Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
2018-03-04	1.0	Maximilian Wenger	Initial version

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Purpose of the Technical Safety Concept

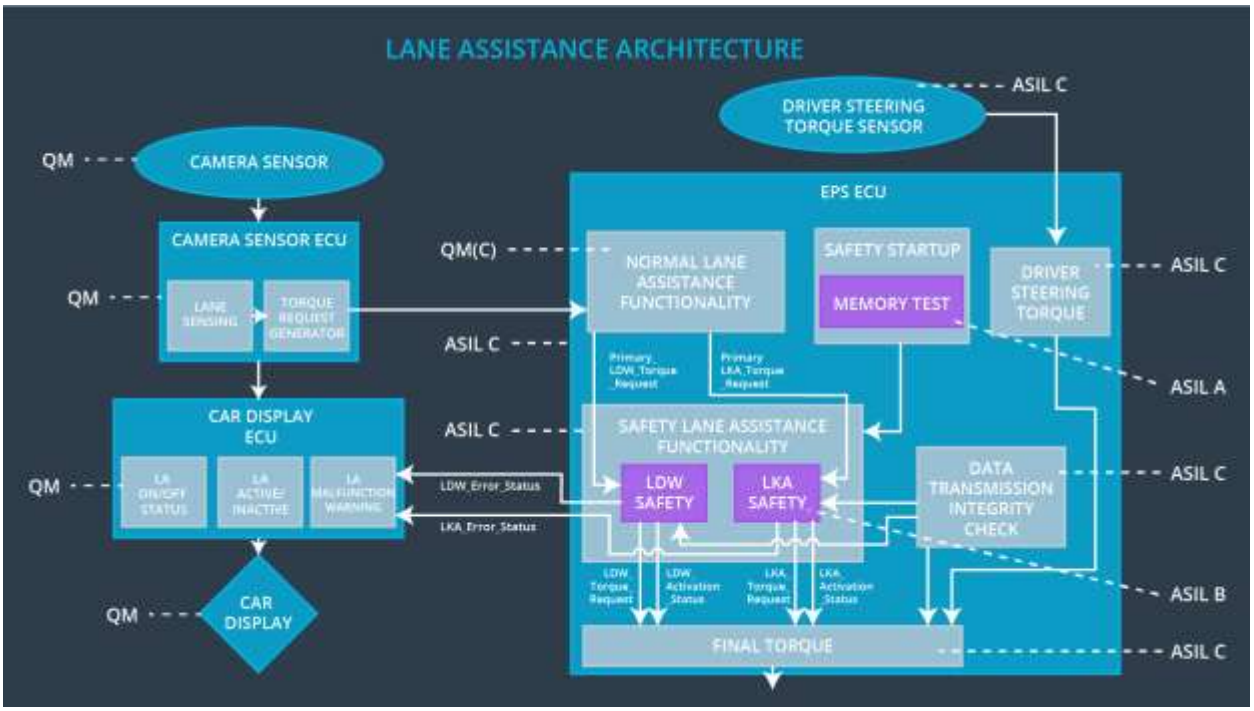
The purpose of this technical safety concept is to translate the functional safety requirements into technical safety requirements that have to be implemented during the development of the item.

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 electronic power steering ECU shall ensure that the oscillating torque amplitude is below Max_Torque_Amplitude.	C	50ms	LA off (torque zero)
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the oscillating torque frequency is below Max_Torque_Frequency.	C	50ms	LA off (torque 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	LA off (torque zero)

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Provide images of the road to the ECU.
Camera Sensor ECU - Lane Sensing	Detect lane markings and position of vehicle in relation to them.
Camera Sensor ECU - Torque request generator	Calculate the torque required to steer the vehicle back into the middle of the ego lane.
Car Display	Show visual information to the driver (e.g. warning light).
Car Display ECU - Lane Assistance On/Off Status	Display the LA system on/off status.
Car Display ECU - Lane Assistant Active/Inactive	Display the LA activity system status received from the EPS ECU.
Car Display ECU - Lane Assistance malfunction warning	Display the LA system malfunction warning received from the EPS ECU or Camera ECU.
Driver Steering Torque Sensor	Measure the torque applied to the steering wheel by the driver.

Electronic Power Steering (EPS) ECU - Driver Steering Torque	Calculate the steering torque the motor should apply to the steering wheel from the camera and torque sensor inputs.
EPS ECU - Normal Lane Assistance Functionality	Translate and integrate torque requests from the camera.
EPS ECU - Lane Departure Warning Safety Functionality	Ensure that the torque amplitude and frequency stay within the lower and upper boundaries.
EPS ECU - Lane Keeping Assistant Safety Functionality	Ensure that the LKA torque amplitude stays within the boundary.
EPS ECU - Final Torque	Ensure that the torque amplitude and frequency stay within the lower and upper boundaries.
Motor	Apply 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 functionality	LA off (torque 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 functionality	LA off (torque 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 functionality	LA off (torque 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	LA off (torque zero)
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	Memory Test	LA off (torque 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 functionality	LA off (torque 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 functionality	LA off (torque 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 functionality	LA off (torque 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	LA off (torque zero)

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	Memory Test	LA off (torque zero)

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

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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 that the 'LKA_Torque_Request' sent to the 'Final electronic power steering Torque' component is different from zero for only Max_Duration.	B	500 ms	LKA Safety functionality	LA off (torque 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 functionality	LA off (torque 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 functionality	LA off (torque 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	LA off (torque zero)
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	Memory Test	LA off (torque zero)

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

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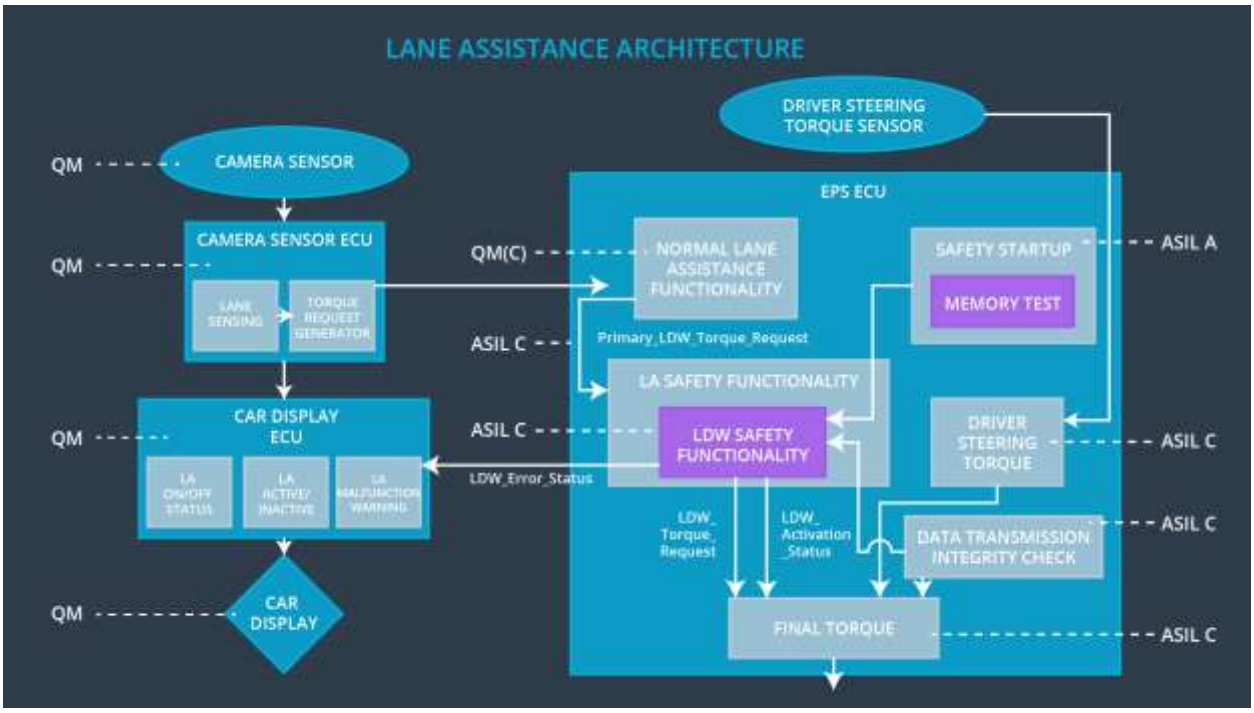
Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

See the technical requirements tables. All technical safety requirements discussed in this document are within the EPS ECU.

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn LA off (additional torque set to zero)	Malfunction_01 Malfunction_02 Malfunction_04 Malfunction_05	Yes	LA malfunction warning light
WDC-02	Turn LA off (additional torque set to zero)	Malfunction_03	Yes	LA malfunction warning light
WDC-03	Turn LA off (additional torque set to zero)	Malfunction_06	Yes	LA malfunction warning light