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**Electromagnetic compatibility and
Radio spectrum Matters (ERM); Coastal Surveillance,
Vessel Traffic Systems and Harbour Radars (CS/VTS/HR);
Harmonized EN covering the essential requirements
of article 3.2 of the R&TTE Directive**

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Foreword

This draft Harmonized 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.

The present document has been produced by ETSI in response to mandate M/284 issued from the European Commission issued under Directive 98/34/EC [i.8] as amended by Directive 98/48/EC [i.10].

The title and reference to the present document are intended to be included in the publication in the Official Journal of the European Union of titles and references of Harmonized Standard under the Directive 1999/5/EC [i.1].

See article 5.1 of Directive 1999/5/EC [i.1] for information on presumption of conformity and Harmonised Standards or parts thereof the references of which have been published in the Official Journal of the European Union.

The requirements relevant to Directive 1999/5/EC [i.1] are summarised in annex A.

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):	18 months after doa

Introduction

The present document intends to present a harmonized way of proving compliance to the essential requirements of the R&TTE directive for other important types of radar like Coastal Surveillance (CS), Vessel Traffic Systems (VTS) and possibly harbour radars.

The emission limits implemented arise from ECC/Recommendation (02)05 (2012) [i.4] and ERC/Recommendation 74-01 (2011) [i.5].

The test methods used arise from Recommendation ITU-R M.1177-4 (2011) [i.7] and Recommendation ITU-R SM.1541-4 (2011) [1].

NOTE: The present document is closely related to EN 303 213-6-1 [i.13] which covers essential requirements for radars used in airport SMCGS systems, but which use largely the same type of radar technology.

The present document is part of a set of standards developed by ETSI and is designed to fit in a modular structure to cover all radio and telecommunications terminal equipment within the scope of the R&TTE Directive [i.1]. The modular structure is shown in EG 201 399 [i.9].

1 Scope

The present document applies to X-band radar sensors intended for use in Vessel Traffic Systems (VTS), Coastal Surveillance (CS) or Harbour Radar Systems with the following characteristics:

- Utilizing modulated or unmodulated pulses.
- Transmitter Peak Envelope Power up to 100 kW.
- The transceiver-antenna connection is using a hollow metallic rectangular waveguide.
- The antenna is rotating, waveguide- based and passive.
- At the transceiver output an RF-circulator is used.

NOTE 1: Since transceiver and antenna are hollow metallic rectangular waveguide based, the frequency range for measurements that needs to be addressed covers 6,56 GHz to 26 GHz. The lower limit of this frequency range is obtained as cut-off frequency of the combination of WR112/R84 taper section and a WR90/R100 Waveguide as defined by IEC 60153-2 [i.3]. The upper limit corresponds to the upper limit stated in ERC/Recommendation 74-01 [i.5]. Other types of waveguide may be used by the same principles to obtain complete measurement coverage of the frequency range of the output flange of the equipment under test.

NOTE 2: Since at the transceiver output an RF circulator is used, it is assumed that the transceiver characteristics remain independent from the antenna.

NOTE 3: According to Article 5 of the ITU Radio Regulations [i.6] there are a number of bands between 8,5 GHz and 10 GHz that are allocated to Radiolocation service. There are national deviations to the detailed band usages, but the basic spectrum usage regulation is the same.

Table 1: Radiolocation service frequency bands [GHz]

8 500-8 550
8 550-8 650
8 650-8 750
8 750-8 850
8 850-9 000
9 000-9 200
9 200-9 300
9 300-9 500
9 500-9 800
9 800-9 900
9 900-10 000

The present document is intended to cover the provisions of Directive 1999/5/EC [i.1] (R&TTE Directive), article 3.2, which states that "... *radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference*".

In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of Article 3 of the R&TTE Directive [i.1] may apply to equipment within the scope of the present document.

NOTE: A list of such ENs is included on the web site <http://www.newapproach.org>.

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] Recommendation ITU-R SM.1541-4 (2011): "Unwanted emissions in the out-of-band domain".

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] Directive 1999/5/EC of The European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).
- [i.2] Merrill I. Skolnik: "Radar Handbook", 2nd Edition, McGraw Hill publications.
- [i.3] IEC 60153-2 (Edition 2.0, 1974): "Hollow metallic waveguides. Part 2: Relevant specifications for ordinary rectangular waveguides".
- [i.4] ECC/Recommendation (02)05 (2012): "Unwanted emissions".
- [i.5] ERC/Recommendation 74-01 (2011): "Unwanted emissions in the spurious domain".
- [i.6] ITU Radio Regulations 2012.
- [i.7] Recommendation ITU-R M.1177-4 (2011): "Techniques for measurement of unwanted emissions of radar systems".
- [i.8] Directive 98/34/EC of the European Parliament and of the Council laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on information society services.
- [i.9] ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of Harmonized Standards for application under the R&TTE Directive".
- [i.10] Directive 98/48/EC of the European Parliament and of the Council of 20 July 1998 amending Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations.
- [i.11] ETSI TR 100 028 (all parts) (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [i.12] ETSI TR 100 028-2 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

- [i.13] ETSI EN 303 213-6-1: "Advanced Surface Movement Guidance and Control System (A-SMGCS); Part 6: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for deployed surface movement radar sensors; Sub-part 1: X-band sensors using pulsed signals and transmitting power up to 100 kW".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

NOTE: This definition is taken from ITU Radio Regulation No. 1.152 [i.6] and it applies to a given class of emission.

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 a specified percentage $\beta/2$ of the total mean power of a given emission

NOTE 1: Unless otherwise specified in a Recommendation ITU-R for the appropriate class of emission, the value of $\beta/2$ should be taken as 0,5 %.

NOTE 2: This definition is taken from ITU Radio Regulation No. 1.153 [i.6].

peak envelope power: average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions

NOTE: This definition is taken from ITU Radio Regulation No. 1.157 [i.6]).

pulse duration: time between the 50 % amplitude (voltage) points

pulse rise time: time taken for the leading edge of the pulse to increase from 10 % to 90 % of the maximum amplitude (voltage)

3.2 Symbols

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

B_{-40}	-40 dB bandwidth
B_C	Chirp bandwidth
B_N	Necessary bandwidth
B_{res}	3 dB resolution bandwidth of transceiver
dB_{pp}	dB with respect to peak power
$D_{no\ spur}$	Detectability Factor (function of PD & Pfa)
k	Boltzmann's constant
MDS	Minimum Detectable Signal
NF_{sys}	Noise Figure of the system
PD	Probability of detection
PEP	Peak Envelope Power
Pfa	Probability of false detection
P_t	Pulse power of transmission
t	Time
t_p	Pulse duration
t_r	Pulse rise time
T_0	Temperature in Kelvin
T_C	Chirp length in seconds
λ	Wavelength

3.3 Abbreviations

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

AC	Alternating Current
CS	Coastal Surveillance
FM-CW	Frequency Modulated Continuous Wave
LNA	Low Noise Amplifier
OoB	Out-of-Band
R&TTE	Radio and Telecommunication Terminal Equipment
SMR	Surface Movement Radar
VTS	Vessel Traffic Systems
SMGCS	Surface Movement Guidance and Control System
RF	Radio Frequency
PEP	Peak Envelope Power
FM	Frequency Modulation
MDS	Minimum Detectable Signal

4 Technical requirements

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be stated by the manufacturer.

The equipment shall comply in any of the operating modes with all the technical requirements of the present document at all times when operating within the boundary limits of the stated operational environmental profile.

4.2 Conformance requirements

4.2.1 Operating frequency

4.2.1.1 Definition

The transmitter of a pulsed radar produces microwave pulses, which cause a broad frequency spectrum, depending on the pulse duration.

The operating frequency is to be understood as the frequency of the microwave emission during the transmitting pulse and is represented by the spectral line of highest amplitude.

NOTE: It is only practicable to indicate an operating frequency for radars with unmodulated pulses. In this case a limit for the frequency tolerance is specified. For radars with modulated pulses such a limit is not applicable. In any case the occupied bandwidth is completely contained in the allocated frequency band(s).

4.2.1.2 Limits

The limit for the frequency tolerance applying unmodulated pulses is ± 30 MHz.

For all radar types covered by the present documents the occupied bandwidth of the signal shall be contained completely within the allocated band in use (e.g. 9 200 MHz to 9 500 MHz) in all operating modes.

4.2.1.3 Conformance

Conformance tests as defined in clause 5.3.1 shall be carried out.

4.2.2 Transmitter power

4.2.2.1 Definition

The transmitter power shall be referenced with respect to the output port of the radar transmitter.

The transmitter power of a pulse radar is understood to be the peak pulse envelope (PEP see [i.6] 1.157) power during the transmitted pulse.

If the transmitter power can be varied according to azimuth, the highest PEP value measured during a period equal to at least one rotation period shall be used.

4.2.2.2 Limits

The transmitter power shall be as specified by the manufacturer with an accuracy of at least ± 2 dB under normal operating conditions. The peak power value shall not exceed 100 kW (50 dBW).

4.2.2.3 Conformance

Conformance tests as defined in clause 5.3.2 shall be carried out.

4.2.3 Out-of-band emissions

4.2.3.1 Definition

An important parameter of the Out-of-Band (OoB) emissions mask of the radar is the -40 dB bandwidth. Annex 8 of Recommendation ITU-R SM.1541-4 [1] specifies the -40 dB bandwidth specified for various types of waveforms (e.g. pulsed radar signals). With the following assumptions which apply to most airport surface movement radars these specifications can be further simplified:

- the radar is operating in a band within the limits 8 500 MHz to 10 000 MHz;
- the pulse power is below 100 kW;
- the pulse rise time t_r is greater than $0,0094t$ where t is the pulse duration.

With the aforementioned assumptions the -40 dB bandwidth (B_{-40}) for primary non-FM pulse radars can be determined as follows:

$$B_{-40} = \frac{7.6}{\sqrt{t \times t_r}}$$

Where:

t is the pulse duration

t_r is the rise time in the case of a trapezoidal pulse

NOTE: For typical values of a pulse duration of $t = 50$ ns and a rise time of $t_r = 10$ ns the formula above yields a -40 dB bandwidth value of 340 MHz.

For radars with multiple pulse waveforms, the B_{-40} bandwidth should be calculated for each individual pulse type and the maximum B_{-40} bandwidth obtained shall be used to establish the shape of the emission mask.

For radars with a highly asymmetrical spectrum, the B_{-40} dB bandwidth can be offset from the frequency of maximum emission level, but the necessary bandwidth, B_N and preferably the overall occupied bandwidth should be contained completely within the allocated band as stipulated in section 4 of Annex 8 of Recommendation ITU-R SM.1541-4 [1].