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Technical Specification

**Intelligent Transport Systems (ITS);
Road Transport and Traffic Telematics (RTTT);
Test specifications for Dedicated Short
Range Communication (DSRC) transmission equipment;
Part 1: DSRC data link layer:
medium access and logical link control;
Sub-Part 2: Test Suite Structure and Test Purposes (TSS&TP)**

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport System(ITS).

The present document is part 1, sub-part 2 of a multi-part deliverable covering Intelligent Transport Systems (ITS); Road Transport and Traffic Telematics (RTTT); Test specifications for Dedicated ShortRange Communication (DSRC) transmission equipment as identified below:

Part 1: "DSRC data link layer: medium access and logical link control,"

Sub-part 1: "Protocol Implementation Conformance Statement (PICS) proforma specification";

Sub-part 2: "Test Suite Structure and Test Purposes (TSS&TP)";

Sub-part 3: "Abstract Test Suite (ATS) and partial PIXIT proforma".

Part 2: "DSRC application layer"

1 Scope

The present document contains the Test Suite Structure (TSS) and Test Purposes (TP) to test the Dedicated Short Range Communication (DSRC); Data Link Control (DLC) layer.

The objective of this test specification is to provide a basis for conformance tests for DSRC equipment giving a high probability of inter-operability between different manufacturer's equipment.

The ISO standard for the methodology of conformance testing (ISO/IEC 9646-1 [5] and ISO/IEC 9646-2 [6]) as well as the ETSI rules for conformance testing (ETS 300 406 [4]) are used as a basis for the test methodology.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

- [1] CEN EN 12795 (2003): "Road transport and traffic telematics - Dedicated Short Range Communication (DSRC) - DSRC data link layer: medium access and logical link control".
- [2] CEN EN 12253 (2003): "Road transport and traffic telematics - Dedicated short-range communication - Physical layer using microwave at 5,8 GHz".
- [3] CEN EN 13372 (2003): "Road transport and traffic telematics (RTTT) - Dedicated short-range communication - Profiles for RTTT".
- [4] ETSI ETS 300 406: "Methods for Testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".
- [5] ISO/IEC 9646-1 (1991): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 1: General concepts".

- [6] ISO/IEC 9646-2 (1991): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 2: Abstract Test Suite specification".
- [7] ISO/IEC 9646-6 (1991): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 6: Protocol profile test specification".
- [8] ISO/IEC 9646-7 (1991): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 7: Implementation Conformance Statement".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

- [i.1] ETSI TS 102 178: "Broadband Radio Access Networks (BRAN); HiperMAN; Data Link Control (DLC) layer".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ISO/IEC 9646-7 [8], EN 12253 [2], EN 12795 [1] and EN 13372 [3] and the following apply:

blocked signal: signal without clock and bit information, e.g. a very weak signal

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ISO/IEC 9646-1 [5], ISO/IEC 9646-6 [7], ISO/IEC 9646-7 [8], TS 102 178 [i.1] and EN 12795 [1] and the following apply:

DLC	Data Link Control
PrWA	MAC frame Private Window Allocation
PrWRq	MAC frame Private Window Request
U8	Uplink bit rate
U13a	Uplink preamble length (duration)
TSS	Test Suite Structure

4 Test Suite Structure (TSS)

4.1 Structure

Figure 1 shows the DLC Test Suite Structure (TSS) including its subgroups defined for the conformance testing.

Group	Type of SUT	Behaviour
DLC MAC Sub layer	On Board Unit	Valid behaviour
		Invalid behaviour
	Road Side Unit	Valid behaviour
		Invalid behaviour
DLC LLC Sub layer	On Board Unit	Valid behaviour
		Invalid behaviour
	Road Side Unit	Valid behaviour
		Invalid behaviour

Figure 1: TSS for DSRC DLC

4.2 Test groups

The test groups are organized in two groups. The first is designed for the DLC MAC sub layer testing and the second is designed for DLC LLC sub layer testing.

4.3 Type of SUT test groups

The type of SUT test groups are organized in two groups. The first is designed for the On Board Unit testing and the second is designed for Road Side Unit testing.

4.4 Behaviour test groups

4.4.1 Valid Behaviour (BV) tests

This test sub group shall verify that the IUT reacts in conformity with the EN, after receipt or exchange of a valid Protocol Data Units (PDUs). Valid PDUs means that the exchange of messages and the content of the exchanged messages are considered as valid.

4.4.2 Invalid Behaviour (BI) tests

This test sub group shall verify that the IUT reacts in conformity with the EN, after receipt of a syntactically invalid PDU.

5 Test Purposes (TP)

5.1 Introduction

5.1.1 TP definition conventions

The TPs are defined following particular rules as shown in table 1.

Table 1: TP definition rules

TP Id according to the TP naming conventions	Title
	Reference
	PICS Selection
	TC Reference
	Initial condition
	Stimulus and Expected behaviour

TP Id	The TP Id is a unique identifier. It shall be specified according to the TP naming conventions defined in the sub-clause below.
Title	Short description of test purpose objective.
Reference	The reference should contain the references of the subject to be validated by the actual TP (specification reference, clause, paragraph).
PICS Selection	Reference to the PICS statement involved for selection of the TP. Contains a Boolean expression. Only those PICS statements are shown that are explicitly related to the test.
TC reference	Shows the reference number of the related Test Case in the ATS.
Initial condition	The condition defines in which initial state the IUT has to be to apply the actual TP.
Stimulus and Expected behaviour	Definition of the events the tester performs, and the events that are expected from the IUT to conform to the base specification.

5.1.2 TP naming conventions

The identifier of the TP is built according to table 2.

Table 2: TP naming convention

Identifier:	TP/<layer>/<sut>/<x>-<nn>		
	<layer>	MAC	MAC sub-layer
		LLC	LLC sub-layer
	<sut> = type of SUT	OBU	On Board Unit
		RSU	Road Side Unit
	x = Type of testing	BV	Valid Behaviour Tests
		BI	Invalid Behaviour Tests
	<nn> = sequential number	(01-99)	Test Purpose Number

5.1.3 Sources of TP definitions

All TPs are specified according to EN 12795 [1] and EN 13372 [3] with side-information from EN 12253 [2].

5.2 MAC test purposes for On-Board Unit

5.2.1 BV test purposes

Test subgroup objective:

- to test the behaviour of the IUT in relation to syntactically and contextual correct behaviour of the test system.

Test purposes:

TP/MAC/OBU/BV/01	Verify that the OBU can receive downlink frames of maximum allowed length as defined by N2
	Reference: EN 12795 [1], clauses 7.3.3, 7.4.3.1.1 d) and annex A
	PICS Selection: Table A.2/2 AND Table A.5/4 AND Table A.6/7
	TC reference: TC_MAC_OBU_BV_01
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows. The number of profiles in the profilelist shall be such, that the number of octets in the frame equals the maximum number as defined by N2. 2. Verify IUT does send a PrWRq within one of the public uplink windows allocated. 	

TP/MAC/OBU/BV/02	Verify that the OBU can receive a downlink frame following immediately within T1 after the end of an uplink frame transmitted by the same OBU
	Reference: EN 12795 [1], clause 7.3.3 and annex A
	PICS Selection: Table A.2/2 AND Table A.5/4 AND Table A.6/1
	TC reference: TC_MAC_OBU_BV_02
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows. 2. Verify IUT sends a PrWRq in any of the public uplink windows allocated. 3. Tester sends PrWA. 4. Verify IUT sends a VST within the private uplink window allocated. 5. Tester sends ACn command, e.g. DLL ECHO or EFC ECHO, such, that the preamble of the ACn command frame starts exactly T1 after the end of the last bit of the end flag of the VST frame. 6. Verify IUT sends the ACn response. 	

TP/MAC/OBU/BV/03	Verify that the OBU implements the timing constraints T3, T4b and T5 for public uplink windows
	Reference: EN 12795 [1], clause 7.3.4.2 and annex A
	PICS Selection: Table A.2/2 AND Table A.6/3 AND Table A.6/5 AND Table A.6/6
	TC reference: TC_MAC_OBU_BV_03
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows. 2. Verify IUT sends a PrWRq in one of the public uplink windows allocated. 3. Tester records time: <ul style="list-style-type: none"> • Ts from the end of last bit of the end flag of the BST frame until the beginning of the preamble of the PrWRq frame, and time. • Te from the end of last bit of the end flag of the BST frame until the end of the last bit of the end flag of the PrWRq frame. 4. Verify IUT behaves according to table 3. 5. Repeat the previous steps until the IUT has selected each of the N5 public uplink windows at least once. 	

Table 3: Timing for public uplink window

Public uplink window number	Start time Ts	End time Te
1	$T3 < Ts < T3 + T4b$	$Te < T3 + T5$
2	$T3 + T5 < Ts < T3 + T5 + T4b$	$Te < T3 + 2 \cdot T5$
...		
N5	$T3 + ((N5-1) \cdot T5) < Ts < T3 + ((N5-1) \cdot T5) + T4b$	$Te < T3 + N5 \cdot T5$

TP/MAC/OBU/BV/04	Verify that the OBU can receive a downlink frame which follows another downlink frame immediately within T2
	Reference: EN 12795 [1], clause 7.3.3 and annex A
	PICS Selection: Table A.2/2 AND Table A.5/4 AND Table A.6/2
	TC reference: TC_MAC_OBU_BV_04
	Initial condition: OBU being not initialized and not in sleep mode
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends a frame with a private LID, not allocating a frame. 2. Within T2, the tester sends downlink frame containing BST, allocating N5 public uplink windows. 3. Verify IUT sends a PrWRq in one of the public uplink windows allocated. 	

TP/MAC/OBU/BV/05	Verify that the OBU implements the timing constraints T3 and T4a and N3 for private uplink windows
	Reference: EN 12795 [1], clause 7.3.4.1 and annex A EN 12253 [2], clause 5.3
	PICS Selection: Table A.2/2 AND Table A.5/2 AND Table A.6/3 AND Table A.6/4 AND Table A.6/8
	TC reference: TC_MAC_OBU_BV_05
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester performs an initialization cycle BST / PrWRq / PrWA / VST. 2. Tester records time: <ul style="list-style-type: none"> • Ts from the end of the last bit of the end flag of the PrWA frame allocating a private uplink window until the beginning of the preamble of the VST frame in the allocated private uplink window, and time. • Te from the end of the last bit of the end flag of the PrWA frame allocating a private uplink window until the end of the last bit of the end flag of the VST frame in the allocated private uplink window. 3. Verify IUT behaves according to table 4. 	

Table 4: Timing for private uplink window

Start time T_s	End time T_e
$T_3 < T_s < T_3 + T_{4a}$	$T_e < T_3 + T_{4a} + U_{13a} + (8 \cdot N_3 + \text{stuff bits}) / U_8$

TP/MAC/OBU/BV/06	Verify that the OBU correctly manages the S-bit and L-Bit in the MAC control field for the purpose of possible re-transmission of VST frames
	Reference: EN 12795 [1], clauses 7.3.2.1, 7.4.3.1.3 and 7.4.3.1.4
	PICS Selection: Table A.2/2 AND Table A.4/6 AND Table A.7/2 AND Table A.7/3
	TC reference: TC_MAC_OBU_BV_06
	Initial condition: OBU not in sleep mode and not yet initialized
	Stimulus and Expected Behaviour:

1. Tester sends downlink frame containing BST, allocating N5 public uplink windows.
2. Verify IUT sends a PrWRq in one of the public uplink windows allocated.
3. Tester sends PrWA and records the value of the S-bit used.
4. Tester ignores a possible reception of a VST in the allocated private uplink window.
5. Tester sends PrWA with the S-bit set to the same value as in step 3.
6. Verify IUT sends the VST.

TP/MAC/OBU/BV/07	Verify that the OBU correctly manages the local S-bit state variable based on the S-bit and L-Bit in the received MAC control field, where an LPDU is present in the allocating downlink frame.
	Reference: EN 12795 [1], clauses 7.3.2.1, 7.4.3.1.3 and 7.4.3.1.4
	PICS Selection: Table A.2/2 AND Table A.4/6 AND Table A.7/2 AND Table A.7/3 AND Table A.7/4
	TC reference: TC_MAC_OBU_BV_07
	Initial condition: OBU being fully initialized and not in sleep mode.
	Stimulus and Expected Behaviour:

1. Tester sends the EFC ECHO ACn command with ECHO_DATA1 and notes the value of the S-bit.
2. Verify IUT sends the EFC ECHO response with ECHO_DATA1.
3. Tester sends the EFC ECHO ACn command with ECHO_DATA2. The S-bit shall be set to the same value as used in step 1.
4. Verify IUT sends the EFC ECHO response with ECHO_DATA2.
5. Tester sends PrWA with the S-bit set to the same value as in step 3.
6. Verify IUT sends the EFC ECHO response with ECHO_DATA2.

TP/MAC/OBU/BV/08	Verify that the OBU randomly selects one of the N5 public uplink windows.
	Reference: EN 12795 [1], clause 7.3.4.3
	PICS Selection: Table A.2/2 AND Table A.5/1
	TC reference: TC_MAC_OBU_BV_08
	Initial condition: OBU not in sleep mode and not yet initialized
	Stimulus and Expected Behaviour:

1. Tester sends downlink frame containing BST, allocating N5 = three public uplink windows.
2. Verify IUT sends a PrWRq within one of the public uplink windows allocated.
3. Tester records number of public uplink window selected.
4. Tester repeats steps 1. to 3. X times with X = 100.
5. Verify IUT selects all possible public uplink windows at least 0,3·X times.

NOTE: In case the test fails, increase value of X and repeat test.

TP/MAC/OBU/BV/09	Verify that the OBU can detect and manage both valid values of the C/R-bit in the MAC control field of a PrWa frame
	Reference: EN 12795 [1], clauses 7.3.2.1 and 7.4.3.1.1 c)
	PICS Selection: Table A.2/2 AND Table A.4/6 <i>Note: Test does not apply for profiles 0/1 of EN 13372 [3]</i>
	TC reference: TC_MAC_OBU_BV_09
	Initial condition: OBU not in sleep mode and not yet initialized
	Stimulus and Expected Behaviour: <ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows. 2. Verify IUT sends PrWRq in the allocated private uplink window. 3. Tester sends PrWA frame with the C/R-bit of the MAC control field set to 1. 4. Verify IUT sends VST in the allocated private uplink window. 5. Tester sends PrWA frame with the C/R-bit of the MAC control field set to 0. The S-bit shall have the same value as in step 3. 6. Verify IUT sends VST in the allocated private uplink window.

5.2.2 BI test purposes

Test subgroup objective:

- to check the behaviour of the of the IUT in response to invalid messages and behaviour from the test tool.

Test purposes:

TP/MAC/OBU/BI/01	Verify that the OBU can detect and manage double-bit errors in the LID field, MAC control field and LPDU field of the downlink frame using the FCS field
	Reference: EN 12795 [1], clauses 5.5 and 7.4.3.1.1 e)
	PICS Selection: Table A.2/2 AND Table A.4/8 AND Table A.7/1 AND Table A.7/6
	TC reference: TC_MAC_OBU_BI_01
	Initial condition: OBU not in sleep mode and not yet initialized
	Stimulus and Expected Behaviour: <ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows, but introduces a random double-bit error in the frame on transmission. The bit error shall be introduced between the end of the start flag and the start of the FCS field 2. Verify IUT does not respond within any of the public uplink windows allocated. 3. Repeat test in case the errors produced a flag or an abort sequence.

TP/MAC/OBU/BI/02	Verify that the OBU can detect and manage double-bit errors in the FCS field of the downlink frame using the FCS field
	Reference: EN 12795 [1], clauses 5.5 and 7.4.3.1.1 e)
	PICS Selection: Table A.2/2 AND Table A.4/8 AND Table A.7/1 AND Table A.7/6
	TC reference: TC_MAC_OBU_BI_02
	Initial condition: OBU not in sleep mode and not yet initialized
	Stimulus and Expected Behaviour: <ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows, but introduces a random double-bit error in the FCS field on transmission. 2. Verify IUT does not respond within any of the public uplink windows allocated. 3. Repeat test in case the errors produced a flag or an abort sequence.

TP/MAC/OBU/BI/03	Verify that the OBU can detect and manage a block of 15 bit errors in the downlink frame using the FCS field
	Reference: EN 12795 [1], clauses 5.5 and 7.4.3.1.1 e)
	PICS Selection: Table A.2/2 AND Table A.4/8 AND Table A.7/1 AND Table A.7/6
	TC reference: TC_MAC_OBU_BI_03
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows, but introduces a block of 15 subsequent bit errors randomly located in the frame on transmission. The block of bit errors shall be introduced between the end of the start flag and the start of the end flag. 2. Verify IUT does not respond within any of the public uplink windows allocated. 3. Repeat test in case the errors produced a flag or an abort sequence. 	
TP/MAC/OBU/BI/04	Verify that the OBU can detect and manage the abort sequence in the LPDU field of a downlink frame
	Reference: EN 12795 [1], clauses 5.7 and 7.4.3.1.1
	PICS Selection: Table A.2/2 AND Table A.7/1
	TC reference: TC_MAC_OBU_BI_04
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST modified such, that the beaconId contains a sequence of seven consecutive one bits, allocating N5 public uplink windows. The zero-bit insertion shall not be applied to the beaconId field. The FCS shall be correct with respect to the actually transmitted frame. 2. Verify IUT does not respond within any of the public uplink windows allocated. 	
TP/MAC/OBU/BI/05	Verify that the OBU can detect and manage the abort sequence at the end of a downlink frame
	Reference: EN 12795 [1], clauses 5.7 and 7.4.3.1.1
	PICS Selection: Table A.2/2 AND Table A.7/1
	TC reference: TC_MAC_OBU_BI_05
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST modified such, that the end flag is replaced by the abort sequence, allocating N5 public uplink windows. The FCS shall be correct. 2. Verify IUT does not respond within any of the public uplink windows allocated. 	
TP/MAC/OBU/BI/06	Verify that the OBU can detect and manage a downlink frame being too long according to N2
	Reference: EN 12795 [1], clauses 7.3.3, 7.4.3.1.1 d) and annex A
	PICS Selection: Table A.2/2 AND Table A.5/4 AND Table A.7/1 AND Table A.6/7
	TC reference: TC_MAC_OBU_BI_06
	Initial condition: OBU not in sleep mode and not yet initialized
Stimulus and Expected Behaviour:	
<ol style="list-style-type: none"> 1. Tester sends downlink frame containing BST, allocating N5 public uplink windows. The number of profiles in the profilelist shall be such, that the number of octets in the frame just exceeds by one the maximum number of octets allowed as defined by N2. 2. Verify IUT does not respond within any of the public uplink windows allocated. 	