Elektrobit

UDACITY

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
2019-5-18	1.0	JesonZhang	First attempt

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 Technical Safety Concept defines how the subsystems interact at the message level and describes how the ECUs communicate with each other.

Inputs to the Technical Safety Concept

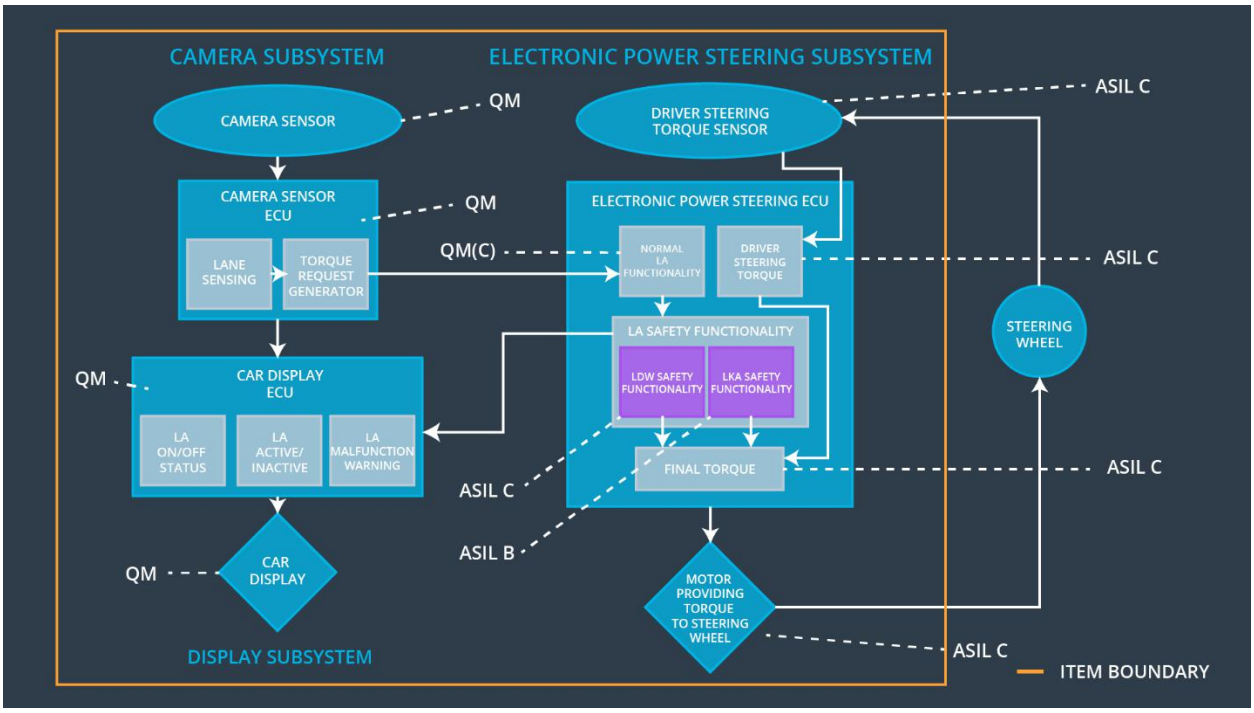
Functional Safety Requirements

[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 ECU shall ensure that the oscillating torque amplitude requested by the LDW function is below Max_Torque_Amplitude	C	50ms	LDW will set the oscillating torque amplitude to 0
Functional Safety Requirement 01-02	The Electronic Power Steering ECU shall ensure that the oscillating torque frequency requested by the LDW function is below Max_Torque_Frequency	C	50ms	Turn off the LDW function
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	500ms	Turn off the LKA function

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?]

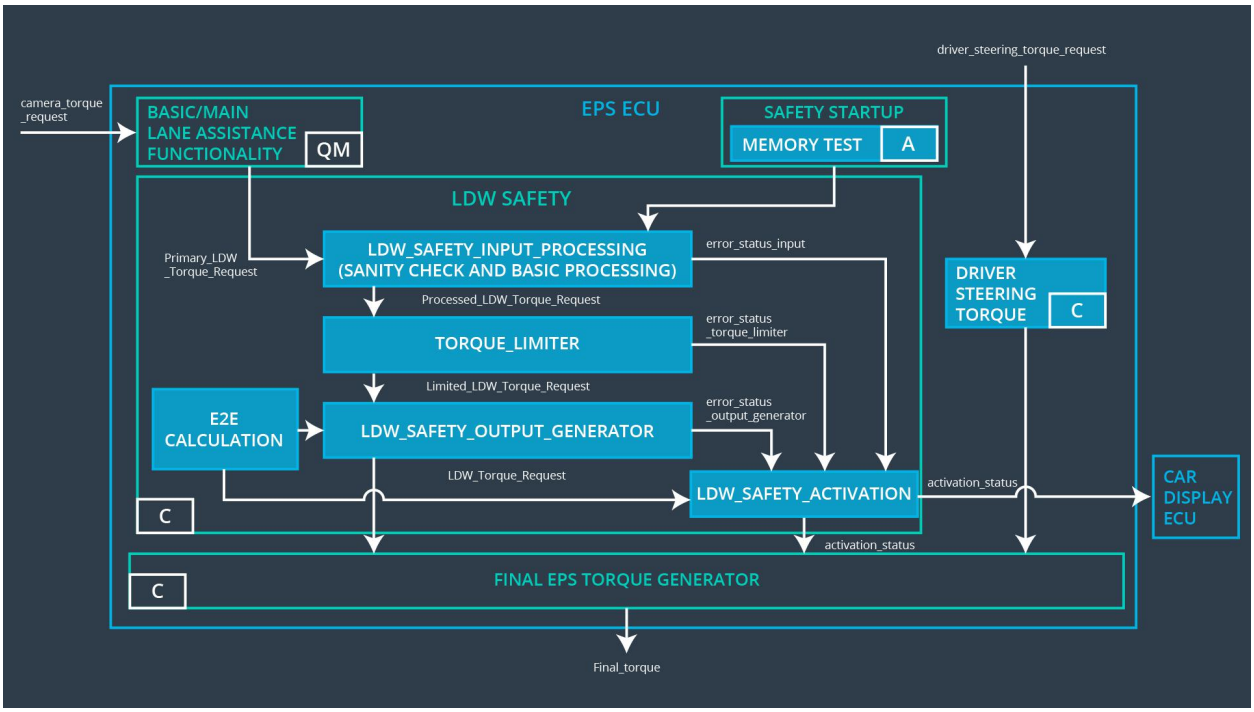
Element	Description
Camera Sensor	The Camera Sensor reads images from the road
Camera Sensor ECU - Lane Sensing	Process images from Camera and detect the lane line position
Camera Sensor ECU - Torque request generator	Calculate the necessary torque to be requested to the Electronic Power Steering ECU
Car Display	Provide the driver with display warnings and the Lane Departure Assistance status.
Car Display ECU - Lane Assistance On/Off Status	Display the status of the Lane Assistance function(On/Off)

Car Display ECU - Lane Assistant Active/Inactive	Indicate whether the Lane Assistance function is Active or Inactive
Car Display ECU - Lane Assistance malfunction warning	Indicate a malfunction on the lane assistance function
Driver Steering Torque Sensor	Measure the steering torque of the steering wheel
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Receive the driver’s torque request from the steering wheel
EPS ECU - Normal Lane Assistance Functionality	Receive the Camera Sensor ECU torque request
EPS ECU - Lane Departure Warning Safety Functionality	Ensure the torque amplitude is below Max_Torque_Amplitude and torque frequency is below Max_Torque_Frequency
EPS ECU - Lane Keeping Assistant Safety Functionality	Ensure the Lane Keeping Assistance functionality application is not activate more then Max_duration time
EPS ECU - Final Torque	Combine the torque request from the Lane Keeping and Lane Departure Warning functionalities and send them to the Motor
Motor	Apply the required torque to the steering wheels

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 element	Lane departure Warning torque to zero.
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	50ms	LDW Safety Software element	Lane departure Warning torque to zero.
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 element	Lane departure Warning torque 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	Lane departure Warning torque 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	Ignition Cycle	Memory Test	Lane departure Warning torque 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 Lane Departure Warning safety component shall ensure the frequency of the ‘LDW_Torque_Reques’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max_Torque_Frequency.’	C	50ms	LDW Safety Software element	Lane departure Warning torque to zero.
Technical Safety Requirement 02	The validity and integrity of the data transmission for 'Max_Torque_Frequency’ signal shall be ensured.	C	50ms	LDW Safety Software element	Lane departure Warning torque to zero.
Technical Safety Requirement 03	As soon as a failure is detected by the LDW function, it shall deactivate the LDW feature and the 'Max_Torque_Frequency‘ shall be set to zero.	C	50ms	LDW Safety Software element	Lane departure Warning torque 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	Data Transmission Integrity Check	Lane departure Warning torque 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	Ignition Cycle	Memory Test	Lane departure Warning torque 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.]

ID	Validation Acceptance Criteria and Method	Verification Acceptance Criteria and Method
Technical Safety Requirement 01-01-01	Validate the Max_Torque_Amplitude is the chosen from the Lane Departure Warning Validation	Verify the Lane Departure Warning functionality is turned off.
Technical Safety Requirement 01-01-02	Validate the 'TORQUE_LIMITER' sends the error_status_torque_limiter signal to the LDW_SAFETY_ACTIVATION.	Verify the Car Display ECU displays the Lane Departure Warning malfunction warning signal.
Technical Safety Requirement 01-01-03	Validate the 'TORQUE_LIMITER' sends 'LDW_Torque_Request' with zero.	Verify the Final EPS Torque generator receives a LDW_Torque_Request of zero.
Technical Safety Requirement 01-01-04	Validate the 'TORQUE_LIMITER' calculate and sends the correct cyclic redundancy check (CRC) and Alive counter for data transmission validity and integrity.	Verify the functionality is turn off if there is a CRC or Alive counter discrepancy.
Technical Safety Requirement 01-01-05	Validate the Safety Startup Memory test to check memory faults catch memory faults.	Verify the Lane Departure Warning is turned off when the Safety Startup Memory fails.
Technical Safety Requirement 01-02-01	Validate the Max_Torque_Frequency set is the chosen from the Lane Departure Warning Acceptance Criteria.	Verify the functionality is turned off if the 'LDW_Torque_Request' frequency exceeds Max_Torque_Request.

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 Lane Keeping Assistance safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max_Duration	C	500 ms	LDW Safety software element	Lane Keeping Assistance torque to zero.
Technical Safety Requirement 02	When the Lane Keeping Assistance function deactivates, the ‘LKA Safety’ shall send a signal to the Car Display ECU to turn on a warning light.	C	500 ms	LDW Safety software element	Lane Keeping Assistance torque to zero.
Technical Safety Requirement 03	When a failure is detected, the Lane Keeping Assistance function shall deactivate and the ‘LKA_Torque_Request’ shall be	C	500 ms	LDW Safety software element	Lane Keeping Assistance torque to zero.

	zero.				
Technical Safety Requirement 04	The validity and integrity of the data transmission for 'LKA_Torque_Request' signal shall be ensured.	C	500 ms	Data Transmission Integrity Check	Lane Keeping Assistance torque to zero.
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	A	Ignition cycle	Memory Test	Lane Departure Warning torque to zero.

Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:

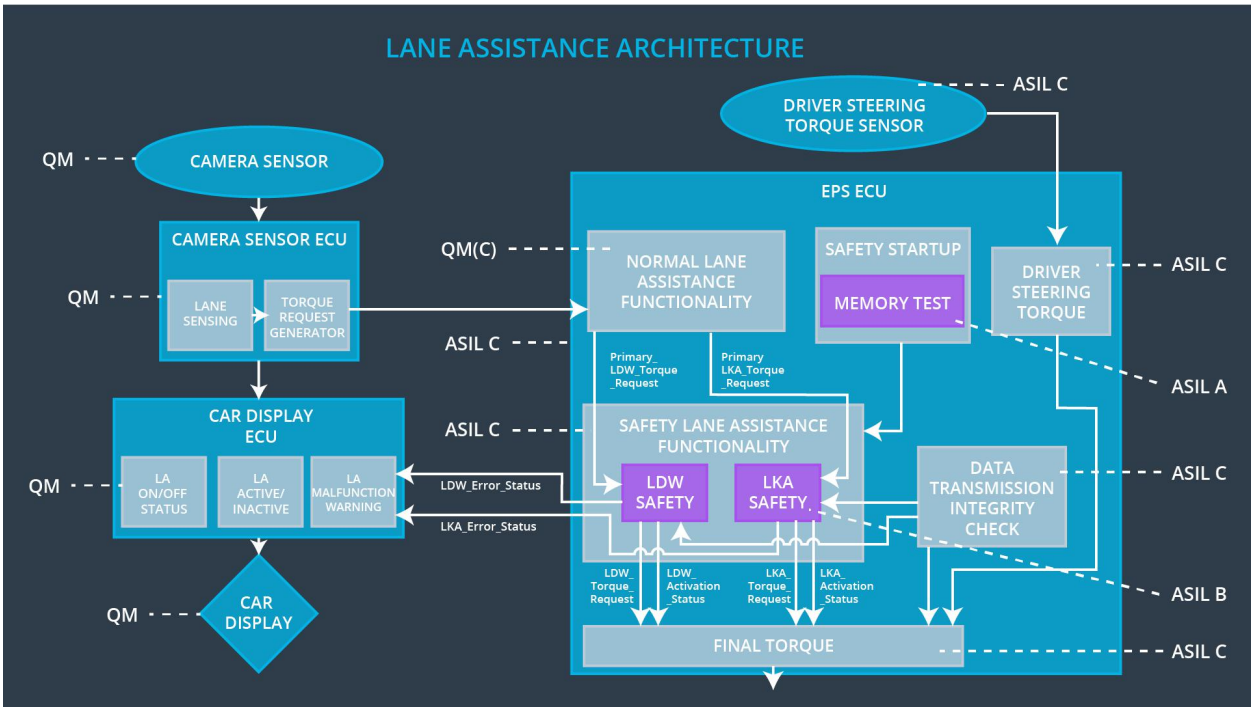
[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. "Validation" asks whether or not you chose the appropriate parameters. "Verification" involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

ID	Validation Acceptance Criteria and Method	Verification Acceptance Criteria and Method
Technical Safety Requirement 02-01-01	Validate the Max_Duration is set to the chosen value from LKA Validation Assistance Criteria	Verify the functionality is turned off after it is applied for Max_Duration.
Technical Safety Requirement 02-01-02	Validate the 'TORQUE_LIMITER' sends the error_status_torque_limiter signal to the LKA_SAFETY_ACTIVATION.	Verify the Car Display ECU displays the Lane Keeping Assistance malfunction warning signal.
Technical Safety Requirement 02-01-03	Validate the 'TORQUE_LIMITER' sends 'LKA_Torque_Request' with zero.	Verify the Final EPS Torque generator receives a LKA_Torque_Request of zero.
Technical Safety Requirement 02-01-04	Validate the 'TORQUE_LIMITER' calculate and sends the correct cyclic redundancy check (CRC) and Alive counter for data transmission validity	Verify the functionality is turn off if there is a CRC or Alive counter discrepancy.

	and integrity.	
Technical Safety Requirement 02-01-05	Validate the Safety Startup Memory test to check memory faults catch memory faults.	Verify the Lane Keeping Assistance is turned off when the Safety Startup Memory fails.

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]

In this section the technical safety requirements are allocated to the architecture elements

ID	Technical Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Technical Safety Requirement 01-01-01	The Lane Departure Warning 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.’	X	-	-
Technical Safety Requirement 01-01-02	When the Lane Departure Warning is deactivated, the ‘LDW Safety’ software module shall send a signal to the Car Display ECU to turn on a warning signal.	X	-	-
Technical Safety Requirement 01-01-03	When a failure is detected by the Lane Departure Warning functionality, it shall deactivate the Lane Departure Warning feature and set ‘LDW_Torque_Request’ to zero.	X	-	-
Technical Safety Requirement 01-01-04	The validity and integrity of the data transmission for ‘LDW_Torque_Request’ signal shall be ensured.	X	-	-
Technical Safety Requirement 01-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	X	-	-
Technical Safety Requirement 01-02-01	The Lane Departure Warning safety component shall ensure the frequency of the ‘LDW_Torque_Reques’ sent to the ‘Final electronic power steering Torque’ component is below ‘Max_Torque_Frequency.’	X	-	-
Technical	The Lane Keeping Assistance	X	-	-

Safety Requirement 02-01-01	safety component shall ensure the duration of the lane keeping assistance torque is applied for less than Max_Duration			
Technical Safety Requirement 02-01-02	When the Lane Keeping Assistance function deactivates, the ‘LKA Safety’ shall send a signal to the Car Display ECU to turn on a warning light.	X	-	-
Technical Safety Requirement 02-01-03	When a failure is detected, the Lane Keeping Assistance function shall deactivate and the ‘LKA_Torque_Request’ shall be zero.	X	-	-
Technical Safety Requirement 02-01-04	The validity and integrity of the data transmission for ‘LKA_Torque_Request’ signal shall be ensured.	X	-	-
Technical Safety Requirement 02-01-05	Memory test shall be conducted at start up of the EPS ECU to check for any memory problems	X	-	-

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	Turn off the LDW function	Malfunction_01, Malfunction_02, Malfunction_04	Yes	LDW Malfunction Warning on Car Display
WDC-02	Turn off the LKA function	Malfunction_03, Malfunction_05	Yes	LKA Malfunction Warning on Car Display