



SLOVENSKI STANDARD
SIST EN 301 091 V1.1.1:2003
01-december-2003

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ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Technical characteristics and test methods for radar equipment operating in the 76 GHz to 77 GHz band

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Ta slovenski standard je istoveten z: EN 301 091 Version 1.1.1

ICS:

33.060.99	Druga oprema za radijske komunikacije	Other equipment for radiocommunications
33.100.01	Elektromagnetna združljivost na splošno	Electromagnetic compatibility in general
35.240.60	Uporabniške rešitve IT v transportu in trgovini	IT applications in transport and trade

SIST EN 301 091 V1.1.1:2003 en

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EN 301 091 V1.1.1 (1998-06)

European Standard (Telecommunications series)

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Road Transport and Traffic Telematics (RTTT);
Technical characteristics and test methods
for radar equipment operating in the 76 GHz to 77 GHz band**

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Reference

DEN/ERM-RP08-0401 (a3o00ico.PDF)

Keywords

Radar, radio

ETSI

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Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

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

This present document, together with ETS 300 683, is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Council Directive on the approximation of the laws of the Member States relating to ElectroMagnetic Compatibility ("the EMC Directive") (89/336/EEC as amended).

The technical parameters which are relevant to the ElectroMagnetic Compatibility (EMC) directive are listed in annex C.

Where equipment compliant with the present document is intended for fitment into vehicles, then it is subject to automotive EMC type approval and has to comply with directive 95/54/EC. For use on vehicles outside the scope of 95/54/EC compliance with an EMC directive/standard appropriate for that use is required (e.g. 97/24/EC for 2/3 wheeled vehicles).

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For non-automotive use, compliance with an EMC directive/standard, appropriate for that use is required.

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National transposition dates

Date of adoption of this EN:	19 June 1998
Date of latest announcement of this EN (doa):	30 September 1998
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 1999
Date of withdrawal of any conflicting National Standard (dow):	31 March 1999

Introduction

The present document contains the technical characteristics for radio equipment referencing CEPT/ERC Decision and Recommendations, including TR 01-06 [6].

The present document was drafted on the assumption that type test measurements performed by an accredited test laboratory, will be accepted by the various national regulatory authorities in order to grant type approval, provided the national regulatory requirements are met. This is in compliance with CEPT/ERC Recommendation T/R 01-06 [6].

The present document refers to short range radar systems using specified modulation schemes, and within the band 76 GHz to 77 GHz as specified by ERC/DEC/(92)02 [1].

Full use of the 76 GHz to 77 GHz band is permitted subject to the constraints as defined in clause 7.

There are two "classes" defined within the present document, class 1 and class 2. The single difference between these two classes is the level of permitted transmitted power in the 76 GHz to 77 GHz band.

The present document reflects the potential for the coexistence of the maximum number of systems in the same geographical location, with minimal interference.

For class 1, the mean power density at the carrier frequency does not exceed $0,9 \text{ W} / \text{m}^2$ at 3 m (50 dBm EIRP).

The peak equivalent power density at the carrier frequency does not exceed $3 \text{ W} / \text{m}^2$ at 3 m (55 dBm EIRP).

For class 2, the mean power density at the carrier frequency does not exceed $0,002 \text{ W} / \text{m}^2$ at 3 m (23,5 dBm EIRP).

The peak equivalent power density at the carrier frequency does not exceed $3 \text{ W} / \text{m}^2$ at 3 m (55 dBm EIRP).

In order to permit the greatest freedom of design of equipment, whilst protecting other radio services from disturbance, a balance is required between the permitted range of frequencies on which the equipment may be used, and its frequency stability and modulation characteristics. The present document specifies the operational frequency and bandwidth as covered by ERC/DEC/(92)02 [1].

Clauses 1 to 3 give a general description of the types of equipment covered by the present document and the definitions and abbreviations used. Clause 4 gives general information in order that type tests may be carried out and any markings on the equipment to be provided by the manufacturer.

Clauses 5 and 6 specify the test conditions.

Clause 7 specifies the limits of the parameters which are required to be tested. These limits have been chosen to minimize harmful disturbance to and from other equipment and services. These clauses also specify how the equipment is to be tested and the conditions which are applied.

Clause 8 specifies the maximum measurement uncertainty values.

Annex A provides normative standards concerning test sites for radiated measurements.

Annex B provides general information relating to measurement methods.

Annex C provides information on the technical parameters which need to comply with the EMC Directive.

Annex D is an informative annex relating to the permitted safe levels of radiated power.

Annex E is an informative annex on the equation for the conversion of power density to Equivalent Isotropically Radiated Power (EIRP).

1 Scope

The present document specifies the requirements for a short range 76 GHz to 77 GHz radar intended for Road Transport and Traffic Telematics (RTTT) applications (amongst others), such as Automotive Cruise Control (ACC), Collision Warning (CW) and Anti-Collision (AC) systems for vehicles, and to assure electromagnetic compatibility.

The present document applies to:

- low power motion and distance monitoring radars for mobile and fixed applications; operating on radio frequencies in the 76 GHz to 77 GHz band, with mean power densities of up to $0,9 \text{ W / m}^2$ at 3 m (50 dBm EIRP), and up to 3 W / m^2 peak at 3 m (55 dBm EIRP) for class 1, and mean power densities of up to $0,002 \text{ W / m}^2$ at 3 m (23,5 dBm EIRP), and up to 3 W / m^2 peak at 3m (55 dBm EIRP) for class 2.

It covers the minimum characteristics considered necessary in order to make the best use of the allocated frequency band. It 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 is based upon ERC/DEC/(92)02 [1]. It is a product standard covering various RTTT applications.

The present document covers radars for fixed and mobile applications. It covers integrated transceivers and separate transmit/receive modules.

The present document includes standards for methods of measurement for equipment fitted with associated antenna.

Additional standards or standards may be required for equipment such as that intended for connection to the public or private networks or other systems.

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2 Normative references (standards.iteh.ai)

References may be made to:

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- a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or
- b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or
- c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or
- d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] ERC Decision of 22 October 1992 on the frequency bands to be designated for the co-ordinated introduction of Road Transport Telematic Systems (RTT) (ERC/DEC/(92)02).
- [2] CISPR 16-1: "Specifications for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [3] CISPR 16-2 "Specifications for radio disturbances and immunity measuring apparatus and methods; Part 2: Methods of measurement of disturbance and immunity".
- [4] EN 55022 (1995): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".
- [5] Regulation 95/54/EEC the Automotive EMC Directive.
- [6] ERC/REC Recommendation TR 01-06: "Procedure for mutual recognition of type testing approval for radio equipment".

- [7] ETR 028: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [8] ENV 50166-2 (1995): "Human Exposure to electromagnetic fields High Frequency (10 kHz to 300 GHz)".
- [9] Radio Regulations - International Telecommunication Union Edition of 1990 revised 1994.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

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

mean power: The mean 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, see Radio Regulations [9].

duty factor: The 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).

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

maximum safe level for radiated power density: That level which can be transmitted in accordance with the current recommended safety levels in ENV 50166-2 [8].

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

operating frequency (operating centre frequency): The nominal frequency at which equipment is operated. Equipment may be able to operate at more than one operating frequency.

peak envelope power: The mean power supplied from the antenna during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions, see Radio Regulations [9].

permitted range of operating frequencies: The frequency range over which the approved equipment may operate.

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

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

radiated power density: The power per unit area normal to the direction of the electromagnetic wave propagation. It is expressed in units of W/m^2 .

radiated spurious emissions: Emissions at frequencies other than those of the carrier and sidebands associated with normal modulation.

radome: An 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:

λ	Wavelength
1/P	repetition rate of the modulation wave form
ac	alternating current
B	Bandwidth
BW	resolution bandwidth used in the measurement
d	largest dimension of the antenna aperture
D	Duty factor
df	spectral distance between 2 lines with similar power levels
Δf_{\max}	maximum amplitude of frequency shift between any two frequency steps
E	Field strength
E _o	Reference field strength
G	Blanking period
P	period of time during in which one cycle of the modulation wave form is completed.
P _a	mean power within the BW
PL	power of an individual spectral line
R	Distance
R _o	Reference distance
t	dwelt time
τ	frequency step duration
T	frequency step repetition frequency
T _x	Transmitter

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3.3 Abbreviations (standards.iteh.ai)

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

EIRP	Equivalent Isotropically Radiated Power
EUT	Equipment Under Test
FMCW	Frequency Modulated Carrier Wave
FMICW	Frequency Modulated Interrupted Continuous Wave
FSK	Frequency Shift Keying
IF	Intermediate Frequency
OATS	Open Area Test Site
PRI	Pulse Repetition Interval
PRF	Pulse Repetition Frequency
RF	Radio Frequency
VSWR	Voltage Standing Wave Ratio

4 General

4.1 Presentation of equipment for testing purposes

Each equipment submitted for type testing shall fulfil the requirements of the present document (specifying the relevant equipment part number) over the frequency and in the application for which it is intended to operate. In the case of an automotive application, EMC type approval testing to 95/54/EEC [5] should be done on the vehicle.

The applicant shall complete the appropriate application form when submitting equipment for type testing. Additionally, technical documentation and operating manuals shall also be supplied.

The performance of the equipment submitted for type 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 type testing purposes (subclause 4.1), conditions of testing (clause 5) and the measurement methods (clauses 7 and 8).

Stand alone equipment shall be offered by the applicant complete with any ancillary equipment needed for testing. The applicant 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 equipment shall be complete, and include the associated antenna structure as will be used in its final application. The inclusion of a radome (if appropriate) is optional. If the equipment is qualified with the radome, then the equipment shall only be used with that radome.

Test fixtures may be supplied by the applicant (see subclause 6.1).

Complete sensor modules should be supplied by the manufacturer to facilitate the tests.

If the submitted unit is capable of meeting both class 1 and class 2 of the present document (i.e. has two modes of operation), it should be clearly documented with the necessary information. Such a unit shall be proven against the full Standard in each operating mode.

4.1.1 Choice of model for type testing

The applicant shall provide one or more complete production (or production intent) models of the equipment, as appropriate, for type testing.

Any essential change shall be notified to the approval authority.

If an equipment has optional features which are considered not to affect the Radio Frequency (RF) parameters, then the tests may only be performed on the equipment configured with the combination of features considered to be the most complex (as proposed by the applicant and agreed by the accredited test laboratory).

4.2 Mechanical and electrical design

4.2.1 General

The equipment submitted by the applicant, or his representative, shall be designed, constructed and manufactured in accordance with good engineering practice, and with the aim of minimizing harmful disturbance to other equipment and services.

Transmitters (Tx) and receivers may be individual or combination units.

4.2.2 Controls

Those controls which if maladjusted might increase the interference possibilities to and from the equipment shall only be accessible by partial or complete disassembly of the device and requiring the use of tools. This also applies (if applicable) to the mechanism which selects between class 1 and class 2 as defined in the present document.

4.2.3 Marking (equipment identification)

The equipment shall be marked in a visible place. This marking shall be legible and durable.

4.2.3.1 Equipment identification

The marking shall include as a minimum:

- the name of the manufacturer and/or his trade mark;
- the type designation.

Where this is not possible due to dimension constraints, the documentation which accompanies the equipment shall contain as a minimum, the information required above.