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Road vehicles — Vehicle to grid communication interface —

Part 9: Physical and data link layer conformance test for wireless communication

Véhicules routiers — Interface de communication entre véhicule et réseau électrique —

Partie 9: Essai de conformité relatif à la couche physique et à la couche liaison de données pour la communication sans-fil

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Foreword

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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 document 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 or www.iec.ch/members_experts/refdocs).

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This document was prepared jointly by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*, and Technical Committee IEC/TC 69, *Electrical power/energy transfer systems for electrically propelled road vehicles and industrial trucks*.

A list of all parts in the ISO 15118 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

Resulting from the wireless physical and data link layer requirements defined in ISO 15118-8, a corresponding set of abstract test cases is necessary to verify the conformance of implementations. This document, therefore, defines a conformance test suite for the wireless physical and data link layer protocols in order to derive a common and agreed basis for conformance tests. The resulting test suite is a prerequisite for downstream interoperability tests. Since interoperability furthermore involves the actual application logic of an implementation, those tests are beyond the scope of this document. Hence, this document focuses on the interface aspects and the corresponding requirements given in ISO 15118-8 only.

Road vehicles — Vehicle to grid communication interface —

Part 9: Physical and data link layer conformance test for wireless communication

1 Scope

This document specifies conformance tests in the form of an abstract test suite (ATS) for a system under test (SUT) implementing an electric-vehicle or supply-equipment communication controller (EVCC or SECC) with support for WLAN-based high-level communication (HLC) according to ISO 15118-8 and against the background of ISO 15118-1. These conformance tests specify the testing of capabilities and behaviours of an SUT, as well as checking what is observed against the conformance requirements specified in ISO 15118-8 and against what the implementer states the SUT implementation's capabilities are.

The capability tests within the ATS check that the observable capabilities of the SUT are in accordance with the static conformance requirements defined in ISO 15118-8. The behaviour tests of the ATS examine an implementation as thoroughly as practical over the full range of dynamic conformance requirements defined in ISO 15118-8 and within the capabilities of the SUT (see NOTE below).

A test architecture is described in correspondence to the ATS. The abstract test cases in this document are described leveraging this test architecture and are specified in descriptive tabular format for the ISO/OSI physical and data link layers (layers 1 and 2).

In terms of coverage, this document only covers normative sections and requirements in ISO 15118-8. This document can additionally refer to specific tests for requirements on referenced standards (e.g. IEEE, or industry consortia standards, like WiFi Alliance) as long as they are relevant in terms of conformance for implementations according to ISO 15118-8. However, it is explicitly not intended to widen the scope of this conformance specification to such external standards, if it is not technically necessary for the purpose of conformance testing for ISO 15118-8. Furthermore, the conformance tests specified in this document do not include the assessment of performance nor robustness or reliability of an implementation. They cannot provide judgments on the physical realization of abstract service primitives, how a system is implemented, how it provides any requested service, nor the environment of the protocol implementation. Furthermore, the abstract test cases defined in this document only consider the communication protocol and the system's behaviour defined ISO 15118-8. The power flow between the EVSE and the EV is not considered.

NOTE Practical limitations make it impossible to define an exhaustive test suite, and economic considerations can restrict testing even further. Hence, the purpose of this document is to increase the probability that different implementations are able to interwork. This is achieved by verifying them by means of a protocol test suite, thereby increasing the confidence that each implementation conforms to the protocol specification. However, the specified protocol test suite cannot guarantee conformance to the specification since it detects errors rather than their absence. Thus, conformance to a test suite alone cannot guarantee interworking. Instead, it gives confidence that an implementation has the required capabilities and that its behaviour conforms consistently in representative instances of communication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15118-1, *Road vehicles — Vehicle to grid communication interface — Part 1: General information and use-case definition*

ISO 15118-2, *Road vehicles — Vehicle-to-Grid Communication Interface — Part 2: Network and application protocol requirements*

ISO 15118-8:2020, *Road vehicles — Vehicle to grid communication interface — Part 8: Physical layer and data link layer requirements for wireless communication*

ISO 15118-20, *Road vehicles — Vehicle to grid communication interface — Part 20: 2nd generation network layer and application layer requirements*

ETSI ES 201 873-5 V4.9.1[1)], *Methods for Testing and Specification (MTS) — The Testing and Test Control Notation version 3 — Part 5: TTCN-3 Runtime Interface (TRI) (April 2022)*

ETSI ES 201 873-6 V4.13.1[2)], *Methods for Testing and Specification (MTS) — The Testing and Test Control Notation version 3 — Part 6: TTCN-3 Control Interface (TCI) (April 2022)*

IEEE 802.11-2012, *IEEE Standard for Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — specific requirements: Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15118-1, ISO 15118-2, ISO 15118-8, ISO 15118-20 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
abstract test case
complete and independent specification of the actions required to achieve a specific *test purpose* (3.25), defined at the level of abstraction of a particular abstract test method, starting in a stable testing state and ending in a stable testing state and optionally involves one or more consecutive or concurrent connections

Note 1 to entry: The specification should be complete in the sense that it is sufficient to enable a *test verdict* (3.29) to be assigned unambiguously to each potentially observable test outcome (i.e. sequence of test events).

Note 2 to entry: The specification should be independent in the sense that it should be possible to execute the derived *executable test case* (3.7) in isolation from other such test cases (i.e. the specification should always include the possibility of starting and finishing in the 'idle' state).

[SOURCE: ITU-T X.290:1995, 3.3.3].

3.2
ATS
abstract test suite
test suite composed of *abstract test cases* (3.1)

[SOURCE: ITU-T X.290:1995, 3.3.6]

1) Available at https://www.etsi.org/deliver/etsi_es/201800_201899/20187305/04.09.01_60/es_20187305v040901p.pdf.

2) Available at https://www.etsi.org/deliver/etsi_es/201800_201899/20187306/04.13.01_60/es_20187306v041301p.pdf.

3.3
APUT
access point under test
ISO/OSI layer 1 and 2 component of the SECC [*system under test (SUT)* (3.19)] for establishing a wireless communication connection

3.4
black box test
method of testing that examines the behaviour of a *system under test (SUT)* (3.19) without considering the internal implementation and structure of the SUT, thus relying on the SUT's open interface for testing

3.5
conformance requirement
conformance of a real system consisting of conformance to each requirement and conformance to the set

Note 1 to entry: Set of interrelated requirements which together define the behaviour of the system and its communication. Conformance of a real system will, therefore, be expressed at two levels, conformance to each individual requirement and conformance to the set. Applicable conformance tests defined in this document, include requirements and transfer syntax requirements as far as they can be validated by *black box tests* (3.4).

Note 2 to entry: See also *static conformance requirement* (3.17) and *dynamic conformance requirement* (3.6).

3.6
dynamic conformance requirement
one of the requirements which specifies what observable behaviour is permitted by the relevant specification(s) in instances of communication

Note 1 to entry: The requirements for this conformance specification are defined in ISO 15118-8.

[SOURCE: ITU-T X.290:1995, 3.3.29, modified — Note 1 to entry has been added.]

3.7
executable test case
realization of an *abstract test case* (3.1)

[SOURCE: ITU-T X.290:1995, 3.3.31]

3.8
expected behaviour
exact response of the *system under test (SUT)* (3.19) according to the underlying protocol specification to the stimulus defined in the *test behaviour* (3.20)

3.9
ICS
implementation conformance statement
statement made by the supplier of an implementation or system claimed to conform to a given specification, stating which capabilities have been implemented

Note 1 to entry: The given specification for this conformance specification is ISO 15118-8.

[SOURCE: ITU-T X.290:1995, 3.3.39, modified — "The ICS can take several forms: protocol ICS, profile ICS, profile specific ICS, and information object ICS." has been removed from the definition and Note 1 to entry has been added.]

3.10
IXIT
implementation extra information for testing
statement made by a supplier or implementer of a *system under test (SUT)* (3.19) which contains or references all of the information [in addition to that given in the *implementation conformance statement (ICS)* (3.9)] related to the SUT and its testing environment, which will enable the test laboratory to run an appropriate test suite against the SUT

[SOURCE: ITU-T X.290:1995, 3.3.41, modified — "An IXIT can take several forms: protocol IXIT, profile IXIT, profile specific IXIT, and information object IXIT, TMP implementation statement." removed from the defintiion and IUT replaced by SUT.]

3.11
MTC
main test component
single *test component* (3.21) in a test component configuration responsible for creating and controlling *parallel test components* (3.12) and computing and assigning the *test verdict* (3.29)

[SOURCE: ITU-T X.292:2002, 3.6.43]

3.12
parallel test component
PTC
test component (3.21) created by the *main test component* (3.11)

[SOURCE: ITU-T X.292:2002, 3.6.53]

3.13
post-condition
test steps needed to define the path from the end of the *test behaviour* (3.20) up to the finishing stable state for the test case

3.14
pre-condition
test steps needed to define the path from the starting stable state of the test case up to the initial state from which the *test bevaviour* (3.20) will start

3.15
PICS
protocol implementation conformance statement
implementation conformance statement (ICS) (3.9) for an implementation or system claimed to conform to a given protocol specification

Note 1 to entry: The given protocol specification for this conformance specification is ISO 15118-8.

[SOURCE: ITU-T X.290:1995, 3.3.80, modified — Note 1 to entry has been added.]

3.16
PIXIT
protocol implementation extra information for testing
implementation extra information for testing (IXIT) (3.10) related to testing for conformance to a given protocol specification

Note 1 to entry: The given protocol specification for this conformance specification is ISO 15118-8.

[SOURCE: ITU-T X.290:1995, 3.3.81, modified — Note 1 to entry has been added.]

3.17
static conformance requirement
one of the requirements that specify the limitations on the combinations of implemented capabilities permitted in a real open system which is claimed to conform to the relevant specification(s)

[SOURCE: ITU-T X.290:1995, 3.3.95]

3.18
STAUT
station under test
ISO/OSI layer 1 and 2 component of the EVCC [*system under test (SUT)* (3.19)] for establishing a wireless communication connection

3.19
SUT
system under test
real open system in which the implementation of one or more OSI protocols in an adjacent user/provider relationship are to be studied by testing.

Note 1 to entry: Adapted from ITU-T X.290:1995, 3.3.103 and 3.3.43.

3.20
test behaviour
set of test steps (test body) which are essential in order to achieve the *test purpose* (3.25) and assign verdicts to the possible outcomes

3.21
test component
named subdivision of a concurrent test case capable of being executed in parallel and declared as having a fixed number of points of control and observation and a fixed or maximal number of co-ordination points

[SOURCE: ITU-T X.292:2002, 3.6.72, modified — "in parallel with other test components" has been replaced by "in parallel".]

3.22
TCI
TTCN-3 control interfaces
four interfaces that define the interaction of the TTCN-3 Executable with the test management, the coding and decoding, the *test component* (3.21) handling and the logging in a *test system* (3.27)

[SOURCE: ETSI ES 201 873-6 V4.13.1:2022, 3.1]

3.23
test execution
interpretation or execution of an *abstract test suite* (3.2)

Note 1 to entry: Conceptually, the test execution can be decomposed into three interacting entities: an executable test suite, a *test framework* (3.24) and an optional internal encoding/decoding system entity.

3.24
test framework
entity to perform all actions of test cases or functions

Note 1 to entry: The test framework interacts with the test management, *system under test (SUT)* (3.19) adaptor and platform adaptor entities via *TTCN-3 control interfaces (TCI)* (3.22) and *test runtime interface (TRI)* (3.26) and additionally manages the executable test suite and encoding/decoding system entities. It initializes adaptors as well as executable test suite and encoding/decoding system entities. This entity performs all the actions necessary to properly start the execution of a test case or function with parameters in the executable test suite entity. It queries the test management entity for module parameter values required by the executable test suite and sends logging information to it. It also collects and resolves associated verdicts returned by the executable test suite entity.

Note 2 to entry: In this document, the TTCN-3 runtime system is used to explain a test framework functionality.

3.25
test purpose
prose description of a well-defined objective of testing, focusing on a single *conformance requirement* (3.5) or a set of related conformance requirements as specified in the appropriate OSI specification

EXAMPLE Verifying the support of a specific value of a specific parameter.

[SOURCE: ITU-T X.290:1995, 3.3.118]

3.26
TRI
test runtime interface
two interfaces that define the interaction of the TTCN-3 executable between the *system under test (SUT)* (3.19) and the platform adapter (PA) and the system adapter (SA) in a *test system* (3.27)

[SOURCE: ETSI ES 201 873-5 V4.9.1:2022, 3.1, modified — The term was originally TTCN-3 runtime interface.]

3.27
test system
real system combining the *test framework* (3.24), *abstract test suite* (3.2), *test execution* (3.23) and adapters as well as codecs

Note 1 to entry: Typically, also containing a common runtime environment based on an operating system.

3.28
TSI
test system interface
test component (3.21) that provides a mapping of the ports available in the (abstract) TTCN-3 *test system* (3.27) to those offered by a real test system

[SOURCE: ETSI ES 201 873-5 V4.9.1:2022, 3.1]

3.29
test verdict
statement of 'pass', 'fail' or 'inconclusive', as specified in an *abstract test case* (3.1), concerning conformance of a *system under test (SUT)* (3.19) with respect to that test case when it is executed

[SOURCE: ITU-T X.290:1995, 3.3.124, modified — IUT was replaced by SUT.]

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply:

AP	(wireless) access point
APUT	access point under test
ATS	abstract test suite
EDCA	enhanced distributed channel access
ETSI	european telecommunications standards institute
EV	electric vehicle
EVCC	electric vehicle communication controller

EVSE	electric vehicle supply equipment
HAL	hardware abstraction layer
ICS	implementation conformance statement
ITB	invalid test behaviour
MAC	media access control
MTC	main test component
PICS	protocol implementation conformance statement
PIXIT	protocol implementation extra information for testing
PTC	parallel test component
SECC	supply equipment communication controller
STA	(wireless) station
STAUT	station under test
SUT	system under test
TC	test case
TCI	TTCN-3 control interface
TCI-CD	TCI-coding and decoding
TE	test execution
TRI	TTCN-3 runtime interface
TSI	TTCN-3 system interface
TSS	test suite structure
TTCN-3	testing and test control notation version 3
V2G	vehicle-to-grid
VTB	valid test behaviour

5 Conventions

5.1 Requirement structure

This document uses unique number identifiers for each individual requirement. This requirement structure allows for easier requirement tracking and management. The following format is used throughout this document:

'[V2G'Y'-'XXX']' requirement text

Where:

— 'V2G' represents the ISO 15118 series;

— Y represents the document part of the ISO 15118 series, for this document Y = 9;

— XXX represents the individual requirement number; and

— 'requirement text' includes the actual text of the requirement.

5.2 Test system description

TTCN-3 is used in this document to define/specify the test system architecture and test suite conventions, where applicable. TTCN-3 is, however, not mandatory for the implementation of a conformance test system according to this document.

[V2G9-001] The implementers of conformance tests shall verify that the test purposes implemented in their executable test cases are identical to the abstract test cases described in this document.

NOTE In this document, test cases are not programmatically specified in TTNC-3 core language. This will be revisited for the next edition of the document.

6 Test architecture reference model

6.1 General information

Figure 1 provides an overview of the test architecture for this document. The following subclauses define the interface requirements for platform and SUT adapters (see 6.2, 6.3) as well as the codecs (see 6.4). The test suite is defined in detail in the remainder of this document.

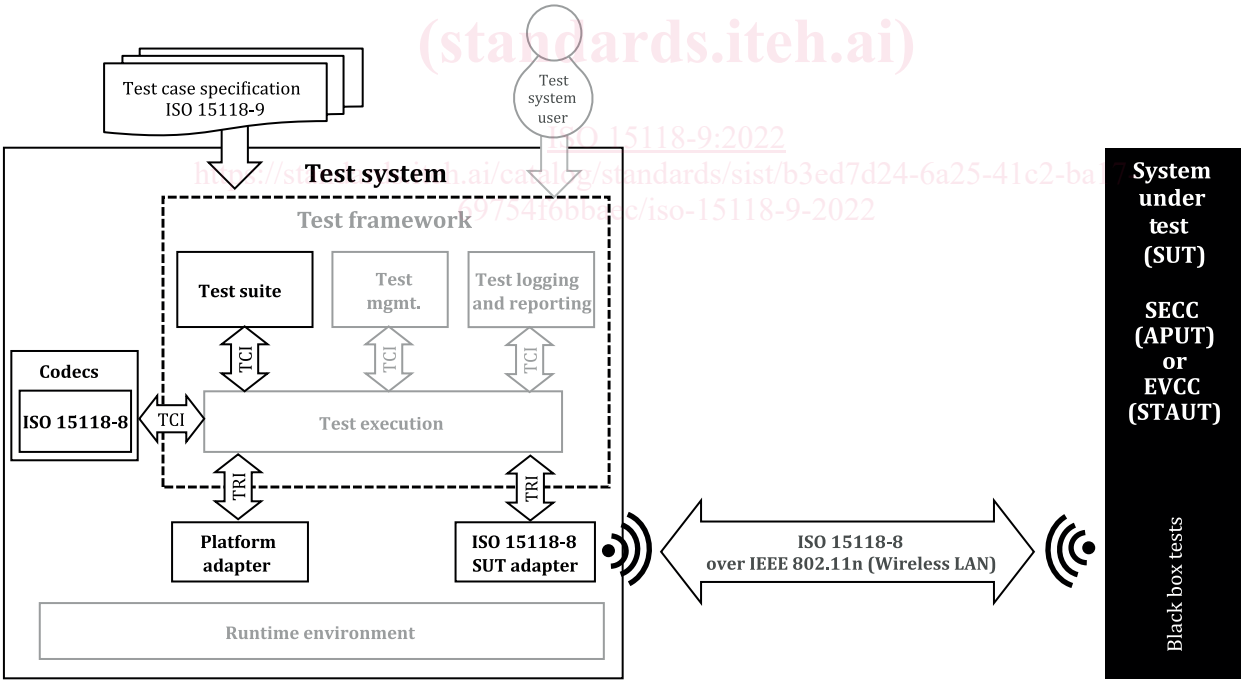

Figure 1 — Test architecture reference model

6.2 Platform adapter interface

The platform adapter within the test system is responsible for timers and external functions. Besides means for timers, which are typically provided as part of the test framework, no external functions are defined for this document.

[V2G9-002] The platform adapter of the test system shall implement the TriPlatformPA and the TriPlatformTE interfaces as defined in ETSI ES 201 873-5 V4.9.1:2022, 6.5.3.

6.3 SUT adapter interfaces

The SUT adapter within the test system adapts the TTCN-3 communication operations to the SUT based on an abstract test system interface and implements the real test system interface. It is responsible of propagating message requests and procedure-based calls from the test execution (see Figure 1) to the SUT, and of notifying the test execution of any received test events by appending them to its port queues.

[V2G9-003] Any SUT adapter of the test system shall implement the TriCommunicationSA and the TriCommunicationTE interfaces as defined in ETSI ES 201 873-5 V4.9.1:2022, 6.5.2.

NOTE 1 The actual implementation of these adapters is out of scope of this document.

[V2G9-004] The ISO 15118-8 SUT adapter of the test system shall send/receive the encoded MAC frame format to/from the SUT as defined in IEEE 802.11-2012, section 8.

NOTE 2 For association support according to ISO 15118-8 the management frames according to IEEE 802.11-2012, section 8.3.3 are used and embedded in the frame body field of the MAC frame format.

[V2G9-005] The wireless communication module of the ISO 15118-8 SUT adapter of the test system shall be certified by WiFi Alliance ('Wi-Fi CERTIFIED n').

The majority of requirements in ISO 15118-8 are based on IEEE 802.11n. WiFi Alliance certification is therefore required for the ISO 15118-8 SUT adapter in order to ensure the test system complies with IEEE 802.11n.

[V2G9-006] In case SUT is a STAUT, the ISO 15118-8 SUT adapter of the test system shall support operation at both the 2,4 GHz and 5 GHz frequency bands in parallel (simultaneous dual band support).

[V2G9-007] The wireless communication module of the ISO 15118-8 SUT adapter of the test system shall at least support all allowed channels per frequency band that are applicable for the SUT according to ISO 15118-8:2020, Tables 1, 2, and Annex D.

NOTE 3 Depending on the target market of the SUT, not all the channels listed in ISO 15118-8:2020, Tables 1 and 2 are allowed to be used due to national regulation.

NOTE 4 A collection of national regulations in usage of the U-NII band channels is listed in ISO 15118-8:2020, Annex D.

[V2G9-008] The ISO 15118-8 SUT adapter of the test system shall support active and passive scanning procedure according to IEEE 802.11-2012.

6.4 Codecs

A codec is responsible for the external encoding and decoding of TTCN-3 values into bit strings suitable to be sent to the SUT. The test execution (TE) determines which codec shall be used and passes the TTCN-3 data to the appropriate encoder to obtain the encoded data. Received data is decoded in this entity by using the appropriate decoder, which translates the received data into TTCN-3 values cf. ETSI ES 201 873-5 that can be matched against expected values or templates.

[V2G9-009] All codecs in this document shall implement the TCI-CD interface as defined in ETSI ES 201 873-6 V4.13.1:2022, 7.3.2.