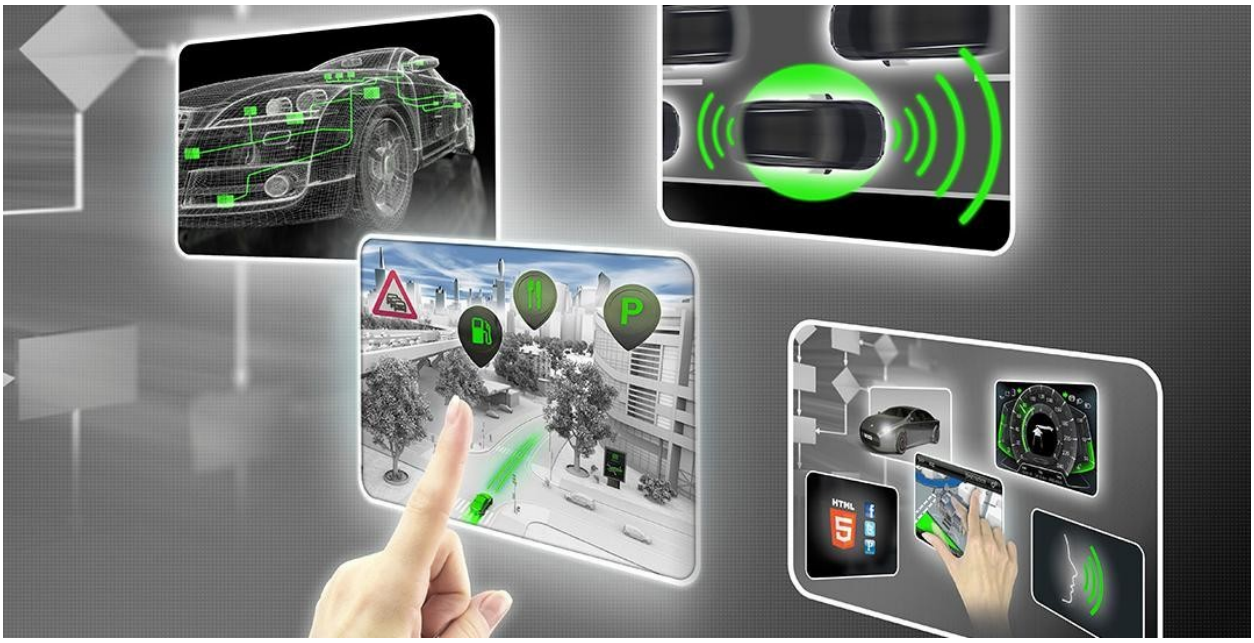
Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

Document Version: [Version]

Template Version 1.0, Released on 2017-06-21



Document history

Date	Version	Editor	Description
25/08/2017	1.0	Bide Huang	Initial draft

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Purpose of the Technical Safety Concept

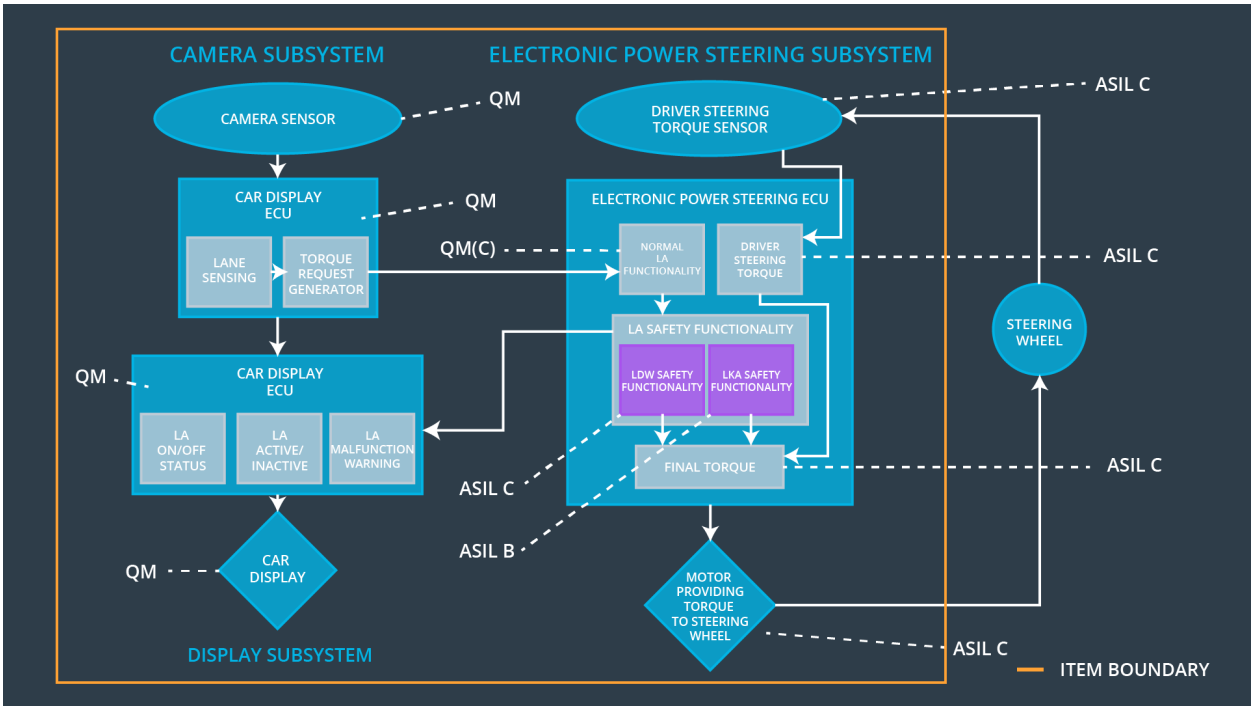
The purpose of the technical safety concept is to identify new requirements and allocate these high level hardware and software requirements to system diagrams for the lane assistance functional safety project as pertain to the potential malfunctions of the electrical and electronic systems as defined by ISO 26262 standard .

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 oscillating torque amplitude is below MAX_Torque_Amplitude	C	50ms	Set vibration torque amplitude to zero
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below MAX_Torque_Frequency	C	50ms	Set vibration torque frequency to zero
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	Set lane keeping assistance torque to zero

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

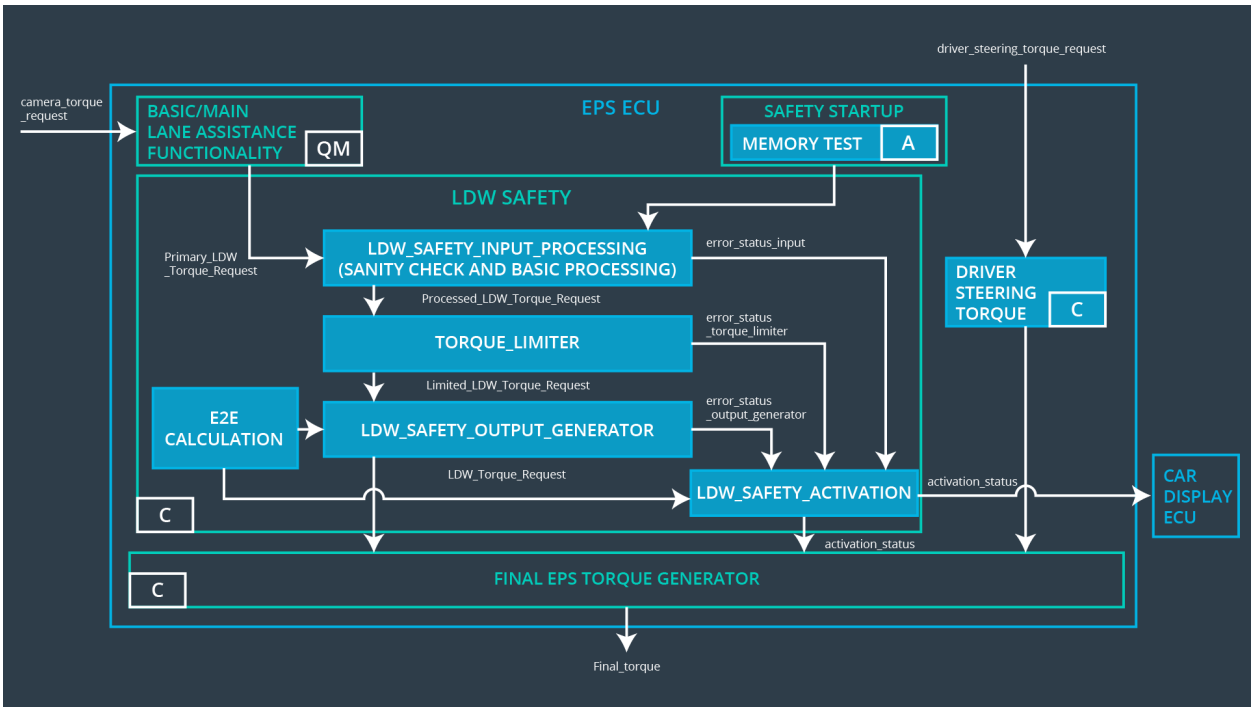
Element	Description
Camera Sensor	Sensor responsible for capturing vehicle driving condition including detectable lane lines.
Camera Sensor ECU - Lane Sensing	Software Module in the Camera Sensor ECU responsible for detecting lane lines and determining when the vehicle leaves the lane by mistake.
Camera Sensor ECU - Torque request generator	Software Module in the Camera Sensor ECU responsible for calculating and sending the additional torque for the LDW and LKA functions.
Car Display	Visual display responsible to displaying warning of lane departures and LKA and LDW activation and deactivations.
Car Display ECU - Lane Assistance On/Off Status	Visual display responsible to displaying LKA and LDW ON/OFF status.
Car Display ECU - Lane Assistant Active/Inactive	Visual display responsible to displaying displaying warning of lane departures, LKA and LDW activation and deactivations.
Car Display ECU - Lane Assistance malfunction warning	Visual display responsible to displaying warning of LKA and LDW malfunctions.
Driver Steering Torque Sensor	Sensor responsible for measuring how much force (steering torque) the driver is applying to the steering wheel.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Software Module in the electronic power steering ECU responsible for receiving the Camera Sensor ECU torque requests.
EPS ECU - Normal Lane Assistance Functionality	Software Module in the electronic power steering ECU responsible for receiving the Driver Steering torque sensor input from the steering wheel.
EPS ECU - Lane Departure Warning Safety Functionality	Software Module in the electronic power steering ECU responsible for keeping the lane departure oscillating torque amplitude and frequence below MAX_Torque_Amplitude and MAX_Torque_Fequency respectively.
EPS ECU - Lane Keeping Assistant Safety Functionality	Software Module in the electronic power steering ECU responsible for ensuring the application of the lane keeping assistance torque does not ever exceeded Max_Duration and if lane detection is lost, the LKA function is deactivated.

EPS ECU - Final Torque	Software Module in the electronic power steering ECU responsible for ensuring the LDW, LKA and the driver’s steering torque requests are combined and sent to the Motor.
Motor	Actuator responsible for applying requested torque to the steering column by the Electronic Power Steering ECU for either the LKA or the LDW functions.

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	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	C	50 ms	LDW Safety block	Set lane departure warning torque 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 block	Set lane departure warning torque 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 block	Set lane departure warning torque to zero
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50ms	LDW Safety block	Set lane departure warning torque 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	Set lane departure warning torque 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	The LDW safety component shall ensure that the frequency of "LDW_Torque_Request" send to the "Final electronic power steering torque" component is below "Max_Torque_Frequency" .	C	50ms	LDW Safety Functionallity	LDW torque output is set to zero
Technical Safety Requirement 02	The validity and integrity of the data transmission for "LDW_Torque_Request" signal shall be ensured.	C	50ms	Data Transmission integrity check	LDW torque output is 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 "LDW_Torque_Request" shall be set to zero.	C	50ms	LDW Safety Functionallity	LDW torque output is set to
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 to turn a warning light.	C	50ms	LDW Safety Functionallity	LDW torque output is set to zero
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check any faults in memory.	A	Ignition Cycle	Safety startup memory test	LDW torque output is 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		

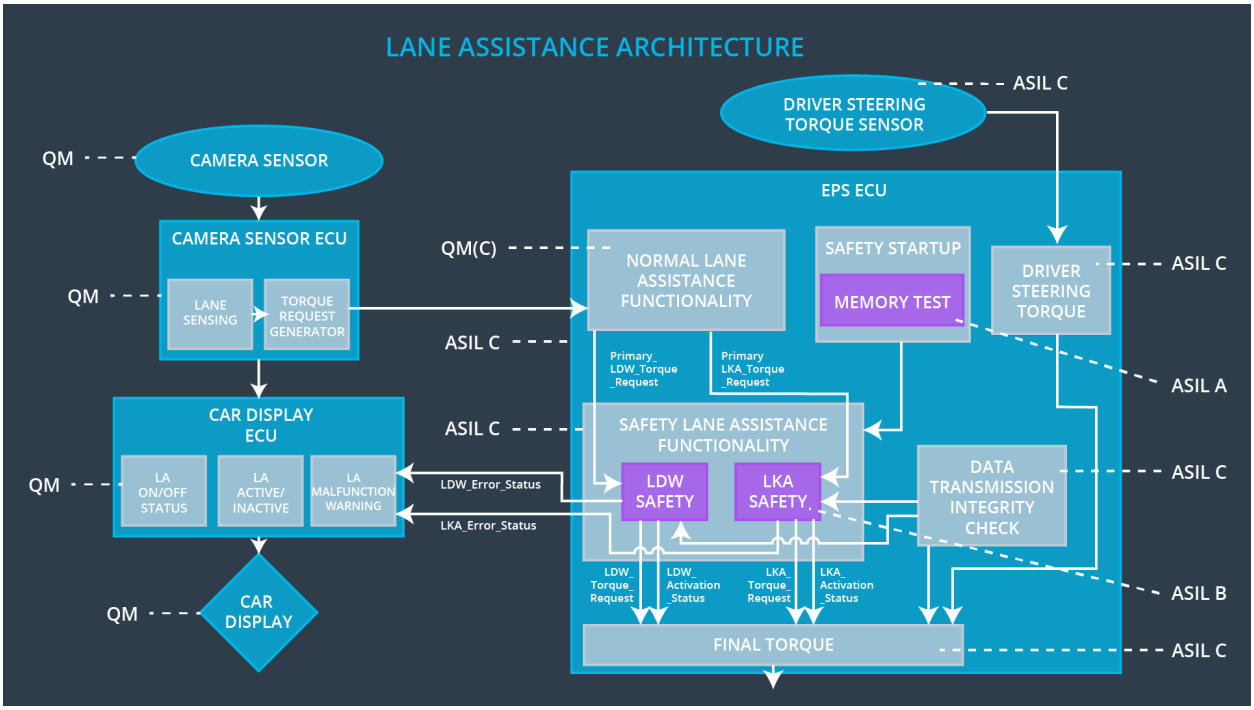
Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

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 of "LKA_Torque_Request" send to the "Final electronic power steering torque" component is below Max_Duration.	B	500ms	LKA Safety Functionallity	LKA torque output is set to zero
Technical Safety Requirement 02	The validity and integrity of the data transmission for "LKA_Torque_Request" signal shall be ensured.	B	500ms	Data Transmission integrity check	LKA torque output is 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 "LKA_Torque_Request" shall be set to zero.	B	500ms	LKA Safety Functionallity	LKA torque output is 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 to turn a warning light.	B	500ms	LKA Safety Functionallity	LKA torque output is set to zero
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check any faults in memory.	A	Ignition Cycle	Safety startup memory test	LKA torque output is 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

[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]

All technical safety requirements for Lane Departure warning and Lane Keeping Assistance are allocated to the Electronic Power Steering ECU.

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off LDW functionality	Maximum torque is beyond Max_Torque_Amplitude	Yes	Car Display
WDC-02	Turn off LKA functionality	Maximum duration is beyond Max_Duration	Yes	Car Display