Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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23/05/2018	1.0	Sanchit Agrawal	First Submission

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Purpose of the Technical Safety Concept

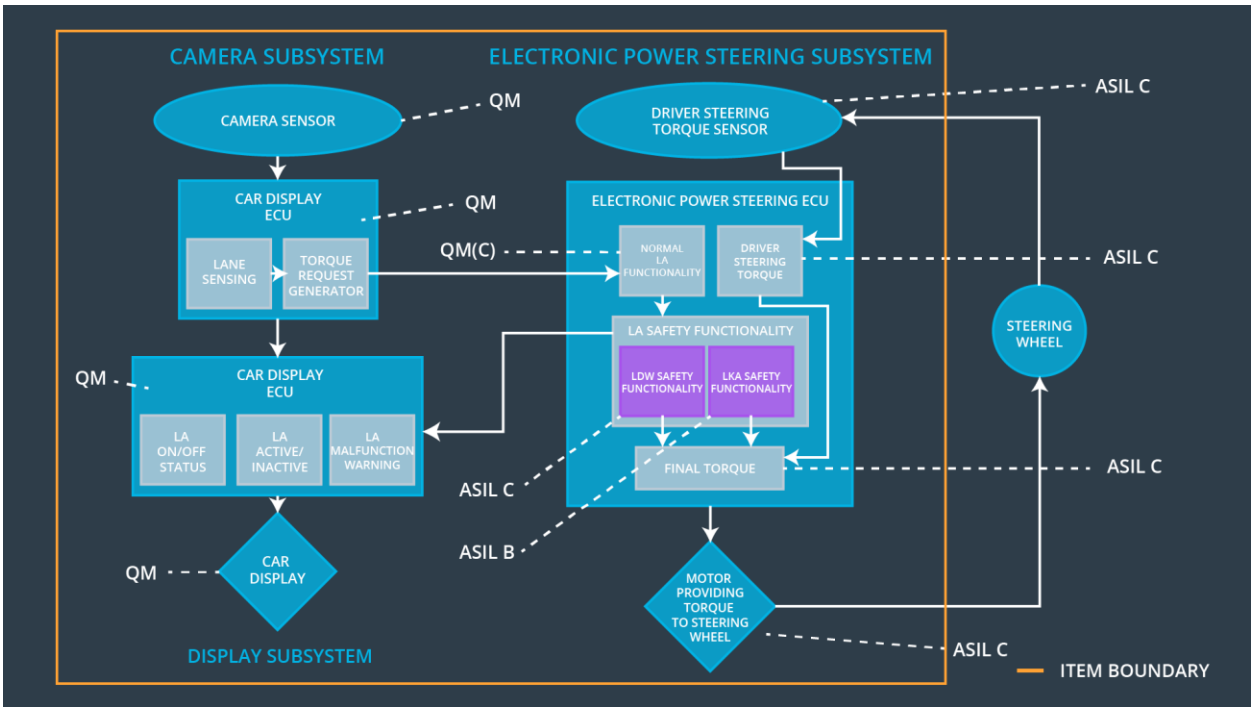
In this document, new requirements are defined and assigned to the system architecture. Technical safety concept is part of the product development phase. The technical safety concept is more concrete and gets into the details of the item's technology.

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 Departure Warning item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude.	C	50ms	Vibration torque amplitude below Max_Torque_Amplitude.
Functional Safety Requirement 01-02	The Lane Departure Warning item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency.	C	50ms	Vibration frequency is below Max_Torque_Frequency.
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the Lane Keeping Assistance torque is applied only Max_Duration.	B	500ms	Lane Keeping Assistance torque is zero.

Refined System Architecture from Functional Safety Concept



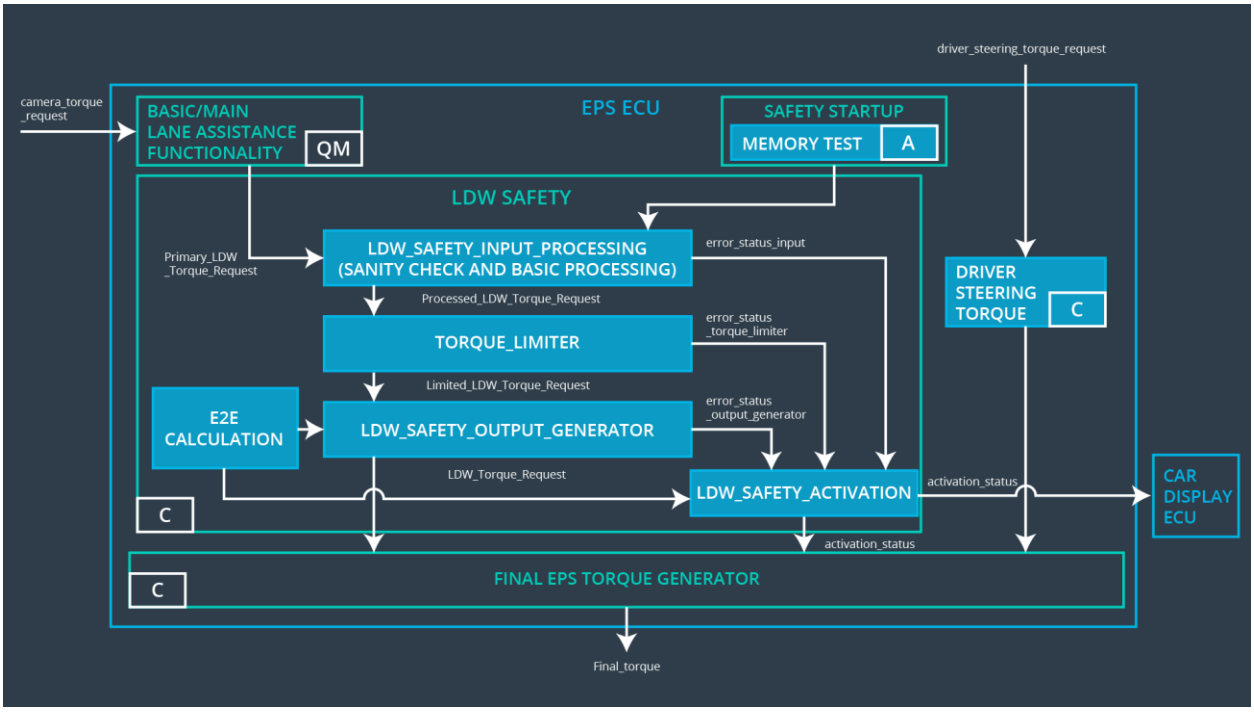
Functional overview of architecture elements

Element	Description
Camera Sensor	Provides images of road to Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Software module detecting lane line position from the camera images.
Camera Sensor ECU - Torque request generator	Software module calculating the necessary torque to be requested to the Electronic Power Steering ECU.
Car Display	Shows warning to driver.
Car Display ECU - Lane Assistance On/Off Status	Indicate status of Lane Assistance functionality.
Car Display ECU - Lane Assistant Active/Inactive	Indicate Lane Assistance functionality is properly working or not.
Car Display ECU - Lane Assistance malfunction warning	Indicate malfunction in Lane Assistance functionality.
Driver Steering Torque Sensor	Senses how much torque already been applied by 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	Ensuring the torque amplitude is below Max_Torque_Amplitude and torque frequency is below Max_Torque_Frequency.
EPS ECU - Lane Keeping Assistant Safety Functionality	Ensuring the Lane Keeping Assistance functionality application is not activate more than Max_duration time.
EPS ECU - Final Torque	Combining the torque request from the Lane Keeping and Lane Departure Warning functionalities and sends them to the Motor.
Motor	Applies the torque.

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	50ms	LDW Safety	Set Lane Departure Warning 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	50ms	LDW Safety	Set Lane Departure Warning 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	50ms	LDW Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirem	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal	C	50ms	LDW Safety	Set Lane Departure Warning

ent 04	shall be ensured.				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	Data Transmission Integrity Check	Set Lane Departure Warning 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 amplitude of the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency.	C	50ms	LDW Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirem	As soon as the LDW function deactivates the LDW feature, the 'LDW Safety' software block	C	50ms	LDW Safety	Set Lane Departure Warning

ent 02	shall send a signal to the car display ECU to turn on a warning light.				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	50ms	LDW Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	LDW Safety	Set Lane Departure Warning 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	Data Transmission Integrity Check	Set Lane Departure Warning torque to zero.

Lane Keeping Assistance (LKA) Requirements:

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

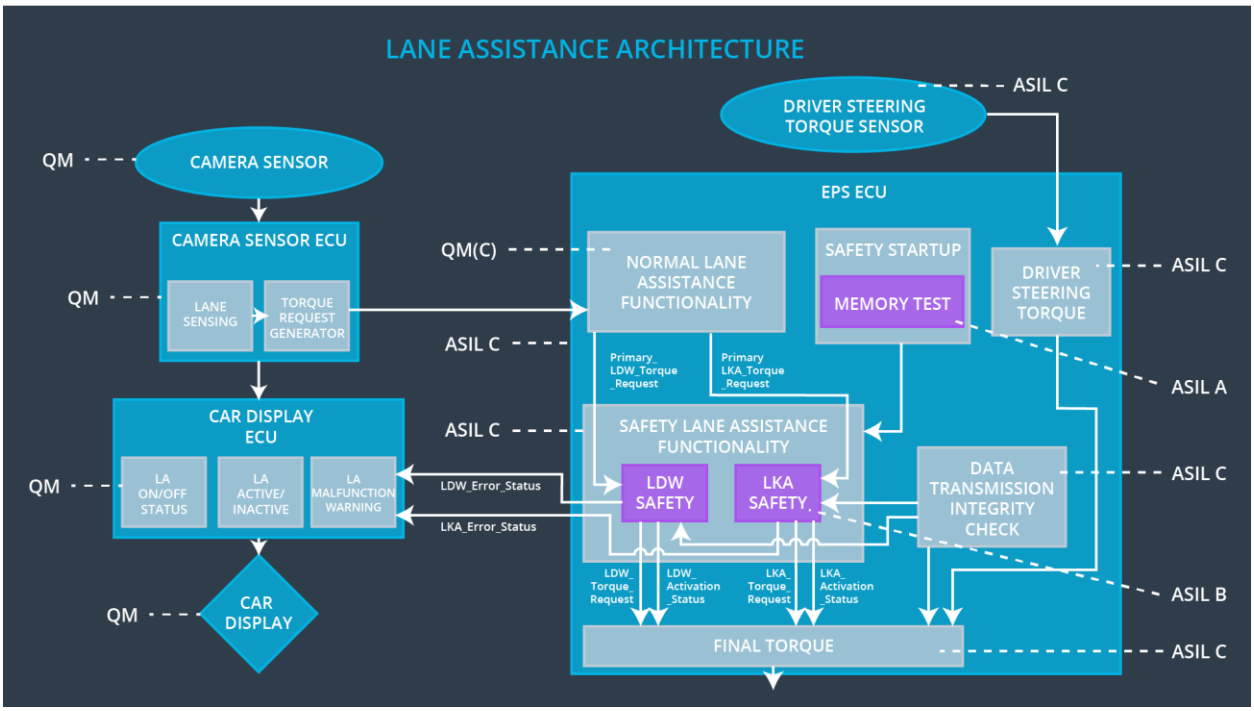
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State

Technical Safety Requirement 01	The Lane Keeping Assistance safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max_Duration	C	500ms	LKA Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirement 02	As soon as the LKS function deactivates the LKS feature, the 'LKA Safety' software block shall send a signal to the car display ECU to turn on a warning light.	C	500ms	LKA Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirement 03	As soon as a failure is detected by the LKS function, it shall deactivate the LKA feature and the 'LKA_Torque_Request' shall be set to zero.	C	500ms	LKA Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	C	500ms	LKA Safety	Set Lane Departure Warning 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	Data Transmission Integrity Check	Set Lane Departure Warning torque to zero.

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 Lane Departure Warning 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.’	**YES**	**NO**	**NO**
Technical Safety Requirement 01-01-02	When the Lane Departure Warning is deactivated, the ‘LDW Safety’ software module shall send a signal to the Car Display ECU to turn on a warning signal.	**YES**	**NO**	**NO**

Technical Safety Requirement 01-01-03	When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set 'LDW_Torque_Request' to zero.	**YES**	**NO**	**NO**
Technical Safety Requirement 01-01-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	**YES**	**NO**	**NO**
Technical Safety Requirement 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	**YES**	**NO**	**NO**
Technical Safety Requirement 01-02-01	The Lane Departure Warning safety component shall ensure the frequency of the 'LDW_Torque_Reques' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency.'	**YES**	**NO**	**NO**
Technical Safety Requirement 02-01-01	The Lane Keeping Assistance safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max_Duration	**YES**	**NO**	**NO**
Technical Safety Requirement 02-01-02	When the Lane Keeping Assistance function deactivates, the 'LKA Safety' shall send a signal to the Car Display ECU to turn on a warning light.	**YES**	**NO**	**NO**
Technical Safety Requirement 02-01-03	When a failure is detected, the Lane Keeping Assistance function shall deactivate and the 'LKA_Torque_Request' shall be zero.	**YES**	**NO**	**NO**
Technical Safety Requirement	The validity and integrity of the data transmission for	**YES**	**NO**	**NO**

02-01-04	‘LKA_Torque_Request’ signal shall be ensured.			
Technical Safety Requirement 02-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	**YES**	**NO**	**NO**

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off Lane Departure Warning functionality	Malfunction_01, Malfunction_02	Yes	Lane Departure Warning Malfunction Warning on Car Display
WDC-02	Turn off Lane Keeping Assistance functionality	Malfunction_03	Yes	Lane Keeping Assistance Malfunction Warning on Car Display