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Road vehicles — Controller area network (CAN) conformance test plan —

Part 1: Data link layer and physical signalling

Véhicules routiers — Plan d'essai de conformité du gestionnaire de réseau de communication (CAN) —
Partie 1: Couche liaison de données et signalisation physique

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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 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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

This first edition of ISO 16845-1 cancels and replaces ISO 16845:2004, which has been technically revised.

A list of all parts in the ISO 16845 series can be found on the ISO website.

Introduction

ISO 16845 was first published in 2004 to provide the methodology and abstract test suite necessary for checking the conformance of any CAN implementation of the CAN specified in ISO 11898-1.

Road vehicles — Controller area network (CAN) conformance test plan —

Part 1: Data link layer and physical signalling

1 Scope

This document specifies the conformance test plan for the CAN data link layer and the physical signalling as standardized in ISO 11898-1. This includes the Classical CAN protocols as well as the CAN FD protocols.

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 11898-1:2015, *Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signalling*

ISO/IEC 9646-1, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 1: General concepts*

ISO/IEC 9646-2, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 2: Abstract Test Suite specification*

ISO/IEC 9646-4, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 4: Test realization*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11898-1 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
bit rate prescaler
BRP
minimum time quantum used for a TQ in CAN Bit time configuration

3.2
conformance testing
applying the *test plan* (3.17) to an IUT

3.3
default state
state of the IUT

Note 1 to entry: The default state is characterized by the default value presented in 5.3.2.5.

3.4
dominant
represents the logical 0

3.5
dominant state
CAN bus is in dominant state when at least one CAN node drives a dominant value on the line

3.6
elementary test
repetitions of the test case for several values of the parameter to test

3.7
end of frame
last field of a data or remote frame before the intermission field

3.8
idle state
CAN bus is in idle state when no frame is started after intermission field

3.9
lower tester
supervises the *test suite* (3.18)

3.10
REC passive state
device is in the passive state because the value of the REC has reached the error passive limit

3.11
recessive
represents the logical 1

3.12
recessive state
CAN bus is in the recessive state when no CAN node drives a dominant value on the line

3.13
TEC passive state
device is in the passive state because the value of the TEC has reached the error passive limit

3.14
test case
each test case is defined by a specific number and a particular name in the *test suite* (3.18)

3.15
test class
each *test type* (3.19) is divided in eight test classes

3.16
test frame
CAN frames containing the test pattern specified in this document

3.17
test plan
specific application of the «OSI conformance testing general concepts» standard

3.18
test suite
checks the behaviour of the IUT for particular parameters of ISO 11898-1

3.19
test type
defines the direction of the *test frames* (3.16)

EXAMPLE Behaviour of the IUT if receiving and/or transmitting messages.

3.20
upper tester
acts as a user of the IUT

4 Abbreviated terms

All abbreviated terms in this document are written in upper case letters.

CTRL	Control field of CAN frame + SRR/RTR + IDE bit
CBFF: CTRL	= RTR, IDE, FDF, DLC merged together as 7 bit hexadecimal value
FBFF: CTRL	= RRS, IDE, FDF, res, BRS, ESI, DLC merged together as 10 bit hexadecimal value
CEFF: CTRL	= SRR, IDE, RTR, FDF, r0, DLC merged together as 9 bit hexadecimal value
FEFF: CTRL	= SRR, IDE, RRS, FDF, res, BRS, ESI, DLC merged together as 11 bit hexadecimal value
IPT	information processing time
LT	lower tester
NTQ(D)	number of time quantum in data bit rate
NTQ(N)	number of time quantum in nominal bit rate
Phase_Seg1(D)	Phase Segment 1 (Phase_Seg1) for data phase bit rate
Phase_Seg1(N)	Phase Segment 1 (Phase_Seg1) for nominal bit rate
Phase_Seg2(D)	Phase Segment 2 (Phase_Seg2) for data phase bit rate
Phase_Seg2(N)	Phase Segment 2 (Phase_Seg2) for nominal bit rate
Prop_Seg(D)	propagation segment (Prop_Seg) for data phase bit rate
Prop_Seg(N)	propagation segment (Prop_Seg) for nominal bit rate
Sampling_Point(D)	Sync_Seg(D) + Prop_Seg(D) + Phase_Seg1(D)
Sampling_Point(N)	Sync_Seg(N) + Prop_Seg(N) + Phase_Seg1(N)
SJW(D)	synchronization jump width (SJW) for data phase bit rate
SJW(N)	synchronization jump width (SJW) for nominal bit rate
Sync_Seg(D)	synchronization segment (Sync_Seg) for data phase bit rate
Sync_Seg(N)	synchronization segment (Sync_Seg) for nominal bit rate
TP	test plan

TQ(D)	time quantum in data bit rate
TQ(N)	time quantum in nominal bit rate
UT	upper tester

5 Global overview

5.1 Scope of test plan

ISO 9646-1, ISO 9646-2 and ISO 9646-4 define the methodology and the abstract test suite necessary to check the conformance of any CAN implementation to ISO 11898-1. The architecture of the TP is as shown in Figure 1.

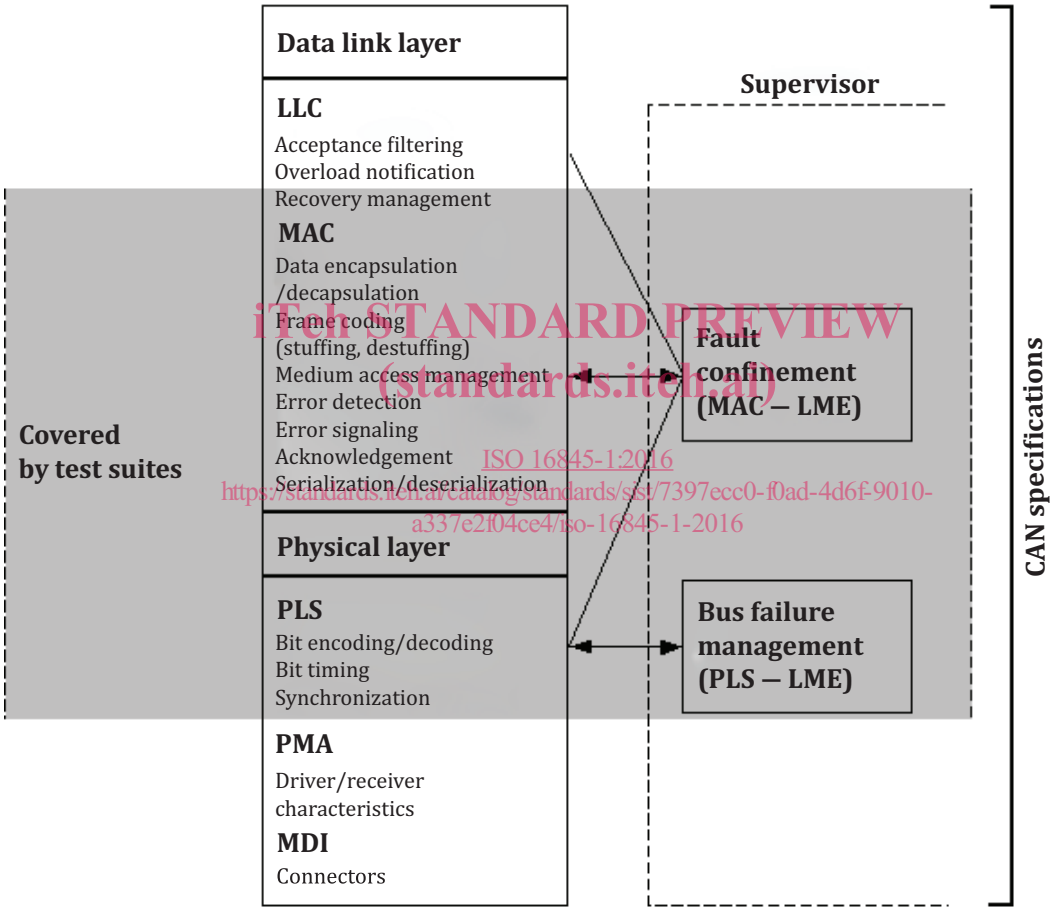

Figure 1 — Architecture of the test plan

5.2 Architecture of test plan

This methodology and the associated abstract test suites will be hereafter referred to as test plan (TP).

The TP is a specific application of the «OSI conformance testing general concepts» ISO 9646-1 and is restricted to the single party testing mode. Since the upper service boundary of a CAN implementation is not standardized and in some cases may not be observed and controlled [due to an application specific behaviour embedded in this implementation, for example, CAN SLIO (serial linked input/output)], the TP will rely either on the «coordinated test method» or the «remote test method».

Depending on the test method applied, the TP will involve up to the following three test functions:

— a lower tester (LT) operating in a way similar to the CAN implementation to be tested (IUT), running test suite and granting test verdict;

— an upper tester (UT) acting as user of the IUT (IUT dependant);

— a test management protocol between the IUT and the LT. The protocol consists in test coordination procedures.

The last two functions are only applicable to the coordinated test procedure.

During test execution, the LT can observe and control the standardized lower service boundary of the IUT (PCO) through the two service primitives provided by the CAN physical signalling sub-layer: PLS-Data.indicate and PLS-Data.request in most cases.

The environment that implements the TP is described in Figure 2.

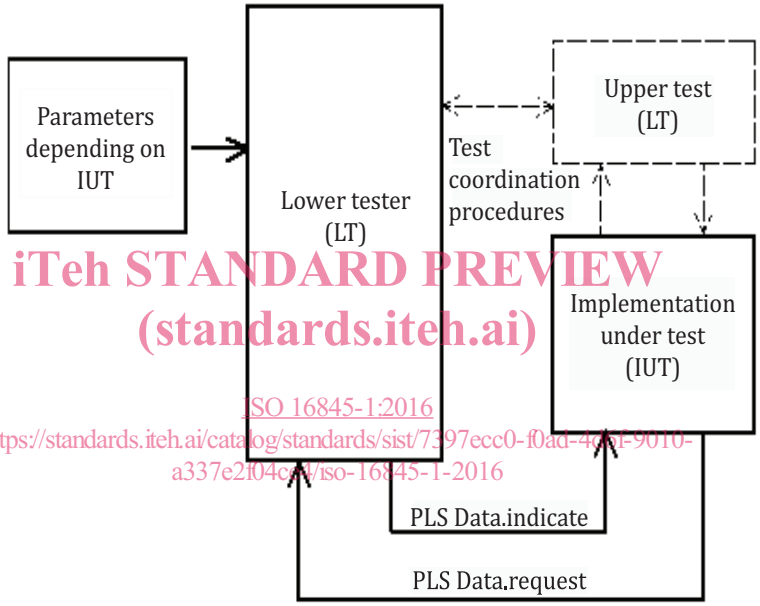

Figure 2 — CAN conformance TP environment

Using the network interface, the LT indicates to the UT the actions to be performed and the UT provides the LT with information concerning the internal behaviour of the IUT.

In order to allow the LT and the UT to communicate, it is necessary to define some test coordination procedures between them. These procedures use the network to the exclusion of any other physical link. They are used to set up the UT and to verify the test results.

5.3 Organization

5.3.1 General organization

The LT verifies if the IUT complies with the MAC, LLC and PLS sub-layers of ISO 11898-1. The LT points out differences between what is expected from the standard and the actual behaviour of the IUT.

The abstract test suites of the TP are independent to one another. Each abstract test suite checks the behaviour of the IUT for a particular parameter of ISO 11898-1. Each test case may be executed one after another in any order or alone.

Test cases requiring variations of individual parameters (identifier, number of data, etc.) should be repeated for each value of the parameter. Each repetition is named elementary test. A test case including different elementary tests is valid only if all tests pass.

5.3.2 Test case organization

5.3.2.1 General

Each elementary test is made of the following three states:

— set-up state;

— test state;

— verification state.

At the PCO, these states involve exchanges of valid sequences of PLS service primitives [CAN frame(s)] or invalid sequences of PLS primitives (invalid CAN frames or noise).

Before the first elementary test is started, the IUT has to be initialized into the default state.

5.3.2.2 Set-up state

The set-up state is the state in which the IUT has to be before entering the test state.

5.3.2.3 Test state

This is the part of the elementary test in which the parameter or protocol feature is actually checked. This state needs one or several exchanges or frames. These frames are named test frames.

5.3.2.4 Verification state

Verification state is made of the data reading frames which verify that the data have been handled in accordance with ISO 11898-1. These data should be checked.

For tests belonging to classes 1 to 6, the LT should be able to detect the correct value of the bit. For bit timing tests (classes 7 and 8), the LT should be able to detect a faulty synchronization of one time quantum.

For tests belonging to class 6, a readable error counter should be used for verification. In case the error counter value is not readable, the test should be applied by driving the IUT to the next error state by additional bus errors. The state change at expected position indicates the correct error counting up to this state change.

5.3.2.5 Default state

The default state is characterized by the following default value:

— both REC and TEC should be equal to 0;

— no pending transmission should be present;

— IUT should be in idle state;

— PLS-Data indicate and PLS-Data request should be recessive.

After the end of each elementary test, the default state should be applied.

5.3.3 Hierarchical structure of tests

5.3.3.1 Overview

All the tests defined in the test plan are grouped into categories in order to aid planning, development, understanding or execution of each test case. There are three levels of categories:

— test types;

— test classes;

— test cases.

5.3.3.2 Test types

The types define the direction of the frames. The three types are as follows.

— **Type 1: Received frame type**

It includes all the tests evaluating the behaviour of the IUT for data frames and remote frames received by the IUT.

— **Type 2: Transmitted frame type**

It includes all the tests evaluating the behaviour of the IUT for data frames and remote frames transmitted by the IUT.

— **Type 3: Bi-directional frame type**

It includes all the tests with data frames or remote frames both received and transmitted by the IUT.

5.3.3.3 Test classes

Each of the three test types defined in 5.3.3.2 is divided in eight classes grouping tests by topic regarding to ISO 11898-1. These eight classes are as follows.

— **Class 1: Valid frame format class**

This class includes the tests involving only error free data or remote frames.

— **Class 2: Error detection class**

This class includes the tests corrupting data or remote frames. These tests check the correct error detection by the IUT.

— **Class 3: Active error frame management class**

This class includes the tests verifying the IUT correct management of error-free and of corrupted active error frames.

— **Class 4: Overload frame management class**

This class includes the tests verifying the IUT correct management of error free and of corrupted overload frames.

— **Class 5: Passive error state and bus-off class**

This class includes the tests verifying the IUT behaviour during passive error state and bus-off state.

— **Class 6: Error counters management class**

This class includes the tests verifying the correct management of the TEC and REC by the IUT in both active and passive error state.