



**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Short Range Devices;
Transport and Traffic Telematics (TTT);
Radar equipment operating in the 76 GHz to 77 GHz range;
Part 1: Technical characteristics and test methods for
ground based vehicular radar equipment operating
in the 76 GHz to 77 GHz range**

Reference

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Foreword

This draft 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.

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

Where equipment compliant with the present document is intended for fitment into vehicles, then it is subject to automotive EMC type approval under directive 2004/104/EC [i.5]. For use on vehicles outside the scope of 2004/104/EC [i.5] another EMC directive/standard appropriate for that use applies.

The present document is part 1 of a multi-part deliverable covering Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range, as identified below:

- Part 1: **"Technical characteristics and test methods for ground based vehicular radar equipment operating in the 76 GHz to 77 GHz range"**;
- Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Ground based vehicular radar equipment operating in the 76 GHz to 77 GHz range";
- Part 3: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Railway/Road Crossings obstacle detection system applications operating in the 76 GHz to 77 GHz range".

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

Modal verbs terminology

In the present document **"shall"**, **"shall not"**, **"should"**, **"should not"**, **"may"**, **"may not"**, **"need"**, **"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 covers radar applications for ground based vehicle applications in the frequency range from 76 GHz to 77 GHz. It covers integrated transceivers and separate transmit/receive modules.

Also the present document specifies the requirements for Short Range Devices (SRD) intended for the use in ground based vehicles applications such as Adaptive Cruise Control (ACC), Collision Warning (CW), Anti-Collision (AC) systems, obstacle detection, Stop and Go, blind spot detection, parking aid, backup aid and other future applications.

NOTE 1: High safety ratings (e.g. EURO NCAP) can only be obtained if such radar based safety applications are installed in a vehicle. The definition of "ground based vehicle" includes but is not limited to passenger cars, busses, trucks, rail engines, ships, aircraft while taxing.

NOTE 2: EURO ENCAP: Euro NCAP organizes crash-tests and provides motoring consumers with a realistic and independent assessment of the safety performance of some of the most popular cars sold in Europe. Established in 1997, Euro NCAP is composed of seven European Governments as well as motoring and consumer organizations in every European country.

The document applies to:

- equipment with an integral antenna;
- ground based vehicle applications only;
- operating in the frequency range from 76 GHz to 77 GHz.

The present document contains the technical characteristics and test methods for ground based vehicle radar equipment fitted with integral antennas operating in the frequency range from 76 GHz to 77 GHz and references CEPT/ERC/ECC Recommendation 70-03 [i.1], CEPT/ECC Decision (12)04 [i.2] and EC DEC (2011/829/EU) [i.9].

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.

2 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 reference document (including any amendments) applies.

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

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 necessary for the application of the present document.

- [1] CISPR 16: "Specifications for radio disturbance and immunity measuring apparatus and methods".
- [2] ETSI TR 100 028 (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 necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] CEPT/ERC Recommendation 70-03 (24 May 2013): "Relating to the use of Short Range Devices (SRD)", ANNEX 5.
- [i.2] CEPT/ECC/DEC(12)04: "ECC Decision of 02 November 2012 on the withdrawal of ECC Decision (02)01".
- [i.3] COMMISSION IMPLEMENTING DECISION of 11 December 2013 (2013/752/EU) amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2005/928/EC.
- [i.4] CEPT/ERC/Recommendation 74-01: "Unwanted emissions in the spurious domain".
- [i.5] 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.6] ETSI TR 102 704 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Radar sensors for non-automotive; ground based vehicular applications in the 76 GHz to 77 GHz frequency range".
- [i.7] Void.
- [i.8] Void.
- [i.9] EC Decision 2011/829/EU amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices.
- [i.10] 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".
- [i.11] Recommendation ITU-R SM.1754: "Measurement techniques of ultra-wideband transmissions".
- [i.12] CEPT/ERC Recommendation 01-06: "Procedure for mutual recognition of type testing and type approval for radio equipment".
- [i.13] Void.
- [i.14] Recommendation ITU-R SM.329-12 (09/2012): "Unwanted emissions in the spurious domain, SM Series, Spectrum management".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

antenna cycle: one complete sweep of a mechanically or electronically scanned antenna beam along a predefined spatial path

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 no intentional emission occurs

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

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

Equipment Under Test: 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 time gating

far field measurements: measurement where distance should be a minimum of $2d^2/\lambda$, where d = largest dimension of the antenna aperture of the EUT and λ is the operating wavelength of the EUT

ground based vehicle: includes but is not limited to passenger cars, busses, trucks, rail engines, ships, aircraft while taxiing

NOTE: For details see [i.6].

mean power: power supplied from the antenna during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions

NOTE: For pulsed systems the mean power is equal the peak envelope power multiplied by the time gating duty factor. For CW systems without further time gating the mean power is equal the transmission power without modulation.

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

Power Spectral Density: 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.

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

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

quiescent period: time instant where no emission occurs

radiated spurious emissions: emission on a frequency or frequencies which are outside the necessary bandwidth and the level of 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.

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)

spread spectrum modulation: modulation technique in which the energy of a transmitted signal is spread throughout a relatively large portion of the frequency spectrum

steerable antenna: directional antenna which can sweep its beam along a predefined spatial path

NOTE: Steering can be realized by mechanical, electronic or combined means. The antenna beamwidth may stay constant or change with the steering angle, dependent on the steering method.

3.2 Symbols

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

λ	wavelength
λ	1/Prepetition rate of the modulation wave form
ac	alternating current
B	bandwidth
d	largest dimension of the antenna aperture
D	antenna scan duty factor
D_{fb}	distance between ferrite beads
dB	decibel
dBi	gain in decibels relative to an isotropic antenna
df	spectral distance between 2 lines with similar power levels
Δf_{max}	maximum frequency shift between any two frequency steps
Δf_{min}	minimum frequency shift between any two frequency steps
E	field strength
E_o	reference field strength
G	blank time period
P	period of time during in which one cycle of the modulation wave form is completed
P_a	mean power within the BW
P_L	power of an individual spectral line
P_{rad}	radiated power
R	distance
R_o	reference distance
τ	pulse width
T_c	chip period

3.3 Abbreviations

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

AC	Anti-Collision
ACC	Automotive Cruise Control
ASK	Amplitude Shift Keying
CW	Continuous Wave
DSS	Direct Sequence Signal
e.i.r.p.	equivalent isotropically radiated power
ECC	Electronic Communications Committee
EMC	ElectroMagnetic Compatibility

ERC	European Radiocommunication Committee
EUT	Equipment Under Test
FM	Frequency Modulation
FMCW	Frequency Modulated Continuous Wave
FMICW	Frequency Modulated Interrupted Continuous Wave
FSK	Frequency Shift Keying
IF	Intermediate Frequency
NCAP	New Car Assessment Programme
OATS	Open Area Test Site
PN	Pseudo Noise
PRF	Pulse Repetition Frequency
PRI	Pulse Repetition Interval
PSD	Power Spectral Density
R&TTE	Radio and Telecommunications Terminal Equipment
RBW	Resolution Bandwidth
RF	Radio Frequency
RMS	Root Mean Square
RTTT	Road Transport and Traffic Telematics
SRD	Short Range Device
TTT	Transport and Traffic Telematics
Tx	Transmitter
VBW	Video BandWidth
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 Equipment requirements 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 2004/104/EC [i.5] shall be done on the vehicle.

The applicant shall provide at least 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 (see clause 5) and the measurement methods (see clauses 7 and 8).

Stand alone equipment for testing shall be offered by the applicant along 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 (see clause 6.1).

The clauses below 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 separate or a combination units.

4.3 Auxiliary test equipment

All necessary additional test equipment and set-up information shall be prepared and provided when the equipment is submitted for testing.

4.4 Interpretation of the measurement results

The interpretation of the results recorded on the appropriate test report for the measurements described in the present document shall be as follows:

- the measured value relating to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document;
- the measurement uncertainty value for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall, for each measurement, be equal to, or lower than, the figures in the table of measurement uncertainty (see clause 9).

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 to be negligible for its effect on the test results.

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;