



Elektrobit



UDACITY

Technical Safety Concept Lane Assistance

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Purpose of the Technical Safety Concept

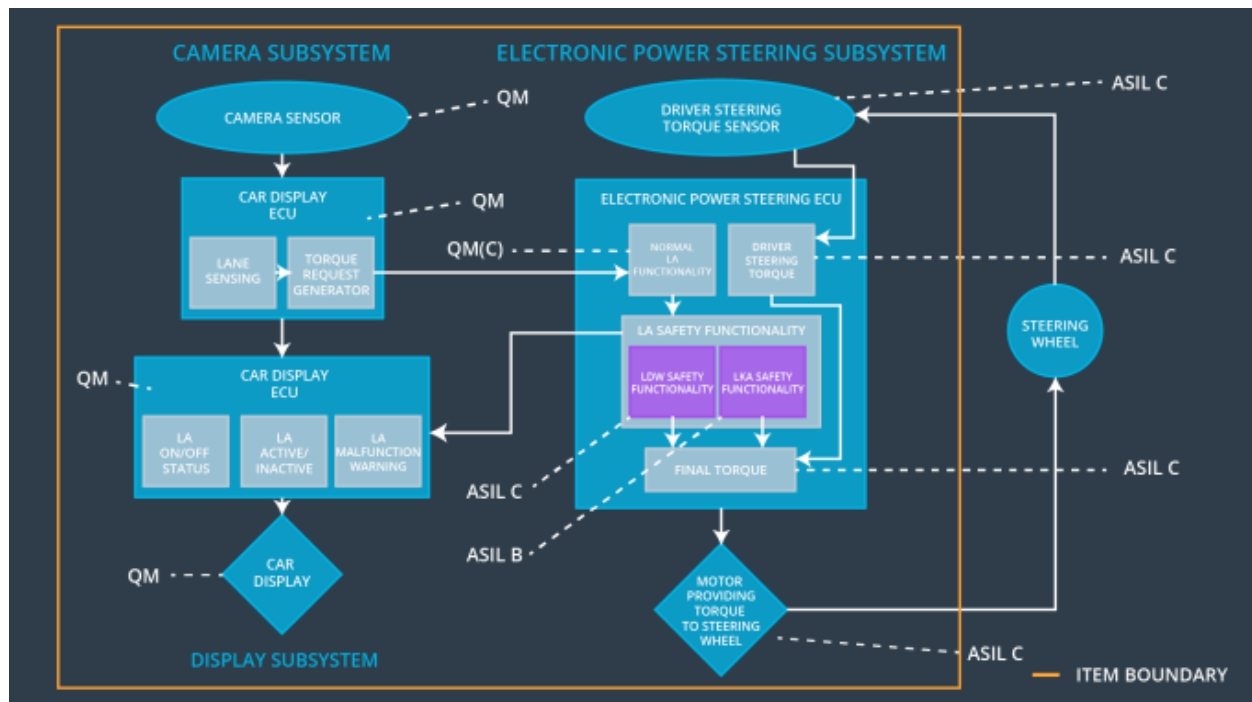
Refines the functional safety concept and allocates technical safety requirements to hardware and software components

Inputs to the Technical Safety Concept

Functional Safety Requirements

ID	Functional Safety Requirement	A S IL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The electronic power steering ECU shall ensure that the oscillating torque amplitude is below Max_Torque_Amplitude	C	50ms	Off
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the oscillating torque frequency is below Max_Torque_Frequency	C	50ms	Off
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

Element	Description
Camera Sensor	Sends an image stream to the Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Responsible for detecting lane lines and determining when the vehicle leaves the lane by mistake
Camera Sensor ECU - Torque request generator	Sends torque request to Lane Assistance functionality
Car Display	Provides feedback to the driver about on/off, active/inactive and malfunction status of the Lane Assistance system
Car Display ECU - Lane Assistance On/Off Status	Provides feedback to the driver about on/off status of the Lane Assistance system
Car Display ECU - Lane Assistant Active/Inactive	Provides feedback to the driver about active/inactive status of the Lane Assistance system

Car Display ECU - Lane Assistance malfunction warning	Provides feedback to the driver about malfunction status of the Lane Assistance system. Receives input from LDW Safety Functionality (LDW_Error_Status)
Driver Steering Torque Sensor	Responsible for measuring the torque provided by the driver
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Responsible for processing input from the Driver Steering Torque Sensor and sending output to the EPS ECU - Final Torque
EPS ECU - Normal Lane Assistance Functionality	Responsible for processing the input from the Camera Sensor ECU and sending Primary_LDW_Torque_Request to the LA Safety Functionality
EPS ECU - Lane Departure Warning Safety Functionality	Part of the Lane Keeping Assistant Safety Functionality. Processes input from Safety Startup and Data Transmission Integrity Check. Sends LDW_Torque_Request and LDW_Activation_Status to Final Torque. Sends LDW_Error_Status to LA Malfunction Warning in the Car Display ECU
EPS ECU - Lane Keeping Assistant Safety Functionality	Processes Primary_LDW_Torque_Request from the Normal Lane Assistance Functionality
EPS ECU - Final Torque	Processes all steering torque related inputs and sends a final torque request to the Motor
Motor	Carries out the Electronic Power Steering ECU torque request and provides torque to the steering wheel

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	A S IL	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 Functionality	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 Functionality	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 to zero.	C	50ms	LDW Safety Functionality	Off
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured	C	50ms	Data Transmission Integrity Check	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	Safety Startup	Off

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	50ms	LDW Safety Functionality	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 Functionality	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 to zero.	C	50ms	LDW Safety Functionality	Off
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured	C	50ms	Data Transmission Integrity Check	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	Safety Startup	Off

Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. “Validation” asks whether or not you chose the appropriate parameters. “Verification” involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

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:

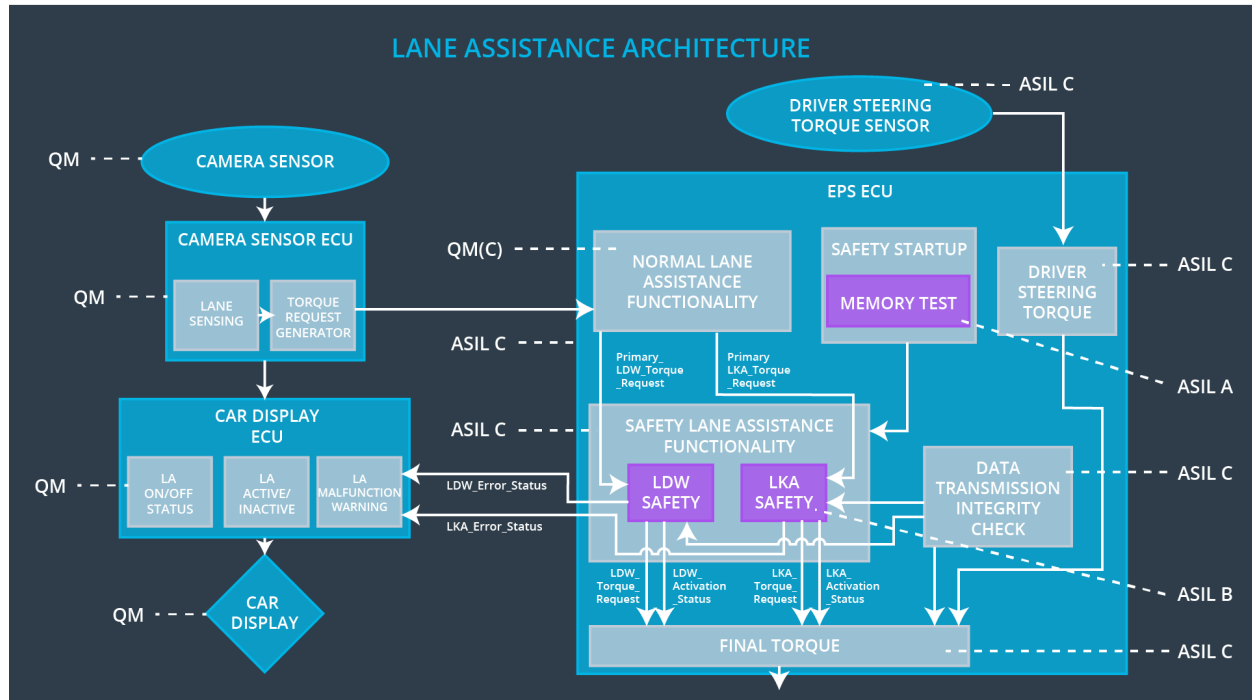
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01	The LDW safety component shall ensure that the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is applied for only Max_Duration	B	500ms	LDW Safety Functionality	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	B	50ms	LDW Safety Functionality	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 to zero.	B	50ms	LDW Safety Functionality	Off
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured	B	50ms	Data Transmission Integrity Check	Off
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	B	Ignition cycle	Safety Startup	Off

Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. “Validation” asks whether or not you chose the appropriate parameters. “Verification” involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

For the Lane Keeping item, all technical safety 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	Off	Oscillating torque frequency is above Max_Torque_Amplitude or Max_Torque_Frequency	Yes	LED on Car Display
WDC-01	Off	Lane keeping assistance torque is applied for more than Max_Duration	Yes	LED on Car Display