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

Table of Contents

[Instructions: We have provided a table of contents. If the table of contents is not showing up correctly in your word processor of choice, please update it. The table of contents should show each section of the document and page numbers or links. Most word processors can do this for you. In Google Docs, you can use headings for each section and then go to Insert > Table of Contents. Microsoft Word has similar capabilities]

Purpose of the Technical Safety Concept

[Instructions: Answer what is the purpose of a technical safety concept?]

The functional safety concept and technical safety concept are similar in that you will need to identify new requirements and allocate these requirements to system architecture.

However, ISO 26262 places the functional safety concept in the concept phase while the technical safety concept is part of the product development phase.

This is because the technical safety concept is more concrete and gets into the details of the item's technology such as sensors, control units and actuators. Technical safety requirements are general hardware and software requirements but still without getting into specific details. For example, in the technical safety concept you might realize that you need to add more ECUs, sensors, and extra software blocks to your system.

So the technical safety concept involves:
- Turning functional safety requirements into technical safety requirements
- Allocating technical safety requirements to the system architecture
- In addition to mapping from the functional safety requirements, ISO26262 requires technical safety requirements to cover five other categories.
    - Two of the categories are for detecting faults either within the system or in an external device interacting with the system.
    - The other three categories are from measures that enable the system to reach a safe state, to implement a warning and degradation concept, or to prevent latent faults.

This will help to drill down into software and hardware implementation.

Inputs to the Technical Safety Concept

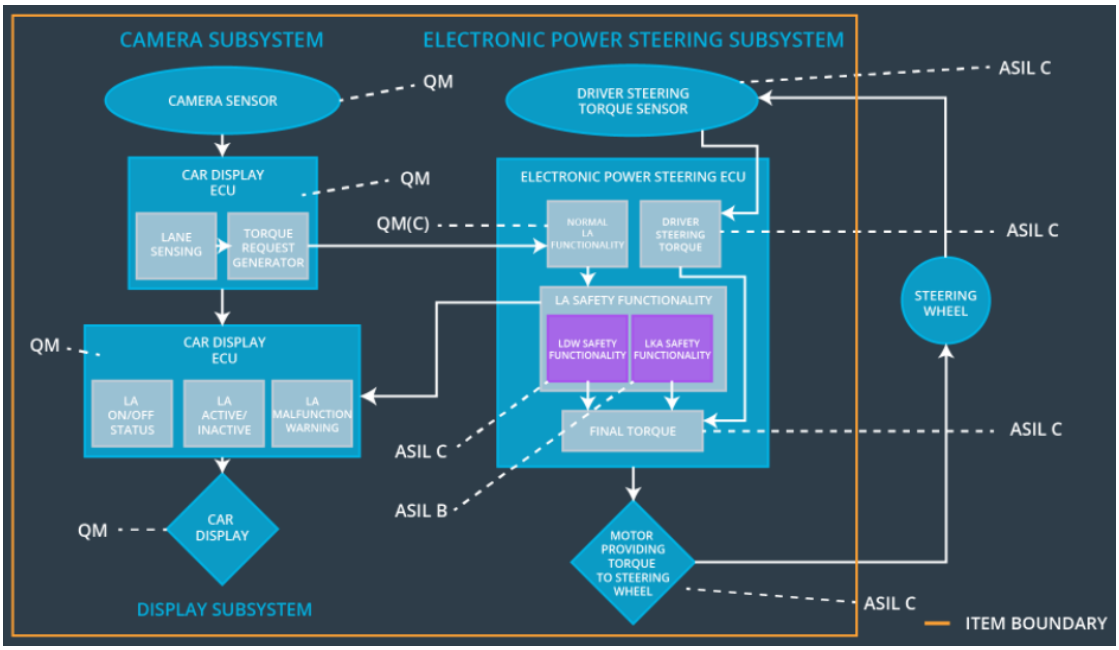
Functional Safety Requirements

[Instructions: Provide the functional safety requirements derived in the functional safety concept]

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The lane keeping items shall ensure that the lane departure oscillating torque amplitude is below max torque amplitude.	C	50 ms	LDW function will be turned off
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below max torque frequency.	C	50 ms	LDW function will be 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	500 ms	LKA function will be turned off

Refined System Architecture from Functional Safety Concept

[Instructions: Provide the refined system architecture from the functional safety concept]



Functional overview of architecture elements

[Instructions: Provide a description for each functional safety element; what is each element's purpose in the lane assistance item?]

Element	Description
Camera Sensor	Sensor responsible for capturing vehicle driving conditions such as surrounding vehicles, obstacles and lane lines.
Camera Sensor ECU - Lane Sensing	Software module in the Camera Sensor ECU that is responsible for detecting lane lines and determining ego vehicle’s position relative to lane lines.
Camera Sensor ECU - Torque request generator	Software module in the Camera Sensor ECU that is responsible for calculating and sending the additional torque for the LDW and LKA functionality.
Car Display	Visual display warning of lane departures, LDW / LKA activation and deactivations.
Car Display ECU - Lane Assistance On/Off Status	Software module in the Car Display ECU that is responsible for processing information from other item elements and accordingly, decide LDW and LKA ON/OFF status on the car display.
Car Display ECU - Lane Assistant Active/Inactive	Software module in the Car Display ECU that is responsible for processing information from other item elements and accordingly, display warning of lane departures, LDW / LKA activations and deactivations.
Car Display ECU - Lane Assistance malfunction warning	Software module in the Car Display ECU that is responsible for processing information from other item elements and accordingly, display warning of LDW / LKA malfunctions.
Driver Steering Torque Sensor	Sensor responsible for measuring steering torque that the driver is applying on the steering wheel.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software module in the EPS ECU that is responsible for receiving camera sensor ECU torque requests.
EPS ECU - Normal Lane Assistance Functionality	Software module in the EPS ECU that is responsible for receiving driver steering torque sensor input from the steering wheel.
EPS ECU - Lane Departure Warning Safety Functionality	Software module in the EPS ECU that is responsible for maintaining the lane departure oscillating torque amplitude and frequency values as stated in requirements

EPS ECU - Lane Keeping Assistant Safety Functionality	Software module in the EPS ECU that is responsible for ensuring that LKA torque does not exceed Max_Duration.
EPS ECU - Final Torque	Software module in the EPS ECU that is responsible for ensuring that requests for LDW, LKA are combined before torque request is sent to the actuator.
Motor	Actuator responsible for taking inputs from ECU and then applying requested torque on the steering column

Technical Safety Concept

Technical Safety Requirements

[Instructions: Fill in the technical safety requirements for the lane departure warning first functional safety requirement. We have provided the associated functional safety requirement in the first table below. Hint: The technical safety requirements were discussed in the lesson videos. The architecture allocation column should contain element names such as LDW Safety block, Data Transmission Integrity Check, etc. Allocating the technical safety requirements to the "EPS ECU" does not provide enough detail for a technical safety concept.]

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	AS	Fault Tolerant	Architecture Allocation	Safe State

		IL	Time Interval		
Technical Safety Requirement 01	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	The LDW torque request amplitude shall be set to zero.
Technical Safety Requirement 02	The validity and integrity of the data transmission for the LDW_Torque_Request signal shall be ensured.	C	50 ms	Data Transmission Integrity Check	The 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	The LDW torque request amplitude shall be set to zero.
Technical Safety Requirement 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.	C	50 ms	LDW safety	The LDW torque request amplitude shall be set to zero.
Technical Safety Requirement 05	Memory test shall be conducted at the start-up of EPS ECU to check for any faults in memory.	A	Ignition cycle	Memory Test	The LDW torque request amplitude shall be set to 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 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	The LDW torque request frequency shall be set to zero.
Technical Safety Requirement 02	The validity and integrity of the data transmission for the LDW_Torque_Request signal shall be ensured.	C	50 ms	Data Transmission Integrity Check	The 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_Request shall be set to zero.	C	50 ms	LDW safety	The LDW torque request frequency shall be set to zero.
Technical Safety Requirement 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.	C	50 ms	LDW safety	The LDW torque request frequency shall be set to zero.

Technical Safety Requirement 05	Memory test shall be conducted at the start-up of EPS ECU to check for any faults in memory.	A	Ignition cycle	Memory Test	The LDW 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 a duration equal to Max_Duration	X		

Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

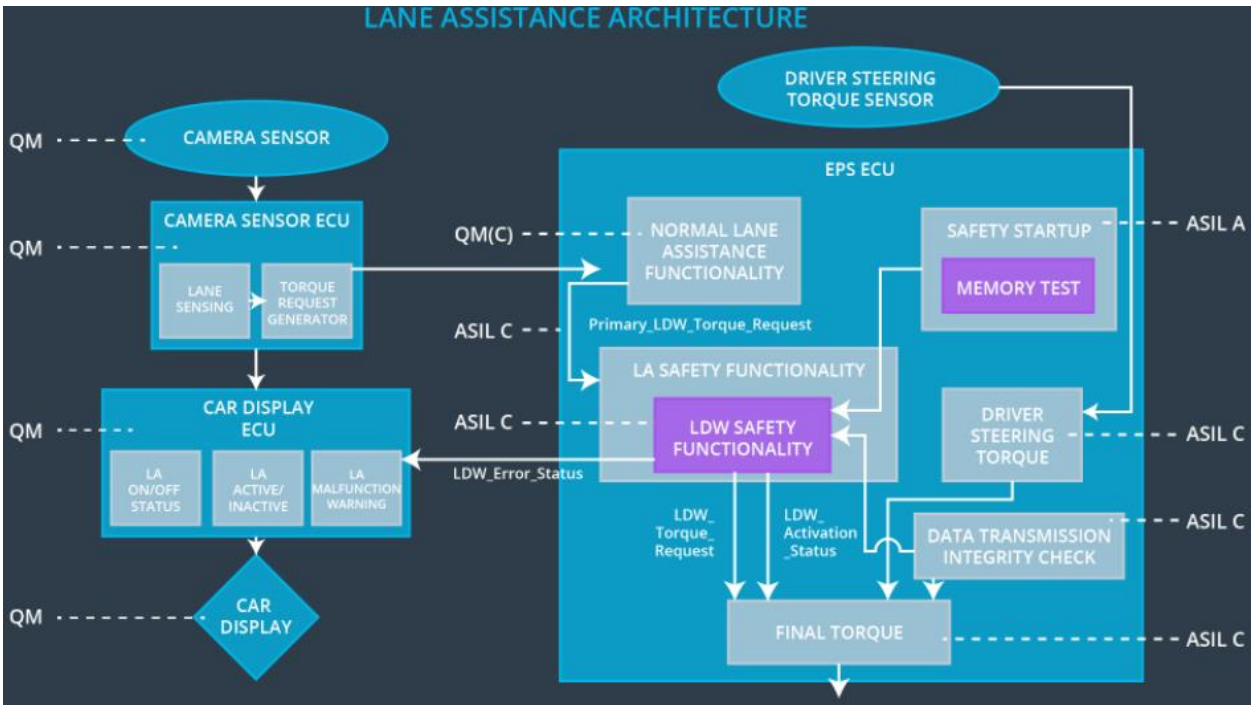
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01	LKA safety component shall ensure that the LKA torque request sent to the final electronic power steering torque component is applied for only Max_duration.	B	500 ms	LKA Safety	The LKA torque request shall be set to zero.
Technical Safety Requirement 02	The validity and integrity of the data transmission for the LKA_Torque_Request signal shall be ensured.	C	500 ms	Data Transmission Integrity Check	The LKA torque request shall be set to 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	The LKA torque request shall be set to zero.
Technical Safety Requirement 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.	B	500 ms	LKA Safety	The LKA torque request shall be set to zero.
Technical Safety Requirement 05	Memory test shall be conducted at the start-up of EPS ECU to check for any faults in memory.	A	Ignition cycle	Memory Test	The LKA torque request shall be set to 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]

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.]