



Elektrobit



UDACITY

# Functional Safety Concept Lane Assistance

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Marcus Erbar, Released on 2017-08-08



# 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
2017-08-08	1.0	Marcus Erbar	Initial draft

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# Purpose of the Functional Safety Concept

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

Allocates safety goals and functional safety requirements to the system architecture. It looks at the general functionality of the item and does not cover technical implementation.

## Inputs to the Functional Safety Concept

### Safety goals from the Hazard Analysis and Risk Assessment

[Instructions:

**REQUIRED:**

Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.

**OPTIONAL:**

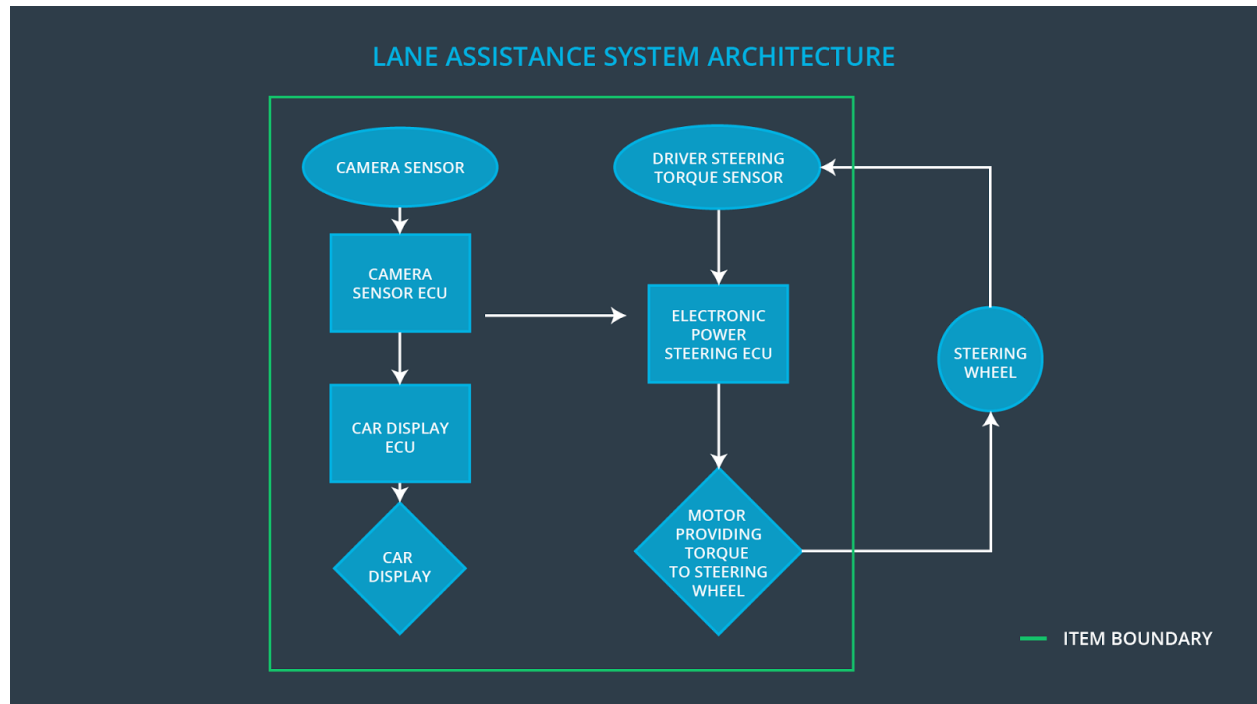
If you expanded the hazard analysis and risk assessment to include other safety goals, include them here.

]

ID	Safety Goal
Safety_Goal_01	The oscillating steering torque from the LDW function shall be limited
Safety_Goal_02	The LKA function shall be time limited and the additional steering torque shall end after a given time interval
Safety_Goal_03	The LKA function shall be deactivated during foggy conditions
Safety_Goal_04	The LKA function shall be deactivated during heavy steering input by the driver

## Preliminary Architecture

[Instructions: Provide a preliminary architecture for the lane assistance item. Hint: See Lesson 3: Item Definition]



## Description of architecture elements

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

Element	Description
Camera Sensor	Sends an image stream to the Camera Sensor ECU
Camera Sensor ECU	Responsible for detecting lane lines and determining when the vehicle leaves the lane by mistake
Car Display	Provides feedback to the driver about on/off and active/inactive status of the Lane Assistance system
Car Display ECU	Processes input from Camera Sensor ECU and engages/disengages LEDs on the Car Display
Driver Steering Torque Sensor	Responsible for measuring the torque provided by the driver
Electronic Power Steering ECU	Responsible for final steering torque output. Adds an appropriate amount of torque based on a Lane Assistance system torque request
Motor	Carries out the Electronic Power Steering ECU torque request and provides torque to the steering wheel

## Functional Safety Concept

The functional safety concept consists of:

- Functional safety analysis
- Functional safety requirements
- Functional safety architecture
- Warning and degradation concept

## Functional Safety Analysis

[Instructions: Fill in the functional safety analysis table below.]

Malfunction ID	Main Function of the Item Related to Safety Goal Violations	Guidewords (NO, WRONG, EARLY, LATE, MORE, LESS)	Resulting Malfunction
Malfunction_01	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback	MORE	The lane departure warning function applies an oscillating torque with very high torque amplitude (above limit)
Malfunction_02	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback	MORE	The lane departure warning function applies an oscillating torque with very high torque frequency(above limit)"
Malfunction_03	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	NO	The lane keeping assistance function is not limited in time duration which leads to misuse as an autonomous driving function

## Functional Safety Requirements

[Instructions: Fill in the functional safety requirements for the lane departure warning ]

Lane Departure Warning (LDW) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time	Safe State
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		L	Interval	
Functional Safety Requirement 01-01	The electronic power steering ECU shall ensure that the oscillating torque amplitude is below Max_Torque_Amplitude	C	50ms	Off
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the oscillating torque frequency is below Max_Torque_Frequency	C	50ms	Off

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

ID	Validation Acceptance Criteria and Method	Verification Acceptance Criteria and Method
Functional Safety Requirement 01-01	Test how drivers react to different torque amplitudes to prove that we chose an appropriate value.	Software test: When the torque amplitude crosses the limit, the lane assistance output is set to zero within the 50 ms fault tolerant time interval
Functional Safety Requirement 01-02	Test how drivers react to different torque frequencies to prove that we chose an appropriate value.	Software test: When the torque frequency crosses the limit, the lane assistance output is set to zero within the 50 ms fault tolerant time interval

[Instructions: Fill in the functional safety requirements for the lane keeping assistance]

Lane Keeping Assistance (LKA) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
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	Off

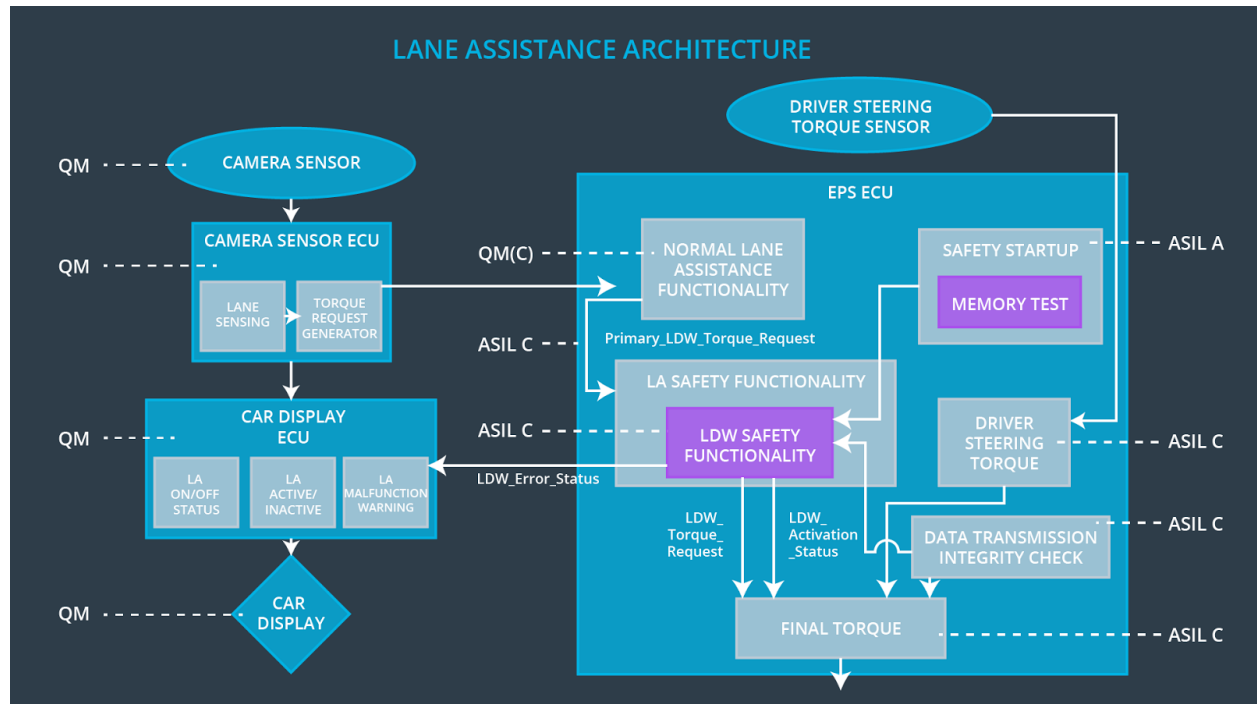
## Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:

ID	Validation Acceptance Criteria and Method	Verification Acceptance Criteria and Method
Functional Safety Requirement 02-01	Test that the max_duration chosen really does dissuade drivers from taking their hands off the wheel	Software Test: Verify that the system really does turn off if the lane keeping assistance every exceeded max_duration

## 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 functional safety lesson including all of the ASIL labels.]





## Allocation of Functional Safety Requirements to Architecture Elements

[Instructions: Mark which element or elements are responsible for meeting the functional safety requirement. Hint: Only one ECU is responsible for meeting all of the requirements.]

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU

Functional Safety Requirement 01-01	The electronic power steering ECU shall ensure that the oscillating torque amplitude is below Max_Torque_Amplitude	X		
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the oscillating torque frequency is below Max_Torque_Frequency	X		
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

## Warning and Degradation Concept

[Instructions: Fill in the warning and degradation concept.]

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Off	Oscillating torque frequency is above Max_Torque_Amplitude or Max_Torque_Frequency	Yes	LED on Car Display
WDC-02	Off	Lane keeping assistance torque is applied for more than Max_Duration	Yes	LED on Car Display