Technical Safety Concept Lane Assistance

Document Version: [Version]

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Document history

Date	Version	Editor	Description
6/2/2018	1.0	Ruixuan.li	First release

Table of Contents

Purpose of the Technical Safety Concept

[Instructions: Answer what is the purpose of a technical safety concept?]

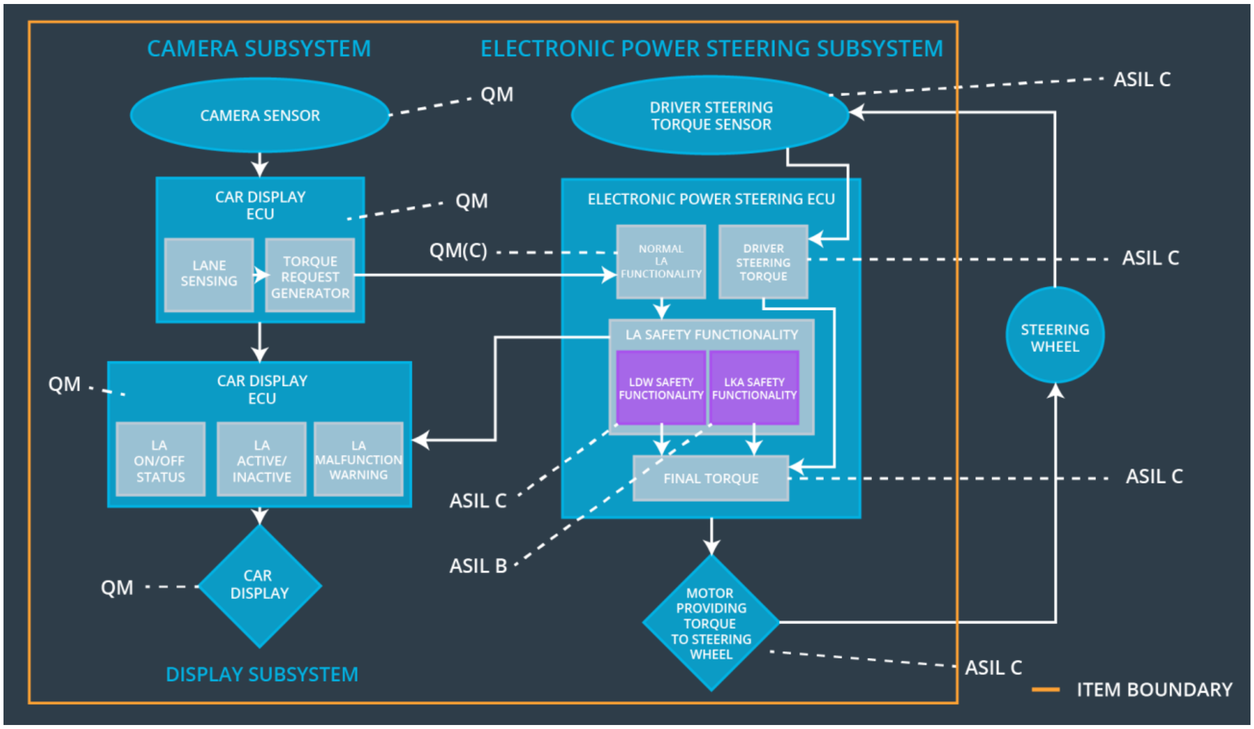
Inputs to the Technical Safety Concept

Functional Safety Requirements

[Instructions: Provide the functional safety requirements derived in the functional safety concept]

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The electronic power steering subsystem shall ensure that the oscillating torque amplitude is less than Max_Torque_Amplitude	C	50ms	LDW torque output is set to zero
Functional Safety Requirement 01-02	The electronic power steering subsystem shall ensure that the oscillating torque frequency is less than Max_Torque_Frequency.	C	50ms	LDW torque output is set to zero
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	500ms	off

Refined System Architecture from Functional Safety Concept



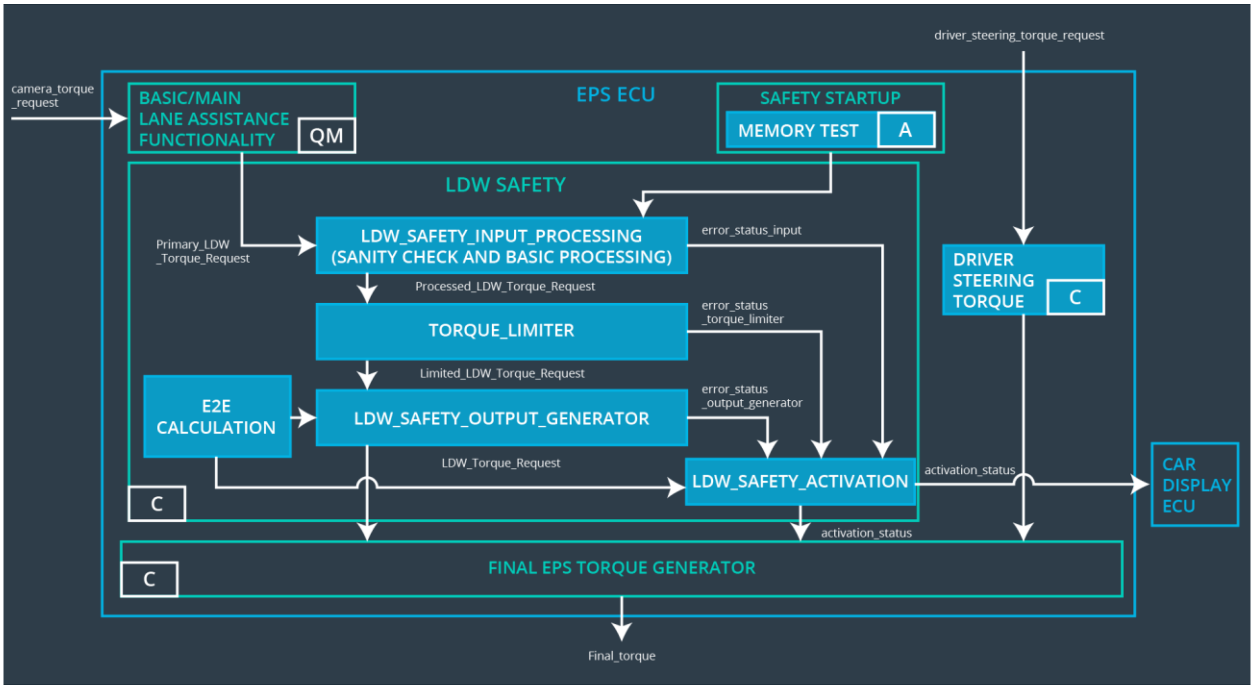
Functional overview of architecture elements

[Instructions: Provide a description for each functional safety element; what is each element's purpose in the lane assistance item?]

Element	Description
Camera Sensor	Capture and stream images to Camera Sensor ECU for processing
Camera Sensor ECU - Lane Sensing	Detect the lane and check if the vehicle is moving away from the ego lane
Camera Sensor ECU - Torque request generator	Responsible for sending a torque request to the electronic power steering subsystem
Car Display	Graphic interface used to display the warning messages and setting changes etc.
Car Display ECU - Lane Assistance On/Off Status	Controlling a light that tells the driver if the lane keeping system on or off.

Car Display ECU - Lane Assistant Active/Inactive	Controlling a light telling the driver that if the lane departure warning is activated.
Car Display ECU - Lane Assistance malfunction warning	Displaying warning message if LA system is malfunctioning
Driver Steering Torque Sensor	Responsible for measuring the torque applied by the driver.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Sends the information to the EPS ECU Final Torque about the torque applied by the driver sensed by the Driver Steering Torque sensor.
EPS ECU - Normal Lane Assistance Functionality	Sends Vibrational_Torque_Request to the Lane Departure Warning Safety Software element.
EPS ECU - Lane Departure Warning Safety Functionality	Alert driver when vehicle start deviating from its lane by applying oscillating torque to steering wheel. The oscillating torque amplitude is limited to be less than Max_Torque_Amplitude, the frequency is less than Max_Torque_Frequency
EPS ECU - Lane Keeping Assistant Safety Functionality	Applying an amount of torque no longer than Max_Duration to help the car to stay in the lane.
EPS ECU - Final Torque	Add torque requests together to output a final torque to the motor that move the steering wheel.
Motor	Actuator used to apply requested torque to steering wheel.

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
DRIVER STEERING TORQUE
C
Processed_LDW_Torque_Request
TORQUE_LIMITER
error_status_torque_limiter
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	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	LDW torque output is set to zero
Technical Safety Requirement 02	The validity and integrity of the data transmission for LDW_Torque_Request signal shall be ensured	C	50ms	Data Transmission Integrity Check	N/A
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	LDW torque output is 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	50ms	LDW Safety	LDW torque output is set to zero
Technical Safety Requirem	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory	A	Ignition Cycle	Memory Test	LDW torque output is set to zero

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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 block	off
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 block	off
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	C	50ms	LDW Safety block	off

	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 block	off
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	A	Ignition cycle	LDW Safety block	off

Lane Keeping Assistance (LKA) Requirements:

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

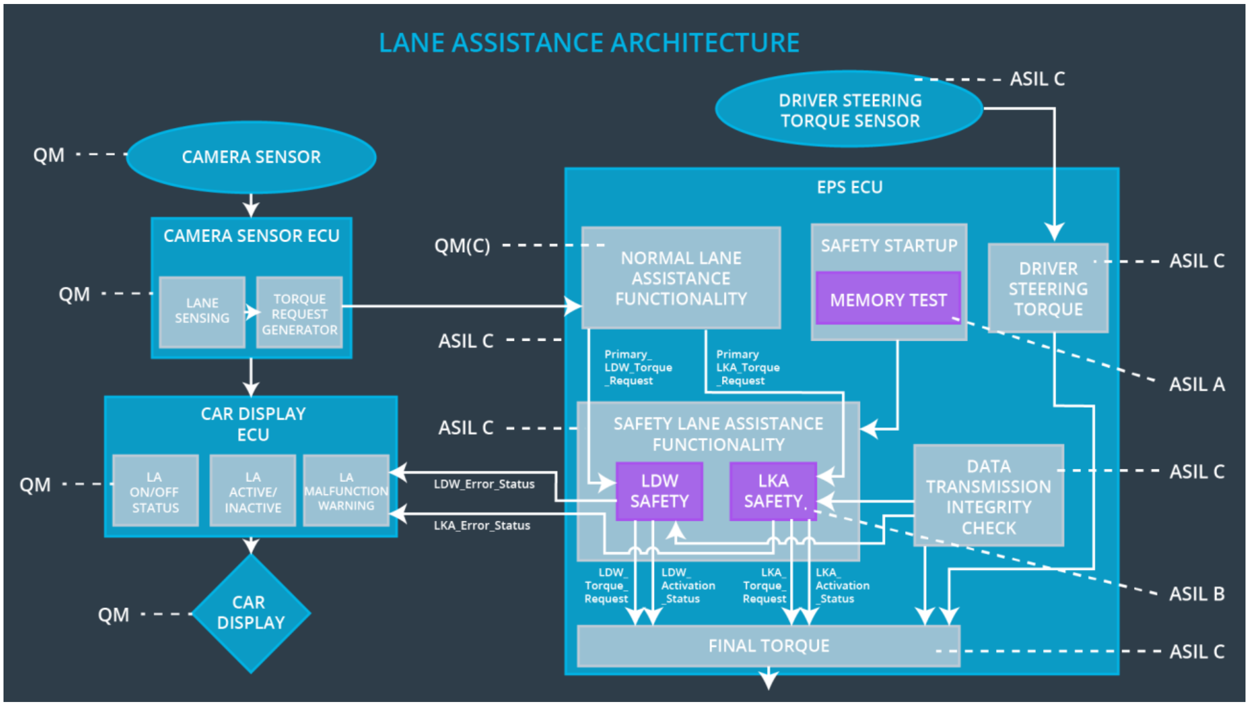
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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	The LKA safety component shall	C	500ms	LKA Safety	off

Safety Requirement 01	ensure that the duration of the lane keeping assistance torque applied is less than Max_Duration			block	
Technical Safety Requirement 02	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	C	500ms	LKA Safety block	off
Technical Safety Requirement 03	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.	C	500ms	LKA Safety block	off
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	C	500ms	LKA Safety block	off
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	LKA Safety block	off

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All Technical Safety Requirements have been allocated to the Electronic Power Steering ECU.

Warning and Degradation Concept

[Instructions: We've already identified that for any system malfunction, the lane assistance functions will be turned off and the driver will receive a warning light indication. The technical safety requirements have not changed how functionality will be degraded or what the warning will be.

So in this case, the warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements. You can copy the functional safety warning and degradation concept here.

Oftentimes, a technical safety analysis will lead to a more detailed warning and degradation concept.]