Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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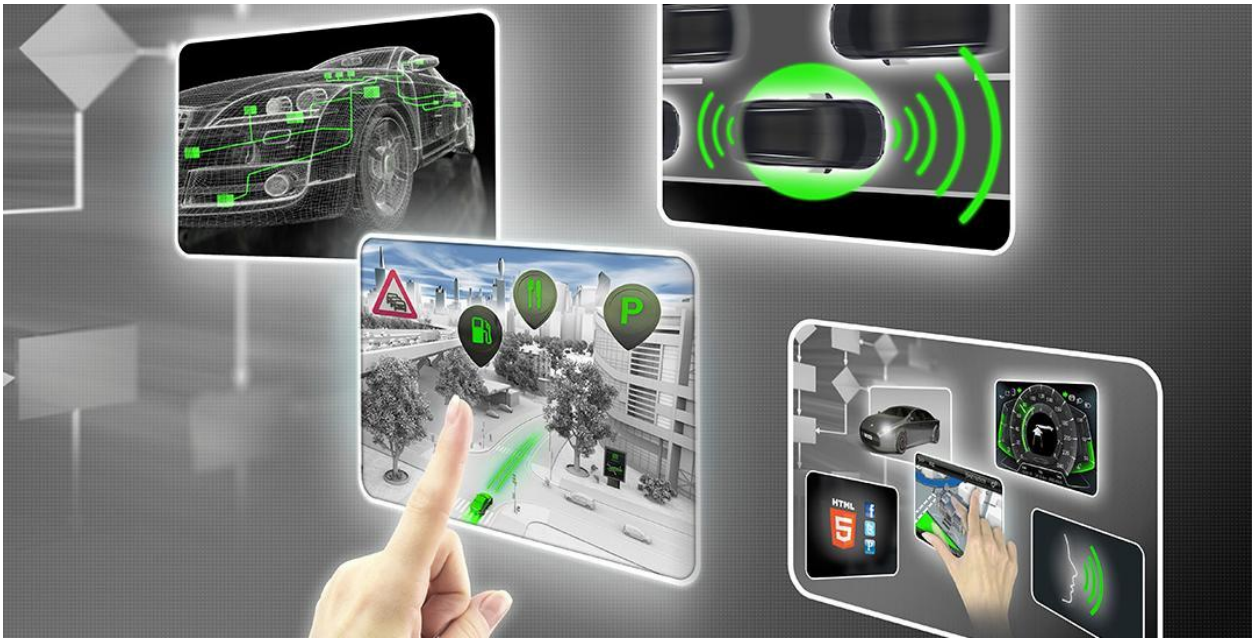

Document history

Date	Version	Editor	Description
12/2/2017	1.0	Eric Lavigne	Initial Draft

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Purpose of the Technical Safety Concept

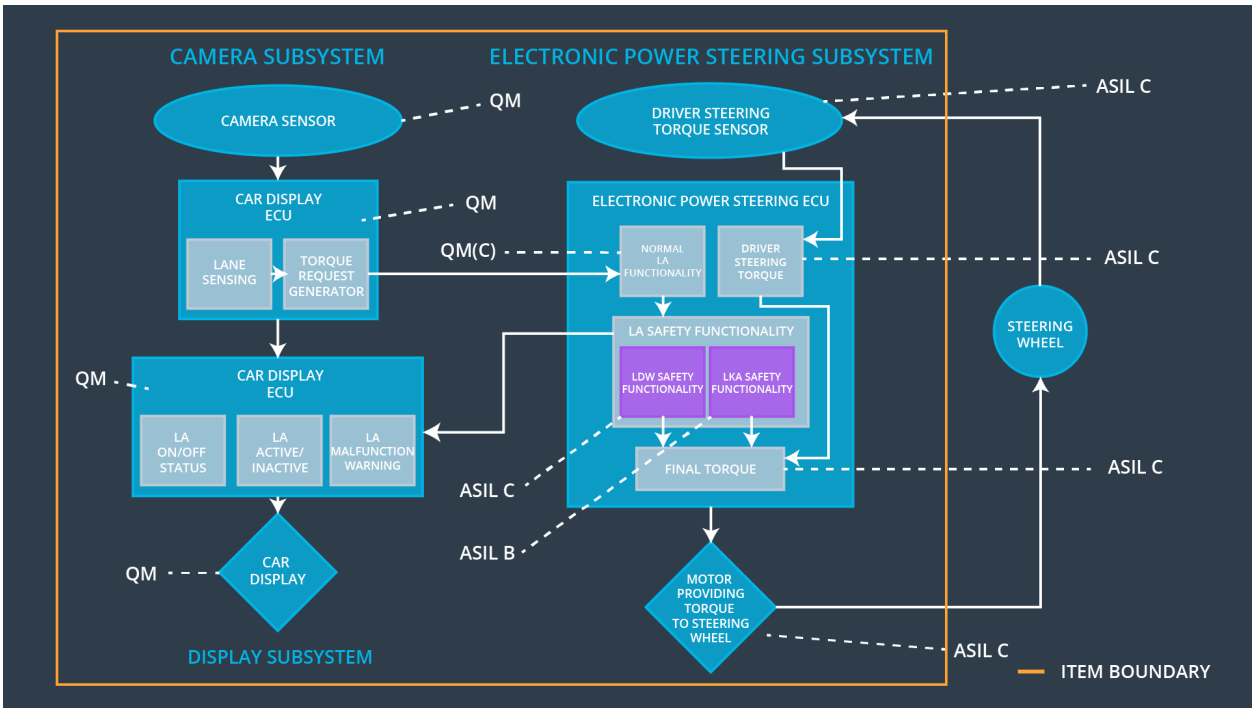
The technical safety concept describes how specific components contribute to safety, including specific types of messages sent between components. Technical safety requirements are often, but not always, derived from translating functional safety requirements to a more concrete level. Technical safety requirements may also be responsible for detecting faults within a system, detecting faults in an external device interacting with the system, reaching a safe state, implementing a warning and degredation concept, or preventing latent faults.

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	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
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	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
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	The LDW system will completely stop affecting the car steering. Warning will display on dashboard informing driver that lane keeping has stopped.

Refined System Architecture from 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	The camera sensor reads in images from the road.
Camera Sensor ECU - Lane Sensing	Camera Sensor ECU Lane Sensing element interprets road images to determine position, orientation, and curvature of lane lines.
Camera Sensor ECU - Torque request generator	The Camera Sensor ECU Torque Request Generator uses lane pose information to determine necessary torque for lane keeping.
Car Display	The Car Display shows the driver the current status of LDW and LK functions, including current operation and warnings.
Car Display ECU - Lane Assistance On/Off Status	The Car Display ECU LA On/Off Status element determines whether each LA function has been turned on or off.

Car Display ECU - Lane Assistant Active/Inactive	The Car Display ECU LA Active/Inactive element determines whether the lane assist is active or inactive for display on the dashboard.
Car Display ECU - Lane Assistance malfunction warning	The Car Display ECU LA Malfunction Warning element receives LDW_Error_Status messages and provides appropriate warnings on the dashboard.
Driver Steering Torque Sensor	The Driver Steering Torque Sensor measures the amount of torque applied by the driver, which must be amplified by the EPS ECU to produce a torque. The LA functions are minor contributors to torque compared to the amplification of driver steering torque.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	The Electronic Power Steering (EPS) ECU Driver Steering Torque element determines appropriate amplification of torque applied by the driver.
EPS ECU - Normal Lane Assistance Functionality	The EPS ECU Normal Lane Assistance Functionality element is responsible for the primary (non-safety) functions of LA.
EPS ECU - Lane Departure Warning Safety Functionality	The LDW Safety element is responsible for safety-related functions of LDW: limiting amplitude and frequency of haptic feedback.
EPS ECU - Lane Keeping Assistant Safety Functionality	The LK Safety element is responsible for safety-related functions of LK: limiting duration of usage.
EPS ECU - Final Torque	The Final Torque element combines torque contributions from driver amplification and LA elements.
Motor	The Motor provides torque for 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 electronic power steering ECU 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 power steering torque component is below Max_Torque_Amplitude.	C	50 ms	LDW safety	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
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	50 ms	LDW safety	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.

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 system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	Data transmission integrity check	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
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	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.

Functional Safety Requirement 01-2 with its associated system elements (derived in the functional safety concept)

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

		ECU		
Functional Safety Requirement 01-02	The electronic power steering ECU 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 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 system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
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	50 ms	LDW Safety	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
Technical Safety Requirement	As soon as a failure is detected by the LDW function, it shall	C	50 ms	LDW Safety	The LDW system will completely stop

03	deactivate the LDW feature and the 'LDW_Torque_Request' shall be set to zero.				applying haptic feedback. Warning will display on dashboard informing driver of the fault.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LDW_Torque_Request' signal shall be ensured.	C	50 ms	Data Transmission Integrity Check	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.
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	The LDW system will completely stop applying haptic feedback. Warning will display on dashboard informing driver of the fault.

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**

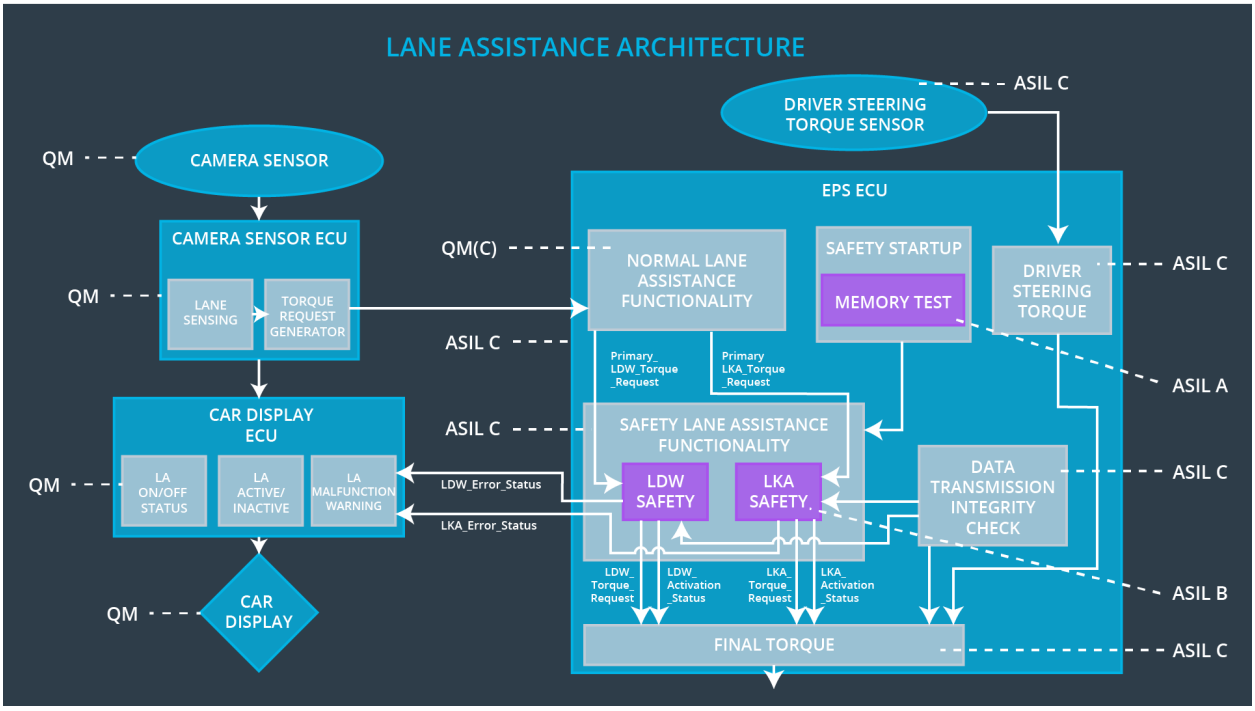
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration.	X		

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 LK safety component shall ensure that the duration of LK usage is below Max_Duration.	B	500 ms	LK Safety	The LK system will completely stop affecting the car steering. Warning will display on dashboard informing driver that lane keeping has stopped.
Technical Safety Requirement 02	As soon as the LK function deactivates the LK feature, the 'LK Safety' software block shall send a signal to the car display ECU to turn on a warning light.	B	500 ms	LK Safety	The LK system will completely stop affecting the car steering. Warning will display on dashboard informing driver that lane keeping has stopped.
Technical Safety	As soon as a failure is detected by the LK function, it shall	B	500 ms	LK Safety	The LK system will

Requirement 03	deactivate the LK feature and the 'LK_Torque_Request' shall be set to zero.				completely stop affecting the car steering. Warning will display on dashboard informing driver that lane keeping has stopped.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LK_Torque_Request' signal shall be ensured.	B	500 ms	Data Transmission Integrity Check	The LK system will completely stop affecting the car steering. Warning will display on dashboard informing driver that lane keeping has stopped.
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	The LK system will completely stop affecting the car steering. Warning will display on dashboard informing driver that lane keeping has stopped.

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All technical safety requirements are allocated to the electronic power steering ECU.

Warning and Degradation Concept

For any system malfunction, the associated lane assistance functions will be turned off and the driver will receive a warning light indication.