Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
5/23/2018	1.0	Gireek Bansal	First Attempt

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Purpose of the Technical Safety Concept

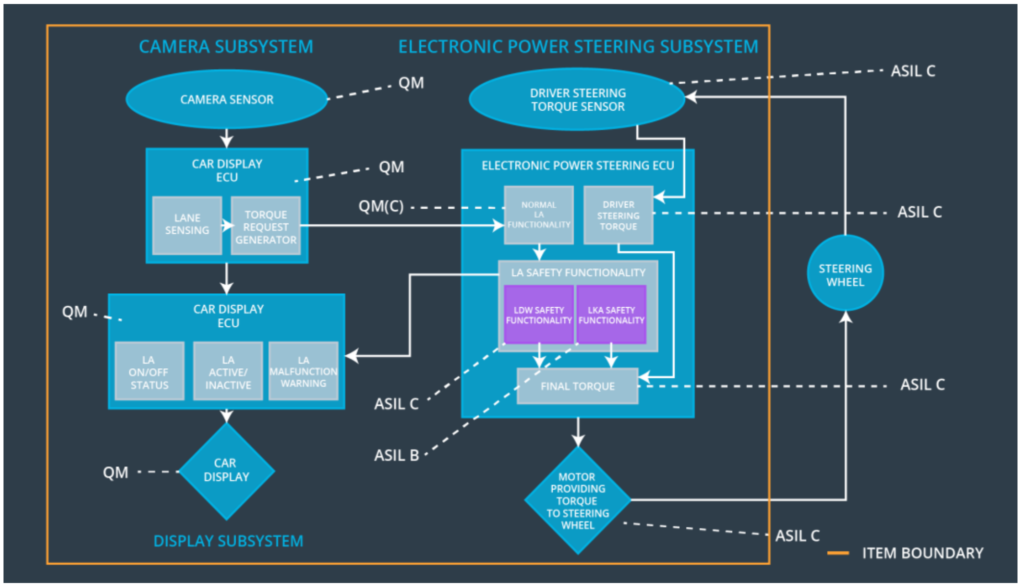
The purpose of the technical safety concept is to convert functional requirements into technical requirements and is an in-depth representation of the item’s technology. Functional safety concept was a part of concept phase but this is a part of product development phase.

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	50 ms	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	50 ms	Vibration frequency is below Max_Torque_Frequency.
Functional Safety Requirement 02-01	The Lane Keeping Assistance function shall be time limited, and additional steering torque shall end after a given time interval so the driver cannot misuse the system for autonomous driving.	B	500 ms	Lane Keeping Assistance torque is zero

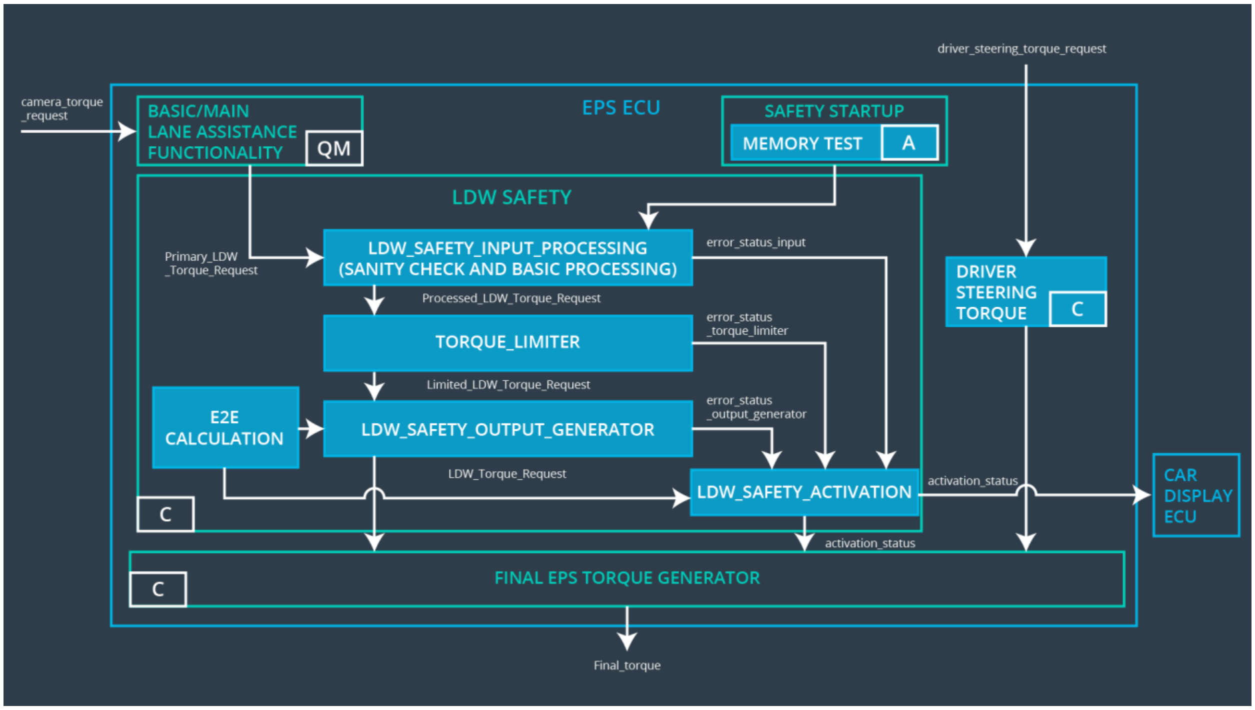
Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Takes the photos of the external environment and passes them on to the Camera sensor ECU
Camera Sensor ECU - Lane Sensing	Analyzes the photos to calculate the car’s position w.r.t. the lane.
Camera Sensor ECU - Torque request generator	It calculates the torque required to re-center the car w.r.t. to the lane
Car Display	A display screen to let the driver know about the car’s status and for any type of warnings.
Car Display ECU - Lane Assistance On/Off Status	Knowledge about On/off status of lane assistance system is provided to car display by Car Display ECU - Lane Assistance On/Off Status
Car Display ECU - Lane Assistant Active/Inactive	Indicates if lane assistance functionality is functioning as required.
Car Display ECU - Lane Assistance malfunction warning	Indicates if a malfunction has hit the Lane assistance functionality
Driver Steering Torque Sensor	Gives the measure of the torque applied to the steering wheel by the driver.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software which receives the driver’s torque request from the steering wheel.
EPS ECU - Normal Lane Assistance Functionality	Software receives the camera sensor ECU torque request.
EPS ECU - Lane Departure Warning Safety Functionality	Software ensures the torque amplitude and frequency are below specific maximum values.
EPS ECU - Lane Keeping Assistant Safety Functionality	Software keeps the check that LKA is not activated for more than a specific time duration.
EPS ECU - Final Torque	Combines the torque request from both LKA and LDW to send to motor
Motor	Responsible for applying the torque to the steering wheel after getting from EPS ECU - Final 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 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	C	50 ms	LDW_safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 02	On failure detection by LDW it shall be deactivated and LDW_torque_request reset to zero.	C	50 ms	LDW_safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 03	When the LDW has been deactivated ‘LDW safety’ shall send a signal to car display ECU to turn on warning for the driver.	C	50 ms	LDW_safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 04	Memory tests shall be conducted at start of EPS ECU for checking memory faults.	A	Ignition cycle	Safety start up	LDW_Torque_Request is set to zero.
Technical Safety Requirement 05	The integrity of data transmission for LDW_Torque_Request signal shall be ensured.	C	50 ms	Data transmission integrity check	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 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_Frequency	C	50 ms	LDW_safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 02	On failure detection by LDW it shall be deactivated and LDW_torque_request reset to zero.	C	50 ms	LDW_safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 03	When the LDW has been deactivated 'LDW safety' shall send a signal to car display ECU to turn on warning for the driver.	C	50 ms	LDW_safety	LDW_Torque_Request is set to zero.
Technical Safety Requirement 04	Memory tests shall be conducted at start of EPS ECU for checking memory faults.	A	Ignition cycle	Safety start up	LDW_Torque_Request is set to zero.
Technical Safety Requirement 05	The integrity of data transmission for LDW_Torque_Request signal shall be ensured.	C	50 ms	Data transmission Integrity check	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)

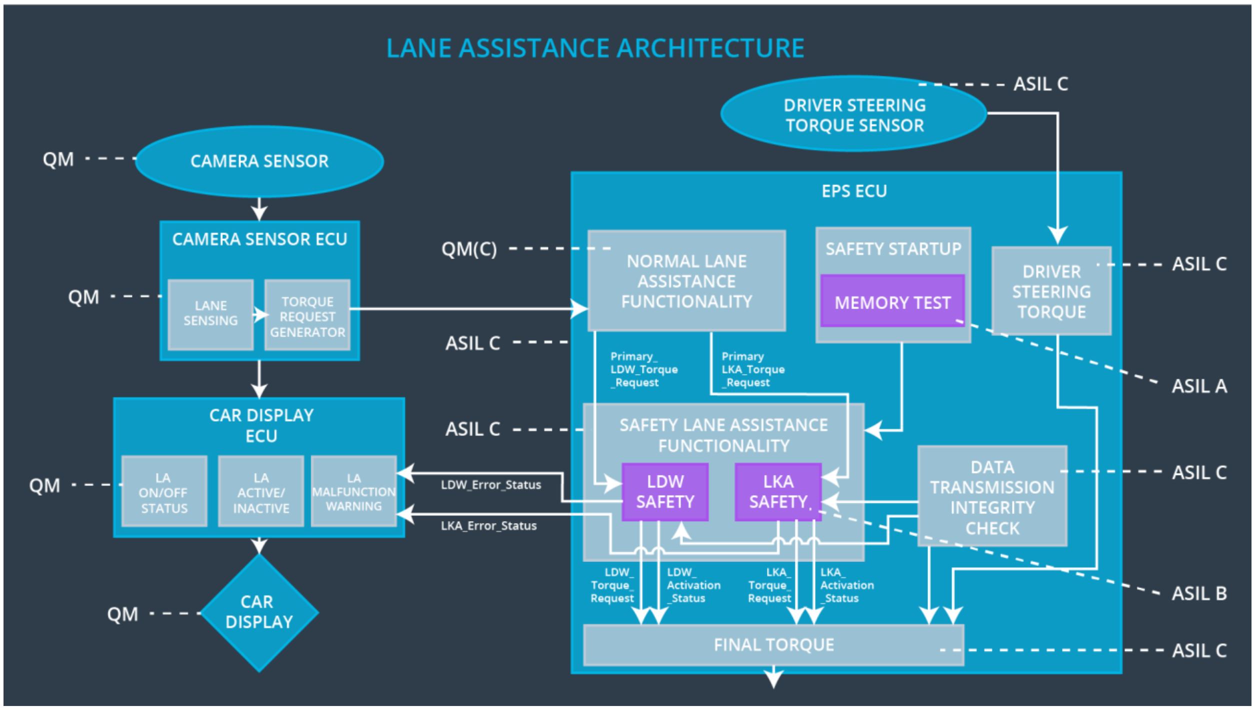
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 module shall keep the duration of LKA_Torque_Request sent to the steering component below Max_Duration	B	500 ms	LKA_safety	LKA_Torque_Request is set to zero.
Technical Safety Requirement 02	On failure detection by LKA it shall be deactivated and LKA_torque_request reset to zero.	B	500 ms	LKA_safety	LKA_Torque_Request is set to zero.
Technical Safety Requirement 03	When the LKA has been deactivated 'LKA safety' shall send a signal to car display ECU to turn on warning for the driver.	B	500 ms	LKA_safety	LKA_Torque_Request is set to zero.
Technical Safety Requirement 04	Memory tests shall be conducted at start of EPS ECU for checking memory faults.	A	Ignition cycle	Safety Start up	LKA_Torque_Request is set to zero.
Technical Safety	The integrity of data transmission for LKA_Torque_Request signal	B	500 ms	Data transmission	LKA_Torque_Request

Requireme nt 05	shall be ensured.			integrity check	is set to zero.

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All technical 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	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