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Advanced Surface Movement Guidance and Control System (A-SMGCS); Part 6: Harmonised Standard for access to radio spectrum for deployed surface movement radar sensors; Sub-part 1: X-band sensors using pulsed signals and transmitting power up to 100 kW

Reference

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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.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.

The present document is part 6, sub-part 1 of a multi-part deliverable covering Advanced Surface Movement Guidance and Control System (A-SMGCS), as identified below:

Part 1: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS surveillance service";

Part 2: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS Level 2 including external interfaces";

Part 3: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for a deployed cooperative sensor including its interfaces";

Part 4: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for a deployed non-cooperative sensor including its interfaces";

Part 5: "Harmonised Standard for access to the radio spectrum for Multilateration (MLAT) equipment";

Part 6: "Harmonised Standard for access to radio spectrum for deployed surface movement radar sensors";

Sub-part 1: "X-band sensors using pulsed signals and transmitting power up to 100 kW".

Part 7: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS routing service";

Part 8: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS guidance service";

National transposition dates	
Date of adoption of this EN:	17 June 2019
Date of latest announcement of this EN (doa):	30 September 2019
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 2020
Date of withdrawal of any conflicting National Standard (dow):	31 March 2021

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 monostatic X-band radar sensors intended for the surveillance of airport surface movement traffic with the following characteristics:

- Operating in one or both of the following frequency ranges:
  - 9 000 MHz to 9 200 MHz and 9 300 MHz to 9 500 MHz 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 IEC 60153-2 [i.3]. The upper limit corresponds to the upper limit stated in table 1 of ERC Recommendation 74-01 [2].

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: Aeronautical Surface Movement Radars covered by the present document are expected to use the bands 9 000 MHz to 9 200 MHz and/or 9 300 MHz to 9 500 MHz. According article 5 of the ITU Radio Regulations [3] the band 9 000 MHz to 9 200 MHz is allocated to the Aeronautical Radionavigation Service on a primary basis and the band 9 300 MHz to 9 500 MHz is allocated to the Radionavigation Service on a primary basis.

NOTE 4: 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 specific, identified by date of publication and/or edition number or version number. Only the cited version 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] ITU Radio Regulations (2016).

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.

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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 (Edition 2.0, 1974): "Hollow metallic waveguides. Part 2: Relevant specifications for ordinary rectangular waveguides".

[i.4] Void.

[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.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

active state: which produces 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 [3].

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

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 [3].

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.

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 [3].

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 [3].

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)

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
MDS	Minimum Detectable Signal
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
A-SMGCS	Advanced - Surface Movement Guidance and Control System
EN	European Standard
FM	Frequency Modulation
LNA	Low Noise Amplifier
MDS	Minimum Detectable Signal
OoB	Out-of-Band
PEP	Peak Envelope Power
ppm	part(s) per million
RF	Radio Frequency
SMR	Surface Movement Radar
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 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 which are identified as applicable in annex A at all times when operating within the boundary limits of the declared operational environmental profile.

4.2 Conformance requirements

4.2.1 Transmitter requirements

4.2.1.1 Frequency Tolerance

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 tolerance 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 tolerance for SMR applying unmodulated pulses shall not exceed 1 250 ppm as per appendix 2 of the Radio Regulations [3].

4.2.1.1.3 Conformance

The conformance tests are specified in clause 5.3.1.1.

4.2.1.2 Transmitter power

4.2.1.2.1 Definition

In the present document the transmitter power of a pulse radar is considered to be the peak value of the transmitter pulse power during the transmission pulse (PEP).

If the transmitter power varies over the azimuth, the highest PEP over at least one rotation period has to be used.

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

4.2.1.2.2 Limits

The transmitter power shall be as specified by the manufacturer and shall not exceed 100 kW (50 dBW).

4.2.1.2.3 Conformance

The conformance tests are specified in clause 5.3.1.2.

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.

NOTE 1: The declared band is always contained in the 9 000 MHz - 9 200 MHz and/or 9 300 MHz - 9 500 MHz frequency range.

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

NOTE 2: 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 5.3.1.3.

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 effective -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.