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Transport and Traffic Telematics (TTT);
Dedicated Short Range Communication (DSRC)
transmission equipment (500 kbit/s / 250 kbit/s)
operating in the 5 795 MHz to 5 815 MHz frequency band;
Part 2: Harmonised Standard for access to radio spectrum;
Sub-part 1: Road Side Units (RSU)

Reference

REN/ERM-TG37-271

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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.3].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

The present document complies with the Commission Implementing Decision (EU) 2019/1345 [i.1] and CEPT/ERC Recommendation 70-03 [i.2].

The present document is part 2, sub-part 1 of a multi-part deliverable covering Transport and Traffic Telematics (TTT); Dedicated Short Range Communication (DSRC) transmission equipment (500 kbit/s / 250 kbit/s) operating in the 5 795 MHz to 5 815 MHz frequency band, as identified below:

Part 1: "General characteristics and test methods for Road Side Units (RSU) and On-Board Units (OBU)";

Part 2: "Harmonised Standard for access to radio spectrum";

Sub-part 1: "Road Side Units (RSU)";

Sub-part 2: "On-Board Units (OBU)".

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	18 months after doa

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document specifies technical characteristics and methods of measurements for Transport and Traffic Telematics (TTT) systems intended to be operated as Road Side Units (RSU) with the following characteristics:

- with a Radio Frequency (RF) connection and specified antenna or with an integral antenna;
- used for data transmission only;
- operating in the 5 795 MHz to 5 815 MHz frequency band (see also table 1).

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.3] is given in annex A.

2 References

2.1 Normative 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 referenced document (including any amendments) applies.

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

[1] EN 12253:2004: "Road transport and traffic telematics - Dedicated short-range communication - Physical layer using microwave at 5,8 GHz", (produced by CEN).

[2] ISO 14906:2018/AMD 1:2020: "Electronic fee collection -- Application interface definition for dedicated short-range communication -- Amendment 1".

[3] ETSI TS 103 052 (V1.1.1) (03-2011): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".

2.2 Informative 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 referenced document (including any amendments) applies.

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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] Commission Implementing Decision (EU) 2019/1345 of 2 August 2019 amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices.

[i.2] CEPT/ERC Recommendation 70-03 (2020): "Relating to the use of Short Range Devices (SRD)".

[i.3] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.4] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

[i.5] ETSI EG 203 336 (V1.2.1) (05-2020): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.6] CEPT/ERC Recommendation 74-01 (2019): "Unwanted emissions in the spurious domain".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in Directive 2014/53/EU [i.3] and the following apply:

adjacent channel: channel at a distance of 5 MHz relative to the centre frequency, i.e. in the channel at the next upper or lower centre frequency

bit: acronym for "binary digit" which can have one out of two possible values

EXAMPLE: 0/1, or +1/-1, or low/high.

bit rate: number of bits occurring per unit time, usually expressed in bits per second

boresight: direction of maximum radiation of a directional antenna

carrier frequency: frequency f_{Tx} to which the RSU transmitter is tuned

carrier signal or carrier: harmonic signal whose nominal single frequency f_{Tx} is capable of being modulated by a second, symbol-carrying signal

channel: continuous part of the radio-frequency spectrum to be used for a specified emission or transmission

NOTE: A radio-frequency channel may be defined by two specified limits, or by its centre frequency and its bandwidth, or any equivalent indication. It is often designated by a sequential number. A radio-frequency channel may be time-shared in order to allow radio communication in both directions by simplex operation. The term "channel" is sometimes used to denote two associated radio-frequency channels, each of which is used for one of two directions of transmission, i.e. in fact a telecommunication circuit.

co-channel: transmission using the same uplink or downlink channel in a frequency band of 5 MHz width

cross-polar discrimination (XPD): ratio $P_{Rx,LHCP}$ / $P_{Rx,RHCP}$ of power $P_{Rx,LHCP}$ of the received left hand circular polarized wave to the power $P_{Rx,RHCP}$ of the received right hand circular wave when the power of the transmitted waves $P_{Tx,LHCP}$ is equal to $P_{Tx,RHCP}$

downlink: transmission in direction from RSU to OBU

environmental profile: range of environmental conditions under which equipment within the scope of the present document is required to comply with the provisions of the present document

equivalent bandwidth: bandwidth equivalent to the bandwidth of a frequency selective power measurement

equivalent isotropically radiated power (e.i.r.p.): signal power fed into an ideal loss-less antenna radiating equally in all directions that generates the same power flux at a reference distance as the one generated by a signal fed into the antenna under consideration in a predefined direction within its far field region

integral antenna: antenna, with or without a connector, designed as an indispensable part of the equipment

monochromatic signal: sinusoidal signal with fixed frequency

operating frequency: nominal frequency at which equipment is operated

NOTE 1: Also referred to as the operating centre frequency.

NOTE 2: Equipment may be able to operate at more than one operating frequency.

out-of-band emissions: emissions on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process and which cannot be reduced without affecting the corresponding transmission of information, excluding spurious emissions

polarization: locus of the tip of the electrical field vector in a plane perpendicular to the direction of transmission

EXAMPLE: Horizontal and vertical linear polarization.
Left- and right-hand circular polarization.

Portable Equipment (PE): generally intended to be self-contained, free standing and portable

NOTE: A PE would normally consist of a single module, but it may consist of several interconnected modules. It is powered by one or more internal batteries.

radiated measurements: measurements where the coupling to the EUT is obtained by radiation

receive mode: mode, in which the device receives a backscattered signal from an OBU while the device is transmitting at the same time an unmodulated carrier to the OBU

Road Side Unit (RSU): equipment that can communicate with an on board unit

spurious emissions: emissions on a frequency, or frequencies, which are outside an exclusion band of ±2,5 times the channel spacing around the selected centre frequency f_{Tx}, at a level which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

stand-by mode: mode, in which the device may receive DSRC signals, but is never transmitting

transmit mode: mode, in which the device transmits a modulated carrier

unwanted emissions: spurious emissions and out-of-band emissions

uplink: transmission in direction from OBU to RSU

3.2 Symbols

For the purposes of the present document, the following symbols apply:

A_{CW}	Amplitude of CW signal
A_{mod}	Amplitude of modulated signal
ATN_{BLN}	Attenuation of balun
BER	Bit Error Ratio
C_F	Number of frames transmitted
C_E	Number of erroneous frames received
d	Distance between phase centres of transmitting and receiving antenna
$d_{displace}$	Horizontal displacement of TTA and RTA antenna phase centres
D_i	Directivity relative to an isotropic radiator
$D_{0,TA}$	Largest linear dimension of test antenna
$D_{0,EUT}$	Largest linear dimension of EUT antenna
$EIRP_{max}$	Maximum e.i.r.p. of RSU
Δf_{RSU}	Relative frequency error of RSU
ΔP_{drl}	Dynamic range limit
f	Frequency

FER	Frame error ratio
f_{Rx}	Nominal RSU receiver centre frequency
$f_{Rx\ hi}$	Highest operational RSU receiver centre frequency
$f_{Rx\ lo}$	Lowest operational RSU receiver centre frequency
f_s	Nominal OBU sub-carrier frequency
f_{Tx}	Nominal RSU carrier frequency
$f_{Tx,actual}$	Actual centre frequency of the downlink carrier
f_u	Nominal centre frequency of unwanted signal
G_{RSA}	Gain of receiving substitution antenna
G_{RTA}	Gain of receiving test antenna
G_{RTxA}	Gain of RSU transmitting antenna
lg(.)	Logarithm to the base ten
m	Modulation index
N	Total number of transmitted bits within a single frame
P_{acsl}	Receiver adjacent channel selectivity
P_{bl}	Receiver blocking capability
P_{cocr}	Co-channel rejection limit
P_{CW}	Power of CW signal
$P_{Rx,LHCP}$	Signal power of the received left hand circular polarized wave
$P_{Tx,LHCP}$	Signal power of the transmitted left hand circular polarized wave
P_{max}	Maximum receiver input power value for BER ≤ 10^{-6}
P_{min}	Minimum receiver input power value for BER ≤ 10^{-6}
P_{mod}	Power of modulated signal
$P_{Rx,RHCP}$	Signal power of the received right hand circular polarized wave
$P_{Tx,RHCP}$	Signal power of the transmitted right hand circular polarized wave
P_{sens}	Receiver sensitivity limit at the antenna connector of the receiver
P_u	Power level of received unwanted signal referred to a linear polarized antenna
P_w	Signal power of wanted signal
RBW	Resolution bandwidth
RMS	Root mean square
V_{max}	Amplitude of modulated output signal of RSU caused by data bit 1
V_{min}	Amplitude of modulated output signal of RSU caused by data bit 0
α	Tilt angle of test antenna
λ	Wavelength

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in EN 12253 [1], clause 4 and the following apply:

AT1	Attenuator 1
AT2	Attenuator 2
BER	Bit Error Ratio
BST	Beacon Service Table
CC	Coaxial Circulator
CRC	Cyclic Redundancy Checking
CW	Continuous Wave
doa	date of announcement
dop	date of publication
dow	date of withdrawal
DSRC	Dedicated Short Range Communication
e.i.r.p.	equivalent isotropically radiated power also called EIRP, eirp, E.I.R.P.
EC	European Community
EFTA	European Free Trade Association
EUT	Equipment Under Test
FER	Frame Error Ratio

LHCP	Left Hand Circular Polarized
M_{centre}	Centre point between phase centres of TTA and RTA
MSS	Monochromatic Signal Source used to measure the antenna decoupling
MSS1	Monochromatic Signal Source 1 used for generating the unwanted signal
n.a.	not applicable
OBU	On Board Unit
ORxA	On Board Unit Receive Antenna
OTxA	On Board Unit Transmit Antenna
PE	Portable Equipment
PM	Power Meter
ppm	parts per million (10^{-6})
RBW	Resolution BandWidth
RF	Radio Frequency
RRxA	RSU Receiving Antenna
RSA	Receiving Substitution Antenna
RSU	Road Side Unit
RTA	Receiving Test Antenna
RTTT	Road Transport and Traffic Telematics
RTxA	RSU Transmitting Antenna
Rx	Receiver
SA	Spectrum Analyser
SR	Special Report
TM1	Test Message 1
TS1	Test Signal 1
TS2	Test Signal 2
TSM	Transmitter Spectrum Mask
TTA	Transmitting Test Antenna
TTT	Transport and Traffic Telematics
Tx	Transmitter
VBW	Video BandWidth
VST	Vehicle Service Table
VSWR	Voltage Standing Wave Ratio
XPD	Cross-Polar Discrimination

4 Technical requirements specifications

4.1 Units

Transmitters and receivers may be individual or combined units; some units may be transmitter only, some units may be receiver only, and some units may combine transmitter and receiver functionalities.

The antenna is always considered to be part of the EUT.

4.2 General characteristics

4.2.1 RSU classes

For the Transmitter Spectrum Mask (TSM) there are three classes of RSU transmitters which are distinguished by the parameter D2 (point 4) "in band unwanted emissions with modulated carrier wave" of EN 12253 [1], clause 5.2, table 1.

Those TSM classes are called class A, class B and class C. Class A shall not be used.

To distinguish between RSUs built for different communication ranges, RSU receiver sensitivity classes are used. They are called class 1, class 2, class 3 and class 4, and they are specified in table 6.

Receiver sensitivity class 1 is applicable for equipment intended to communicate at a distance shorter than 1 m with a static OBU.

Receiver sensitivity class 2 is applicable for an RSU mounted at medium height, communicating with an OBU moving at medium speed.

Receiver sensitivity class 3 is applicable for an RSU mounted at heights above 5 m, communicating with an OBU at a minimum of 4 m distance along the road moving at medium and high speed.

Receiver sensitivity class 4 is applicable for an RSU mounted at heights above 5 m, communicating with an OBU at a minimum of 8 m distance along the road moving at high speed.

EXAMPLE 1: The receiver sensitivity class 1 is used in OBU programming stations.

EXAMPLE 2: The receiver sensitivity class 2 is used for access systems.

EXAMPLE 3: The receiver sensitivity classes 3 and 4 are used in tolling systems.

4.2.2 Carrier frequencies

The present document applies to RSUs operating in some or all of the channels detailed in table 1.

The centre frequencies f_{Tx} indicated in table 1 are referred to as parameter D1 in EN 12253 [1], clause 5.2, table 1.

Table 1: Frequency bands and centre frequencies f_{Tx} allocated for DSRC

	Pan European Service Frequencies	National Service Frequencies
Channel 1	5,795 GHz to 5,800 GHz, f_{Tx} = 5,7975 GHz	
Channel 2	5,800 GHz to 5,805 GHz, f_{Tx} = 5,8025 GHz	
Channel 3		5,805 GHz to 5,810 GHz, f_{Tx} = 5,8075 GHz
Channel 4		5,810 GHz to 5,815 GHz, f_{Tx} = 5,8125 GHz

NOTE: The corresponding receiver centre frequencies f_{Rx} are equivalent to the transmitter carrier frequencies f_{Tx}.

4.2.3 Modulation

The carrier of frequency f_{Tx}, see table 1, shall be two level amplitude modulated with a modulation index m in the range from 0,5 to 0,9 as defined in EN 12253 [1], clause 5.2, table 1 (parameters D6 and D6a). The modulation index is defined in clause B.4 of annex B.

4.2.4 Antenna characteristic

All RSU antennas shall be LHCP with a cross-polar discrimination (XPD) larger or equal to 15 dB in boresight and larger or equal to 10 dB for a direction with 3 dB less antenna gain than in boresight, as defined in EN 12253 [1], clause 5.2, table 1 (parameters D5 and D5a).

4.3 Testing for compliance with technical requirements

4.3.1 Environmental conditions for testing

Tests defined in the present document shall be carried out at representative points within the boundary limits of the operational environmental profile defined by its intended use, which, as a minimum, shall be that specified in the test conditions contained in the present document.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions as specified in the present document to give confidence of compliance for the affected technical requirements.

4.3.2 Environmental test conditions

4.3.2.1 General

All the tests shall be performed in both normal and extreme test conditions unless otherwise specified.

4.3.2.2 Normal test conditions

Normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity, within the following ranges:

- temperature: +15 ºC to +35 ºC
- relative humidity: 20 % to 75 %

4.3.2.3 Extreme test conditions

For tests at extreme temperatures, measurements shall be made at the lower and upper temperatures of -20 °C and +55 °C.

Under extreme conditions the relative humidity is not applicable.

4.3.3 Power supply

The power supply for testing shall be able to provide the nominal supply voltage range under load as specified in the RSU manual. All characteristics and essential requirements applying to RSUs shall be fulfilled with such a power supply.

4.4 Conformance requirements

4.4.1 General requirements

For an RSU with a transmitter only, the transmitter requirements in clause 4.4.2 shall be applied.

For an RSU with a receiver only, the receiver requirements in clause 4.4.3 shall be applied.

For a combined RSU with a transmitter and a receiver, the transmitter requirements in clause 4.4.2 and the receiver requirements in clause 4.4.3 shall be applied.

4.4.2 Transmitter requirements

4.4.2.1 Maximum equivalent isotropically radiated power

4.4.2.1.1 Definition

The maximum e.i.r.p. is the e.i.r.p. in the direction of maximal radiation of the RSU antenna (boresight).

The maximum e.i.r.p. is defined in EN 12253 [1], clause 5.2, table 1 (parameter D4).

4.4.2.1.2 Limit

For the operation in transmit mode (modulated carrier) and receive mode (unmodulated carrier), the maximum e.i.r.p. shall not exceed the limit of 2 W.

4.4.2.1.3 Conformance

The conformance test for the e.i.r.p. limit is specified in clause 5.2.1.1.