Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

Document Version: 1.0

Template Version 1.0, Released on 2017-06-21

Document history

Date	Version	Editor	Description
1/2/2018	1.0	Joshua Schoenfield	First submission

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Purpose of the Technical Safety Concept

The technical safety concept defines how the subsystems interact at the message level and describes how the ECUs communicate with each other. It will be defining new specific technical safety requirements, based on the functional safety requirements outlined in the functional safety concept, and allocating these requirements to parts of the system architecture.

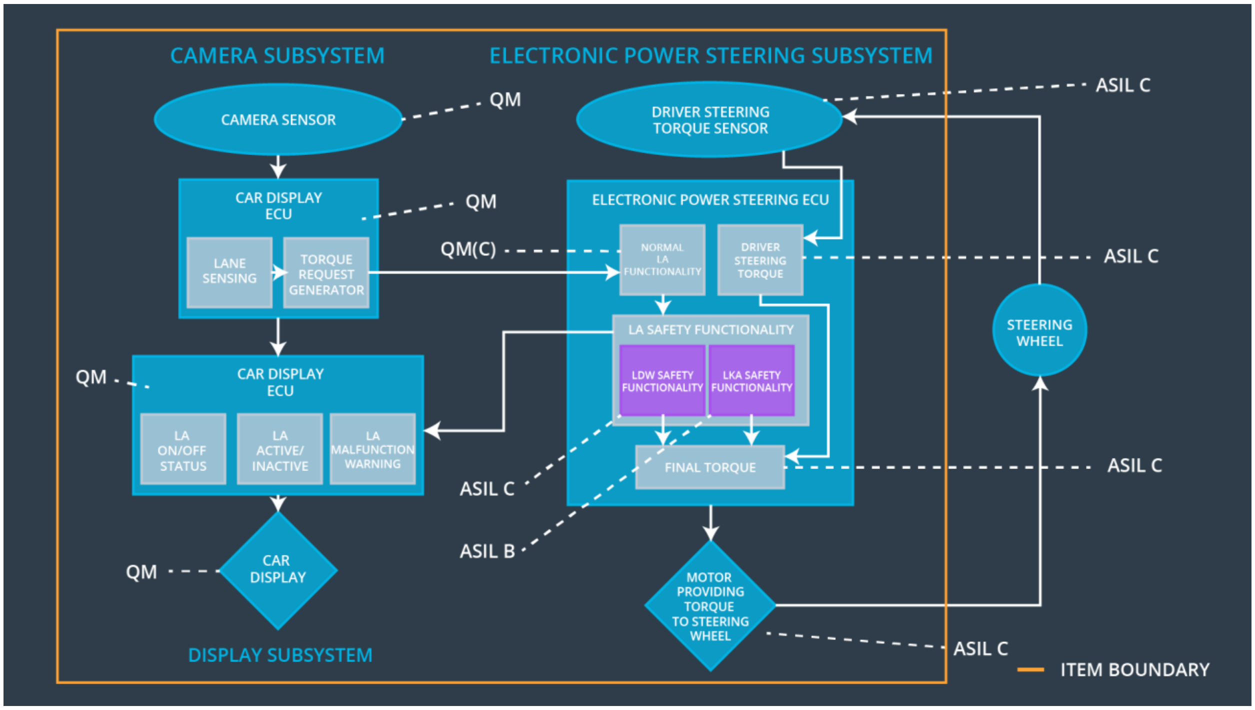
Inputs to the Technical Safety Concept

Functional Safety Requirements

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The electronic power steering ECU **shall** ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude	C	50 ms	Lane assistance output is set to zero, and the driver is able to steer.
Functional Safety Requirement 01-02	The electronic power steering ECU **shall** ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	C	50 ms	Lane assistance output is set to zero, and the driver is able to steer.
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	Lane assistance output is set to zero, and the driver is able to steer.

Refined System Architecture from Functional Safety Concept

A diagram of the refined system architecture from the functional safety concept can be found in the following image:



Functional overview of architecture elements

Element	Description
Camera Sensor	The camera sensor reads in images from the road and reports these images to the Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	The camera sensor ECU – Lane Sensing module identifies when the vehicle's position within its lane and sends that information to the Torque request generator.
Camera Sensor ECU - Torque request generator	The Camera Sensor ECU – Torque request generator element takes the information about the car's position within its lane and generates the appropriate torque to request from the Electronic Steering ECU
Car Display	Displays information about the status of the Lane Assistance System to the driver

Car Display ECU - Lane Assistance On/Off Status	Summarizes the on/off status of the Lane Assistance Item, in preparation for display to the driver by the Car Display Element
Car Display ECU - Lane Assistant Active/Inactive	Summarizes the active/inactive status of the Lane Assistance Item, in preparation for display to the driver by the Car Display Element
Car Display ECU - Lane Assistance malfunction warning	Generates a warning for display to the Driver on the Car Display in the event of a detected malfunction with the Lane Assistance item
Driver Steering Torque Sensor	Senses the torque provided to the steering wheel by the driver and provides that information to the Electronic Power Steering ECU – Driver Steering Torque module
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Processes the messages from the Driver Steering Torque Sensor for use by the EPS ECU Final Torque Element
EPS ECU - Normal Lane Assistance Functionality	Processes the messages from the Driver Steering Torque Sensor for use by the Camera ECU Torque Request Generator Element. Sends the normal lane assistance functionality for processing by the Lane Assistance Functional Safety Element
EPS ECU - Lane Departure Warning Safety Functionality	Implements the safety goals associated with the Lane Departure Warning, by modulating the final torque requested and by sending status messages to the Car Display ECU
EPS ECU - Lane Keeping Assistant Safety Functionality	Implements the safety goals associated with the Lane Keeping Assistant, by modulating the final torque requested and by sending status messages to the Car Display ECU
EPS ECU - Final Torque	Calculates the total torque required to be provided by the Motor, taking into account the safe values provided by the LA Safety Functionality elements and the torque already being provided by the driver.
Motor	Receives the final torque value from the EPS ECU and applies it 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 Safety Requirement 01-01	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 Block	Lane assistance output is set to zero
Technical Safety Requirement 01-02	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 Block	Lane assistance output is set to zero
Technical Safety Requirement 01-03	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	Lane assistance output is set to zero

Technical Safety Requirement 01-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	Data Transmission Integrity Check	Lane assistance output is set to zero
Technical Safety Requirement 01-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Safety Startup: Memory Test Block	Lane assistance output is 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 02-01	The 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 Block	Lane assistance output is set to zero

Technical Safety Requirement 02-02	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 Block	Lane assistance output is set to zero
Technical Safety Requirement 02-03	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	Lane assistance output is set to zero
Technical Safety Requirement 02-04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	Data Transmission Integrity Check	Lane assistance output is set to zero
Technical Safety Requirement 02-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Safety Startup: Memory Test Block	Lane assistance 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:

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 03-01	The LKA safety component shall ensure that the total continuous duration over which the 'LKA_Torque_Request' sent to the 'Final electronic power steering Torque' is non zero is shorter than 'Max_Duration.	B	500 ms	LKA Safety Block	Lane assistance output is set to zero
Technical Safety Requirement 03-02	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.	B	500 ms	LKA Safety Block	Lane assistance output is set to zero
Technical Safety Requirement 03-03	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 Block	Lane assistance output is set to zero
Technical Safety Requirement 03-04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500 ms	Data Transmission Integrity Check	Lane assistance output is set to zero

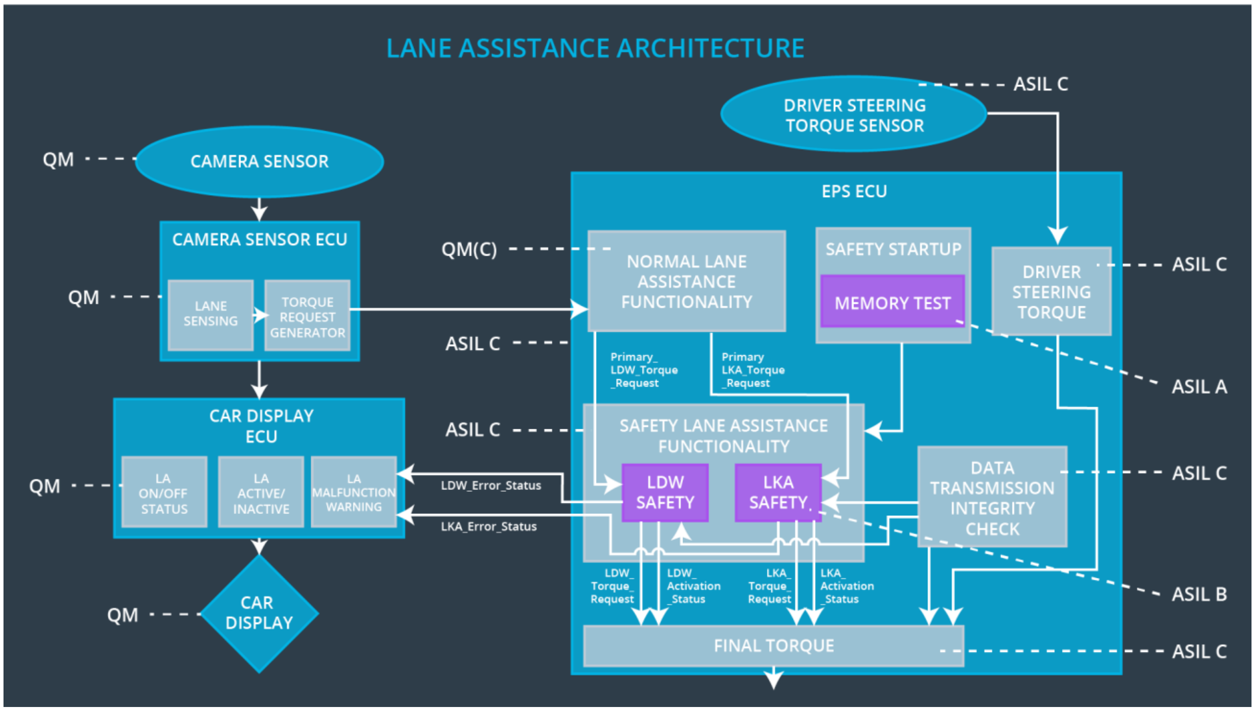
Technical Safety Requirement 03-05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Ignition cycle	Safety Startup: Memory Test Block	Lane assistance output is set to zero

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

The Refined System architecture, including all the relevant components ASIL labels can be found in the following figure:



Allocation of Technical Safety Requirements to Architecture Elements

For this item, all technical safety requirements are allocated to the Electronic Power Steering ECU. Details of the allocation can be found in the technical requirement tables.

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	LDW System Turns Off	Malfunction_01 or Malfunction_02	Yes	Lane Assistance Malfunction Warning Appears on Car Display
WDC-02	LKA System Turns Off	Malfunction_03	Yes	Lane Assistance Malfunction Warning Appears on Car Display