Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
2018-05-24	1.0	Yogesh Mahawar	First draft for Technical Safety

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Purpose of the Technical Safety Concept

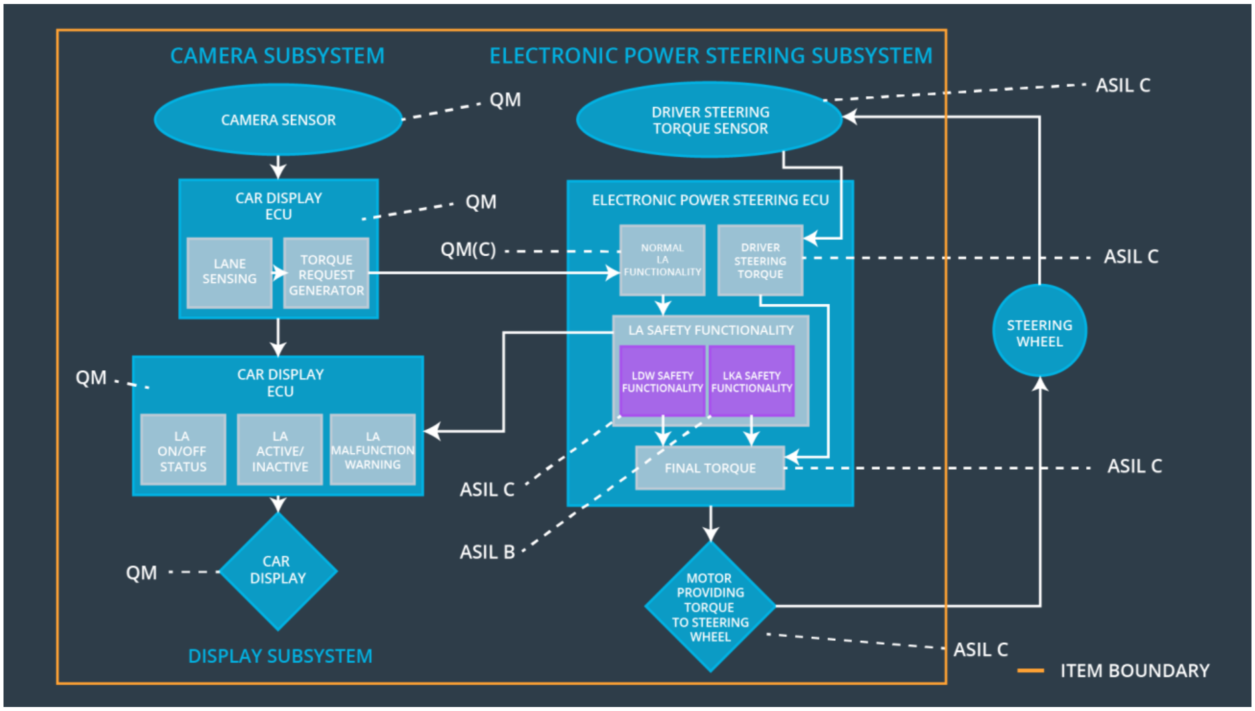
In this document, new requirements are defined and assigned to the system architecture. These new requirements are more concrete and gets into details of the item’s technology as specified by ISO 26262.

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 is 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

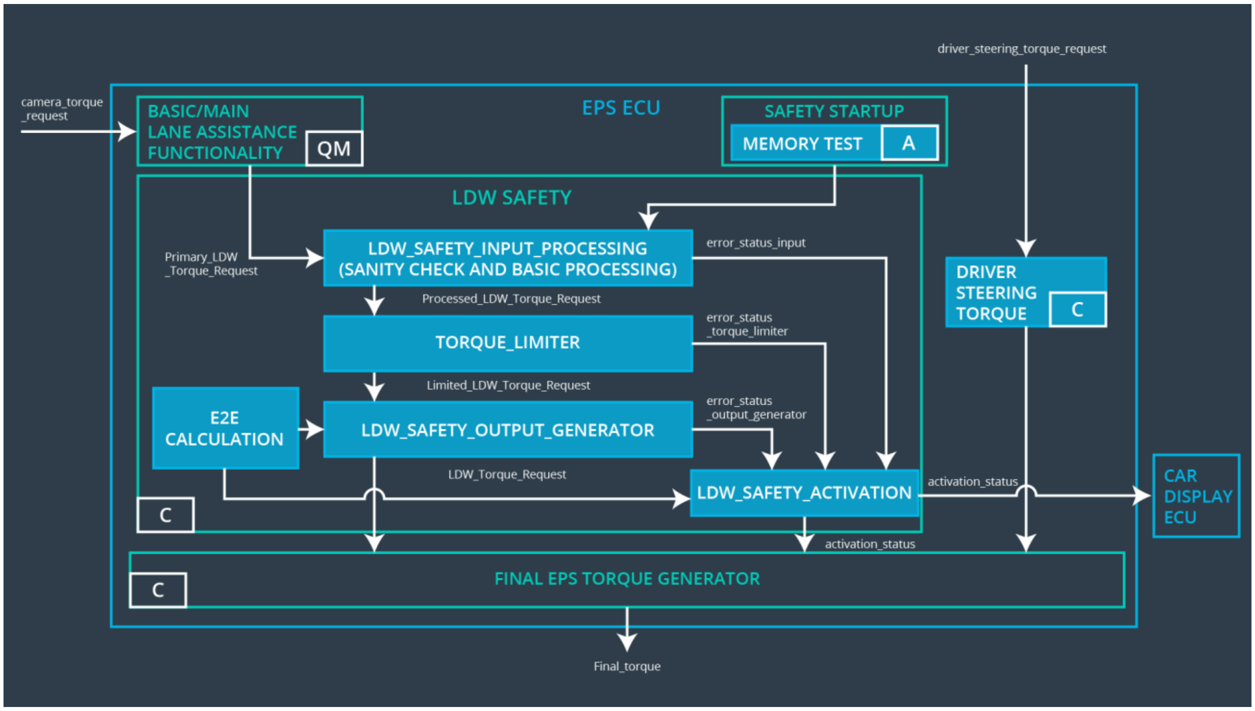


Functional overview of architecture elements

Element	Description
Camera Sensor	Capture road images and provide them to the Camera Sensor ECU for processing.
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 Motor.
Motor	Applies the required torque to the steering wheels.

Technical Safety Concept


driver_steering_torque_request
camera_torque _request
BASIC/MAIN LANE ASSISTANCE FUNCTIONALITY
QM
EPS ECU
SAFETY STARTUP
MEMORY TEST
A
LDW SAFETY
Primary_LDW _Torque_Request
LDW_SAFETY_INPUT_PROCESSING (SANITY CHECK AND BASIC PROCESSING)
error_status_input
Processed_LDW_Torque_Request
TORQUE_LIMITER
error_status _torque_limiter
DRIVER STEERING TORQUE
C
Limited_LDW_Torque_Request
E2E CALCULATION
LDW_SAFETY_OUTPUT_GENERATOR
error_status _output_generator
LDW_Torque_Request
LDW_SAFETY_ACTIVATION
activation_status
CAR DISPLAY ECU
C
activation_status
C
FINAL EPS TORQUE GENERATOR
Final_torque

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	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	Lane Departure Warning torque to set zero.
Technical Safety Requirement 02	When the LDW is deactivated, the 'LDW Safety' software module shall send a signal to the Car Display ECU to turn on a warning signal.	C	50ms	LDW Safety	Set Lane Departure Warning torque to zero.
Technical Safety Requirement 03	When a failure is detected by the LDW functionality, it shall deactivate the LDW feature and set 'LDW_Torque_Request' 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	Data Transmission Integrity	Set Lane Departure Warning

ent 04	shall be ensured.			Check	torque to zero.
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any memory problems	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 the frequency of the ‘LDW_Torque_Reques’ 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.

Lane Keeping Assistance (LKA) Requirements:

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

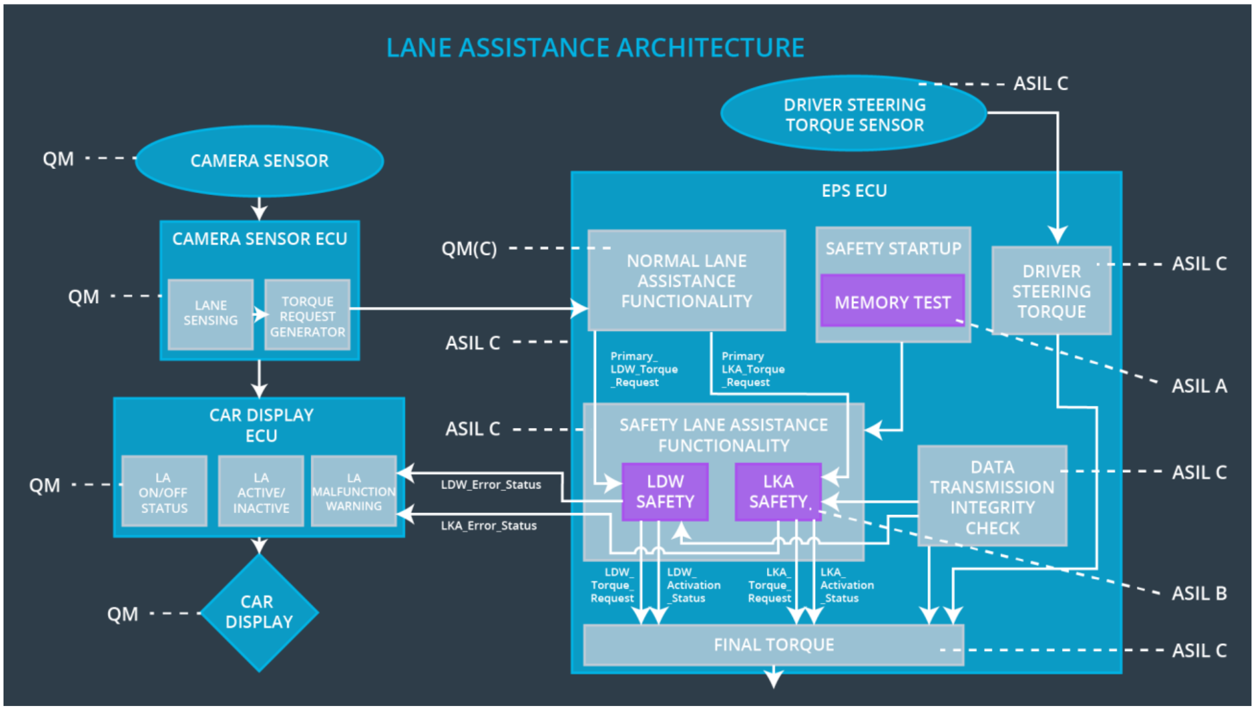
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 lane keeping assistance torque is applied for less than Max_Duration	C	500ms	LKA Safety	Set Lane Keeping Assistance 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	500ms	LKA Safety	Set Lane Keeping Assistance torque to zero.
Technical Safety Requirement 03	At time of failure, the Lane Keeping Assistance function shall deactivate and the ‘LKA_Torque_Request’ shall be zero.	C	500ms	LKA Safety	Set Lane Keeping Assistance 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	Data Transmission Integrity Check	Set Lane Keeping Assistance torque to zero.

Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Data Transmission Integrity Check	Set Lane Keeping Assistance 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.’	X		

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.	**X**		
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.	**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 Requirement 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	**X**		
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.’	**X**		
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	**X**		
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.	**X**		
Technical Safety	When a failure is detected, the	**X**		

Requirement 02-01-03	Lane Keeping Assistance function shall deactivate and the ‘LKA_Torque_Request’ shall be zero.			
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 start up of the EPS ECU to check for any memory problems			

Warning and Degradation Concept

ID	**Degradation Mode**	**Trigger for Degradation Mode**	**Safe State invoked?**	**Driver Warning**
WDC-01	Steering torque frequency and/or Amplitude are degraded	Malfunction_01, Malfunction_02	Yes	Lane Departure Warning Malfunction Warning on Car Display
WDC-02	Lane keeping Assistance function will turn off	Malfunction_3	Yes	Lane keeping Assistance Malfunction Warning on Car Display