INTERNATIONAL STANDARD

ISO 15118-5

First edition
2018-02

Corrected version
2018-05

Road vehicles — Vehicle to grid communication interface —

Part 5: Physical layer and data link layer conformance test

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

Partie 5: Essai de conformité relatif à la couche physique et à la couche liaison de données



Reference number
ISO 15118-5:2018(E)

© ISO 2018



COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Foreword vii

Introduction viii

1 Scope 1

2 Normative references 2

3 Terms and definitions 2

4 Symbols (and abbreviated terms) 7

5 Conventions 8
5.1 Requirement structure 8
5.2 Test system description 8

6 Test architecture reference model 8
6.1 General information 8
6.2 Platform adapter interface 9
6.3 SUT adapter interfaces 9
6.4 Codecs 10

7 Test suite conventions 10
7.1 General information 10
7.2 Test suite structure (TSS) 10
7.3 Test profiles 12
7.3.1 Test configurations 12
7.3.2 Components and ports 13
7.3.3 Protocol implementation conformance statement (PICS) definition 14
7.3.4 Protocol implementation extra information for testing (PIXIT) definition 15
7.3.5 Test control 17

Table 12 — SECC AC PICS/PIXIT configuration 17

Table 13 — SECC DC PICS/PIXIT configuration 18

Table 14 — EVCC AC PICS/PIXIT configuration 19

Table 15 — EVCC DC PICS/PIXIT configuration 20
7.4 Test suite identifiers 22
7.4.1 Module identifiers 22
7.4.2 Test case identifiers 22
7.4.3 Template identifiers 24
7.4.4 Function identifiers 25
7.4.5 Timer identifiers 26
7.4.6 PICS/PIXIT identifiers 26
7.4.7 Verdict identifiers 27
7.5 Test suite coverage 27

Table 29 — ATS coverage of requirements in ISO 15118-3 28

Table 30 — Groups for a simplified TC Id representation (see Table 29) 46
7.6 Test case description 56
7.7 Test case specification 57
7.7.1 Data types 57
7.7.2 Templates 57
7.7.3 Timeouts and timers 58
7.7.4 Library functions 58

© ISO 2018 – All rights reserved

7.7.5 Test case modelling 58
7.7.6 SLAC Message handling for different SUT types 59
7.7.7 IEC 61851-1 PWM event handling and control 59
7.7.8 Data link status control functionality 61
7.7.9 EIM status control functionality 61
7.7.10 Transmission power limitation functionality 61
7.7.11 Attenuator injection functionality 61

8 Test case descriptions for ISO 15118-3 HPGP PLC signal measurement 62
8.1 General information 62
8.2 Test case for PLC signal measurement for ISO 15118-3 62
8.3 SECC + PLC bridge test cases 62
8.3.1 SECC test cases for CmSlacParm 62
8.3.2 SECC test cases for AttenuationCharacterization 69
8.3.3 SECC test cases for CmValidate 79
8.3.4 SECC test cases for CmSlacMatch 86
8.3.5 SECC test cases for PLCLinkStatus 98
8.3.6 SECC test cases for CmAmpMap 110
8.4 EVCC + PLC bridge test cases 114
8.4.1 EVCC test cases for CmSlacParm 114
8.4.2 EVCC test cases for AttenuationCharacterization 122
8.4.3 EVCC test cases for CmValidate 130
8.4.4 EVCC test cases for CmValidateOrCmSlacMatch 142
8.4.5 EVCC test cases for CmSlacMatch 142
8.4.6 EVCC test cases for PLCLinkStatus 148
8.4.7 EVCC test cases for CmAmpMap 159

Annex A (normative) Configuration specifications 164
A.1 Timer configuration 164
A.2 PICS configuration 165
A.3 PIXIT configuration 165

Annex B (normative) Control part specification 167
B.1 SECC control parts 167
B.1.1 AC specific control parts 167
B.1.2 DC specific control parts 172
B.2 EVCC control parts 177
B.2.1 AC specific control parts 177
B.2.2 DC specific control parts 181

Annex C (normative) Test-case specifications for 15118-3 186
C.1 SECC + PLC bridge test cases 186
C.1.1 SECC test cases for CmSlacParm 186
C.1.2 SECC test cases for AttenuationCharacterization 190
C.1.3 SECC test cases for CmValidate 197
C.1.4 SECC test cases for CmSlacMatch 202
C.1.5 SECC test cases for PLCLinkStatus 209
C.1.6 SECC test cases for CmAmpMap 212
C.2 EVCC + PLC bridge test cases 214

© ISO 2018 – All rights reserved

C.2.1 EVCC test cases for CmSlacParm 214
C.2.2 EVCC test cases for AttenuationCharacterization 219
C.2.3 EVCC test cases for CmValidate 224
C.2.4 EVCC test cases for CmValidateOrCmSlacMatch 232
C.2.5 EVCC test cases for CmSlacMatch 232
C.2.6 EVCC test cases for PLCLinkStatus 236
C.2.7 EVCC test cases for CmAmpMap 244
Annex D (normative) Function specifications for supporting test execution 248
D.1 Configuration functions 248
D.2 Pre-condition functions 250
D.2.1 SECC + PLC bridge functions 250
D.2.2 EVCC + PLC bridge functions 253
D.3 Post-condition functions 256
D.3.1 SECC + PLC bridge functions 256
D.3.2 EVCC + PLC bridge functions 257
D.4 Library functions 257
Annex E (normative) Function specifications for 15118-3 259
E.1 SECC + PLC bridge functions 259
E.1.1 SECC functions for CmSlacParm 259
E.1.2 SECC functions for AttenuationCharacterization 266
E.1.3 SECC functions for CmValidate 281
E.1.4 SECC functions for CmSlacMatch 298
E.1.5 SECC functions for CmSetKey 303
E.1.6 SECC functions for PLCLinkStatus 304
E.1.7 SECC functions for CmAmpMap 313
E.2 EVCC + PLC bridge functions 318
E.2.1 EVCC functions for CmSlacParm 319
E.2.2 EVCC functions for AttenuationCharacterization 324
E.2.3 EVCC functions for CmValidate 346
E.2.4 EVCC functions for CmValidateOrCmSlacMatch 367
E.2.5 EVCC functions for CmSlacMatch 370
E.2.6 EVCC functions for CmSetKey 373
E.2.7 EVCC functions for PLCLinkStatus 373
E.2.8 EVCC functions for CmAmpMap 379
Annex F (normative) Template specifications for 15118-3 385
F.1 Common + PLC bridge templates 385
F.1.1 CMN templates for CmSlacParm 386
F.1.2 CMN templates for CmStartAttenCharInd 387

© ISO 2018 – All rights reserved

F.1.3 CMN templates for CmMnbcSoundInd 387
F.1.4 CMN templates for CmAttenCharRsp 387
F.1.5 CMN templates for CmValidate 388
F.1.6 CMN templates for CmSlacMatch 389
F.1.7 CMN templates for CmSetKey 390
F.1.8 CMN templates for CmAmpMap 391
F.1.9 CMN templates for CmNwStats 394
F.2 SECC + PLC bridge templates 394
F.2.1 SECC templates for CmAttenCharInd 395
F.3 EVCC + PLC bridge templates 395
F.3.1 EVCC templates for CmAttenProfileInd 395
F.3.2 EVCC templates for CmAttenCharInd 395
Annex G (normative) Data type definitions 397
G.1 Data types for PICS 397
G.2 Data types for PIXIT 397
G.3 Data types for SLAC 398
Bibliography 403

© ISO 2018 – All rights reserved

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html

This document was prepared jointly by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*, and Technical Committee IEC/TC 69, *Electric road vehicles and electric industrial trucks*. The draft was circulated for voting to the national bodies of both ISO and IEC.

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

This corrected version of ISO 18541-6:2018 incorporates the following corrections:

— the foreword has been revised to indicate joint development with IEC/TC 69, *Electric road vehicles and electric industrial trucks*.

© ISO 2018 – All rights reserved

Introduction

The first two parts of ISO 15118 describe the use cases and the technical specification of the Vehicle-to-Grid Communication Interface which is intended for the optimized use of energy resources so that electric road vehicles can recharge in the most economic or most energy efficient way. It is furthermore required to develop efficient and convenient billing systems in order to cover micro-payments resulting from charging processes. The necessary communication channel may serve in the future to contribute to the stabilization of the electrical grid, as well as to support additional information services required to operate electric vehicles efficiently and economically.

Resulting from the physical and data link layer requirements defined in the third part of the standard, a corresponding set of test cases are required in order to verify conformance of implementations. This document therefore defines a conformance test suite for the physical and data link layer protocols in order to derive a common and agreed basis for conformance tests. The resulting test suite is a necessary 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 part three only.

© ISO 2018 – All rights reserved

Road vehicles — Vehicle to grid communication interface — Part 5: Physical and data link layer conformance tests

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 PLC-based High Level Communication (HLC) and Basic Signaling according to ISO 15118-3. These conformance tests specify the testing of capabilities and behaviors of an SUT, as well as checking what is observed against the conformance requirements specified in ISO 15118-3 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 15118-3. The behavior tests of the ATS examine an implementation as thoroughly as is practical over the full range of dynamic conformance requirements defined in ISO 15118-3 and within the capabilities of the SUT (see NOTE 1).

A test architecture is described in correspondence to the ATS. The conformance test cases in this part of the standard are described leveraging this test architecture and are specified in TTCN-3 Core Language for the ISO/OSI Physical and Data Link Layers (Layers 1 and 2). The conformance test cases for the ISO/OSI Network Layer (Layer 3) and above are described in ISO 15118-4.

In terms of coverage, this document only covers normative sections and requirements in ISO 15118-3. This document can additionally include specific tests for requirements of referenced standards (e.g. IEEE, or industry consortia standards) as long as they are relevant in terms of conformance for implementations according to ISO 15118-3. 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 15118-3. 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 test cases defined in this document only consider the communication protocol and the system's behavior defined ISO 15118-3. Power flow between the EVSE and the EV is not considered.

NOTE 1 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. What it does do is give confidence that an implementation has the required capabilities and that its behavior conforms consistently in representative instances of communication.

NOTE 2 This document has some interdependencies to the conformance tests defined in ISO 15118-4 which result from ISO/OSI cross layer dependencies in the underlying protocol specification (e.g. for sleep mode)

© ISO 2018 – All rights reserved

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.

IEC 61851-1:2017, *Electric vehicle conductive charging system — Part 1: General requirements (Ed 3.0, 2017)*

ISO 15118-1:2013, *Road vehicles — Vehicle to grid communication interface — Part 1: General information and use-case definition*

ISO 15118-2:2014, *Road vehicles — Vehicle-to-Grid Communication Interface — Part 2: Network and application protocol requirements*

ISO 15118-3:2015, *Road vehicles — Vehicle to grid communication interface — Part 3: Physical and data link layer requirements*

ETSI ES 201 873-5 V4.6.1, *TTCN-3: TTCN-3 Runtime Interface (June 2014)*

ETSI ES 201 873-6 V4.6.1, *TTCN-3: TTCN-3 Control Interface (June 2014)*

HomePlug Green PHY Specification, release version 1.1.1, July 4, 2013

NOTE 1 Even though ISO 15118-3:2015, which is the baseline for this conformance test document, explicitly references IEC 61851-1:2011, this document references IEC 61851-1:2017 because of applicability on the market.

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 15118-1, ISO 15118-2, ISO 15118-3 and the following apply.

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

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

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

3.1
abstract test case
complete and independent specification of the actions required to achieve a specific test purpose

Note 1 to entry: This specification is 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 may involve one or more consecutive or concurrent connections.

Note 2 to entry: The specification should be complete in the sense that it is sufficient to enable a test verdict to be assigned unambiguously to each potentially observable test outcome (i.e. sequence of test events).

Note 3 to entry: The specification should be independent in the sense that it should be possible to execute the derived executable test case in isolation from other such test cases (i.e. the specification should always include the possibility of starting and finishing in the "idle" state).

Note 4 to entry: Compare with ITU-T X.290.

3.2
abstract test suite
ATS
test suite composed of abstract test cases

© ISO 2018 – All rights reserved

Note 1 to entry: Compare with ITU-T X.290.

3.3
black box testing
method of testing that examines the behavior of an SUT without considering the internal implementation and structure of the SUT, thus relying on the SUT's open interface for testing

3.4
conformance requirements
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 behavior 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 ISO 15118-4 conformance tests include requirements and transfer syntax requirements as far as they can be validated by black box testing.

Note 2 to entry: See also *static conformance requirements* (3.20) and *dynamic conformance requirements* (3.6).

3.5
conforming implementation
IUT which satisfies both static and dynamic conformance requirements, consistent with the capabilities stated in the PICS(s)

Note 1 to entry: Compare with ITU-T X.290.

3.6
dynamic conformance requirements
one of the requirements which specifies what observable behavior 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 15118-3.

Note 2 to entry: Compare with ITU-T X.290.

3.7
executable test case
realization of an abstract test case

Note 1 to entry: Compare with ITU-T X.290.

3.8
expected behavior
exact response of the SUT according to the underlying protocol specification to the stimulus defined in the test behavior

3.9
implementation conformance statement
ICS
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 15118-3.

Note 2 to entry: Compare with ITU-T X.290.

3.10

© ISO 2018 – All rights reserved

implementation extra information for testing
IXIT
statement made by a supplier or implementer of an IUT which contains or references all of the information (in addition to that given in the ICS) related to the IUT and its testing environment, which will enable the test laboratory to run an appropriate test suite against the IUT

Note 1 to entry: Compare with ITU-T X.290.

3.11
implementation under test
IUT
implementation of one or more OSI protocols in an adjacent user/provider relationship, being that part of a real open system which is to be studied by testing

Note 1 to entry: Compare with ITU-T X.290.

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

Note 1 to entry: Compare with ITU-T X.292.

3.13
parallel test component
PTC
test component created by the main test component

Note 1 to entry: Compare with ITU-T X.292.

3.14
post-condition
test steps needed to define the path from the end of the *test behavior* up to the finishing stable state for the test case

Note 1 to entry: See also *test behavior* (3.23).

3.15
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 bevavior* will start

Note 1 to entry: See also *test behavior* (3.23).

3.16
protocol implementation conformance statements
PICS
ICS 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 15118-3.

Note 2 to entry: Compare with ITU-T X.290.

3.17
protocol implementation extra information for testing
PIXIT

© ISO 2018 – All rights reserved

IXIT related to testing for conformance to a given protocol specification

Note 1 to entry: The given protocol specification for this conformance specification is ISO 15118-3.

Note 2 to entry: Compare with ITU-T X.290.

3.18
runtime environment
environment that describes the operating system and corresponding platform requirements of a system

EXAMPLE *Test system*.

3.19
semantically invalid test behavior
SemITB
test steps where the test system sends stimuli to the SUT that are semantically invalid according to the protocol requirements

Note 1 to entry: This type of test behavior is defined in this document and explicitly includes requirements which define the appropriate error handling of the SUT.

3.20
static conformance requirements
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)

Note 1 to entry: Compare with ITU-T X.290.

3.21
system under test
SUT
real open system in which the IUT resides

Note 1 to entry: Compare with ITU-T X.290.

3.22
syntactically invalid test behavior
SynITB
test steps where the test system sends stimuli to the SUT that are syntactically invalid according to the protocol requirements

Note 1 to entry: This type of test behavior is not defined in this conformance standard, see codec requirements.

3.23
test behavior
set of test steps (test body) which are essential in order to achieve the test purpose and assign verdicts to the possible outcomes

3.24
test execution
interpretation or execution of an abstract test suite

Note 1 to entry: Conceptually, the TE can be decomposed into three interacting entities: an Executable Test Suite (ETS), a Test Framework (TFW) and an optional internal Encoding/Decoding System (EDS) entity.

Note 2 to entry: See also ETSI ES 201 873-5 V4.6.1.

© ISO 2018 – All rights reserved

3.25
test framework
TFW
entity to perform all actions of test cases or functions

Note 1 to entry: The Test Framework interacts with the Test Management (TM), SUT Adaptor (SA) and Platform Adaptor (PA) entities via Test Control Interface (TCI) and Test Runtime Interface (TRI) and additionally manages the Executable Test Suite (ETS) and Encoding/Decoding System (EDS) entities. It initializes adaptors as well as ETS and EDS entities. This entity performs all the actions necessary to properly start the execution of a test case or function with parameters in the ETS entity. It queries the TM entity for module parameter values required by the ETS and sends logging information to it. It also collects and resolves associated verdicts returned by the ETS entity.

Note 2 to entry: See also ETSI ES 201 873-5 V4.6.1.

Note 3 to entry: In this document, the Test Framework TTCN-3 Runtime System (T3RTS) is used to explain a Test Framework functionality.

3.26
test purpose
prose description of a well-defined objective of testing, focusing on a single conformance requirement 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.

Note 1 to entry: Compare with ITU-T X.290.

3.27
test system
real system combining the test framework, abstract test suite, test execution and adapters as well as codecs

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

3.28
test control interface
TCI
four interfaces that define the interaction of the TTCN-3 Executable with the test management, the coding and decoding, the test component handling and the logging in a test system

Note 1 to entry: Compare with ITU-T X.290.

Note 2 to entry: Compare with ETSI ES 201 873-6 V4.6.1.

3.29
test runtime interface
TRI
two interfaces that define the interaction of the TTCN-3 Executable between the SUT and the Platform Adapter (PA) and the System Adapter (SA) in a test system

Note 1 to entry: Compare with ETSI ES 201 873-5 V4.6.1.

3.30
test system interface
TSI
test component that provides a mapping of the ports available in the (abstract) TTCN-3 test system to those offered by a real test system

© ISO 2018 – All rights reserved

Note 1 to entry: Compare with ETSI ES 201 873-6 V4.6.1.

3.31
valid test behavior
VTB
test steps where the test system sends stimuli to the SUT that are valid (syntactically and semantically) according to the protocol requirements

Note 1 to entry: This type of test behavior is defined in this conformance document.

Note 2 to entry: The protocol requirements for this conformance specification are defined in ISO 15118-3.

3.32
verdict
test verdict
statement of "pass", "fail" or "inconclusive", as specified in an abstract test case, concerning conformance of an IUT with respect to that test case when it is executed

Note 1 to entry: Compare with ITU-T X.290.

4 Symbols (and abbreviated terms)

For the purposes of this document, the following abbreviations apply:

AC	Alternating Current
ATS	Abstract Test Suite
CPL	Control Pilot Line
DC	Direct Current
EIM	External Identification Means
ETSI	European Telecommunications Standards Institute
EV	Electric Vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric Vehicle Supply Equipment
HAL	Hardware Abstraction Layer
HPGP	HomePlug GreenPHY
ITB	Invalid Test Behavior
MME	Management Message Entry
MTC	Main Test Component
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PLC	Power Line Communication
PnC	Plug and Charge
PTC	Parallel Test Component
PWM	Pulse Width Modulation
SECC	Supply Equipment Communication Controller
SLAC	Signal Level Attenuation Characterization

© ISO 2018 – All rights reserved