

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Short Range Devices (SRD);
Radio equipment to be used
in the 40 GHz to 246 GHz frequency range;
Part 1: Technical characteristics and
test methods**

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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.

The present document is part 1 of a multi-part deliverable covering Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 40 GHz to 246 GHz frequency range, 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".

For non EEA countries the present document may be used for regulatory (type approval) purposes.

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 applies to the following Short Range Device major equipment types:

- Generic Short Range Devices, including alarms, telecommand, telemetry, data transmission in general, etc.

These radio equipment types are capable of operating in frequency bands within the 40 GHz to 246 GHz range as specified in table 1:

- either with a Radio Frequency (RF) output connection and dedicated antenna or with an integral antenna;
- for all types of modulation.

Table 1 shows a list of the frequency bands as designated in the CEPT/ERC Recommendation 70-03 [i.1] as known at the date of publication of the present document.

NOTE 1: Table 1 represents the most widely implemented position within the CEPT countries [i.1], but it should not be assumed that all designated bands are available in all countries. It is also foreseen that these frequencies may be implemented in [i.3], [i.4], [i.5] in the future.

Table 1: Short Range Devices within the 40 GHz to 246 GHz frequency range

Frequency Bands (Transmit and Receive)	Applications	Notes
57 GHz to 66 GHz	Non-specific SRD	See LS from SRDMG to ETSI ERM [i.7]. Implementation in [i.1] under discussion.
61,0 GHz to 61,5 GHz	Non-specific SRD	
122 GHz to 123 GHz	Non-specific SRD	
244 GHz to 246 GHz	Non-specific SRD	

NOTE 2: In addition, it should be noted that other frequency bands may be available for short range devices in a country within the frequency range 40 GHz to 246 GHz covered by the present document. See the CEPT/ERC Recommendation 70-03 [i.1] or as implemented through National Radio Interfaces (NRI) and additional NRI as relevant.

NOTE 3: On non-harmonized parameters, national administrations may impose certain conditions such as the type of modulation, frequency, channel/frequency separations, maximum transmitter radiated power, duty cycle, and the inclusion of an automatic transmitter shut-off facility, as a condition for the issue of an individual or general licence, or as a condition for the issuing of Individual Rights for use of spectrum or General Authorization, or as a condition for use "under licence exemption" as it is in most cases for Short Range Devices.

The present document covers fixed stations, mobile stations and portable stations.

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 referenced 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 (2006) (parts 1-1, 1-4 and 1-5): "Specification for radio disturbance and immunity measuring apparatus and methods".
- [2] ITU-T Recommendation O.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".
- [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".
- [4] 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 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: "Relating to the use of Short Range Devices (SRD)".
- [i.2] ETSI TS 103 052: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".
- [i.3] European Commission Decision 2006/771/EC of 9 November 2006 on harmonization of the radio spectrum for use by short-range devices.
- [i.4] European Commission Decision 2008/432/EC of 23 May 2008 (amending Decision 2006/771/EC) on harmonization of the radio spectrum for use by short-range devices.
- [i.5] CEPT/ERC Recommendation 74-01: "Unwanted emissions in the spurious domain", Hradec Kralove, 2005.
- [i.6] ITU-R Recommendation P.676-5 (2001): "Attenuation by atmospheric gases".
- [i.7] Liaison statement from SRDMG to ETSI ERM: "LS from CEPT/ECC-SRD/MG to ERM and ERM-TG28 on 57-66 GHz non specific SRDs in Annex 1 of ERC/REC 70-03", DOC number: ERM TG28-23-11, 27.April 2009.
- [i.8] European Commission Decision 2009/381/EC of 13 May 2009 (amending Decision 2006/771/EC) on harmonization of the radio spectrum for use by short-range devices.
- [i.9] ETSI TR 102 215: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Recommended approach, and possible limits for measurement uncertainty for the measurement of radiated electromagnetic fields above 1 GHz".
- [i.10] IEC 60153: "Hollow metallic waveguides".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

alarm: use of radio communication for indicating an alarm condition at a distant location

artificial antenna: non-radiating dummy load equal to the nominal impedance specified by the provider

assigned frequency band: frequency band within which the device is authorized to operate and to perform the intended function of the equipment

Direct Sequence Spread Spectrum (DSSS): form of modulation where a combination of data to be transmitted and a fixed code sequence (chip sequence) is used to directly modulate a carrier, e.g. by phase shift keying

NOTE: The code rate determines the occupied bandwidth.

dedicated antenna: removable antenna supplied and tested with the radio equipment, designed as an indispensable part of the equipment

fixed station: equipment intended for use in a fixed location

Frequency Hopping Spread Spectrum (FHSS): spread spectrum technique in which the transmitter signal occupies a number of frequencies in time, each for some period of time, referred to as the dwell time

NOTE: Transmitter and receiver follow the same frequency hop pattern. The number of hop positions and the bandwidth per hop position determine the occupied bandwidth.

integral antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment

mobile station: equipment normally fixed in a vehicle or used as a transportable station

necessary bandwidth: width of the emitted frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions

NOTE: The necessary bandwidth including the frequency tolerances is accommodated within the assigned frequency band.

occupied bandwidth: width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0,5 % of the total mean power of a given emission

NOTE: This corresponds to the -23 dBc bandwidth of the signal.

operating frequency: nominal frequency at which equipment is operated; this is also referred to as the operating centre frequency

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 tuning, switching or reprogramming

portable station: equipment intended to be carried, attached or implanted

radiated measurements: measurements which involve the absolute measurement of a radiated field

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

unwanted 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: Unwanted emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products.

ultra low power equipment: equipment using transmit envelope power below the receiver and idle/standby transmitter limits given in CEPT/ERC Recommendation 74-01 [i.5], see table 5

3.2 Symbols

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

D_{ant}	Aperture dimension of the radiating antenna
dB	deciBel
dB _i	gain in decibels relative to an isotropic antenna
E	Electrical field strength
E_0	Reference electrical field strength (see annex A)
f	Frequency
P	Power
R	Distance
R_0	Reference distance (see annex A)
t	Time
λ	wavelength

3.3 Abbreviations

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

DSSS	Direct Sequence Spread Spectrum
e.i.r.p.	equivalent isotropical radiated power
EIRP	Equivalent Isotropic Radiated Power
EMC	Electro Magnetic Compatibility
emf	electromagnetic field
ERC	European Radiocommunication Committee
EUT	Equipment Under Test
FH	Frequency Hopping
FHSS	Frequency Hopping Spread Spectrum
FMCW	Frequency Modulated Continuous-wave radar
FSK	Frequency Shift Keying
IF	Intermediate Frequency
ITU-R	International Telecommunications Union, Radio Sector
ITU-T	International Telecommunications Union, Telecommunications Sector
LO	Local Oscillator
NRI	National Radio Interfaces
OATS	Open Area Test Site
OBW	Occupied BandWidth
PDL	Power Density Limit
PRF	Pulse Repitition Frequency
R&TTE	Radio and Telecommunications Terminal Equipment
RBW	Resolution BandWidth
RF	Radio Frequency
RX	Receiver
SRD	Short Range Device
TX	Transmitter
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 General requirements

4.1.1 Receiver category

For SRDs in the scope of the present document, there is no need to distinguish between different receiver categories.

4.2 Presentation of equipment for testing purposes

Equipment submitted for testing, where applicable, shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

Where appropriate, testing shall be carried out on suitable frequencies for the equipment concerned.

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

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

A test fixture for equipment with an integral antenna may be supplied (see clause 6.2).

To simplify and harmonize the testing procedures between the different testing laboratories, measurements shall be performed, according to the present document, on samples of equipment defined in clauses 4.2.1 to 4.2.3.2.

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.

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.

4.2.1 Choice of model for testing

One or more samples of the equipment, as appropriate, shall be tested.

Stand alone equipment shall be tested complete with any ancillary equipment needed for testing.

If 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.

4.2.2 Testing of equipment with alternative power levels

If a family of equipment has alternative output power levels provided by the use of separate power modules or add on stages, or additionally has alternative frequency coverage, then all these shall be declared. Each module or add on stage shall be tested in combination with the equipment. The necessary samples and tests shall be based on the requirements of clause 4.2. As a minimum, measurements of the radiated power (e.i.r.p.) and unwanted emissions shall be performed for each combination and shall be stated in the test report.

4.3 Mechanical and electrical design

4.3.1 General

The equipment tested 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.

4.3.2 Controls

Those controls which, if maladjusted, might increase the interfering potentialities of the equipment shall not be easily accessible to the user.

4.3.3 Transmitter shut-off facility

If the transmitter is equipped with an automatic transmitter shut-off facility, it should be made inoperative for the duration of the test. In the case this not possible, a proper test method shall be described and documented.

4.3.4 Receiver automatic switch-off

If the receiver is equipped with a battery-saving circuit for automatic switch-off, this circuit shall be made inoperative for the duration of the tests. In the case this not possible, a proper test method shall be described and documented.

4.3.5 Marking (equipment identification)

4.3.5.1 Equipment identification

The marking shall include as a minimum:

- the name of the manufacturer or his trademark;
- the type designation.

4.3.5.2 Marking

The equipment shall be marked in a visible place. This marking shall be legible and durable. In cases where the equipment is too small to carry the marking, it is sufficient to provide the relevant information in the users' manual.

4.4 Auxiliary test equipment

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

The following product information shall be provided by the manufacturer:

- the type of modulation technology implemented in the equipment (e.g. FMCW or pulsed);
- the operating frequency range(s) of the equipment;
- the intended combination of the transmitter/transceiver and its antenna and their corresponding e.i.r.p. levels in the main beam;
- the nominal power supply voltages of the radio equipment;
- for FMCW, FH, FSK or similar carrier based modulation schemes, it is important to describe the modulation parameters in order to ensure that the right settings of the measuring receiver are used. Important parameters are the modulation period, deviation or dwell times within a modulation period, rate of modulation (Hz/s);
- the implementation of features such as gating, hopping or stepped frequency hopping;
- the implementation of any mitigation techniques such as duty cycle;
- for pulsed equipment, the Pulse Repetition Frequency (PRF) is to be stated.

4.5 General requirements for RF cables

All RF cables including their connectors at both ends used within the measurement arrangements and set-ups shall be of coaxial or waveguide type featuring within the frequency range they are used:

- a VSWR of less than 1,2 at either end;
- a shielding loss in excess of 60 dB.

When using coaxial cables for frequencies above 40 GHz attenuation features increase significantly and decrease of return loss due to mismatching caused by joints at RF connectors and impedance errors shall be considered.

All RF cables and waveguide interconnects shall be routed suitably in order to reduce impacts on antenna radiation pattern, antenna gain, antenna impedance. Table 2 provides some information about connector systems that can be used in connection with the cables.

Table 2: Connector systems

Connector System	Frequency	Recommended coupling torque
N	18 GHz	0,68 Nm to 1,13 Nm
SMA	18 GHz (some up to 26 GHz)	~0,56 Nm
3,50 mm	26,5 GHz	0,8 Nm to 1,1 Nm
2,92 mm	40 GHz (some up to 46 GHz)	0,8 Nm to 1,1 Nm
2,40 mm	50 GHz (some up to 60 GHz)	0,8 Nm to 1,1 Nm
1,85 mm	65 GHz (some up to 75 GHz)	0,8 Nm to 1,1 Nm

4.6 RF waveguides

Wired signal transmission in the millimeter range is preferably realized by means of waveguides because they offer low attenuation and high reproducibility. Unlike coaxial cables, the frequency range in which waveguides can be used is limited also towards lower frequencies (highpass filter characteristics). Wave propagation in the waveguide is not possible below a certain cutoff frequency where attenuation of the waveguide is very high. Beyond a certain upper frequency limit, several wave propagation modes are possible so that the behaviour of the waveguide is no longer unambiguous. In the unambiguous range of a rectangular waveguide, only H₁₀ waves are capable of propagation.

The dimensions of rectangular and circular waveguides are defined by international standards such as IEC [i.10] for various frequency ranges. These frequency ranges are also referred to as waveguide bands. They are designated using different capital letters depending on the standard. Table 3 provides an overview of the different waveguide bands together with the designations of the associated waveguides and flanges.

For rectangular waveguides, which are mostly used in measurements, harmonic mixers with matching flanges are available for extending the frequency coverage of measuring receivers. Table 3 provides some information on waveguides.