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Technical Safety Concept Lane Assistance

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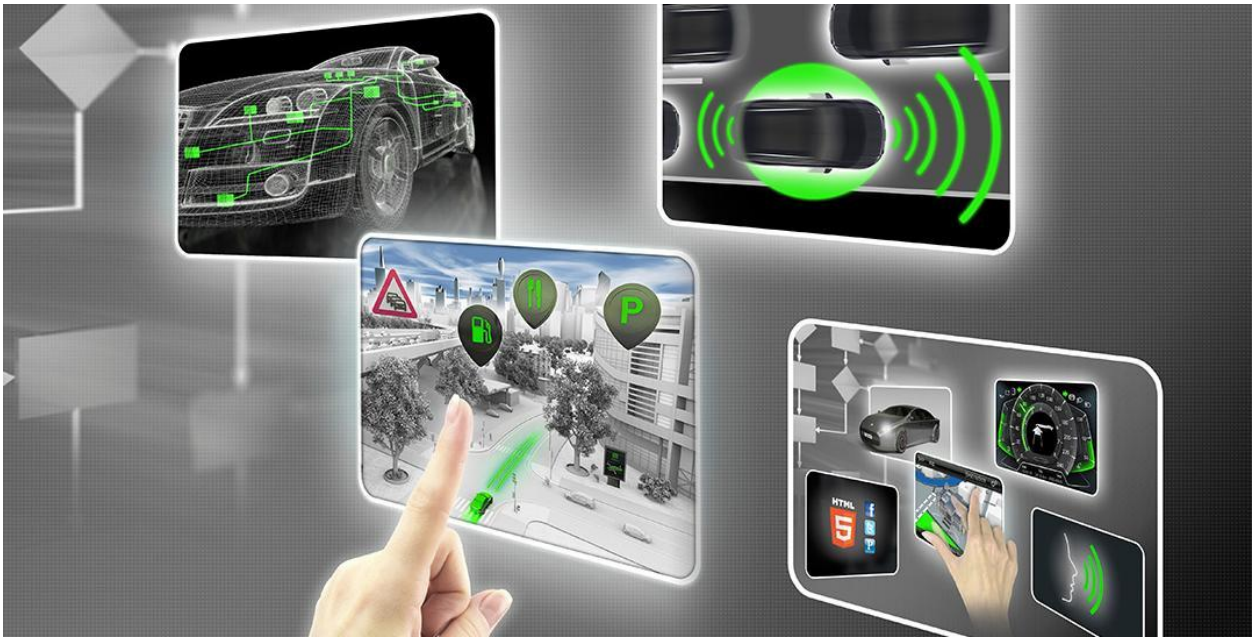


Document history

[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
August 13,2017	1.0	Ryosuke Honda	Initial Draft
August 14,2017	2.0	Ryosuke Honda	Revised "Functional Overview of the Architecture" and changed the "Refinement of the System Architecture" diagram. and add description on purpose

Table of Contents

[Instructions: We have provided a table of contents. If the table of contents is not showing up correctly in your word processor of choice, please update it. The table of contents should show each section of the document and page numbers or links. Most word processors can do this for you. In Google Docs, you can use headings for each section and then go to Insert > Table of Contents. Microsoft Word has similar capabilities]

Purpose of the Technical Safety Concept

[Instructions: Answer what is the purpose of a 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 that is related to the potential malfunctions of the electric and elctronic systems as defined by ISO26262.

Inputs to the Technical Safety Concept

Functional Safety Requirements

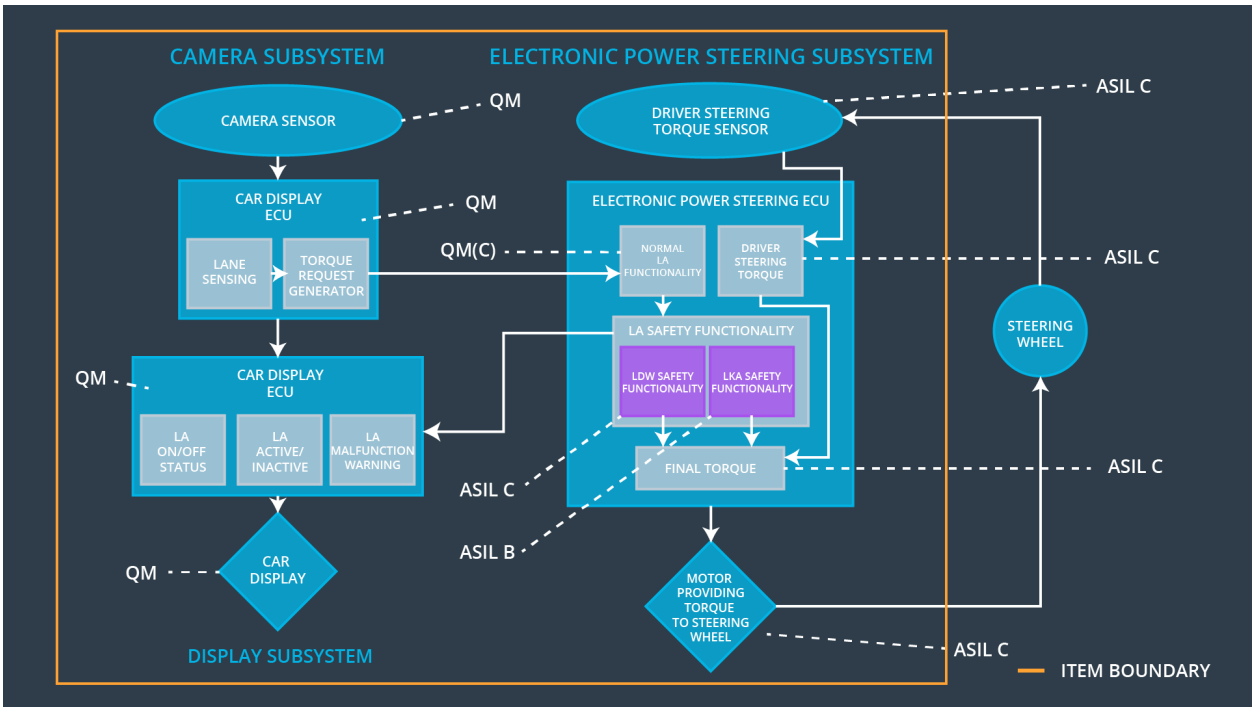
[Instructions: Provide the functional safety requirements derived in the functional safety concept]

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 depature 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 depature oscillating torque frequency torque is below Max_Torque_Frequency	C	50ms	Set vibration torque frequency to zero
Functional	The lane keeping assistance function shall	B	500ms	Set lane keeping

Safety Requirement 02-01	be time limited and additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving			assistance torque to zero

Refined System Architecture from Functional Safety Concept

[Instructions: Provide the refined system architecture from the 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	responsible for capturing vehicle driving condition including detectable lane lines

Camera Sensor ECU - Lane Sensing	responsible for measuring the distance from the lane line
Camera Sensor ECU - Torque request generator	responsible for getting the distance from ECU-Lane Sensing and generating torque request towards EPS ECU- Normal Lane Assistance Functionality.
Car Display	responsible for warning drivers whether lane assistance is malfunction or misused.
Car Display ECU - Lane Assistance On/Off Status	responsible for dispplaying Lane Keeping Assistance and Lane Departure Warning On/Off status.
Car Display ECU - Lane Assistant Active/Inactive	responsible for getting a signal from LA Safety Functionality. if LDW or LKA function is deactivated, it will get “activation_status_set = 0” Otherwise, it will get ”activation_status_set = 1”.
Car Display ECU - Lane Assistance malfunction warning	responsible for getting a signal of whether or not turning on a warning light from LDW or LKA Safety Functionality software when a failure is detected.
Driver Steering Torque Sensor	responsible for measuring driver steering torque.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	responsible for receiving steering torque from Driver Steering Torque Sensor and transmit it to the EPS-ECU -Final Torque
EPS ECU - Normal Lane Assistance Functionality	responsible for receiving torque request from “Camera Sensor ECU -Torque request generator” and sending Vibrational_Torque_Request to the Lane Departure Warning Safety Software Element.
EPS ECU - Lane Departure Warning Safety Functionality	responsible for getting a torque request from “EPS ECU- Normal Lane Assistance Functionality”. If the torque request is below Max_Torque_Request, the torque request is delivered to “EPS ECU -Final Torque” But if the torque request is beyond “Max_Torque_Request”, the “EPS ECU -Lane Departure Warning Safety Functionality” will transmit a signal toward “Car Display ECU -Lane Assistance malfunction warning” to turn on a warning light and also transmit torque request which is set to zero to “EPS ECU -Final Torque”.
EPS ECU - Lane Keeping Assistant Safety Functionality	responsible for getting a torque request from “EPS ECU- Normal Lane Assistance Functionality”. If the torque request is below Max_Torque_Request, the torque request is delivered to “EPS ECU -Final Torque” But if the torque request is beyond

	“Max_Torque_Request”, the “EPS ECU -Lane Keeping Warning Safety Functionality” will transmit a signal toward “Car Display ECU -Lane Assistance malfunction warning” to turn on a warning light and also transmit torque request which is set to zero to “EPS ECU -Final Torque”.
EPS ECU - Final Torque	responsible for receiving driver steering torque and torque request from “EPS ECU Lane Departure Warning Safety Functionality” and ”EPS ECU Lane Keeping Assistant Safety Functionality” and then trasmit the torque to “Motor” only when those torque values are below maximum. If those torque values are above maximum, it will transmit zero torque request to “Motor”.
Motor	responsible for providing torque request from"EPS ECU -Final Torque" to steering wheel.

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	The lane keeping item shall	X		

Safety Requirement 01-01	ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude			

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 "LDW_Torque_Request" send to the "Final electronic power steering torque" component is below "Max_Torque_Amplitude" .	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 zero
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

[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	C	50ms	LDW Safety Functionallity	LDW torque output is set to

	"LDW_Torque_Request" shall be set to zero.				zero
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	Camera ECU	Car Display ECU

		Steering 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:

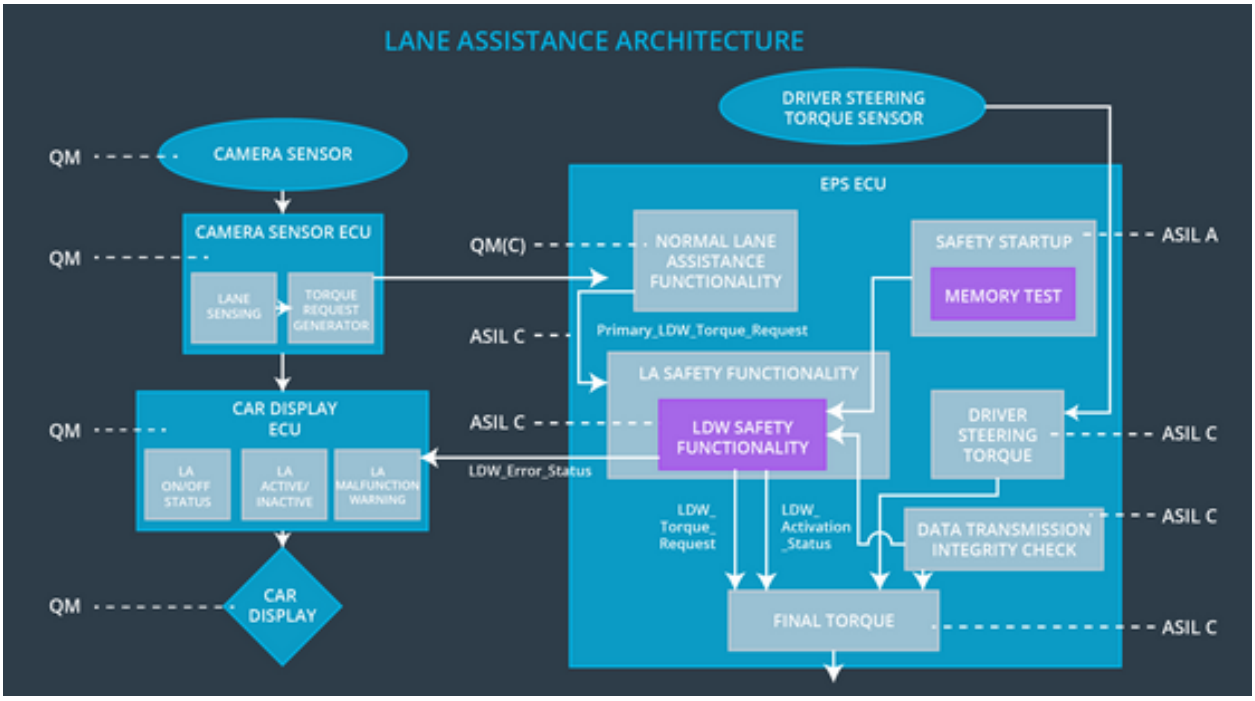
ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01	The LKA safety component shall ensure that the duration of "LKA_Torque_Request" send to the "Final electronic power steering torque" component is below Max_Duration.	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

[Instructions: Include the refined system architecture. Hint: The refined system architecture should include the system architecture from the end of the technical safety lesson, including all of the ASIL labels.]



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

[Instructions: We've already identified that for any system malfunction, the lane assistance functions will be turned off and the driver will receive a warning light indication. The technical safety requirements have not changed how functionality will be degraded or what the warning will be.

So in this case, the warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements. You can copy the functional safety warning and degradation concept here.

Oftentimes, a technical safety analysis will lead to a more detailed warning and degradation concept.]

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Trun off the LDW functionality	Maximum torque is beyond Max_Torque_Amplitude	Yes	Car Display
WDC-02	Trun off the LDW functionality	Maximum torque is beyond Max_Torque_Freqency	Yes	Car Display
WDC-03	Trun off the LKA functionality	Maximum duration is beyond Max_Duration	Yes	Car Display