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Navigation radar for use on non-SOLAS vessels;
Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] 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.

National transposition dates	
Date of adoption of this EN:	31 October 2016
Date of latest announcement of this EN (doa):	31 January 2017
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 July 2017
Date of withdrawal of any conflicting National Standard (dow):	31 July 2018

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 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 ITU Radio Regulations [i.2].

Table 1: Radio navigation service frequencies

	Radio navigation 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 contains requirements to demonstrate that radio equipment both effectively uses and supports the efficient use of radio spectrum in order 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 of Directive 2014/53/EU [i.1] may apply to equipment within the scope of the present document.

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 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.

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

[1] IEC 62388:2013/COR1:2014: "Corrigendum 1 - Maritime navigation and radiocommunication equipment and systems - Shipborne radar - Performance 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.1541-6 (2015): "Unwanted emissions in the out-of-band domain".

[4] ETSI TS 103 052 (V1.1.1) (03-2011): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".

[5] CISPR 16-1-1:2015: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".

[6] CISPR 16-1-4:2010+AMD1:2012: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements".

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] ITU Radio Regulations (2016).

[i.3] ETSI TR 100 028-1 (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1".

[i.4] 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".

[i.5] 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.6] Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment and repealing Council Directive 96/98/EC.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

non SOLAS: equipment not proscribed under the SOLAS Convention and not subject to the Marine Equipment Directive 2014/90/EU [i.6]

radar cross-section: cross-section determining the power density returned to the radar for a particular power density incident on a target

radar echo: signal reflected by a target to a radar antenna that appears in the radar video signal and radar image

3.2 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

3.3 Abbreviations

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

AC	Alternating Current
CISPR	Comité International Spécial des Perturbations Radioélectriques
CW	Carrier Wave
DC	Direct Current
EBL	Electronic Bearing Line
EFTA	European Free Trade Association
EN	European Norm
EUT	Equipment Under Test
FM	Frequency Modulation
FMCW	Frequency Modulated Carrier Wave
FTC	Fast Time Constant
IEC	International Electrotechnical Committee
ITU-R	International Telecommunications Union - Radiocommunications
LNA	Low Noise Amplifier
NM	Nautical Mile
OOB	Out Of Band
PEP	Peak Envelope Power
PRT	Pulse Repetition Time
RCS	Radar Cross-Section
RF	Radio Frequency
RJ	Rotary Joint
SOLAS	Safety Of Life At Sea
STC	Sensitivity Time Control
VRM	Variable Range Marker

4 Testing for compliance with technical requirements

4.1 Environmental conditions for testing

4.1.0 General

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

4.1.1 Standard operating mode of the radar equipment

Unless otherwise stated the radar equipment shall be set to the standard operating mode which is understood to be as follows:

Operation state: transmitting with antenna turning;

Antenna height: 15 m;

Pulse Width: shortest;

TUNE setting: optimal;

GAIN setting: optimal;

STC setting: off;

FTC setting: off;

Range rings: visible;

VRM: visible;

EBL: visible;

Brilliance of all attributes: optimal (well readable).

5 General conditions of measurement

5.1 Test conditions, power sources and ambient temperatures

5.1.1 Normal test conditions

5.1.1.1 Normal temperature and humidity

The temperature and humidity conditions for tests shall be a combination of temperature and humidity within the following ranges:

a) temperature: +15 ºC to +35 ºC; or within the manufacturers stated operating range and stated in the report;

b) relative humidity: 20 % to 75 %.

When the relative humidity is lower than 20 %, it shall be stated in the test report.

5.1.1.2 Normal test power supply

5.1.1.2.0 General

For the purpose of the present document, the test power supply shall be the primary input source that the equipment is designed for. If the equipment is designed for direct connection to DC power supplies then that shall take precedent over a combination using an AC adaptor.

5.1.1.2.1 AC test power supply

The test voltage for equipment to be connected to an AC supply shall be the nominal mains voltage declared by the manufacturer -10 % to +10 %. For the purpose of the present document, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment is indicated as having been designed. The frequency of the test voltage shall be within ± 1 Hz of the manufacturers declared specification.

5.1.1.2.2 DC test power supply

Where the equipment is designed to operate from a DC source, the normal test voltage shall be the nominal voltage as declared by the manufacturer -10 % to +20 %.

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of testing the power source voltage shall be measured at the input terminals of the equipment.

During testing, the power source voltages shall be maintained within a tolerance of ±3 % relative to the voltage level at the beginning of each test.

5.1.2 Extreme test conditions

5.1.2.1 Extreme temperatures

5.1.2.1.1 Protected unit

The temperature and humidity conditions for extreme tests shall be a combination of nominal temperature and humidity within the following ranges:

a) temperature: 0 ºC to +40 ºC;

b) relative humidity: 20 % to 75 %.

When the relative humidity is lower than 20 %, it shall be stated in the test report.

5.1.2.1.2 Outdoor unit

The temperature and humidity conditions for extreme tests shall be a combination of nominal temperature and humidity within the following ranges:

a) temperature: -20 ºC to +55 ºC;

b) relative humidity: 20 % to 93 %.

When the relative humidity is lower than 20 %, it shall be stated in the test report.

5.1.2.2 Extreme power supply voltage test conditions

The extreme power supply test voltages applied to the equipment shall be according to table 2.

Table 2: Extreme power supply voltage and frequency tolerances

Power supply	Voltage variation (%)	Frequency variation (%)
AC	±10	±5
DC	+20 -10	Not applicable

6 Radio tests

6.1 Radiated emissions

6.1.1 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.

6.1.2 Method of measurement

6.1.2.1 General

On a test site selected from clause 5 of ETSI TS 103 052 [4], the EUT shall be placed on a non-conductive support with a height of 1,5 m.

The quasi-peak measuring receivers specified in CISPR 16-1-1 [5] shall be used. The receiver bandwidth in the frequency ranges 150 kHz to 30 MHz shall be 9 kHz and in the frequency ranges 30 MHz to 2 GHz shall be 120 kHz.

For frequencies from 150 kHz to 30 MHz measurements shall be made of the magnetic H field. The measuring antenna shall be an electrically screened loop antenna of dimension so that the antenna can be completely enclosed by a square having sides of 60 cm in length, or an appropriate ferrite rod as described in CISPR 16-1-4 [6]. The correction factor for the antenna shall include the factor +51,5 dB to convert the magnetic field strength to equivalent electric field strength.

For frequencies above 30 MHz measurements shall be made of the electric E field. The measuring antenna shall be a balanced dipole of resonant length, or alternate shortened dipole or higher gain antenna as described in CISPR 16-1-4 [6]. The dimension of the measuring antenna in the direction of the EUT shall not exceed 20 % of its distance from the EUT. At frequencies above 80 MHz it shall be possible to vary the height of the centre of the measuring antenna above the ground over a range of 1 m to 4 m.

The EUT shall be fully assembled, complete with its associated interconnecting cables and mounted in its normal plane of operation, where possible the antenna may be replaced by a suitable dummy load.

When the EUT consists of more than one unit the interconnecting cables shall have the maximum length and type as indicated by the manufacturer or 20 m whichever is shorter. Available input and output ports of the ancillary equipment under test shall be connected to the maximum length of cable as indicated by the manufacturer or 20 m whichever is shorter and terminated to simulate the impedance of the relevant ports of the radio equipment. These cables shall be bundled at the approximate centre of the cable with the bundles of 30 cm to 40 cm in length running in the horizontal plane from the port to which it is connected. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be precisely noted in the test report.

The test antenna shall be placed at a radial distance of 3 m from the edge of the minimum dimension circle, the smallest dimension circle in the horizontal plane that encloses all elements of the protected- and the outdoor -units, at a height of 1,5 m above the ground plane.

The test antenna shall be placed at a distance of 3 m from the EUT. The centre of the antenna shall be at least 1,5 m above the ground plane. The E-field antenna only shall be adjusted in height and rotated to give horizontal and vertical polarization, one being parallel to the ground, in order to determine the maximum emission level. Finally the antenna shall either be moved around the EUT, again in order to determine the maximum emission level, or alternatively, the EUT may be placed on a plane orthogonal to the test antenna at its mid-point and rotated to achieve the same effect.

In the frequency band 156 MHz to 165 MHz testing shall be performed according to either clause 6.1.2.2 or 6.1.2.3.

6.1.2.2 Frequency band 156 MHz to 165 MHz method 1

In addition, for the frequency band 156 MHz to 165 MHz, the measurement shall be repeated with a receiver bandwidth of 9 kHz, all other conditions of clause 6.2.1.1 remaining unchanged.

6.1.2.3 Frequency band 156 MHz to 165 MHz method 2

Alternatively, for the frequency band 156 MHz to165 MHz, a peak receiver or a frequency analyser may be used, in accordance with the agreement between the manufacturer and the test house.

6.1.3 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 3.

Table 3: Radiated electromagnetic emission

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

6.2 Operating frequency

6.2.1 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.

6.2.2 Method of measurement

The antenna shall be replaced by a suitable adapter to adapt the rotary joint to a waveguide with a plane flange. This adapter shall be provided by the radar manufacturer. On that flange a high-power directional coupler will be mounted with its main port terminated by a matching high-power dummy load. The coupled port shall have an adequate attenuation within the whole frequency band 2 800 MHz to 3 200 MHz or 8 900 MHz to 9 900 MHz to protect the measurement equipment.

To measure and display the transmitted signal a suitable spectrum analyser will be used. The spectral line of highest amplitude will be considered to be the operating frequency.

Alternatively the operating frequency can be measured as well with a direct reading frequency meter.

The results obtained shall be compared to the limits in clause 6.2.3 in order to prove compliance with the requirement.

6.2.3 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.

6.3 Transmitter pulse power

6.3.1 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.

6.3.2 Method of measurement

The antenna shall be replaced by a suitable adapter to adapt the rotary joint to a waveguide with a plane flange. This adapter shall be provided by the radar manufacturer. On that flange a high-power directional coupler will be mounted with its main port terminated by a matching high-power dummy load. The coupled port shall have a known attenuation of about 40 dB within the whole frequency band 2 800 MHz to 3 200 MHz or 8 900 MHz to 9 900 MHz.

To determine the pulse power, the use of both, a mean power meter or a suitable pulse power meter with direct reading of the transmitter pulse power is permitted. In case of measurement with a mean power meter the transmission pulse duration t_p and the pulse repetition time PRT have to be determined in a preceding step i.e. by use of a detector and an oscilloscope. Then the transmitter pulse power P_t is calculated as follows:

$$P_t = P_m \times PRT/t_p$$

6.3.3 Limits

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

6.4 Out of band emissions

6.4.1 Definition

6.4.1.0 General

Recommendation ITU-R SM.1541-6 [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).

6.4.1.1 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 4.

Table 4: 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

6.4.1.2 FM pulse radars

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

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

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

6.4.1.3 Other modulation formats

For all other modulation formats the -40 dB bandwidth shall be calculated according to annex 8 of Recommendation ITU-R SM.1541-6 [3].

6.4.2 Method of measurement

To perform the measurement, the radar and the measuring equipment shall be installed as described in the Recommendation ITU-R M.1177-4 [2]. Then the radar equipment shall be set to the shortest range (shortest pulse duration).

Measures described in the Recommendation ITU-R M.1177-4 [2] shall be taken to ensure that interferences caused by multiple reflections do not occur.

The radiated out of band power emission shall be measured in the frequency bands given in table 5 with the antenna rotating using the selected method from those described in the Recommendation ITU-R M.1177-4 [2].

Table 5: Out of band emissions measurement bands

Operating frequency	Lower measurement band	Upper measurement band
9,3 GHz to 9,5 GHz	8,0 GHz to 9,3 GHz	9,5 GHz to 10,8 GHz
2,9 GHz to 3,1 GHz	2,7 GHz to 2,9 GHz	3,1 GHz to 3,3 GHz

6.4.3 Limits

6.4.3.1 Out of band limits

For all radar types except those excluded in clause 6.4.3.2, the roll-off shall be 30 dB/decade as shown in figure 1.

The maximum radiated Out Of Band-emission power level shall not exceed the limits given in figure 1.

NOTE: See also figure B.2.

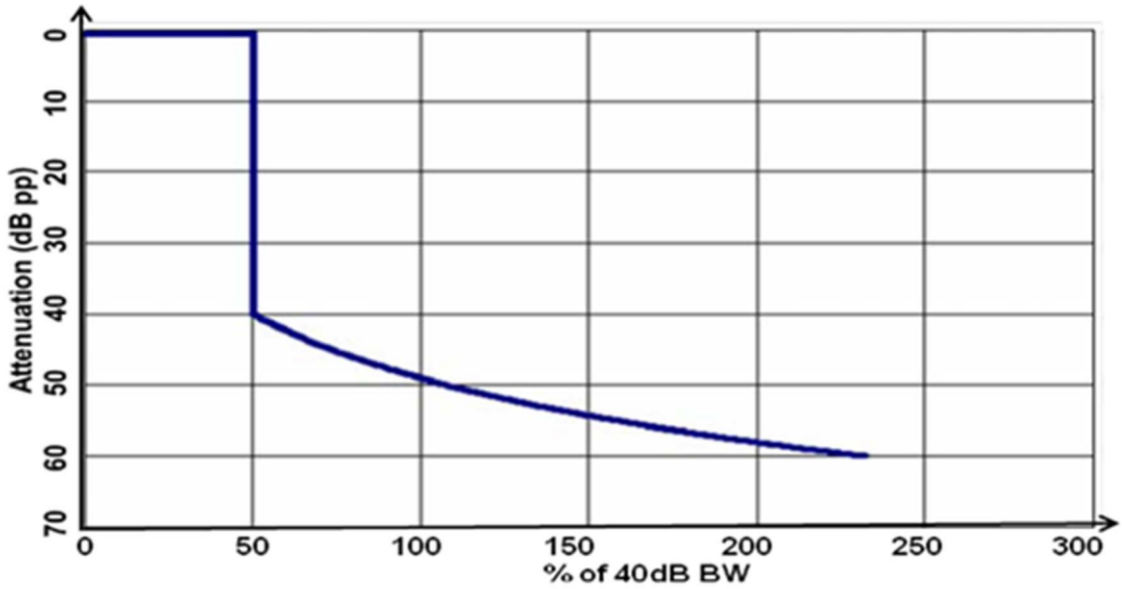


Figure 1: OoB mask for all non-excluded radar waveforms in clause 6.4.3.2

6.4.3.2 Out of band limits (excluded types)

Radars using CW, FMCW and phase coded waveforms are excluded from the requirements of clause 6.4.3.1 and for these radars the roll-off shall be 20 dB/decade as shown in figure 2.

The maximum radiated Out Of Band-emission power level shall not exceed the limits given in figure 2.

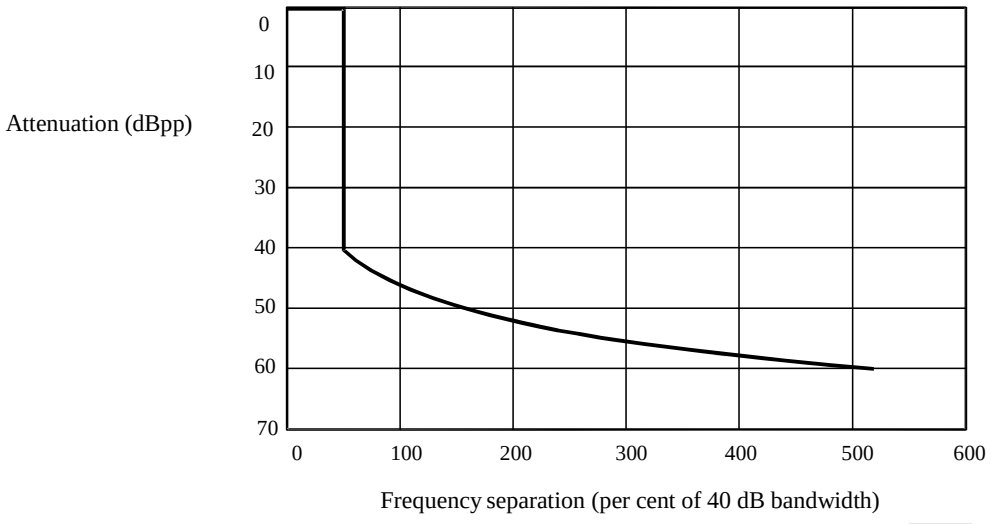


Figure 2: OoB mask for radars using CW, FMCW and phase coded waveforms

6.5 Radiated spurious emissions

6.5.1 Definition

Spurious emissions are defined as the entity of all emissions in the frequency range of 30 MHz to 26 GHz, but outside the OOB-boundaries. In the case where waveguide is used, the lower frequency limit may be set at 70 % of the cut-off frequency of the waveguide.

They include:

- harmonic emissions (whole multiples of the operating frequency);
- parasitic emissions (independent, accidentally);
- intermodulation (between oscillator- and operation frequency or between oscillator and harmonics);
- emissions caused by frequency conversions.

6.5.2 Method of measurement

To perform the measurement, the radar and the measuring equipment shall be installed as described in the Recommendation ITU-R M.1177-4 [2]. Then the radar equipment shall be set to the shortest range (shortest pulse duration).

Measures described in the Recommendation ITU-R M.1177-4 [2] shall be taken to ensure that interferences caused by multiple reflections do not occur.

The radiated spurious power emission shall be measured in several overlapping frequency sweep steps in the frequency bands given in table 6.

If required to reach a dynamic amplitude measuring range of 70 dB minimum, a Low Noise Amplifier (LNA), and a notch filter for the operating frequency should be used.

The results obtained shall be compared to the limits in clause 6.5.3 in order to prove compliance with the requirement.

Table 6: Spurious emissions measurement bands

Operating frequency	Lower measurement band	Upper measurement band
9,3 GHz to 9,5 GHz	4,5 GHz to 8,0 GHz	10,8 GHz to 26 GHz
2,9 GHz to 3,1 GHz	2,0 GHz to 2,7 GHz	3,3 GHz to 26 GHz

6.5.3 Limits

All radiated spurious emission levels shall be 43 + 10 log PEP or 60 dB below the PEP level of the radiated operating frequency (see figure B.3 in annex B) whichever is less stringent.

6.6 Minimum range

6.6.1 Definition

The minimum range is the shortest distance at which a stationary target is presented separately from the position and image representing the antenna position.

6.6.2 Method of measurement

Before measurements are made the range index compensation shall be set correctly as described in clause 6.7.2 of IEC 62388 [1].

For this measurement, a test target (equivalent to the navigational buoy with corner reflector) having a known RCS of 10 m^2 at X-band (having a known RCS of 1 m^2 at S-band) and mounted at a height of 3,5 m shall be used.

For this measurement, only the range scale selector may be changed. The sea and gain controls may be adjusted before commencing this test. After adjustment, the test target shall be visible at the minimum range and at 1 NM with the same setting of the sea and gain control. An off-centred presentation is permitted for this measurement. The methods of test and the required results are as follows:

a) confirm by observation and document inspection that if a down-mast transceiver is an option for the radar under test, the test is conducted using a down-mast transceiver, or otherwise the test shall be conducted with an up-mast unit. If the implementation of up-mast and down-mast systems is different, both types of systems shall be tested;

b) confirm by observation that a reference test target is available having the same properties as the mobile test target. The reference test target shall be stationary and positioned at 1 NM range. Adjust the radar system so that the reference test target at approximately 1 NM is clearly visible;

c) confirm by measurement that with the radar antenna mounted at the specified height, the separation of a mobile test target (representative of a navigational buoy) and the antenna position can be decreased to the closest point at which the target can be identified within 75 m of the antenna position. Record the result. After adjustment, the mobile test target at the minimum range and the reference target at 1 NM shall be visible with the same setting of the gain and clutter controls;

d) alternatively a mobile target with an RCS of 10 m^2 at X-band may be used and moved from the closest point at which the target is visible up to 1 NM with the same settings of the gain and clutter controls.

6.6.3 Limits

The distance of the test target from the radar under test shall be not greater than 75 m.

6.7 Range discrimination

6.7.1 Definition

The ability of a radar to display two point targets on the same bearing, separated by a short distance in range.

6.7.2 Method of measurement

The radar shall be set to a range scale of 0,75 NM. Two test targets having a known RCS of 10 m^2 at X-band (having a known RCS of 1 m^2 at S-band) shall be placed on the same bearing with respect to the radar antenna, at a distance of between 0,375 NM and 0,75 NM, and separated from each other by a distance of not more than 75 m. The rain control and the effective pulse length of the radar shall be set to their minimum values. The sea and gain controls shall be adjusted to show separation of the two targets on the display.

6.7.3 Limits

When the two targets are visibly separated for at least 8 scans out of 10, the linear distance between the two targets shall not be greater than 75 m.

6.8 Bearing discrimination

6.8.1 Definition

The ability of a radar to display two point targets at the same range, separated by a narrow angle.

6.8.2 Method of measurement

The radar shall be set to the range scale of 1,5 NM or less and the test targets positioned at between 60 % and 100 % of the range scale selected. Two test targets of equal radar cross-section having a known RCS of 10 m^2 at X-band (having a known RCS of 1 m^2 at S-band) shall be placed at the same distance and shall be separated in bearing with respect to the radar antenna. The measurement may be made at any convenient bearing from the antenna location. The angular separation between the two targets shall be decreased until they cease to be displayed separately.

6.8.3 Limits

When the two targets are visibly separated for at least 8 scans out of 10 the linear distance between the two targets shall be not be greater than 8,0 degrees.

6.9 Range of first detection in minimal clutter

6.9.1 Definition

Range at which the radar system will detect a range of different targets at various distances and in the absence of significant sea clutter, precipitation and evaporation duct, and with an antenna height of 15 m.

6.9.2 Method of measurement

If the radar is capable of being supplied with a range of antennas, the lowest gain antenna shall be used for this test.

Adjust the system for best target visibility with a light and even background noise speckle to provide good detection sensitivity. The sea conditions shall be calm for assessing the range of first detection (maximum sea state 1, see table 6 of IEC 62388 [1] for guidance on sea states). The test may be conducted from a land site overlooking the sea or from a stable platform at sea. All observations shall be conducted in clear conditions.

Additional information can be found in IEC 62388 [1], section 9.2.

6.9.3 Limits

Limits for range of first detection in minimal clutter are defined in table 7.

Table 7: Range of first detection in clutter-free conditions

Target description	Radar cross-section	Target feature height above sea level	Detection Range
Navigation Buoy with corner reflector	10 sq m	3,5 m	1,4 NM
Small vessel of length 10 m with no radar reflector	2,5 sq m	2,0 m	1,0 NM

7 Testing for compliance with technical requirements

7.1 Environmental conditions for testing

These shall be as described in clause 5.

7.2 Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 8.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028-1 [i.3] and ETSI TR 100 028-2 [i.4], in particular in annex D of the ETSI TR 100 028-2 [i.4].

Table 8 is based on such expansion factors.

Table 8: Maximum measurement uncertainty

Parameter	Uncertainty
RF frequency	1×10^{-7}
RF pulse power	1,5 dB
Radiated emission of transmitter	6 dB
Angular measurement	0,5°
Linear distance	1 %

Annex A (normative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] 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.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 302 248 The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.1]				
Requirement			**Requirement Conditionality**	
No	**Description**	**Reference: Clause No**	**U/C**	**Condition**
1	Radiated emissions	6.1	U	
2	Operating frequency	6.2	U	
3	Transmitter pulse power	6.3	U	
4	Out of band emissions	6.4	U	
5	Radiated spurious emissions	6.5	U	
6	Minimum range	6.6	U	
7	Range discrimination	6.7	U	
8	Bearing discrimination	6.8	U	
9	Range of first detection in minimal clutter	6.9	U	

Key to columns:

Requirement:

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Clause Number Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement shall be unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement shall or shall not be applicable for a requirement which is classified "conditional".

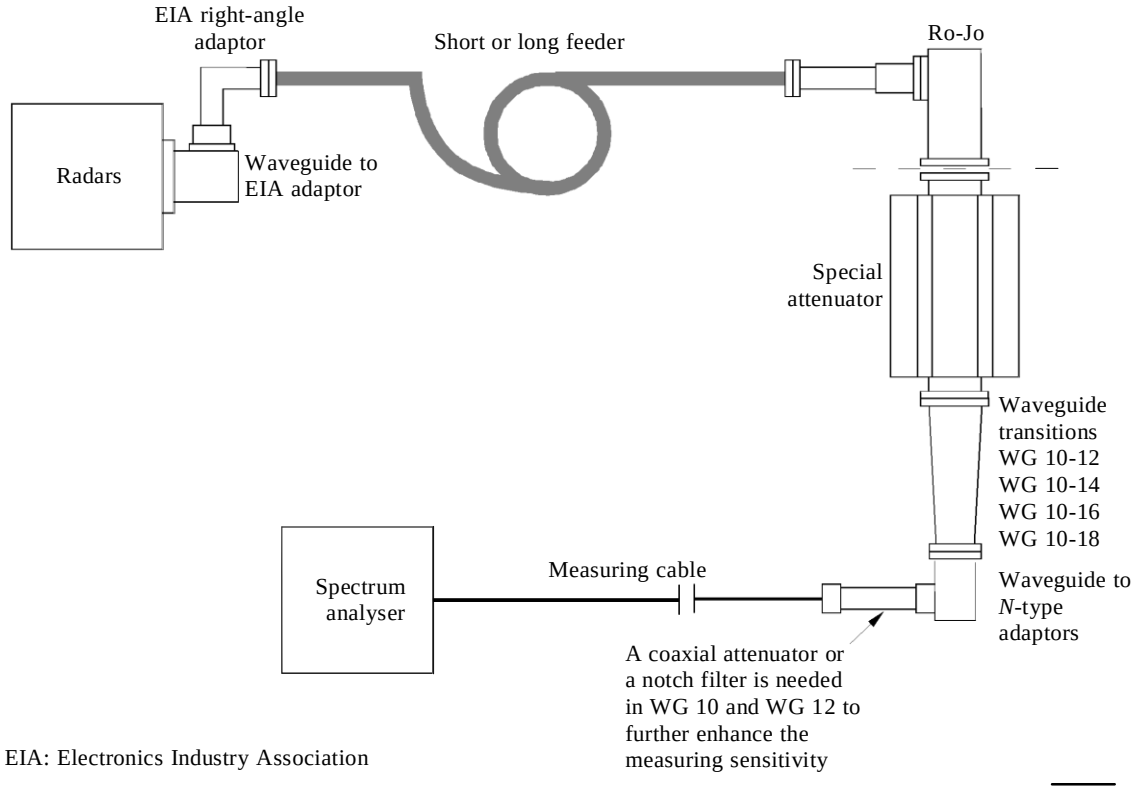
Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (normative): Transmission power and unwanted emissions of radar systems; measuring methods

B.1 Indirect connection via the rotating joint

Test set up shall be as illustrated in figure B.1.



EIA: Electronics Industry Association

Figure B.1: Measurement at the Ro-Jo port

B.2 Maximum permitted out of band emissions power levels

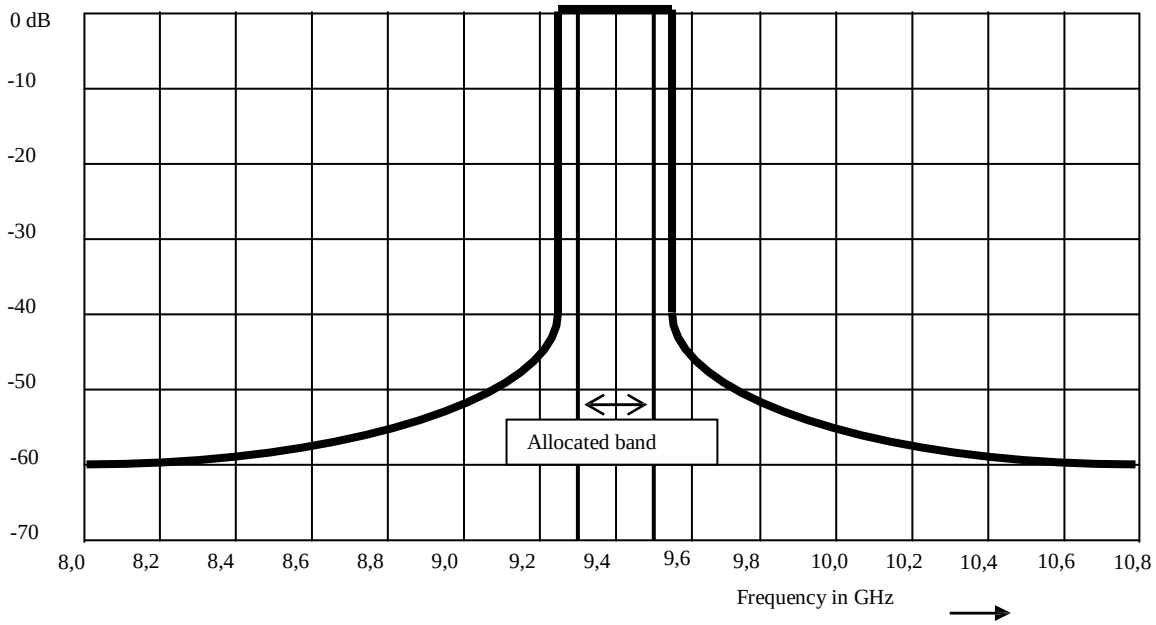


Figure B.2: Maximum permitted Out Of Band-emissions power level

The 0 dB level means the radiated power level at the operation frequency (see figure B.2). All power levels shall be determined by the same method and the same measuring parameters.

B.3 Maximum permitted spurious emissions power levels

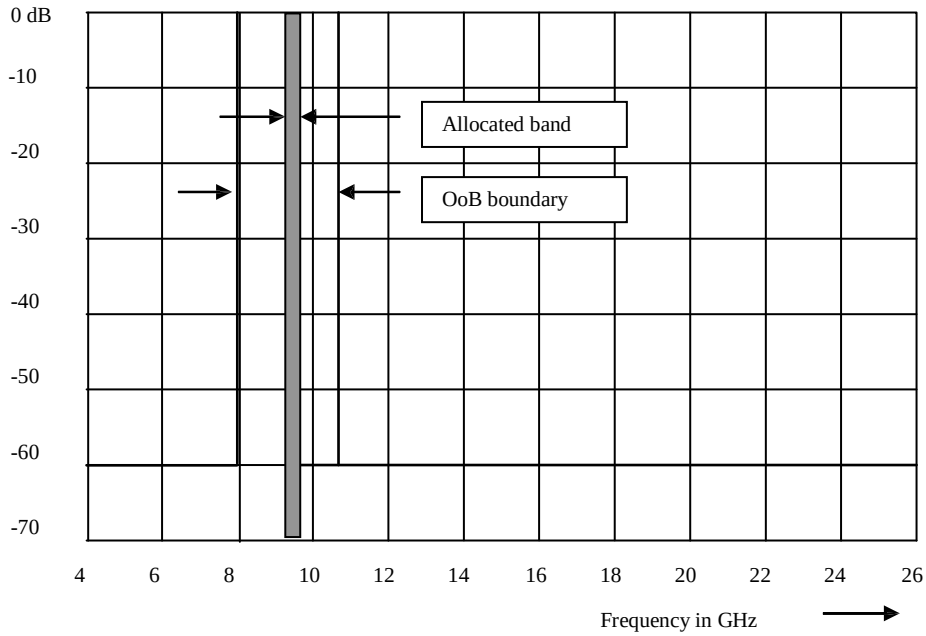


Figure B.3: Maximum permitted spurious emissions power level

The 0 dB level means the radiated power level at the operation frequency (see figure B.3). All power levels shall be determined by the same method and the same measuring parameters.

History

Document history				
V1.1.2	June 2008	Publication		
V1.2.1	November 2013	Publication		
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