Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
4/17/2017	1.0	Noriaki.H	First attempt

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Purpose of the Technical Safety Concept

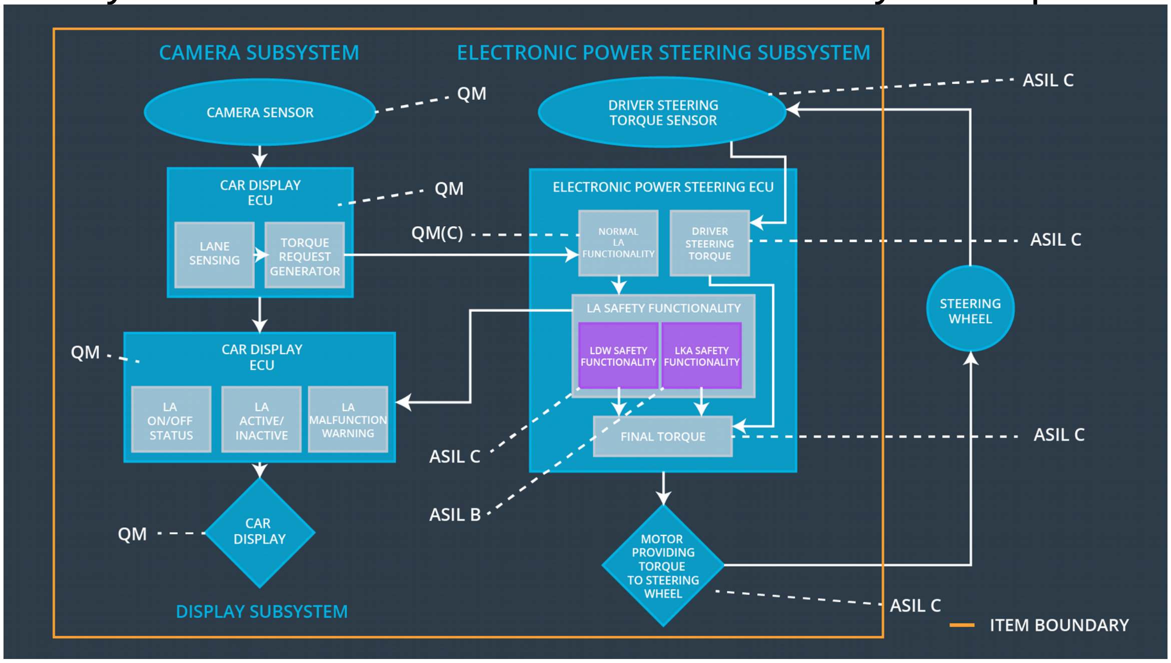
The Technical Safety Concept defines how the subsystem interact at the message level and describes how the ECUs communicate with each other.

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 lane depature oscillating torque amplitude is below Max Torque Amplitude.	C	50 ms	LDW will set the oscillating torque amplitude to 0.
Functional Safety Requirement 01-02	The Electronic Power Steering ECU shall ensure that the lane depature oscillating torque frequency is below Max Torque Frequency.	C	50 ms	LDW will set the oscillating torque frequency to 0.
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	B	500 ns	

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	**Description**
Camera Sensor	The camera sensor reads in images from the road.
Camera Sensor ECU - Lane Sensing	Analyze whether you are running in the center of the lane
Camera Sensor ECU - Torque request generator	Receives information from Lane Sensing, send TORQUE REQUEST to CAR DISPLAY ECU and NORMAL LANE ASSISTANCE FUNCTIONALITY
Car Display	Display current status of automatic operation
Car Display ECU - Lane Assistance On/Off Status	Displays On/Off of lane assistance function
Car Display ECU - Lane Assistant Active/Inactive	Displays Active/Inactive of lane assistance function
Car Display ECU - Lane Assistance malfunction warning	Displays malfunction warning of lane assistance function
Driver Steering Torque Sensor	Detects the driver's steering torque value and sends it to EPS
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Receives information from DRIVER STEERING TORQUE SENSOR, send information to FINAL TORQUE
EPS ECU - Normal Lane Assistance Functionality	Receives information from TORQUE REQUEST GENETRATOR, send infromation to LA SAFETY FUNCTIONALITY
EPS ECU - Lane Departure Warning Safety Functionality	Send information to FINAL TORUE
EPS ECU - Lane Keeping Assistant Safety Functionality	Send information to FINAL TORUE
EPS ECU - Final Torque	Send information to MOTOR PROVIDING TORQUE TO STEERING WHEEL
Motor	Applies the torque indicated by the Electronic Power Steering ECU 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	LDW Torque Request Amplitude Shall be set to 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	LDW Torque Request Amplitude Shall be set to 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	LDW Torque Request Amplitude Shall be 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	LDW Safety	LDW Torque Request Amplitude Shall be set to 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	Data Transmission Integrity Check	LDW Torque Request Amplitude Shall be 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	A S I L	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	50 ms	LDW Safety	LDW Torque Request Frequency Shall be set to 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	LDW Torque Request Frequency Shall be set to 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_Frequency' shall be set to zero.	C	50 ms	LDW Safety	LDW Torque Request Frequency Shall be 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	LDW Safety	LDW Torque Request Frequency Shall be set to 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	Data Transmission Integrity Check	LDW Torque Request Frequency Shall be set to zero.

Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:
Lane Keeping Assistance (LKA) Requirements:

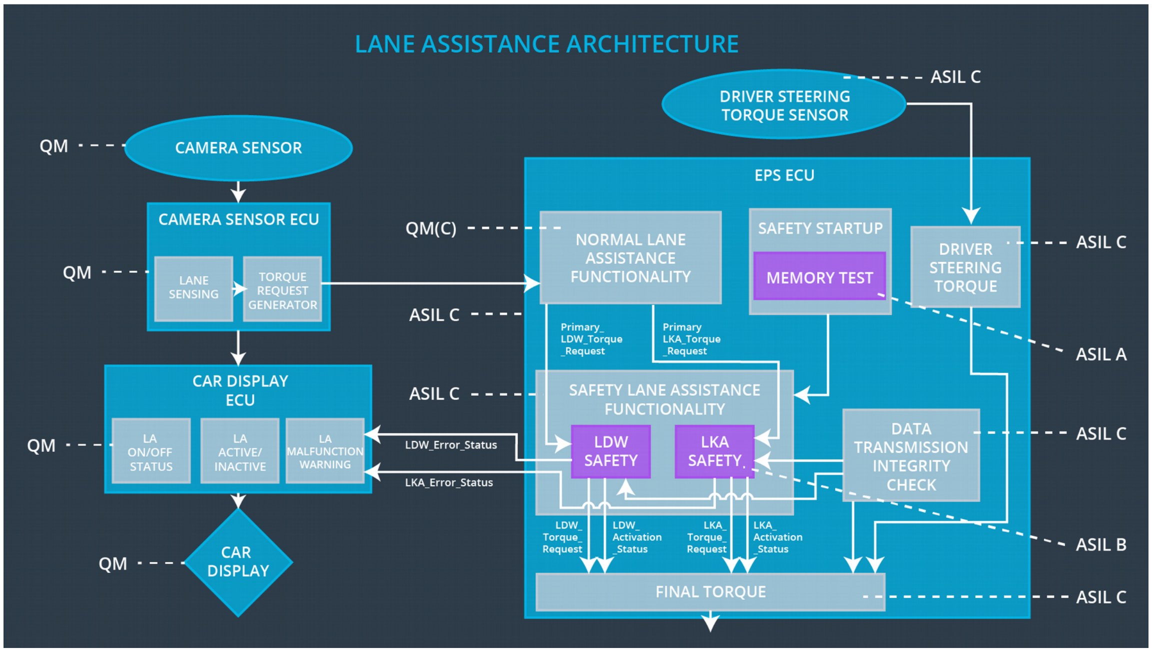
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 dulation of the lane keeping assistance torque is applied for only Max_Duration.	B	500 ms	LKA Safety	Lane Keeping Assistance torque is 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	Lane Keeping Assistance torque is 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	Lane Keeping Assistance torque is Zero.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500 ms	LKA Safety	Lane Keeping Assistance torque is 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	LKA Safety	Data Transmission Integrity Check	Lane Keeping Assistance torque is Zero.

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

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

ID	Functional 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 steering Torque' component is below 'Max_Torque_Amplitude.	X		
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, it shall deactivate the LDW feature and 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 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 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, it shall deactivate the LDW feature and the 'LDW_Torque_Frequency' 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 dulation of the lane keeping assistance torque is applied for only 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, it shall deactivate the LKA feature and 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	Turn System off	Malfunction_01	yes	warning light on the dashboard
WDC-02	Turn System off	Malfunction_02	yes	warning light on the dashboard