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Harmonised Standard for access to radio spectrum;

Part 2: Air Traffic Control (ATC) Primary Surveillance Radar Sensors operating in 2700-3100 MHz frequency band (S band)

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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 Commission Implementing Decision C(2015) 5376 final [i.2] 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 2 of a multi-part deliverable covering ground based ATC Primary Surveillance Radars (PSR), as identified below:

Part 1: “Harmonized Standard for access to radio spectrum for Air Traffic Control (ATC) Primary Surveillance Radar sensors operating in 1215-1400 MHz frequency band (L band)”

**Part 2: "Harmonized Standard for access to radio spectrum for Air Traffic Control (ATC) Primary Surveillance Radar sensors operating in 2700-3100 MHz frequency band (S band)".**

Part 3: “Harmonized Standard for access to radio spectrum for Air Traffic Control (ATC) Primary Surveillance Radar sensors operating in 8500-10000 MHz frequency band (X band)”

|  |  |
| --- | --- |
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| Date of latest publication of new National Standard or endorsement of this EN (dop/e): | 6 months after doa |
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# 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](https://portal.etsi.org/Services/editHelp!/Howtostart/ETSIDraftingRules.aspx) (Verbal forms for the expression of provisions).

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# Scope

The present document specifies technical characteristics and methods of measurements for ground based monostatic ATC primary surveillance radars with the following characteristics:

* operating in the 2700 MHz to 3100 MHz frequency range
* transmitter output power up to 100 kW
* the transceiver-antenna connection is using a hollow metallic rectangular waveguide of type WR284/WG10/R32 according to IEC 60153-2 [i.2].
* the antenna is rotating, waveguide-based and passive

NOTE 1: Phased array ATC primary surveillance radars are not covered by the present document.

NOTE 2: Since at the transceiver output a RF circulator is used, it is assumed that the transceiver characteristics remain independent from the antenna, and the indirect measurement method is used at the output of the transceiver.

NOTE 3: 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.

# References

## 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] ITU Radio Regulations (2016).

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

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

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

## 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] 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.3] ITU-R Recommendation SM.1541-6 (2015) "Unwanted emissions in the out-of-band domain"

[i.4] ITU-R Recommendation SM.329-12 (2012) "Unwanted emissions in the spurious domain"

[i.5] ITU-R Recommendation SM.1539 Variation of the boundary between the out-of-band and spurious domains required for the application of Recommendations ITU-R SM.1541 and ITU-R SM.329

[i.6] ETSI EG 203 336 V1.1.1 (2012) "ERM) 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.7] IEC 60 153-2 ed. 2.0 1974] (ref in 6.3.5) “Hollow metallic waveguides, Part 2: Relevant specifications for ordinary rectangular waveguides”, (Cut-off frequency).

[i.8] ITU-R Recommendation SM.331-4 (1978) "Noise and sensitivity of receivers"

[i.9] Merrill I. Skolnik: "Radar Handbook", 2nd Edition, McGraw Hill publications (1990).

[i.10] ETSI EG 201 399 "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the RE Directive".

# Terms, symbols and abbreviations

## Terms

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

**Active State:**  State which produces the authorised emission.

**Allocated frequency 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 is normally available from the national radio regulatory authority for each country.

**Assigned frequency:** centre of the frequency band assigned to a station

NOTE: This definition is taken from the ITU Radio Regulations [4].

**Assigned frequency band:** frequency band within which the emission of a station is authorized

NOTE 1: The width of the band equals the necessary bandwidth plus twice the absolute value of the frequency tolerance. Where space stations are concerned, the assigned frequency band includes twice the maximum Doppler shift that may occur in relation to any point of the Earth's surface.

NOTE 2: This definition is taken from the ITU Radio Regulations [4].

**Characteristic frequency:** frequency which can be easily identified and measured in a given emission

NOTE 1: A carrier frequency may, for example, be designed as the characteristic frequency.

NOTE 2: This definition is taken from the ITU Radio Regulations [4].

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

NOTE 1: The declared frequency band will often correspond to a nationally allocated frequency band.

NOTE 2: The declared frequency band for a given region or country is always contained within the allocated frequency band.

**Equipment Under Test (EUT):** device that is the subject of the specific test investigation being described

**Matched filter:** The matched filter is the receiver filter that matches the transmitted radar waveform, i.e. this is the filter that maximises the signal-to-noise ratio of the received pulse.

**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 1: This definition is taken from ITU Radio Regulation [1]

NOTE 2: For Primary radars the necessary bandwidth BN is considered to be B-20 (20 dB bandwidth) as defined in ITU-R SM.1541-6 [i.3]

**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 Regulation [1]

NOTE 2: Unless otherwise specified in an ITU-R Recommendation 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.

**Operating frequency:** centre of the occupied bandwidth

**Operating frequency band:** declared possibilities of frequencies where the radar can operate.

**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 [1]

**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)

**Reference frequency:** frequency having a fixed and specified position with respect to the assigned frequency

NOTE 1: The displacement of this frequency with respect to the assigned frequency has the same absolute value and sign that the displacement of the characteristic frequency has with respect to the centre of the frequency band occupied by the emission.

NOTE 2: This definition is taken from the ITU Radio Regulations [4].

**System coupler:** directional waveguide coupler with forward and reverse port or only a forward port

NOTE: The system coupler is inserted in the waveguide run between the circulator and the antenna but not directly located behind the antenna. Usually it is located very close behind the circulator.

## Symbols

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

*B-40* -40 dB bandwidth of the spectrum of the transmitted waveform.

*BC* Chirp bandwidth

*BN* Necessary bandwidth

*Bres* 3 dB resolution bandwidth of transceiver

dB/decdB per decade

*dBpp* dB with respect to peak power

*Dno spur* Detectability Factor

*fc* Carrier Frequency

*fIF* Intermediate Frequency

*fRF* Receiver operating Frequency

*fimage* Image Frequency

*k* Boltzmann's constant

*fLO* Local Oscillator Frequency

*Pt* Pulse power of transmission

*RF* Radio Frequency

*S/N* Signal-to-Noise ratio

*t* Time

*TC* Pulse length (of individual chirp waveforms) in seconds

*tp* Pulse duration

*tr* Pulse rise time

*T0* Temperature in Kelvin

*λ* Wavelength

## Abbreviations

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

AC Alternating Current

ADC Analog to Digital Converter

CW Continuous Wave

EIRP Effective Isotropically Radiated Power

ESASSP EUROCONTROL Specification for ATM Surveillance System Performance

EUT Equipment Under Test

*FAR* False Alarm Rate

FM-CW Frequency Modulated Continuous Wave

ICAO International Civil Aviation Organization

ITU International Telecommunication Union

LNFE Low Noise Front End (= RF Front End)

NF Noise Factor

OoB Out-of-Band

PEP Peak Envelope Power

ppm parts per million

PSR Primary Surveillance Radar

RF Radio Frequency

WG Waveguide

# Technical requirements specifications

## 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 at all times when operating within the boundary limits of the declared operational environmental profile.

## Conformance Requirements

### Transmitter requirements

#### Frequency tolerance

##### Definition

The frequency tolerance is the maximum permissible departure by the center 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.

NOTE 1: The frequency tolerance is expressed in parts in 106 or in Hertz.

NOTE 2: this definition is taken from the ITU Radio Regulations [1]

##### Limits

The frequency tolerance of ATC radar systems at the defined operating frequency shall not exceed +/- 1 250 ppm.

NOTE: This value is specified in Appendix 2 of the ITU Radio Regulations [1].

##### Conformance

The conformance tests are specified in clause 5.4.1.1.

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

#### Transmitter output power

##### Definition

The transmitter power is considered to be the peak value of the transmitter pulse power during the transmission pulse (PEP).

NOTE: The transmitter power is measured at the output port of the transceiver.

##### Limits

The transmitter power shall not exceed 100 kW (i.e. 80 dBm).

##### Conformance

The conformance tests are specified in clause 5.4.1.2.

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

#### Measured B-40 bandwidth

##### Definition

The measured -40 dB bandwidth (B-40) is the measured bandwidth of the emissions 40 dB below the measured PEP.

##### Limits

The transmitted band of the emitted signal measured at B-40 bandwidth shall be always contained within the frequency range 2 700 MHz to 3 100 MHz.

In case of multiple-carrier frequencies where the B-40 bands of the individual signals do not overlap, all measured B-40 bands while transmitting shall always be contained within the frequency range 2 700 MHz to 3 100 MHz.

##### Conformance

The conformance tests are specified in clause 5.4.1.3.

The results obtained shall not exceed the limit specified in clause 4.2.1.3.2

#### Unwanted emissions

##### Unwanted emissions general requirements

The Out-of-Band emission limits and the spurious emission limits shall be based on the calculated B-40 bandwidth as defined in Annex C. The OoB and Spurious domain boundaries are defined in §5.4.1.5.

For radars using a single carrier with multiple pulse waveforms, the emission mask shall be calculated for each individual pulse and the widest mask shall be considered. An example can be seen in figure 1.



Figure 1: Definition of OoB and spurious emission domains (case of a single carrier frequency)   
(Not to scale)

For radars using multiple carrier frequencies, the overall emission mask is the envelope of the individual emission masks. An example can be seen in figure 2.



Figure 2: Example of superimposed (combined) mask from two carrier frequencies

For radars with multiple carrier frequencies, if two or more B-40 overlap, the emissions in the OoB and spurious domains shall be measured taking into account the overall B-40. Whenever the PEP related to two adjacent carrier frequencies are different, the combined B-40 shall be related to the higher PEP value.

For radars with multiple carrier frequencies, if B-40 of the single carriers do not overlap, the emissions in the OoB and spurious domains shall be related to each individual B-40.

##### Emissions in the Out-of-Band domain

###### Definition

Out-Of Band (OOB) emission is an emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious

NOTE: In accordance to ECC/Recommendation (02)05 (2012): "Unwanted emissions" [2] this definition is taken from article 1.144 of the ITU Radio Regulations [1].

OoB domain emission limits for primary radars are based on the 40 dB bandwidth (B-40) of the spectrum of the transmitted waveform.

NOTE: In accordance to ECC/Recommendation (02)05 (2012): "Unwanted emissions" [2] this definition is taken from annex 8 §3 of ITU-R Recommendation SM.1541-6 (2015) "Unwanted emissions in the out-of-band domain" [i.6]

###### Limits

The limits of emissions in the OoB domain shall be as specified in Annex 2 of ECC/Recommendation (02)05 [2] also shown in Table 1 (for single frequency radars) and Table 2 (for multiple frequency radars) below.

Table 1: Limits for emissions in the OoB domain for single frequency radars

|  |  |  |
| --- | --- | --- |
| Frequency offset  relative to B-40 | Limit  dBpp | Slope  dB/decade |
| 0,5 to 5 | -40 to -70 | -30 |
| 5 to 15,8 | -70 to -100 / -30 dBm (See note 1) | -60 |
| NOTE 1: from -70 to -100 or -30 dBm whichever is less stringent  NOTE 2: Frequency offset is a multiplicative factor of B-40 value | | |

Table 2: Limits for emissions in the OoB domain for multiple frequency radars

|  |  |  |
| --- | --- | --- |
| Frequency offset  relative to B-40 | Limit  dBpp | Slope  dB/decade |
| 0,5 to 2.3 | -40 to -43 - 10\*log(PEP) / -60 (see note 1) | -30 |
| NOTE1: from -40 to -43 - 10\*log(PEP) or -60 dBpp whichever is less stringent  NOTE 2: Frequency offset is a multiplicative factor of B-40 value  NOTE 3: PEP unit is Watt | | |

###### Conformance

The conformance tests are specified in clause 5.4.1.5.1.

The results obtained shall not exceed the limits specified in clause 4.2.1.4.2.2.

##### Emissions in the spurious domain

###### Definition

Emission on a frequency or frequencies which are outside the B-40 bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions

NOTE 1: This definition is taken from article 1.145 of the ITU Radio Regulations [1].

NOTE 2: For radar, transmission of information should be understood as transmit and receive radar signals for self-performing the radar mission

###### Limits

The spurious emissions limits are related to the PEP and shall be as specified in ERC/Recommendation 74-01 [3] Annex 5 also shown in Table 3 below.

Table 3 - Limits for emissions in the spurious domain

|  |  |
| --- | --- |
| Radar type | Limits (see note 1) |
| Single frequency | 100 dB or -30 dBm |
| Multi-frequency | 43 + 10\*log(PEP) or 60 dB |
| NOTE 1: Absolute levels (dBm in PEP in the reference bandwidth) or attenuation  (dB) below the power (PEP) supplied to the antenna port (whichever is less stringent) | |

###### Conformance

The conformance tests are specified in clause 5.4.1.5.2.

The results obtained shall not exceed the limits specified in clause 4.2.1.4.3.2.

##### Stand-by mode emissions

###### Definition

Stand-by mode emissions are residual emissions at the transceiver output when the transmitter is in stand-by mode. In this mode, the transmitter is available for operation, but is not in the active state.

###### Limits

The stand-by mode emissions for each operating frequency shall be not greater than -47 dBm as specified in Table 15 of ERC/Recommandation 74-01 [3] apart from ±250% of the measured necessary bandwidth BN .

NOTE: No limit is specified in this central range

###### Conformance

The conformance tests for this requirement shall be as defined in clause 5.4.1.5.3.

The results obtained shall not exceed the limit in clause 4.2.1.4.4.2.

##### Examples of limits

Figures 3 and 4 below show examples of the emissions limits (half of the mask above the carrier centre frequency is shown) in the OoB and Spurious domain for the radar systems above mentioned.



Figure 3: Example of emission limits in the OoB and Spurious domains in case of a single carrier frequency radar with PEP> 10kW

Figure 4: Example of emissions limits in the OoB and Spurious domains in case of a multiple carrier frequencies radar (considering only one carrier with PEP> 50W)

### Receiver requirements

#### Noise Figure

##### Definition

The Noise Figure is the noise factor as defined below expressed in dB.

The noise factor is the ratio of noise power measured at the output of the receiver to the noise power which would be present at the output if the thermal noise due to the resistive component of the source impedance were the only source of noise in the system; both noise powers are determined at an absolute temperature of the source equal to *T* = 293 K;

NOTE 1: The definition of noise factor is taken from ITU-R Radio Recommendation ITU-R SM.331-4 p.2 [i.8]

##### Limits

The System Noise Figure shall not exceed 6dB.

##### Conformance

The conformance tests are specified in clause 5.4.2.1

The result obtained shall not exceed the limits specified in clause 4.2.2.1.2.

#### Receiver Compression Level

##### Definition

The compression level is defined as when one of the receiver stages becomes non-linear thereby causing distortion and other non-linear effects that prevent proper operation of the receiver.

The receiver input compression level is defined as the input power when the receiver gain is reduced by 1 dB (i.e. when the receiver output is 1 dB into compression).

NOTE 1: A high compression level corresponds to high immunity against blocking. Receiver blocking takes place, if a strong unwanted signal with specific power in the vicinity of the operating frequency band reduces the gain, resulting in a reduction of detection sensitivity (desensitization) or induces energy into the receiver band which may result in spurious responses. Depending on the application and thus the design of the receiver, blocking levels at the input of the receiver may vary considerably.



Figure 5: Illustration of finding the receiver 1dB compression point

##### Limits

The receiver input compression level of the radar shall be at least -40 dBm.

##### Conformance

The conformance tests are specified in clause 5.4.2.2.

The result obtained shall not exceed the limits specified in clause 4.2.2.2.2.

#### Receiver selectivity

##### Definition

The radar receiver selectivity is the ability of a receiver to transpose at its output the radar desired signal and to reject unwanted perturbing signals located outside the B-40 bandwidth.

NOTE 1: Receiver selectivity refers to effects measured within the linear range of the receiver.

NOTE 2: Unwanted signals inside the B-40 bandwidth are not considered for the receiver selectivity because they fall into the desired frequency range for the reception of wanted signals.

NOTE 3: The selectivity curve is the rejection of an unwanted CW signal for a range of frequencies.

##### Limit

The required input selectivity characteristic of the radar receiver is based on the receiver B-40 bandwidth (see Annex B). In case of multifrequency radar, if two carrier frequencies are close to each other so that the B-40 bandwidths overlap, the selectivity is assessed on the resulting B-40 bandwidth. If two carrier frequencies are not close to each other, the selectivity is assessed separately.

The receiver selectivity of each operating frequency shall be at least verified in the range of:

* Lower B-40 to (Lower B-40 – 500 MHz)
* Upper B-40 to (Upper B-40 + 500 MHz)

The B-40 band of the operating frequency shall be excluded from the receiver selectivity measurement.

If the image frequencies, as calculated in formula (1) below, are not covered by the frequency range as defined above, the selectivity measurement shall be done also on a frequency range of fimage +/- B-40 to cover the image frequencies susceptibility.

(1)

The receiver selectivity mask shall be as defined in Table 4 .

Table 4: Receiver selectivity mask

|  |  |  |
| --- | --- | --- |
| Frequency offset relative to fc by multiple of the  B-40 bandwidth | Relative rejection  in dB referenced to in-band level | Slope  dB/decade |
| 0 to 0,5 | 0 |  |
| 0,5 | -40 | -∞ |
| 0,5 to 3 | -40 to -60 | -30 |
| 3 to ∞ | -60 dB | 0 |



Figure 6: Receiver selectivity mask (not to scale)

##### Conformance

The conformance tests are specified in clause 5.4.2.3.

The results obtained shall not exceed the limits of the selectivity mask specified in clause 4.2.2.3.2.

# Testing for compliance with technical requirements

## General requirements

The manufacturer shall ensure that all operating modes and product configurations are in compliance with the technical requirements in the present document.

## Environmental conditions for testing

### General requirements

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.

### Normal temperature and humidity

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

1. temperature: +15 oC to +35 oC;
2. relative humidity: not exceeding 75 %.

### Normal 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 each of the declared voltages for which the equipment is indicated as having been designed. The frequency of the test voltage shall be 50 Hz ± 1 Hz.

## 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;

Recommended values for the maximum measurements uncertainty figures can be found in Annex F.

## Radio test suites

### Transmitter test specification

#### Frequency Tolerance

The measurement set-up shall be as described in Annex C.

To measure the frequency tolerance a spectrum analyser shall be used. An additional attenuator shall be used if needed in order to protect the spectrum analyser input from the power of RF pulses.

When measuring the frequency tolerance for radars with a phase or frequency modulated pulse, the tolerance is measured on the frequency reference(s) used for generating the radar output signal. The frequency tolerance shall be measured at least the lowest and highest operating frequency.

The frequency measurements shall be performed with all available pulse length settings. The corresponding PRF shall be chosen in order to get the maximum possible duty cycle for each pulse length. After the frequencies for the maximum duty cycles are measured, the measurements shall be repeated with the lowest duty cycle. The lowest duty cycle is defined as the combination of shortest pulse length and lowest PRF.

Between each measurement, a waiting period of at least 5 minutes shall be observed, so as to achieve thermal stability. Thermal stability is achieved if the temperature of the final RF power solid state amplifier does not change by more than 2 K per minute. During this time, the transmitter shall be in operation and transmitting with the new pulse length and PRF values.

#### Transmitter power

The measurement set-up shall be as described in Annex C.

The antenna shall be replaced by dummy load. On that flange a directional coupler will be mounted with its main port terminated by the dummy load. The transmitter power shall be referenced with respect to the output port of the radar transceiver.

The PEP shall be measured.

If the transmitter power is varied over the azimuth coverage, the highest PEP value set shall be considered.

#### Measured B-40 bandwidth

Measurement setup shall be as described in Annex C.

The measurements of the B-40 bandwidth shall be performed with the same settings as in clause 5.4.1.5 (Unwanted emissions). The bandwidth of the emissions 40 dB below PEP shall be measured.

The B-40 bandwidth shall be measured for the minimum and the maximum operating frequencies (Fmin and Fmax) and for each carrier in case of radars using multiple carrier frequencies.

#### Measured B-20 bandwidth

Measurement setup shall be as described in Annex C.

The measurements of the B-20 bandwidth shall be performed with the same settings as in clause 5.4.1.5 (Unwanted emissions). The bandwidth of the emissions 20 dB below PEP shall be measured.

The B-20 bandwidth shall be measured for the minimum and the maximum operating frequencies (Fmin and Fmax) and for each carriers in case of radars using multiple carrier frequencies.

#### Unwanted emissions

##### Out-of-Band-emissions

The measurement set-up shall be as described in Annex C.

The transmitter spectrum shall be measured at the output port of the transceiver as illustrated in figure C.1.

For single-frequency radars, the Out-of-Band power emissions shall be measured in the frequency range given in Table 5. For multi-frequency radars, the Out-of-Band power emissions shall be measured in the frequency range given in Table 6.

.

Table 5: Out-of-Band emissions boundaries for single frequency

|  |  |
| --- | --- |
| Lower OoB measurement limit | Upper OoB measurement limit |
| Maximum (Carrier frequency -15,8 x*B-40* , 1454 MHz) | Carrier frequency + 15,8 x*B-40* |
| NOTE1: 1454 MHz corresponds to 0,7 x Cut-off frequency of the waveguide specified in ERC 74/01  NOTE2: B-40 is calculated from the formulae in Annex B | |

Table 6: Out-of-Band emissions boundaries for multiple frequency

|  |  |
| --- | --- |
| Lower OoB measurement limit | Upper OoB measurement limit |
| Maximum (Centre frequency -2,3 x *B-40* , 1454 MHz) | Centre frequency + 2,3 x *B-40* |
| NOTE1: 1454 MHz corresponds to 0,7 x Cut-off frequency of the waveguide specified in ERC 74/01  NOTE2: B-40 is calculated from the formulae in Annex B | |

All measurements of Out-of-Band emissions shall be made with measurement bandwidth equal to the reference bandwidth of 1 MHz according to Annex 2 of Recommendation ITU-R 1177-4 [4].

A noise margin of the measurement equipment shall be at least 10 dB below the Out-of-Band emission limits

EXAMPLE : with a centre frequency of 2,8 GHz, a pulse duration of t = 100 µs and a rise time of tr = 200 ns, the 40 dB bandwidth calculated applying the equation given at Appendix C is ≈ 10MHz depending on the modulation bandwidth. This leads to OoB boundaries at 100 dB below peak power of the carrier equal to 15,8 × 10 MHz = 158 MHz away from the centre frequency. For this example (case of single carrier frequency), the absolute boundaries between out-of-band emissions and spurious emissions are: 2,8 GHz – 0,158 GHz = 2,642 GHz and 2,8 GHz + 0,158 GHz = 2,958 GHz.

##### Spurious emissions

The measurement set-up shall be as described in Annex D.

The spurious power emission shall be measured in frequency ranges outside the Out-of-Band emissions boundaries as shown in Table 7.

For the measurements below 3 950 MHz, a WR284/R32/WG10 waveguide shall be used as indicated in Table 8. The lower measurement frequency shall be equal to 0,7 times the waveguide cut-off frequency of 2 077 MHz while the upper boundary is defined in Table 1 of ERC/Recommendation 74-01 [1] (see Table 8).

All measurements of spurious emissions shall be made with a reference bandwidth of 1 MHz according to ERC/Recommendation 74-01 [1].

Table 7: Spurious emissions measurement bands

|  |  |
| --- | --- |
| Lower band measurement limit | Upper band measurement limit |
| From 1454 GHz  to the lower OoB boundary | From the upper OoB boundary  to 15,5 GHz |
| NOTE 1: the lower limit correspond to the cut-off frequency of the WR-284/R32/WG10 waveguide as defined in IEC 60153-2 [i.7]  NOTE 2: the upper limit corresponds to the 5th harmonic of 3.1 GHz as defined in ERC Recommendation (74) 01 [3] | |

NOTE: The radars covered by the present document use waveguides to transfer power between the transmitter and the antenna and the waveguide is selected such that the cut-off frequency is always above 1 GHz as shown in Table 7. Therefore, measurements below this frequency do not provide valid results since the waveguide is unable to support power transfer along its length below the cut-off frequency.

Wave propagation in the waveguide is not possible below a certain cut-off frequency where the attenuation of the waveguide is very high. Beyond a certain upper frequency limit, several propagation modes are possible so that the behavior of the waveguide is no longer unambiguous. In the unambiguous range of a rectangular waveguide, only TE1,0 waves are capable of propagation. In the WG12 waveguide the cut-off frequency is 3 152 MHz which is higher than the operating frequency of the S-Band ATC radar systems. Therefore, at least a 15 cm long WG12 waveguide shall be inserted in the measurement setup in order to protect the measurement device from the operating frequency in the WG12 and higher waveguide bands. The waveguide acts as a high pass in this setup.

Due to the ambiguous propagation modes of the used S-Band waveguide for higher frequencies, smaller waveguides with linear tapers shall be used for the measurement of higher frequencies. These frequency ranges are also referred to as waveguide bands as described in Table 8.

Each waveguide band shall be measured with its corresponding waveguide resulting in unambiguously measurements for the spurious measurements.

EXAMPLE: For the measurement of the frequency range 5,85 GHz to 8,2 GHz the following setup is used: a taper from WG10 to WG12 followed by a second taper from WG12 to WG14, followed by at least 15 cm of WG14 waveguide terminated with a WG14 to coax transition.

Table 8: Waveguide bands and associated waveguides

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Waveguide band | Frequency | Cut-off frequency | Waveguide designation | | |
| EIA | UK | R |
| S | 2 600 MHz to 3 950 MHz | 2 077 MHz | WR284 | WG10 | R32 |
| C | 3 950 MHz to 5 850 MHz | 3 152 MHz | WR187 | WG12 | R48 |
|  | 5 850 MHz to 8 200 MHz | 4 300 MHz | WR137 | WG14 | R70 |
| X | 8 200 MHz to 12 400 MHz | 6 556 MHz | WR90 | WG16 | R100 |
| Ku | 12 400 MHz to 18 000 MHz | 9 486 MHz | WR62 | WG18 | R140 |

NOTE: In the taper from the WG10 to the WG12 waveguide, the high power transmitted on the operating frequency is completely reflected and oriented to the dummy load by the circulator of the test bench.

##### Stand-by mode emissions

The measurement set-up shall be as described in Annex D.

The radar system shall be placed in stand-by mode.

The standby mode emissions shall be measured in the frequency ranges outside ± 2,5 times the measured necessary bandwidth aside the carrier frequency and with a reference bandwidth as shown in Table 8. A WR-284/R32/WG10 waveguide as defined in IEC 60153-2 [i.7] shall be used. In case of a multifrequency radar, standby mode emissions shall be measured for each operating frequency.

Table 9: Frequency range for measurement and Reference Bandwidths

|  |  |
| --- | --- |
| Frequency Range | RBWREF |
| 1,454 GHz ≤ f < fm1 | 1 MHz |
| fm2 ≤ f ≤ 15,5 GHz | 1 MHz |
| NOTE 1: f is the measurement frequency.  NOTE 2: fm1 = fc - 2,5 x BN where BN is the measured Necessary Bandwidth, i.e. the B-20 bandwidth measured in clause 5.4.1.4  NOTE 3: fm2 = fc + 2,5 x BN .  NOTE 4: if 2 carrier frequencies are close to each other so that the Necessary Bandwidths related to the 2 carrier frequencies overlap, then fm1 = fc1-2,5 x BN1 and fm2 = fc2+2,5 x BN2 where BN1 is the Necessary Bandwidth of fc1 and BN2 is the Necessary Bandwidth of fc2  NOTE 5: The Out-of-Band Domain is defined in clause 4.2.1.4.2  NOTE 6: 1,454 GHz correspond to 0,7 times the cut-off frequency of the WR-284/R32/WG10 waveguide as defined in IEC 60153-2 [i.7]  NOTE 7: 15,5 GHz corresponds to the 5th harmonic of the upper limit of the operating frequency band (3.1 GHz) as defined in ERC Recommendation (74) 01 [3] | |

NOTE: The radars covered by the present document use waveguides to transfer power between the transmitter and the antenna and the waveguide is selected such that the cut-off frequency is always above 1 GHz. Therefore, measurements below this frequency do not provide valid results since the waveguide is unable to support power transfer along its length below the cut-off frequency.

All measurements of stand-by mode emissions shall be made with a reference bandwidth of 1 MHz as indicated in Table 9

### Receiver test specification

#### Noise Figure

The measurement set-up shall be as described in Annex E.

The Noise Figure *NF* of the radar receiver is measured along the complete receiving signal chain. It shall be measured using a calibrated noise source and a power detector. The radar receiver should be tuned to the centre frequency of the operating band. The receiver frequency shall be documented in the test report.

The Y-factor method for the measurement of the receiver noise figure shall be used. A noise source with known Excess Noise Ratio (ENR) is connected to the radar receiver input port. The System Noise Figure is then determined from the ratio between the noise power values at output of the intermediate frequency stage (or its digitized equivalent) with noise source on and noise source off.

The Noise Figure can be calculated as:

And

Where:

* ENR is the Excessive Noise Ratio of the used noise source.
* Non is the output noise power with the noise source on.
* Noff is the output noise power with the noise source off.

In case of a multifrequency radar, the Noise Figure shall be measured for each operating frequency.

#### Receiver Compression Level

The measurement set-up shall be as described in Annex E.

The receiver shall be tuned to the centre frequency of the operating frequency band. The receiver frequency shall be documented in the test report.

A CW test signal tuned at the operating frequency shall be injected into the radar receiver input port. The gain response curve of the complete receiver shall be measured at the output of the matched filter of the radar receiver and the 1 dB compression point shall be noted (see Figure 5 above).

In case of a multifrequency radar, the receiver compression level shall be measured for each operating frequency.

#### Receiver selectivity

##### General setup

The measurement setup shall be as described in Annex E figure E.1.

In order to determine if the receiver selectivity follows the required mask, a disturbing test signal level is applied at the radar receiver input port and the residual level of test signal is measured at the output of the matched filter of the radar receiver.

##### Disturbing Test Signals

The disturbing signal shall be a CW signal. The input level of the disturbing signal shall be 6 dB below the measured compression level obtained from §5.4.2.2 such that the receiver will not be saturated.

##### Measurement Points

The receiver selectivity measurements shall be performed in the range from 2 200 MHz to 3 600 MHz and shall always include the image frequency present in the receiver design. If the image frequency does not fall within the above mentioned frequency range, the measurement range shall be augmented so as to cover the image frequency of the operating frequencies, i.e. including the range [fimage-B-40/2, fimage+B-40/2].

A selectivity curve shall be built for the minimum and the maximum declared operating frequencies. The receiver frequency shall be documented in the test report for each measured selectivity curve.

The discrete frequency steps shall be equal to or lower than 1 MHz. They shall not exceed half of the bandwidth of the matched filter.

##### Measurement Procedure

In case of a single frequency radar:

1. The receiver operating frequency shall first be tuned to the minimum operating frequency Fmin.
2. The test signal shall be 6 dB below the measured compression level and shall be injected at the operating frequency, and the receiver output power shall be measured. This measured power shall be noted and used as the reference level RL0 for calculating the rejection value from the other following measurements. After the measurement, the test signal is turned off.
3. In order to get reference levels for the evaluation of rejection levels in the defined measurement bandwidth, the receiver output noise floor shall first be measured in the absence of disturbing signal and the level shall be noted as the reference measurement noise level. This level shall be below the selectivity mask otherwise the measurement dynamic range is not sufficient and needs to be adjusted
4. The disturbing signal shall be set 6 dB below the measured compression level
5. The disturbing signal shall then be applied at the starting frequency of measurement point at 2 200 MHz
6. The maximum level of the disturbing signal in the defined measurement bandwidth shall be measured at the output of the receiver and the difference to the reference level RL0 shall be plotted on the selectivity curve.
7. This measurement step e) shall be repeated for all discrete frequency steps ending at 3 600 MHz.
8. Steps from e) to g) shall be repeated for a frequency range [fimage-B-40/2, fimage+B-40/2] if the image frequency is outside the 2 200 MHz to 3600MHz range.
9. The operating frequency shall then be tuned to the maximum frequency Fmax of the operating range and the above procedure shall be repeated from step b).

In case of a multi-frequency radar, the above procedure from steps b) to e) shall be done for each receivers of the frequency arrangement with one of its paired operating frequencies tuned firstly at the lowest frequency in the operating range, then secondly at the highest frequency in the operating range

If spurious signals from the signal generator are present, this shall be documented in the test report.

# Annex A (informative): 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.2] 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 303 364-2 | | | | |
| --- | --- | --- | --- | --- |
| Requirement | | | Requirement Conditionality | |
| No | Description | Reference: Clause No | U/C | Condition |
|  |  |  |  |  |
| 1 | Operating frequency | 4.2.1.1 | U |  |
| 2 | Transmit Power | 4.2.1.2 | U |  |
| 3 | Measured -40 dB bandwidth | 4.2.1.3 | U |  |
| 4 | Out-of-Band emissions | 4.2.1.4.2 | U |  |
| 5 | Spurious emissions | 4.2.1.4.3 | U |  |
| 6 | Standby mode emissions | 4.2.1.4.4 | U |  |
| 7 | System Noise Figure | 4.2.2.1 | U |  |
| 8 | Receiver Compression Level | 4.2.2.2 | U |  |
| 9 | Receiver Selectivity | 4.2.2.3 | 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 is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

**Condition** Explains the conditions when the requirement is or is not 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): Calculation of the B-40 bandwidth

Annex 8 of Recommendation ITU‑R SM.1541‑6 [i.3] defines B-40 for various types of waveforms (e.g. pulsed radar signals). Assuming that:

* the radar is operating in the band 2 700 MHz to 3 100 MHz;
* the pulse rise time *tr* is greater than 0,0094∙*t*, where *t* is the pulse duration.

For primary non-FM pulse radars B-40 is determined as follows:

 (1)

Where:

*t* is the pulse duration.

*tr* is the rise time in the case of a trapezoidal pulse.

NOTE: For non-FM pulse PSR radars, typical values of a pulse duration of *t* = 1µs and a rise time of *tr =* 200 ns the formula above yields a ‑40 dB bandwidth value of 17 MHz.

For pulse FM radars, two formulas are specified in ITU‑R SM.1541‑6 [i.3] for B-40:

(2)

Where:

* B-40 is the -40 dB bandwidth in Hz;
* BC is the bandwidth of the frequency deviation (total frequency shift during the pulse generation);
* τ is the pulse length including rise & fall times;
* to account for the rise time. (3)
* to account for the fall time. (4)
* to account for both the rise and fall times combination. (5)
* tr is the rise time in seconds;
* tf is the fall time in seconds,

(6)

Where:

* K = 7.6 and A = 0,065

NOTE: The term A/tr adjusts the value of B−40 to account for the influence of the rise time, which is substantial when the time-bandwidth product Bc ∙ t, is small or moderate and the rise time is short.

NOTE: For FM pulse PSR radars, typical values for a pulse duration of t = 100µs and a rise time of tr = 200 ns the formulas above yield a ‑40 dB bandwidth value of ≈10 MHz depending on the modulation bandwidth.

Equation (2) is only valid when the following conditions are both met:

1. The product BC ∙ Minimum (tr, tf) is greater than or equal to 0.10 and
2. the product of BC ∙ τ or compression ratio is greater than 10.

In all other cases, equation (6) is used.

For radars with an asymmetrical spectrum (e.g. magnetron based radars), the B-40 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.1541‑6 [i.3].

The application of this rule is illustrated in figure B.1.



Figure B.1: Application of the offset-rule for the Out-of-Band emission limit mask

# Annex C (normative): Operating frequency, transmitter power and Out-of-band emissions measurement set-up



Figure C.1: Method for Operating frequency, transmitter power and unwanted Out-of-band emissions measurements

The indirect method for radio frequency measurements is performed at the waveguide output of the transceiver with dismounted connection toward the antenna system.

A WR-284/WG10/R32 waveguide as defined in IEC 60153-2 [i.7] shall be used to connect the transceiver output.

The method for measurement of the operation frequency, transmit power as well as out‑of-band, stand-by emissions shown in figure C.1 shall be applied.

The length of the WG10 waveguide between the output of the transceiver and the coupler shall be at least of 20cm, to avoid measurement of potential evanescent waves.

The coupling ratio of the waveguide coupler shall be added to the measurement.

To determine the Peak Envelope Power of the pulse, a peak power meter with direct reading of the transmitter peak power shall be used.

NOTE: To obtain a sufficient dynamic range, the radar signal may need to be suppressed by e.g. adding a notch filter.

# Annex D (normative): Spurious and stand-by emissions measurement set-up



Figure D.1: Method for the spurious emissions measurements

The indirect method for radio frequency measurements is performed at the waveguide output of the transceiver with dismounted connection toward the antenna system which is replaced by a dummy load.

The method for measurement of the spurious and stand-by emissions shown in figure D.1 shall be applied.

The length of the WG10 waveguide between the circulator and the coupler shall be at least of 20cm, to avoid measurement of potential evanescent waves.

The coupling ratio from the WG10 waveguide coupler shall be added to the measurement on this sub-band.

The length of the WG12 waveguide, used as high pass filter, shall be at least of 15cm.

The frequency ranges of the used waveguides to coaxial transition can be seen in Table 8.

NOTE: To obtain a sufficient dynamic range, the radar signal may need to be suppressed by e.g. adding a notch filter to the attenuators.

# Annex E (normative):

# Receiver noise factor, compression level, and selectivity measurement set-up



Figure E.1: Method for receiver measurements

The method for measurements of the noise factor, compression level and receiver selectivity of the transceiver shown in figure E.1 shall be applied.

The test signal shall be applied at the radar transceiver RF input port, and the measurement equipment shall be connected at the output the digital receiver. The values read at the output the digital receiver shall be representative of the internal values from the output of the digital matched filter function.

The radar transmitter shall be placed in stand-by mode.

For noise factor measurement, the noise level shall be applied using a noise source connected to WG10 waveguide coupler.

For compression level measurement, the test signal shall be applied using a RF signal generator connected to WG10 waveguide coupler.

For selectivity measurement, the disturbing signal shall be applied using a signal generator and the appropriate waveguide and coupler as defined below:

* WG10 for perturbing signal with a frequency between 2 200 MHz and 2 600 MHz
* WG12 for perturbing signal with a frequency between 2 600 MHz and 3 600 MHz
* WG10 if the image frequency is between 1454 MHz and 2200 MHz
* WG14 if the image frequency is between 3 600 MHz and 8 200 MHz. The WG14 shall follow the WG12 as shown in Figure E.1 (dotted line)
* In order to measure the 60 dB suppression of the disturbing test signal, the dynamic range of the power measurement equipment shall be at least of 70 dB.

NOTE: One technique to increase the dynamic range of the measurement equipment is to collect a set of uncorrelated data samples of measured values and to perform a rms evaluation across these collected samples.

For all measurements, the coupling ratio of the used waveguide coupler shall be added to the measured values from the measurement equipment.

# Annex F (informative):

# Maximum Measurement Uncertainty

Table F.1 below shows the recommended values for the maximum measurement uncertainty figures.

Table F.1: Maximum measurement uncertainty

|  |  |
| --- | --- |
| Parameter | Uncertainty |
| **Environment measurements** | |
| Temperature | 1 °C |
| Relative humidity | 5 % |
| Transmitter measurements | |
| Frequency tolerance | ±1 ppm |
| Transmitter power | ±1,5 dB |
| Out-of-Band emissions | ± 4 dB |
| Spurious emissions | ± 4 dB |
| Mains Supply Voltage | ± 2 % |
| **Receiver measurements** | |
| Noise Figure | ± 1dB |
| Receiver Selectivity | ± 4 dB |
| Receiver Compression Level | ± 1 dB |

Annex G (informative): Checklist

This annex provides a traceability of the technical parameters for article 3.2 of Directive 2014/53/EU [i.1] defined in ETSI EG 203 336 [i.6] with the technical requirements for conformance defined in clause 4 of the present document. If a technical parameter for article 3.2 of Directive 2014/53/EU [i.1] defined in ETSI EG 203 336 [i.6] has not been included in the present document, an explanation is provided. An explanation is also provided whenever a technical parameter defined in ETSI EG 203 336 [i.6] is covered by an alternative technical requirement.

Some technical parameters defined in ETSI EG 203 336 [i.6] are applicable only to communication systems and not to non-cooperative radar systems such as ATC radar systems. Non-cooperative radar systems are different from radiocommunication systems since they do not communicate with a known target with known properties. They continually scan for unknown targets of any nature and do not adjust receiver or transmitter parameters according to what they detect.

Table G.1: Checklist

|  |  |  |
| --- | --- | --- |
| **Technical Parameters defined in EG 203 336 [i.6]** | **Clauses of the present document** | **Comments** |
| **Transmitter Parameters** | | |
| Transmit power (and possible accuracy) | 4.2.1.2 |  |
| Spectrum mask | 4.2.1.4 |  |
| Transmitter Frequency stability | 4.2.1.1 |  |
| Transmitter Intermodulation attenuation | na | At the transceiver output an RF circulator is used as indicated in the Scope. This prevents an interfering signal entering from the antenna into the transmitter. |
| Unwanted emissions (OoB and spurious domains) | 4.2.1.4.1  4.2.1.4.2  4.2.1.4.3 |  |
| Transmitter Time domain characteristics (e.g. e.g. the duty cycle, turn-on and turn-off, frequency hopping cycle, dynamic changes of  modulation scheme and others) | na | ATC radar systems are not able to share the used operating frequency band as commonly used with communication systems. Otherwise the reception of the echoes would not be possible if another system transmitted during its reception. |
| Transmitter Transients | 4.2.1.4.1  4.2.1.4.2  4.2.1.4.3 | This is covered by the unwanted emission. In the OoB and spurious domain. |
| **Receiver Parameters** | | |
| Receiver sensitivity | 4.2.2.1 | The radar output power is not varied as a result of the received signal strength of a single target, which means that it does not affect the efficient use of the radio spectrum. Nevertheless an integral part of the receiver sensitivity is the noise figure. |
| Receiver co-channel rejection | na | ATC radar systems in the same location cannot operate on the same operating frequency, as it would not be possible to meet safety requirements |
|  | | |
|  |  |  |
| Spurious response Rejection | 4.2.2.3 |  |
|  | | |
| Receiver blocking | 4.2.2.2 | Receiver Blocking is addressed by requiring a sufficiently high compression level in the receiver. |
| Receiver radio-frequency intermodulation | 4.2.2.2 |  |
| Adjacent band/channel selectivity | 4.2.2.3 | ATC radar systems are not operating in a channelized frequency arrangement. Therefore, the requirements for selectivity differ from scenarios with channelization. Adjacent band/channel selectivity for multiple signals is not only addressed by requiring a sufficiently high compression level in the receiver but also the adjacent band/channel selectivity for single signals. |
|  | | |
| Receiver dynamic range | 4.2.2.1  4.2.2.2 | The lower end of the receiver dynamic range is addressed by the noise figure. The upper end is addressed by the receiver compression level. |
| Reciprocal mixing | 4.2.2.2  4.2.2.3 | Interference characteristics are specified in terms of selectivity and/or blocking requirements, thus removing the need for this parameter to be explicitly included, as the effects of receiver selectivity and reciprocal mixing cannot be separated. |
| Desensitization | 4.2.2.3 | Desensitization is linked to the receiver compression level and the receiver selectivity test where the receiver is subject to disturbance signals of levels up to the compression level. |
| Receiver unwanted emissions in the spurious domain | 4.2.1.4 |  |

# Annex H (informative): Bibliography

# Annex J (informative): Change history

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| **Document history** | | |
| V1.0.0 | December 2018 | Draft |
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