Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

[Instructions: Fill in the date, version and description fields. You can fill out the Editor field with your name if you want to do so. Keep track of your editing as if this were a real world project.

For example, if this were your first draft or first submission, you might say version 1.0. If this is a second submission attempt, then you'd add a second line with a new date and version 2.0]

Date	Version	Editor	Description
26/12/2018	1.0	Manjunath Gasthi	Initial version
27/12/2018	1.1	Manjunath Gasthi	Technical requirement revisit

Table of Contents

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Purpose of the Technical Safety Concept

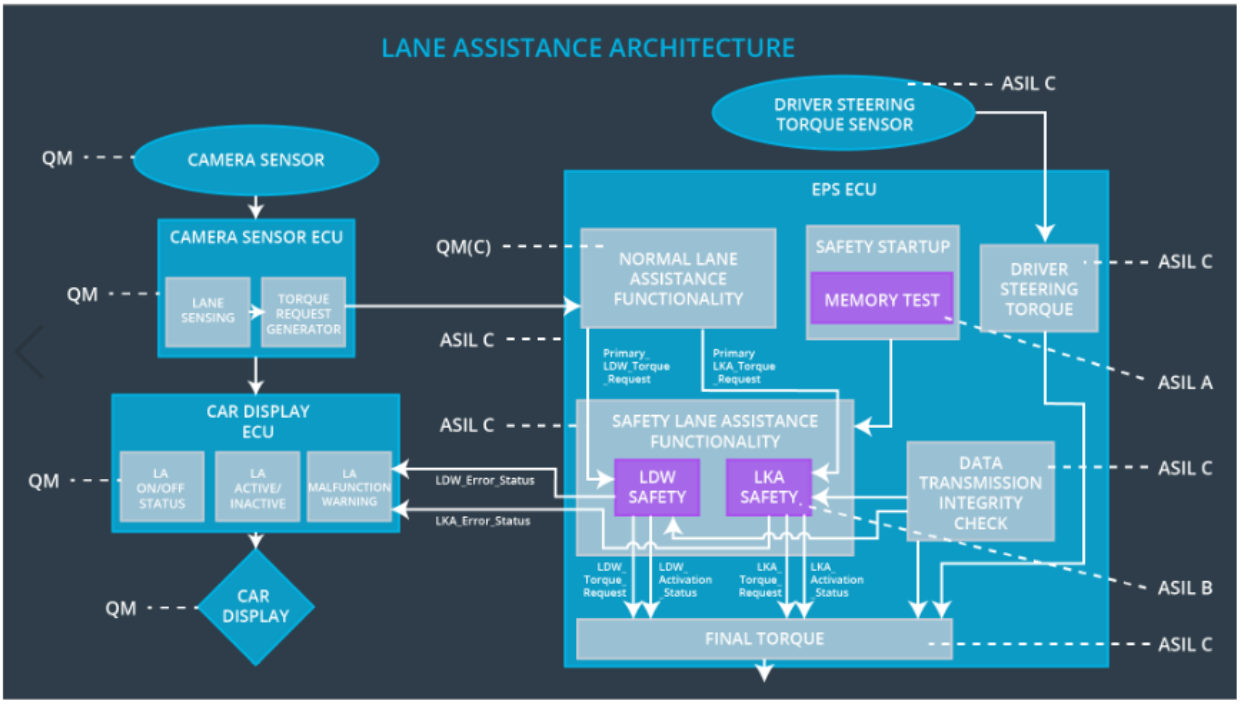
In this document new requirements are defined and assigned to the system architecture. These requirements are more concrete and gets into details of the item's technology as specified by ISO 26262.

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	Test and validate that the Max_Torque_Amplitude chosen is low enough that the driver does not loose control over the car.	C	50mS	Vibration torque amplitude is below Max_Torque_Amplitude.
Functional Safety Requirement 01-02	Test and validate that the Max_Torque_Frequency chosen is low enough that the driver does not loose control over the car.	C	50mS	Vibration 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 for only Max_Duration.	B	500mS	Lane Keeping Assistance torque is zero.

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 detecting the lane line positions from the Camera Sensor images.
Camera Sensor ECU - Torque request generator	Software module calculating the necessary torque to be requested to the Electronic Power Steering ECU.
Car Display	Display warning for the driver.
Car Display ECU - Lane Assistance On/Off Status	Indicate the status of the Lane Assistance functionality (On/Off.)

Car Display ECU - Lane Assistant Active/Inactive	Indicate if the Lane Assistance functionality is properly functioning (Active/Inactive.)
Car Display ECU - Lane Assistance malfunction warning	Indicate a malfunction on 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	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	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 the 'LDW_Torque_Request' sent to the 'Final electronically 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	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 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	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 electronically 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	The validity and integrity of the data transmission for 'Max_Torque_Frequency’ signal shall be ensured.	C	50 mS	LDW Safety	LDW Torque Request Frequency shall be set to zero.
Technical Safety Requirement	As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and	C	50 mS	LDW Safety	LDW Torque Request

03	the 'Max_Torque_Frequency‘ shall be set to zero.				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 Keeping Assistance (LKA) Requirements:

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

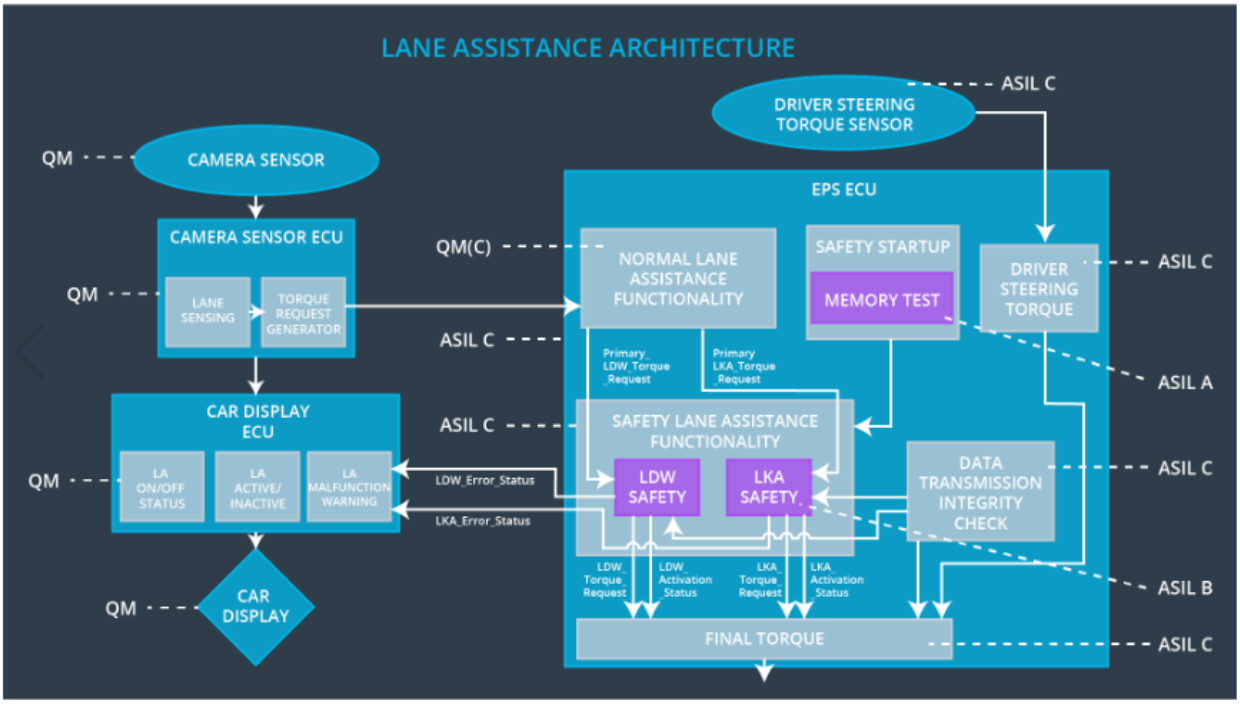
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 Lane Keeping Assistance safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max_Duration	C	500 ms	LKA Safety	Lane Keeping Assistance torque to 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.	C	500 ms	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.	C	500 ms	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.	C	500 ms	LKA Safety	Lane Keeping Assistance torque to zero.
Technical Safety Requireme	Memory test shall be conducted at start up of the EPS ECU to check for any	A	Ignition cycle	Data Transmission Integrity	Lane Keeping Assistance

nt 05	memory problems			Check	torque to zero.

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	The LDW safety component shall ensure that the amplitude of the 'LDW_Torque_Request‘ sent to the ‘Final electronically power	X		

01-01-01	steering Torque‘ component is below 'Max_Torque_Amplitude’.			
Technical Safety Requirement 01-01-02	The validity and integrity of the data transmission for 'LDW_Torque_Request’ signal shall be ensured.	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	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 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	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 electronically power steering Torque‘ component is below 'Max_Torque_Frequency’.	X		
Technical Safety Requirement 01-02-02	The validity and integrity of the data transmission for 'Max_Torque_Frequency’ signal shall be ensured.	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 'Max_Torque_Frequency‘ shall be set to zero.	X		
Technical Safety Requirement 01-02-04	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 01-02-05	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 the duration of the lane keeping assistance torque is applied for less than Max_Duration.	X		
Technical Safety Requirement 02-01-02	The validity and integrity of the data transmission for ‚LKA_Torque_Request' signal shall be ensured.	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	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 02-01-05	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 Malfunction_02	Yes	Warning light on the dashboard
WDC-02	Turn system off.	Malfunction_03	Yes	Warning light on the dashboard