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Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices;
Road Transport and Traffic Telematics (RTTT); Short range radar equipment operating in
the 24 GHz range; Part 1: Technical requirements and methods of measurement

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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 24 GHz range;
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 Directive 95/54/EC [8]. For use on vehicles outside the scope of Directive 95/54/EC [8] 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 24 GHz range, as identified below:

Part 1: "Technical requirements and methods of measurement";

Part 2: "Harmonized EN under article 3.2 of the R&TTE Directive"

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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 500 MHz bandwidth in the 22,000 GHz to 26,625 GHz frequency range intended for Road Transport and Traffic Telematics (RTTT) applications, such as automotive 24 GHz Short Range Radar (SRR) for e.g. obstacle detection, stop and go, blind spot detection, parking aid, backup aid, precrash and other automotive applications.

The present document covers transmitters intended to operate in a temporary frequency designation under the 24 GHz ECC decision ECC/DEC/(04)10 [11]. The application is also subject to the EU Commission decision on 24 GHz SRR EC 2005/50/EC [12].

The present document applies to:

- a) Transmitters in the range from 22,000 GHz to 26,625 GHz operating as broadband devices over the specific bandwidth defined for the individual devices.
- b) Receivers operating in the range from 22,000 GHz to 26,625 GHz.
- c) Integrated transceivers.

The present document contains the technical characteristics and test methods for short range radar equipment fitted with integral antennas.

The present document does not necessarily include all the characteristics which may be required by a user, nor does it necessarily represent the optimum performance achievable.

The present document covers short range radar mobile applications. It covers integrated transceivers and separate transmit/receive modules.

The present document covers only SRR equipment for road vehicles.

The present document complies with field limits for human exposure to electromagnetic fields as provided by the EC Recommendation 1999/519/EC [5] and the methods for compliance demonstration in EN 50371 [13].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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.
- For a non-specific reference, the latest version applies.

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

- [1] CEPT/ERC/REC 70-03: "Relating to the use of Short Range Devices (SRD)".
- [2] CISPR 16 (parts 1-1, 1-4 and 1-5): "Specifications for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [3] CEPT/ERC/REC 01-06: "Procedure for mutual recognition of type testing and type approval for radio equipment".
- [4] ETSI TR 102 273-2: "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".

- [5] Council Recommendation 1999/519/EC on the limitation of exposure of the general public to electromagnetic fields 0 Hz to 300 GHz.
- [6] Void.
- [7] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [8] Commission Directive 95/54/EC of 31 October 1995 adapting to technical progress Council Directive 72/245/EEC on the approximation of the laws of the Member States relating to the suppression of radio interference produced by spark-ignition engines fitted to motor 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.
- [9] ETSI EN 302 288-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Road Transport and Traffic Telematics (RTTT); Short range radar equipment operating in the 24 GHz range; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive".
- [10] CEPT/ERC/REC 74-01: "Unwanted emissions in the spurious domain".
- [11] CEPT/ECC/DEC/(04)10: "ECC Decision of 12 November 2004 on the frequency bands to be designated for the temporary introduction of Automotive Short Range Radars (SRR)". (Amended 2005).
- [12] Commission Decision 2005/50/EC on the harmonization of the 24 GHz range radio spectrum band for the time-limited use by automotive short-range radar equipment in the Community.
- [13] CENELEC EN 50371: "Generic standard to demonstrate the compliance of low power electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (10 MHz - 300 GHz) - General public".

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3 Definitions, symbols and abbreviations

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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

antenna scan duty factor: ratio of the area of the beam (measured at its -3 dB point) to the total area scanned by the antenna (as measured at its -3 dB point)

assigned frequency band: frequency band within which the device is authorized to operate

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

average time: time interval on which a mean measurement is integrated

blanking period: time period where either no waveform or a constant waveform within the 24 GHz SRD band occurs

boresight: axis of the main beam in a directional antenna

channel dwell duty cycle: ratio of the time of uninterrupted continuous transmission within a given frequency channel to the channel repetition interval

NOTE: Channel dwell time/channel repetition interval.

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: the 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 density transmitted, assuming an isotropic radiator

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

far field measurements: measurement at a distance "X" of at least $2d^2/\lambda$, where d is the largest dimension of the antenna aperture of the EUT

maximum safe level for radiated power density: level which can be transmitted in accordance with the current recommended safety levels in Council Recommendation 1999/519/EC [5]

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 (root 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

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 to the RBW.

precrash: time before the crash occurs when safety mechanism are 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

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_0 | 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 |
| $P_{\text{PK 3 MHz}}$ | Radiated peak power measured in 3 MHz bandwidth |
| P_s | Signal generator power |
| R | Distance |
| R_0 | 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 |

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3.3 Abbreviations

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

| | |
|-----------------|---|
| dB | decibel |
| dB _i | gain in decibels relative to an isotropic antenna |
| 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 |
| FHSS | Frequency Hopping Spread Spectrum |
| FMCW | Frequency Modulated Continuous Wave |
| FSK | Frequency Shift Keying |
| IF | Intermediate Frequency |
| LNA | Low Noise Amplifier |
| PDCF | Pulse Desensitization Correction Factor |
| PM | Pulse Modulation |
| PPM | Pulse Position Modulation (staggered) |
| PRF | Pulse Repetition Frequency |
| PRI | Pulse Repetition Interval |
| 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 |
| SNR | Signal to Noise Ratio |
| 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 Directive 95/54/EC [8] 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 ancillary 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 present 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.