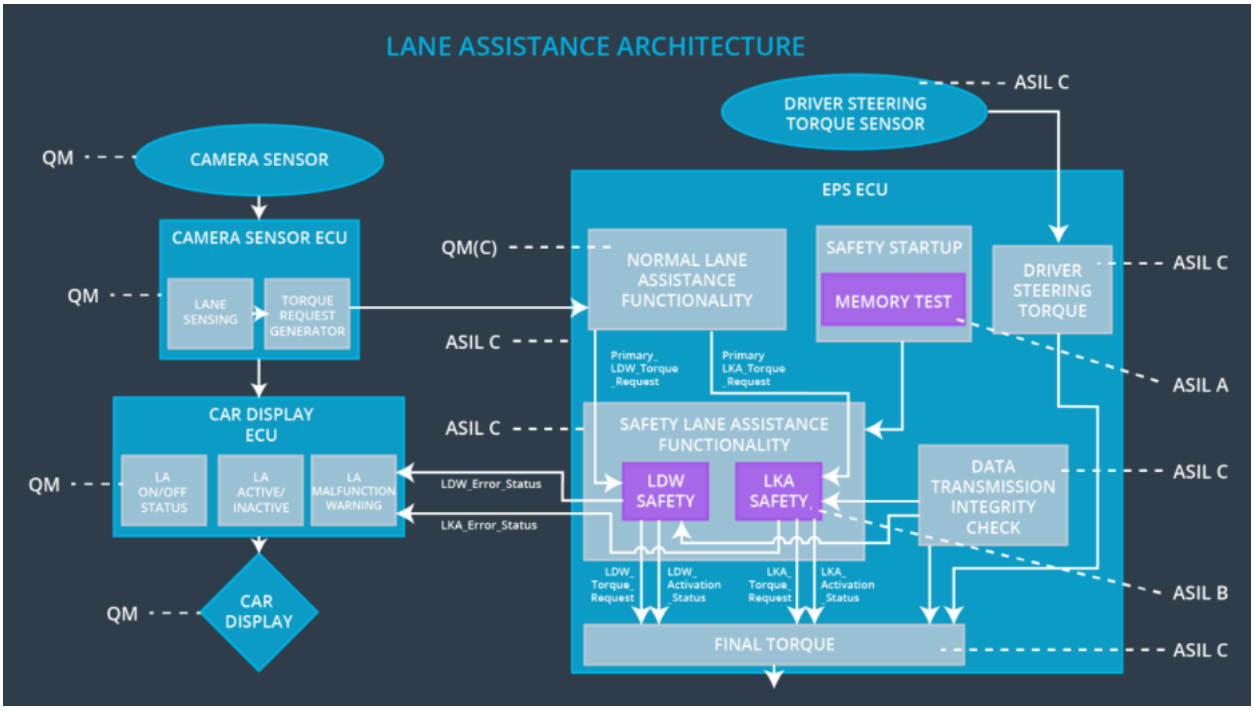
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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' sent to the 'Final electronic power steering Torque' component is below 'Max_Duration'	B	500 ms	LKA Safety	LKA_Torque_Request is set to zero.

Technical Safety Requirement 02	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.
Technical Safety Requirement 03	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 04	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 05	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.

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	Disable lane departure warning	Malfunction_01, Malfunction_02	Yes	Alert on car display: Lane Departure Warning Malfunction
WDC-02	Disable lane keeping assistance	Malfunction_03	Yes	Alert on car display: Lane Keeping Assistance Malfunction