Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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Purpose of the Technical Safety Concept

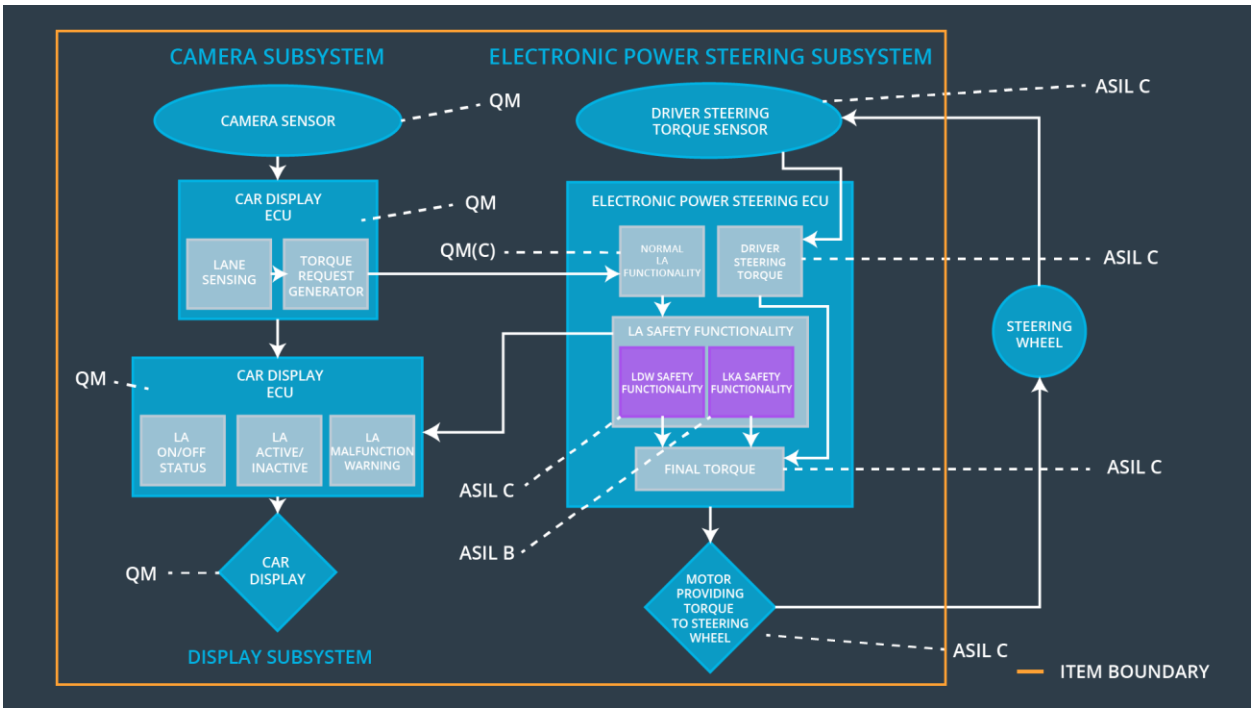
The Technical Safety Concept defines how the subsystems interact at the message level and describes how the ECUs communicate with each other.

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 Electric Power Steering ECU shall ensure that the oscillation torque amplitude requested by the LDW function is below MAX_Torque_Amplitude	C	50 ms	LDW will set the oscillating torque amplitude to 0.
Functional Safety Requirement 01-02	The Electric Power Steering ECU shall ensure that the oscillation torque frequency requested by the LDW function is below MAX_Torque_Frequency	C	50 ms	LDW will set the oscillating torque frequency to 0.
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	50 ms	LKA will turn off the assistance system.

Refined System Architecture from Functional Safety Concept



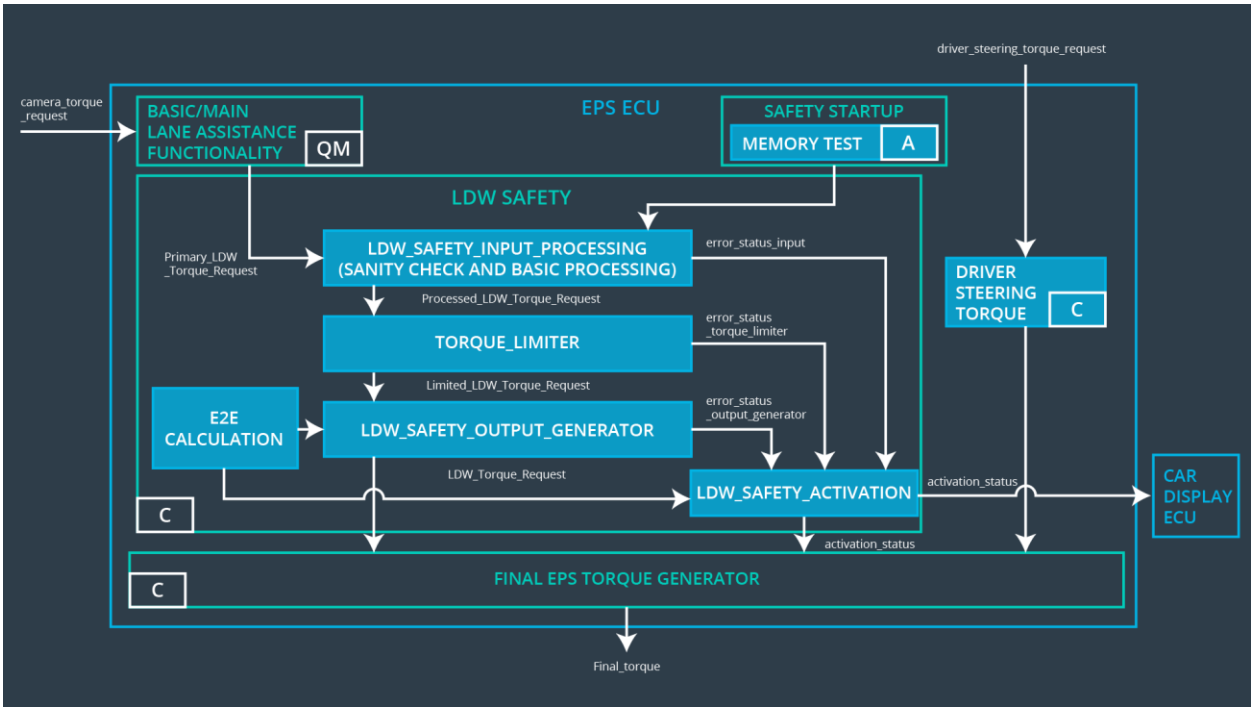
Functional overview of architecture elements

Element	Description
Camera Sensor	Capture road images and provide them to the Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Software module detecting the lane line positions from the Camera Sensor images.
Camera Sensor ECU - Torque request generator	Software module calculating the necessary torque to be requested to the Electronic Power Steering ECU.
Car Display	Display warning for the driver.
Car Display ECU - Lane Assistance On/Off Status	Indicate the status of the Lane Assistance functionality (On/Off).
Car Display ECU - Lane Assistant Active/Inactive	Indicate if the Lane Assistance functionality is properly functioning (Active/Inactive).
Car Display ECU - Lane Assistance malfunction warning	Indicate a malfunction on the Lane Assistance functionality.

Driver Steering Torque Sensor	Measure the torque applied to the steering wheel by the driver.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software module receiving the driver's torque request from the steering wheel.
EPS ECU - Normal Lane Assistance Functionality	Software module receiving the Camera Sensor ECU torque request.
EPS ECU - Lane Departure Warning Safety Functionality	Software module ensuring the torque amplitude is below Max_Torque_Amplitude and torque frequency is below Max_Torque_Frequency.
EPS ECU - Lane Keeping Assistant Safety Functionality	Software module ensuring the Lane Keeping Assistance functionality application is not activate more than Max_Duration time.
EPS ECU - Final Torque	Combine the torque request from the Lane Keeping and Lane Departure Warning functionalities and sends them to the driver.
Motor	Applies the required torque to the steering wheels.

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 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 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 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 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	LDW Safety	LDW torque 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 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 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 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 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	LDW Safety	LDW torque to zero

Lane Keeping Assistance (LKA) Requirements:

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

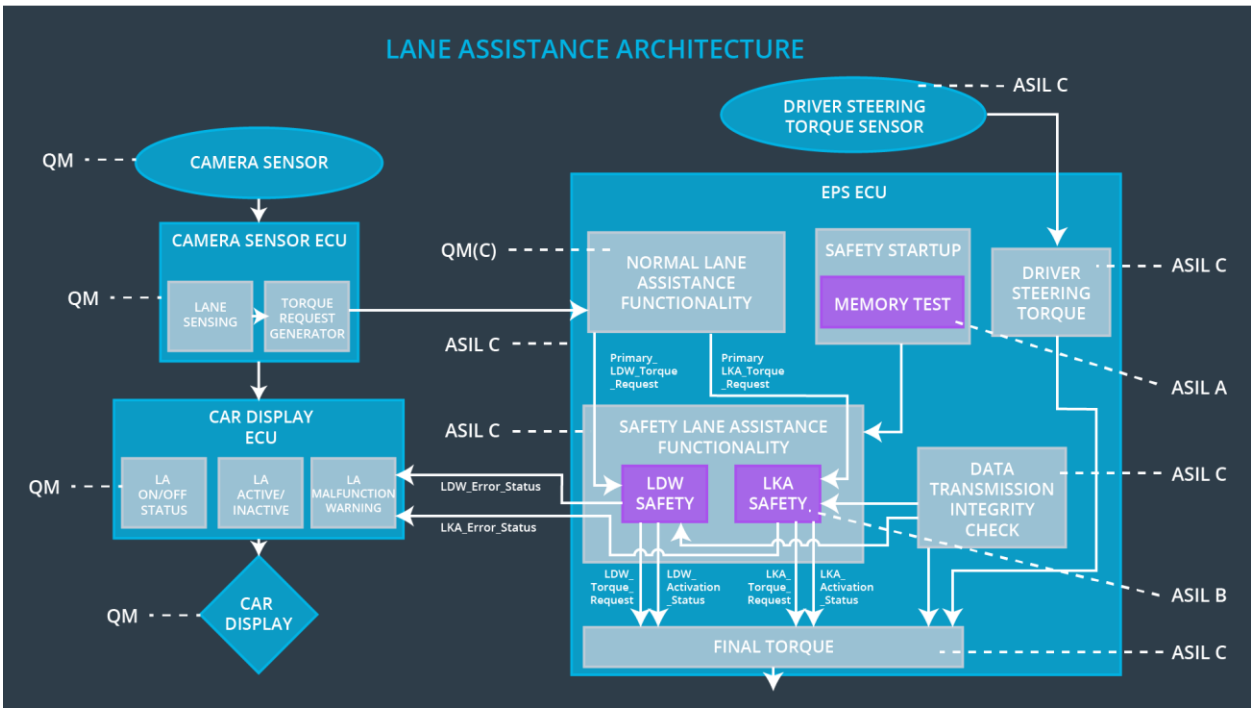
ID	Functional Safety Requirement	Electronic Power	Camera ECU	Car Display ECU

		Steering 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 lane keeping assistance torque is applied for less than Max_Duration	C	50 ms	LKA Safety	LKA torque to zero
Technical Safety Requirement 02	When the LKA function deactivates, the “LKA Safety” shall send a signal to the Car Display ECU to turn on a warning light.	C	50 ms	LKA Safety	LKA torque to zero
Technical Safety Requirement 03	When a failure is detected, the LKA function shall deactivate and the “LKA_Torque_Request” shall be zero.	C	50 ms	LKA Safety	LKA torque to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for “LKA_Torque_Request” signal shall be ensured.	C	50 ms	LKA Safety	LKA torque to zero
Technical Safety Requirement 05	Memory test shall be conducted at stat up of the EPS ECU to check for any memory problems.	A	Ignition cycle	Data Transmission Integrity Check	LKA torque to zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

ID	Functional 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 warning light.	X		
Technical Safety	As soon as a failure is detected by	X		

Requirement 01-01-03	the LDW function, it shall deactivate the LDW feature and the “LDW_Torque_Request” shall be set to zero.			
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 Requirement 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” sent to the “Final Electronic Power Steering Torque” component is below Max_Torque_Frequency.	X		
Technical Safety Requirement 01-02-02	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.	X		
Technical Safety Requirement 01-02-03	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 01-02-04	The validity and integrity of the data transmission for “LDW_Torque_Request” signal shall be ensured.	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 lane keeping assistance torque is	X		

	applied for less than Max_Duration			
Technical Safety Requirement 02-01-02	When the LKA function deactivates, the “LKA Safety” shall send a signal to the Car Display ECU to turn on a warning light.	X		
Technical Safety Requirement 02-01-03	When a failure is detected, the LKA function shall deactivate and the “LKA_Torque_Request” shall be zero.	X		
Technical Safety Requirement 02-01-04	The validity and integrity of the data transmission for “LKA_Torque_Request” signal shall be ensured.	X		
Technical Safety Requirement 02-01-05	Memory test shall be conducted at stat up of the EPS ECU to check for any memory problems.	X		

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,Malfunction_04	Yes	The warning is shown on the Car Display system.
WDC-02	Turn off the functionality.	Malfunction_03,Malfunction_05	Yes	The warning is shown on the Car Display system.