

SLOVENSKI STANDARD
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Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Equipment for Detection and Movement; Tanks Level Probing Radar (TLPR) operating in the frequency bands 5,8 GHz, 10 GHz, 25 GHz, 61 GHz and 77 GHz; Part 1: Technical characteristics and test methods

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European Standard (Telecommunications series)

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Short Range Devices (SRD);
Equipment for Detection and Movement;
Tanks Level Probing Radar (TLPR) operating in the
frequency bands 5,8 GHz, 10 GHz, 25 GHz, 61 GHz and 77 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).

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 Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Equipment for Detection and Movement; Tanks Level Probing Radar (TLPR) operating in the frequency bands 5,8 GHz, 10 GHz, 25 GHz, 61 GHz and 77 GHz, as identified below:

Part 1: "Technical characteristics and test methods";

Part 2: "Harmonized EN under article 3.2 of the R&TTE Directive".

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1 Scope

The present document specifies the requirements for Tank Level Probing Radar (TLPR) applications based on pulse RF, FMCW, or similar wideband techniques, operating in the following frequency bands or part hereof:

- 4,5 GHz to 7 GHz;
- 8,5 GHz to 10,6 GHz;
- 24,05 GHz to 27 GHz;
- 57 GHz to 64 GHz;
- 75 GHz to 85 GHz.

TLPRs are used for tank level measurement applications.

The scope is limited to TLPRs operating as Short Range Devices, in which the devices are installed in closed metallic tanks or reinforced concrete tanks, or similar enclosure structures made of comparable attenuating material, holding a substance, liquid or powder.

The radar applications in the present document are not intended for communications purposes. Their intended usage excludes any intended radiation into free space.

The present document applies to TLPRs radiating RF signals directly from the tank top downwards to the surface of a substance contained in a closed tank. Any radiation outside of the tank is caused by leakage and is considered as unintentional emission. It applies only to TLPRs fitted with dedicated antennas. 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 contains the technical characteristics and test methods for TLPR applications and references CEPT/ERC Recommendation for SRDs, CEPT/ERC Recommendation 70-03 [1].

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2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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.
- For a non-specific reference, the latest version applies.

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

- [1] CEPT/ERC/Recommendation 70-03: "Relating to the use of Short Range Devices (SRD)".
- [2] CISPR 16: "Specification for radio disturbance and immunity measuring apparatus and methods".
- [3] 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".
- [4] ANSI C63.5 (2004): "American National Standard for Electromagnetic Compatibility-Radiated Emission Measurements in Electromagnetic Interference (EMI) Control-Calibration of Antennas (9 kHz to 40 GHz)".

- [5] ETSI TR 102 273 (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".
- [6] ETSI EN 302 372-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Equipment for Detection and Movement; Tanks Level Probing Radar (TLPR) operating in the frequency bands 5,8 GHz, 10 GHz, 25 GHz, 61 GHz and 77 GHz; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

dedicated antenna: antenna that is designed as an indispensable part of the equipment

Device Under Test (DUT): TLPR under test without a test tank

duty cycle: ratio of the total on time of the transmitter to the total time in any one-hour period reflecting normal operational mode

emissions: signals that leaked or are scattered into the air within the frequency range (that includes harmonics) which depend on equipment's frequency band of operation

NOTE: For TLPRs there is no intended emission outside the tank.

Equipment Under Test (EUT): TLPR under test mounted on a test tank

equivalent isotropically radiated power (e.i.r.p.): total power transmitted, assuming an isotropic radiator

NOTE: e.i.r.p. is conventionally the product of "power into the antenna" and "antenna gain". e.i.r.p. is used for both peak and average power.

Frequency Modulated Continuous Wave (FMCW) radar: radar where the transmitter power is fairly constant but possibly zero during periods giving a big duty cycle (such as 0,1 to 1)

NOTE: The frequency is modulated in some way giving a very wideband spectrum with a power versus time variation which is clearly not pulsed.

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

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

pulsed radar (or here simply "pulsed TLPR"): radar where the transmitter signal has a microwave power consisting of short RF pulses

power spectral density (psd): amount of the total power inside the measuring receiver bandwidth expressed in dBm/MHz

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

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

radiation: signals emitted intentionally inside a tank for level measurements

3.2 Symbols

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

f	Frequency
f_C	Frequency at which the emission is the peak power at maximum
f_H	Highest frequency of the frequency band of operation
f_L	Lowest frequency of the frequency band of operation
t	Time
k	Boltzmann constant
T	Temperature
G	Efficient antenna gain of radiating structure
G_a	Declared measurement antenna gain
d	Largest dimension of the antenna aperture of the TLPR
d_1	Largest dimension of the DUT/dipole after substitution (m)
d_2	Largest dimension of the test antenna (m)
D	Duty cycle
D_U	Duty cycle determined by the users transmission time
D_X	Duty cycle determined by the transmitters modulation type
P_s	Output power of the signal generator measured by power meter
Δf	Bandwidth
X	Minimum radial distance (m) between the DUT and the test antenna
λ	Wavelength

3.3 Abbreviations

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

dB	decibel
dB _i	antenna gain in decibels relative to an isotropic antenna
DUT	Device Under Test
e.i.r.p.	equivalent isotropically radiated power
EMC	ElectroMagnetic Compatibility
ERC	European Radiocommunication Committee
EUT	Equipment Under Test
FMCW	Frequency Modulated Continuous Wave
LNA	Low Noise Amplifier
OATS	Open Area Test Site
ppm	parts per million
PRF	Pulse Repetition Frequency
PSD	Power Spectral Density
R&TTE	Radio and Telecommunications Terminal Equipment
RBW	Resolution BandWidth
RF	Radio Frequency
SA	Spectrum Analyser
SRD	Short Range Device
TLPR	Tank Level Probing Radar
Tx	Transmitter
VBW	Video BandWidth
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 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.

The provider shall submit 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 (clause 4), conditions of testing (clauses 5 and 6) and the measurement methods (clause 8).

The provider shall offer equipment complete with any auxiliary equipment needed for testing. The provider shall also submit a suitable test tank, as described in annex E.

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 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 create the highest unintentional emissions outside the tank structure.

In addition, when a device has the capability of using different dedicated antennas, tank connections or other features that affect the RF parameters, at least the worst combination of features from an emission point of view as agreed between the provider and the test laboratory shall be tested.

The choice of model(s) for testing shall be recorded in the test report.

4.3 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.

4.3.1 Marking (equipment identification)

The equipment shall be marked in a visible place. This marking shall be legible and durable. Where this is not possible due to physical constraints, the marking shall be included in the user's manual.

4.3.1.1 Equipment identification

The marking shall include as a minimum:

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

4.4 Auxiliary test equipment

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

4.5 General requirements for RF cables

Due to the low power levels involved in the measurements, 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 nominal characteristic impedance of 50 Ω ;
- a VSWR of less than 1,2 at either end;
- a shielding loss in excess of 60 dB.

4.6 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 measurement uncertainty is explained in clause 7. Additionally, the interpretation of the measured results depending on the measurement uncertainty is described in clauses 4.6.1 and 4.6.2.

4.6.1 Measurement uncertainty is equal to or less than maximum acceptable uncertainty

The interpretation of the results when comparing measurement values with specification limits shall be as follows:

- a) when the measured value does not exceed the limit value the equipment under test meets the requirements of the present document;
- b) when the measured value exceeds the limit value the equipment under test does not meet the requirements of the present document;
- c) the measurement uncertainty calculated by the test technician carrying out the measurement should be recorded in the test report;
- d) the measurement uncertainty calculated by the test technician may be a maximum value for a range of values of measurement, or may be the measurement uncertainty for the specific measurement undertaken. The method used should be recorded in the test report.

4.6.2 Measurement uncertainty is greater than maximum acceptable uncertainty

The interpretation of the results when comparing measurement values with specification limits should be as follows:

- a) when the measured value plus the difference between the maximum acceptable measurement uncertainty and the measurement uncertainty calculated by the test technician does not exceed the limit value the equipment under test meets the requirements of the present document;
- b) when the measured value plus the difference between the maximum acceptable measurement uncertainty and the measurement uncertainty calculated by the test technician exceeds the limit value the equipment under test does not meet the requirements of the present document;
- c) the measurement uncertainty calculated by the test technician carrying out the measurement should be recorded in the test report;