Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
01/10/2018	1.0	Anil Kumar	First version of the document

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Purpose of the Technical Safety Concept

The technical safety concept involves:

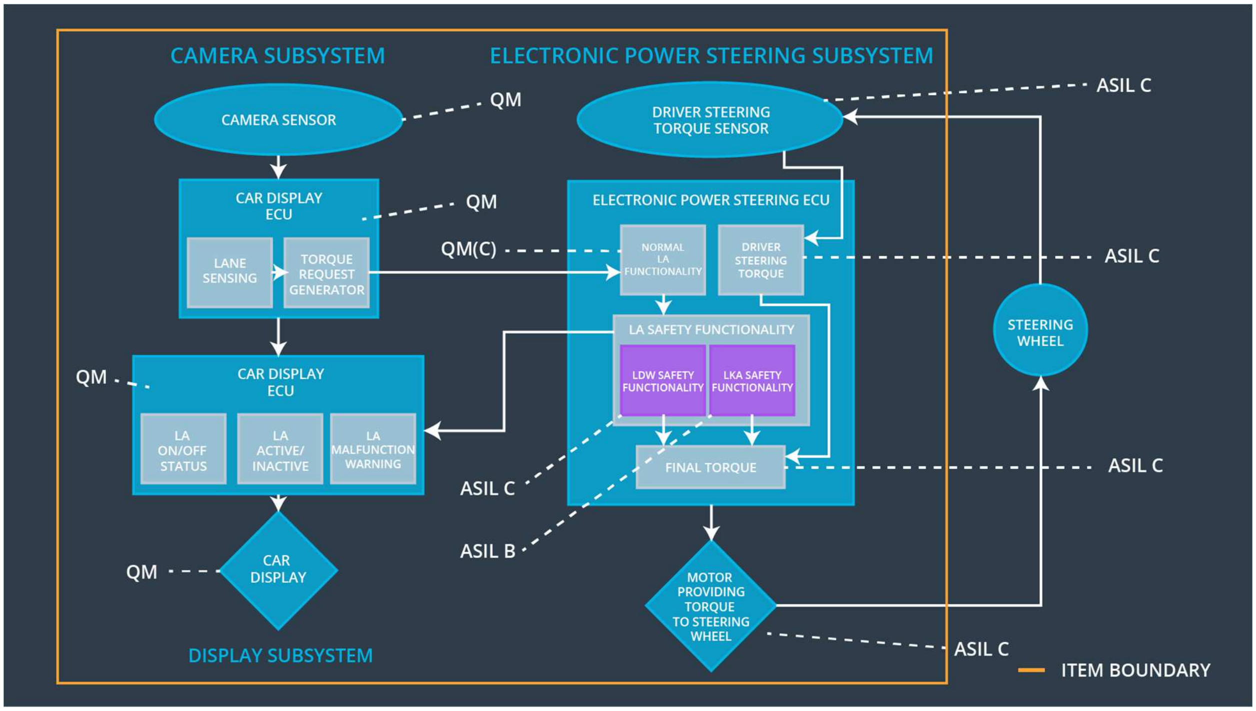
- Turning functional safety requirements into technical safety requirements
- Defining other into technical safety requirements for :
  - Detecting Faults within a system
  - Detecting faults in an external device interacting with the system
  - Reaching the safe state
  - Implementing a warning and degradation concept
  - Preventing latent faults
- Allocating technical safety requirements to the system architecture
- Defining attributes to the requirements

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 lane keeping item shall ensure that the lane departure oscillation torque amplitude is below Max_Torque_Amplitude	C	50ms	The oscillation torque amplitude is below Max_Torque_Amplitude
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillation torque frequency is below Max_Torque_Frequency	C	50ms	The oscillation torque 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 set to zero

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Captures the road image stream video
Camera Sensor ECU - Lane Sensing	the camera system detects lane and lane departure
Camera Sensor ECU - Torque request generator	Request the EPS ECU to apply Torque
Car Display	Displays warning and information to the driver
Car Display ECU - Lane Assistance On/Off Status	Display if Lane Assistance function is On/Off
Car Display ECU - Lane Assistant Active/Inactive	Display if lane Assistance function is active or not
Car Display ECU - Lane Assistance malfunction warning	Display warning Lane Assistance Error
Driver Steering Torque Sensor	Senses the torque applied to the steering wheel

Electronic Power Steering (EPS) ECU - Driver Steering Torque	Turns and vibrates the steering wheel according to the request received from Camera Sensor ECU
EPS ECU - Normal Lane Assistance Functionality	Responsible for managing Normal Lane Assistance Functionality
EPS ECU - Lane Departure Warning Safety Functionality	Responsible for managing Lane departure warning safety Functionality
EPS ECU - Lane Keeping Assistant Safety Functionality	Responsible for managing Lane Keeping Assistance safety Functionality
EPS ECU - Final Torque	Responsible deriving and sending Final Torque value to the motor
Motor	Provides Torque 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	The LDW safety component	C	50ms	LDW Safety	LDW torque

Safety Requirement 01	shall ensure that the amplitude of the ‘LDW_Torque_Request’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max_Torque_Amplitude’				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	50ms	LDW Safety	LDW torque 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	50ms	LDW Safety	LDW torque set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	Data Transmission Integrity check	LDW torque 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	Safety Startup	LDW torque 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 torque frequency of the ‘LDW_Torque_Request’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max_Torque_Frequency’	C	50ms	LDW Safety	LDW torque 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	50ms	LDW Safety	LDW torque 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	50ms	LDW Safety	LDW torque set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	Data Transmission Integrity check	LDW torque 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	Safety Startup	LDW torque 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:
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		

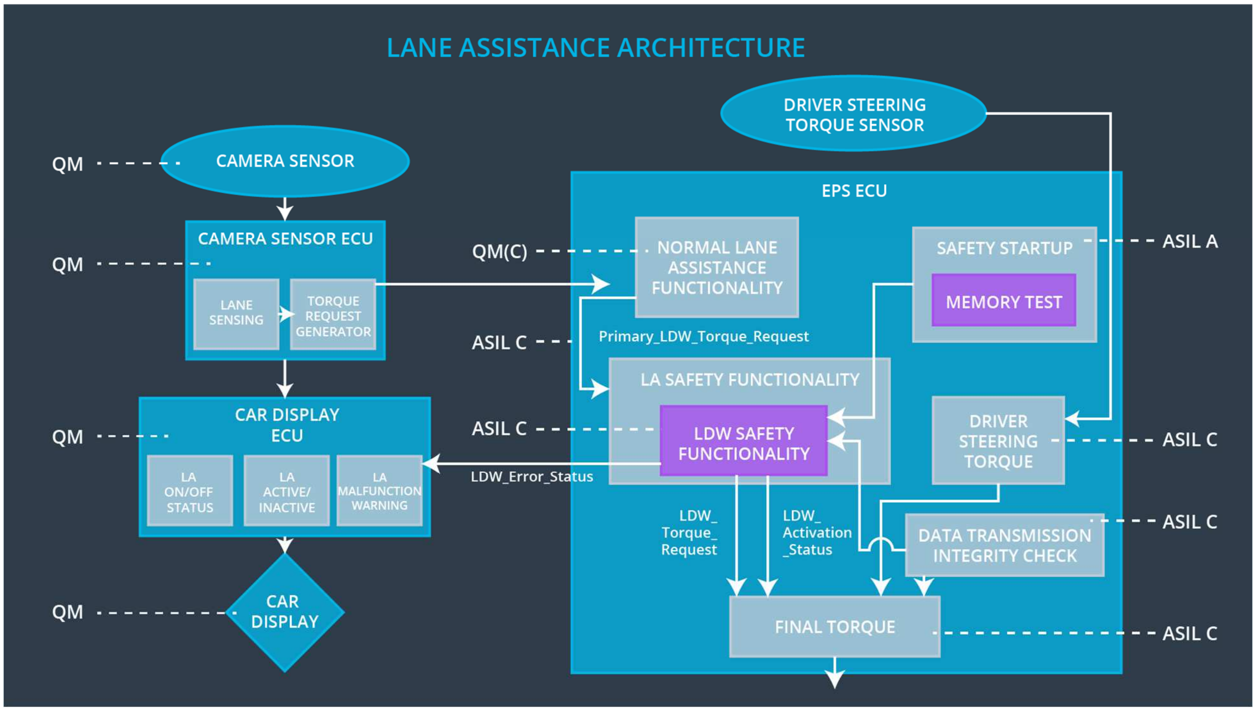
Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

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 torque is applied below ‘Max_Duration’	C	500ms	LKA Safety	LKA torque set to 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.	C	500ms	LKA Safety	LKA torque 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.	C	500ms	LKA Safety	LKA torque set to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	C	500ms	Data Transmission Integrity check	LKA torque 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	Safety Startup	LKA torque 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



Allocation of Technical Safety Requirements to Architecture Elements

For this item all the technical safety requirements allocated to the Electronic Power Steering ECU as showed in the System Architecture diagram

Warning and Degradation Concept

ID	Degradation	Trigger for	Safe State	Driver Warning

	Mode	**Degradation Mode**	**invoked?**	
WDC-01	Turning the system off (The torque request from the lane keeping assistance will be set to zero)	Malfunction_01 Malfunction_02	YES	Turn on Lane Departure warning system malfunction warning light
WDC-02	Turning the system off (The torque request from the lane keeping assistance will be set to zero)	Malfunction_03	YES	Turn on Lane Keep Assis system malfunction warning light