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Coastal Surveillance, Vessel Traffic Services and Harbour Radars (CS/VTS/HR);
Harmonised Standard for access to radio spectrum

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Foreword

This draft Harmonised 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 prepared under the Commission's standardisation request C(2015) 5376 final [i.6] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

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

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document specifies technical characteristics and methods of measurements for X-band radar sensors intended for Coastal Surveillance (CS), Vessel Traffic Services (VTS) and harbour surveillance with the following characteristics:

- Operating in the following frequency range:
  - 8 500 MHz to 10 000 MHz utilizing modulated or unmodulated pulses.
- Transmitter Peak Envelope Power up to 100 kW.
- The transmitter output (from power amplifier) towards the antenna uses a hollow metallic rectangular waveguide of type WR90/WG16/R100 according to IEC 60153-2 [i.3] with a minimum length of 92 cm (20 times the wavelength of the waveguide cut-off frequency).
- The antenna is rotating, waveguide-based and passive.
- At the transceiver output an RF-circulator is used.

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.1] is given in annex A.

2 References

2.1 Normative 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 https://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.

The following referenced documents are necessary for the application of the present document.

[1] ECC Recommendation (02)05 (2012): "Unwanted emissions".

[2] ERC Recommendation 74-01 (2019): "Unwanted emissions in the spurious domain".

[3] Recommendation ITU-R M.1177-4 (04/2011): "Techniques for measurement of unwanted emissions of radar systems".

2.2 Informative 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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.2] Merrill I. Skolnik: "Radar Handbook", 2nd Edition, McGraw Hill publications.

[i.3] IEC 60153-2:2016: "Hollow metallic waveguides. Part 2: Relevant specifications for ordinary rectangular waveguides".

[i.4] ETSI EG 203 336: "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.5] Recommendation ITU-R SM.1541-6 (08/2015): "Unwanted emissions in the out-of-band domain".

[i.6] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

[i.7] ITU Radio Regulations (2016).

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

active state: state producing the authorized emission

allocated band: frequency span that regionally or nationally is allocated to one or more radio services on a primary or secondary basis

NOTE: A table of national frequency allocations are normally available from the radio authority for each national state. Also a generic frequency allocation table is available in the ITU Radio Regulations [i.7].

declared band: band or bands within which the product under test is declared to operate in the applicable operating modes

NOTE: The declared band for a given region or country is always contained within the allocated band.

idle/standby state: state where the transmitter is available for traffic, but is not in the active state

Minimum Detectable Signal (MDS): measure of the lowest detectable signal amplitude for a given signal type for a given radar

NOTE: For solid state radars a processing gain can be associated with a received signal. This processing gain has the effect of lowering the MDS level in comparison to a MDS which is based only on noise temperature.

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 for a given class of emission

NOTE: This definition is taken from ITU Radio Regulations [i.7].

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 β/2 of the total mean power of a given emission

NOTE 1: This definition is taken from ITU Radio Regulations [i.7].

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

operating mode: predefined configuration for a given service accessible to the operator of the radar system

NOTE 1: Several operating modes may be available.

NOTE 2: Changing operating mode might affect the radio characteristics of the radar system.

Peak Envelope Power (PEP): 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 Regulations [i.7].

product configuration: hardware variant of the same typology of system under test (e.g. different power outputs, magnetrons)

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)

receiver selectivity: ability of a receiver to detect and decode a desired signal in the presence of an unwanted interfering signal outside the B_{-40} bandwidth.

simple pulse radar: radar using pulsed emissions but not using frequency, phase or power modulation

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/dec	dB per decade
dBpp	dB with respect to peak power
$D_{no\ spur}$	Detectability Factor (function of PD & Pfa)
k	Boltzmann's constant
NF_{sys}	Noise Factor of the system
P_D	Probability of detection
P_{FA}	Probability of false alarm
P_t	Pulse power of transmission
t	Time
t_p	Pulse duration
t_r	Pulse rise time
T_0	Temperature in Kelvin
T_C	Pulse length (of individual chirp) in seconds
λ	Wavelength

3.3 Abbreviations

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

AC	Alternating Current
CS	Coastal Surveillance
CW	Continous Wave
dBm	Power ratio expressed in decibels (dB) with reference to one milliwatt
dBW	Power ratio expressed in decibels (dB) with reference to one Watt
EFTA	European Free Trade Association
EM	ElectroMagnetic
EN	European Norm

FM	Frequency Modulation
HR	HaRbour
kW	kiloWatt
LNA	Low Noise Amplifier
LO	Local Oscillator
MDS	Minimum Detectable Signal
NA	Not Applicable
OoB	Out-of-Band
PEP	Peak Envelope Power
PPI	Plan Position Indicator (Display showing the radar video etc)
ppm	part(s) per million
RF	Radio Frequency
VTS	Vessel Traffic Services
WG	WaveGuide

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use, but as a minimum, shall be that specified in the test conditions contained in the present document. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 Conformance requirements

4.2.1 Transmitter requirements

4.2.1.1 Frequency Accuracy

4.2.1.1.1 Definition

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

The frequency accuracy is the maximum permissible departure by the centre frequency of the frequency band occupied by an emission from the assigned frequency or, by the characteristic frequency of an emission from the reference frequency.

4.2.1.1.2 Limits

The frequency accuracy at the defined operating frequency for radars applying unmodulated pulses shall not exceed 1 250 ppm.

NOTE: This value is defined in appendix 2 of the ITU Radio Regulations [i.7].

4.2.1.1.3 Conformance

The conformance tests are specified in clause 5.2.1.1.

The results obtained shall not exceed the limits specified in clause 4.2.1.1.2.

4.2.1.2 Transmitter power

4.2.1.2.1 Definition

In the present document the transmitter power of a pulse radar is the peak value of the transmitter pulse power during the transmission pulse (PEP) measured at the antenna flange (output port of the transmitter).

4.2.1.2.2 Limits

The transmitter power shall not exceed 100 kW (50 dBW).

4.2.1.2.3 Conformance

The conformance tests are specified in clause 5.2.1.2.

The results obtained shall not exceed the limits specified in clause 4.2.1.2.2.

4.2.1.3 Measured Bandwidth

4.2.1.3.1 Definition

The measured -40 dB bandwidth (B_{-40}) is the measured bandwidth of the emission 40 dB below the measured PEP.

The measured -20 dB bandwidth (B_{-20}) is the measured bandwidth of the emission 20 dB below the measured PEP.

4.2.1.3.2 Limits

For radar types using a modulated pulse the measured -40 dB bandwidth of the signal shall be contained completely within the declared band in all operating modes.

In case of multiple carrier-frequencies, all measured -40 dB emissions shall be contained within the declared band.

For magnetron radars the measured -20 dB bandwidth of the signal shall be contained completely within the declared band. In case of multiple carrier-frequencies magnetron radars, all measured -20 dB emissions shall be contained within the declared band.

NOTE: Magnetron radars will not be able to fit the -40 dB bandwidth within the band due to the physical properties of this technology and the requirements for the minimal operational performance.

4.2.1.3.3 Conformance

The conformance tests are specified in clause 5.2.1.3.

The results obtained shall not exceed the limits specified in clause 4.2.1.3.2.

4.2.1.4 Out-of-band emissions

4.2.1.4.1 Definition

Out-of-Band emissions refer to emissions in the region between the calculated -40 dB bandwidth and the spurious region (see definition of spurious region in clause 4.2.1.5.1).

The Out-of-Band emission limits and the spurious emission limits are defined based on the calculated -40 dB bandwidth. Annex C contains the applicable formulae for calculating the -40 dB bandwidth.

For radars with multiple carrier frequencies, the overall emission mask is obtained by superimposing the emission masks of each individual carrier frequency. An example can be seen in figure 1.

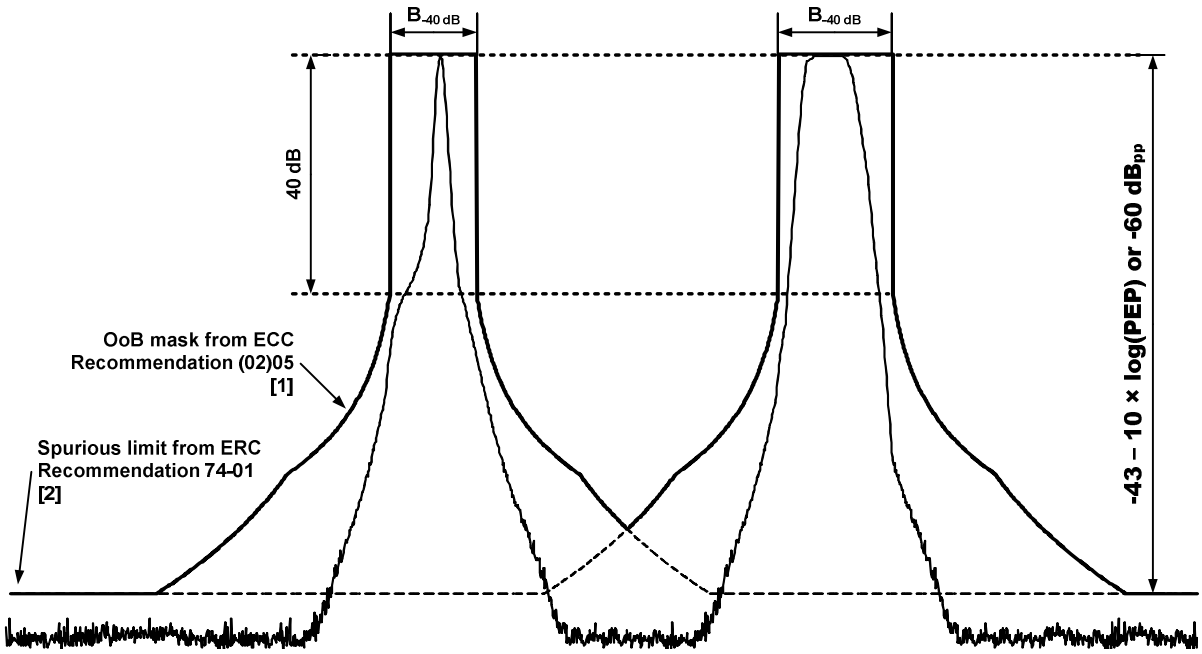

Figure 1: Example of superimposed (combined) mask from two carrier frequencies

4.2.1.4.2 Limits

The limits for the OoB spectrum mask shall be as specified in annex 2 of ECC Recommendation (02)05 [1].

The Out-of-Band emission limits are defined based on the -40 dB bandwidth (B_{-40}). The Out of Band mask rolls off at 30 dB per decade, from the B_{-40} bandwidth to the level specified for spurious emissions.

For multi-frequency/frequency diversity and active array radars spurious emission limits shall be 43 + 10log (PEP) or 60 dB_{pp} (whichever is less stringent) as specified in table 15 of ERC Recommendation 74-01 [2] and in table 1.

Table 1: Limits for unwanted emissions for multiple frequency and active arrays

Frequency offset relative to B_{-40}	Limit dB_{pp}	Slope dB/decade
0,5 to 2,3	-40 to -43 - 10 × log(PEP) / -60 (see note)	-30
NOTE: From -40 to -43 - 10 × log(PEP) or -60 whichever is less stringent.		

For all other radar systems spurious emission limits shall be -30 dBm or 100 dB_{pp} (whichever is less stringent) as specified in table 15 of ERC Recommendation 74-01 [2] and in table 2.

Table 2: Limits for unwanted emissions for all other radar systems

Frequency offset relative to B_{-40}	Limit dB_{pp}	Slope dB/decade
0,5 to 5	-40 to -70 dB	-30
5 to 15,8	-70 to -100 dB / -30 dBm (see note)	-60
NOTE: From -70 to -100 dB or -30 dBm whichever is less stringent.		

Example of the unwanted emission mask per table 2 is shown in figure 2.