
Elektromagnetna združljivost in zadeve v zvezi z radijskim spektrom (ERM) - Navigacijski radar za uporabo na plovilih brez opreme SOLAS - Harmonizirani EN, ki zajema bistvene zahteve člena 3.2 direktive R&TTE

Electromagnetic compatibility and Radio spectrum Matters (ERM) - Navigation radar for use on non-SOLAS vessels - Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive

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and Radio spectrum Matters (ERM);
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of article 3.2 of the R&TTE Directive**

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Contents

Intellectual Property Rights	5
Foreword.....	5
Introduction	5
1 Scope	6
2 References	6
2.1 Normative references	6
2.2 Informative references	7
3 Symbols and abbreviations.....	7
3.1 Symbols.....	7
3.2 Abbreviations	7
4 Technical requirements	8
4.1 Environmental profile.....	8
4.2 Conformance requirements	8
4.2.1 Radiated emissions	8
4.2.1.1 Definition	8
4.2.1.2 Limits	8
4.2.1.3 Conformance.....	9
4.2.2 Operating frequency	9
4.2.2.1 Definition	9
4.2.2.2 Limits	9
4.2.2.3 Conformance.....	9
4.2.3 Transmitter pulse power	9
4.2.3.1 Definition	9
4.2.3.2 Limits	9
4.2.3.3 Conformance.....	9
4.2.4 Out of band emissions.....	9
4.2.4.1 Definition	9
4.2.4.1.1 Non-FM pulse radar	9
4.2.4.1.2 FM pulse radars	10
4.2.4.1.3 Other modulation formats.....	10
4.2.4.2 Limits	10
4.2.4.2.1 Out of band limits	10
4.2.4.2.2 Out of band limits (excluded types).....	11
4.2.4.3 Conformance.....	11
4.2.5 Radiated spurious emissions	12
4.2.5.1 Definition	12
4.2.5.2 Limits	12
4.2.5.3 Conformance.....	12
5 Testing for compliance with technical requirements.....	12
5.1 Environmental conditions for testing	12
5.1.1 Standard operating mode of the radar equipment	12
5.1.2 Normal test conditions	13
5.1.2.1 Normal temperature and humidity	13
5.1.2.2 Normal test power supply	13
5.1.2.2.1 AC test power supply	13
5.1.2.2.2 DC test power supply	13
5.1.3 Extreme test conditions.....	13
5.1.3.1 Extreme temperatures.....	13
5.1.3.1.1 Indoor unit	13
5.1.3.1.2 Outdoor unit	13
5.1.3.2 Extreme power supply voltage test conditions.....	14
5.2 Interpretation of the measurement results	14
5.3 Essential radio test suites.....	14

5.3.1	Radiated emissions	14
5.3.2	Operating frequency	15
5.3.3	Transmitter pulse power	15
5.3.4	Out of band emissions.....	15
5.3.5	Radiated spurious emissions	16
Annex A (normative):	HS Requirements and conformance Test specifications Table (HS-RTT).....	17
Annex B (normative):	Radiated measurement.....	19
B.1	Test sites and general arrangements for measurements involving the use of radiated fields	19
B.1.1	Anechoic chamber	19
B.1.2	Anechoic chamber with a ground plane	20
B.1.3	OATS	21
B.1.4	Test antenna.....	22
B.1.5	Substitution antenna	22
B.1.6	Measuring antenna	23
B.2	Guidance on the use of radiation test sites	23
B.2.1	Verification of the test site	23
B.2.2	Preparation of the EUT.....	23
B.2.3	Power supplies to the EUT.....	23
B.2.4	Volume control setting for analogue speech tests	23
B.2.5	Range length.....	24
B.2.6	Site preparation	24
Annex C (normative):	Transmission power and unwanted emissions of radar systems; measuring methods.....	26
C.1	Indirect connection via the rotating joint.....	26
C.2	Maximum permitted out of band emissions power levels.....	27
C.3	Maximum permitted spurious emissions power levels.....	27
History	28

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Foreword

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

The present document has been produced by ETSI in response to mandate M/284 issued from the European Commission under Directive 98/34/EC [i.2] as amended by Directive 98/48/EC [i.8].

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 Harmonized 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 summarized in annex A.

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Introduction

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.7].

1 Scope

The present document applies to non-SOLAS radar equipment.

The applicable frequencies of operation of this type of radio equipment are given in table 1. These frequencies are allocated to the radio navigation service, as defined in article 5 of the Radio Regulations [i.6].

Table 1: Radionavigation service frequencies

	Radionavigation service frequencies
Transmit	2 900 MHz to 3 100 MHz
Receive	2 900 MHz to 3 100 MHz
Transmit	9 300 MHz to 9 500 MHz
Receive	9 300 MHz to 9 500 MHz

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>.

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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] CENELEC EN 60945 (Edition 4 - 2002) + Corrigendum 1 (2010): "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".
- [2] Recommendation ITU-R M.1177-4 (2011): "Techniques for measurement of unwanted emissions of radar systems".
- [3] 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] 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.3] ANSI C63.5 (1988): "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference (EMI) Control".
- [i.4] ETSI TR 100 028 (V1.3.1 - all parts): "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [i.5] 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".
- [i.6] ITU Radio Regulations (2012).
- [i.7] 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.8] 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.9] ETSI TR 100 028-2 (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

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3 Symbols and abbreviations

3.1 Symbols

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

B_{-40}	-40 dB bandwidth
P_m	Transmission mean power
P_t	Transmission pulse power
t	Time
t_p	Transmission pulse duration
t_r	Pulse rise time

3.2 Abbreviations

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

AC	Alternating Current
CSP	Channel Spacing
CW	Carrier Wave
DC	Direct Current
EBL	Electronic Bearing Line
EUT	Equipment Under Test
FM	Frequency Modulation

FMCW	Frequency Modulated Carrier Wave
FTC	Fast Time Constant
HS	Harmonized Standard
ITU-R	International Telecommunications Union-Radiocommunications
LNA	Low Noise Amplifier
OATS	Open Area Test Site
OOB	Out Of Band
PEP	Peak Envelope Power
PRT	Pulse Repetition Time
RF	Radio Frequency
RJ	Rotary Joint
SOLAS	Safety Of Life At Sea
STC	Sensitivity Time Control
VRM	Variable Range Marker
VSWR	Voltage Standing Wave Ratio

4 Technical requirements

4.1 Environmental profile

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile which, as a minimum, shall be that specified in the test conditions contained in the present document.

As technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions as specified in the present document to give confidence of compliance for the affected technical requirements (which shall also be within the boundary limits of the declared operational environmental profile).

4.2 Conformance requirements

4.2.1 Radiated emissions

4.2.1.1 Definition

Radiated electromagnetic emissions are to be understood as any signals radiated by the completely assembled and operated radar equipment, other than the operating frequency, with its spectra, which can potentially disturb other equipment on the ship, such as radio receivers or rate of turn indicators.

4.2.1.2 Limits

In the frequency range 150 kHz to 2 GHz, the measured radio frequency field strength at a distance of 3 m caused by the EUT shall not exceed the limits shown in table 2.

Table 2: Radiated electromagnetic emission

Frequency range	Measuring Bandwidth	Limits
150 kHz to 300 kHz	9 kHz	10 mV/m to 316 μ V/m (80 dB μ V/m to 52 dB μ V/m)
300 kHz to 30 MHz	9 kHz	316 μ V/m to 50 μ V/m (52 dB μ V/m to 34 dB μ V/m)
30 MHz to 156 MHz and 165 MHz to 2 GHz	120 kHz	500 μ V/m (54 dB μ V/m)
156 MHz to 165 MHz	9 kHz	16 μ V/m (24 dB μ V/m) quasi peak or 32 μ V/m (30 dB μ V/m) peak

4.2.1.3 Conformance

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

4.2.2 Operating frequency

4.2.2.1 Definition

The transmitter produces short microwave pulses, which causes a broad frequency spectrum, depending on the pulse duration and the pulse repetition frequency. The operating frequency is to be understood as the frequency of the microwave during the transmitting pulse and is represented by the spectral line of highest amplitude.

4.2.2.2 Limits

In all switchable distance ranges and pulse durations the operation frequency of the radar equipment shall have values in the range of 2 900 MHz to 3 100 MHz or 9 300 MHz to 9 500 MHz.

4.2.2.3 Conformance

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

4.2.3 Transmitter pulse power

4.2.3.1 Definition

Transmitter pulse power P_t is to be understood as the mean value of the microwave power during the transmission pulse at the antenna side of the Rotary Joint (RJ). For the arithmetic mean value of the transmitting power, integrated over the PRT, the abbreviation P_m will be used.

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4.2.3.2 Limits

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The transmitter pulse power P_t shall be as specified by the manufacturer +0 dB to -3 dB.

4.2.3.3 Conformance

Conformance tests as defined in clause 5.3.3 shall be carried out.

4.2.4 Out of band emissions

4.2.4.1 Definition

Recommendation ITU-R SM.1541-4 [3] gives guidance to calculate the -40 dB bandwidth and to specify the OOB mask for primary radars in per cent of the -40 dB bandwidth (see figure 1).

4.2.4.1.1 Non-FM pulse radar

The -40 dB bandwidth (B_{-40}) for non-FM pulse radars shall be determined with the following established formula by using the lesser of:

$$B_{-40} = \frac{K}{\sqrt{t \times t_r}} \text{ or } \frac{64}{t}$$

where the coefficient K is 6,2 for radars with output power greater than 100 kW and 7,6 for lower-power radars and radars operating in the radio navigation service in the 2 900 MHz to 3 100 MHz and 9 300 MHz to 9 500 MHz band. The latter expression applies if the rise time t_r is less than about $0,0094t$ when K is 6,2 or about $0,014t$ when K is 7,6.

For ideal rectangular pulses, the spectrum falls off at 20 dB per decade leading to a B_{-40} of $6,4/t$ and a 40 dB bandwidth ten times as large, i.e. $64/t$. To discourage the use of pulses with abrupt rise and fall times, no margin is allowed. The spectra of trapezoidal pulses fall off firstly at 20 dB per decade and then ultimately at 40 dB per decade. If the radio or rise time to pulse duration exceeds 0,008 the 40 dB points will fall on the 40 dB per decade slope, in which case the bandwidth B_{-40} would be:

$$B_{-40} = \frac{5,7}{\sqrt{t \times t_r}}$$

e.g. a radar with a fixed 10 ns rise time would result in bandwidth values as shown in table 3.

Table 3: Examples of -40 dB bandwidth of a primary radar at different pulse durations (rise time = 10 ns)

Pulse duration	-40 dB bandwidth B_{-40}
Short pulse ($t = 50$ ns)	$B_{-40} = 255$ MHz
Medium Pulse ($t = 200$ ns)	$B_{-40} = 127$ MHz
Long Pulse ($t = 500$ ns)	$B_{-40} = 81$ MHz

4.2.4.1.2 FM pulse radars

The -40 dB bandwidth (B_{-40}) for FM pulse radars shall be determined with the following formula:

$$B_{-40} = 1.5 \times \left\{ B_c + \sqrt{\pi} \times [\ln(B_c \times \tau)]^{0.53} \times \left[\text{Min}(B_{rise}, B_{fall}, B_{rise+fall}) + \text{Max}(B_{rise}, B_{fall}, B_{rise+fall}) \right] \right\}$$

Where:

$$B_{rise} = \frac{1}{\sqrt{\tau \times t_r}}$$

$$B_{fall} = \frac{1}{\sqrt{\tau \times t_f}}$$

$$B_{rise+fall} = \frac{1}{\sqrt[3]{\tau \times t_r \times t_f}}$$

B_c = bandwidth of the frequency deviation (total frequency shift during the pulse generation)

τ = pulse length including rise and fall times

And where:

t_r = pulse rise time

t_f = pulse fall time

4.2.4.1.3 Other modulation formats

For all other modulation formats refer to Annex 8 of Recommendation ITU-R SM.1541-4 [3].

4.2.4.2 Limits

4.2.4.2.1 Out of band limits

For all radar types except those excluded in clause 4.2.4.2.2, the roll-off shall be 30dB/decade as shown in figure 1.