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European Standard (Telecommunications series)

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Short Range Devices;
Road Transport and Traffic Telematics (RTTT);
Short Range Radar equipment operating
in the 77 GHz to 81 GHz band;
Part 1: Technical requirements and methods of measurement**

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

For non EU countries the present document may be used for regulatory (Type Approval) purposes.

Equipment compliant with the present document is intended for fitment into road vehicles, therefore it is subject to automotive EMC type approval and has to comply with Commission Directive 2004/104/EC [i.4]. For use on vehicles outside the scope of Commission Directive 2004/104/EC [i.4] compliance with an EMC directive/standard appropriate for that use is required.

The present document is part 1 of a multi-part deliverable covering Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Road Transport and Traffic Telematics (RTTT); Short Range Radar equipment operating in the 77 GHz to 81 GHz band, as identified below:

- Part 1: "Technical requirements and methods of measurement";**
- Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

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| Date of adoption of this EN: | 16 June 2009 |
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1 Scope

The present document specifies the technical requirements and methods of measurement for Short Range Devices (SRD) working as broadband devices with at least 50 MHz occupied bandwidth in the 77 GHz to 81 GHz frequency range, hereinafter referred to as the 79 GHz range, intended for Road Transport and Traffic Telematics (RTTT) applications. Applications include e.g. Short Range Radar (SRR) for obstacle detection, stop&go, blind spot detection, parking aid, backup aid, precrash and other automotive applications. Applications that might interfere with automotive SRR systems, e.g. road infrastructure systems, are explicitly excluded.

The present document covers transmitters intended to operate in the frequency range as defined in the EC decision 2004/545/EC [i.2] and the ECC decision ECC/DEC/(04)03 [i.1].

The document applies to:

- a) transmitters in the 79 GHz range operating as broadband devices;
- b) receivers operating in the 79 GHz range;
- c) integrated transceivers in the 79 GHz range.

The present document:

- contains the technical characteristics and test methods for short range radar equipment fitted with integral antennas operating in the 79 GHz range;
- covers short range radar vehicle applications in the 79 GHz range. It covers integrated transceivers and separate transmit/receive modules.

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.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
 - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
 - for informative references.

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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] CISPR 16 (2006) (parts 1-1, 1-4 and 1-5): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".

- [2] ETSI TR 102 273 (all parts - V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 2: Anechoic chamber".
- [3] ETSI TR 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

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] ECC decision ECC/DEC/(04)03 of 19 March 2004 on the frequency band 77 - 81 GHz to be designated for the use of Automotive Short Range Radars.
- [i.2] EC decision 2004/545/EC of 8 July 2004 on the harmonization of radio spectrum in the 79 GHz range for the use of automotive short-range radar equipment in the Community.
- [i.3] Radio Regulations: "International Telecommunication Union, Edition of 2004".
- [i.4] Commission Directive 2004/104/EC of 14 October 2004 adapting to technical progress Council Directive 72/245/EEC relating to the radio interference (electromagnetic compatibility) of vehicles and amending Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers.
- [i.5] ETSI EN 302 264-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Road Transport and Traffic Telematics (RTTT); Short Range Radar equipment operating in the 77 GHz to 81 GHz band; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

activity factor: actual on-the-air time divided by active session time or actual on-the-air emission time within a given time window

associated antenna: antenna and all its associated components which are designed as an indispensable part of the equipment

blanking period: time period where either no waveform or a constant waveform within the 79 GHz range occurs

boresight: axis of the main beam in a directional antenna

channel dwell time: accumulated amount of transmission time of uninterrupted continuous transmission within a single given frequency channel and within one channel repetition interval

duty cycle: ratio of the total on time of the "message" to the total off-time in any one hour period

NOTE: The device may be triggered either automatically or manually and depending on how the device is triggered will also depend on whether the duty cycle is fixed or random. The duty cycle is categorized in 4 different duty cycle classes.

Equipment Under Test (EUT): radar sensor including the integrated antenna together with any external antenna components which affect or influence its performance

equivalent isotropically radiated power (e.i.r.p.): total power or power spectral density transmitted, assuming an isotropic radiator

NOTE: e.i.r.p. is conventionally the product of "power or power spectral density into the antenna" and "antenna gain". e.i.r.p. is used for both peak or average power and peak or average power spectral density.

equivalent pulse power duration: duration of an ideal rectangular pulse which has the same content of energy compared with the pulse shape of the EUT with pulsed modulation or on-off gating

on-off gating: methods of transmission with fixed or randomly quiescent period that is much larger than the PRF

operating frequency (operating centre frequency): nominal frequency at which equipment is operated

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

operating frequency range: range of operating frequencies over which the equipment can be adjusted through switching or reprogramming or oscillator tuning

NOTE 1: For pulsed or phase shifting systems without further carrier tuning the operating frequency range is fixed on a single carrier line.

NOTE 2: For analogue or discrete frequency modulated systems (FSK, FMCW) the operating frequency range covers the difference between minimum and maximum of all carrier frequencies on which the equipment can be adjusted.

peak envelope power: mean power (round mean square for sinusoidal carrier wave type) supplied from the antenna during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions (see Radio Regulations [i.3])

Power Spectral Density (PSD): ratio of the amount of power to the used radio measurement bandwidth

NOTE: It is expressed in units of dBm/Hz or as a power in unit dBm with respect to the used bandwidth. In case of measurement with a spectrum analyser the measurement bandwidth is equal the RBW.

precrash: time before the crash occurs when safety mechanism is deployed

Pulse Repetition Frequency (PRF): inverse of the Pulse Repetition Interval, averaged over a time sufficiently long as to cover all PRI variations

Pulse Repetition Interval (PRI): time between the rising edges of the transmitted (pulsed) output power

quiescent period: time instant where no intentional emission occurs

radome: external protective cover which is independent of the associated antenna, and which may contribute to the overall performance of the antenna (and hence, the EUT)

spatial radiated power density: power per unit area normal to the direction of the electromagnetic wave propagation

NOTE: Spatial radiated power density is expressed in units of W/m².

spread spectrum: modulation technique in which the energy of a transmitted signal is spread throughout a larger frequency range

ultra-wideband bandwidth: equipment using ultra-wideband technology means equipment incorporating, as an integral part or as an accessory, technology for short-range radiocommunication, involving the intentional generation and transmission of radio-frequency energy that spreads over a frequency range wider than 50 MHz

3.2 Symbols

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

| | |
|-----------------|-----------------------------|
| λ | Wavelength |
| ac | alternating current |
| B | Bandwidth |
| B _{FH} | Frequency hopping bandwidth |

| | |
|------------------|---|
| d | largest dimension of the antenna aperture |
| D_{fb} | distance of ferrite beads |
| E | Field strength |
| E_o | Reference field strength |
| f_c | Carrier frequency |
| f_{hop} | Hopping frequency |
| f_h | highest frequency |
| f_l | lowest frequency |
| G_a | Antenna gain |
| P_{rad} | Radiated power |
| $P_{PK\ 3\ MHz}$ | Radiated peak power measured in 3 MHz bandwidth |
| P_s | Signal generator power |
| R | Distance |
| R_o | Reference distance |
| Rx | Receiver |
| τ | Pulse width |
| T_{blk} | Blank time period |
| T_c | Chip period |
| T_{dw} | Dwell time |
| T_{fr} | Frame time |
| T_{pw} | Pulse power duration |
| Tx | Transmitter |

3.3 Abbreviations

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

| | |
|----------|---|
| ASK | Amplitude Shift Keying |
| CW | Call Waiting |
| dB | deciBel |
| DC | Direct Current |
| DSB | Dual Side Band |
| DSS | Direct Sequence Signal |
| e.i.r.p. | equivalent isotropically radiated power |
| ECC | Electronic Communications Committee |
| EMC | Electro Magnetic Compatibility |
| ERC | European Radiocommunication Committee |
| EUT | Equipment Under Test |
| FH | Frequency Hopping |
| FMCW | Frequency Modulated Continuous Wave |
| FMICW | Frequency Modulated Interrupted Continuous Wave |
| FSK | Frequency Shift Keying |
| IF | Intermediate Frequency |
| LNA | Low Noise Amplifier |
| PDCF | Pulse Desensitisation Correction Factor |
| PM | Pulse Modulation |
| PN | Pseudo Noise |
| PPM | Pulse Position Modulation (staggered) |
| PRF | Pulse Repetition Frequency |
| PRI | Pulse Repetition Interval |
| PSD | Power Spectral Density |
| PSK | Phase Shift Keying |
| R&TTE | Radio and Telecommunications Terminal Equipment |
| RBW | Resolution BandWidth |
| RF | Radio Frequency |
| RMS | Root Mean Square |
| RTTT | Road Transport and Traffic Telematics |

| | |
|------|------------------------------------|
| SA | Spectrum Analyser |
| SPM | Staggered Pulse Position Modulated |
| SRD | Short Range Device |
| SRR | Short Range Radar |
| VBW | Video BandWidth |
| VSWR | Voltage Standing Wave Ratio |

4 Technical requirements specifications

4.1 Presentation of equipment for testing purposes

Each equipment submitted for testing, where applicable, shall fulfil the requirements of the present document on all frequencies over which it is intended to operate. EMC type approval testing to Commission Directive 2004/104/EC [i.4] shall be done on the vehicle.

The provider shall provide one or more samples of the equipment, as appropriate for testing.

Additionally, technical documentation and operating manuals, sufficient to allow testing to be performed, shall be supplied.

The performance of the equipment submitted for testing shall be representative of the performance of the corresponding production model. In order to avoid any ambiguity in that assessment, the present document contains instructions for the presentation of equipment for testing purposes, conditions of testing (clause 5) and the measurement methods (clauses 7 and 8). Instructions for installation of the equipment in a road vehicle are provided in annex D.

Stand alone equipment submitted for testing shall be offered by the provider complete with any auxiliary equipment needed for testing. The provider shall declare the frequency range(s), the range of operation conditions and power requirements, as applicable, in order to establish the appropriate test conditions.

The EUT will comprise the sensor, antenna and radome if needed and will be tested as a stand alone assembly. The EUTs test fixtures may be supplied by the provider to facilitate the tests (clause 6.1).

These clauses are intended to give confidence that the requirements set out in the document have been met without the necessity of performing measurements on all frequencies.

4.1.1 Choice of model for testing

If an equipment has several optional features, considered not to affect the RF parameters then the tests need only to be performed on the equipment configured with that combination of features considered to be the most complex, as proposed by the provider and agreed by the test laboratory.

4.2 Mechanical and electrical design

The equipment submitted by the provider shall be designed, constructed and manufactured in accordance with good engineering practice and with the aim of minimizing harmful interference to other equipment and services.

Transmitters and receivers may be individual or combination units.

4.3 Auxiliary test equipment

All necessary test signal sources and set-up information shall accompany the equipment when it is submitted for testing.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Testing shall be carried out under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in clauses 5.2 to 5.4.

5.2 External test power source

During tests the power source of the equipment shall be an external test power source, capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.2. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible.

The test voltage shall be measured at the point of connection of the power cable to the equipment.

During tests the external test power source voltages shall be within a tolerance of ± 1 % relative to the voltage at the beginning of each test. The level of this tolerance can be critical for certain measurements. Using a smaller tolerance provides a reduced uncertainty level for these measurements.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

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

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

When it is impracticable to carry out tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

5.3.2 Normal test power source

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment.

5.3.2.1 Mains voltage

The normal test voltage for equipment shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages, for which the equipment was designed.

The frequency of the test power source corresponding to the ac mains shall be between 49 Hz and 51 Hz.

5.3.2.2 Other power sources

For operation from other power sources the normal test voltage shall be that declared by the provider. Such values shall be stated in the test report.