Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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23.06.2018	1.0	Malgorzata Plonka	Initial version

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Purpose of the Technical Safety Concept

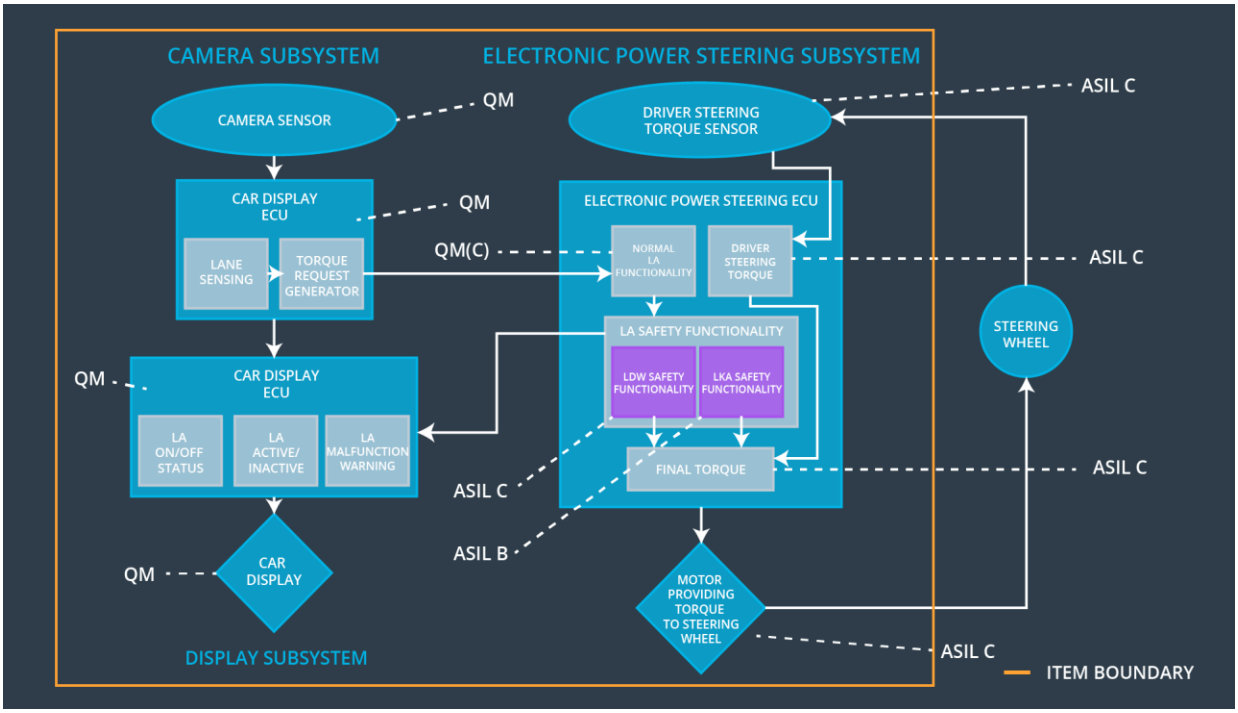
The purpose of the technical safety concept is to refine the functional safety requirements established in the functional safety concept into technical safety requirements.
These requirements are assigned to the system architecture. They are more concrete and go into details of the item's technology as specified by ISO 26262.

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*	C	50 ms	Turn off Lane Departure Warning
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below *Max_Torque_Frequency*	C	50 ms	Turn off Lane Departure Warning
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	500 ms	Turn off Lane Keeping Assistant

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Captures road images and provide them to the Camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Detects lane line positions from camera images.
Camera Sensor ECU - Torque request generator	Generates a torque request to the Electronic Power Steering ECU.
Car Display	Shows warning to driver.
Car Display ECU - Lane Assistance On/Off Status	Indicates the status of the Lane Assistance functionality (On/Off.)
Car Display ECU - Lane Assistant Active/Inactive	Indicates if the Lane Assistance functionality is properly functioning (Active/Inactive.)
Car Display ECU - Lane Assistance malfunction warning	Indicates fault malfunction of Lane Assistance functionality.
Driver Steering Torque Sensor	Measures the torque applied to the steering wheel by the driver.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Processes input from Driver Steering Torque Sensor.
EPS ECU - Normal Lane Assistance Functionality	Receives torque request from Camera Sensor ECU and transfers it to Safety Lane Assistance Functionality.
EPS ECU - Lane Departure Warning Safety Functionality	Ensures the torque amplitude is below *Max_Torque_Amplitude* and torque frequency is below *Max_Torque_Frequency*.
EPS ECU - Lane Keeping Assistant Safety Functionality	Ensures the Lane Keeping Assistance functionality application is not activate more than *Max_duration* time.
EPS ECU - Final Torque	Generates final torque from torque requests received from LDW and LKA safety.
Motor	Applies the required torque to the steering wheels.

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 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below *Max_Torque_Amplitude*.	C	50 ms	LDW Safety	LDW torque set to zero.
Technical Safety Requirement 02	When the LDW is deactivated, the 'LDW Safety' software module shall send a signal to the Car Display ECU to turn on a warning signal.	C	50 ms	LDW Safety	LDW torque set to zero.
Technical Safety Requirement 03	When the 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	LDW torque 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	N/A
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	Memory Test	LDW torque 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 component shall ensure that the frequency of 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below *Max_Torque_Frequency*.	C	50 ms	LDW Safety	LDW torque set to zero.
Technical Safety Requirement 02	When 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	LDW torque set to zero.
Technical Safety Requirement 03	When LDW function deactivates the LDW feature, the 'LDW Safety' software block shall send a signal to the car display	C	50 ms	LDW Safety	LDW torque set to zero.

	ECU to turn on a warning light.				
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	N/A
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	Memory test	LDW torque set to zero.

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

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		

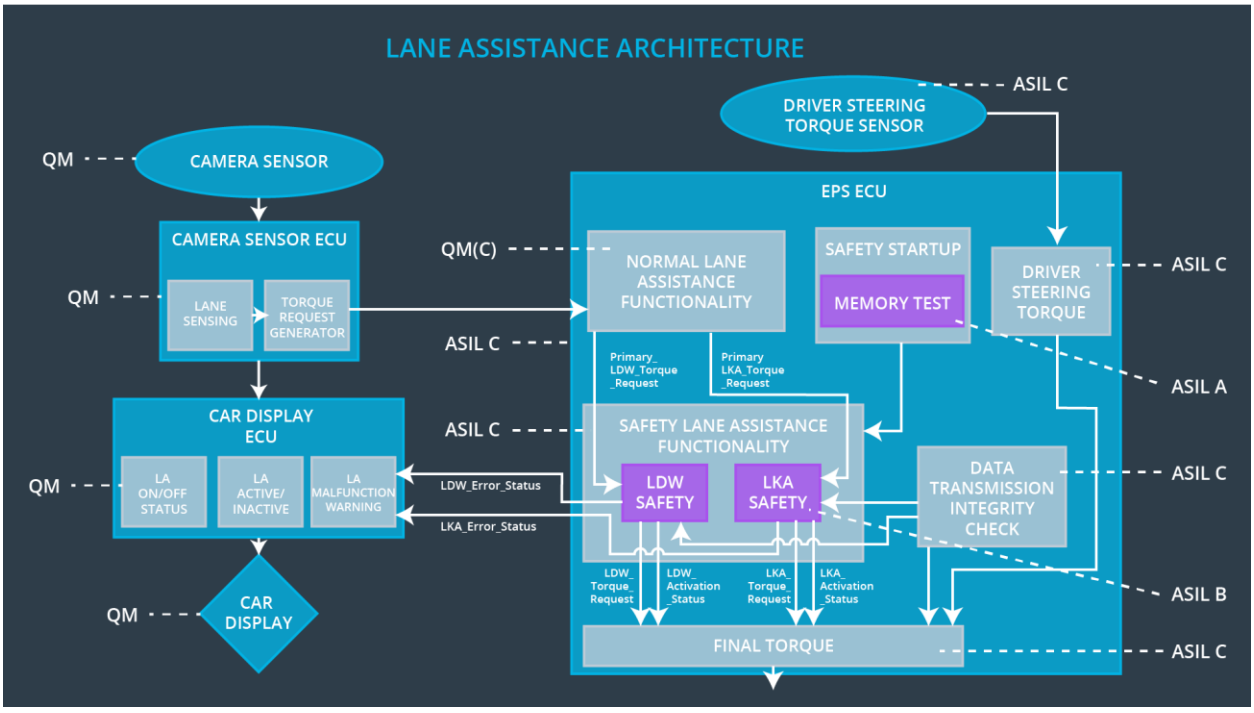
Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

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 active duration time is below *Max_Duration*.	B	500 ms	LKA safety	LAK torque set to zero.
Technical Safety	When failure is detected by the LKA function, it shall	B	500 ms	LKA safety	LAK torque set to zero.

Requirement 02	deactivate the LKA feature and the “LKA_Torque_Request” shall be set to zero.				
Technical Safety Requirement 03	When 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	LAK torque 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	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	500 ms	Memory Test	LAK torque set to zero.

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

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

As shown in the tables above, all technical safety requirements are allocated to the Electronic Power Steering ECU.

Power Steering ECU.Warning and Degradation Concept

The technical safety requirements have not changed how functionality will be degraded or what the warning will be. Thus, the warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked ?	Driver Warning
WDC-01	Turn off LDW functionality	Malfunction_01, Malfunction_02	YES	LDW Malfunction Warning on Car Display
WDC-02	Turn off LKA functionality	Malfunction_03	YES	LKA Malfunction Warning on Car Display