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Intelligent Transport Systems (ITS);
Test specifications for the methods to ensure coexistence of Cooperative ITS G5 with RTTT DSRC;
Part 2: Test Suite Structure and Test Purposes (TSS&TP)

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Contents

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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 2 of a multi-part deliverable covering the test specifications for the methods to ensure coexistence of cooperative ITS G5 with RTTT DSRC, as identified below:

Part 1: "Protocol Implementation Conformance Statement (PICS)";

Part 2: "Test Suite Structure and Test Purposes (TSS&TP)";

Part 3: "Abstract Test Suite (ATS) and partial Protocol Implementation eXtra Information for Testing (PIXIT)".

1 Scope

The present document provides the Test Suite Structure and Test Purposes (TSS&TP) for the test specifications for the methods to ensure coexistence of cooperative ITS G5 with RTTT DSRC as specified in TS 102 792 [i.1] and ES 202 663 [1] in compliance with the relevant requirements and in accordance with the relevant guidance given in ISO/IEC 9646-7 [7] and ETS 300 406 [8].

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI ES 202 663: "Intelligent Transport Systems (ITS); European profile standard for the physical and medium access control layer of Intelligent Transport Systems operating in the 5 GHz frequency band".

[2] ETSI TS 102 916-1: "Intelligent Transport Systems (ITS); Test specifications for the methods to ensure coexistence of Cooperative ITS G5 with RTTT DSRC; Part 1: Protocol Implementation Conformance Statement (PICS)".

[3] CEN/EN 12253: "Road transport and traffic telematics - Dedicated Short Range Communication (DSRC) - Physical layer using microwave at 5,8 GHz".

[4] CEN/EN 13372: "Road transport and traffic telematics - Dedicated Short Range Communication (DSRC) - Profiles for RTTT applications".

[5] CEN/EN 15509: "Road transport and traffic telematics - Electronic fee collection - Interoperability application profile DSRC".

[6] ISO/IEC 9646-1: "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 1: General concepts".

[7] ISO/IEC 9646-7: "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 7: Implementation Conformance Statements".

[8] ETSI ETS 300 406: "Methods for testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

[9] ETSI TS 102 916-3: "Intelligent Transport Systems (ITS); Test specifications for the methods to ensure coexistence of Cooperative ITS G5 with RTTT DSRC; Part 3: Abstract Test Suite (ATS) and partial Protocol Implementation eXtra Information for Testing (PIXIT)".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 102 792: "Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (RTTT DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range".

[i.2] ETSI TR 102 960: "Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (RTTT DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range; Evaluation of mitigation methods and techniques ".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TS 102 792 [i.1], ES 202 663 [1] and the following apply:

Abstract Test Method (ATM): Refer to ISO/IEC 9646-1 [6].

Abstract Test Suite (ATS): Refer to ISO/IEC 9646-1 [6].

Implementation Under Test (IUT): Refer to ISO/IEC 9646-1 [6].

Test Purpose (TP): Refer to ISO/IEC 9646-1 [6].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TS 102 792 [i.1], ES 202 663 [1] and the following apply:

CEN	Comité Européen de Normalisation
DSRC	Dedicated Short Range Communication
ITS	Intelligent Transport System
ITS-G5	Acronym for the 5,9 GHz vehicular adhoc network
OBU	On Board Unit
RSU	Road Side Unit
RX	Receive
TP	Test Purpose
TSS	Test Suite Structure
TX	Transmit

4 Test configurations

Test purposes of the present document address the mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (RTTT DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range. The test configurations defined in TR 102 960 [i.2] apply.

5 Test Suite Structure (TSS)

5.1 Introduction

Test Purposes have been written for mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (RTTT DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range as defined in TS 102 792 [i.1] and ES 202 663 [1]. All test purposes in the present document assess mandatory functionality unless they have been marked with the keyword "OPTIONAL" at the beginning of the TP summary.

The test purposes have been divided according to the functionalities into several groups:

- TP_CAL Calibration Measurements
- TP_COEX_OBU Co-existence Interference Tests OBU

5.1.1 TP naming convention

TPs are numbered, starting at 001, within each group. Groups are organized according to the TSS.

Table 1: TP identifier naming convention scheme

Identifier: **<TP>_<scope>_<iut>_<nnn>**				
<tp>	=	Test Purpose:	fiexd to "TP"	
<scop>	=	group	CAL COEX	Calibration Test Coexistence Test
<iut>	=	type of IUT:	OBU	On Board Unit
<nn>	=	sequential number	(01 to 99)	

5.1.2 Test strategy

As the base standards TS 102 792 [i.1] and ES 202 663 [1] contain no explicit requirements for testing, the TPs were generated as a result of an analysis of the base standard and the PICS specification TS 102 916-1 [2].

5.2 Test Purposes

All PICS items referred to in this clause are as specified in TS 102 916-1 [2] unless indicated otherwise by another numbered reference.

5.2.1 Calibration tests

The calibration tests are the initial measurements to ensure a proper operation of the IUT in different operational stages. The results are used to interpret the evaluation results in the further test purposes.

5.2.1.1 Reference measurement interference signal

In this step the OBU antenna is replaced by a reference RX antenna at the same position. The reference RX antenna is an OBU system only containing an antenna and an antenna port thus having the same antenna pattern as an original functional OBU. The interferer TX antenna system installed in the measurement hall will be fed with a reference continuous ITS-G5 signal of a specific TX power (39 dBm e.i.r.p.) and a centre frequency of 5,880 GHz. The received interference power will be measured at the position of the OBU at the antenna output port. This test is repeated for each angle from 0° to 360° in fix degree steps (e.g. 7,5°).

Identifier:	TD_CAL_01		
Summary:	Interference signal reference measurement at OBU position		
Configuration:	CF#1		
SUT	ITS-G5A		
Specification Reference:	Not applicable		
Pre-test conditions:	• ITS unit sends with fixed duty cycle of 100 % • ITS positioned 10 m from OBU at Φ = 0° (in front of OBU) • ITS antenna position in the same height as OBU • OBU replaced by a measurement receiver antenna (OBU only with antenna and antenna output port) • ITS-G5A Channel: SCCH1 (5,875 GHz to 5,885 GHz)		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS unit sends with 39 dBm e.i.r.p.
	2	action	Measure ITS signal strength at OBU position at the antenna output
	3	action	Record spectrum at the ITS TX output
	4	action	Move ITS antenna system as specified in table 2
	5	loop	Repeat step 2 to 4 until final position reached

Table 2

Test TD_CAL_01 shall be executed with the following value combinations	
Sequence Number	**Position**
Test run 1	Vertical 90 (fixed) Horizontal 0 to 360 Degree step size as by PICS A.3/2 [2]
Test run 2	Horizontal 0 (fixed) Vertical 90 to -90, Degree step size as by PICS A.3/2 [2]
NOTE: "Vertical" corresponds to elevation angle and "Horizontal" to azimuth angle.	

5.2.1.2 Reference measurement CEN DSRC tolling system

The different power levels of the CEN DSRC system will be evaluated. In the further interference evaluation measurement steps the CEN DSRC system will be set into two different operational modes:

- **Mode A:** Typical case with a typical path loss attenuation between RSU and OBU and, e.g. 6 dB above sensitivity limit.
- **Mode B:** Worst case with a path attenuation leading to an operation of the OBU at the sensitivity limit.

Identifier:	TD_CAL_02		
Summary:	CEN DSRC signal reference measurement at OBU position		
Configuration:	CF#2		
SUT	CEN DSRC RSU		
Specification Reference:	CEN EN 12253 [3]		
Pre-test conditions:	• OBU antenna positioned in the middle of the measurement chamber • RSU position around 5 m above reference level and around 5 m away from OBU antenna position		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	RSU unit set to maximum power level (33 dBm e.i.r.p setting)
	2	action	Measure RSU signal strength at OBU antenna position
	3	action	Decrease RSU TX power setting by 1 dB
	4	loop	Repeat step 2 to 3 for OBU antenna output power down to -55 dBm

5.2.1.3 BER reference measurement at the CEN DSRC tolling system with ITS interference

In this reference measurement the dependency of the RSU BER and the ITS interference power will be evaluated using an ITS signal with 100 % duty cycle. The resulting dependency can be used as the reference for further evaluation and as a functional verification of the overall set-up.

Identifier:	TD_CAL_03		
Summary:	CEN DSRC BER reference measurement with ITS interference 100 %		
Configuration:	CF#3		
SUT	CEN DSRC RSU		
Specification Reference:	CEN EN 12253 [3], ES 202 663 [1]		
Pre-test conditions:	• OBU positioned in the middle of the measurement chamber • RSU position around 5 m above reference level and around 5 m away from OBU position • Set RSU – OBU communication in worst case mode (Mode B) • Set RSU – OBU communication into echo mode • Position ITS interference TX in front of the OBU Φ = 0° and θ = 0° (worst case position for passenger car) • ITS-G5A Channel: SCCH1 (5,875 GHz to 5,885 GHz) • CEN DSRC Channel: highest CEN DSRC channel 5,8125 GHz centre frequency and 5,815 GHz upper channel limit.		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS unit sends with 36 dBm e.i.r.p.
	2	action	Measure ITS signal strength at OBU position
	3	action	Record BER of ECHO communication at RSU
	4	action	Decrease ITS TX power by 1 dB
	5	loop	Repeat step 2 to 4 until ITS TX power is < 10 dBm

5.2.2 Measurement 1: OBU sensitivity evaluation

The interfering signal will be fed into the chamber's antenna system and transmitted in the direction of the OBU installed in the reference car positioned on the turntable in the middle of the chamber. The chambers antenna system will be moved 180° or 360°, respectively around the OBU installed in the car. At each position the e.i.r.p. power of the interfering signal will be varied from a low level to the maximum level, e.g. 10 dBm to 33 dBm. The interfering signal activity factor in this measurement will be 100 %. The injected interference signal should behave as if it would be at the worst case distance (5 m) to the OBU. Thus the real TX power values of the ITS interfering source need to be increased by 6 dB in order to account for the real distance of 10 m given by the test setup. The tolling station link will be set into two different operational modes:

- **Mode A:** Typical case with a typical path loss attenuation between RSU and OBU and, e.g. 6 dB above sensitivity limit.
- **Mode B:** Worst case with a path attenuation leading to an operation of the OBU at the sensitivity limit.

The interfering effect at the CEN DSRC tolling station will be evaluated and recorded.

Identifier:	TD_COEX_OBU_01		
Summary:	OBU Interference sensitivity pattern		
Configuration:	CF#3		
SUT	OBU		
Specification Reference:	CEN EN 12253 [3], ES 202 663 [1]		
Pre-test conditions:	• ITS unit sends with fixed duty cycle of 100 % • ITS positioned 10 m from OBU at Φ = 0° (in front of OBU) • ITS antenna position at same height as OBU • OBU positioned in the specified car mounting position • RSU positioned based on typical requirements • Stable communication between RSU and OBU in mode A or B, respectively • ITS-G5A Channel: SCCH1 (5,875 GHz to 5,885 GHz) • CEN DSRC Channel: highest CEN DSRC channel 5,8125 GHz centre frequency and 5,815 GHz upper channel limit.		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS unit sends with initial output power level according to the results of TD_CAL_03
	2	action	Record BER of RSU
	3	verify	IF BER < 10^{-6} Goto step 9 ELSE Continue
	4	action	Decrease ITS power by 3 dB
	5	stimulus	ITS unit sends with decreased power
	6	action	Record BER of RSU
	7	verify	IF ITS power < 10 dBm reached or BER < 10^{-6} Non-interference threshold detected, goto step 9 ELSE Continue
	8	loop	Repeat steps 4 to 7
	9	action	Move ITS clockwise by 7,5° from last position
	10	verify	IF all positions covered (360°) Goto step 12 ELSE Continue
	11	loop	Repeat steps 1 to 9
	12	action	Stop execution

Table 3

Test TD_COEX_OBU_01 shall be executed with the following value combinations		
Sequence Number	**Mode**	**ITS-G5 Transmit Power Range e.i.r.p. in dBm**
Test run 1	Mode A	Initial transmit power increased in steps as by PICS A.3/1 [2]
Test run 2	Mode B	
NOTE: The ITS-G5 transmit power applied at 10 m distance to the CEN DSRC OBU.		

5.2.3 Measurement 2: Single interferer from front

This scenario represents the worst case scenario of the interference set up. In this case the interfering ITS-G5 station will be positioned directly in front of the OBU unit in a distance of 5 m. This represents the case where a car is directly in front of the victim car equipped with a CEN DSRC OBU. In addition to the normal car case where a passenger car is positioned in front of a passenger car, a scenario using OBUs as victims installed in a truck like position will be measured. In this specific measurement the OBU antenna will have no upwards tilt. In the measurement setup the distance will be 10 m and thus a correction factor needs to be taken into account.

5.2.3.1 OBU Interference for different duty cycles, front position

Identifier:	TD_COEX_OBU_02		
Summary:	OBU Interference for different duty cycles, front position		
Configuration:	CF#3		
SUT	OBU		
Specification Reference:	CEN EN 12253 [3], CEN EN 13372 [4], CEN EN 15509 [5], ES 202 663 [1]		
Pre-test conditions:	• ITS unit sends with variable off times (T_{off}) • ITS unit sends with variable packet length • ITS TX power: Level well above recorded interfering level in TD_COEX_OBU_01 (+3 dB) • ITS positioned 10 m from OBU at Φ= 0° (in front of OBU) • ITS TX antenna position at same height as OBU • OBU positioned in the middle of the measurement chamber • RSU positioned based on typical requirements • Stable communication between RSU and OBU (bit error rate approximately 10^{-6}) when ITS interference is inactive • ITS-G5A Channel: SCCH1 (5,875 GHz to 5,885 GHz) • CEN DSRC Channel: highest CEN DSRC channel 5,8125 GHz centre frequency and 5,815 GHz upper channel limit.		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS unit sends with 29 dBm power value based on initial results with fixed on time and initial off time values (see PICS A.3/3 [2])
	2	action	Record number of transactions and measure transaction duration and frame re-transmissions per transaction
	3	verify	Determine Pass criteria per transaction: Transaction is complete Transaction duration < 100 ms (see PIXIT item A.2/3 [9]) Number of empty uplink frames < threshold value (see PIXIT itemA.2/2 [9])
	4	action	Change to next off time value (see PICS A.3/4 [2])
	5	loop	Repeat Step 2 to 4 until all off time values done

5.2.4 Measurement 3: Single ITS-G5A Station installed on rooftop

In this measurement the interference effects of an ITS station mounted on the rooftop of a vehicle is evaluated. The geometry of the measurement has to be chosen in a way that both, the CEN DSRC OBU and the ITS antenna are in the communication zone of the CEN DSRC RSU.

5.2.4.1 OBU Interference power levels, ITS on rooftop

Identifier:	TD_COEX_OBU_03		
Summary:	OBU Interference for different duty cycles, car mounted position		
Configuration:	CF#3		
SUT	OBU		
Specification Reference:	CEN EN 12253 [3], CEN EN 13372 [4], CEN EN 15509 [5], ES 202 663 [1]		
Pre-test conditions:	• ITS unit sends with variable off times (T_{off}) • ITS unit sends with variable packet length • ITS TX power: Level well above recorded interfering level in TD_COEX_OBU_01 (+3 dB) • ITS positioned on the back part of the car roof • OBU positioned at the front window of the car • RSU positioned based on typical requirements • Stable communication between RSU and OBU (bit error rate approximately 10^{-6}) when ITS interference is inactive • ITS-G5A Channel: SCCH1 (5,875 GHz to 5,885 GHz) • CEN DSRC Channel: highest CEN DSRC channel 5,8125 GHz centre frequency and 5,815 GHz upper channel limit.		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS unit sends with 29 dBm power value based on initial results with fixed on time and initial off time values (see PICS A.3/3 [2])
	2	action	Record number of transactions and measure transaction duration and frame re-transmissions per transaction
	3	verify	Determine test verdict based on threshold TER Pass criteria per transaction: Transaction is complete Transaction duration < 100 ms (see PIXIT itemA.2/3 [9]) Number of empty uplink frames < threshold value (see PIXIT itemA.2/2 [9])
	4	action	Change to next off time value (see PICS A.3/4 [2])
	5	loop	Repeat Step 2 to 4 until all off time values done

History

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