Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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Date	Version	Editor	Description
07/02/2018	1.0	A. Zheng	

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Purpose of the Technical Safety Concept

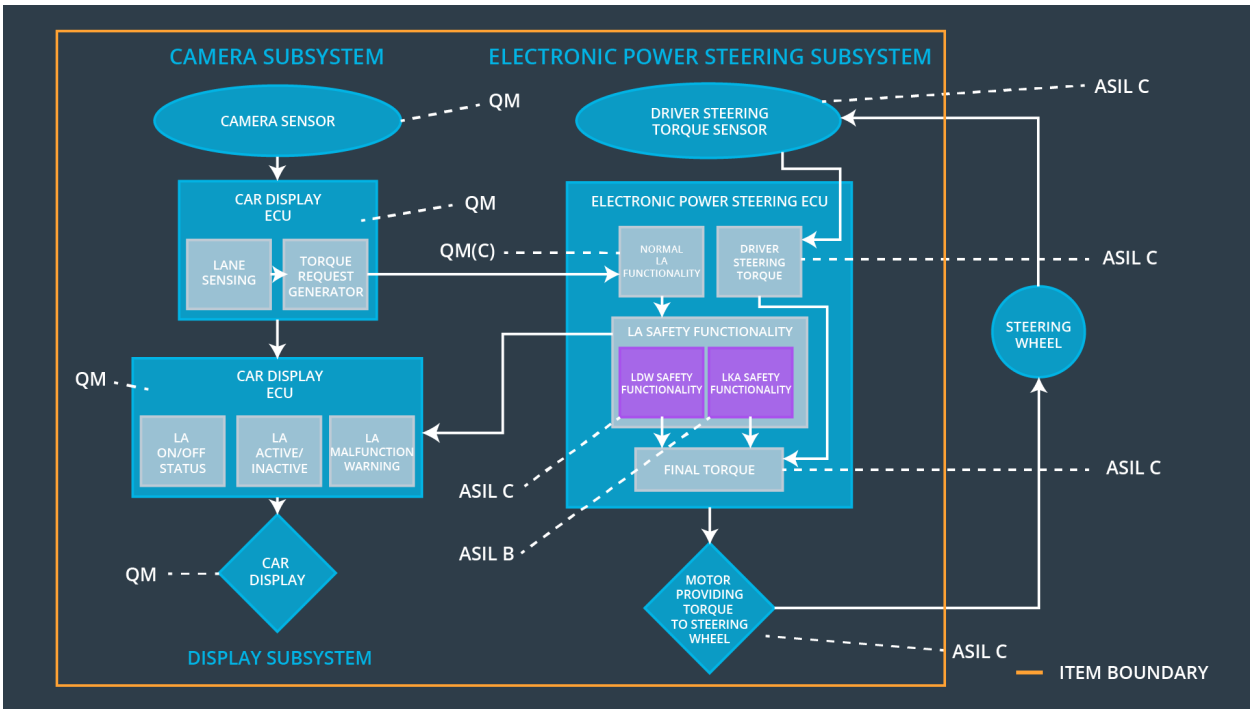
The purpose of the technical safety concept is to turn functional safety requirements into technical safety requirements and allocating technical safety requirements to the system architecture. The technical safety concept gets into the details of the item's technology.

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 stays below the max torque amplitude.	C	50 ms	Turn system off
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the oscillating torque amplitude stays above the minimum torque amplitude	C	50 ms	Turn system off
Functional Safety Requirement 02-01	The electronic power steering control unit shall ensure that the lane keeping assistance torque is applied only until a max duration.	B	500 ms	Turn system off

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Sensor used to capture the road images and provide them to the Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Software module used to detect the lane line positions from the Camera Sensor's images
Camera Sensor ECU - Torque request generator	Software module used to calculate the required torque requested by the Electronic Power Steering ECU
Car Display	Displays warning to the driver
Car Display ECU - Lane Assistance On/Off Status	Indicates the status of the Lane Assistance function
Car Display ECU - Lane Assistant Active/Inactive	Indicates a malfunction on the Lane Assistance function

Car Display ECU - Lane Assistance malfunction warning	Indicates if the Lane assistance function is properly functioning
Driver Steering Torque Sensor	Measures the torque applied to the steering wheel by the driver
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software module used to receive the driver's torque request on the steering wheel
EPS ECU - Normal Lane Assistance Functionality	Software module used to receive the Camera Sensor ECU torque request
EPS ECU - Lane Departure Warning Safety Functionality	Software module used to ensure the torque amplitude stays below the maximum torque amplitude and above the minimum torque amplitude
EPS ECU - Lane Keeping Assistant Safety Functionality	Software module used to ensure the Lane Keeping Assistance functionality application is not activate more than the maximum duration time
EPS ECU - Final Torque	Combine the torque request from the Lane Keeping and Lane Departure Warning functionalities and send the final torque to the motor
Motor	Applies to the requested 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	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 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 Amplitude shall be set to zero
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	LDW Safety	LDW Torque Request Amplitude shall be set to zero
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	LDW Safety	LDW Torque Request Amplitude shall be 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	LDW Safety	LDW Torque Request Amplitude shall be set to zero
Technical Safety Requirem	Memory test shall be conducted at start up of the	A	Ignition cycle	Data Transmission and Integrity	LDW Torque Request Amplitude

ent 05	EPS ECU to check for any faults in memory.			Check	shall be 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_Frequency ' sent to the to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency'	C	50 ms	LDW Safety	LDW Torque Request Frequency shall be set to zero
Technical Safety Requirement 02	As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'LDW_Torque_Request_Frequency' shall be set to zero.	C	50 ms	LDW Safety	LDW Torque Request Frequency shall be set to zero

Technical Safety Requirement 03	The validity and integrity of the data transmission for 'LDW_Torque_Request_Frequency' signal shall be ensured.	C	50 ms	LDW Safety	LDW Torque Request Frequency shall be set to zero
Technical Safety Requirement 04	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 Frequency shall be set to zero
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	Data Transmission and Integrity Check	LDW Torque Request Frequency shall be set to zero

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 the duration of the 'LKA_Torque_Request' is applied for less than the max duration.	B	500 ms	LKA Safety	LKA torque set to zero
Technical Safety Requirement 02	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	LKA Safety	LKA torque set to zero
Technical Safety Requirement 03	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500 ms	LKA Safety	LKA torque 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 set to zero
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	Data Transmission and Integrity Check	LKA torque set to zero

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

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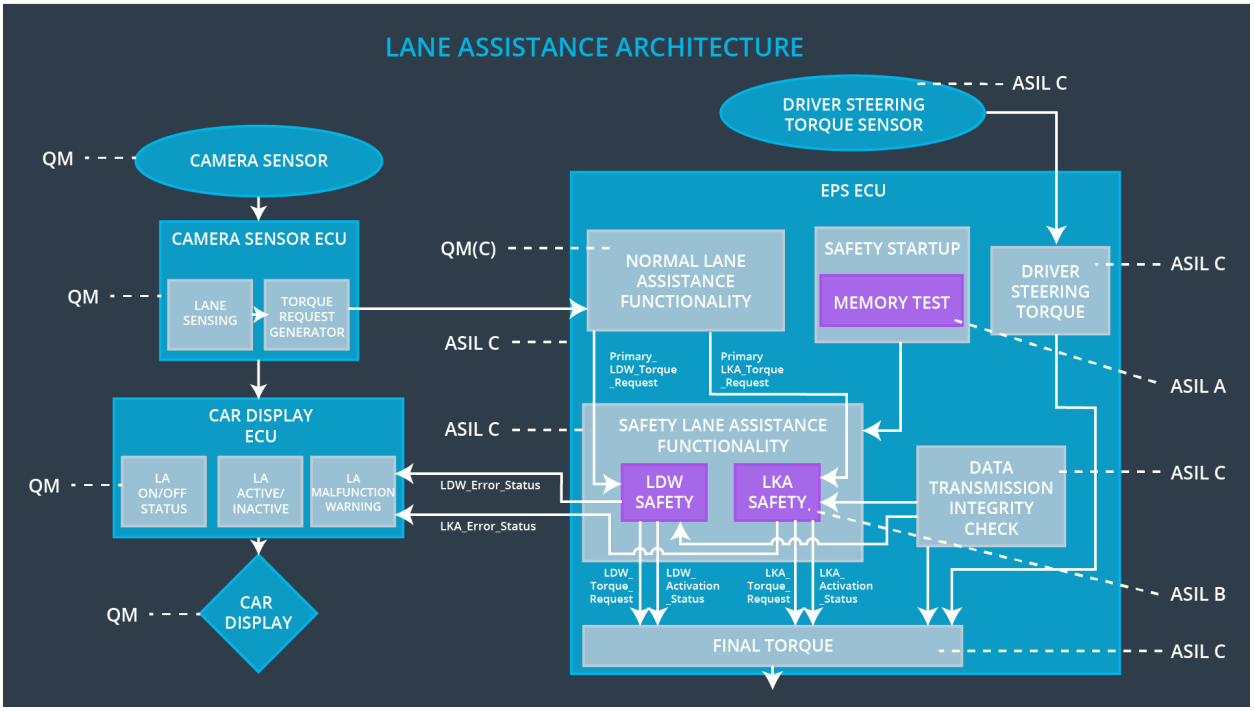
Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

ID	Technical Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Technical Safety Requirement 01-01-01	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.	X		
Technical Safety Requirement 01-01-02	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	x		

	warning light.			
Technical Safety Requirement 01-01-03	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.	X		
Technical Safety Requirement 01-01-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	X		
Technical Safety Requirernent 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	X		
Technical Safety Requirement 01-02-01	The LDW safety component shall ensure that the frequency of the 'LDW_Torque_Request_Frequency' sent to the to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency'	X		
Technical Safety Requirement 01-02-02	As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'LDW_Torque_Request_Frequency' shall be set to zero.	X		
Technical Safety Requirement 01-02-03	The validity and integrity of the data transmission for 'LDW_Torque_Request_Frequency' signal shall be ensured.	X		

Technical Safety Requirement 01-02-04	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.	X		
Technical Safety Requirement 01-02-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	X		
Technical Safety Requirement 02-01-01	The LKA safety component shall ensure the duration of the 'LKA_Torque_Request' is applied for less than the max duration.	X		
Technical Safety Requirement 02-01-02	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.	X		
Technical Safety Requirement 02-01-03	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	X		
Technical Safety Requirement 02-01-04	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.	X		

Technical Safety Requirement 02-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	X		

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn System off	Malfunction 01 Malfunction 02	Yes	Dashboard warning light
WDC-02	Turn System off	Malfunction 03	Yes	Dashboard warning light