Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
8/25/2018	Ver 1.0	Jun Imamura	First attempt

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Purpose of the Technical Safety Concept

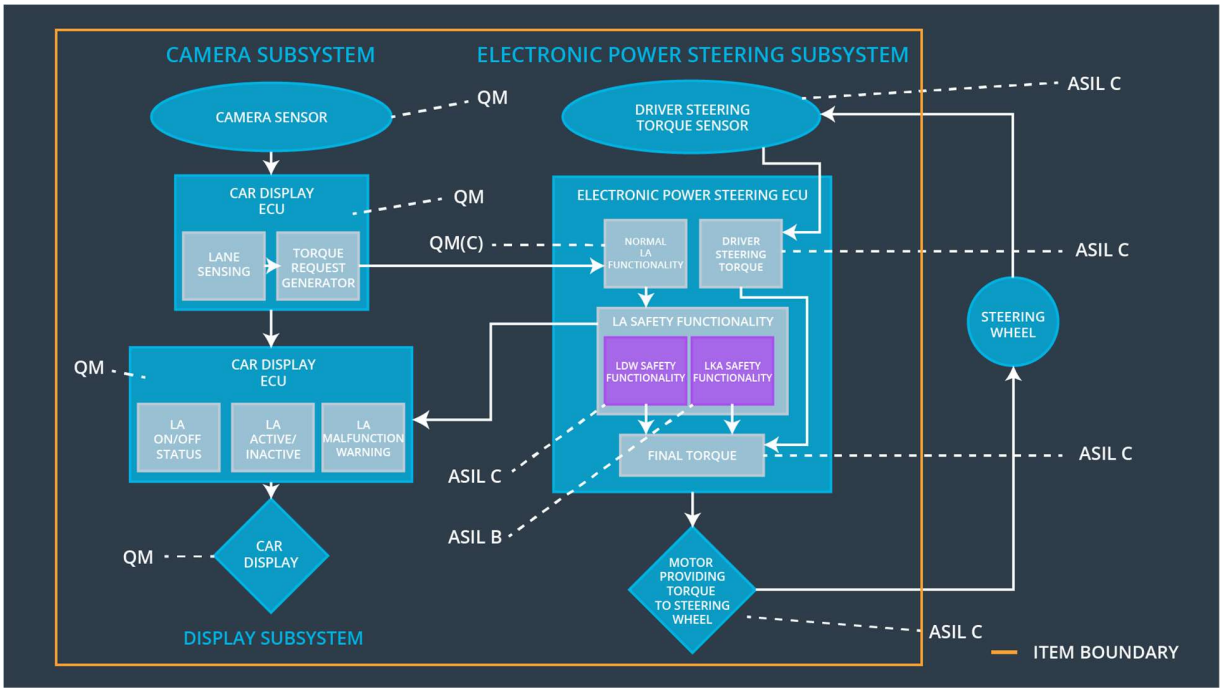
Technical safety concept is a documentation activity to define requirements in more detail. This will define the requirement for each sensor/controller/actuator level.

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	System turned off
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is blow Max_Torque_Frequency	C	50ms	System turned off
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	System turned off

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Capture the images ahead of the vehicle and provide them to the Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Process the provided sensor raw values and detect / calculate the position of the car on the road.
Camera Sensor ECU - Torque request generator	Request a desirable torque to the electronic power steering ECU.
Car Display	Provide both activation status and operating status of the lane assistance functionality.
Car Display ECU - Lane Assistance On/Off Status	Indicate the ON/OFF status of the lane assistance functionality.
Car Display ECU - Lane Assistant Active/Inactive	Indicate the activation status of the lane assistance functionality.
Car Display ECU - Lane Assistance malfunction warning	Indicate a malfunction status of the lane assistance functionality.
Driver Steering Torque Sensor	Measure the torque applied to the steering wheel by the driver.

Electronic Power Steering (EPS) ECU - Driver Steering Torque	Receive steering torque value from driver steering torque sensor.
EPS ECU - Normal Lane Assistance Functionality	Receive torque request from camera sensor ECU torque request.
EPS ECU - Lane Departure Warning Safety Functionality	Ensure the torque amplitude and frequency are below Max_Torque_Amplitude / Max_Torque_Frequency respectively.
EPS ECU - Lane Keeping Assistant Safety Functionality	Ensure the lane keeping assistance functionality won't be activated longer than Max_duration.
EPS ECU - Final Torque	Integrate the information from lane safety functionality and driver steering torque sensor. Then send and steering torque request to the motor.
Motor	Apply required 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	A	Fault	Architecture	Safe State

	Requirement	SIL	Tolerant Time Interval	Allocation	
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'	C	50ms	EPS ECU - Lane Departure Warning Safety Functionality	LDW Torque Request Amplitude set to zero.
Technical Safety Requirement 01-01-02	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	50ms	EPS ECU - Lane Departure Warning Safety Functionality	LDW Torque Request Amplitude set to zero.
Technical Safety Requirement 01-01-03	As soon as a failure is detected by the LDW function, the 'LDW_Torque_Request' shall be set to zero	C	50ms	EPS ECU - Lane Departure Warning Safety Functionality	LDW Torque Request Amplitude set to zero.
Technical Safety Requirement 01-01-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	EPS ECU - Lane Departure Warning Safety Functionality	
Technical Safety Requirement 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Data Transmission Integrity Check	

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 01-02-01	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	50ms	EPS ECU - Lane Departure Warning Safety Functionality	LDW Torque Request Amplitude set to zero.
Technical Safety Requirement 01-02-02	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	50ms	EPS ECU - Lane Departure Warning Safety Functionality	
Technical Safety Requirement 01-02-03	As soon as a failure is detected by the LDW function, the 'LDW_Torque_Request' shall be set to zero	C	50ms	EPS ECU - Lane Departure Warning Safety Functionality	
Technical Safety Requirement 01-02-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	EPS ECU - Lane Departure Warning Safety Functionality	
Technical Safety Requirement	Memory test shall be conducted at start up of the EPS ECU to check	A	Ignition cycle	Data Transmission Integrity	

01-02-05	for any faults in memory.			Check	

Lane Keeping Assistance (LKA) Requirements:

Functional Safety Requirement 02-1 with its associated system elements (derived in the functional safety concept)

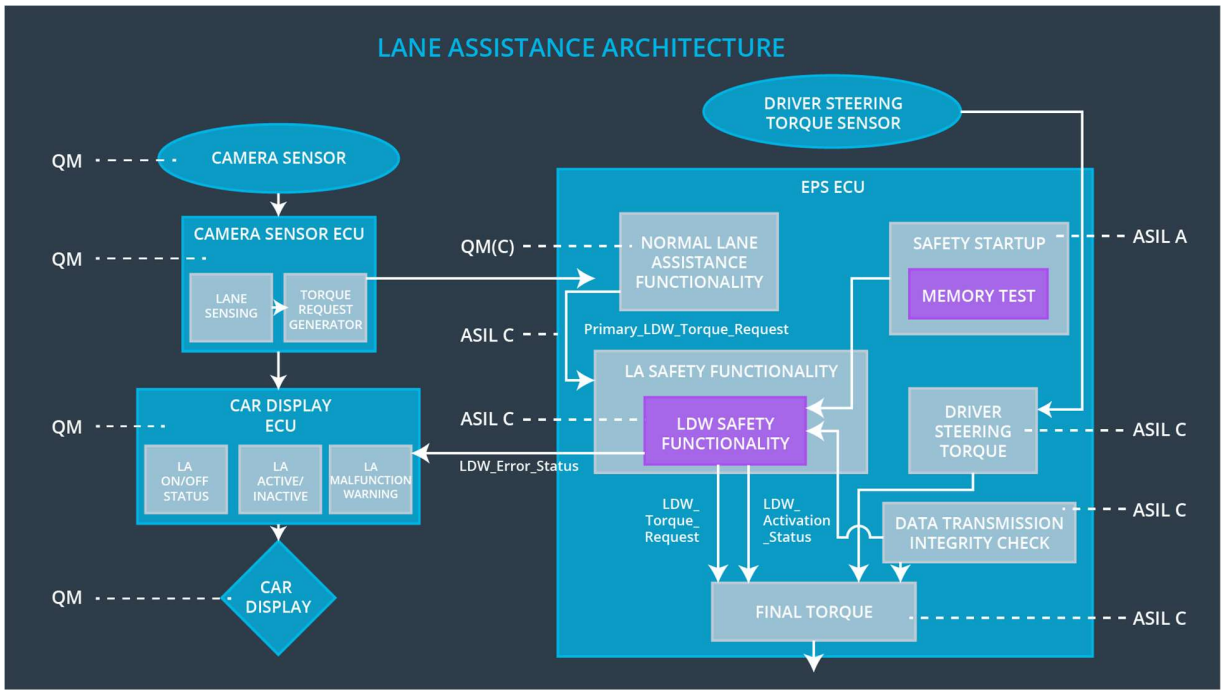
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 02-01-01	The LKA safety component shall ensure that the duration of the lane keeping assistance torque is applied for less than 'Max_Duration'.	B	50ms	EPS ECU - Lane Keeping Assistance Safety Functionality	Lane Keeing Assistance torque set to zero.
Technical Safety Requirement 02-01-02	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	50ms	EPS ECU - Lane Keeping Assistance Safety Functionality	
Technical Safety Requirement 02-01-03	As soon as a failure is detected by the LKA function, the 'LKA_Torque_Request' shall be set to zero	B	50ms	EPS ECU - Lane Keeping Assistance Safety Functionality	
Technical Safety Requireme	The validity and integrity of the data transmission for	B	50ms	EPS ECU - Lane Keeping Assistance	

nt 02-01-04	'LKA_Torque_Request' signal shall be ensured.			Safety Functionality	
Technical Safety Requirement 02-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Data Transmission Integrity Check	

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

ID	Technical Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display 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	**X**		

	steering Torque' component is below 'Max_Torque_Amplitude'			
Technical Safety Requirement 01-01-02	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.	**X**		
Technical Safety Requirement 01-01-03	As soon as a failure is detected by the LDW function, the 'LDW_Torque_Request' shall be set to zero	**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 start up of the EPS ECU to check for any faults in memory.	**X**		
Technical Safety Requirement 01-02-01	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	**X**		
Technical Safety Requirement 01-02-02	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.	**X**		
Technical Safety Requirement 01-02-03	As soon as a failure is detected by the LDW function, the 'LDW_Torque_Request' shall be set to zero	**X**		
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 start up of the EPS ECU to check for any faults in memory.	**X**		
Technical Safety Requirement 02-01-01	The LKA safety component shall ensure that the duration of the lane keeping assistance torque is applied for less than 'Max_Duration'.	**X**		
Technical Safety Requirement 02-01-02	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.	**X**		
Technical Safety Requirement 02-01-03	As soon as a failure is detected by the LKA function, the 'LKA_Torque_Request' shall be set to zero	**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 start up of the EPS ECU to check for any faults in memory.	**X**		

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	System turned off	Malfunction_01 Malfunction_02	Yes	Warning indication on the car display

WDC-02	System turned off	Malfunction_03	Yes	Warning indication of the car display