



Testing and Evaluation Methods for ICT-based Safety Systems

Collaborative Project

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Deliverable D2.1

Testing Matrix Definition

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Executive Summary

eVALUE will address the functionality of ICT-based safety systems and their capability to perform the function through two courses of action: defining and quantifying the function output to be achieved by the safety system and developing the testing and evaluation methods for the ICT-based safety systems.

WP2 aims at developing testing procedures based on the system descriptions and scenarios defined in WP1. The testing procedures will be integrated in WP3 and finally carried out and assessed in WP4.

D2.1 forms the basis for the work that will be done in the next steps of WP2. Its main contribution is the testing matrix. It relates all the proposed tests procedures to scenarios, systems and types of tests.

The document also describes the criteria followed to relate the test procedures and sets the starting point for the deeper development of these test procedures.

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Version Chart

Version	Date	Comment
0.1	28/07/2008	Draft version created by IDIADA
0.2	22/10/2008	Draft version, reviewed by IDIADA
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1 INTRODUCTION

The general objective of eVALUE is to develop testing and evaluation procedures for Information and Communication Technologies (ICT)-based safety systems and, thereby, to increase public perception and customer acceptance of ICT-based safety systems and to support development of ICT-based safety systems at vehicle OEMs and suppliers.

The objective of Work Package 2 (WP2) inside eVALUE is to provide specific test procedures for each safety system and integrate them into general procedures (WP3 objective) for global performance assessments and evaluations (WP4 objective). For this reason, WP2 is providing many test procedures that might overlap and need to be integrated in the future work packages.

In other words, the specific objective of WP2 is the definition, development and analysis of test and evaluation procedures for all different properties/features of the systems selected as the focus of eVALUE (defined in WP1).

This can be divided into two objectives:

- the assignment of testing procedures to ICT-based safety systems
- definition and detailed development of testing and evaluation procedures for each feature of the domain of ICT-based safety systems

This Deliverable, D2.1, is partially fulfilling the first objective, while D2.2 will compile all the results of WP2 and complete the remaining objective.

1.1 Introduction of Deliverable D2.1

This document uses a special nomenclature to refer to different terms related to testing and assessment. In order to avoid any confusion and improve the suitable wording, as a first step, the following roadmap is presented.

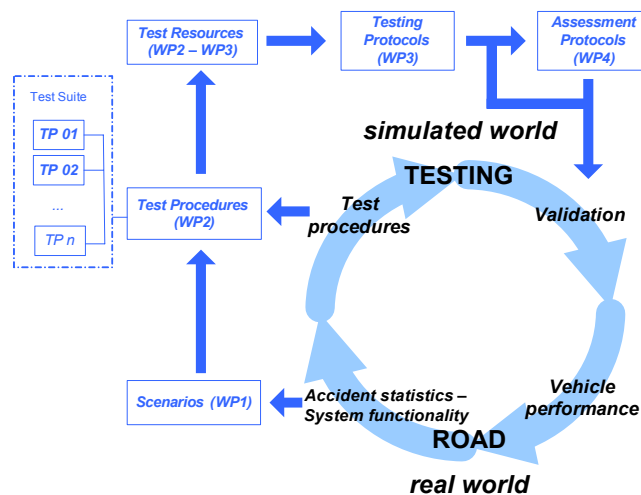


Fig. 1-1: Roadmap – eVALUE, continuous improvement loop

Fig. 1-1 shows the roadmap of the concept offered by eVALUE in parallel with the traditional scheme using accident research as the basis to improve the development of safer vehicles. The eVALUE project started with the definition of the scenarios which are used as the bases for the test procedures. The test procedures will be gathered in test suites to evaluate the overall performance of a system. The tests will be performed following detailed testing protocols and evaluated by assessments protocols. The goal of eVALUE is to improve the testing and evaluation capabilities offered to the vehicle manufacturers to enable them to improve the safety level of their cars.

Concepts for testing

With the research done in WP1 some scenarios are developed representing specific driving situations (related to real driving situations) which are relevant regarding functionality of the considered systems in the different clusters. To test these scenarios test procedures are proposed which describe how to perform a test. It can contain specific driving manoeuvres to be performed in proving grounds, with some particular test cases, laboratory tests or design reviews to evaluate a vehicle equipped with suitable systems. It is important that the test results are repeatable; therefore the test procedures should be very detailed and clearly specify the test resources and boundary conditions that are needed to perform the test.

Documentation

A collection of test procedures forms a test suite which is representative for the evaluation of a car's safety function, safety system or behaviour during specific scenarios for one cluster. The description on how to perform the tests necessary to evaluate a vehicle equipped with a safety system is defined in a testing protocol. The obtained test results are evaluated by using an assessment protocol to be able to make final conclusions of a vehicle's behaviour under these specific scenarios.

Considered type of tests

There are different ways of performing tests, depending on the purpose and the resources to implement them. For a specific safety function, tests of different nature should be applied in order to have a wide view of the performance of the function. Initially, eVALUE defined three types of tests and until now, they are still being considered. The first one considered is Design Review, which can be defined as a systematic, comprehensive and documented analysis of a design to determine its capability and adequacy to meet its requirements. The first test phase always starts with a design review. After that it is possible to do Physical Vehicle Testing or Laboratory Testing. The objective of Physical Vehicle Testing is to gather quantitative information about the specified safety requirements, response or reaction and the results of the activation of a safety function. Laboratory Testing is focusing on the use of test suites and test procedures for the evaluation of system components or subsystem functionalities and it also includes driving simulator tests for the evaluation of driver behaviour.

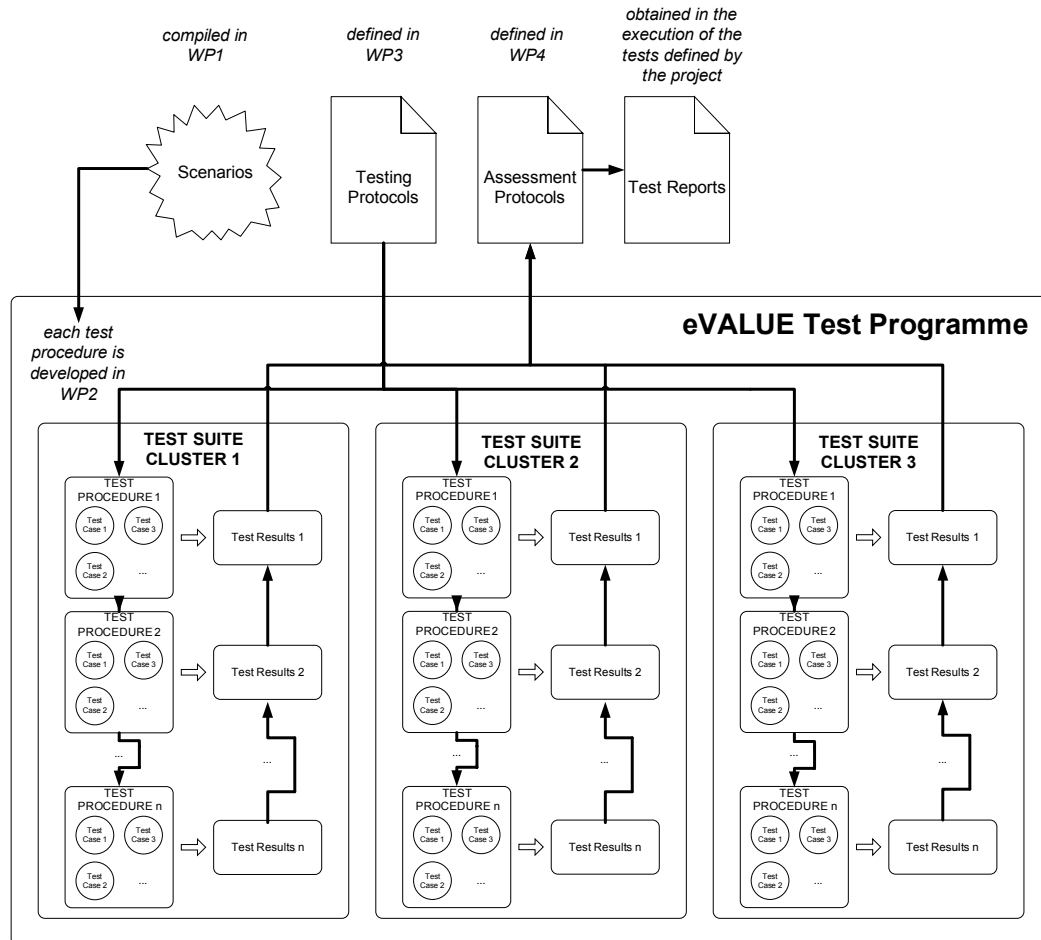


Fig. 1-2: Roadmap – eVALUE, test programme

Purpose of the tests: validation and verification

The tests performed can have different purposes. Tests can be mentioned for the validation of a system, which refers to the evaluation of the complete vehicle with the real system installed and the driver in the loop: validation checks and tests whether the system "does what it was designed for". They can also be mentioned for the verification of a system/function against its requirements, that is, whether it fulfils its requirements.

1.2 Contents and structure of the document

This document compiles the information from the State of the Art done in D1.1 and the scenarios collected and presented in D1.2. Other test procedures have been provided by partners, directly from their own experience. The test procedures have been specified in opened terms, their purpose has been identified and they are related to clusters, scenarios and systems.

Following the structure of eVALUE, test procedures are classified into 3 Clusters:

- Cluster 1 – longitudinal domain
- Cluster 2 – lateral domain
- Cluster 3 – stability domain

Scenarios were defined in D1.2 as follows:

- 3 scenarios in Cluster 1
- 7 scenarios in Cluster 2
- 4 scenarios in Cluster 3

For each scenario, several test procedures have been defined. These test procedures are named as TP_Cx-y, where 'x' refers to the associated cluster and 'y' the scenario. An exception on this rule is made for TP_C1-4 (for pedestrian detection). This test procedure is added later and fits in Scenario 3 of Cluster 1 (Scen-C1-3).

There are other test procedures which are not based on a specific scenario and shall apply to more than one. They commonly refer to Design Reviews or Laboratory Tests. They have been named as TP_Gz, where 'z' is a counting number for a general test (G). These general Test Procedures are also grouped into 5 basic areas:

- Functional Safety
- HMI
- Sensors
- Electronics Integration
- Actuators

A brief compilation of all the TPs is presented in table form in Chapter 2 of this document. It can be used to get a quick overview of all the TPs, the systems and the scenarios addressed. Chapter 2 is aimed to provide general comments of the TPs as a global set which in WP4 will constitute the general Test Program, integrating several Test Suites. It draws together all the TPs per Cluster, Scenario and Test Type.

The objective of this deliverable, the definition of the test matrix, is presented in chapter 3. The test matrix is classified per Cluster and Scenario. For each scenario which represents a common accident situation a set of TPs is proposed, which will be further developed during the next phase of WP2.

Chapter 4 is the annex of the document. In order to keep D2.1 as a usable and easy document, all the TPs description has been annexed in Chapter 4. They are classified by cluster. These descriptions will be used as priori information to start the work on tasks T2.2, T2.3 and T2.4. At end of Chapter 4, a glossary with the definitions used in this deliverable is added.

2 TESTING METHODOLOGIES

In total, 15 scenario-related test procedures and 18 non scenario-related test procedures have been defined, which constitute a total of 33 test procedures. The execution of all these TPs would complete a global evaluation of the safety functions of a vehicle under the scenarios defined in WP1 and to which the safety systems selected in WP1 are applying.

A table relating TPs, purposes, systems and scenarios addressed is presented, Table 2-1.

TEST METHODS					SCENARIOS															
					CLUSTER 1 - LONGITUDINAL DOMAIN			CLUSTER 2 - LATERAL DOMAIN							CLUSTER 3 - STABILITY DOMAIN					
NAME	CLASSIFICATION	TYPE OF TEST	DESCRIPTION	SYSTEMS ADDRESSED	Comments	Scen-C1-1 Straight road	Scen-C1-2 Curved road	Scen-C1-3 Transversally moving target	Scen-C2-1 Lane departure on a straight road	Scen-C2-2 Road departure on a straight road	Scen-C2-3 Lane departure on a curve	Scen-C2-4 Road departure on a curve	Scen-C2-5 Lane departure on a straight road before a curve	Scen-C2-6 Road departure on a straight road before a curve	Scen-C2-7 Lane change collision avoidance in a straight road	Scen-C3-1 Emergency braking on a μ -split	Scen-C3-2 Driver collision avoidance	Scen-C3-3 Fast driving into a curve	Scen-C3-4 Roll stability scenario	
TP_C1-1	Cluster 1	P, D, L	Rear end collision	FCW, CMbB, ACC	verification	1														
TP_C1-2	Cluster 1	P, D, L	Rear-end collision obstacle in curve	FCW, CMbB, ACC	verification		1													
TP_C1-3	Cluster 1	P, D, L	Collision with moving target crossing the lane	FCW, CMbB, ACC	verification			1												
TP_C1-4	Cluster 1	P	Pedestrian detection and action capabilities on urban scenarios	Pedestrian detection	verification			1												
TP_C2-1	Cluster 2	P, D, L	Lane departure on a straight road	LDW, LKA, BSD	verification				1											
TP_C2-2	Cluster 2	P, D, L	Road departure on a straight road	LDW, LKA, BSD	verification					1										
TP_C2-3	Cluster 2	P, D, L	Lane departure in a curve	LDW, LKA, BSD	verification						1									
TP_C2-4	Cluster 2	P, D, L	Road departure in a curve	LDW, LKA, BSD	verification							1								
TP_C2-5	Cluster 2	P, D, L	Lane departure on a straight lane just before a curve	LDW, LKA, BSD	verification								1							
TP_C2-6	Cluster 2	P, D, L	Road departure on a straight lane just before a curve	LDW, LKA, BSD	verification									1						
TP_C2-7	Cluster 2	P, D, L	Lane change collision avoidance on a straight road	LDW, LKA, BSD	verification										1					
TP_C3-1	Cluster 3	P, D	Emergency braking on a μ -split	ESC, ABS	validation											1				
TP_C3-2	Cluster 3	P, D	Driver collision avoidance	ESC, ABS	validation												1			
TP_C3-3	Cluster 3	P, D	Fast driving into a curve	ESC, ABS	validation													1		
TP_C3-4	Cluster 3	P, D	Roll stability test	ESC, ABS	validation															1
TP_G1	HMI	D	HMI design review	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G2	Functional Safety	D	Environmental conditions	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G3	Functional Safety	D	Basic Design review for Cluster 1	FCW, CMbB, ACC	verification	1	1	1												
TP_G4	Functional Safety	D	Basic Design review for Cluster 2	LDW, LKA, BSD	verification				1	1	1	1	1	1	1					
TP_G5	Functional Safety	D	Basic Design review for Cluster 3	ABS, ESC	verification															
TP_G6	Functional Safety	D	Functional safety design review	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G7	Functional Safety	D	Communication system design review	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G8	Functional Safety	D	Type of vehicle design review	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G9	Sensors	L	False alarms and no warnings	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G10	Sensors	L	Detection area test	FCW, ACC, CMbB, BSD, LDW	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G11	Sensors	L	Discrimination test	FCW, ACC, CMbB, BSD, LDW	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G12	Sensors	L	Resolution test	FCW, ACC, CMbB, BSD, LDW	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G13	Sensors	L	Susceptibility test	FCW, ACC, CMbB, BSD, LDW	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G14	Electronics Integration	L	Fault insertion test	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G15	Electronics Integration	L	Response time test	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G16	Electronics Integration	L	Warning indicator characteristics test	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G17	Electronics Integration	L	Warning indicator location tests	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TP_G18	Actuators	L	Actuator characteristics test	all	verification	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 2-1: Testing methodologies

In the next subchapters, a comprehensive description of the TPs by cluster and type of test is presented.

2.1 Test procedures and Clusters

2.1.1 Cluster 1 – Longitudinal domain

The longitudinal domain cluster includes Forward Collision Warning (FCW), Collision Mitigation by Braking (CMbB) and Adaptive Cruise Control (ACC). All these systems are based on sensors which monitor the frontal environment of the vehicle and warn, support or intervene in case of a dangerous situation against oncoming obstacles and crossing pedestrians. The pedestrian detection system was not mentioned in eVALUE WP1, but is added in Deliverable D2.1 because it was requested by some partners, e.g. Ibeo and IDIADA. The proposed test procedures are oriented to these frontal situations and emphasize the capabilities of the sensors in this field.

2.1.2 Cluster 2 – Lateral domain

The lateral domain includes Lane Departure Warning (LDW), Lane Keeping Assistant (LKA) and Blind Spot Detection (BSD). These systems are based on sensors monitoring the side of the vehicle and will warn, support or intervene in case of a dangerous situation against side obstacles or lane/road departures. For this cluster, the TPs try to ensure that the safety functions are able to handle all situations where the linearity inside the lane is lost unintentionally or when a vehicle is approaching from another lane.

2.1.3 Cluster 3 – Stability domain

The stability cluster will evaluate the response of a vehicle in situations where the dynamics are compromised. ESC and ABS are the systems included in this cluster. All the physical testing procedures proposed in this cluster are only intended for validation. There is a reason for this choice: generally, chassis tuning of a vehicle is done by subjective methods, which are not easily gathered together. Then, for the verification phase, only Laboratory Testing and Design Reviews are proposed.

2.2 Test procedures and type of tests

2.2.1 Design Reviews

As it has been commented, there are basic test suites grouped under Design Reviews: HMI design review and Functional safety. Both of them apply to all clusters generally, but there are also some special considerations.

HMI design review covers the properties of the ICT-based system with respect to the interaction with the driver. The main objective is to assess the characteristics and design of the human machine interface in terms of e.g. colours, icons and placement fulfils available standards and principles. This TP is proposed as a design review with the aim of keeping time and resources as compact as possible.

Functional Safety is a major group which integrates the design of the system in connection to hazards and risks (integrity, fault detection, safe state, and information to driver). The communication system used by the function and the type of vehicle orientation are also proposed. As an additional point, it considers the design of the system against environmental conditions. There is also a special consideration with the aim of checking the cluster-oriented structure. eVALUE has grouped the safety functions in clusters, because more than one function can be activated under specific conditions. The objective is to get familiar with the vehicle in general terms and its capability to handle hazards related to the cluster defined.

There are shared design reviews by some of the scenarios in the same cluster.

There are other test procedures oriented to scenarios to be used during the verification phase with the aim of checking if the system is fulfilling the requirements it has been designed for. There is a Design Review Test Procedure per scenario, always related to a Physical Testing Test Procedure.

2.2.2 Laboratory Testing

There is also a basic test suite grouped under Laboratory Testing, which would apply to all clusters.

- Sensors
 - Discrimination test
 - Resolution test
 - Susceptibility test
- Electronics integration
 - Fault insertion test
 - Response time test
 - Warning indicator characteristics test
 - Warning indicator location tests
- Actuators
 - Actuator characteristics test

Electronics integration and Actuator groups are defined for all clusters while the Sensors group is oriented to clusters where RADAR, LIDAR, Vision or IR based systems would be relevant (Cluster 1, 2 but not Cluster 3). This is done with component testing to verify the right working of the systems.

Most of these tests are encouraged to check the capabilities of the system by itself, under a verification phase. The objective of these test procedures is the evaluation of special characteristics of the system. The sensor and component testing can be performed either with the system working on the subject vehicle, or dismantled and tested separately, but always taking into account the conditions of the cluster and scenario it is applying to.

Another group of Laboratory Tests includes driving simulator studies having the 'driver in the loop', with the objective to validate the driver's behaviour and interaction with the system. These Laboratory Tests are closely related to the Physical Testing TPs in the validation phase. One Laboratory Test Procedure per Scenario has been defined.

2.2.3 Physical Testing

Physical Testing is applied in both the verification and the validation phase. The proposed TPs are directly based on the scenarios. The only difference is the purpose of the test, the criteria for evaluation and the parameters observed.

The objective of the Verification Physical Test Procedures is to check if the subject vehicle equipped with a suitable system for a specific scenario is able to warn / support / intervene when this vehicle is subjected to a determined situation related to the specific scenario.

The objective of the Validation Physical Test Procedures is to check if the driver and the subject vehicle equipped with safety functions will be able to keep control in a hazardous situation representing the scenario.

There are two Test Procedures per scenario, one oriented for the verification and one oriented on the validation phase.

3 TESTING MATRIX

3.1 Cluster 1 – Longitudinal domain

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C1-1: Straight road scenario	FCW / CMbB / ACC	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G3 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C1-1 Scen-C1-2 Scen-C1-3
		HMI	Evaluate the combined HMI of the ICT-based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes and can avoid a collision when the subject vehicle is having a critical distance to a target vehicle in front on a straight road section.	TP_C1-1	Verification Validation	P, D, L	Verification: HMI of warning/support/intervention (icons, colours, sound etc.) TTC if and when warning is issued. TTC if and when intervention takes place. Distance between vehicles if and when a warning is issued. Distance between vehicles if and when an intervention takes place. Validation: Control indicator: Minimum distance to vehicle in front. Collision indicator: Collision speed. Acceptance of warning/support/intervention Usability of warning/support/intervention	
Scen-C1-2: Curve scenario	FCW / CMbB / ACC	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G3 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C1-1 Scen-C1-2 Scen-C1-3
		HMI	Evaluate the combined HMI of the ICT-based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes when the subject vehicle is having a critical distance to a target vehicle in front in a curve.	TP_C1-2	Verification Validation	P, D, L	Verification: HMI Timing of warning/support/intervention TTC at the instant of warning/intervention Distance between vehicles Validation: Subjective measure of function Collision indicators Control indicators	

Table 3-1-1 Testing matrix, Cluster 1 - Longitudinal domain, part 1

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C1-3: Discrimination scenario	FCW / CMbB / ACC	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G3 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C1-1 Scen-C1-2 Scen-C1-3
		HMI	Evaluate the combined HMI of the ICT-based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
	System by itself and system under real conditions	Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes when a moving target obstacle cross the lane in front. And check if the subject vehicle + it's driver equipped with a longitudinal system will have control in a situation where a moving target obstacle cross the lane in front and that a collision is avoided.	TP_C1-3	Verification Validation	P, D, L	Verification: HMI Timing of warning/intervention TTC at the instant of warning/intervention Distance between vehicle and target. Validation: Subjective measure of function Collision indicators Control indicators		
	Pedestrian detection	System under real conditions	Determine the capabilities of detection of a pedestrian detection system under representative conditions for urban scenarios and evaluate its potential on injuries mitigation or accident avoidance.	TP_C1-4	Verification Validation	P	Validation: Collision indicator: Collision speed or avoidance capabilities. Acceptance of warning/support/intervention Usability of warning/support/intervention False alarm rates in urban scenarios	

Table 3-1-2 Testing matrix, Cluster 1 - Longitudinal domain, part 2

3.2 Cluster 2 – Lateral domain

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C2-1: Lane departure on a straight road scenario	LDW, LKA, BSM	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road.	TP_C2-1	Verification Validation	P, D, L	Verification: HMI Timing of warning/intervention TLC at the instant of warning/intervention Validation: Subjective measure of function Collision indicators Control indicators	
Scen-C2-2: Road departure on a straight road scenario	LDW, LKA, BSD	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road.	TP_C2-2	Verification Validation	P, D, L	Verification: HMI Timing of warning/intervention TLC at the instant of warning/intervention Validation: Subjective measure of function Collision indicators Control indicators	
Scen-C2-3: Lane departure in a curve scenario	LDW, LKA, BSD	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure in a predefined curve.	TP_C2-3	Verification Validation	P, D, L	Verification: HMI Timing of warning/intervention TLC at the instant of warning/intervention Validation: Subjective measure of function Collision indicators Control indicators	

Table 3-2-1 Testing matrix, Cluster 2 - Lateral domain, part 1

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C2-4: Road departure in a curve scenario	LDW, LKA, BSD	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure in a predefined curve.	TP_C2-4	Verification Validation	P, D, L	Verification: HMI Timing of warning/intervention TLC at the instant of warning/intervention Validation: Subjective measure of function Collision indicators Control indicators	
Scen-C2-5: Lane departure on a straight road before a curve scenario		Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road (just before a curve).	TP_C2-5	Verification Validation	P, D, L	Verification: Subjective measure of function Collision indicators Control indicators Validation: Subjective measure of function Collision indicators Control indicators	

Table 3-2-2 Testing matrix, Cluster 2 - Lateral domain, part 2

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C2-6: Road departure on a straight road before a curve scenario	LDW, LKA, BSD	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verificate the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road (just before a curve).	TP_C2-6	Verification Validation	P, D, L	Verification: Subjective measure of function Collision indicators Control indicators Validation: Subjective measure of function Collision indicators Control indicators	
Scen-C2-7: Lane change collision avoidance in a straight road scenario	LDW, LKA, BSD	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G4 TP_G6 TP_G7 TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C2-1 Scen-C2-2 Scen-C2-3 Scen-C2-4 Scen-C2-5 Scen-C2-6 Scen-C2-7
		HMI	Verificate the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Sensors	Check the capabilities of the sensors	TP_G9 to TP_G13	Verification	L	Detection area Discrimination Resolution Susceptibility	
		Electronics integration	Check the fault and time responses and the indicators	TP_G14 to TP_G17	Verification	L	Fault insertion tests Response time Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System by itself and system under real conditions	Check if the subject vehicle equipped with a lateral support system is capable of avoiding a lateral collision when changing lane on a straight road, and encountering an approaching target vehicle in the blind spot.	TP_C2-7	Verification Validation	P, D, L	Verification: Subjective measure of function Collision indicators Control indicators Validation: Subjective measure of function Collision indicators Control indicators	

Table 3-2-3 Testing matrix, Cluster 2 - Lateral domain, part 3

3.3 Cluster 3 – Stability domain

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C3-1: Emergency braking on a μ -split	ESC / ABS	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G5 to TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C3-1 Scen-C3-2 Scen-C3-3 Scen-C3-4
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Electronics integration	Check the fault and time responses and the indicators	TP_G16 TP_G17	Verification	L	Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System under real conditions	This test method is meant to validate the subject vehicles capability to maintain a reasonable stopping distance while keeping the desired driving direction with different payloads, resulting in different locations of the centre of mass.	TP_C3-1	Validation	D, P	Validation: Vehicles ability to maintain course Stopping distance Max yaw, pitch, roll angle for vehicle / trailer	
Scen-C3-2: Driver collision avoidance	ESC / ABS	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G5 to TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C3-1 Scen-C3-2 Scen-C3-3 Scen-C3-4
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Electronics integration	Check the fault and time responses and the indicators	TP_G16 TP_G17	Verification	L	Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System under real conditions	This test method is meant to validate the subject vehicle capability to avoid the loss of control in case of a sudden obstacle avoidance manoeuvre, followed by a come back to the original lane in order to avoid the collision with an incoming vehicle.	TP_C3-2	Validation	D, P	Validation: Stopping distance Lateral Deviation from centre of lane Max yaw, pitch, roll angle for vehicle/ trailer	

Table 3-3-1 Testing matrix, Cluster 3 - Stability domain, part 1

Scenarios	Potential systems addressed	Test levels to be performed	Objective with the test levels	Test procedure identifier	Purpose of the test	Type of test	Parameters to be analysed	Comments
Scen-C3-3: Fast driving into a curve	ESC / ABS	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G5 to TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C3-1 Scen-C3-2 Scen-C3-3 Scen-C3-4
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Electronics integration	Check the fault and time responses and the indicators	TP_G16 TP_G17	Verification	L	Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System under real conditions	This test method is meant to validate the subject vehicle capability to avoid a loss of control as well as a lane/road departure in the case of a curve approached too fast.	TP_C3-3	Validation	D, P	Validation: Lateral Deviation from centre of lane Max yaw, pitch, roll angle for vehicle/ trailer	
Scen-C3-4: Roll stability test	ESC / ABS	Functional safety	To get familiar with the vehicle and the system and check if it will be able to handle with hazardous situations	TP_G2 TP_G5 to TP_G8	Verification	D	sensors: type and performance handling level: warn, support and intervene range enabling / disabling fault detection capability safety integrity level communication protocol and range, sensibility type of vehicle false alarms	shared by: Scen-C3-1 Scen-C3-2 Scen-C3-3 Scen-C3-4
		HMI	Verify the combined HMI of the ICT based safety system	TP_G1	Verification	D	Visual warnings – telltales Acoustic warnings Haptic warnings Status indication Combination of warnings / workload / interference Driver override / System override	
		Electronics integration	Check the fault and time responses and the indicators	TP_G16 TP_G17	Verification	L	Warning indicators	
		Actuators	Check the characteristics and capabilities of the actuator	TP_G18	Verification	L	Time and range response	
		System under real conditions	This test method is meant to validate the subject vehicle capability to avoid a loss of stability which may result in a rollover event while negotiating a long curve, such as highway entrance or exit ramps.	TP_C3-4	Validation	D, P	Validation: Lateral Deviation from centre of lane Max yaw, pitch, roll angle for vehicle/ trailer	

Table 3-3-2 Testing matrix, Cluster 3 - Stability domain, part 2

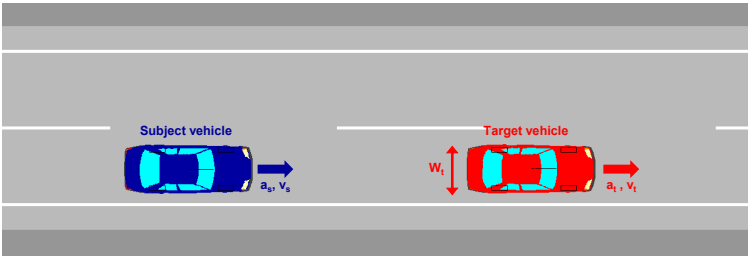
4 ANNEX

To be able to make a distinction between verification and validation tests for scenario based testing, some of the outlined test procedures in this chapter are split up in part A (verification) and part B (validation).

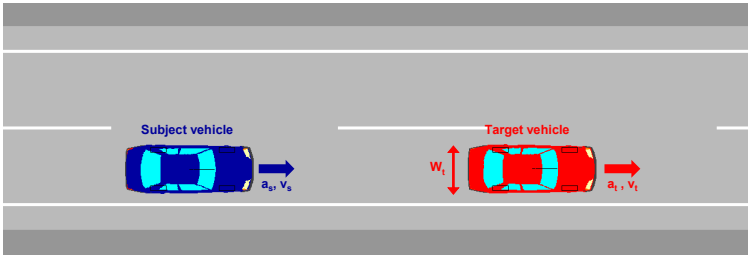
4.1 Test procedures description

4.1.1 Cluster 1 test procedures

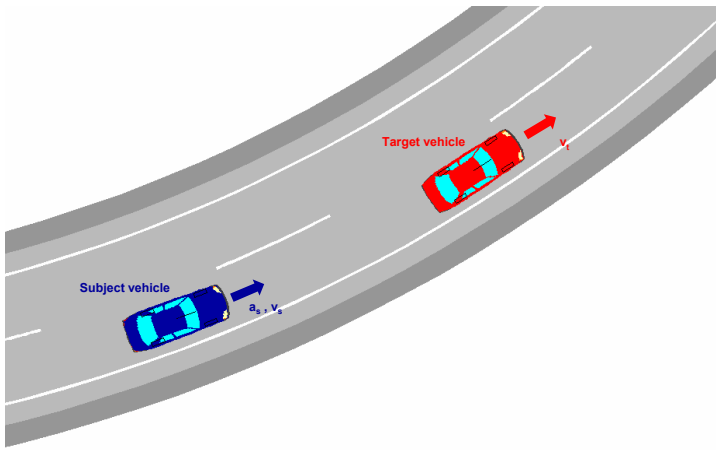
Rear-end collision with stationary/slower target vehicle - A

Test procedure name Rear-end collision with stationary/slower target vehicle - A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C1-1 (A)
Function output Warn/Support/Intervene	Scenario(s) addressed Longitudinal control Scen C1-1 Straight road scenario <ul style="list-style-type: none"> • Rear-end collision with stationary target vehicle. • Rear-end collision with slower moving target vehicle. 	System(s) addressed FCW/CMbB/ACC
Objective Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes when the subject vehicle is having a critical distance to a target vehicle in front on a straight road section.		
Description Two vehicles, the subject vehicle and the target vehicle (target) will be positioned in the same lane, the target vehicle in front of the subject vehicle. The target vehicle is stationary or drives at a slower speed than the subject vehicle, to decrease the distance between the vehicles. Case 1: Both vehicles have speed > 0 km/h. The target vehicle has speed v_T and the subject vehicle has speed v_S , where $v_T < v_S$. Case 2: The target vehicle is stationary. The test will be performed at different speeds of the two vehicles, and with different vehicles; a truck as subject vehicle and a car as target vehicle, or a car as both subject and target vehicle. The target vehicle is a dummy car (e.g. a balloon car). The warning and/or the intervention of the system will be validated at different conditions. Depending on the relative speeds and the distances, different configurations will be used. The aim with the test is to verify the correct activation of the functions warning/support/intervention (different depending on systems) and that the functions have a suitable HMI.		
Sketch 		
Motivation of the test The test validates the ability of the subject vehicle to detect and warns/supports/intervenes when there is a critical distance to the target vehicle. Furthermore the test validates the suitability of the HMI.		
Input parameters and range Speed: 20 to 70 km/h Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • HMI of warning/support/intervention (icons, colours, sound etc.) • TTC (Time To Collision) if and when warning is issued. • TTC if and when intervention takes place. • Distance between vehicles if and when a warning is issued. • Distance between vehicles if and when an intervention takes place. 	
Required facilities Dynamic platform Test track with long straight section >=1.5 km for managing acceleration of a truck.	Required vehicles Subject vehicle- truck or car Target vehicle Balloon car (dummy) possible to move in longitudinal direction.	Required instrumentation Differential GPS for subject and silhouette Steering robot Braking robot Test driver/drivers (professional) Expert panel for HMI test Logging equipment Radar Absorbing material Foam
Evaluation Check <ul style="list-style-type: none"> • HMI functionality • Timing of warning/support/intervention • TTC at the instant of warning/intervention • Distance between vehicles at the instant of warning/intervention • Speed and acceleration when detecting target 		

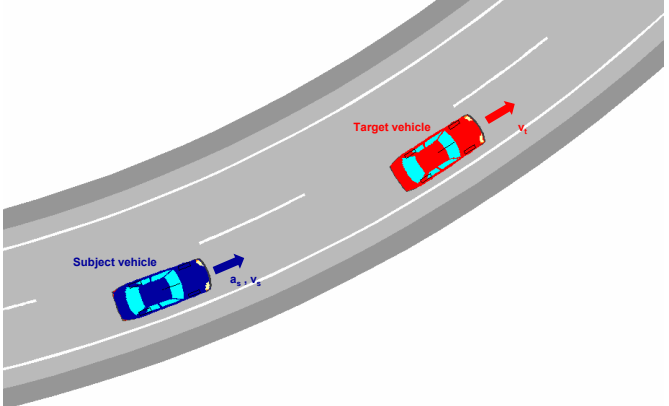
Rear-end collision with stationary/slower target vehicle - B

Test procedure name Rear-end collision with stationary/slower target vehicle - B	Type of test Physical testing on test track Simulator study	Test procedure identifier TP_C1-1 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Longitudinal control Scen C1-1 Straight road scenario <ul style="list-style-type: none"> Rear-end collision with stationary target vehicle. Rear-end collision with slower moving target vehicle. 	System(s) addressed FCW/CMbB/ACC
Objective Check if the subject vehicle equipped with a longitudinal system and its driver can avoid a collision or a critical distance to a target vehicle in front on a straight road section.		
Description 2 vehicles, the subject vehicle and the target vehicle (target) will be positioned in the same lane, the target vehicle in front of the subject vehicle. The target vehicle is stationary or driving at a lower speed than the subject vehicle, to decrease the distance between the vehicles. Case 1: Both vehicles have speed > 0 km/h. The target vehicle has speed v_T and the subject vehicle has speed v_S , where $v_T < v_S$. Case 2: The target vehicle is stationary. The test will be performed at different speeds of the two vehicles, and with different vehicles; a truck as subject vehicle and a car as target vehicle, or a car as both subject and target vehicle. The target vehicle can be a dummy car (e.g. a balloon car). The warning and/or the intervention of the system will be validated at different conditions. Depending on the relative speeds and the distances, different configurations will be used. The aim with the test is to validate that the functions provide a safety benefit in the situations tested, by means of the reaction of the system or the driver and system in interaction. Test drivers are needed in this situation but also braking robots might be used to a certain extent, with different reaction times to warning.		
Sketch 		
Motivation of the test This test aims to validate the safety impact of the functions equipped in the subject vehicle, the ability for the subject vehicle and its driver to avoid or mitigate a collision with the target vehicle.		
Input parameters and range Speed: 20 to 70 km/h Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> Control indicator: Minimum distance to vehicle in front. Collision indicator: Collision speed. Acceptance of warning/support/intervention Usability of warning/support/intervention 	
Required facilities Dynamic platform Test track with long straight section >=1.5 km for managing acceleration of a truck.	Required vehicles Subject vehicle- truck or car Target vehicle Balloon car (dummy) possible to move in longitudinal direction.	Required instrumentation Differential GPS for subject and silhouette Test drivers Braking robots (programmed with appropriate spectrum of reaction times) Tools for secondary tasks for driver to create distraction Radar Absorbing material Foam
Evaluation Check <ul style="list-style-type: none"> Subjective measures of the situation and the functionalities in the vehicle Collision indicators Control indicators Distance between vehicles Speed and acceleration when detecting target		

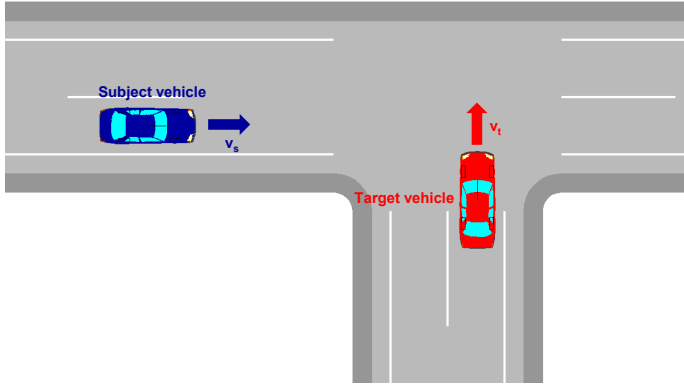
Curve scenario - Rear-end collision with stationary target vehicle in curve - A

Test procedure name Rear-end collision with stationary target vehicle in curve - A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C1-2 (A)
Function output Warn/Support/Intervene	Scenario(s) addressed Longitudinal control <ul style="list-style-type: none"> ScenC1-2 Rear-end collision with stationary target vehicle in a curve Rear-end collision with slower moving target vehicle in a curve 	System(s) addressed FCW/CMbB/ACC
Objective Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes when the subject vehicle is having a critical distance to a target vehicle in front in a curve .		
Description Two vehicles, the subject vehicle and the target vehicle (target) will be positioned in the same lane, the target vehicle in front of the subject vehicle. The target vehicle is stationary or drives at a slower speed than the subject vehicle, to decrease the distance between the vehicles. The warning and/or the intervention of the system will be validated at different conditions. Depending on the relative speeds and the distances, different configurations would be used. The aim with the test is to validate that the functions provide a safety benefit in the situations tested, by means of the reaction of the system or the driver and system in interaction. Test drivers are needed in this situation but also braking robots might be used to a certain extent, with different reaction times to warning.		
Sketch 		
Motivation of the test This test validates the ability of the subject vehicle to detect and warn/support/intervene in a curve to a critical distance to a target vehicle in front. Further the test aims to validate the suitability of the HMI.		
Input parameters and range Speed: 20 to 70 km/h Curve radius: 0 - 500 m Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> HMI of warning/support/intervention (icons, colours, sound etc.) TTC if and when warning is issued. TTC if and when intervention takes place. Distance between vehicles if and when if warning is issued. Distance between vehicles if and when intervention takes place. 	
Required facilities Dynamic platform Test track with long straight section >=1.5 km for managing acceleration of a truck and a curve radius varying from 100 - 500 m.	Required vehicles Subject vehicle- truck or car Target vehicle Balloon car (dummy) possible to move in longitudinal direction.	Required instrumentation Differential GPS for subject and silhouette Steering robot Braking robot Test driver/drivers (professional) Expert panel for HMI test Logging equipment Radar absorbing material
Evaluation Check <ul style="list-style-type: none"> HMI functionality Timing of warning/support/intervention TTC at the instant of warning/intervention Distance between vehicles Speed and acceleration when detecting target 		

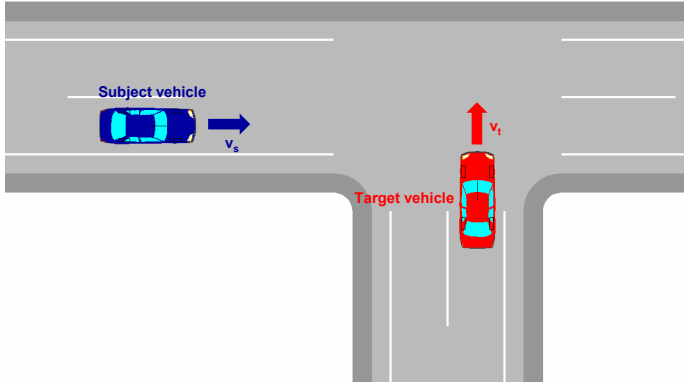
Curve scenario - Rear-end collision with stationary target vehicle in curve - B

Test procedure name Rear-end collision with stationary target vehicle in curve - B	Type of test Physical testing on test track Simulator study	Test procedure identifier TP_C1-2 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Longitudinal control Scen C1-2 <ul style="list-style-type: none"> Rear-end collision with stationary target vehicle in a curve Rear-end collision with slower moving target vehicle in a curve 	System(s) addressed FCW/CMbB/ACC
Objective Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes when the subject vehicle is having a critical distance to a target vehicle in front in <u>a curve</u> .		
Description 2 vehicles, the subject vehicle and the target vehicle (target) will be positioned in the same lane, the target vehicle in front of the subject vehicle. The target vehicle is stationary or drives at a slower speed than the subject vehicle, to decrease the distance between the vehicles. Case 1: Both vehicles have speed > 0 km/h. The target vehicle has speed v_T and the subject vehicle has speed v_S , where $v_T < v_S$. Case 2: The target vehicle is stationary. The test will be performed at different speeds of the two vehicles, and with different vehicles; a truck as subject vehicle and a car as target vehicle, or a car as both subject and target vehicle. The target vehicle can be a dummy car (balloon car). The warning and/or the intervention of the system will be validated at different conditions. Depending on the relative speeds and the distances, different configurations will be used. The aim with the test is to validate that the functions provide a safety benefit in the situations tested, by means of the reaction of the system or the driver and system in interaction. Test drivers are needed in this situation but also braking robots might be used to a certain extent, with different reaction times to warning.		
Sketch 		
Motivation of the test This test aims to validate the safety impact of the functions equipped in the subject vehicle, the ability for the subject vehicle and its driver to avoid or mitigate a collision with the target vehicle.		
Input parameters and range Speed: 20 to 70 km/h Curve radius 0 – 500 m Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> Control indicators: Minimum distance to vehicle in front. Collision indicator: Collision speed. Acceptance of warning/support/intervention Usability of warning/support/intervention 	
Required facilities Dynamic platform Test track with long straight section ≥ 1.5 km for managing acceleration of a truck.	Required vehicles Subject vehicle- truck or car Target vehicle Balloon car (dummy) possible to move in longitudinal direction.	Required instrumentation Differential GPS for subject and silhouette Test drivers Braking robots (programmed with appropriate reaction times) Tools for secondary tasks for driver to create distraction Radar Absorbing material Foam
Evaluation Check <ul style="list-style-type: none"> Subjective measure of function Collision indicators Control indicators Distance between vehicles (subject and target) Speed and acceleration when detecting target 		

Discrimination scenarios - Collision with moving target crossing the lane - A

Test procedure name Discrimination scenarios - Collision with moving target crossing the lane -A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C1-3 (A)
Function output Warn/Support/Intervene	Scenario(s) addressed Longitudinal control Scen C1-3 <ul style="list-style-type: none"> Collision with moving target crossing the lane. 	System(s) addressed FCW/CMbB/ACC
Objective Check if the subject vehicle equipped with a longitudinal system warns / supports/ intervenes when a moving target obstacle cross the lane in front. Furthermore, to validate the suitability of the HMI.		
Description A vehicle; the subject vehicle, is driving at a certain speed at a straight road segment. A moving target is crossing the lane. The target vehicle can be a dummy vehicle, a dummy pedestrian adult or child with stroller, a dummy bicycle or a dummy animal. The warning and/or the intervention of the system will be validated at different conditions. The aim with the test is to verify that the subject vehicle equipped with the safety system provides a warning/support/intervention to avoid a collision with the moving target, and that an suitable HMI is used for the function.		
Sketch 		
Motivation of the test This test validates the ability of the subject vehicle to detect and warn/support/intervene to a critical distance to a target vehicle in front. Further the test aims to validate the suitability of the HMI.		
Input parameters and range Speed: 20 to 70 km/h Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> HMI of warning/support/intervention (icon, colour, sound etc.) TTC if and when warning is issued. TTC if and when intervention takes place. Distance between vehicle and target if and when if warning is issued. Distance between vehicle and target if and when intervention takes place. 	
Required facilities Dynamic platform Test track with long straight section >=1.5 km for managing acceleration of a truck.	Required vehicles Subject vehicle- truck or car Target vehicle Moving dummy target Target IR emissions	Required instrumentation Differential GPS for subject and silhouette Steering robot Braking robot Test driver/drivers (professional) Expert panel for HMI test Logging equipment Foam Shock sensor
Evaluation Check <ul style="list-style-type: none"> HMI functionality Timing of warning/intervention TTC at the instant of warning/intervention Distance between vehicle and target. Vehicle speed and acceleration when detecting target 		

Discrimination scenarios - Collision with moving target crossing the lane – B

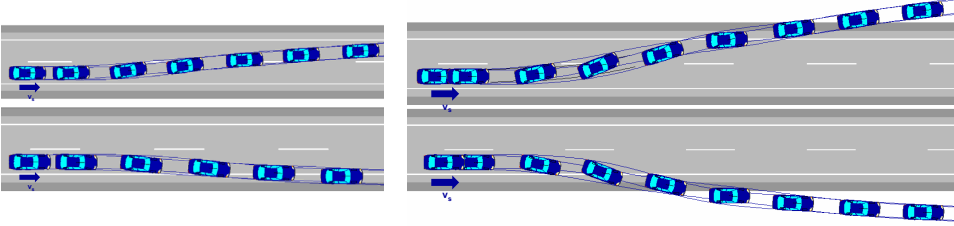
Test procedure name Discrimination scenarios - Collision with moving target crossing the lane - B	Type of test Physical testing on test track Simulator study	Test procedure identifier TP_C1-3 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Longitudinal control Scen C1-3 <ul style="list-style-type: none"> Collision with moving target crossing the lane. 	System(s) addressed FCW/CMbB/ACC
Objective Check if the subject vehicle + its driver equipped with a longitudinal will have control in a situation where a moving target obstacle cross the lane in front and that a collision is avoided.		
Description A vehicle; the subject vehicle, is driving at a certain speed at a straight road segment. A moving target is crossing the lane. The target vehicle can be a dummy vehicle, dummy pedestrian adult or child with stroller, a dummy bicycle or a dummy animal. The warning and/or the intervention of the system will be validated at different conditions. The aim with the test is to validate that the functions provide a safety benefit in the situations tested, by means of the reaction of the system or the driver and system in interaction. Test drivers are needed in this situation but also braking robots might be used to a certain extent, with different reaction times to warning.		
Sketch 		
Motivation of the test This test aims to validate the safety impact of the functions equipped in the subject vehicle, the ability for the subject vehicle and its driver to avoid or mitigate a collision with the target vehicle.		
Input parameters and range Speed: 20 to 70 km/h Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> Control indicators: Minimum distance to target. Collision indicator: Collision speed and acceleration. Acceptance of warning/support/intervention Usability of warning/support/intervention 	
Required facilities Dynamic platform Test track with long straight section >=1.5 km for managing acceleration of a truck.	Required vehicles Subject vehicle- truck or car Target vehicle Moving dummy target	Required instrumentation Differential GPS for subject and dummy target Test drivers Braking robots (programmed with appropriate reaction times) Tools for secondary tasks for driver to imply distraction Foam Radar Absorbing material Shock absorber.
Evaluation Check <ul style="list-style-type: none"> Subjective measure of function Collision indicators Control indicators Distance between vehicle and target Vehicle speed and acceleration when detecting moving obstacle 		

Discrimination scenarios – Pedestrian detection and action capabilities on urban scenarios

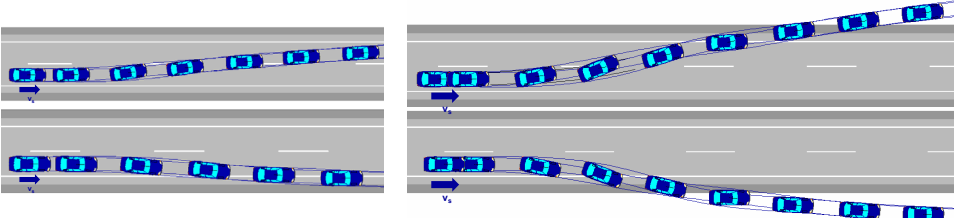
Test procedure name Pedestrian detection and action capabilities on urban scenarios	Type of test Physical testing	Test procedure identifier TP_C1-4
Function output Warn/Support/Intervene	Scenario(s) addressed Scen C1-3	System(s) addressed FCW/CMbB/ACC
Objective Determine the capabilities of detection of a pedestrian detection system under representative conditions for urban scenarios and validate its potential on injuries mitigation or accident avoidance.		
Description The pedestrian detection system will be tested under a situation where the subject vehicle is circulating on a straight road or it is approaching an intersection and a target object, representing a pedestrian, is crossing the street. The detection, warning and action capabilities will be validated. The system should be able to detect the target in a specified field but only warn or act if the pedestrian is intercepting the trajectory of the subject vehicle. In order to make the testing more representative, the target needs to have a representative human shape.		
Sketch		
Motivation of the test Pedestrian accidents represent more than 15% of the fatal accidents in Europe. As TRACE project concluded in their analysis on vulnerable road users, most of the urban accidents take place when the pedestrian is crossing the street, with or without right of crossing. In some of the cases, the driver detected the pedestrian but did not perceive it as a risky situation until there was no avoidance possibility. It is needed to improve the detection, evaluation and action capabilities of the driver in these situations.		
Input parameters and range Subject vehicle speed: 5 – 60 km/h Target object: height, speed, moving legs	Parameters to be analysed Detection time and distance Warning time Action time	
Required facilities Dynamic platform representing an intersection	Required vehicles Subject vehicle Movable target with human shape	Required instrumentation Differential GPS for positioning and velocity Trigger signals monitoring
Evaluation Check the detection and action capabilities of the system Speed and acceleration		

4.1.2 Cluster 2 test procedures

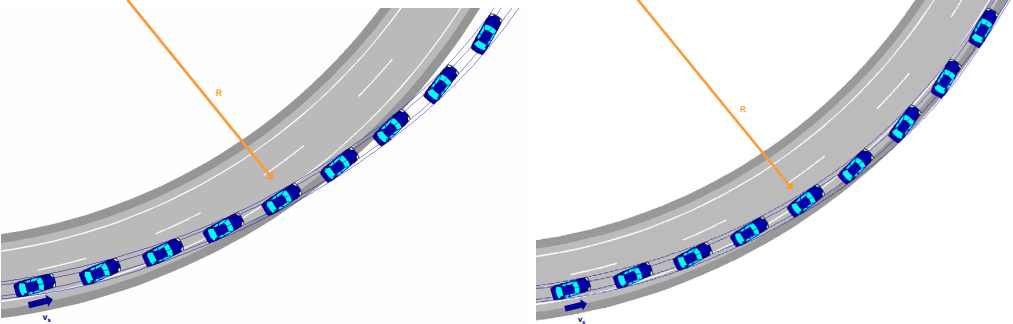
Straight road scenario – Lane/road departure on a straight road - A

Test procedure name Lane/road departure on a straight road - A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C2-1 (A)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control Scen C2-1 Lane departure on a straight road ScenC2-2 Road departure on a straight road	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road.		
Description A vehicle; the subject vehicle, is driving at a certain speed at a straight road segment when it is drifting out of the lane/road. The aim with the test is to verify that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane/road departure before the situation becomes critical. The warning and/or the intervention of the system will be validated at different conditions. Also the suitability of the HMI will be tested.		
Sketch 		
Motivation of the test This test validates the ability of the subject vehicle to warn/support/intervene when the vehicle is departing from its lane or road on a straight road. Further the test aims to validate if the HMI fulfils the requirements.		
Input parameters and range Speed: 20 to 80 km/h city driving Speed: 80 to 150 km/h highway driving Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • HMI of warning/support/intervention (icon, colour, sound, torque etc.) • TLC if and when warning is issued. • TLC if and when intervention takes place. • Distance between vehicles, speed and acceleration. 	
Required facilities Test track with long straight section >=1.5 km for managing acceleration of a truck. Lane markings Large free area or verge next to the lane for the test.	Required vehicles Subject vehicle- truck or car	Required instrumentation Differential GPS for subject and silhouette Steering robot Braking robot Expert panel for HMI test Logging equipment
Evaluation Check <ul style="list-style-type: none"> • HMI • Timing of warning/intervention • TLC at the instant of warning/intervention • Distance between vehicle and target. • Vehicle speed and acceleration when detecting target vehicle. 		

Straight road scenario – Lane/road departure on a straight road – B

Test procedure name Lane/road departure on a straight road - B	Type of test Physical testing on test track Simulator study	Test procedure identifier TP_C2-1 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control Scen C2-1 Lane departure on a straight road ScenC2-2 Road departure on a straight road	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road.		
Description A vehicle; the subject vehicle, is driving at a certain speed at a straight road segment when it is drifting out of the lane/road. The aim with the test is to validate that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane/road departure before the situation becomes critical. The test will be performed under different conditions and vehicles, with a truck and a car. The lane/road drift can take place either to the right or to the left. The warning and/or the intervention of the system will be validated at different conditions. Also the suitability of the HMI will be tested.		
Sketch 		
Motivation of the test This test validates the ability of the subject vehicle to warn/support/intervene when the vehicle is departing from its lane or road on a straight road. Further the test aims to validate the suitability of the HMI.		
Input parameters and range Speed: 20 to 80 km/h city driving Speed: 80 to 150 km/h highway driving Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • Control indicators: <ul style="list-style-type: none"> ○ Time spent outside target lane ○ Driver reaction time • Collision indicator: Collision speed and acceleration. • Acceptance of warning/support/intervention • Usability of warning/support/intervention 	
Required facilities Test track with long straight section >=1.5 km for managing acceleration of a truck. Lane markings Large free area or verge next to the lane for the test. Tools for creating a naturalistic lane departure	Required vehicles Subject vehicle- truck or car	Required instrumentation Differential GPS for subject and dummy target Test drivers Dual controls Tools for secondary tasks for driver to imply distraction
Evaluation Check <ul style="list-style-type: none"> • Subjective measure of function • Collision indicators • Control indicators • Distance between vehicle and target. Vehicle speed and acceleration when detecting.		

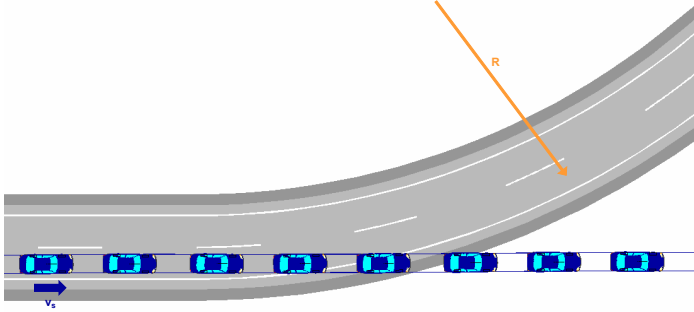
Curve scenario – Lane/road departure in a curve – A

Test procedure name Lane/road departure in a curve - A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C2-3
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control ScenC2-3 Lane departure on a curve ScenC2-4 Road departure on a curve	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure in a predefined curve.		
Description A vehicle; the subject vehicle, is driving at a certain speed in a curve when it is drifting out of the lane/road. The aim with the test is to verify that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane/road departure before the situation becomes critical. The warning and/or the intervention of the system will be validated at different conditions. Also the suitability of the HMI will be tested.		
Sketch 		
Motivation of the test This test validates the ability of the subject vehicle to warn/support/intervene when the vehicle is departing from its lane or road on a straight road. Further the test aims to validate if the HMI fulfils its requirements.		
Input parameters and range Speed: 20 to 80 km/h Curve radius: 0 to 500m Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • HMI of warning/support/intervention (icon, colour, sound, torque etc.) • TLC if and when warning is issued. • TLC if and when intervention takes place. • Speed and acceleration in curves and when TLC 	
Required facilities Test track with long straight section >=1.5 km for managing acceleration of a truck. Lane markings Large free area (est.: 500m curve radius) or verge next to the lane for the test.	Required vehicles Subject vehicle- truck or car	Required instrumentation Differential GPS for subject and silhouette Steering robot Braking robot Expert panel for HMI test Logging equipment
Evaluation Check <ul style="list-style-type: none"> • HMI functionality • Timing of warning/intervention • TLC at the instant of warning/intervention • Vehicle speed and acceleration when detecting TLC 		

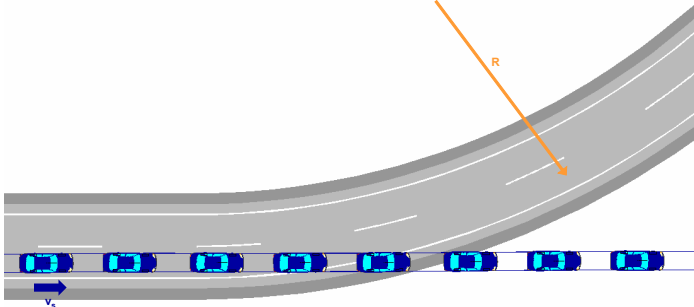
Curve scenario – Lane/road departure in a curve – B

Test procedure name Lane/road departure in a curve - B	Type of test Physical testing on test track Simulator study	Test procedure identifier TP_C2-3 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control ScenC2-3 Lane departure on a curve ScenC2-4 Road departure on a curve	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure in a predefined curve.		
Description A vehicle; the subject vehicle, is driving at a certain speed in a curve when it is drifting out of the lane/road. The aim with the test is to validate that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane/road departure before the situation becomes critical. The warning and/or the intervention of the system will be validated at different conditions, as well as the suitability of the rest of the HMI will be tested.		
Sketch 		
Motivation of the test This test validates the ability of the subject vehicle to warn/support/intervene when the vehicle is departing from its lane or road on a straight road. Further the test aims to validate the suitability of the HMI.		
Input parameters and range Speed: 20 to 70 km/h Curve radius: 0 to 500m Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • Control indicators: <ul style="list-style-type: none"> ○ Time spent outside target lane ○ Driver reaction time • Collision indicator: Collision speed. • Acceptance of warning/support/intervention • Usability of warning/support/intervention • Speed and acceleration in curves 	
Required facilities Test track with long straight section >=1.5 km for managing acceleration of a truck. Lane markings Large free area (est.: 500m curve radius) or verge next to the lane for the test.	Required vehicles Subject vehicle- truck or car	Required instrumentation Differential GPS for subject and silhouette Steering robot Braking robot Expert panel for HMI test Logging equipment
Evaluation Check <ul style="list-style-type: none"> • HMI • Timing of warning/intervention • TLC at the instant of warning/intervention • Distance, speed and acceleration upon detecting TLC 		

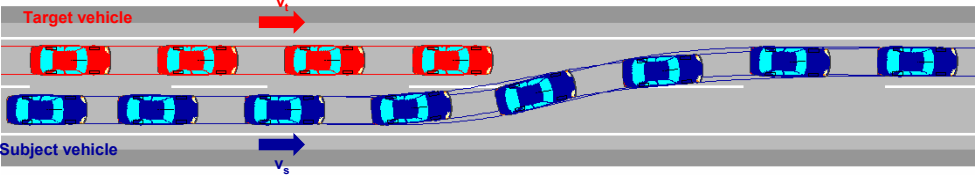
Lane/road departure on a straight lane just before a curve – A

Test procedure name Lane/road departure on a straight lane just before a curve - A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C2-5 (A)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control ScenC2-5 Lane departure on a straight lane just before a curve ScenC2-6 Road departure on a straight lane just before a curve	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road just before a curve.		
Description A vehicle; the subject vehicle, is driving on a straight road just before a curve, inside the lane boundaries. Involuntarily the subject vehicle keeps on forward and leaves the lane at the defined speed. If the related ICT-based systems for this scenario i.e. LDW and LKA, provide more than one type of function output all conditions should be triggered. The test will be finished (correctly) when the subject vehicle returns in lane inside the boundaries or (incorrectly) at any other case. The aim with the test is to verify that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane/road departure before the situation becomes critical. The test will be performed under different conditions and vehicles, with a truck and a car. The lane/road drift can take place either to the right or to the left. The warning and/or the intervention of the system will be validated at different conditions, as well as the suitability of the rest of the HMI.		
Sketch 		
Motivation of the test This test validates the ability of the systems to warn/support/intervene when the subject vehicle is departing from its lane or road on a straight road just before a curve. Further the test aims to validate if the HMI fulfils requirements.		
Input parameters and range Speed: 20 to 70 km/h Curve radius: 0 to 500m Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • HMI of warning/support/intervention (icon, colour, sound, torque etc.) • TLC if and when warning is issued. • TLC if and when intervention takes place. • Speed and acceleration 	
Required facilities Test track with long straight section ≥ 1.5 km for managing acceleration of a truck. Lane markings Large free area or verge next to the lane for the test. Tools for creating a naturalistic lane departure	Required vehicles Subject vehicle- truck or car	Required instrumentation Differential GPS for subject and dummy target Test drivers Dual controls Tools for secondary tasks for driver to imply distraction
Evaluation Check <ul style="list-style-type: none"> • Subjective measure of function • Collision indicators • Control indicators Distance, speed and acceleration upon detecting TLC		

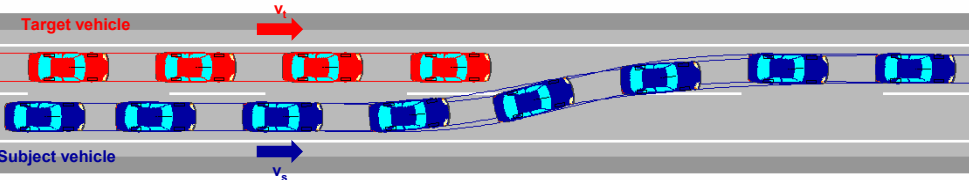
Lane/road departure on a straight lane just before a curve – B

Test procedure name Lane/road departure on a straight lane just before a curve - B	Type of test Physical testing on test track Simulator study?	Test procedure identifier TP_C2-5 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control ScenC2-5 Lane departure on a straight lane just before a curve ScenC2-6 Road departure on a straight lane just before a curve	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system warns / supports/ intervenes in case the subject vehicle makes an unintended lane or road departure on a straight road.		
Description A vehicle; the subject vehicle, is driving on a straight road just before a curve, inside the lane boundaries. Involuntarily the subject vehicle keeps on forward and leaves the lane at the defined speed. If the related ICT-based systems for this scenario i.e. LDW and LKA, provides more than one type of function output both conditions should be triggered. The test will be finished (correctly) when the subject vehicle returns in lane inside the boundaries or (incorrectly) at any other case. The aim with the test is to validate that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane/road departure before the situation becomes critical. The test will be performed under different conditions and vehicles, with a truck and a car. The lane/road drift can take place either to the right or to the left. The warning and/or the intervention of the system will be validated at different conditions, as well as the suitability of the rest of the HMI.		
Sketch 		
Motivation of the test This test validates the ability of the systems to warn/support/intervene when the subject vehicle is departing from its lane or road on a straight road just before a curve. Further the test aims to validate the suitability of the HMI.		
Input parameters and range Speed: 20 to 70 km/h Curve radius: 0 to 500 m Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • Control indicators: <ul style="list-style-type: none"> ○ Time spent outside target lane ○ Driver reaction time • Collision indicator: Collision speed. • Acceptance of warning/support/intervention • Usability of warning/support/intervention 	
Required facilities Test track with long straight section ≥ 1.5 km for managing acceleration of a truck. Lane markings Large free area or verge next to the lane for the test. Tools for creating a naturalistic lane departure	Required vehicles Subject vehicle- truck or car	Required instrumentation Differential GPS for subject and dummy target Test drivers Dual controls Tools for secondary tasks for driver to imply distraction
Evaluation Check <ul style="list-style-type: none"> • Subjective measure of function • Collision indicators • Control indicators • Distance, speed and acceleration TLC 		

Lane change collision avoidance on a straight road – A

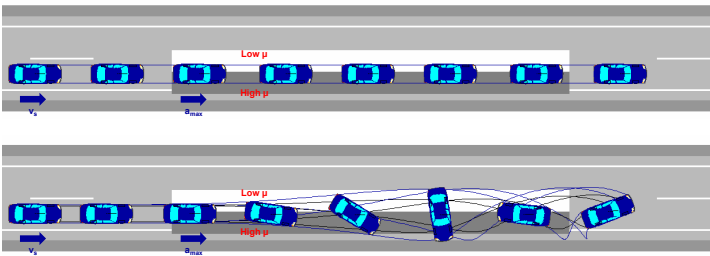
Test procedure name Lane change collision avoidance on a straight road - A	Type of test Physical testing on test track Design review	Test procedure identifier TP_C2-7 (A)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control Scen C2-7 Lane change collision avoidance on a straight road	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system is capable of avoiding a lateral collision when changing lane on a straight road, and encountering an approaching target vehicle in the blind spot.		
Description The subject vehicle is driving at a certain speed on a straight road, inside the lane boundaries. Voluntarily the subject vehicle leaves the lane and encounters a target vehicle in its blind spot. If the related ICT –based system i.e. BSD provides more than one type of function output (warn or support) all conditions should be triggered. The aim with the test is to verify that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane change before the situation becomes critical. The test will be performed under different conditions and vehicles, with a truck and a car. The lane change can take place either to the right or to the left. (right side of most interest for trucks, due to larger blind spot area). The warning and/or the intervention of the system will be validated at different conditions, as well as the suitability of the rest of the HMI.		
Sketch 		
Motivation of the test This test aims to validate the safety impact of the functions equipped in the subject vehicle, the ability for the subject vehicle and its driver to avoid or mitigate a collision with the target vehicle.		
Input parameters and range Speed: 20 to 80 km/h (city) Speed: 80 to 150 km/h (highway) Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -		Parameters to be analysed <ul style="list-style-type: none"> • HMI of warning/support/intervention (icon, colour, sound, torque etc.) • TLC if and when warning is issued. • TLC if and when intervention takes place. • Distance, speed and acceleration
Required facilities Test track with long straight section ≥ 1.5 km for managing acceleration of a truck. Lane markings Large free area or verge next to the lane for the test. Tools for creating a naturalistic lane change	Required vehicles Subject vehicle- truck or car Target vehicle Dummy vehicle	Required instrumentation Differential GPS for subject and dummy target Test drivers Dual controls Logging equipment
Evaluation Check <ul style="list-style-type: none"> • Subjective measure of function • Collision indicators • Control indicators • Distance, speed and acceleration upon detecting TLC and target vehicle 		

Lane change collision avoidance on a straight road – B

Test procedure name Lane change collision avoidance on a straight road - B	Type of test Physical testing on test track Simulator study?	Test procedure identifier TP_C2-7 (B)
Function output Warn/Support/Intervene	Scenario(s) addressed Lateral Control Scen C2-7 Lane change collision avoidance on a straight road	System(s) addressed LDW/LKA/Blind spot detection
Objective Check if the subject vehicle equipped with a lateral support system is capable of avoiding a lateral collision when changing lane on a straight road, and encountering an approaching target vehicle in the blind spot.		
Description The subject vehicle is driving at a certain speed on a straight road, inside the lane boundaries. Voluntarily the subject vehicle leaves the lane and encounters a target vehicle in its blind spot. If the related ICT –based system i.e. BSD provides more than one type of function output (warn or support) all conditions should be triggered. The aim with the test is to validate that the subject vehicle equipped with the safety system provides a warning/support/intervention that interrupts the lane change before the situation becomes critical. The test will be performed under different conditions and vehicles, with a truck and a car. The lane change can take place either to the right or to the left. (Right side of most interest for trucks, due to larger blind spot area). The warning and/or the intervention of the system will be validated at different conditions, as well as the suitability of the rest of the HMI.		
Sketch 		
Motivation of the test This test aims to validate the safety impact of the functions equipped in the subject vehicle, the ability for the subject vehicle and its driver to avoid or mitigate a collision with the target vehicle.		
Input parameters and range Speed: 20 to 80 km/h (city) Speed: 80 to 120 km/h (highway) Longitudinal relative positions: - Lateral relative positions: - Lateral closing speed: -	Parameters to be analysed <ul style="list-style-type: none"> • Control indicators: <ul style="list-style-type: none"> ○ Time spent outside target lane ○ Driver reaction time • Collision indicator: Collision speed. • Acceptance of warning/support/intervention • Usability of warning/support/intervention • Distance, speed and acceleration 	
Required facilities Test track with long straight section ≥ 1.5 km for managing acceleration of a truck. Lane markings Large free area or verge next to the lane for the test. Tools for creating a naturalistic lane change	Required vehicles Subject vehicle- truck or car Target vehicle Dummy vehicle	Required instrumentation Differential GPS for subject and dummy target Test drivers Dual controls Logging equipment Tools for secondary tasks for driver to imply distraction
Evaluation Check <ul style="list-style-type: none"> • Subjective measure of function • Collision indicators • Control indicators • Distance, speed and acceleration upon detecting lane change and dummy vehicle 		

4.1.3 Cluster 3 test procedures

Emergency braking on a μ -split

Test procedure name Emergency braking on a μ -split	Type of test Physical testing on test track Design review	Test procedure identifier TP_C3-1
Function output Intervene	Scenario(s) addressed Emergency braking on a μ -split Scen-C3-1	System(s) addressed ESC, ABS
Objective This test procedure is meant to validate the subject vehicles capability to maintain a reasonable stopping distance while keeping the desired driving direction with different payloads, resulting in different locations of the centre of mass.		
Description This is a single vehicle test procedure. The subject vehicle is driving on a straight road at a V_S speed when it reaches the brake test course with the μ -split surface. On the μ -split surface the vehicle brakes heavily while the driver tries to follow the initial driving direction. Related to the subject vehicle, the scenario can consider all types of vehicles. Concerning the environment, the scenario regards different temperature and visibility conditions. Truck specific different payloads should be tested to validate the systems capability to cope with different locations of the centre of mass. The following truck classes could be differentiated: <ul style="list-style-type: none"> • Tractor without trailer • Tractor with trailer, different payloads • Rigid with different payloads 		
Sketch 		
Motivation of the test This test procedure is meant to validate the subject vehicles capability to maintain a reasonable stopping distance while keeping the desired driving direction with different payloads, resulting in different locations of the centre of mass.		
Input parameters and range Speed: 20 to 80 km/h Deceleration: - minimum 3 m/s ²		Parameters to be analysed <ul style="list-style-type: none"> • Stopping distance • Lateral deviation from initial course • Speed and acceleration
Required facilities Test track with μ -split suitable for trucks	Required vehicles Subject vehicle- truck	Required instrumentation Driving robot / Professional Test Driver Logging equipment for internal vehicle data Measurement and logging equipment as reference measurement system
Evaluation Check <ul style="list-style-type: none"> • Vehicles ability to maintain course • Stopping distance • Max yaw, pitch, roll angle for vehicle/ trailer • Speed and acceleration 		

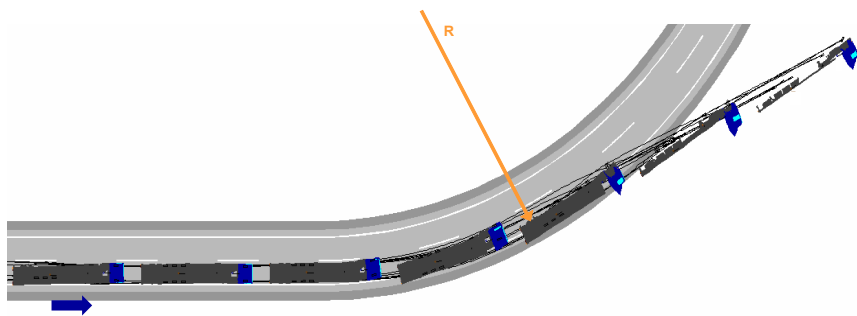
Driver collision avoidance

Test procedure name Driver collision avoidance	Type of test Physical testing on test track Design review	Test procedure identifier TP_C3-2
Function output Intervene	Scenario(s) addressed Driver Collision Avoidance Scen-C3-2	System(s) addressed ESC, ABS
Objective This test procedure is meant to validate the subject vehicle capability to avoid the loss of control in case of a sudden obstacle avoidance manoeuvre, followed by a come back to the original lane in order to avoid the collision with an incoming vehicle.		
Description This is a single vehicle test procedure. The subject vehicle is driving on a straight road at a V_s speed when the driver, in order to avoid a collision with an unexpected object, brakes the vehicle heavily, then tries to change the lane without running off the road and finally tries to come back to the original lane in order to avoid a front collision. Related to the subject vehicle, the scenario can consider all type of vehicles. Concerning the environment, the scenario regards different surface, temperature and visibility conditions, as well as traffic situation and road infrastructure standardized settings, in particular lane configuration. Different truck/ trailer configurations with different payloads should be considered. Truck specific different payloads should be tested to validate the systems capability to cope with different locations of the centre of mass.		
The following truck classes could be differentiated: <ul style="list-style-type: none"> • Tractor without trailer • Tractor with trailer, different payloads • Rigid with different payloads 		
Sketch 		
Motivation of the test The side loads transfer within this manoeuvre compromises the stability of the vehicle.		
Input parameters and range Speed: 20 to 80 km/h Deceleration: - minimum 3.0 m/s ²	Parameters to be analysed <ul style="list-style-type: none"> • Speed when entering first bend • Lateral deviation from centre of lane • Speed and acceleration 	
Required facilities Test track	Required vehicles Subject vehicle- truck	Required instrumentation Driving robot / Professional Test Driver Logging equipment for internal vehicle data Measurement and logging equipment as reference measurement system
Evaluation Check <ul style="list-style-type: none"> • Stopping distance • Lateral Deviation from centre of lane • Max yaw, pitch, roll angle for vehicle/ trailer 		

Fast driving into a curve

Test procedure name Fast driving into a curve	Type of test Physical testing on test track Design review	Test procedure identifier TP_C3-3
Function output Intervene	Scenario(s) addressed Fast Driving into a curve Scen-C3-2	System(s) addressed ESC, ABS
Objective This test procedure is meant to validate the subject vehicle capability to avoid a loss of control as well as a lane/road departure in the case of a curve approached too fast.		
Description This is a single vehicle test procedure. The subject vehicle is driving on a straight road at a V_s speed when the driver tries to negotiate a curve with a radius too small for the vehicle speed, so it tends to depart road edge outside or inside the curve depending on its understeering or oversteering behavior. Concerning the environment, the scenario regards different surface, temperature and visibility conditions, as well as traffic situation and road infrastructure standardized settings, in particular lane/road configuration. Different truck/ trailer configurations with different payloads should be considered. Truck specific different payloads should be tested to validate the systems capability to cope with different locations of the centre of mass. The following truck classes could be differentiated: <ul style="list-style-type: none"> • Tractor without trailer • Tractor with trailer, different payloads • Rigid with different payloads 		
Sketch		
Motivation of the test		
Input parameters and range Speed: 20 to 80 km/h Deceleration: - minimum 3.0 m/s ²	Parameters to be analysed <ul style="list-style-type: none"> • Speed and acceleration when entering curve • Lateral deviation from centre of lane 	
Required facilities Test track	Required vehicles Subject vehicle- truck	Required instrumentation Driving robot / Professional Test Driver Logging equipment for internal vehicle data Measurement and logging equipment as reference measurement system
Evaluation Check <ul style="list-style-type: none"> • Lateral Deviation from centre of lane • Max yaw, pitch, roll angle for vehicle/ trailer • Speed and acceleration 		

Roll stability test

Test procedure name Roll stability test	Type of test Physical testing on test track Design review	Test procedure identifier TP_C3-4
Function output Intervene	Scenario(s) addressed Fast Driving into a curve Scen-C3-2	System(s) addressed ESC, ABS
Objective This test procedure is meant to validate the subject vehicle capability to avoid a loss of stability which may result in a rollover event while negotiating a long curve, such as highway entrance or exit ramps.		
Description This is a single vehicle test procedure. The subject vehicle is driving on a straight road at a V_s speed when the driver tries to negotiate a long curve for which such speed is excessive. Related to the subject vehicle, the scenario considers mainly heavy-duty trucks. Concerning the environment, the scenario regards different surface, temperature and visibility conditions, as well as traffic situation and road infrastructure standardized settings, in particular lane/road configuration. Different truck/ trailer configurations with different payloads should be considered. Truck specific different payloads should be tested to validate the systems capability to cope with different locations of the centre of mass. The following truck classes could be differentiated: Tractor without trailer Tractor with trailer, different payloads Rigid with different payloads		
Sketch 		
Motivation of the test To see if the system can avoid an rollover of the subject vehicle or -truck.		
Input parameters and range Speed: 20 to 80 km/h Deceleration: -		Parameters to be analysed <ul style="list-style-type: none"> • Speed and acceleration when entering curve • Lateral deviation from centre of lane
Required facilities Test track with curve or a large verge area for safety.	Required vehicles Subject vehicle- truck	Required instrumentation Logging equipment for internal vehicle data Measurement and logging equipment as reference measurement system Steering robot Braking robot
Evaluation Check <ul style="list-style-type: none"> • Lateral Deviation from centre of lane • Max yaw, pitch, roll angle for vehicle/ trailer • Distance, speed and acceleration when entering-, in- and leaving the curve 		

4.1.4 Non scenario-oriented test procedures

HMI Design Review

Test procedure name HMI Design Review	Type of test Design Review	Test procedure identifier TP_G1
Function output Warn/Support	Scenario(s) addressed All	System(s) addressed All
Objective To verify the combined HMI of the ICT-based safety systems		
Description To check properties of the combined HMI of the ICT-based safety systems. <ul style="list-style-type: none"> • level <ul style="list-style-type: none"> ○ warn <ul style="list-style-type: none"> ▪ adequacy of warning signals and status indicators <ul style="list-style-type: none"> • perceivable • combinations (distinguishable, priority) ▪ workload ○ support ○ intervene <ul style="list-style-type: none"> ▪ system/driver override ▪ combinations (competition between systems) 		
Sketch None		
Motivation of the test Due to the limited time and resources during performance testing, design review could be used to validate the HMIs of the test vehicle. The HMI is very important in many ICT-based safety systems since several of them involve a reaction and action by the driver to avoid the hazard.		
Input parameters and range None	Parameters to be analysed Visual warnings – telltales <ul style="list-style-type: none"> • Colour • Symbol • Luminance • Interval • Location Acoustic warnings <ul style="list-style-type: none"> • Pressure • Tone • Interval • Location Haptic warnings <ul style="list-style-type: none"> • Force/Acceleration • Interval Status indication <ul style="list-style-type: none"> • Activated – deactivated • Faulty – fault-free Combination of warnings / workload / interference Driver override / System override Loop duration (to see when system can crash)	
Required facilities Workshop	Required vehicles Test vehicle	Required instrumentation None
Evaluation To verificate if the HMI (indicators, warnings, etc) fulfil their requirements. System looping (to see when system crashes)		
References -		

Environmental Conditions Design Review

Test procedure name Environmental conditions design review	Type of test Design review	Test procedure identifier TP_G2
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All
Objective To verify that the vehicle and its ICT-based safety systems have been verified during different environmental conditions.		
Description Studying documentation provided by the OEM or safety system supplier concerning testing of the safety systems during different environmental conditions. The parameters to be analysed depend on the system validated. E.g. lane markings affect the performance of LDW systems but not ESC.		
Sketch None		
Motivation of the test Due to the limited time and resources during performance testing, design review could be used to validate which environmental conditions the test vehicle can handle. During performance testing typical conditions are normally used. Sensors, controllers, and actuators might be negatively affected by adverse environmental conditions.		
Input parameters and range None	Parameters to be analysed <ul style="list-style-type: none"> • visibility <ul style="list-style-type: none"> ○ lighting (day, night, dusk, dawn) ○ precipitation (rain, snow) ○ dirt (mud, salt) • surface <ul style="list-style-type: none"> ○ material (concrete, asphalt, gravel) ○ friction ○ lane markings • obstacles <ul style="list-style-type: none"> ○ road infrastructure <ul style="list-style-type: none"> ▪ signs ▪ guard rails ▪ lamp posts ▪ parked cars ○ road inclination ○ road curvature • vehicle loading <ul style="list-style-type: none"> ○ load on roof ○ load in baggage compartment ○ trailer • temperature <ul style="list-style-type: none"> ○ under freezing point ○ normal ○ hot 	
Required facilities None	Required vehicles None	Required instrumentation None
Evaluation To verify if the safety systems fulfil their requirements on operation during different environmental conditions.		
References -		

Longitudinal Cluster Design Review

Test procedure name Longitudinal cluster design review	Type of test Design review	Test procedure identifier TP_G3
Function output Warn	Scenario(s) addressed Cluster 1 scenarios	System(s) addressed E.g. FCW, ACC, CMbB
Objective To get familiar with the vehicle and its systems capable to detect and handle hazards occurring in the longitudinal direction of the vehicle.		
Description The test vehicle and documentation shall be studied. All ICT-based safety systems operating in the longitudinal direction shall be identified and their limitations established. The overall goal is to get familiar with the vehicle and its specific longitudinal ICT-based safety systems. This test procedure may also involve an informal "test drive" of the vehicle. The design review shall be performed together with the OEM and/or the supplier of safety systems.		
Sketch None		
Motivation of the test To prepare for the physical vehicle tests and laboratory test it is important to get to know the vehicle and its ICT-based safety systems.		
Input parameters and range None	Parameters to be analysed <ul style="list-style-type: none"> • sensors <ul style="list-style-type: none"> ○ type <ul style="list-style-type: none"> ▪ RADAR ▪ LIDAR ▪ Camera ○ performance <ul style="list-style-type: none"> ▪ detection range ▪ detection width ▪ discrimination <ul style="list-style-type: none"> • target size • moving/stationary • multiple targets • handling level <ul style="list-style-type: none"> ○ warn ○ support ○ intervene • system <ul style="list-style-type: none"> ○ speed range ○ enable/disable 	
Required facilities Workshop, Test track	Required vehicles Test vehicle	Required instrumentation None
Evaluation The aim of this design review is rather to get familiar with the longitudinal ICT-based safety systems of the vehicle than to verify their performance. The purpose is also to get to know the limitations of the vehicle to see if all eVALUE test scenarios become applicable.		
References -		

Lateral Cluster Design Review

Test procedure name Lateral cluster design review	Type of test Design review	Test procedure identifier TP_G4
Function output Warn	Scenario(s) addressed Cluster 2 scenarios	System(s) addressed E.g. LDW and BSD
Objective To get familiar with the vehicle and its systems capable to detect and handle hazards occurring in the lateral direction of the vehicle.		
Description The test vehicle and documentation shall be studied. All ICT-based safety systems operating in the lateral direction shall be identified and their limitations established. The overall goal is to get familiar with the vehicle and its specific lateral ICT-based safety systems. This test procedure may also involve an informal "test drive" of the vehicle. The design review shall be performed together with the OEM and/or the supplier of safety systems.		
Sketch None		
Motivation of the test Decision for further investigation and eventually detailed set up of laboratory tests and physical vehicle tests		
Input parameters and range None	Parameters to be analysed <ul style="list-style-type: none"> • sensors <ul style="list-style-type: none"> ○ type <ul style="list-style-type: none"> ▪ Optical ▪ Electromagnetic ▪ GPS ○ performance <ul style="list-style-type: none"> ▪ detection range ▪ detection width ▪ discrimination <ul style="list-style-type: none"> • target size • handling level <ul style="list-style-type: none"> ○ warn ○ support ○ intervene • system <ul style="list-style-type: none"> ○ speed range ○ enable/disable 	
Required facilities Workshop, Test track	Required vehicles Test vehicle	Required instrumentation None
Evaluation The aim of this design review is rather to get familiar with the lateral ICT-based safety systems of the vehicle than to verify their performance. The purpose is also to get to know the limitations of the vehicle to see if all eVALUE test scenarios become applicable.		
References -		

Stability Cluster Design Review

Test procedure name Stability cluster design review	Type of test Design review	Test procedure identifier TP_G5
Function output Warn	Scenario(s) addressed Cluster 3	System(s) addressed E.g. ABS and ESC
Objective To get familiar with the vehicle and its systems capable to detect and handle hazards related to the stability of the vehicle.		
Description The test vehicle and documentation shall be studied. All ICT-based safety systems enhancing stability shall be identified and their limitations established. The overall goal is to get familiar with the vehicle and its specific ICT-based safety systems for stability control. This test procedure may also involve an informal "test drive" of the vehicle. The design review shall be performed together with the OEM and/or the supplier of safety systems.		
Sketch None		
Motivation of the test Stability control can be designed in different ways. The performance testing based on scenarios will not address individual safety systems, but knowledge of the design will make it easier to perform the tests.		
Input parameters and range Manufacturer documentation	Parameters to be analysed <ul style="list-style-type: none"> • sensors <ul style="list-style-type: none"> ○ type <ul style="list-style-type: none"> ▪ gyro ▪ accelerometer ▪ speed ▪ steering angle ▪ pedal position ○ performance <ul style="list-style-type: none"> ▪ speed limits ▪ loading limits • handling level <ul style="list-style-type: none"> ○ warn ○ support ○ intervene • system <ul style="list-style-type: none"> ○ speed range ○ enable/disable 	
Required facilities None	Required vehicles A vehicle can be used for demonstration, but is not compulsory.	Required instrumentation None
Evaluation No pass/fail judgement can be made in this design review. (A vehicle may well be entered for performance testing of stability control even if it lacks the safety systems.)		
References -		

Functional Safety Design Review

Test procedure name Functional safety design review	Type of test Design review	Test procedure identifier TP_G6
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All safety-related systems
Objective Examination of safety functions in connection to hazard and risk analysis, safety requirements and safety integrity requirements (ex. Safety integrity level, fault detection mechanism, transition to "safe state", information to the driver)		
Description Hardware, software, control signals, time aspects, redundancy		
Sketch None		
Motivation of the test Analysis of implementation of safety and safety-related functions, reliability as well as preliminary review prior to further investigations for detailed set up of laboratory tests and physical vehicle tests		
Input parameters and range Response time, actuator reaction	Parameters to be analysed Fault detection capability, safety integrity level,	
Required facilities Documentation	Required vehicles	Required instrumentation
Evaluation Implementation of appropriate fault detection mechanisms, fault mitigation or transition to safe states, Indicators (warning, support, intervene).		
References -		

Communication System Design Review

Test procedure name Communication system design review	Type of test Design review	Test procedure identifier TP_G7
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All where communication between vehicles are part of the system functionality
Objective Analysis of basic functionality and dependency of communication devices/equipment or signals. (ex. GPS, Alert activation)		
Description Investigate the integration of communication module(s) in the device. Input: receivers and type, channel(s), frequencies, transmission medium, signal characteristics (analogue, digital), requirements. Signal processing: microcontroller, control signals, time aspects, accuracy, capacity, connection process Output: transmitters and type, transmission medium, target (receiver), actuators, indicators (warning, support, intervene)		
Sketch None		
Motivation of the test First examination phase that precedes further investigations and preparations for detailed set up of laboratory tests and physical vehicle tests.		
Input parameters and range Receiver sensibility, communication range, frequencies, amplitude		Parameters to be analysed Communication protocol, communication range, sensibility
Required facilities Road or other network infrastructure Other vehicles equipment	Required vehicles	Required instrumentation Network (transceivers, repeaters)
Evaluation Check the dependency of as well as the availability of communication infrastructure, conditions of operation, general requirements and limitations.		
References -		

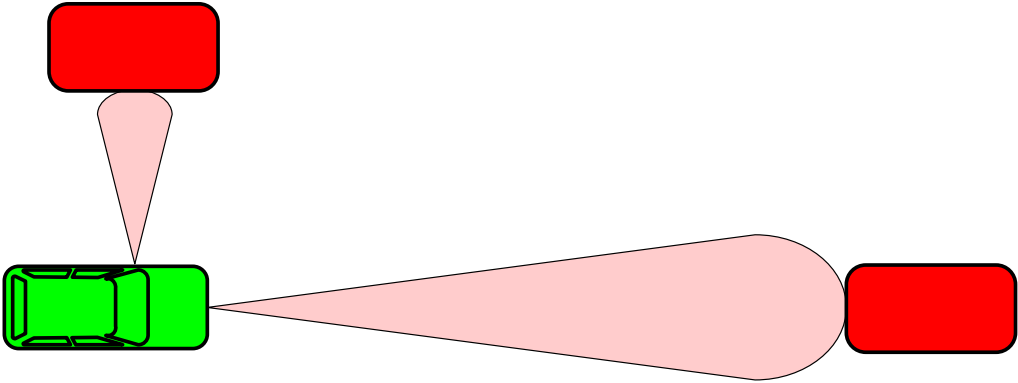
Type of Vehicle Design Review

Test procedure name Type of vehicle design review	Type of test Design review	Test procedure identifier TP_G8	
Function output Warn/Support/Intervene	Scenario(s) addressed None	System(s) addressed All	
Objective To identify the vehicle under test and all other variations of the vehicle intended to be covered by the performance test.			
Description The design review is performed together with the OEM to identify the vehicle under test. The design review will define the vehicle under test using at least following questions: <ul style="list-style-type: none"> - Which names and type designation are used for the vehicle under test? - Which other versions of the vehicle are expected to be covered by the test? - Which different chassis are expected to be covered by the test? - Which different engines are expected to be covered by the test? - Which different brakes are expected to be covered by the test? - Which active safety systems are included? - Is the vehicle a prototype vehicle? 			
Sketch N.A.			
Motivation of the test The vehicle under test must be clearly identified.			
Input parameters and range N.A.		Parameters to be analysed N.A.	
Required facilities None	Required vehicles A vehicle can be used for demonstration, but is not compulsory.	Required instrumentation None	
Evaluation No pass/fail judgement can be made in this design review.			
References -			

False alarms and no warning

Test procedure name False Alarms and No Warning	Type of test Laboratory test	Test procedure identifier TP_G9
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All
Objective To show that the safety functions have low probability of false alarms.		
Description A false alarm scenario is a scenario which provokes a reaction (warn/support/intervene) when no reaction is expected from the safety function. The laboratory test is performed together with the OEM and/or the supplier of the safety system. The laboratory test focuses on the following questions for each safety function of the vehicle under test: <ul style="list-style-type: none"> - Which risks have been identified if a false alarm is given? - Which scenarios have been identified as possible sources of a false alarm? - Which scenarios have been identified as most important to test for no warning? - Which design measures have been taken to reduce the risk of false alarms? - Which tests have been made to check for false alarms? - Which tests have been made to check for no warning? 		
Sketch N.A.		
Motivation of the test Performance testing will be limited to the few most critical scenarios. The objective of those performance tests will be to show if the safety functions react (warn/support/intervene) in the critical scenarios. The manufacturer also has to show low probability for false alarms and unintended activation of the safety function. Extensive testing to check for low probability is not included in the performance testing. This laboratory test supplements the test scenarios chosen for performance testing. The work of the OEM and/or the supplier of the safety system is reviewed.		
Input parameters and range Manufacturer documentation on risk analysis and test protocols from tests of false alarm	Parameters to be analysed N.A.	
Required facilities No	Required vehicles A vehicle can be used for demonstration, but is not compulsory.	Required instrumentation None
Evaluation The outcome of the laboratory test depends on if: <ul style="list-style-type: none"> - Risks have been identified - False alarm scenarios have been validated 		
References -		

Detection device detection area test

Test procedure name Detection device detection area test	Type of test Laboratory test	Test procedure identifier TP_G10
Function output Warn/Support/Intervene	Scenario(s) addressed Cluster 1 and 2	System(s) addressed E.g. FCW, ACC, CMbB, BSD, LDW
Objective To verify the detection area performance of the detection devices of the safety systems		
Description The purpose of this test is to determine the limits of the detection devices, their "fields of vision". This test presents a target of a specific size at different positions and at different velocities to determine the detection range of the detection devices of the safety systems. As a consequence it is important to be able to accurately measure the distance between the target and the detection device. The velocity of the target also needs to be set and recorded.		
Sketch 		
Motivation of the test Due to the limited time and resources during performance testing, lab tests could be used to validate the performance of the detection devices of the test vehicle. The detection devices are key components of the safety systems. Therefore it is important to determine the limitations of these devices.		
Input parameters and range Target type Target size Target position Target velocity Target acceleration	Parameters to be analysed Detection range (length, width, height) Processing information with different speeds and acceleration.	
Required facilities Test area	Required vehicles Test vehicle Target (vehicle or object)	Required instrumentation GPS to measure distances and velocities
Evaluation To verify if the performance of the detection devices meets the requirements of the safety systems in terms of detection ranges.		
References (Partly ISO 15622:2002, ISO 15623:2002)		

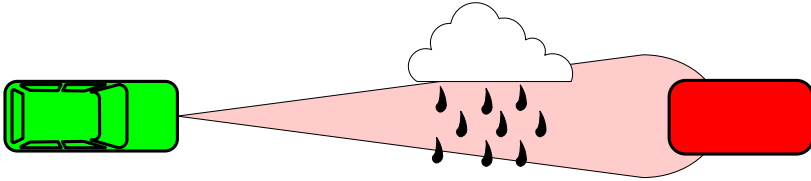
Detection device discrimination test

Test procedure name Detection device discrimination test	Type of test Laboratory test	Test procedure identifier TP_G11
Function output Warn/Support/Intervene	Scenario(s) addressed Mainly cluster 1 but also cluster 2	System(s) addressed E.g. FCW, ACC, CMbB, BSD
Objective To verify longitudinal and lateral discrimination detection performance of the detection device of the safety system		
Description The purpose of this test is to determine discrimination limits of the detection devices of the safety systems. In these tests two or more targets are used and the longitudinal and lateral distance between them is varied to determine the discrimination limits. The position of the detection devices as well of the targets need to be well defined.		
Sketch		
Motivation of the test Due to the limited time and resources during performance testing, lab tests could be used to validate the performance of the detection devices of the test vehicle. The detection devices are key components of the safety systems. Therefore it is important to determine the limitations of these devices.		
Input parameters and range Targets type Targets sizes Targets positions Targets velocities Target acceleration	Parameters to be analysed Longitudinal discrimination Lateral discrimination	
Required facilities Test area	Required vehicles Test vehicle Targets (vehicles or objects)	Required instrumentation GPS to measure distances
Evaluation To verify if the performance of the detection devices meets the requirements of the safety systems in terms of discrimination.		
References (Partly ISO 15622:2002, ISO 15623:2002)		

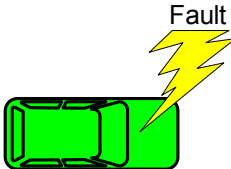
Detection device resolution test

Test procedure name Detection device resolution test	Type of test Laboratory test	Test procedure identifier TP_G12
Function output Warn/Support/Intervene	Scenario(s) addressed Cluster 1 and 2	System(s) addressed E.g. FCW, ACC, CMbB, BSD, LDW
Objective To verify longitudinal and lateral discrimination detection performance of the detection device of the safety system		
Description The purpose of this test is to determine the resolution of the detection devices of the safety systems. In these tests one target is used and the longitudinal distance between the detection device and the target is varied to determine the resolution. The position of the detection devices as well of the target need to be well defined.		
Sketch		
Motivation of the test Due to the limited time and resources during performance testing, lab tests could be used to validate the performance of the detection devices of the test vehicle. The detection devices are key components of the safety systems. Therefore it is important to determine the limitations of these devices.		
Input parameters and range Target type Target size Target position Target velocity Target acceleration	Parameters to be analysed Resolution	
Required facilities Test area	Required vehicles Test vehicle Target (vehicle or object)	Required instrumentation GPS to measure distances and velocities
Evaluation To verify if the performance of the detection devices meets the requirements of the safety systems in terms of resolution		
References -		

Detection device susceptibility test

Test procedure name Detection device susceptibility test	Type of test Laboratory test	Test procedure identifier TP_G13
Function output Warn/Support/Intervene	Scenario(s) addressed Cluster 1 and 2	System(s) addressed E.g. FCW, ACC, CMbB, BSD, LDW
Objective To verify the susceptibility of the detection device of the safety system in terms of lighting conditions, precipitation, and dirt.		
Description The purpose of this test is to determine the susceptibility of the detection device. The performance of the detection devices shall be related to the performance during best case conditions, i.e. daylight, no precipitation, and clean detection devices and targets. The goal is to verify the possible performance loss due to adverse environmental conditions. Tests include: 1. test during night time 2. test with artificial precipitation 3. test with dirty target 4. test with dirty detection devices		
Sketch 		
Motivation of the test Due to the limited time and resources during performance testing, lab tests could be used to validate the performance of the detection devices of the test vehicle. The detection devices are key components of the safety systems. Therefore it is important to determine the limitations of these devices.		
Input parameters and range Target type Target size Target position Target velocity Target acceleration Lighting level Precipitation level Dirt level		Parameters to be analysed Susceptibility
Required facilities Test area (day- and night-time access) Precipitation device	Required vehicles Test vehicle Target (vehicle or object)	Required instrumentation GPS to measure distances and velocities
Evaluation To verify if the performance of the detection devices meets the requirements of the safety systems in terms of susceptibility		
References -		

Fault insertion test

Test procedure name Fault insertion test	Type of test Laboratory test	Test procedure identifier TP_G14
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All
Objective To verify the fault tolerance (i.e. error detection and fault/error handling) of the safety systems.		
Description The purpose of this test is to assess the fault tolerance of the safety systems. Faults according to the fault models (e.g. loose contacts or EMI) are inserted and behaviour of the safety systems is studied.		
Sketch <div style="text-align: center;">  </div>		
Motivation of the test A malfunction of the safety system could possibly lead to a hazardous event. As a consequence, the error detection and handling capabilities of the safety systems are paramount.		
Input parameters and range Fault models		Parameters to be analysed Fault tolerance (coverage, safe state, etc)
Required facilities Test area Workshop	Required vehicles Test vehicle	Required instrumentation Electronic equipment
Evaluation To verify if the performance of the safety systems meets the overall requirements in terms of fault tolerance		
References -		

System response time test

Test procedure name System response time test	Type of test Laboratory test	Test procedure identifier TP_G15
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All
Objective To verify the response time of the safety systems.		
Description The purpose of this test is to determine the response time of the safety systems. The safety system is presented with input stimuli and the response time to the expected output is achieved is measured. The input stimuli can be presented during ideal or adverse conditions.		
Sketch None		
Motivation of the test Due to the limited time and resources during performance testing, lab tests could be used to validate the performance of the safety systems of the test vehicle. In the safety systems, the response time is a very important parameter when a hazardous event shall be handles and prevented to become an accident.		
Input parameters and range Fault models		Parameters to be analysed Response time
Required facilities Test area Workshop	Required vehicles Test vehicle Target	Required instrumentation Electronic equipment GPS system for time measurement
Evaluation To verify if the response time of the safety system meets the overall requirements for such a system.		
References -		

Warning indicator characteristics test

Test procedure name Warning indicator characteristics test	Type of test Laboratory test	Test procedure identifier TP_G16
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All
Objective Examination of the indicators response to activation impulses and compliance to intensity requirements for providing warning.		
Description Activation conditions, combination with other systems/modules, functional limitations. Input : warning initiating signal Signal processing : conversion of control signal into warning. Output : warning		
Sketch None		
Motivation of the test Validate the characteristics of the indicator and assess its suitability for the safety function.		
Input parameters and range Depending on indicator type	Parameters to be analysed Visual indicator: Light colour, contrast, intensity Acoustic: Sound frequency, intensity, Haptic: Vibration amplitude, frequency	
Required facilities Laboratory	Required vehicles Possible the test vehicle	Required instrumentation Measurement equipment
Evaluation Effectiveness of the warning signal and compatibility with intended warning.		
References -		

Warning indicator location test

Test procedure name Warning indicator location test	Type of test Laboratory test	Test procedure identifier TP_G17
Function output Warn/Support/Intervene	Scenario(s) addressed All	System(s) addressed All
Objective Examination of the location of the indicator.		
Description Activate the indicator according to specifications. Validate the suitability of the generated warnings with respect to the position of the driver. Input : control signals Signal processing : conversion of control signal into warning. Output : warning and location.		
Sketch None		
Motivation of the test Validate if the warnings are generated at the appropriate location		
Input parameters and range Type of indicator		Parameters to be analysed Height, lateral position relative to the driver
Required facilities Laboratory	Required vehicles Possible the test vehicle	Required instrumentation ?
Evaluation Fitness to expected warning to driver		
References -		

Actuator characteristics test

Test procedure name Actuator characteristics test	Type of test Laboratory test	Test procedure identifier TP_G18
Function output Support/Intervene	Scenario(s) addressed All where a system supports or intervenes	System(s) addressed All where the system supports or intervenes
Objective Determine the magnitude of forces, torques applied by the actuators on specific part of the vehicle as well as their conditions of operation.		
Description Based on the actuator type. Install the actuator on appropriate rig. Determine which test cases cover the critical situations in a possible scenario. Generate specified control signals and measure the displacement of the dedicated part of the actuator. Compare the obtained measured values with expected values within the nominal operational range of the actuator, limit values included, for each selected test case. Input : activation impulses Signal processing : conversion of control impulse into a specified movement Output : e.g. force, torque magnitude		
Sketch None		
Motivation of the test Ensure that the current actuator fulfils the specification requirements		
Input parameters and range Type of actuator, positioning data	Parameters to be analysed e.g. braking force, torque magnitude	
Required facilities Laboratory	Required vehicles	Required instrumentation Measurement equipment
Evaluation Actuation force (braking, rotating) versus control signals, reaction time, accuracy, etc.		
References -		

4.2 Glossary

Scenarios	Scenarios represent specific driving situations (related to real driving situations) which are relevant regarding the functionality of considered systems in the different clusters.
Test Case	A Test Case is a particular implementation of a test procedure which differentiates from other test cases by the variation of one or more of specified parameters.
Assessment Protocol	An Assessment protocol is the formal document which describes how to evaluate the test results.
Test Procedure	A description of how to perform a test. It can contain specific driving manoeuvres, including different test cases (tests with different speeds, different weather conditions, etc.), laboratory tests or design reviews to evaluate the system. (A test procedure should be described in such detail so the test results will be repeatable. A test procedure will specify the test resources needed to perform the test.)
Testing Protocol	A Testing Protocol is the formal document containing test procedures necessary to evaluate the functionality of a vehicle or a system.
Test Suite	A Test Suite is a collection of the tests procedures of a cluster which are representative for the evaluation of a safety function, a safety system or the behaviour of a vehicle under a specific scenario.
Test Program	A Test Program is the collection of all the test procedures for all clusters. The eVALUE Test Program will be integration of all the test procedures developed within the project.
Test Resource	A resource used to perform a test.
Test	The execution of a Test Procedure
Design Review	A Design Review is a systematic, comprehensive and documented analysis of a design to determine its capability and adequacy to meet its requirements. A design review also serves to identify present and potential problems.
Physical Testing	The Physical Vehicle Testing shall be based on preliminary scenarios that simulate the sequence of events that potentially can lead to specific hazards. The objective of this test procedure is to gather quantitative information regarding safety requirements, response of the system and result of the activation of the system.
Laboratory Testing	Laboratory Tests include the use of test benches and test setups for the evaluation of system components or subsystem functionalities. Another part of laboratory testing will include driving simulator tests aimed at the evaluation of driver-vehicle interaction and the assessment of human-machine-interface functionality.
Validation	Validation describes the process of evaluating the system impact e. g. on safety. That is, validation checks and tests whether the system "does what it was designed for", e. g. increase traffic safety by increasing headway, by avoiding impacts and so on. For this purpose the driver needs to be in the loop. Driver in the loop testing is required.
Verification	Verification describes the test of a system/ function against its requirements, that is, whether it fulfils its requirements.