Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

Document Version: [1.1]

Template Version 1.0, Released on 2017-06-21

Document history

Date	Version	Editor	Description
20 June, 2018	1.0	Akhil Suri	Initial Submission
22 June, 2018	1.1	Akhil Suri	Corrected typos

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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. This is a crucial step before developing reliable hardware and software. As part of product development technical safety concept involves:

- Turning functional safety requirements into technical safety requirements
- Allocating technical safety requirements to the system architecture
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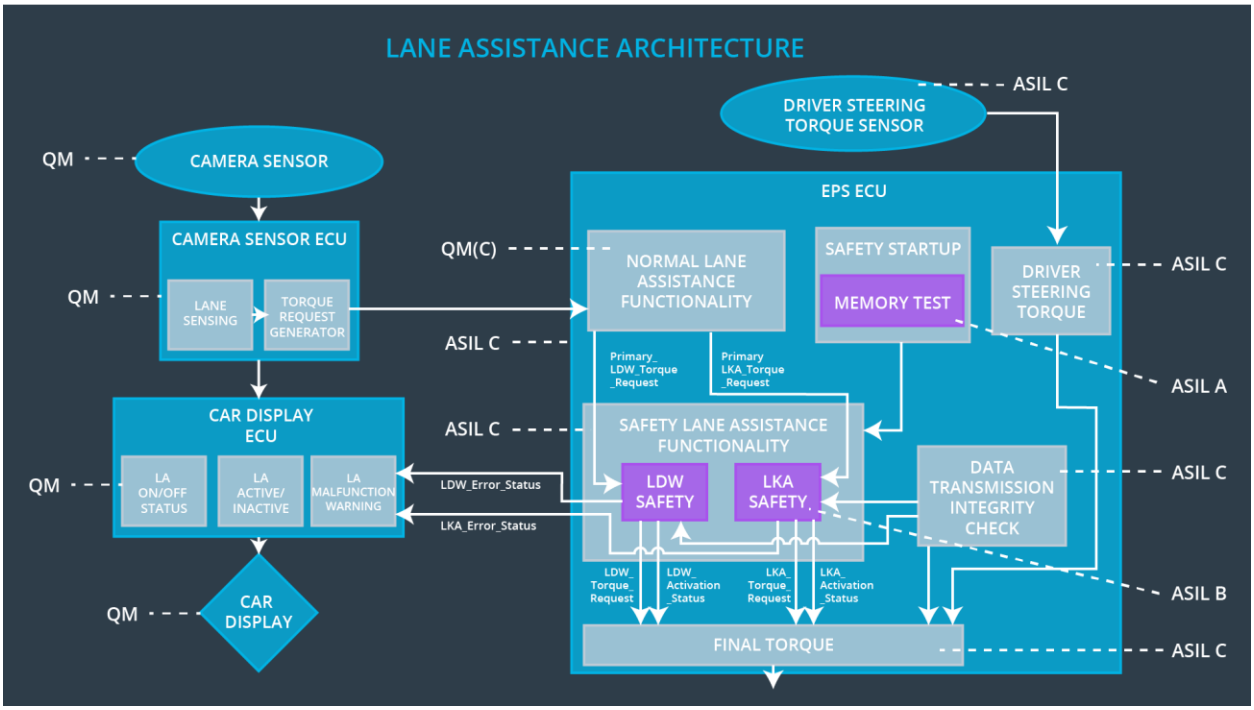
As a subsequent step technical safety requirements will be considered within software and hardware implementation.

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	To provide the images captured from camera to the camera Sensor ECU.
Camera Sensor ECU - Lane Sensing	Images will be analyzed and will calculate the car position and detect the lane lines.
Camera Sensor ECU - Torque request generator	Generating torque request to the Electronic Power Steering ECU.
Car Display	It will display warning to the driver.
Car Display ECU - Lane Assistance On/Off Status	Indicates if the Lane Assistance function is turned on.
Car Display ECU - Lane Assistant Active/Inactive	Indicates if the Lane Assistance function is active at that time.
Car Display ECU - Lane Assistance malfunction warning	Indicates if the Lane Assistance is having malfunction.
Driver Steering Torque Sensor	It will be measuring the steering torque which will

	be applied by the driver to the steering wheel.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Input from Driver Steering Torque is processed.
EPS ECU - Normal Lane Assistance Functionality	Request from the Camera Sensor ECU torque will be received by this module.
EPS ECU - Lane Departure Warning Safety Functionality	It will check if Lane Departure Warning function is having malfunction and will translate the request to final torque output.
EPS ECU - Lane Keeping Assistant Safety Functionality	It will check if Lane Keeping Assistant function is having malfunction and will translate the request to final torque output.
EPS ECU - Final Torque	Generates final torque from torque requests received from LDW and LKA safety.
Motor	The component is responsible for applying the work required to produce the torque required to execute actions delivered to the power steering ECU.

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 Amplitude to be set as 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 Amplitude to be set as 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 Amplitude to be set as 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 Amplitude to be set as 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 Amplitude to be set as zero

[Instructions: Fill in the technical safety requirements for the lane departure warning second functional safety requirement. We have provided the associated functional safety requirement in the table below. Hint:. Most of the technical safety requirements will be the same. At least one technical safety requirement will have to be slightly modified

because we are talking about frequency instead of amplitude. These requirements were not given in the lessons]

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	LDW safety components should ensure that frequency of LDW_Torque_Request sent to the Final Power steering torque should be below Max_Torque_Frequency	C	50 ms	LDW Safety	Lane Departure Warning Torque Request Frequency shall be set to zero.
Technical Safety Requirement 02	Integrity and validity of the Max_Torque_Frequency should be ensured.	C	50 ms	LDW Safety	Lane Departure Warning Torque Request Frequency shall be set to zero.
Technical Safety	As soon as the LKA function deactivates the LKA feature, it	C	50 ms	LDW Safety	Lane Departu

Requirement 03	should set the Max_Torque_Frequency to zero.				re Warning Torque Request Frequency shall be set to zero
Technical Safety Requirement 04	When the LKA feature is deactivated by the LKA function, then the signal needs to be send to the display ECU for turning on the warning light.	C	50 ms	LDW Safety	Lane Departure Warning Torque Request Frequency shall be set to zero
Technical Safety Requirement 05	Memory test shall be conducted to check for any faults in the memory at start of the EPS ECU.	A	Ignition cycle	Data Transmission and Integrity Check	Lane Departure Warning Torque Request Frequency shall be set to zero

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

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. "Validation" asks whether or not you chose the appropriate parameters. "Verification" involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

Lane Keeping Assistance (LKA) Requirements:

[Instructions: Fill in the technical safety requirements for the lane keeping assistance functional safety requirement 02-01. We have provided the associated functional safety

requirement in the table below. Hint:. You can reuse the technical safety requirements from functional safety requirement 01-01. But you need to change the language because we are now looking at a different system. The ASIL and Fault Tolerant Time Interval are different as well.]

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:

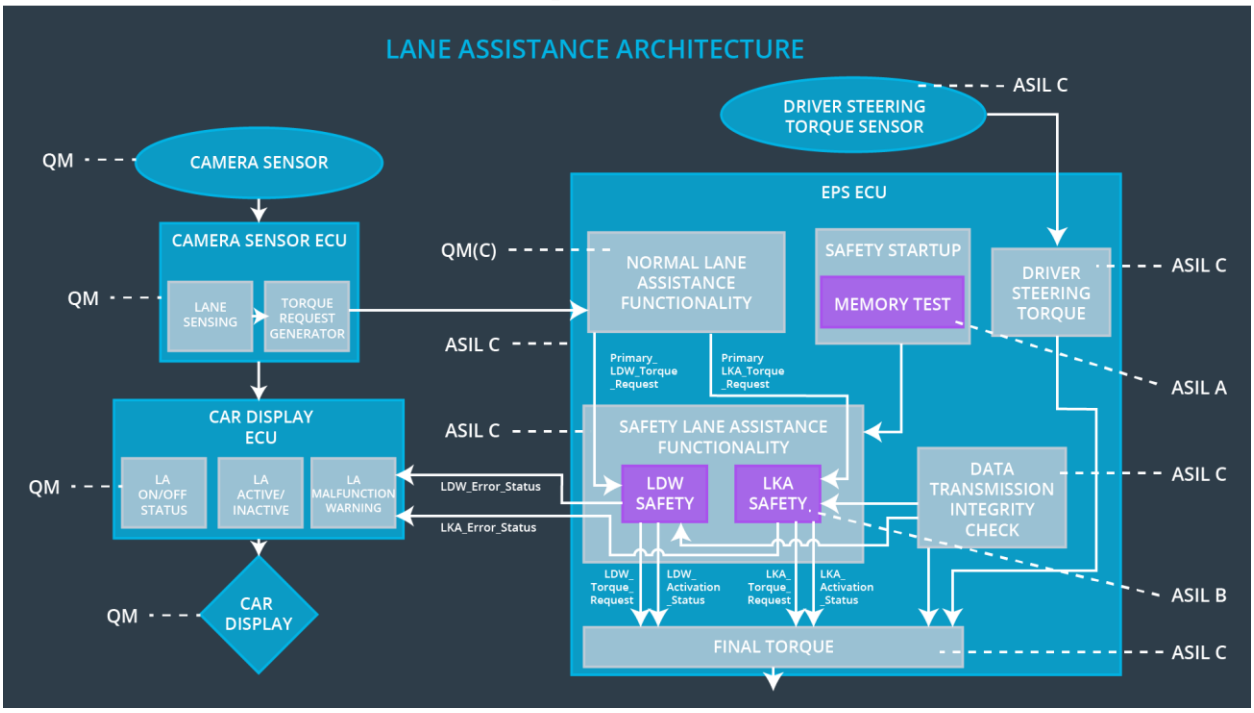
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01	The LKA safety component shall ensure that the duration or time taken by the lane keeping assistance LKA torque applied is less than Max_Duration	B	500 ms	LKA Safety	Set LKA torque to be zero
Technical Safety Requirement 02	When the LKA feature is deactivated by the LKA function, then the signal needs to be send to the display ECU for turning on the warning light.	B	500 ms	LKA Safety	Set LKA torque to be zero
Technical Safety Requirement 03	As soon as the LKA function deactivates the LKA feature, it should set the LKA_Torque_Request to zero.	B	500 ms	LKA Safety	Set LKA torque to be zero
Technical Safety Requirement 04	Integrity and validity of the LKA_Torque_Request should be ensured.	B	500 ms	LKA Safety	Set LKA torque to be zero
Technical Safety Requirement 05	Memory test shall be conducted to check for any faults in the memory at start of the EPS ECU.	A	Ignition cycle	Data Transmission Integrity Check	Set LKA torque to be zero

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

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. "Validation" asks whether or not you chose the appropriate parameters. "Verification" involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

Refinement of the System Architecture

[Instructions: Include the refined system architecture. Hint: The refined system architecture should include the system architecture from the end of the technical safety lesson, including all of the ASIL labels.]



Allocation of Technical Safety Requirements to Architecture Elements

[Instructions: We already included the allocation as part of the technical requirement tables. Here you can state that for this particular item, all technical safety requirements are allocated to the Electronic Power Steering ECU]

The technical safety requirements will be allocated to different software elements such as the "LDW Safety Functionality" block, the "Data Transmission Integrity Check", or other relevant blocks inside the EPS ECU.

Warning and Degradation Concept

[Instructions: We've already identified that for any system malfunction, the lane assistance functions will be turned off and the driver will receive a warning light indication. The technical safety requirements have not changed how functionality will be degraded or what the warning will be.

So in this case, the warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements. You can copy the functional safety warning and degradation concept here.

Oftentimes, a technical safety analysis will lead to a more detailed warning and degradation concept.]

WDC-01 is for Lane Departure Warning function
WDC-02 is for Lane Keeping assistance function

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off the functionality	Malfunction_01 Malfunction_02	Yes	a warning light on the dashboard
WDC-02	Turn off the functionality	Malfunction_03	Yes	a warning light on the dashboard