



Technical Safety Concept Lane Assistance

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Document history

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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
9/1/2017	1.0	Flora Sun	Initial draft

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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 translate high-level functional safety concept requirements into technical safety concept requirements that dictate specific performance parameters.

The technical safety concept involves:

- Turning functional safety requirements into technical safety requirements.
- Allocating technical safety requirements to the system architecture.

Inputs to the Technical Safety Concept

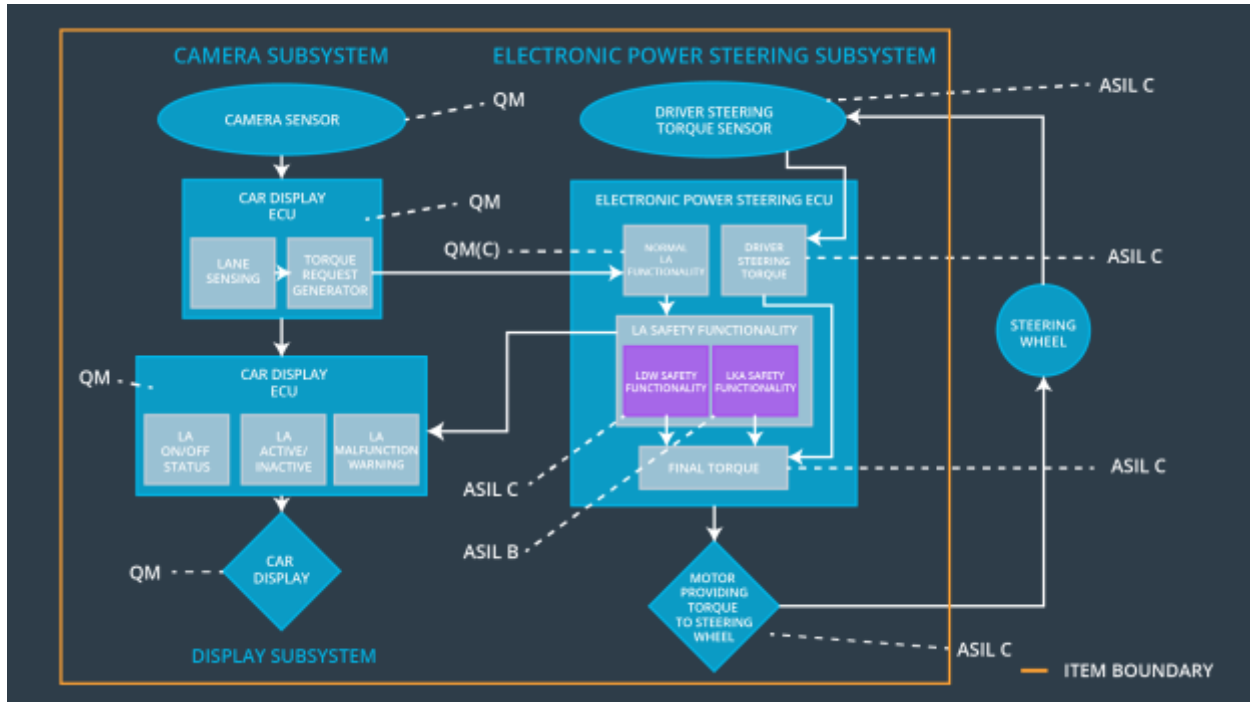
Functional Safety Requirements

[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 electronic power steering shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude.	C	50ms	The Lane Assistance shall be switched off.
Functional Safety Requirement 01-02	The electronic power steering keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency.	C	50ms	The Lane Assistance shall be switched off.
Functional Safety Requirement 02-01	The lane keeping assistance function shall be time limited and the additional steering torque shall end after a given timer interval so that the driver cannot misuse the system for autonomous driving.	B	500ms	The Lane Assistance shall be switched off.

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	Camera Sensor acquires image from the road.
Camera Sensor ECU - Lane Sensing	Camera Sensor ECU - Lane Sensing is responsible for detecting lanes and determining when the vehicle leaves the lane by mistake.
Camera Sensor ECU - Torque Request Generator	Camera Sensor ECU - Torque Request Generator is responsible for determine the amount of torque is needed to respond to the situation.

Car Display	Car Display displays the warning signals.
Car Display ECU - Lane Assistance On/Off Status	Car Display ECU - Lane Assistance On/Off Status handles information on Lane Assistance whether the system is On/Off.
Car Display ECU - Lane Assistant Active/Inactive	Car Display ECU - Lane Assistant Active/Inactive handles information on whether Lane Assistant is Active/Off.
Car Display ECU - Lane Assistance Malfunction Warning	Car Display ECU - Lane Assistance Malfunction Warning handles malfunction info on Lane Assistance.
Driver Steering Torque Sensor	Driver Steering Torque Sensor is responsible for measuring the torque provided by the driver.
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Electronic Power Steering (EPS) ECU - Driver Steering Torque handles the information on torque provided by the driver.
EPS ECU - Normal Lane Assistance Functionality	EPS ECU - Normal Lane Assistance Functionality is responsible for normal lane assistance functions.
EPS ECU - Lane Departure Warning Safety Functionality	EPS ECU - Lane Departure Warning Safety Functionality is responsible for lane departure warning function.
EPS ECU - Lane Keeping Assistant Safety Functionality	EPS ECU - Lane Keeping Assistant Safety Functionality is responsible for lane keeping assistant functionality.
EPS ECU - Final Torque	EPS ECU - Final Torque is responsible for final determination of the torque output.
Motor	The Motor provides 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 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 power steering Torque' component is below 'Max_Torque_Amplitude.'	C	50ms	LDW Safety Software component	The LDW Torque output is set to zero.
Technical Safety Requirement	The validity and integrity of the data transmission for	C	50ms	Data Transmission Integrity	N/A

02	'LDW_Torque_Request' signal shall be ensured.			Check	
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 Software component	The 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 ECU to turn on a warning light.	C	50ms	LDW Safety Software component	The LDW Torque output is 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	Length of Ignition Cycle	Memory Test Block	The 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 the 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency.'	C	50ms	LDW Safety Software component	The LDW torque output is set to zero.
Technical Safety Requirement 02	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 Software component	The LDW torque output is set to zero.
Technical Safety Requirement 03	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 Software component	The LDW torque output is 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	N/A
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	A	Length of Ignition Cycle	Memory Test Block	The 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 the duration of lane keeping module is not active for more than MAX_DURATION	B	500ms	LKA Safety software component	The LKA torque output is set to zero.
Technical Safety Requirement 02	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	500ms	LKA Safety software component	The LKA torque output is set to zero.
Technical Safety	As soon as the LKA function deactivates the	B	500ms	LKA Safety software	The LKA torque

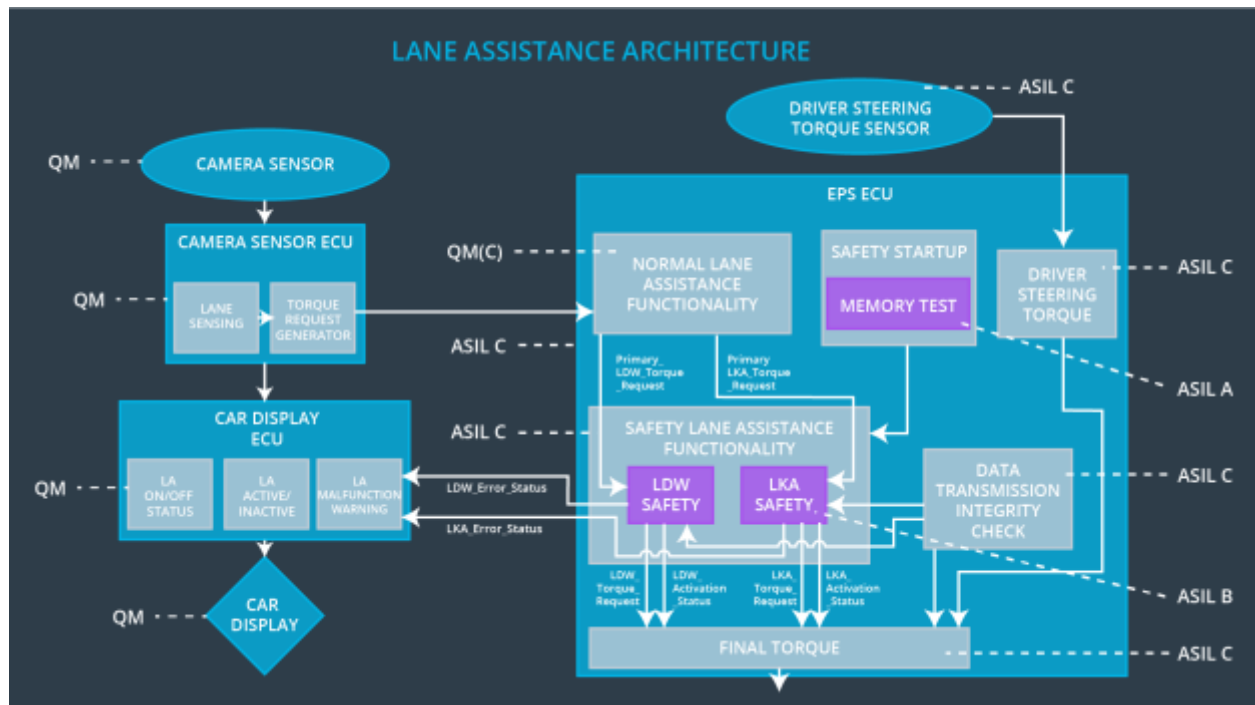
Requirement 03	LKA feature, the 'LKA Safety' software block shall send a signal to the car display ECU to turn on a warning light.			component	output is set to zero.
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	B	500ms	Data Transmission Integrity Check	N/A
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory.	A	Length of ignition cycle	Memory Test Block	The 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]

For the Lane Assistance item, all technical safety requirements 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.

Ofentimes, 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	Turn off the functionality	Max_Torque_Amplitude or Max_Torque_Frequency is reached.	YES	A warning light will turn on if the Lane Assistance item malfunctions. This situation will also be discussed in the user manual.
WDC-02	Turn off the functionality	Max_Duration is reached.	YES	A warning light will turn on if the Lane Assistance item malfunctions. This situation will also be discussed in the user manual.