

# ETSI TS 104 022 V1.1.1 (2024-06)



**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;  
performance tests**

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**Reference**

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DTS/ERM-TG37-278

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**Keywords**

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# Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

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# Modal verbs terminology

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# Executive summary

The present document comprises performance test specifications for Transport and Traffic Telematics (TTT) Dedicated Short Range Communication (DSRC) transmission equipment operating in the 5 795 MHz to 5 815 MHz frequency band.

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# 1 Scope

The present document defines the performance test cases for 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.

NOTE: Technical requirements for conformance against article 3.2 of the Radio Equipment Directive [i.1] and related test procedures are defined in in ETSI EN 300 674-2-1 [i.2] and ETSI EN 300 674-2-2 [i.3].

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# 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).

## 2.2 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.

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

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] [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.2] ETSI EN 300 674-2-1 (2022): "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)".
- [i.3] ETSI EN 300 674-2-2 (2019): "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 2: On-Board Units (OBU)".
- [i.4] ISO 14906 (2022): "Electronic fee collection -- Application interface definition for dedicated short-range communication".
- [i.5] EN 13372 (2003): "Road transport and traffic telematics (RTTT). Dedicated short-range communication. Profiles for RTTT applications", (produced by CEN).

- [i.6] EN 12795 (2003): "Road transport and traffic telematics. Dedicated short range communication (DSRC). DSRC data link layer. Medium access and logical link control", (produced by CEN).
- [i.7] EN 12834 (2003): "Road transport and traffic telematics. Dedicated Short Range Communication (DSRC). DSRC application layer", (produced by CEN).
- [i.8] IEC 60721-3-4 (2019): "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 4: Stationary use at non-weather protected locations".
- [i.9] IEC 60721-3-5 (1997): "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 5: Ground vehicle installations".
- [i.10] ETSI TS 103 052: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".

## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

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

**bit:** binary digit

NOTE: It can have one out of two possible values, e.g. 0/1 or +1/-1 or low/high.

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

**bore sight:** direction of maximum radiation of a directional antenna

NOTE: If bore sight cannot be determined unambiguously, then bore sight may be declared by the provider.

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

NOTE: In DSRC, the carrier frequency is in the centre of a channel, see table 2 of the present document.

**carrier signal or carrier:** harmonic signal whose nominal single frequency  $f_{Tx}$  can vary within a range specified by the carrier frequency tolerance and which 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 radiocommunication 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.

**cross-polar discrimination, ellipticity of polarization:** antenna designed to transmit left hand circular waves may transmit some right hand circular waves in addition

NOTE: Cross-Polar Discrimination (XPD) is defined as the ratio PLHCP/PRHCP of power PLHCP of the left hand circular polarized wave to the power PRHCP of the right-hand circular wave when the total power of the transmitted wave is PLHCP + PRHCP.

**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 isotropic radiated power:** 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

**OBU sleep mode:** mode where the OBU can only detect the presence of DSRC down-link signal

NOTE: An OBU may be either in sleep mode, the stand-by mode, or the transmit mode. The sleep mode is an optional mode for battery powered OBUs that allows to save battery power. In this mode, the OBU can only detect the presence of a DSRC down-link signal which under certain defined conditions, see EN 12253 [1], a transition to the stand-by mode is triggered by a wake-up event (detection of a DSRC down-link).

**OBU stand-by mode:** mode in which the OBU is capable of receiving DSRC down-link signals

NOTE: In stand-by mode the OBU is never transmitting.

**operating frequency:** nominal frequency at which equipment is operated; also referred to as the operating centre frequency

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

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

EXAMPLE: The polarization can be horizontal or vertical linear polarized, or left or right-hand circular polarized.

**provider:** manufacturer, supplier, or person responsible for placing the apparatus on the market

**radiated measurements:** measurements which involve the measurement of a radiated electromagnetic field

## 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                                        |
| $ATN_{AT2}$      | Attenuation of attenuator AT2                                        |
| $ATN_{BLN}$      | Attenuation of balun BLN                                             |
| $ATN_{CA1}$      | Attenuation of calibrated coaxial cable 1                            |
| $BER$            | 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         |
| $d_{F1}$         | Distance from transmitting antenna to first Fresnel ellipse          |
| $d_{F2}$         | Distance from first Fresnel ellipse to receiving antenna             |
| $D_{fb}$         | Distance between neighbouring ferrite beads                          |
| $D_i$            | Directivity relative to an isotropic radiator                        |
| $D_{0,TA}$       | Largest linear dimension of test antenna                             |
| $D_{0,EUT}$      | Largest linear dimension of EUT antenna                              |
| $EIRP_{ObuTx}$   | e.i.r.p. generated by the OBU within a single side band              |
| $f$              | Frequency                                                            |
| $FER$            | Frame error ratio                                                    |
| $f_s$            | Nominal OBU sub-carrier frequency                                    |
| $f_{Tx}$         | Nominal RSU carrier frequency                                        |
| $f_u$            | Nominal centre frequency of unwanted signal                          |
| $f_{u1}, f_{u2}$ | Centre frequencies of unwanted signal                                |
| $G_c$            | Conversion gain                                                      |
| $G_{OBU,Rx}$     | Gain of OBU receiving antenna                                        |
| $G_{OBU,Tx}$     | Gain of OBU transmitting antenna                                     |
| $G_{RSA}$        | Gain of receiving substitution antenna                               |

|                     |                                                                                      |
|---------------------|--------------------------------------------------------------------------------------|
| $G_{TA}$            | Gain of test antenna                                                                 |
| $G_{TSA}$           | Gain of transmitting substitution antenna                                            |
| $\lg(.)$            | Logarithm to the base ten                                                            |
| $m$                 | Modulation index                                                                     |
| $N$                 | Total number of transmitted bits within a single frame                               |
| $P_{CW}$            | Power of CW signal                                                                   |
| $P_{D11a}$          | Power limit for communication (upper)                                                |
| $P_{D11b}$          | Power limit for communication (lower)                                                |
| $P_{inc}$           | Incident signal power as received by an ideal isotropic receiving antenna            |
| $P_{inc,dBm}$       | $P_{inc}$ in dBm                                                                     |
| $P_{LHCP}$          | Signal power of left hand circular polarized wave                                    |
| $P_{mod}$           | Power of modulated signal                                                            |
| $P_{MMS2}$          | Output signal power of MSS2                                                          |
| $P_{ObuRx}$         | Incident signal power to OBU, referred to an ideal isotropic receiving antenna       |
| $P_{reTx}$          | Retransmitted signal power                                                           |
| $P_{RSA}$           | Signal power obtained from receiving substitution antenna                            |
| $P_{RHCP}$          | Signal power of right hand circular polarized wave                                   |
| $P_{ssb}$           | Signal power within single side band                                                 |
| $P_u$               | Power of unwanted signal                                                             |
| $RBW$               | Resolution bandwidth                                                                 |
| $T_{CW}$            | Duration of CW signal                                                                |
| $T_{mod}$           | Duration of modulated signal                                                         |
| $V_{max}, V_{min}$  | Maximal amplitude of modulated output signal of RSU caused by data bit 1, or 0       |
| $\alpha$            | Tilt angle of test antenna                                                           |
| $\alpha_{displace}$ | Displacement angle between TTA and RTA                                               |
| $\theta$            | Angle relative to OBU bore sight indicating worst case direction                     |
| $\lambda$           | Wavelength                                                                           |
| $\rho_{RSA}$        | Reflection coefficient at antenna connector of the receiving substitution antenna    |
| $\rho_{TSA}$        | Reflection coefficient at antenna connector of the transmitting substitution antenna |

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### 3.3 Abbreviations

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

General abbreviations:

|          |                                           |
|----------|-------------------------------------------|
| AT1      | Attenuator 1                              |
| AT2      | Attenuator 2                              |
| BER      | Bit Error Ratio                           |
| BLN      | Balun                                     |
| BST      | Beacon Service table                      |
| CA       | Corresponding Antenna                     |
| CC       | Coaxial Circulator                        |
| CEN      | Comité Européen de Normalisation          |
| CRC      | Cyclic Redundancy Checking                |
| CW       | Continuous Wave                           |
| DC       | Direct Current                            |
| DSRC     | Dedicated Short Range Communication       |
| e.i.r.p. | Equivalent Isotropic Radiated Power       |
| EFC      | Electronic Fee Collection                 |
| EU       | European Union                            |
| EUT      | Equipment Under Test                      |
| FCCA     | Ferrited Coaxial CAble                    |
| FCCA1    | Ferrited Coaxial CAble 1                  |
| FER      | Frame Error Ratio                         |
| IEC      | International Electrotechnical Commission |

|                     |                                                   |
|---------------------|---------------------------------------------------|
| ISO                 | International Organization for Standardization    |
| LHCP                | Left Hand Circular Polarized                      |
| LOS                 | Line-Of-Sight                                     |
| LP                  | Linear Polarized                                  |
| Mc                  | Location of the OBU antenna phase centre          |
| M <sub>centre</sub> | Centre point between phase centres of TTA and RTA |
| MSS1                | Monochromatic Signal Source 1                     |
| MSS2                | Monochromatic Signal Source 2                     |
| n.a.                | not applicable                                    |
| OBU                 | On Board Unit                                     |
| PM1                 | Power Meter 1                                     |
| RBW                 | Resolution BandWidth                              |
| RD                  | Receiving Device                                  |
| 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                                          |
| SMS1                | Signal or Message Source 1                        |
| SR                  | Special Report                                    |
| SSB                 | Single Side Band                                  |
| TA                  | Test Antenna                                      |
| TM1                 | Test Message 1                                    |
| TS1                 | Test Signal 1                                     |
| TS2                 | Test Signal 2                                     |
| TSA                 | Transmitting Substitution Antenna                 |
| TTA                 | Transmitting Test Antenna                         |
| TTT                 | Transport and Traffic Telematics                  |
| Tx                  | Transmitter                                       |
| VBW                 | Video BandWidth                                   |
| VST                 | Vehicle Service table                             |
| VSWR                | Voltage Standing Wave Ratio                       |
| XP                  | Cross Polarized                                   |
| XPD                 | Cross-Polar Discrimination                        |

EN 12253 [1] list of down-link parameter abbreviations:

|      |                                       |
|------|---------------------------------------|
| D1   | Carrier frequencies                   |
| D3   | OBU minimum frequency range           |
| D5   | Polarization                          |
| D5a  | Cross polarization                    |
| D6   | Modulation                            |
| D6a  | Modulation index                      |
| D6b  | Eye pattern                           |
| D7   | Data coding                           |
| D8   | Bit rate                              |
| D8a  | Tolerance of bit clock                |
| D9a  | BER for communication                 |
| D11a | Power limit for communication (upper) |
| D11b | Power limit for communication (lower) |
| D12  | Cut-off power level of OBU            |

EN 12253 [1] list of up-link parameter abbreviations:

|     |                                                |
|-----|------------------------------------------------|
| U1  | Sub-carrier frequencies                        |
| U1b | Use of side bands                              |
| U4a | Maximum single side band e.i.r.p. (bore sight) |
| U4b | Maximum single side band e.i.r.p. (35°)        |
| U5  | Up-link polarization                           |

|     |                           |
|-----|---------------------------|
| U5a | Cross polarization        |
| U6  | Sub-carrier modulation    |
| U6b | Eye pattern/duty cycle    |
| U6c | Modulation on carrier     |
| U7  | Data coding               |
| U8  | Bit rate                  |
| U8a | Tolerance of symbol clock |
| U9a | BER for communication     |
| U12 | Conversion gain           |

## 4 General characteristics for testing

### 4.1 Units

Units can be either Road Side Units or On Board Units.

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

### 4.2 Environmental profiles

#### 4.2.1 Environmental profile for testing

The technical requirements of the present document shall apply under the mandatory environmental profile for intended operation of the equipment as specified in clause 4.2.2. The equipment shall always comply with all the technical requirements of the present document when operating within the boundary limits of the mandatory environmental profile.

The provider may additionally select environmental profiles as specified in clause 4.2.3 for testing.

An environmental profile shall include at least the minimum and maximum value of the operational temperature range.

The environmental conditions for tests shall be any convenient selection of environmental parameter values within the selected ranges from clause 4.2.2 and optionally from clause 4.2.3.

#### 4.2.2 Mandatory environmental conditions

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and relative humidity within the following ranges:

- temperature: +15 °C to +35 °C;
- relative humidity: 20 % to 75 %.

#### 4.2.3 Extreme environmental conditions

Extreme environmental conditions are classified in categories according to table 1.

**Table 1: Extreme environmental conditions**

| Temperature category  | RSU                           | OBU                           |
|-----------------------|-------------------------------|-------------------------------|
| Category I (General): | temperature: -20 °C to +55 °C | temperature: -20 °C to +55 °C |
| Category II:          | IEC 60721-3-4 [i.8] / 4K2     | IEC 60721-3-5 [i.9] / 5K2     |
| Category III          | IEC 60721-3-4 [i.8] / 4K3     | IEC 60721-3-5 [i.9] / 5K3     |
| Category IV:          | IEC 60721-3-4 [i.8] / 4K4     | IEC 60721-3-5 [i.9] / 5K4     |