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European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Short range radar equipment operating in the 24,05 GHz to 24,25 GHz frequency range for automotive application; Part 1: Technical characteristics and test methods

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

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 needs to comply with Directive 95/54/EC [i.3].

For use on vehicles outside the scope of Directive 95/54/EC [i.3] 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); Road Transport and Traffic Telematics (RTTT); Short range radar equipment operating in the 24,05 GHz to 24,25 GHz frequency range for automotive application, as identified below:

Part 1: "Technical characteristics and test methods";

Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

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):	6 months after doa

1 Scope

The present document specifies the technical requirements and methods of measurement for Short Range Devices (SRD) operating in the 24,05 GHz to 24,25 GHz frequency range intended for Narrow Band Short Range Radar (NB SRR) for Road Transport and Traffic Telematics (RTTT) applications such as Automotive Cruise Control (ACC), Collision Warning, Anti-Collision (AC) systems, obstacle detection, Stop and Go, blind spot detection, parking aid, precrash, backup aid and other safety relevant automotive applications.

The present document contains the technical characteristics and test methods for narrowband short range radar equipment fitted with integral antennas and applies to transmitters and receivers with integral antennas operating in all or part of the range from 24,05 GHz to 24,25 GHz.

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 only NB SRR equipment for vehicles.

The present document complies with field limits for human exposure to electromagnetic fields as provided by the EC Recommendation 1999/519/EC [i.4] and the methods for compliance demonstration in EN 50371 [i.5].

Table 1 shows the frequency bands as designated to narrow band short range radar devices.

Table 1: Narrow band short range radar devices frequency of operation

	Frequency Bands/frequencies	Applications
Transmit and Receive	24,05 GHz to 24,25 GHz	Short range radar for vehicle applications

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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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 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 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[3] ETSI TR 102 273 (V1.2.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

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

[i.2] CEPT/ECC Report #134 on analysis of potential impact of mobile Vehicle Radars (VR) on Radar Speed Meters (RSM) operating at 24 GHz.

[i.3] 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.

[i.4] Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz).

[i.5] CENELEC EN 50371 (2002): "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".

[i.6] CEPT/ERC/REC 74-01: "Unwanted emissions in the spurious domain".

[i.7] ITU-R Recommendation SM.328-10: "Spectra and Bandwidth of Emissions".

[i.8] ITU-R Recommendation SM.329: "Variation of the boundary between the out-of-band and spurious domains".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

boresight: axis of the main beam in a directional antenna

bumper: generally 3D shaped plastic sheet normally mounted in front of the NB SRR

co-located receiver: receiver is located in the same module box as the transmitter

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, whether the duty cycle is fixed or random depends on how the device is triggered.

dwell time: in general, a time interval for which a certain frequency range is occupied

NOTE: "Cumulated dwell time" is the sum of individual dwell times within a measurement time frame and in a defined frequency range.
"Absolute dwell time" is the time from first entrance into a defined frequency range until last exit from a defined frequency range.

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.

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

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

power envelope: power supplied to the antenna by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions

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

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)

3.2 Symbols

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

DT	Dwell Time
E	Field strength
f_c	Carrier frequency
FMCW	Frequency Modulation Continuous Wave (transmission)
G_a	Antenna gain
NB	Narrow Band
P_{rad}	Radiated power
R	Distance
RSM	Radar Speed Meters
R_o	Reference distance
Rx	Receiver
T_{dw}	Dwell time
Tx	Transmitter

3.3 Abbreviations

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

ac	alternating current
AC	Anti-Collision systems
ACC	Automotive Cruise Control,
dB	decibel
DC	Direct Current
DT0	Average dwell time value
e.i.r.p.	equivalent isotropically radiated power
ECC	Electronic Communications Committee
EMC	Electro Magnetic Compatibility
ERC	European Radiocommunication Committee
EUT	Equipment Under Test
FFT	Fast Forward Transfer
FH	Frequency Hopping
f_H	the frequency of the upper marker resulting from the OBW function
f_L	the frequency of the lower marker resulting from the OBW function
FMCW	Frequency Modulated Continuous Wave

IF	Intermediate Frequency
LNA	Low Noise Amplifier
NB SRR	Narrow Band Short Range Radar
OBW	Occupied BandWidth
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
RTTT	Road Transport and Traffic Telematics
Rx	Receiver (Receive)
SA	Spectrum Analyzer
SRD	Short Range Device
Tx	Transmitter
VSWR	Voltage Standing Wave Ratio

4 Equipment under test

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 [i.3] 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 (clause 7). Instructions for installation of the equipment in a road vehicle are provided in annex B.

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 is tested as a stand alone assembly. The EUTs test fixtures may be supplied by the provider to facilitate the tests (clause 6.2).

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.

If an equipment is designed to operate with different powers, measurements of each transmitter parameter shall be performed at the highest power level at which the transmitter is intended to operate.

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.

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.

All measurements shall be preceded by calibrated measurements according to annex A.

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 Test equipment voltage and nominal test 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.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

5.4.1.1 Procedure for tests at extreme temperatures

Before measurements are made, the equipment shall have reached thermal balance in the test chamber. The equipment shall not be switched off during the temperature stabilizing period.

If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or such period as may be decided by the accredited test laboratory, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

5.4.1.2 Extreme temperature ranges

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.4.1.1, at the upper and lower temperatures of one of the following limits:

- Temperature: -20 °C to +55 °C.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

The extreme test voltages for equipment to be connected to an ac mains source shall be the nominal mains voltage ±10 %.

5.4.2.2 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be that declared by the provider. These shall be recorded in the test report.

6 Measurement setup

6.1 Test sites and general arrangements for radiated measurements

Detailed descriptions of the radiated measurement arrangements are included in annex A. In general, measurements shall be carried out under far field conditions. The far field condition for the EUTs is considered to be fulfilled in a minimum radial distance "X" that shall be a minimum of $2d^2/\lambda$, where d is the largest dimension of the antenna aperture of the EUT, for a single device measurement.

Absolute power measurements shall be made using an appropriate method to ensure that the wave front is properly formed (i.e. operating in far field conditions).

6.2 Test fixture

The test fixture may be used to facilitate measurements for equipment having an integral antenna, if required even under extreme conditions. Tests on radiated signals may be carried out using the test fixture. For tests of unwanted emissions in the spurious domain, the test fixture bandwidth shall be used up to 50 GHz. If this is not the case, a radiated measurement according to annex A shall be used.

6.2.1 Characteristics

The fixture is a radio frequency device for coupling the integral antenna of the NB SRR to a 50 Ω RF terminal at all frequencies for which measurements need to be performed.

The test fixture shall be fully described.

In addition, the test fixture shall provide:

a) a connection to an external power supply;

b) a method to provide the input to or output from the equipment. This may include coupling to or from the antenna. The test fixture could also provide the suitable coupling means e.g. for data or video outputs.

The test fixture is normally be supplied by the provider.

The performance characteristics of the test fixture shall be approved by the testing laboratory and shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) adequate bandwidth properties;

c) a coupling loss variation over the frequency range used for the measurement shall not exceed 2 dB;

d) circuitry associated with the RF coupling shall contain no active or non-linear devices;

e) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;

f) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced. Normally, the text fixture is in a fixed position and provides a fixed location for the EUT;

g) the coupling loss shall remain substantially constant when the environmental conditions are varied.

The coupler attenuation of the test-fixture may amount to a maximum of the noise level of the measurement instrument +10 dB. If the attenuation is too high, a linear LNA can be used outside the test-fixture.

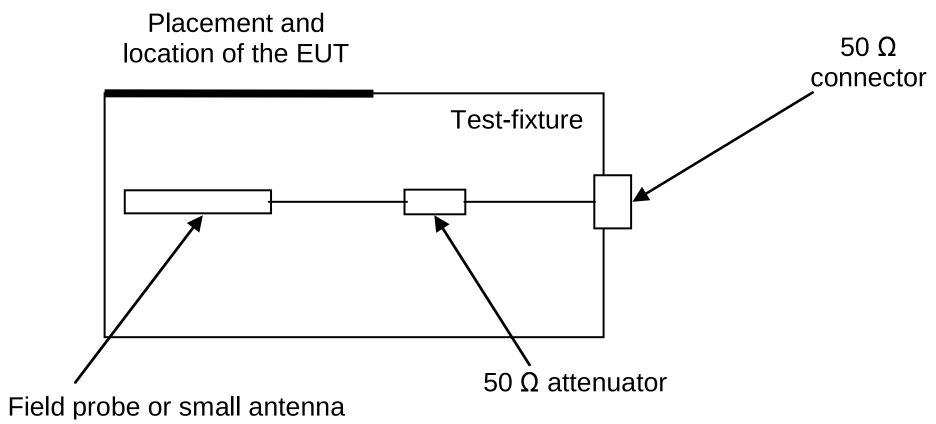

Figure 1: Test fixture

The field probe (or small antenna) needs to be properly terminated.