Elektrobit

UDACITY

Technical Safety Concept Lane Assistance

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Document history

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24.05.2018	1.0	Arindam Baidya	First attempt

Table of Contents

Purpose of the Technical Safety Concept

ISO 26262 places the technical safety concept is part of the product development phase which also includes designing of hardware and software. This is because the technical safety concept is more concrete and gets into the details of the item's technology. The purpose of Technical Safety Concept is to refine the functional safety requirements established in the functional safety concept, into technical safety requirements. The technical safety concept involves:

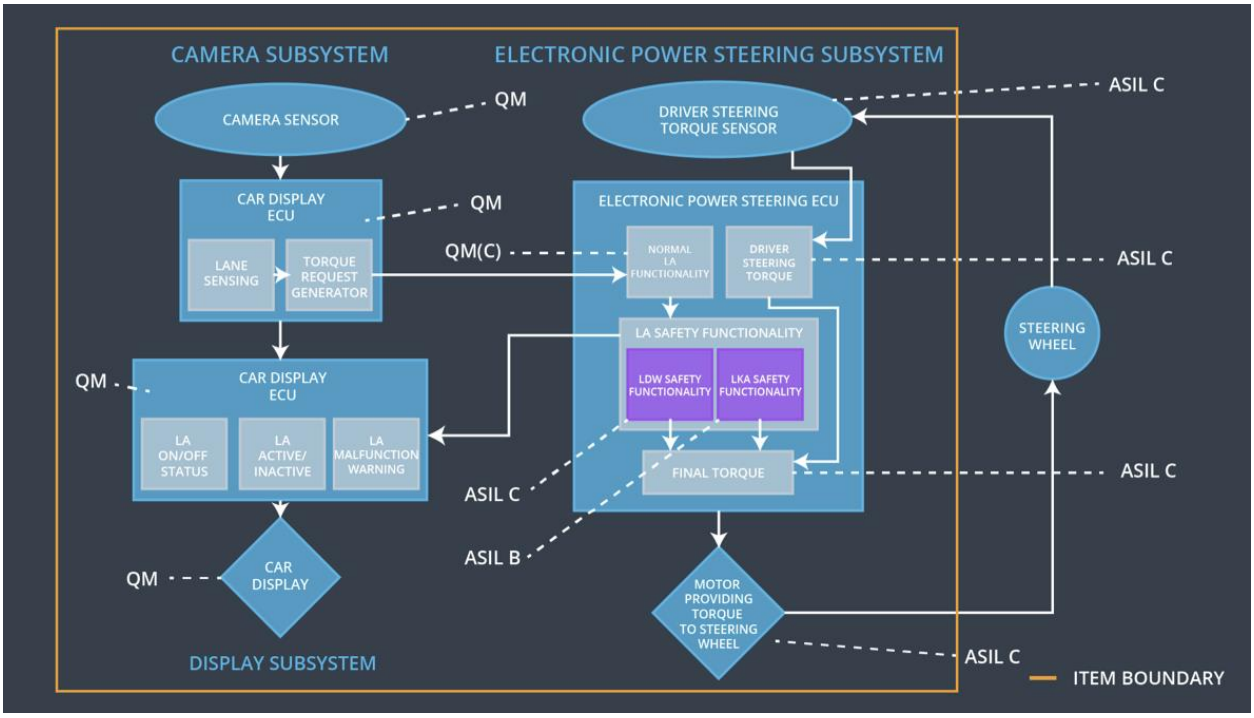
- Turning functional safety requirements into technical safety requirements
- Allocating technical safety requirements to the system architecture

Inputs to the Technical Safety Concept

Functional Safety Requirements

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	Lane Assistant functionality off
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	Lane Assistant functionality off
Functional Safety Requirement 02-01	The LKA function shall be deactivated when the camera sensor or any other sensor starts malfunctioning.	C	10ms	LKA Function is deactivated

Refined System Architecture from Functional Safety Concept



Functional overview of architecture elements

Element	Description
Camera Sensor	Captures images from the road and provide them to Camera Sensor ECU
Camera Sensor ECU - Lane Sensing	Detects lane lines from camera sensor images
Camera Sensor ECU - Torque request generator	Calculates the necessary torque to be requested to the Power Steering ECU
Car Display	Displays warning, feedback status to the driver
Car Display ECU - Lane Assistance On/Off Status	Indicates the status of Lane Assistance functionality
Car Display ECU - Lane Assistant Active/Inactive	Indicates if Lane Assistance functionality is properly functioning and is active at the moment
Car Display ECU - Lane Assistance malfunction warning	Indicates malfunction of Lane assistance functionality
Driver Steering Torque Sensor	Measures the driving torque intensity of the driver and send it to Electronic Power Steering ECU

Electronic Power Steering (EPS) ECU - Driver Steering Torque	Processes input from Driver's Steering torque sensor
EPS ECU - Normal Lane Assistance Functionality	Receives torque request from Camera sensor ECU and transfers it to Lane Assistance Safety functionality.
EPS ECU - Lane Departure Warning Safety Functionality	Checks for malfunctions in Lane Departure Warning and translates torque request into final torque output
EPS ECU - Lane Keeping Assistant Safety Functionality	Checks for malfunctions in Lane Keep Assistance and translates torque request into final torque output
EPS ECU - Final Torque	Combines the torque requests from Lane Keep Assistance and Lane Departure Warning functionalities and sends them to the motor.
Motor	Applies the required torque 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	The LDW safety component shall ensure that the amplitude of 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below Max_Torque_Amplitude'.	C	50ms	LDW Safety	LDW_Activation_Status is 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	LDW_Activation_Status is 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	LDW_Activation_Status is 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	NA
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	A	Ignition Cycle	Memory Test	LDW_Activation_Status is 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 01	The LDW safety component shall ensure that the frequency of 'LDW_Torque_Request' sent to the 'Final electronic power steering Torque' component is below 'Max_Torque_Frequency'.	C	50ms	LDW Safety	LDW_Activation_Status is 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	LDW_Activation_Status is 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	LDW_Activation_Status is 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	LDW_Activation_Status is zero
Technical Safety	Memory test shall be conducted at startup of the EPS ECU to check	A	Ignition Cycle	Memory Test	LDW_Activation

Requirement 05	for any faults in memory.				_Status is zero

Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:

Lane Keeping Assistance (LKA) Requirements:

Functional Safety Requirement 02-1 with its associated system elements (derived in the functional safety concept)

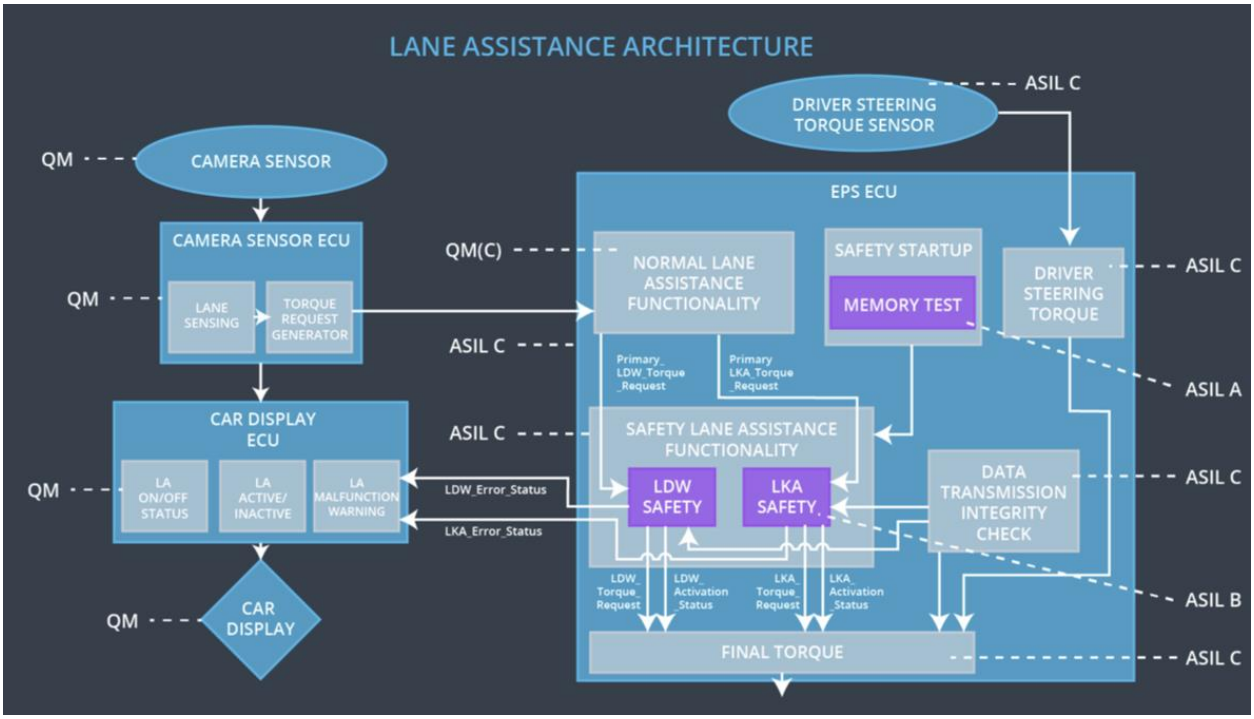
ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

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 01	The LKA safety component shall ensure that 'LKA_Torque_Request' is sent to the 'Final electronic power steering Torque' component for only 'Max_Duration'.	B	500ms	LKA Safety	LKA_Activation_Status is 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	LKA_Activation_Status is zero
Technical Safety Requireme	As soon as the LKA function deactivates the LKA feature, the 'LKA Safety' software block shall	B	500ms	LKA Safety	LKA_Activation_Status is zero

nt 03	send a signal to the car display ECU to turn on a warning light.				
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	LKA_Activation_Status is zero
Technical Safety Requirement 05	Memory test shall be conducted at startup of the EPS ECU to check for any faults in memory.	A	Ignition Cycle	Memory Test	LKA_Activation_Status is zero

Refinement of the System Architecture



Allocation of Technical Safety Requirements to Architecture Elements

All technical safety requirements were allocated to the Electronic Power Steering ECU. For the exact allocation within EPS ECU compare the technical requirement tables above.

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off Lane Assistant functionality	Malfunction_01	Yes	Lane Departure Warning Malfunction Warning on Car Display
WDC-02	Turn off Lane Assistant functionality	Malfunction_02	Yes	Lane Departure Warning Malfunction Warning on Car Display
WDC-03	Turn off Lane Assistant functionality	Malfunction_03	Yes	Lane Keeping Assistance Malfunction Warning on Car Display
WDC-04	Turn off Lane Assistant functionality	Malfunction_04	Yes	Lane Departure Warning Malfunction Warning on Car Display
WDC-05	Turn off Lane Assistant functionality	Malfunction_05	Yes	Lane Keeping Assistance Malfunction Warning on Car Display