Technical Safety Concept Lane Assistance

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Document history

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Purpose of the Technical Safety Concept

The technical safety concept is more concrete than the functional safety concept and gets into the details of the item's technology.
The technical safety requirements need to be determined for each of item’s systems.

The technical safety concept involves:

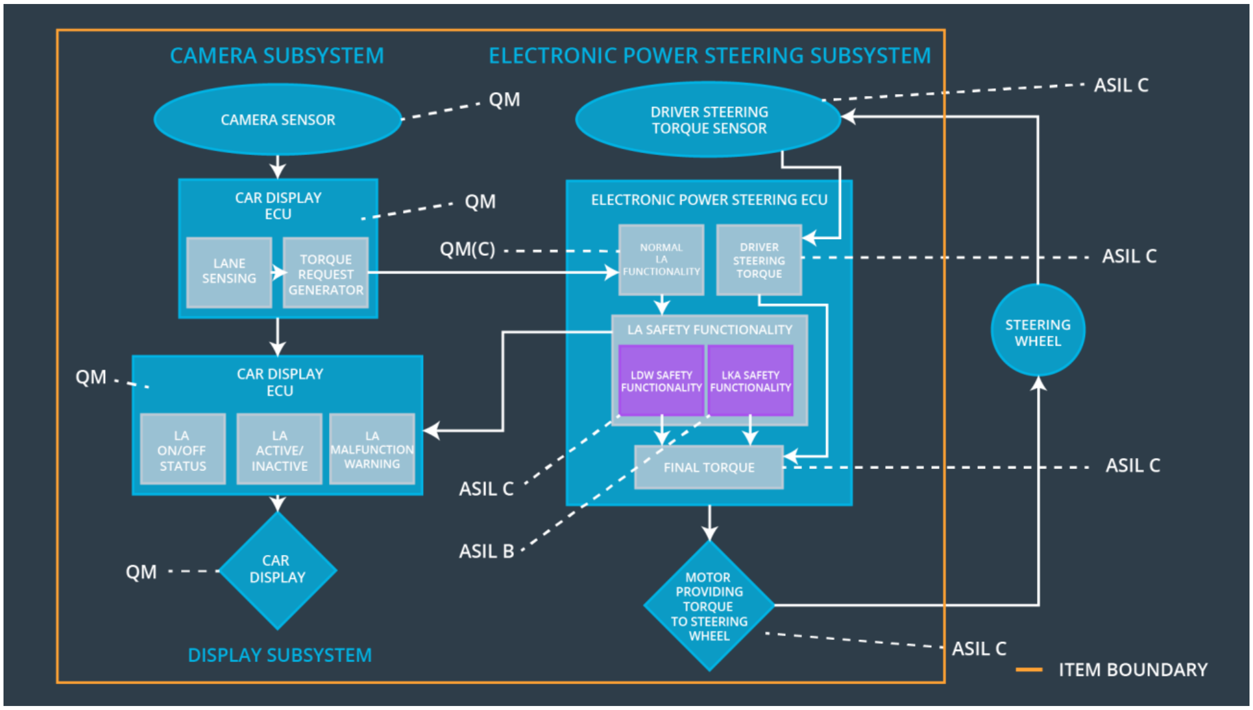
- Turning functional safety requirements into technical safety requirements
- Allocating technical safety requirements to the system architecture

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	50ms	Lane departure oscillating torque amplitude is below Max_Torque_Amplitude
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	C	50ms	Lane departure oscillating torque frequency is below Max_Torque_Frequency
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the Lane Keeping Assistance torque is applied only Max_Duration	B	500ms	Lane Keeping Assistance is deactivated

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Image Processing and providing images to Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Object perception and recognition, detection of lane boundaries
Camera Sensor ECU - Torque request generator	Generation of torque request to the Electronic Power Steering ECU
Car Display	Displaying of Lane Assistant item state, activity and warning messaged to the driver
Car Display ECU - Lane Assistance On/Off Status	Indicating Lane Assistance On/Off Status
Car Display ECU - Lane Assistant Active/Inactive	Indicating Lane Assistance Active/Inactive Status
Car Display ECU - Lane Assistance malfunction warning	Indicating Lane Assistance malfunction warnings

Driver Steering Torque Sensor	Measuring of torque applied to the steering wheel by the driver to Electronic Power Steering ECU
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Processing of input from Driver Steering Torque Sensor
EPS ECU - Normal Lane Assistance Functionality	Receiving the torque request from Camera Sensor ECU and sending to Safety Lane Assistance Functionality
EPS ECU - Lane Departure Warning Safety Functionality	Checking for malfunction of Lane Departure Warning Functionality and sending torque request to final torque output or malfunction warning to Car Display ECU - Lane Assistance malfunction warning
EPS ECU - Lane Keeping Assistant Safety Functionality	Checking for malfunction of Lane Keeping Assistant Functionality and sending torque request to final torque output or malfunction warning to Car Display ECU - Lane Assistance malfunction warning
EPS ECU - Final Torque	Evaluating of final torque from Lane Departure Warning Safety Functionality and Lane Keeping Assistant Safety Functionality requests
Motor	Receiving torque request from Electronic Power Steering ECU and applying to 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	50ms	LDW Safety	LDW torque output is set to zero
Technical Safety Requirement 02	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	LDW torque output is set to zero
Technical Safety Requirement 03	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	LDW torque output is set 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	N/A
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any errors in memory	A	Ignition cycle	Safety Startup Memory Test	LDW torque output is set to zero

Functional Safety Requirement 01-02 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	LDW torque output is set to zero
Technical Safety Requirement 02	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	LDW torque output is set to zero
Technical Safety Requirement 03	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	LDW torque output is set 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	N/A
Technical Safety Requirement	Memory test shall be conducted at startup of the EPS ECU to check for any errors in memory	A	Ignition cycle	Safety Startup Memory Test	LDW torque output is

05					set to zero

Lane Keeping Assistance (LKA) Requirements:

Functional Safety Requirement 02-01 with its associated system elements
(derived in the functional safety concept)

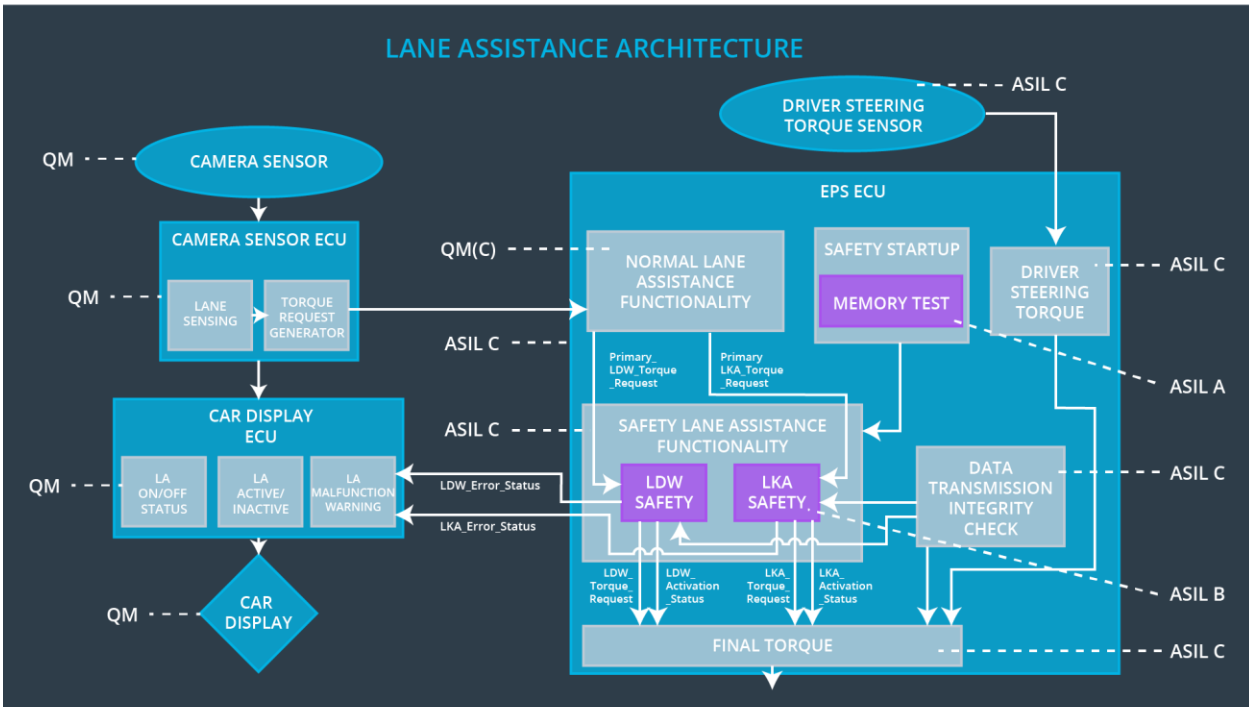
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 the 'LKA_Torque_Request' is sent to 'Final electronic power steering Torque' for less than Max_Duration	C	500ms	LKA Safety	LKA torque output is set to zero
Technical Safety Requirement 02	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	C	500ms	LKA Safety	LKA torque output is set to zero
Technical Safety Requirement 03	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	C	500ms	LKA Safety	LKA torque output is set to zero

Technical Safety Requireme nt 04	The validity and integrity of the data transmission for ‘LKA_Torque_Request’ signal shall be ensured	C	500ms	Data Transmission Integrity Check	N/A
Technical Safety Requireme nt 05	Memory test shall be conducted at startup of the EPS ECU to check for any errors in memory	A	Ignition cycle	Safety Startup Memory Test	LKA torque output is set to zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

ID	Functional Safety Requirement	Electronic Power	Camera ECU	Car Display ECU

		Steering ECU		
Technical Safety Requirement 01-01-01	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	**X**		
Technical Safety Requirement 01-01-02	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	**X**		
Technical Safety Requirement 01-01-03	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	**X**		
Technical Safety Requirement 01-01-04	The validity and integrity of the data transmission for ‘LDW_Torque_Request’ signal shall be ensured	**X**		
Technical Safety Requirement 01-01-05	Memory test shall be conducted at startup of the EPS ECU to check for any errors in memory	**X**		
Technical Safety Requirement 01-02-01	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	**X**		
Technical Safety Requirement 01-02-02	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	**X**		
Technical	As soon as the LDW function	**X**		

Safety Requirement 01-02-03	deactivates the LDW feature, the LDW Safety software block shall send a signal to the car display ECU to turn on a warning light			
Technical Safety Requirement 01-02-04	The validity and integrity of the data transmission for ‘LDW_Torque_Request’ signal shall be ensured	**X**		
Technical Safety Requirement 01-02-05	Memory test shall be conducted at startup of the EPS ECU to check for any errors in memory	**X**		
Technical Safety Requirement 02-01-01	The LKA safety component shall ensure the ‘LKA_Torque_Request’ is sent to ‘Final electronic power steering Torque’ for less than Max_Duration	**X**		
Technical Safety Requirement 02-01-02	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	**X**		
Technical Safety Requirement 02-01-03	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	**X**		
Technical Safety Requirement 02-01-04	The validity and integrity of the data transmission for ‘LKA_Torque_Request’ signal shall be ensured	**X**		
Technical Safety Requirement 02-01-05	Memory test shall be conducted at startup of the EPS ECU to check for any errors in memory	**X**		

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off Lane Departure Warning functionality	Malfunction_01	Yes	Lane Assistance malfunction Warning
WDC-02	Turn off Lane Departure Warning functionality	Malfunction_02	Yes	Lane Assistance malfunction Warning
WDC-03	Turn off Lane Keeping Assistance functionality	Malfunction_03	Yes	Lane Assistance malfunction Warning
WDC-04	Turn off Lane Keeping Assistance functionality	Malfunction_04	Yes	Lane Assistance malfunction Warning
WDC-05	Turn off Lane Departure Warning functionality	Malfunction_05	Yes	Lane Assistance malfunction Warning