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Electronic fee collection — Test procedures for user and fixed equipment

Part 1: Description of test procedures

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Elektronische Gebührenerhebung - Testverfahren für straßenseitige und fahrzeugseitige Einrichtungen - Teil 1: Beschreibung von Testverfahren (ISO/TS 14907-1:2015)

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European foreword

This document (CEN ISO/TS 14907-1:2015) has been prepared by Technical Committee ISO/TC 204 "Intelligent transport systems" in collaboration with Technical Committee CEN/TC 278 "Intelligent transport systems" the secretariat of which is held by NEN.

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This document supersedes CEN ISO/TS 14907-1:2010.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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The text of ISO/TS 14907-1:2015 has been approved by CEN as CEN ISO/TS 14907-1:2015 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

This third edition cancels and replaces the second edition (ISO/TS 14907-1:2010). It also incorporates the Technical Corrigenda ISO/TS 14907-1:2010/Cor.1:2010. The main changes are related to the revision of the references.

ISO/TS 14907 consists of the following parts, under the general title *Electronic fee collection — Test procedures for user and fixed equipment*:

— *Part 1: Description of test procedures*

— *Part 2: Conformance test for the onboard unit application interface*

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Introduction

For an electronic fee collection (EFC) system, approvals and tests are required to determine whether the system (or individual components of the system) conforms to standards and application requirements and to enable parameters such as quality, availability, and maintainability to be measured.

There are complete EFC systems available, including documentation and approvals, and these could already be in operation in some European countries. This part of ISO/TS 14907 provides a toolbox of tests and procedures for the assessment and proof of such EFC systems that they are suitable for specified EFC applications under specific operational conditions. Dependent on a system to be tested and based on the available documentation and the status of previously performed approvals, this part of ISO/TS 14907 enables parties involved, e.g. system provider, operators, and test houses, to take into consideration already proven references and to identify such parameters which still have to be tested according to the specified applications.

At the time of publication of this part of ISO/TS 14907, the determination of common system requirements for Europe (or any other region) has not been agreed. For this reason, this part of ISO/TS 14907 does not specify any particular performance requirements, unless these are already determined elsewhere (such as safety or radio regulations), but rather identifies the key parameters which will comprise such requirements. Where reference to an existing test is available, this part of ISO/TS 14907 provides that reference. This part of ISO/TS 14907 defines only the test and test procedures, not the benchmark figures that these are to be measured against. Benchmark figures which the systems or components under test can be compared with and validated against might form the subject of a future part of this Technical Specification. Within the framework of the European Electronic Toll System (EETS), this part of ISO/TS 14907 could provide inputs for the work of the notified bodies in view to certify the different systems' part of the EETS in particular to check the suitability for use.

This part of ISO/TS 14907 is furthermore limited to automated (electronic) payment using a standardized dedicated short-range communication (DSRC). The scope of this part of ISO/TS 14907 does not include manual payment, conventional money transaction, nor payment by means of sticker, vignettes, tickets, or magnetic-stripe cards, etc. The applications to which EFC is related are toll collection, road pricing, parking, and individual traffic information.

This part of ISO/TS 14907 enables groups of operators to determine common specific performance levels and operating conditions and to enable regional variation where appropriate. It provides operating and environmental parameters (or classes of operating and environmental parameters) within which such systems shall successfully function without impairing interoperability to ensure that the person who specified the system can state their requirements clearly to implementation designers and integrators and to enable the measurement of the performance of such systems.

The following guidelines have been followed when selecting the test procedures for test parameters:

— reference as far as possible to existing standardized test procedures;

— focusing on those tests that are essential to ensure that EFC equipment is able to exchange information and mutually use the exchanged information.

A brief guide describing how to use this part of ISO/TS 14907 is provided by Annex A.

While this part of ISO/TS 14907 relates to general test procedures, certain provisions relate specifically to test procedures for certification purposes. Many features of this part of ISO/TS 14907 are relevant internationally; it is recognized that due to different regulatory requirements outside Europe, extension may be required to make its applicability as comprehensive in non-EU countries, before this International Standard can be reviewed for acceptance as in EU countries.

The ISO/TS 17444 series provides an examination framework for EFC charging performance.

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Electronic fee collection — Test procedures for user and fixed equipment —

Part 1: Description of test procedures

1 Scope

This part of ISO/TS 14907 specifies the test procedures of EFC roadside equipment (RSE) and on-board equipment (OBE) with regard to the conformance to standards and requirements for type approval and acceptance testing which is within the realm of EFC application specifically.

The scope of this part of ISO/TS 14907 is restricted to systems operating within the radio emission, electromagnetic compatibility (EMC) regulations, traffic, and other regulations of the countries in which they are operated.

This part of ISO/TS 14907 identifies a set of suitable parameters and provides test procedures to enable the proof of a complete EFC system, as well as components of an EFC system, e.g. OBE, related to the defined requirements of an application. The defined parameter and tests are assigned to the following groups of parameters:

— functionality;

— quality;

— referenced pre-tests.

An overview of the tests and parameters provided by this part of ISO/TS 14907 is given in 5.1 and 5.2.

This part of ISO/TS 14907 describes procedures, methods and tools, and a test plan which shows the relation between all tests and the sequence of these tests. It lists all tests that are required to measure the performance of EFC equipment. It describes which EFC equipment is covered by the test procedures; the values of the parameters to be tested are not included. It also describes how the tests are to be performed and which tools and prerequisites are necessary before this series of tests can be undertaken. It is assumed that the security of the system is inherent in the communications and EFC functionality tests, therefore they are not addressed here. All tests in this part of ISO/TS 14907 provide instructions to evaluate the test results.

The test procedures can be used for prototype testing, type approvals, test of installations, and periodic inspections. Thus this part of ISO/TS 14907 defines only the test and test procedures, not the benchmark figures that these are to be measured against.

Related to a conceptual model of an EFC system, this part of ISO/TS 14907 relates only to the equipment of the user and the service provider as illustrated in Figure 1. Any other entities are outside the scope of this part of ISO/TS 14907.

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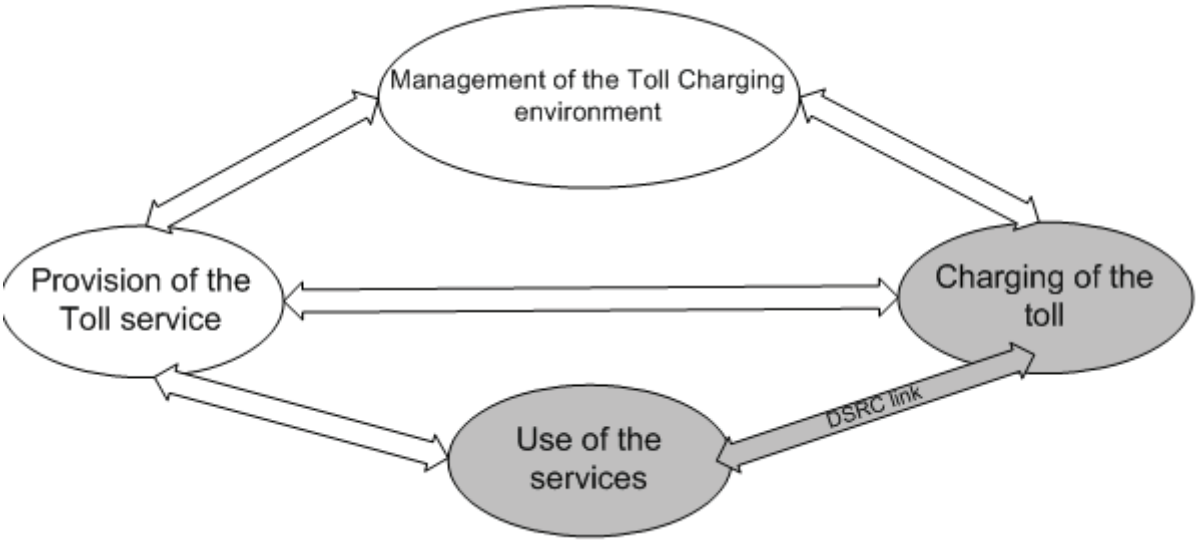

Figure 1 — Conceptual model of EFC

EFC systems for DSRC consist, in principle, of a group of technical components, which in combination fulfil the functions required for the collection of fees by electronic automatic means. These components comprise of all, or most, of the following:

— OBE within a vehicle;

— OBE containing the communications and computing sub-functions;

— optional integrated circuit card which may carry electronic money, service rights, and other secured information;

— communication between OBE and RSE based on DSRC;

— equipment for the fee collection at the RSE containing the communications and computing sub-functions;

— equipment for the enforcement at the roadside;

— central equipment for the administration and operation of the system.

The scope of this part of ISO/TS 14907 relates solely to OBE and RSE and the DSRC interface between OBE and RSE including its functions to perform the fee collection as illustrated by Figure 2. All the equipment used for enforcement (e.g. detection, classification, localization, and registration) and central equipment are outside the scope of this part of ISO/TS 14907.

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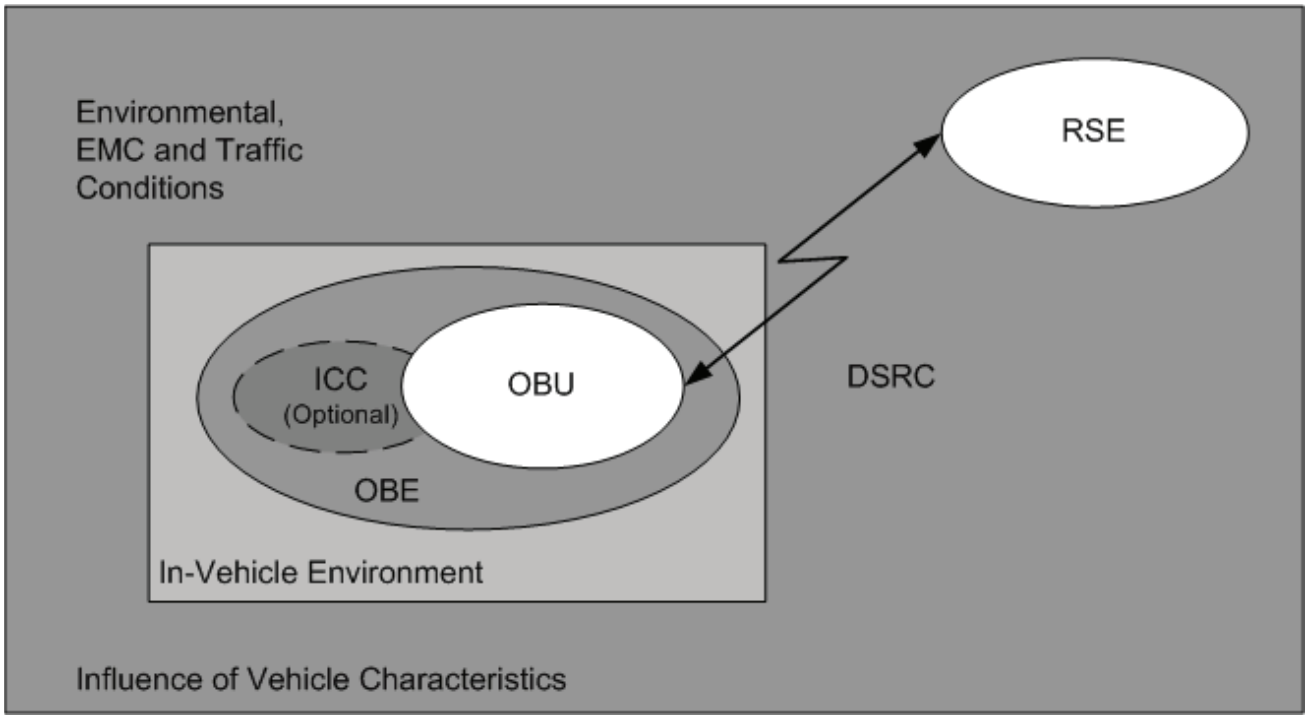

Figure 2 — OBE/RSE interface and associated environments

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO/IEC 17065:2012, *Conformity assessment — Requirements for bodies certifying products, processes and services*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
acceptance testing
examination that a product, process, or service is in conformity with the system specification

3.2
availability
property of being accessible and useable upon demand by an authorized entity

[SOURCE: ISO 7498-2:1989, 3.3.11]

3.3
certification
procedure by which a party gives written assurance that a product, process, or service conforms to specified requirements

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3.4
compatibility
suitability of products, processes, or services for use together under specific conditions to fulfil relevant requirements without causing unacceptable interactions

3.5
EFC equipment
equipment comprising roadside equipment (RSE) and on-board equipment (OBE)

3.6
EFC system
system that enables electronic debiting for the use of transport services

3.7
evaluation
systematic process of determining how individuals, procedures, systems, or programs have met formally agreed objectives and requirements

[SOURCE: ISO 10798:2011, 1.90]

3.8
evaluation assurance level
set of assurance requirements, usually involving documentation, analysis and testing, representing a point on a predefined assurance scale, that form an assurance package

[SOURCE: ISO/IEC 15408-1:2009, 3.1.27, modified]

3.9
field test
test that is performed under real-life conditions

3.10
functionality test
assessing the performance of an EFC system, based on specific parameters

Note 1 to entry: Functionality parameters can include communication, application, and vehicle and traffic characteristics.

3.11
inspection
conformity evaluation by observation and judgement accompanied, as appropriate, by measurement, testing, or gauging

3.12
interoperability
ability of systems to exchange information and to make mutual use of the information that has been exchanged

[SOURCE: ISO/IEC/TR 10000-1:1998, 3.2.1, modified]

3.13
laboratory test
test which is performed in a laboratory under specified conditions

3.14
maintainability
ability of a system or subsystem to be maintained or restored to specified conditions within a given period of time

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3.15
on-board equipment
OBE
equipment located on-board a vehicle including nomadic devices with the function of exchanging information with external systems

Note 1 to entry: OBE is composed of the on-board unit (OBU) and other sub-units whose presence is considered optional for the execution of the DSRC interface.

[SOURCE: ISO 14906:2011, 3.14]

3.16
quality
degree to which a set of inherent characteristics fulfils requirements

Note 1 to entry: User requirements can include ease of use, safety, availability, reliability, sturdiness, economy, and environmental safety. Such requirements can be explicit or implicit.

[SOURCE: ISO 9000:2005, 3.1.1]

3.176
reliability
ability of a device or a system to perform its intended function under given conditions of use for a specified period of time or number of cycles

3.18
roadside equipment
RSE
equipment located along the road, either fixed or mobile

3.19
simulation
representation of selected behavioural characteristics of one physical or abstract system by another system

[SOURCE: ISO/IEC 2382-1:1993, definition 01.06.01]

3.20
test
procedure designed to measure characteristics of a component or system in specified conditions

3.21
test parameter
parameter that specifies one or more characteristics of a system to be tested

3.22
test procedure
instructions for the setup, execution, and evaluation of results for a given test case

[SOURCE: ISO/IEC 25051:2014, 4.1.22, modified]

3.23
test status
nature of a test, either basic or conditional

Note 1 to entry: A test labelled “conditional” is performed if, and only if, it is applicable to a feature identified in the specification of the system or component, whereas a test labelled “basic” indicates a highly recommended test as part of a foundation for meaningful evaluation. See 5.2.

3.24
test type
kind of test, such as inspection, simulation, lab test, and field test

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3.25
test house
third party that carries out the test

3.26
type approval
approval based on conformity testing on the basis of one or more specimens of a product representative of the production

3.27
validation
confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled

3.28
verification
confirmation by examination and provision of objective evidence that specified requirements have been fulfilled

4 Abbreviated terms

ARIB Association of Radio Industries and Businesses

NOTE A Japanese standards development organisation.

DSRC dedicated short-range communication (ISO 14906)

EAL Evaluation Assurance Level

EFC electronic fee collection (ISO 17573)

EIRP equivalent isotropically radiated power

EMC electromagnetic compatibility

ETSI European Telecommunications Standards Institute

ICC integrated circuit card

IEC International Electrotechnical Commission

IUT implementation under test

MMI man-machine interface

MTBF mean time between failure

MTTF mean time to failure

MTTR mean time to repair

OBE onboard equipment (ISO 14906)

OBU onboard unit

RSE roadside equipment (ISO 14906)

SUT system under test

tbd to be determined

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5 Test parameters and test procedures for EFC

5.1 Tests overview

5.1.1 General

The test parameters for EFC systems or components are categorized in three groups as follows:

a) functionality tests;

b) quality tests;

c) referenced pre-tests.

Figure 3 shows the general structure of all test parameter groups relevant for EFC systems and those which are relevant to this part of ISO/TS 14907. The test parameters for pre-tests are referenced from sources other than this part of ISO/TS 14907. The specific test parameters that are ultimately deemed relevant for a specific EFC system shall be identified and listed in the test plan according to 5.3. The individual test plan for type approval or acceptance testing shall take into account those pre-tests that have already been passed, i.e. for EMC, DSRC, and environment.

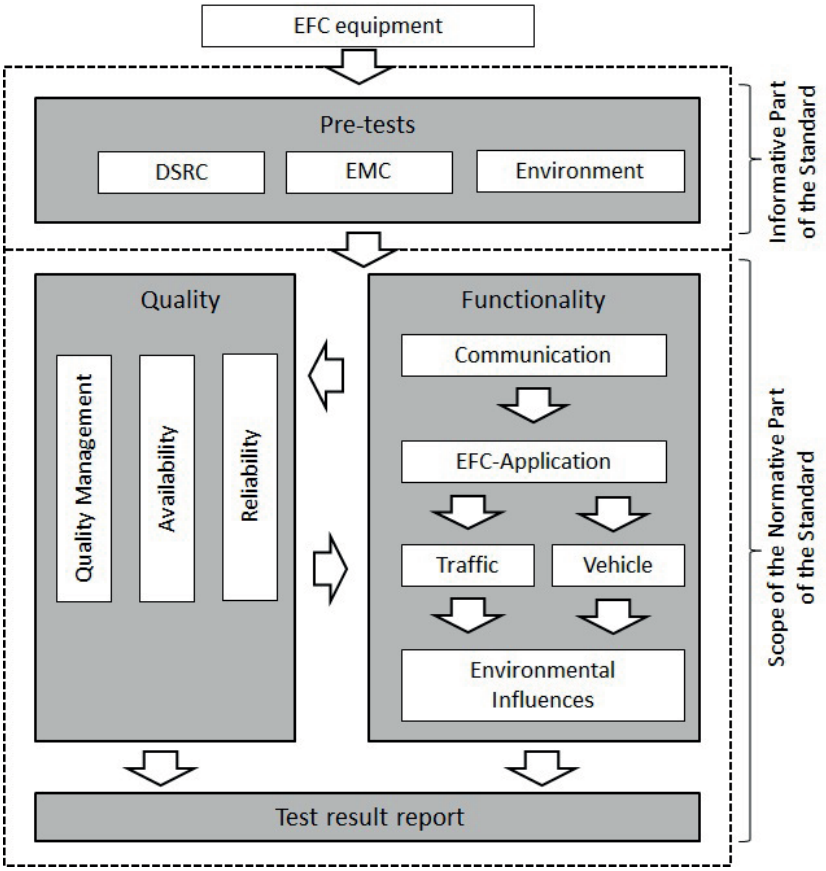

Figure 3 — Test plan — Interdependencies

5.1.2 Functionality tests

The first category of tests is related to test procedures which aim to verify the functionality of the EFC equipment.

The functionality tests are related to the essential test parameters that need to be applied to verify the performance and capability of EFC equipment of different vendors and system operators.

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The following parameters shall be tested:

— communication;

— EFC application;

— influence of vehicle characteristics;

— influence of traffic characteristics;

— environmental influences.

Communication and EFC application tests are described in 6.1. Tests related to vehicle and traffic characteristics and environmental influences are listed in Annex B.

5.1.3 Quality tests

The second category of tests is related to procedures that aim to determine the quality of the EFC equipment. These are relevant for both operators and users.

The following test parameters shall be tested:

— quality management;

— reliability;

— availability.

For some of these test parameters, there are some existing test procedures available, which are referenced.

These tests are described in 6.2 and Annex C.

5.1.4 Referenced pre-tests

The third category of tests is related to test parameters which are fundamental for the performance of EFC equipment. The specific parameters and requirements are not within the scope of this part of ISO/TS 14907. The parameters that are relevant can be assigned to the following groups:

— DSRC;

— EMC;

— environment.

5.2 Parameter overview

Tables 1 to 3 provide a comprehensive list of the parameters that are relevant for type approval or acceptance testing of a complete EFC system, as well as components of an EFC system. The tables are divided according to the subjects of 5.1.2, 5.1.3, and 5.1.4, namely functionality, quality, and referenced pre-tests. The subclause in which the tests are described or referenced is shown. An indication as to the nature of these tests (basic or conditional) is provided as not all tests are relevant to all operators and their specific operating situations and environment.

As used in Tables 1 to 3,

— "basic" means that the identified tests are highly recommended as part of a foundation for meaningful evaluation, and

— "conditional" means that the test shall be performed if, and only if, it is applicable to a feature identified in the specification of the system or component under evaluation, for example, performing the lane changing test (T6) if the RSE is characterized as multilane.

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Table 1 provides an overview of the parameters for which tests are defined in this part of ISO/TS 14907 to measure the performance and assess the level of conformance of an EFC system or components under test.

Table 2 provides a list of the quality tests.

Table 3 provides a list of parameters that are necessary for pre-tests and whose performance and conformance are tested by reference to existing standards or Technical Specifications.

NOTE The tests have been categorized into inspection tests, laboratory tests, simulation tests, and field tests. The appropriate test or types of tests are indicated, in the following tables, for each parameter. It is not expected that all the named types of tests for a parameter will be performed on that parameter. Where a set of appropriate tools is available to a test house, it is up to the test house to decide which type of test is most appropriate to meet its specific remit.

Where a particular category of test shall be performed to conform to this part of ISO/TS 14907, the test is indicated in the following tables with a “p”. Where a particular category of test is optional, this is indicated with an “o”.

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Table 1 — Functionality

Tests			Location	Test status	Applicable test type (p = shall be performed, o = optional)			
Parameter	**Item**	**Name**	**Reference to subclause**	**Basic/ conditional[a]**	**Inspection**	**Laboratory**	**Simulation**	**Field test**
Category 1								
Communication	C1	Conformance assessment	6.1.1	B	—	p	o	o
EFC application tests	F1	Validation of the specification	6.1.2	B	p	—	—	—
	F2	Implementation test	6.1.2	B	p	o	o	o
	F3	Functionality tests	6.1.2	B	p	o	o	p
Traffic conditions	T1	Longitudinal distance between vehicles	6.1.3, B.2	B	—	—	o	p
	T2	Lateral distance between vehicles	6.1.3, B.2	C	—	—	o	o
	T3	Lateral distance between OBEs	6.1.3, B.2	C	—	—	o	o
	T4	Speed of vehicles	6.1.3, B.2	C	—	—	o	o
	T5	Driving angle	6.1.3, B.2	C	—	—	o	o
	T6	Lane changing	6.1.3, B.2	C	—	—	o	o
	T7	Shadowing	6.1.3, B.2	B	—	—	o	p
	T8	Traffic scenarios — free flow	6.1.3, B.2	C	—	—	o	o
	T9	Traffic scenarios — restricted flow	6.1.3, B.2	C	—	—	o	o
	T10	Traffic volume	6.1.3, B.2	C	—	—	o	o

[a] Test only to be applied if function or item is specified.

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Table 1 — (*continued*)

Tests			Location	Test status	Applicable test type (p = shall be performed, o = optional)			
Parameter	**Item**	**Name**	**Reference to subclause**	**Basic/ conditional[a]**	**Inspection**	**Laboratory**	**Simulation**	**Field test**
Category 2								
Vehicle characteristics	V1	Length of vehicle	6.1.4, B.3	C	—	—	o	o
	V2	Height of vehicle	6.1.4, B.3	C	—	—	o	o
	V3	Width of vehicle	6.1.4, B.3	C	—	—	o	o
	V4	Length of bonnet	6.1.4, B.3	C	—	—	o	o
	V5	Other vehicle features, weight, number of axles, volume, shape, paintwork, colour, air conditioner, mobile communication equipment	6.1.4, B.2	C	—	—	o	o
	V6	Constructive elements, superstructures in the windscreen area, lorries with external sun visors, car transporters with projecting loading surface sun roof (open/closed)/roof mountings	6.1.4, B.3	C	—	—	o	o
	V7	Attenuation of windscreen, caused by e.g. metallized, coated, heated, or dirty windscreen	6.1.4, B.3	C	—	o	o	o
	V8	Angle of windscreens, horizontal plane cars, small trucks and vans, trucks, buses, and touring coaches	6.1.4, B.3	C	—	o	o	o
	V9	Angle of windscreens, vertical plane location in the outer curve area	6.1.4, B.3	C	—	o	o	o
	V10	Mounting height of OBE antenna	6.1.4, B.3	C	—	o	o	o
	V11	Lateral mounting of OBE antenna from middle of windscreen	6.1.4, B.3	C	—	o	o	o
	V12	OBE behaviour, variation of supply voltage, operational state of OBE, fixing of OBE, ICC behaviour	6.1.4, B.3	C	—	o	o	o
Test only to be applied if function or item is specified.								

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Table 1 — (*continued*)

Tests			Location	Test status	Applicable test type (p = shall be performed, o = optional)			
Parameter	**Item**	**Name**	**Reference to subclause**	**Basic/ conditionala**	**Inspection**	**Laboratory**	**Simulation**	**Field test**
Category 3								
Environmental influences	I1	Width of pavement	6.1.5, B.4	C	o	—	o	o
	I2	Number of lanes	6.1.5, B.4	C	o	—	o	o
	I3	Other topographical influences	6.1.5, B.4	C	o	o	o	o
	I4	Water and dust	6.1.5, B.4	C	—	o	o	o
	I5	Temperature, humidity, and daylight	6.1.5, B.4	C	—	o	o	o
	I6	Other weather conditions	6.1.5, B.4	C	—	o	o	o

a Test only to be applied if function or item is specified.

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Table 2 — Quality

Tests			Location	Test status	Applicable test type (p = shall be performed, o = optional)			
Parameter	**Item**	**Name**	**Reference to subclause**	**Basic/ conditional**[a]	**Inspection**	**Laboratory**	**Simulation**	**Field test**
Quality management	Q1	Design, development, production, installation, and servicing	6.2.1	B	p	—	—	—
Reliability/ availability	R1	Components, equipment, system	6.2.2, C.1	B	p	o	o	o
	R2	Transaction-level reliability	6.2.2, C.2	B	p	o	o	o
	R3	OBE life duration	6.2.2, C.2	B	p	o	o	o
	R4	OBE battery duration	6.2.2, C.2	B	p	o	o	o
	R5	OBE smart card life duration	6.2.2, C.2	B	p	o	o	o

[a] Test only to be applied if function or item is specified.

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Table 3 — Referenced pre-tests

Tests			Location	Test status	Test type
Parameter	**Item**	**Name**	**Reference to subclause**	**Basic/ conditional**[a]	**(R = refer to standards/regulations which specify these pre-tests)**
DSRC	D1	Layer 1	6.3.1, F.1	B	R
	D2	Layer 2	6.3.1, F.1	B	R
	D3	Layer 7	6.3.1, F.1	B	R
Environment	ET1	Basic parameter	6.3.2, F.2	B	R
	ET2	Mechanical	6.3.2, F.2	B	R
	ET3	Electrical	6.3.2, F.2	B	R
	ET4	Chemical/biological	6.3.2, F.2	B	R
	ET5	Safety	6.3.2, F.2	B	R
EMC	E1.1	Emission	6.3.3, F.3	B	R
	E1.2	Immunity	6.3.3, F.3	B	R

[a] Test only to be applied if function or item is specified.

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5.3 Test plan

The manufacturer or the test house carrying out the type approval or acceptance testing shall devise an individual test plan for each tested EFC system or EFC component, in accordance with Figure 3, taking into account the system-specific characteristics of the EFC application. With respect to *type approval*, the requirements of applicable standards or other normative and referenced documents shall be tested by the manufacturer or by a test house.

With respect to *acceptance tests*, only the features that are specified or implicit in the system specification shall be tested. Where additional features are provided for contingent use at some future date, these shall be tested only if such contingency is included in the system specification. Where additional features are present in products supplied, but are neither used nor included in the system specification or implementation, there is no requirement that they shall be tested unless they have an effect on the operation of the system.

Results of pre-tests that have already been passed shall be compared with the application-specific requirements. If deviations are detected, additional tests will need to be carried out. The test plan shall make references to each listed test parameter with respect to the following details:

— identification of test parameter and item;

— reference of the related requirements/severity of the test;

— required equipment and documentation;

— selected test type;

— required test equipment, measurement equipment, interfaces, and tools;

— required test environment;

— department carrying out the test;

— required documentation of the tests and the results (see G.5).

Interdependencies between the results of the different tests are anticipated and shall be taken into account by the manufacturer or the test house. An example test protocol form is given in G.5.

5.4 Required documentation

The following listed documentation shall be supplied by the manufacturer to carry out the tests defined by a test plan:

— system description (overview, block diagrams);

— system specification including functions, timing, operational data on a detailed level;

— safety and security concept (threat analysis, implemented measures to detect and control failures, threats, and manipulations);

— user documentation (service provider and user);

— specification of ambient conditions;

— operational directives;

— quality assurance directives, development rules;

— maintenance and installation directives;

— list of all available documents from the manufacturer relating to the EFC system under test created during the design and manufacture of the equipment.

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6 Inspection and tests

6.1 Functionality tests

6.1.1 Communication

The test specifications with regard to communication are defined in ISO/TS 14907-2. It specifies the tests that verify OBU conformance of implemented communication (transaction) protocols to conform with the specifications given in ISO 14906 to be used for EFC applications.

NOTE ISO/TS 14907-2 can also be used as a source of inspiration for roadside equipment testing in accordance with ISO 14906.

ISO/TS 14907-2 describes general requirements for conformance testing and specific test procedures for the following:

— basic DSRC L7 functionality;

— EFC application functions;

— EFC attributes;

— addressing procedures of EFC attributes and (hardware) components (e.g. ICC and MMI);

— EFC transaction model;

— behaviour of the interface.

6.1.2 EFC application

6.1.2.1 General

The tests are related to components or to a complete EFC system consisting of an OBE, RSE, or both and RSE/OBE in combination. The objective of the tests is to validate that the equipment to be tested fulfils the functional and technical requirements of the specification. The proof consists of inspections, simulations, and tests which are to ensure that the system specifications and the equipment of EFC are in conformance with the EFC requirements based on standards and regulations, national requirements, and other requirements.

6.1.2.2 and 6.1.2.3 describe a set of tests (see also Annex B); which of those tests are relevant and sufficient to prove the performance of an EFC system or its components shall be defined by a test plan (see 5.3).

The EFC application test is divided into two sections:

a) validation of the EFC specification;

b) inspection and test of the EFC system or component under test (SUT).

The relationship between the test sections is shown in Figure 4.

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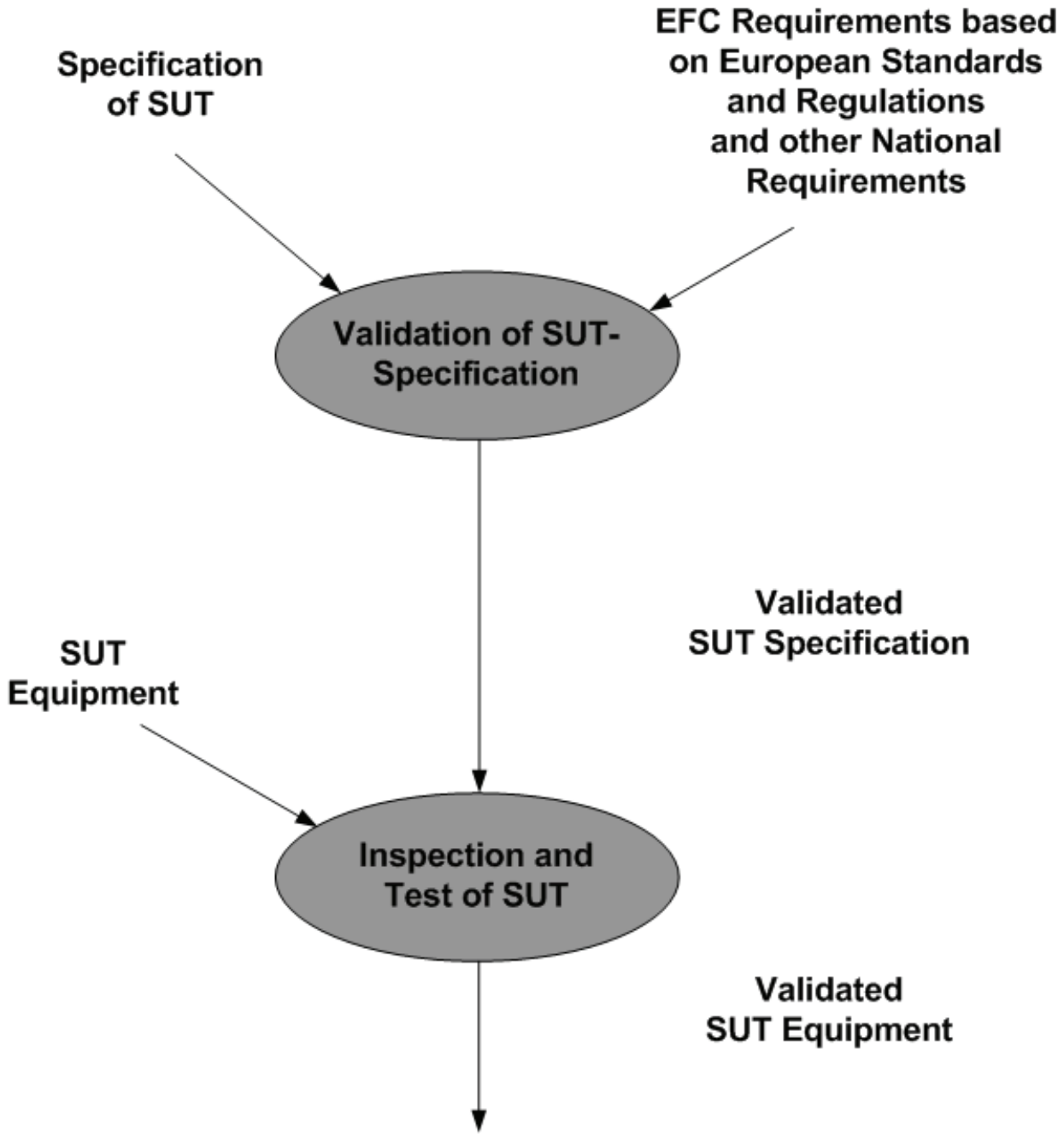

Figure 4 — Structure of application tests

6.1.2.2 addresses the validation of the EFC system specification with respect to the design specification. The objective is a validation of the system specification to verify that it is in conformance with the EFC requirements based on standards and regulations, national requirements, and other requirements. The activity consists of inspection and analysis of the referenced documentation. The output of this phase is an authorized and valid system specification of the SUT which meets the requirements of the selected standards and regulations. Additionally, a test plan will be specified which identifies the required test steps to prove the performance of the SUT.

6.1.2.3 addresses EFC equipment that is designed according to a validated system specification. The activities of this section are inspections, simulations, and tests. Before the functionality test can start, an implementation test (pre-test after installation) is carried out to ensure the principal performance of the system. The implementation includes the activities of installation and commissioning. The objective

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of the tests is to validate the conformity of the equipment with the specification and compliance with the EFC requirements of standards and regulations, national requirements, and other requirements.

The inspection and test shall take into consideration results of tests that have been previously performed, for example, quality tests and reference tests, and shall be detailed by a test plan (see 5.3). Annex B contains a list of tests that are related to traffic conditions, vehicle characteristics, and other environment influences. Annex H provides examples of EFC scenarios as part of a functionality test.

6.1.2.2 Validation of the SUT specification

EFC application test		
Name:	Validation of the specification (F1)	
Group:	EFC application	
Purpose:	To ensure that the specification of the SUT or component is in conformance with the EFC requirements of standards and regulations, national requirements, and user requirements.	
Requirement reference:	— National requirements for EFC. — EFC requirements for a DSRC communication. — User requirements of the specified EFC application.	
Default:	All specifications to be inspected shall be in conformance regarding the DSRC regulations and DSRC standards applicable in the countries and regions in which the system or component will be operated.	
Test configuration:	A set of documentation as listed in 5.4 is required.	
Behaviour description:	The task consists of inspection and analysis (Annex G) of the provided documentation. The details of the system specification of the SUT are compared with the requirements of the EFC standards and regulations, national requirements, and user requirements. The documentation is inspected concerning completeness, validity, unambiguity, consistency, and understandability. The analysis is carried out to evaluate the system structure, reliability figures, measures to detect and control failures, timing behaviour, security and safety, maintenance, and other technical and non-technical measures concerning system performance.	
Constraints reference:	None	
Verdict:	**Test result** Authorized and valid system specification of the SUT. Test plan for the performance proof. The system specification does not conform to the requirements. List of discovered deviations.	**Verdict** Pass Fail
Comments:		

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6.1.2.3 Inspection and test of SUT

EFC application test		
Name:	Implementation test (F2)	
Group:	EFC application	
Purpose:	The objective of this test is to verify that the specified EFC system (SUT) or component is in conformance with the fundamental requirements of the EFC application.	
Requirement reference:	Validated system specification of the SUT.	
Default:	Certified DSRC equipment according to the requirements of DSRC regulations and DSRC standards applicable in the countries and regions in which the system or component will be operated.	
Test configuration:	— Documentation and equipment according to test plan. — Test facilities according to test plan.	
Behaviour description:	The SUT or component shall be tested according to the specified requirements. Prerequisite for the inspection and test is a validation of the system specification, certified DSRC equipment according to the DSRC standards and a qualification of the SUT in accordance with other fundamental requirements. The qualification of this phase consists of inspection, test, and simulation. The work is separated into the following steps: — Verification of the quality items of 6.2 and Annex C. — Inspection of the hardware and software to confirm that the system requirements (validated SUT specification) are implemented in the SUT. — Inspection of housing protection, electrical safety, shielding, and earthing of installed equipment. — Test of range of electromagnetic emissions, EMC interference, and environmental conditions. Simulation of functions of the SUT to verify its ability to meet the functionality tests (traffic, vehicle, environment, and communication requirements). The simulations are carried out according to the specifications of Annex G (simulation). — Test of the basic functions and adjustment of RSE-transmitter/receiver (communication zone) and determination of the footprint range (static test without vehicle). — Test of basic communication functions between RSE and OBE in relation to the determined footprint range of the antenna (static test without vehicle). — Test of subsystems (OBE, chipcard, and RSE) to perform the functions as specified in the SUT documentation.	
Constraints reference:	The requirements of the tests are according to the details of the documents identified under “requirement reference”.	
Verdict:	**Test result** The results are stating the SUT ability to meet principal requirements under specific conditions. The SUT does not meet the principal requirements.	**Verdict** Pass Fail
Comments:		

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EFC application test		
Name:	Functionality tests (F3)	
Group:	EFC application	
Purpose:	The objective of this test is to validate that the installed EFC system (SUT) or component is in accordance with the specifications of the SUT or component.	
Requirement reference:	— Validated system specification of the SUT. — EFC requirements for a DSRC communication. — National requirements for EFC. — User requirements of the specified EFC application.	
Default:	Certified DSRC equipment according to the requirements of DSRC regulations and DSRC standards applicable in the countries and regions in which the system or component will be operated.	
Test configuration:	— Documentation and equipment according to test plan. — Installed EFC equipment according to the manufacturer's instructions. — Test facilities according to the test plan.	
Behaviour description:	The SUT shall be tested according to the specified requirements. Prerequisite for the functionality test is a successful pass of the tests communication, quality, and pre-tests. The tests are carried out according to a test plan. The qualification procedure of this section is separated in inspections, tests, and simulations. The following steps are required: — Simulation of functions of the SUT to verify its ability to meet traffic, vehicle, environment, and communication requirements. The simulations are carried out according to the specifications of Annex G. — Test of the integrated functionality of the selected EFC protocols within the affected communication area including overlapping of different communication units under basic requirements (static and dynamic tests). — EMC interference on realistic applications, e.g. mobile radio, of DSRC functions to verify resistance from outside. — Real-time simulation of traffic and vehicle scenarios (Annex B) to verify the ability of the SUT to meet traffic, vehicle, environment, and communication requirements. — Real traffic and vehicle scenarios (Annex B use of vehicles or special constructions) to verify the ability of the SUT to meet traffic, vehicle, environment, and communication requirements. — Real traffic and vehicle scenarios (Annex B) based on different EFC transaction profiles to verify compatibility and interoperability characteristics.	
Constraints reference:	The requirements of the tests are according to the details of the documents identified under "requirement reference" and the details of selected classes of performance.	
Verdict:	**Test result** The results confirm the ability of the SUT to meet functionality, compatibility, and interoperability requirements based on the conditions of all carried-out tests. Not in accordance with the specifications.	**Verdict** Pass Fail
Comments:		

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6.1.3 Traffic conditions

Table 4 shows typical traffic conditions, for which individual test case specifications are described in B.2.

Table 4 — Traffic conditions

No.	Traffic conditions
T1	longitudinal distance between vehicles
T2	lateral distance between vehicles
T3	lateral distance between OBEs
T4	speed of vehicle
T5	angle of approach
T6	lane changing
T7	shadowing
T8	traffic scenarios — free flow
T9	traffic scenarios — restricted flow
T10	traffic flow (vehicles/h)

Conditions T1 to T3 and T5 to T7 are shown in Figure 5.

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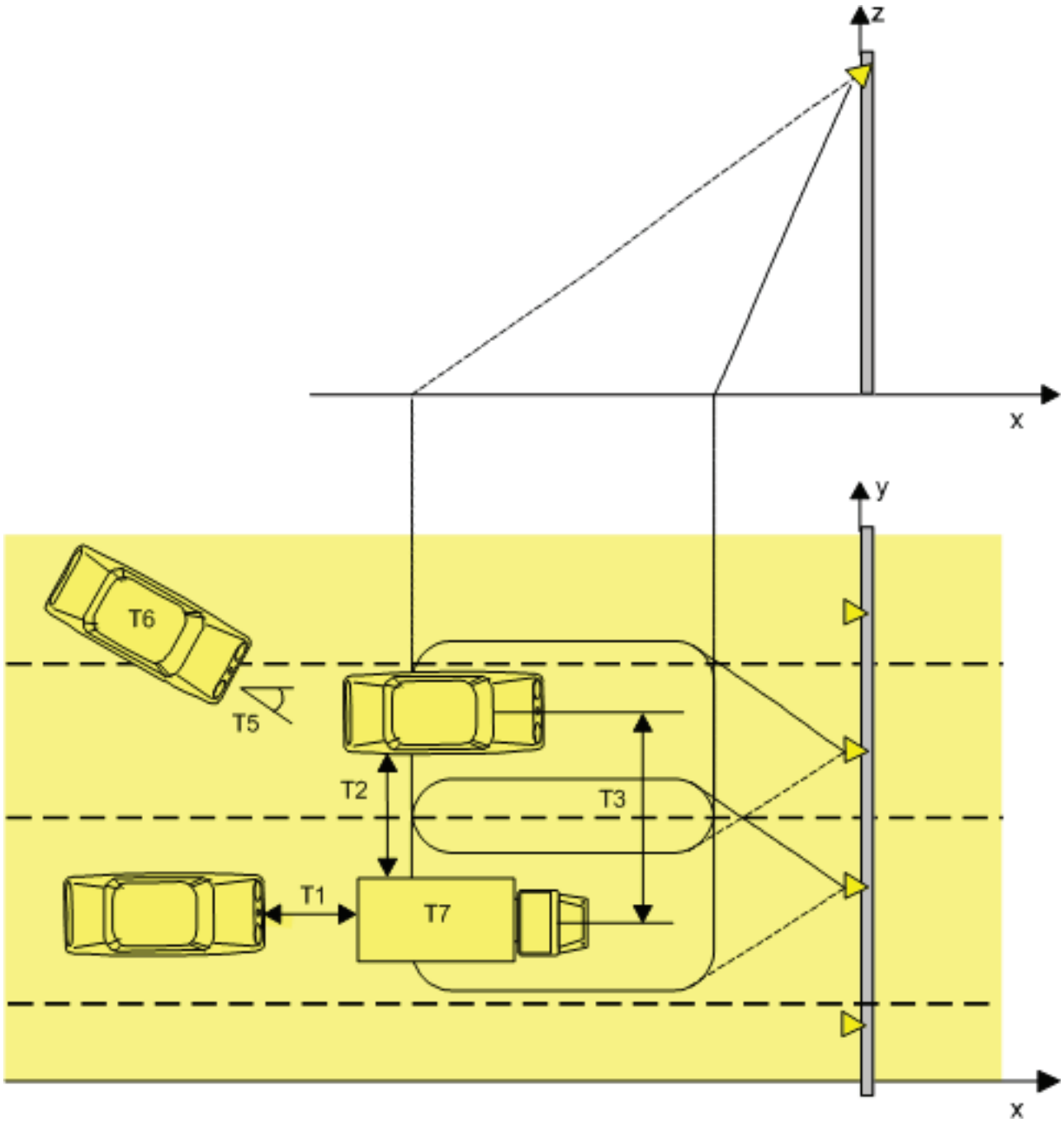

Figure 5 — Traffic conditions

6.1.4 Vehicle characteristics

Table 5 shows typical vehicle characteristics for which individual test case specifications have been described in B.3.

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Table 5 — Vehicle characteristics

No.	Vehicle characteristics
V1	length of vehicle
V2	height of vehicle
V3	width of vehicle
V4	length of bonnet
V5	other vehicle features, weight, number of axles, volume, shape, paintwork, colour, air conditioner, mobile communication equipment, trailer
V6	constructive elements, superstructures in the windscreen area, lorries with external sun visors, car transporters with projecting loading surface sun roof (open/closed)/roof mountings
V7	attenuation of windscreen, caused by e.g. metallized, coated, heated, dirty windscreen
V8	angle of windscreens, from horizontal plane cars, small trucks and vans, trucks, buses, and touring coaches
V9	angle of windscreens, vertical plane location in the outer curve area
V10	mounting height of OBE antenna
V11	lateral mounting of OBE antenna from middle of windscreen
V12	OBE behaviour, variation of supply voltage, operational state of OBE, fixing of OBE, ICC behaviour

The vehicle characteristics in Table 5 excluding V5 to V7 and V12 are shown in Figure 6.

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