Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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Table of Contents

Document history

Table of Contents

Purpose of the Technical Safety Concept

Inputs to the Technical Safety Concept
- Functional Safety Requirements
- Refined System Architecture from Functional Safety Concept
  - Functional overview of architecture elements

Technical Safety Concept
- Technical Safety Requirements
- Refinement of the System Architecture
- Allocation of Technical Safety Requirements to Architecture Elements
- Warning and Degradation Concept

Purpose of the Technical Safety Concept

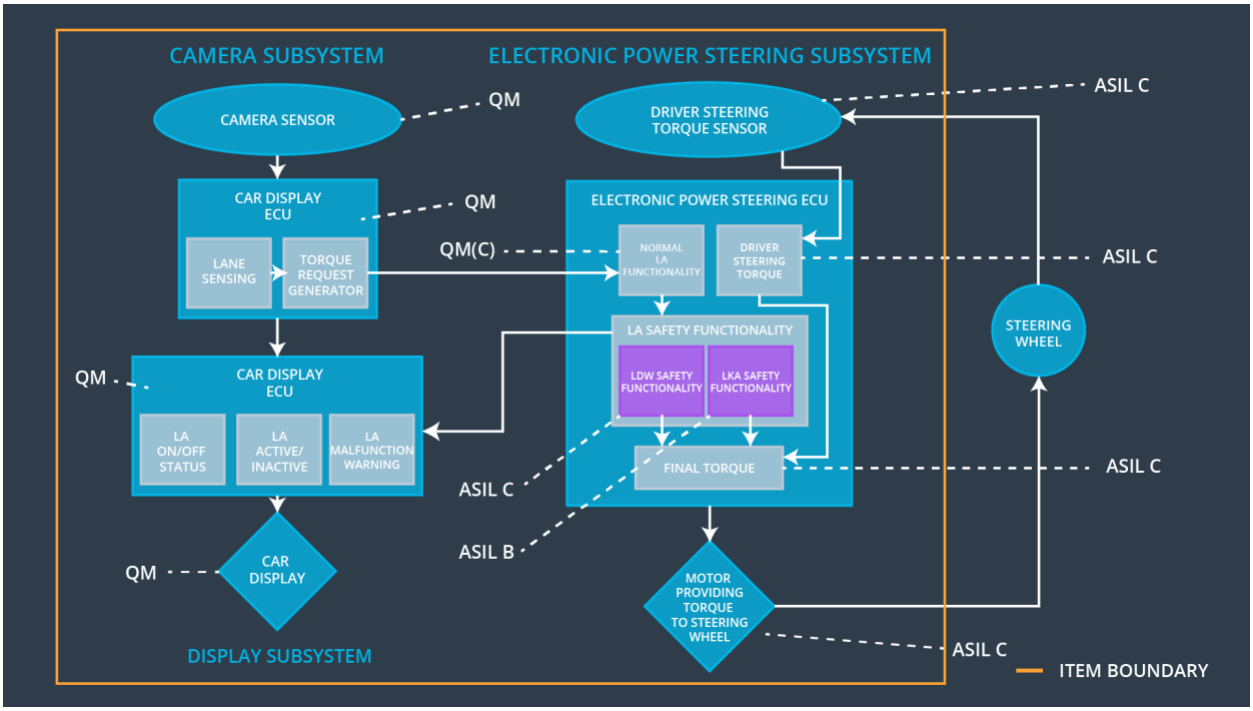
A technical safety concept, part of the product development phase, is more concrete and gets into the details of the item's technology when compared to a Functional safety concept.

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 keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude	B	50ms	Turn off the system
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	B	50ms	Turn off the system
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	Turn off the system

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Captures lanes data
Camera Sensor ECU - Lane Sensing	Detects any lane changes
Camera Sensor ECU - Torque request generator	Sends required torque requests to bring the car back to ego lane
Car Display	Displays warnings or any other alerts to the driver
Car Display ECU - Lane Assistance On/Off Status	Shows the status of the Lane Assistance function
Car Display ECU - Lane Assistant Active/Inactive	Shows the status of the Lane Assistance function's current active status – if lane assistance is triggered or not
Car Display ECU - Lane Assistance malfunction warning	Shows if there is a malfunction in the Lane Assistance function

Driver Steering Torque Sensor	Gets the current torque applied by the driver
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Calculates the amount of torque applied by the driver
EPS ECU - Normal Lane Assistance Functionality	Calculates the amount of torque generated by the Camera Sensor ECU - Torque request generator and makes sure it is within torque limits
EPS ECU - Lane Departure Warning Safety Functionality	Monitors the oscillating torque applied to the steering and makes sure it is within set limits
EPS ECU - Lane Keeping Assistant Safety Functionality	Monitors any misuse by the driver as an autonomous mode and restricts the time the LKA is applied
EPS ECU - Final Torque	Applies the final required torque with inputs from EPS ECU - Normal Lane Assistance Functionality and EPS ECU - Driver Steering Torque
Motor	Applies final 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	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	50 ms	LDW Safety Software component	LDW Torque Request Amplitude shall be set 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	50 ms	LDW Safety Software component	LDW Torque Request Amplitude shall be set 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	50 ms	LDW Safety Software component	LDW Torque Request Amplitude shall be set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	Data Transmission Integrity Check software block	N/A
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	External Safety Startup Memory Test software block	LDW Torque Request Amplitude shall be 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 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	50 ms	LDW Safety Software component	LDW Torque Request Frequency shall be set 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	50 ms	LDW Safety Software component	LDW Torque Request Frequency shall be set 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	50 ms	LDW Safety Software component	LDW Torque Request Frequency shall be set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	Data Transmission Integrity Check software block	N/A

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	External Safety Startup Memory Test software block	LDW Torque Request Frequency shall be set to zero

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:

[Instructions: Fill in the technical safety requirements for the lane keeping assistance functional safety requirement 02-01. We have provided the associated functional safety requirement in the table below. Hint:. You can reuse the technical safety requirements from functional safety requirement 01-01. But you need to change the language because we are now looking at a different system. The ASIL and Fault Tolerant Time Interval are different as well.]

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:

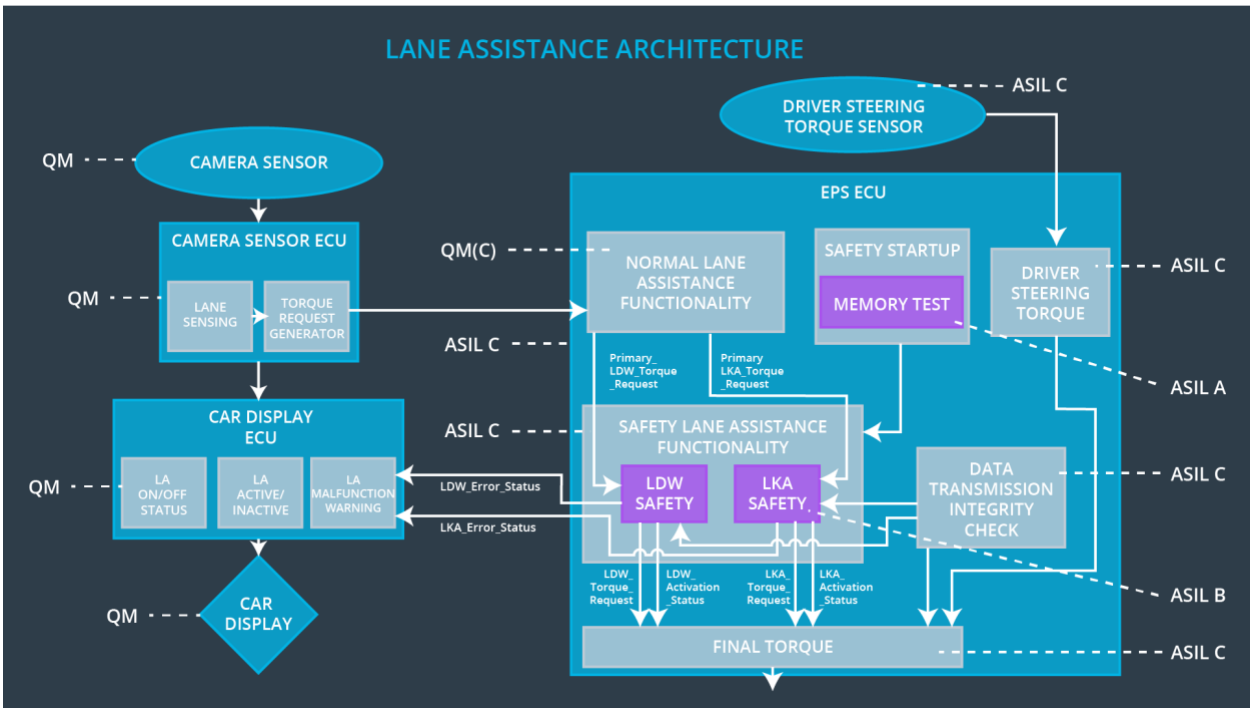
ID	Technical Safety Requirement	A	Fault	Allocation to	Safe State

		SIL	Tolerant Time Interval	Architecture	
Technical Safety Requirement 01	The LKA safety component shall ensure that the Torque of the 'LKA_Torque_Request' sent to the 'Final electronic power steering Torque' component is applied for only 'Max_Duration'.	B	500 ms	LKA Safety Software component	LKA Torque Request shall be set to zero
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.	B	500 ms	LKA Safety Software component	LKA Torque Request shall be set to zero
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.	B	500 ms	LKA Safety Software component	LKA Torque Request shall be set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500 ms	Data Transmission Integrity Check software block	N/A
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	External Safety Startup Memory Test software block	LKA Torque Request shall be set to zero

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

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	Turn off Lane Departure warning function	When the oscillating torque amplitude and frequency go beyond limit	Yes	The driver will see a warning light on the dashboard when the system malfunctions
WDC-02	Turn off Lane Keeping assistance function	When the lane keeping assistance goes beyond the set time limit	Yes	The driver will see a warning light on the dashboard when the system malfunctions