Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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6/18/2019	1.0	Bob Li	Initial Version

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Purpose of the Technical Safety Concept

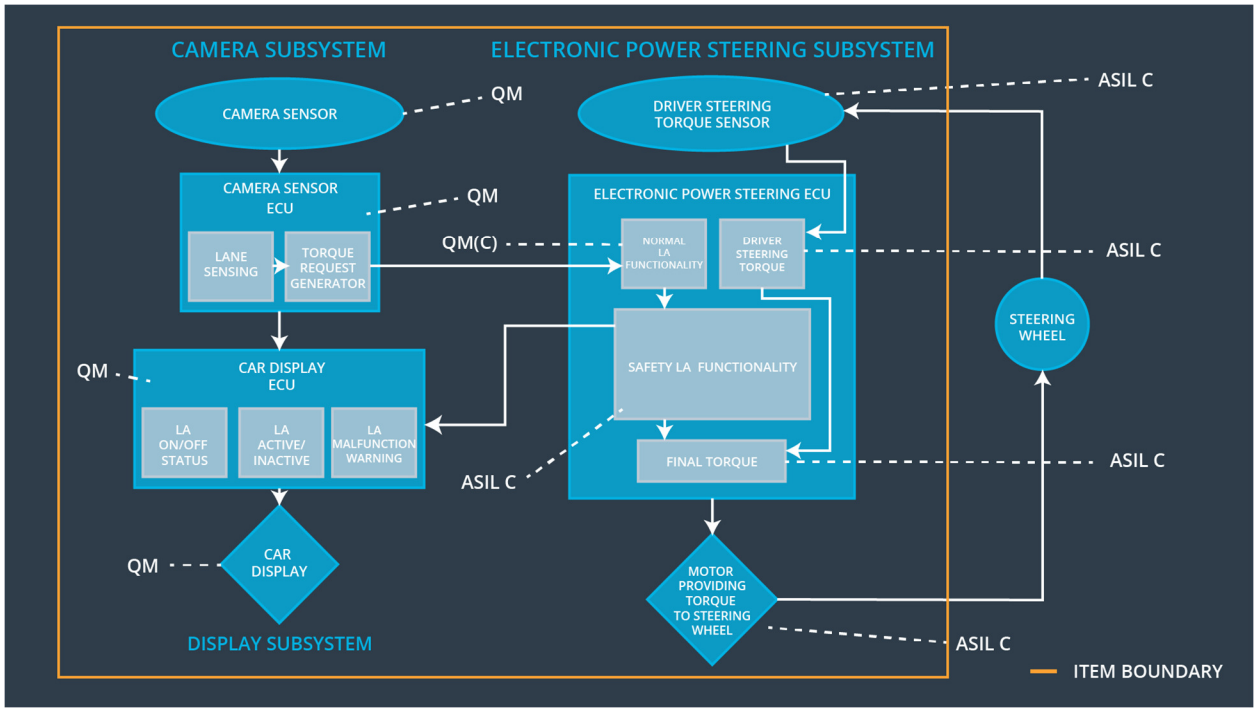
ISO 26262 places the functional safety concept in the concept phase while the technical safety concept is part of the product development phase. Technical safety concept is more concrete and gets into the details of the item's technology.

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 EPS ECU shall ensure that the lane departure warning torque amplitude is below Max_Torque_Ampliture	C	50ms	Turn system off
Functional Safety Requirement 01-02	The EPS ECU shall ensure that the lane departure warning torque frequency is below Max_Torque_Frequency	C	50ms	Turn system off
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max-Duration	B	500ms	Turn system off

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Capture road images and provide them to the Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Software module detection the lane line positions from the Camera Sensor images
Camera Sensor ECU - Torque request generator	Software module calculation the necessary torque to be requested to the Electronic Power Steering ECU.
Car Display	Provide information to the driver by display warnings and status of Lane Assistance System
Car Display ECU - Lane Assistance On/Off Status	Indicate the Lane Assistance On/Off Status
Car Display ECU - Lane Assistant Active/Inactive	Indicate the Lane Assistant Active/Inactive status
Car Display ECU - Lane Assistance malfunction warning	Indicate the Lane Assistance malfunction status

Driver Steering Torque Sensor	Measure the Handwheel torque of the driver
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software module receiving the driver's torque request from the steering wheel.
EPS ECU - Normal Lane Assistance Functionality	Software module receiving the Camera Sensor ECU torque request
EPS ECU - Lane Departure Warning Safety Functionality	Software module ensuring the torque amplitude is below Max_Torque_Amplitude and torque frequency is below Max_Torque_Frequency
EPS ECU - Lane Keeping Assistant Safety Functionality	Software module ensuring the Lane Keeping Assistance functionality application is not activate more than Max_duration time
EPS ECU - Final Torque	Combine the torque request from the Lane Keeping and Lane Departure Warning functionalities and sends them to the motor
Motor	Apply the motor torque request from the Electronic Power Steering ECU

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 EPS ECU shall ensure that the lane departure warning torque amplitude is below Max_Torque_Ampliture	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	50ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 02	When the Lane Departure Warning is deactivated, the 'LDW Safety' software module shall send a signal to the Car Display ECU to turn on a warning signal.	C	50ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 03	When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set 'LDW_Torque_Request' to zero.	C	50ms	LDW Safety	Lane Departure Warning torque to zero.
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	Lane Departure Warning torque to zero.
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Safety startup-Memory test	Lane Departure Warning torque 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 EPS ECU shall ensure that the lane departure warning 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 frequency of the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency.'	C	50ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 02	When the Lane Departure Warning is deactivated, the 'LDW Safety' software module shall send a signal to the Car Display ECU to turn on a warning signal.	C	50ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement 03	When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set 'LDW_Torque_Request' to zero.	C	50ms	LDW Safety	Lane Departure Warning torque to zero.
Technical Safety Requirement	The validity and integrity of the data transmission for	C	50ms	Data Transmission Integrity	Lane Departure

04	'LDW_Torque_Request' signal shall be ensured.			Check	Warning torque to zero.
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Safety startup-Memory test	Lane Departure Warning torque to zero.

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)

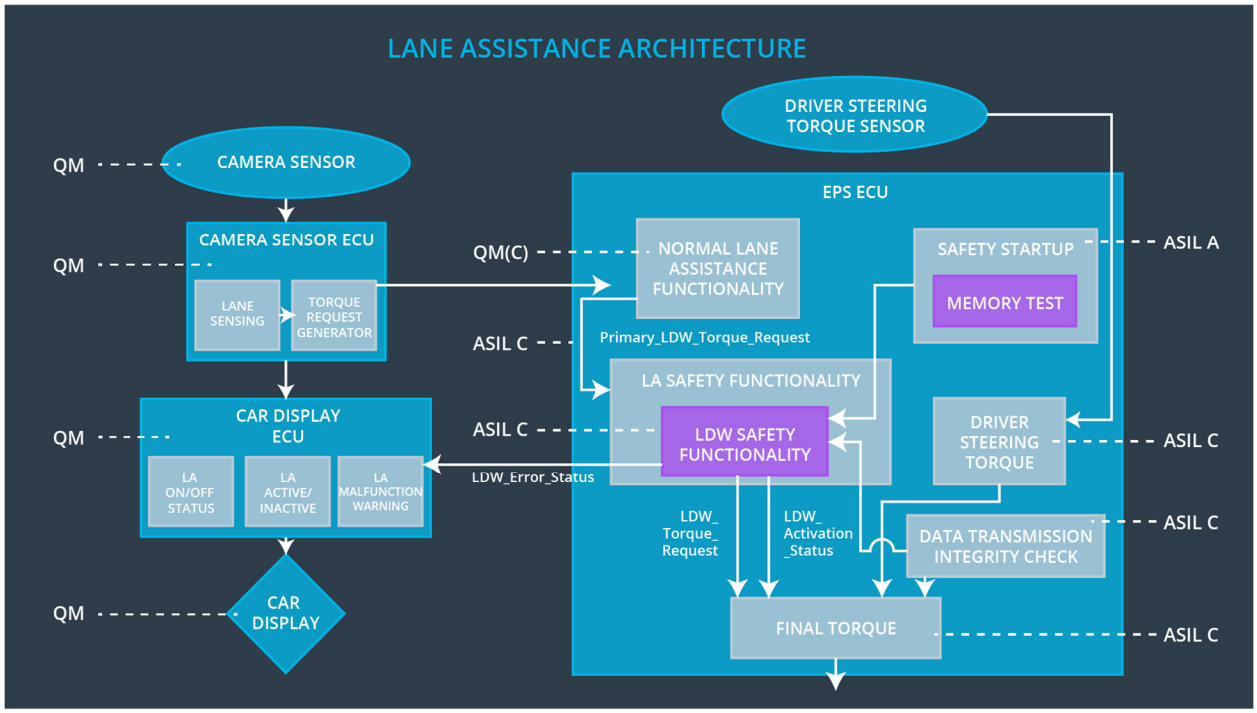
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement	The Lane Keeping Assistance safety component shall ensure the duration of the lane keeping assistance torque is applied for	B	500ms	LKA Safety	Lane Keeping Assistance torque to

01	less than Max_Duration				zero.
Technical Safety Requirement 02	When the Lane Keeping Assistance function deactivates, the ‘LKA Safety’ shall send a signal to the Car Display ECU to turn on a warning light.	B	500ms	LKA Safety	Lane Keeping Assistance torque to zero.
Technical Safety Requirement 03	When a failure is detected, the Lane Keeping Assistance function shall deactivate and the ‘LKA_Torque_Request’ shall be zero.	B	500ms	LKA Safety	Lane Keeping Assistance torque to zero.
Technical Safety Requirement 04	The validity and integrity of the data transmission for ‘LKA_Torque_Request’ signal shall be ensured.	B	500ms	Data Transmission Integrity Check	Lane Keeping Assistance torque to zero.
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Safety startup-Memory test	Lane Keeping Assistance torque to zero.

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 system off	Malfunction_01 Malfunction_02	Yes	Warning light on the car display
WDC-02	Turn system off	Malfunction_03	Yes	Warning light on the car display