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European Standard (Telecommunications series)

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Short Range Devices (SRD);
Technical characteristics for SRD equipment
using Ultra WideBand technology (UWB);
Object Discrimination and Characterization Applications
for power tool devices operating in the frequency band
from 2,2 GHz to 8,5 GHz;
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).

Equipment covered by the present document operates in accordance with amended ECC Decision of 30 March 2007 on specific Material Sensing devices using Ultra-Wideband (UWB); technology (ECC/DEC/(07)01), amended 26 June 2009 (ECC/DEC/(07)01 [5]).

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

The present document is part 1 of a multi-part deliverable covering Ultra WideBand (UWB) Discrimination and Characterization Applications for power tool devices operating in the frequency band from 2,2 GHz to 8,5 GHz; 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".

Clauses 1 and 3 provide a general description on the types of equipment covered by the present document and the definitions and abbreviations used.

Clauses 4 and 5 provide the technical requirements for the conduction of the tests and information for equipment to be presented.

Clauses 6 and 7 give guidance on the general conditions for testing of the device and the interpretation of results and maximum measurement uncertainty values.

Clause 8 specifies the transmitter spectrum utilization parameters. The clause provides details on how the equipment should be tested and the conditions which should be applied.

Annex A (normative) provides specifications concerning radiated measurements.

Annex B (normative) provides specifications concerning the design requirements.

Annex C (informative) gives information for the measurement antenna and the preamplifier specifications.

Annex D (normative) provides a representative wall definition for emission measurements and the LBT function.

Annex E (informative) Bibliography covers other supplementary information.

National transposition dates

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1 Scope

The present document specifies the requirements for Object Discrimination and Characterization Applications (ODC) for power tool devices using UWB technology operating in all or part of the frequency band from 2,2 GHz to 8,5 GHz. Additionally, it specifies reduced emissions in the ranges from 0,96 GHz to 2,2 GHz and 8,5 GHz to 10,6 GHz.

The present document applies to:

- a) UWB object discrimination and characterisation equipment for imaging and object detection applications;
- b) equipment fitted with an integral antenna;
- c) Two main categories:
 - 1) Category A: user protection in benchtop tools/table saws (quasi fixed sawing equipment).
 - 2) Category B: breakthrough protection in drilling devices.

The present document does not apply to:

- UWB communication devices; and
- Ground penetrating radar devices; and
- through-wall radar imaging devices;
- building material devices;

as defined in ITU-R Recommendation SM.1754 [i.1] and EN 302 435-1 [i.6].

The present document specifies the equipment which is designed to not radiate into the free space. It is designed to function only when positioned such that it radiates directly into:

- a) free space (for category A equipment); or
- b) to the absorptive material such as walls and other building materials which absorb emissions for category B.

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 16-1 (2003): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus".
- [2] ETSI TR 100 028 (all parts) (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

- [3] ETSI TR 102 273 (all parts) (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".
- [4] ANSI C63.5 (2006): "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference (EMI)".
- [5] ECC Decision of 30 March 2007 on specific Material Sensing devices using Ultra-Wideband (UWB) technology (ECC/DEC/(07)01), amended 26 June 2009.

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] ITU-R Recommendation SM.1754: "Measurement techniques of ultra-wideband transmissions".
- [i.2] ITU-R Recommendation SM.1538: "Technical and operating parameters and spectrum requirements for short-range radiocommunication devices".
- [i.3] ETSI TR 102 070-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide to the application of harmonized standards to multi-radio and combined radio and non-radio equipment; Part 2: Effective use of the radio frequency spectrum".
- [i.4] CEPT/ERC/REC 74-01E (2005): "Unwanted emissions in the spurious domain".
- [i.5] CENELEC EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement".
- [i.6] ETSI EN 302 435-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra WideBand technology (UWB); Building Material Analysis and Classification equipment applications operating in the frequency band from 2,2 GHz to 8,5 GHz; Part 1: Technical characteristics and test methods".
- [i.7] "Antenna Pattern Measurement, Theory and Equations", Michael D. Foegelle, ETS Lindgreen, Compliance Engineering, Annual Reference Guide 2002.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

activity factor: effective transmission time ratio, actual on-the-air time divided by active session time or actual on-the-air emission time within a given time window

clutter: undesired radar reflections (echoes) e.g. from inhomogenities, interfaces, gravel stones, cavities in building material structures

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

Listen Before Talk (LBT): mechanism to avoid signal transmission in the presence of other radio service signals

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

quasi fixed: UWB sensor is fixed mounted on a device which cannot moved very quick (stationary)

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

spatial resolution: ability to discriminate between two adjacent targets

SRD: equipment defined to operate on a non-interference, no protection from interference basis (as also defined in ITU-R Recommendation SM.1538 [i.2])

Total Power (TP): integration of the undesired emissions in the whole area around the BM&A-scenario

NOTE: The integration is over a sphere (same procedure as for Total Radiated Power (TRP)). This value is comparable to an equivalent isotropic radiator.

undesired emissions: any emissions into free space during operation of the equipment when equipment is faced to a wall or other absorptive material to be investigated

NOTE: Undesired emissions are:

- leaked emissions from the side or backside of the antenna; and/or
- scattered/reflected emissions from the building material to be investigated; and/or
- residual emissions through the building material.

3.2 Symbols

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

c11	cable loss 1
c12	cable loss 2
dB	deciBel
dB _i	gain in deciBel relative to an isotropic antenna
dB _m	deciBel reference to 1 mW
E	Electrical field strength
E _R	relative dielectric constant of earth materials
E _{rms}	Average electrical field strength measured as root mean square
f	frequency
f _c	frequency at which the emission is the peak power at maximum
GLNA	Gain of the measurement LNA
G _A	Gain of the measurement antenna
G(f)	Antenna gain over frequency
f _H	Highest frequency of the frequency band of operation
f _L	Lowest frequency of the frequency band of operation
P	Power
P _{e.i.r.p.}	spectral power density
P _m	measured spectral power
P _{wall, e.i.r.p.}	undesired spectral power density
P _{victim}	power of a different device at the BMA
R	Distance
rms	Root mean square
t	time
T _P	pulse rise time
Z _{F0}	Free space wave impedance
λ	wavelength
c	velocity of light in a vacuum
δR	range resolution
δt	time interval between the arrivals of two signals from targets separated in range by δR

3.3 Abbreviations

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

BMA	Building Material Analysis
CEPT	Conférence Européenne des administrations de Postes et des Télécommunications
CW	Continuous Wave
DUT	Device Under Test
e.i.r.p.	equivalent isotropically radiated power
ECC	Electronic Communications Committee
EMC	Electro-Magnetic Compatibility
ERC	European Radiocommunication Committee
LBT	Listen Before Talk
LNA	Low Noise Amplifier
OE	Other Emissions
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
SRD	Short Range Device
TE	Total maximum Emissions
TH	ThresHold
TP	Total Power
TPC	Total Power Control
TP-UE	Total Power of Undesired (UWB) Emissions
TRP	Total Radiated Power
UE	Undesired (UWB) Emissions
UMTS	Universal Mobile Telecommunication System
UWB	Ultra WideBand
VBW	Video BandWidth
VSWR	Voltage Standing Wave Ratio

4 Technical requirement specifications

4.1 General requirements

Equipment to be tested against the present document shall be fitted with an integral antenna.

4.2 Presentation of equipment for testing purposes

Each equipment to be tested shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

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 to be tested shall be representative of the performance of the corresponding production model. In order to avoid any ambiguity, the present document contains instructions for the preparation of equipment for testing purposes, conditions of testing (see clause 5) and the measurement methods (see clause 8).

Equipment 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.

4.2.1 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.

4.2.2 Auxiliary test equipment

All necessary set-up information, means for activation and hardware necessary (e.g. standardized wall structure for testing, see annex D) shall accompany the equipment when it is submitted for testing.

4.2.3 Declarations by the provider

The provider shall submit the necessary information regarding the equipment with respect to all technical requirements set by the present document.

4.2.4 Marking and equipment identification

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

The marking shall include as a minimum:

- the name of the manufacturer or his trademark;
- the type designation. This is the manufacturer's numeric or alphanumeric code or name that is specific to particular equipment.

4.3 Mechanical and electrical design

4.3.1 General

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.

4.3.2 Controls

The equipment shall be equipped with controls as defined in annex B.

4.3.3 Transmitter shut-off facility

For the automatic transmitter shut-off facility it shall be possible to disable this feature for the purposes of testing.

Controls for testing purposes, which, if maladjusted, may increase the interfering potential of the equipment, shall not be easily accessible to the user.

4.4 Other device emissions

The equipment may contain digital circuit elements, radio circuit elements and other elements whose performance is not covered by the present document. These elements of the equipment shall meet the appropriate performance requirements for those components, as specified in other standards (EN 55022 [i.5]).

NOTE: For further information on this topic, see TR 102 070-2 [i.3].

5 Test conditions, power sources and ambient temperatures

5.1 Test conditions

Testing shall be performed under normal test conditions. The test conditions and procedures shall be as specified in clauses 5.2 to 5.3.

5.2 Test power source

The equipment shall be tested using the appropriate test power source as specified in clauses 5.2.1 or 5.2.2. Where equipment can be powered using either external or internal power sources, then equipment shall be tested using the external test power source as specified in clause 5.2.1 then repeated using the internal power source as specified in clause 5.2.2.

The test power source used shall be recorded and stated.

5.2.1 External test power source

During tests, the power source of the equipment shall be replaced by an external test power source capable of producing normal test voltages as specified in clause 5.3.2. The internal impedance of the external 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. The external test power source shall be suitably de-coupled and applied as close to the equipment battery terminals as practicable. For radiated measurements any external power leads should be so arranged so as not to affect the measurements.

During tests, the external test power source voltages shall be within a tolerance $< \pm 1$ % relative to the voltage at the beginning of each test.

5.2.2 Internal test power source

For radiated measurements on portable equipment with integral antenna, fully charged internal batteries shall be used. The batteries used should be as supplied or recommended by the provider. If internal batteries are used, at the end of each test the voltage shall be within a tolerance of $< \pm 5$ % relative to the voltage at the beginning of each test.

If appropriate, the external test power source may replace the supplied or recommended internal batteries at the required voltage - this shall be recorded and stated. In this case, the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

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 recorded and stated.