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Meteorological Radars;
Harmonised Standard for access to radio spectrum;
Part 3: X band Meteorological Radar Sensor operating in the frequency band 9 300 MHz to 9 500 MHz

Reference

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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

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

The present document is part 3 of a multi-part deliverable covering meteorological radar systems for different frequency bands, as identified below:

Part 1: "S band Meteorological Radar Sensor operating in the frequency band 2 700 MHz to 2 900 MHz";

Part 2: "C band Meteorological Radar Sensor operating in the frequency band 5 250 MHz to 5 850 MHz";

Part 3: "X band Meteorological Radar Sensor operating in the frequency band 9 300 MHz to 9 500 MHz".

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	18 months after doa

Modal verbs terminology

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

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

1 Scope

The present document specifies technical characteristics and methods of measurements for X-band meteorological radar systems intended for the surveillance and classification of hydrometeors with the following characteristics:

- Operating in the following frequency range:
  - 9 300 MHz to 9 500 MHz
- Utilizing unmodulated pulses or phase/frequency modulated pulses also known as pulse compression.
- The maximum output power (PEP) is not greater than 250 kW (i.e. 84 dBm).
- The transceiver antenna connection and its feeding RF line are using a hollow metallic rectangular or elliptic waveguide.
- The antenna is rotating and can be changed in elevation.
- The antenna feed is waveguide based and the antenna is passive.
- The orientation of the transmitted field from the antenna can be vertical or horizontal orientated or it can be both simultaneously.
- At the transceiver output a RF circulator is used.

NOTE 1: Since transceiver and antenna are based on hollow metallic rectangular waveguide the frequency range for measurements that needs to be addressed covers 6 556 MHz to 26 GHz. The lower limit of this frequency range is obtained as the cut-off frequency of the generally used WR90/WG16 waveguide according to IEC 60153-2 [i.2]. The upper limit corresponds to the upper limit stated in ERC/Recommendation 74-01 [1], Table 1.

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

NOTE 3: Meteorological radar systems covered by the present document are expected to use the band 9 300 MHz to 9 500 MHz. According to provision 5.475B of the ITU Radio Regulations [4], ground-based radars used for meteorological purposes in the band 9 300 MHz to 9 500 MHz have priority over other radiolocation uses.

NOTE 4: Further technical and operational characteristics of meteorological radar systems can be found in Recommendation ITU-R M.1849-1 [i.3].

NOTE 5: 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] ERC/Recommendation 74-01 (2011): "Unwanted emissions in the spurious domain".

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

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

[4] 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.

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] IEC 60153-2 (Edition 2.0, 1974): "Hollow metallic waveguides. Part 2: Relevant specifications for ordinary rectangular waveguides".

[i.3] Recommendation ITU-R M.1849-1 (09/2015): "Technical and operational aspects of ground-based meteorological radars".

[i.4] Recommendation ITU-R SM.1541-6 (08/2015): "Unwanted emissions in the out-of-band domain".

[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.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

active state: 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. A generic frequency allocation table is also available in the ITU Radio Regulations [4].

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 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.

frequency tolerance: 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

NOTE 1: The frequency tolerance is expressed in parts in 10^6 or in Hertz.

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

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

necessary bandwidth B_N: 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 the ITU Radio Regulations [4].

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 $\beta/2$ of the total mean power of a given emission

NOTE 1: Unless otherwise specified in a Recommendation ITU-R for the appropriate class of emission, the value of $\beta/2$ should be taken as 0,5 %.

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

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.

out-of-band emission: emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious

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

peak envelope power (of a radio transmitter): 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 the ITU Radio Regulations [4].

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

pulse duration: time in seconds between the 50 % amplitude (voltage) points of a transmitted pulse

pulse rise time: time taken for the leading edge of the pulse to increase from 10 % to 90 % of the maximum amplitude (voltage) in seconds

receiver selectivity: ability of a receiver to detect and decode a desired signal in the presence of an unwanted interfering signal which is usually in the adjacent band

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].

spurious emission: emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

NOTE 1: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

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

system coupler: high power 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.

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
dB/dec	dB per decade
dBpp	dB with respect to peak power
f_c	characteristic frequency
f_t	transmitter frequency tolerance
k	Boltzmann's constant
t	Pulse duration
t_r	Pulse rise time

3.3 Abbreviations

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

A/D	Analog to Digital converter
AC	Alternating Current
CW	Continuous Wave
EFTA	European Free Trade Association
EIA	Electronic Industries Alliance
FM	Frequency Modulation
IF	Intermediate Frequency
LNA	Low Noise Amplifier
LNFE	Low Noise Front End
MDS	Minimum Detectable Signal
OoB	Out-of-Band
PEP	Peak Envelope Power
PM	Phase Modulation
PRF	Pulse Repetition Frequency
RF	Radio Frequency
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 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 system produces microwave pulses, which cause a broad frequency spectrum depending on the pulse duration. The operating frequency is the frequency of the microwave emission during the transmitting pulse and is represented by the spectral line of highest amplitude. For phase/frequency modulated radar systems the operating frequency is to be understood as the centre between the highest and lowest transmitted frequency. The frequency tolerance is the maximum permissible departure from the operating frequency.

4.2.1.1.2 Limits

The frequency tolerance for meteorological radar systems shall not exceed:

$$\mathrm{f_t} = 1\,250 \cdot 10^{-6} \cdot \mathrm{f_c} = 1\,250\ ppm \qquad (1)$$

as specified in Appendix 2 of ITU Radio Regulations [4].

4.2.1.1.3 Conformance

The conformance tests are specified in clause 5.4.1.1.

4.2.1.2 Transmitter output power

4.2.1.2.1 Definition

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

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

4.2.1.2.2 Limits

The transmitter power shall not exceed 250 kW (i.e. 84 dBm).

NOTE: The maximum transmitter power may be subject to national regulations.

4.2.1.2.3 Conformance

The conformance tests are specified in clause 5.4.1.2.

4.2.1.3 Measured B_{-40} 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 PEP.

4.2.1.3.2 Limits

For all radar types covered by the present document the measured B_{-40} 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 in the declared band.

NOTE: The declared band is always contained in the 9 300 MHz to 9 500 MHz frequency range.

4.2.1.3.3 Conformance

The conformance tests are specified in clause 5.4.1.3.

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 clause 4.2.1.5.1 for the definition of spurious region).

For meteorological radar systems with multiple pulse length, the B_{-40} bandwidth shall be calculated for each individual used pulse length and the maximum B_{-40} bandwidth obtained shall be used to establish the shape of the emission mask.

NOTE: The shortest pulse length used is usually 500 ns.

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.

The applicable formulae for the calculation of the B_{-40} bandwidth are described in Annex B.

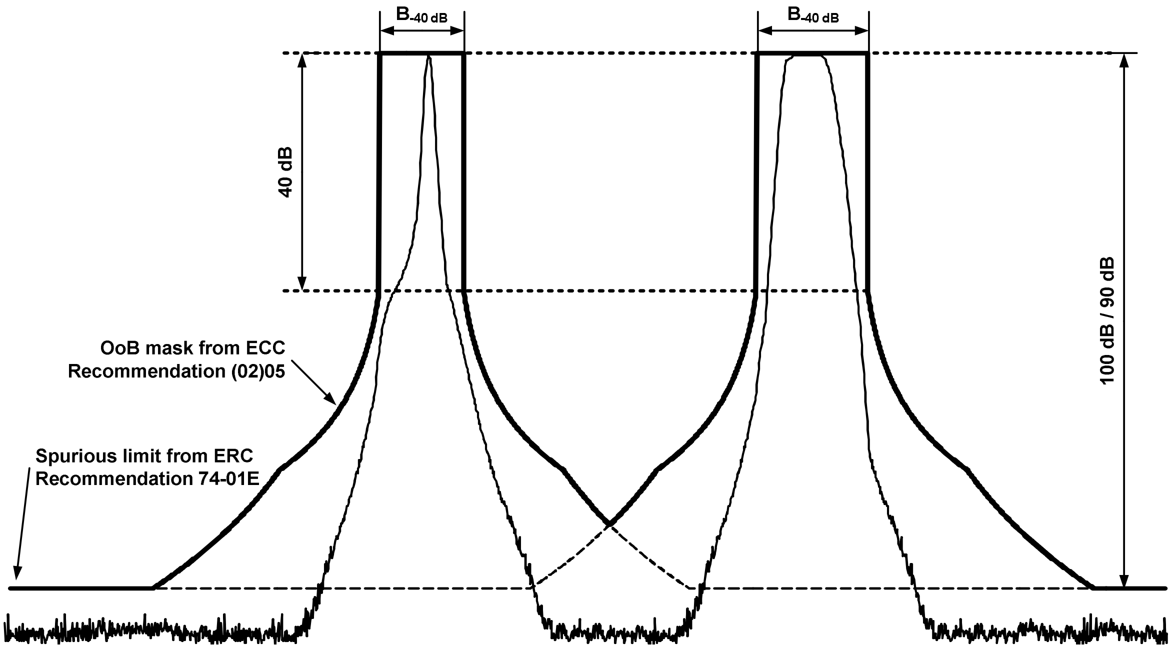

Figure 1: Example of superimposed (combined) mask from two carrier frequencies

4.2.1.4.2 Limits

Depending on the PEP power the maximum OoB emission power level shall not exceed the limits stated in Table 1 or Table 2 and shall not exceed the corresponding mask depicted in Figure 2 as specified in Annex 2 in ECC/Recommendation (02)05 [2]. The roll-off of the OoB mask beyond the B_{-40} bandwidth in relation to B_{-40} is specified as follows:

- The mask has a roll-off at 30 dB/dec from the calculated (identified) B_{-40} bandwidth to a level of -70 dBpp.
- The mask then continues to roll-off at 60 dB/dec to a spurious emission limit level of -100 dBpp or -90 dBpp with regard to the PEP.

NOTE 1: The -100 dBpp mask corresponds to the dashed line in Figure A2.1c and the -90 dBpp corresponds to the dashed line in Figure A2.1b of unwanted emissions in Annex 2 of the ECC/Recommendation (02)05 [2].

NOTE 2: ERC/Recommendation 74-01 [1] stipulates in its Table 5.1 for meteorological radars a spurious emission limit in the reference bandwidth of "-30 dBm or 100 dB/90 dB below PEP, whichever is less stringent".

Table 1: Limits for Out-of-Band emissions for a PEP of greater than 150 kW

Multiple of the B_{-40} bandwidth	Limit dBpp	Slope dB/decade
0,5	-40	$-\infty$
0,5 to 5	-40 to -70	-30
5 to 10,8	-70 to -90	-60

Table 2: Limits for Out-of-Band emissions for a PEP of equal or lower than 150 kW

Multiple of the B_{-40} bandwidth	Limit dBpp	Slope dB/decade
0,5	-40	-∞
0,5 to 5	-40 to -70	-30
5 to 15,8	-70 to (-100 or -30 dBm, see note)	-60
NOTE: -70 dBpp to -100 dBpp or -30 dBm whichever is less stringent.		

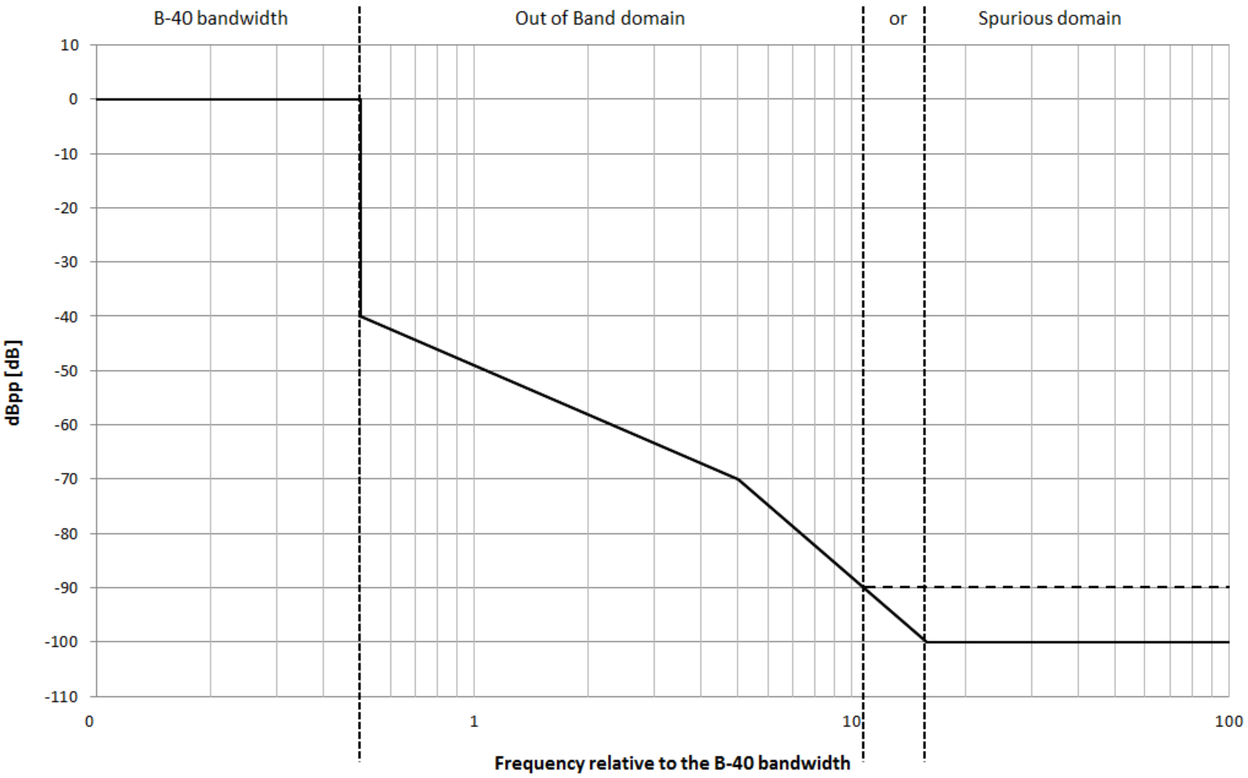

Figure 2: Unwanted emission limit masks

4.2.1.4.3 Conformance

The conformance tests are specified in clause 5.4.1.4.

4.2.1.5 Spurious emissions

4.2.1.5.1 Definition

Spurious emissions are defined as the entity of all emissions in the frequency range from the cut-off frequency 6 556 MHz of the waveguide section to 26 GHz, but outside B_{-40} boundaries and outside the OoB domain.

NOTE: The lower limit of this frequency range is obtained as the cut-off frequency of the generally used WR90/WG16 waveguide according to IEC 60153-2 [i.2]. The upper limit corresponds to the upper limit stated in ERC/Recommendation 74-01 [1], Table 1.

They include:

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

The boundaries between OoB domain and the spurious domain are where the OoB limit mask specified in Annex 2 in ECC/Recommendation (02)05 [2] reaches the spurious emission limit of -100 dBpp or -90 dBpp or -30 dBm according to ERC/Recommendation 74-01 [1], Table 5.1. This is illustrated in Figure 3.

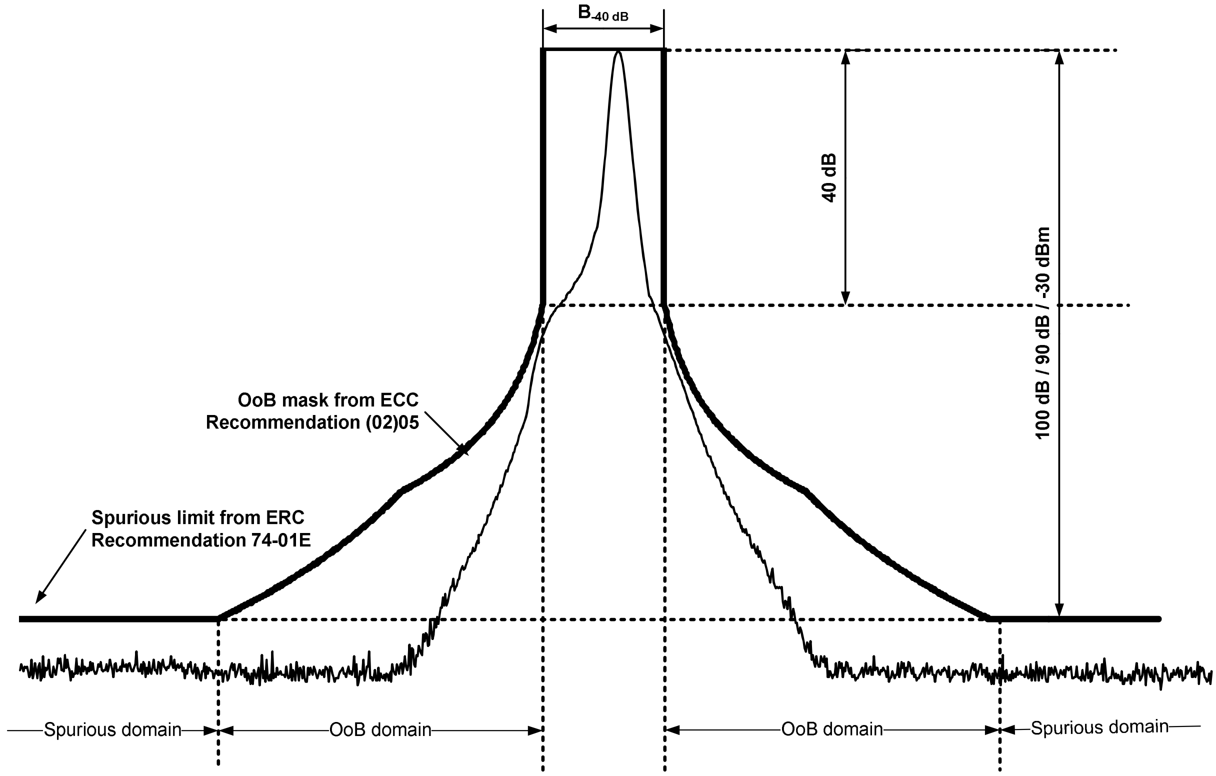

Figure 3: Definition of OoB and spurious emission domains for non FM/PM pulsed radar (Not to scale)

4.2.1.5.2 Limits

For meteorological radar systems the spurious emission limits are related to the PEP. The limits shall be as specified in Table 3 and also defined in ERC/Recommendation 74-01 [1], Annex 5, Table 5.1.

The spurious emission limits are either absolute levels (dBm in PEP in the reference bandwidth) or attenuation (dB) below the PEP supplied to the antenna port.

Table 3: Spurious emission levels

Transmitter PEP	Spurious emission limits
< 10 kW	-30 dBm
10 kW ≤ PEP ≤ 150 kW	100 dB
> 150 kW	90 dB

The spurious domain emission limits shall take into account the attenuation of spurious domain emissions by the antenna as indicated in Annex 5 of ERC/Recommendation 74-01 [1].

NOTE: A reference bandwidth of 1 MHz is recommended for frequencies above 1 GHz as indicated in ERC/Recommendation 74-01 [1].

4.2.1.5.3 Conformance

The conformance tests are specified in clause 5.4.1.5.

4.2.1.6 Stand-by Mode Emissions

4.2.1.6.1 Definition

Stand-by Mode emissions refer to emissions radiated during periods of non-transmission (e.g. between pulses).

The stand-by mode output power is defined as the power output at the antenna flange in the spurious region.

For the stand-by mode the limits between OoB and spurious regions are considered the same as calculated for the active state.

4.2.1.6.2 Limits

The maximum allowed power level shall be -47 dBm as specified in Table 5.1 in ERC/Recommendation 74-01 [1] when measured with a measurement bandwidth of 1 MHz.

4.2.1.6.3 Conformance

The conformance tests are specified in clause 5.4.1.6.

4.2.2 Receiver Requirements

4.2.2.1 Noise Figure

4.2.2.1.1 Definition

The receiver noise figure measures the degradation of the signal-to-noise ratio, caused by components in the radio-frequency signal chain.

4.2.2.1.2 Limits

The maximum receiver noise figure shall be 6 dB.

4.2.2.1.3 Conformance

The conformance test is specified in clause 5.4.2.1.

4.2.2.2 Receiver selectivity

4.2.2.2.1 Definition

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

NOTE: Signals inside the B_{-40} bandwidth are not considered as interfering signals because they fall into the desired frequency range for the reception of wanted signals.

4.2.2.2.2 Limits

The input selectivity of the radar shall correspond to the requirements shown in Figure 4. The maximum power level of the unwanted signal, measured at the output of the LNFE, shall be no more than 12 dB above the calculated MDS level.

EXAMPLE 1: If the calculated MDS of the radar system is -102 dBm, then the maximum level of unwanted signals at the output of the LNFE is -90 dBm.

For radars with an asymmetrical spectrum, the calculated B_{-40} bandwidth can be offset from the operating frequency. The operating frequency shall be kept inside the calculated B_{-40} bandwidth.

The receiver selectivity shall be at least verified in the range of ±500 MHz from the operating frequency starting at the lower and upper B_{-40} frequency. The B_{-40} bandwidth shall be excluded from the receiver selectivity measurement. The minimum frequency range that is verified shall be in the frequency range from 8 800 MHz to 10 000 MHz. The manufacturer shall ensure that the swept frequency span encompasses all image frequencies present in the receiver design. If the image frequencies are not covered by the verified frequency range as defined above the range shall be extended to cover the image frequencies accordingly.

EXAMPLE 2: If the meteorological radar operates at 9 375 MHz and the B_{-40} is equal to 20 MHz than the lower frequency limit of the disturbing signal shall be 8 800 MHz. The upper limit will shall be equal to 10 000 MHz.

The receiver selectivity depends on an analogue filter and a digital matched filter. The analogue filter is wider than the matched filter due to the permissible frequency drift of the transmitter. Both receiver selectivity measurements are described in the following and shall be measured and documented.

NOTE: The matched filter bandwidth usually corresponds to the transmitted pulse length and is usually the inverse of the pulse length. For example, a 0,8 µs pulse length will result in a 1,25 MHz matched filter bandwidth.

In order to determine if the receiver selectivity follows the required selectivity mask, a disturbance signal level at the MDS level plus the required attenuation shall be applied. The maximum input level of the receiver shall be 6 dB below the compression level for the given receiver design. The minimum input level is the MDS level and is calculated by the following formula:

$$MDS(dBm) = -174\ dBm + NF_{(dB)} + BW_{(dB)} + L_{(dB)} \quad (2)$$

Where:

- -174 dBm is the noise power value in dBm, measured with 1 Hz bandwidth (B_N) at 290° Kelvin and derived from the available noise power N_i on the receiver input. $N_i = k \cdot T_0 \cdot B_N$. Where:
  - k Boltzmann constant = $1{,}38064852 \cdot 10^{-23} \frac{J}{K}$.
  - T_0 Temperature in Kelvin.
- $NF_{(dB)}$ is the receiver noise figure in dB. Measurement of the noise figure is described in clause 5.4.2.1.
- $BW_{(dB)}$ is the receiver or matched filter bandwidth in dB. Calculated as: $10 \cdot \log\left(BW_{(Hz)}\right)$.
- $L_{(dB)}$ are any additional losses in dB.

The power level which shall be applied at the lower and upper B_{-40} frequency is the MDS level + 40 dB as shown in Figure 4.

Table 4 shows the frequency offset relative to f_c with a calculated MDS value of -110 dBm and a maximum disturbance level of -30 dBm.

Table 4: Receiver selectivity mask

Frequency offset relative to f_c by multiple of the B_{-40} bandwidth	Maximum interfering power level dB above MDS	Slope dB/decade
0 to 0,5	None	0
0,5	40	-∞
0,5 to 5	+40 to 70 or -30 dBm (see note)	-30
5 to 10,8	70 to 90 or -30 dBm (see note)	-60
10,8 to ∞	-30 dBm	0
NOTE: The maximum input power of the receiver shall not exceed -30 dBm.		

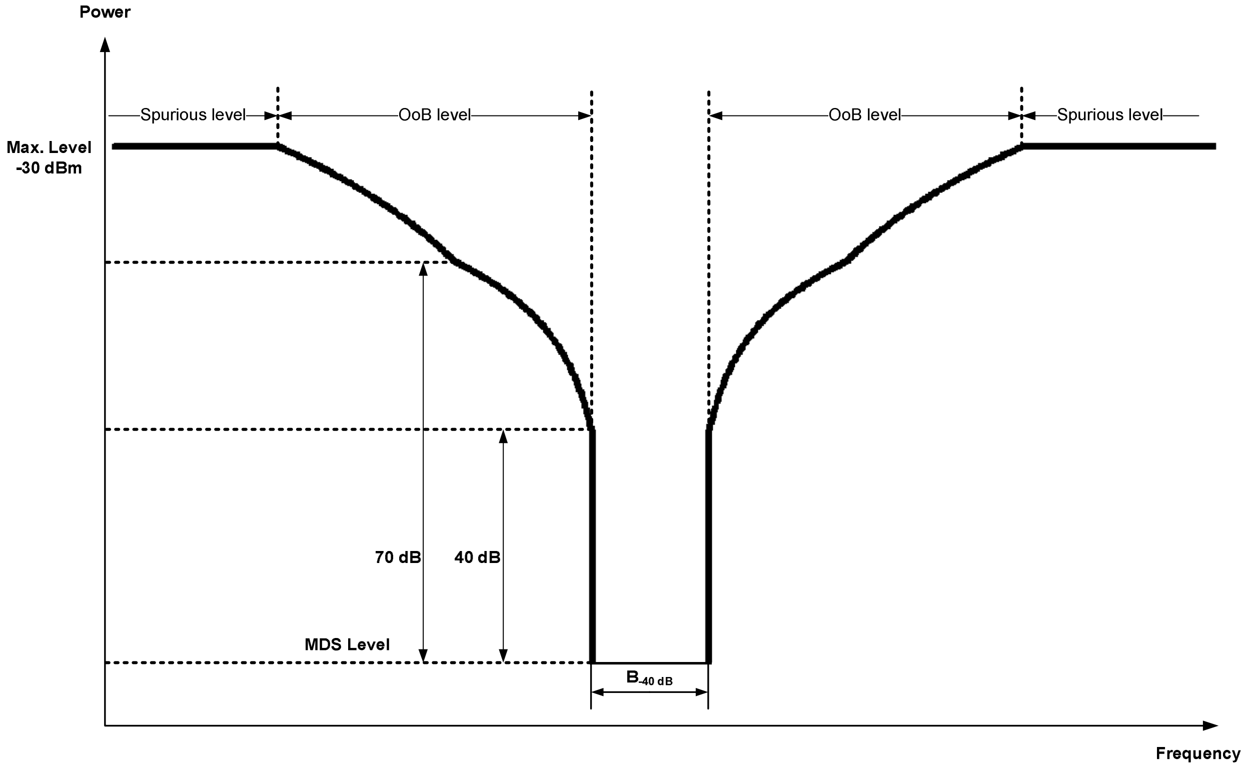

Figure 4: Resulting receiver selectivity mask (not to scale) - The maximum disturbance level was set to -30 dBm

4.2.2.2.3 Conformance

The conformance tests are specified in clause 5.4.2.2.

4.2.2.3 Receiver Compression Level

4.2.2.3.1 Definition

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

The receiver input compression level is defined as when the receiver output is 1 dB into compression as can be seen in Figure 5.

The compression level shall be measured at the nominal receiver frequency which is used to detect the desired signal generated by the transmitter.

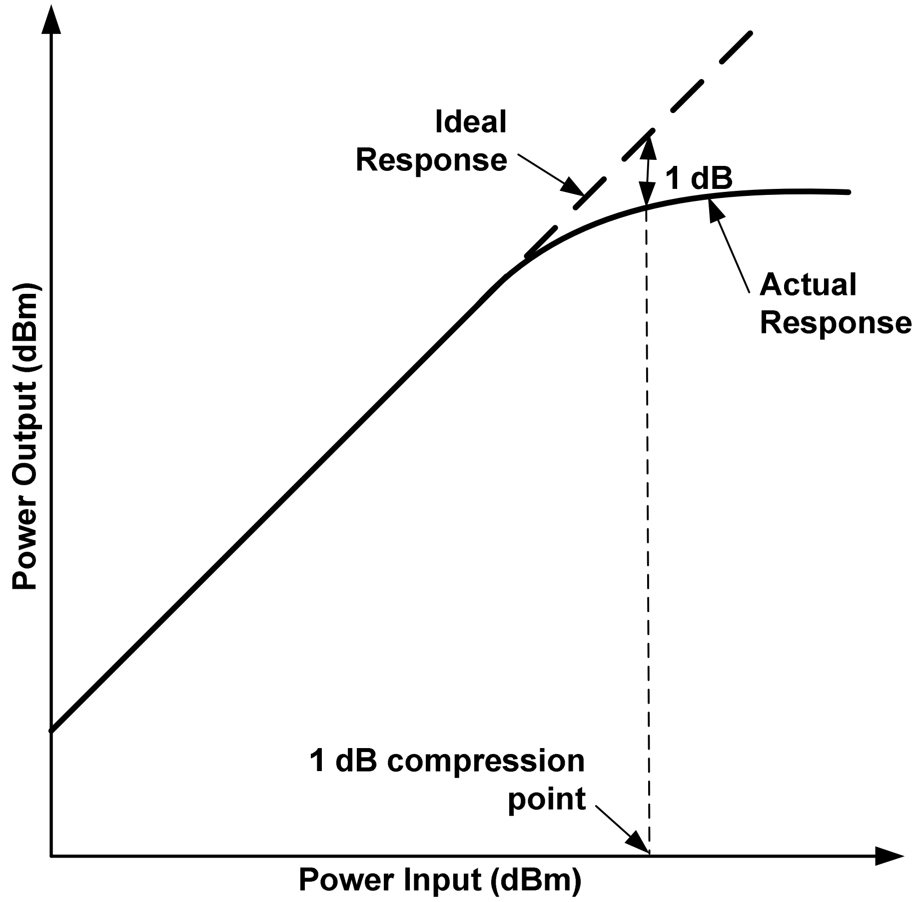

Figure 5: Illustration of finding the LNA input 1 dB compression point

4.2.2.3.2 Limits

The input of the radar shall be able to handle signal levels up to at least -35 dBm without being in compression.

NOTE 1: A high compression level corresponds to high immunity against blocking. Blocking is the effect when a strong Out-of-Band or spurious signal degrades the receiver ability to detect the wanted signal.

NOTE 2: Outside the B_{-40} dB bandwidth the maximum disturbance level is -30 dBm as stated in clause 4.2.2.2.2.

The measurement of the saturation signal shall be done at the IF output of the LNFE (analogue) and shall be done by data analysis at the output of the A/D converter (digital). The IF output of the LNFE is defined as the port which is connected directly via a RF connection to the A/D converter of the digital receiver in normal operation of the radar system. Both ports can be seen in Figure C.1.

4.2.2.3.3 Conformance

The conformance tests are specified in clause 5.4.2.3.

5 Testing for compliance with technical requirements

5.1 General requirements

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

5.2 Environmental conditions for testing

5.2.1 Test Conditions

Unless otherwise stated, all tests shall take place under the following normal test conditions.

The standard operating parameters depend very much on the type of the radar. If a particular operating mode is used for measurement this shall be noted by the manufacturer.

5.2.2 Normal temperature and humidity

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

a) temperature: +15 °C to +35 °C.

b) relative humidity: not exceeding 75 %.

5.2.3 Normal test power supply

The test voltage for the equipment to be connected to an AC supply shall be the nominal mains voltage declared by the manufacturer including a variation of ±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.

5.3 Interpretation of the measurements 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 documented in the test report.

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

5.4 Radio test suites

5.4.1 Transmitter test specification

5.4.1.1 Frequency Tolerance

The antenna shall be replaced by a high power dummy load. The forward port of the system coupler shall be used and shall have an adequate attenuation. An optional reverse port shall be terminated with an appropriate 50 Ω terminator.

To measure the frequency tolerance a frequency meter or spectrum analyser shall be used. The frequency meter shall be capable of measuring the short RF pulses. An additional attenuator shall be used if needed in order to protect the frequency meter input from the high power RF pulses. The measurement setup from Annex C shall be used.

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. The lowest PRF shall be the one, which will be generally used in meteorological radar systems during normal operation.

NOTE: A typical lower value for the PRF is 250 Hz as mentioned in Recommendation ITU-R M.1849-1 [i.3].

Between each measurement, a waiting period of at least 20 minutes shall be applied. During this time, the transmitter shall be in operation and transmitting with the new pulse length and PRF values. This will give the transmitter enough time to reach a stable temperature. If the transmitter has not reached a stable temperature the waiting period shall be extended until the frequency drift has come to an end.

The results obtained for all available pulse length settings shall be compared and shall remain below the limit specified in clause 4.2.1.1.2 in order to prove compliance with the requirement.

Preferably a spectrum analyser shall be used to display the frequency spectrum in order to obtain the centre between the highest and lowest frequencies.

5.4.1.2 Transmitter Power

The antenna shall be replaced by a high power dummy load. If the meteorological radar system is equipped with dual polarization capability, the single polarization mode shall be activated and shall be used for the measurements. If only permanent dual polarization mode is available and no coupler in front of the power divider is available, the coupling ratio from the power divider shall be taken into account. The forward port of the system coupler shall be used and shall have an adequate attenuation. An optional reverse port shall be terminated with an appropriate 50 Ω terminator. The measurement from Annex C shall be used.

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 value measured during a period equal to at least one rotation period shall be used.

The transmitter power measurements shall be performed with all available pulse length settings. The corresponding PRF shall be chosen in order to get the same duty cycle for each pulse length setting.

To determine the PEP of the pulse a peak power meter with direct reading of the transmitter pulse power shall be used. The PEP shall be measured at the 50 % point of the pulse length. If the transmitter pulse is rippled the average over the pulse shall be used as can be seen in Figure 6.

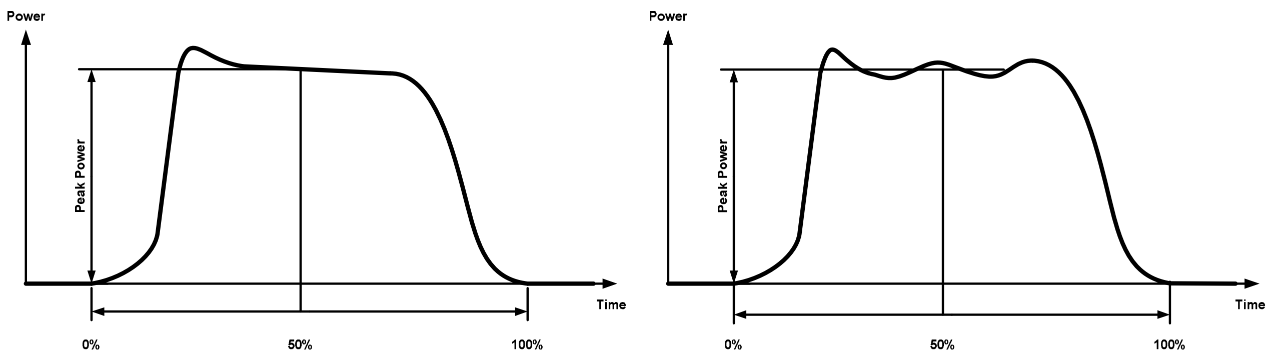

Figure 6: Transmitter output power

To reference the indicated transmitter power to the transmitter output flange the coupling factor of the system coupler shall be taken into account. If an additional attenuator or RF cable has been inserted between the system coupler forward port and the power meter this shall be taken into account. If the power meter does not allow for compensation of the coupling loss and additional attenuator, then the coupling loss and attenuator value shall be added to the meter reading.

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.1.2.2 in order to prove compliance with the requirement.

5.4.1.3 Measured B_{-40} Bandwidth

The measurements of the -40 dB bandwidth shall be performed with the same settings as in clause 5.4.1.4 Out-of-Band emissions.

The bandwidth of the emissions 40 dB below PEP shall be measured. Measurement setup shall be as described in Annex C.

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.1.3.2 in order to prove compliance with the requirement.

5.4.1.4 Out-of-Band emissions

The antenna shall be replaced by a high power dummy load. If the meteorological radar system is equipped with dual polarization capability, the single polarization mode shall be activated and shall be used for the measurements. If only permanent dual polarization mode is available and no coupler in front of the power divider is available, the coupling ratio from the power divider shall be taken into account. The forward port of the system coupler shall be used and shall have an adequate attenuation. An optional reverse port shall be terminated with an appropriate 50 Ω terminator.

The measurement bandwidth shall be according to Annex 2 of Recommendation ITU-R M.1177-4 [3].

The so-called indirect method specified in Annex 2 of Recommendation ITU-R M.1177-4 [3] shall be applied for the measurement of unwanted emissions of radar systems. The transmitter output spectrum shall be measured at the system coupler of the transmitter as illustrated in Annex C.

NOTE 1: To obtain a sufficient dynamic range the radar signal may need to be attenuated by an additional notch filter.

NOTE 2: Further information how to perform the measurement can be found in Recommendation ITU-R M.1177-4 [3].

The OoB power emission shall be measured in the frequency bands given in Table 5 or Table 6 depending on the PEP. If the PEP is greater than 150 kW the Table 5 shall be used and for powers equal to or lower to 150 kW the Table 6 shall be used. The results obtained shall be compared and shall remain below the limit specified in clause 4.2.1.4.2 and depicted in Figure 2 in order to prove compliance with the requirement.

Table 5: OoB emission boundaries for -90 dBpp

Lower OoB boundary	Upper OoB boundary
Carrier frequency - 10,8 × B_{-40}	Carrier frequency + 10,8 × B_{-40}
NOTE: The values are taken from Table 1 in ECC/Recommendation (02)05 [2].	

Table 6: OoB emission boundaries for -100 dBpp

Lower OoB boundary	Upper OoB boundary
Carrier frequency - 15,8 × B_{-40}	Carrier frequency + 15,8 × B_{-40}
NOTE: The values are taken from Table 1 in ECC/Recommendation (02)05 [2].	

NOTE 3: Typical meteorological radar system parameters are e.g. a centre frequency of 9 375 MHz, transmitter power of 80 kW, a pulse duration of t = 500 ns and a rise time of t_r = 100 ns. The 40 dB bandwidth calculated applying the equation from Annex B is 34 MHz. This leads to OoB boundaries at 15,8 × 34 MHz = 537,2 MHz away from the operating frequency. For this example the absolute boundaries between OoB emissions and spurious emissions are: 9 375 MHz - 537,2 MHz = 8 837,8 MHz and 9 375 MHz + 543,5 MHz = 9 912,2 MHz (see Figure 7).

All measurements of Out-of-Band emissions shall be made with a reference bandwidth of 1 MHz.

Figure 7 shows the calculated emission masks for the aforementioned parameters of a typical meteorological radar system applying the mask specification in Annex B which is corresponding to the dashed line in Figure A2.1b of ECC/Recommendation (02)05 [2].

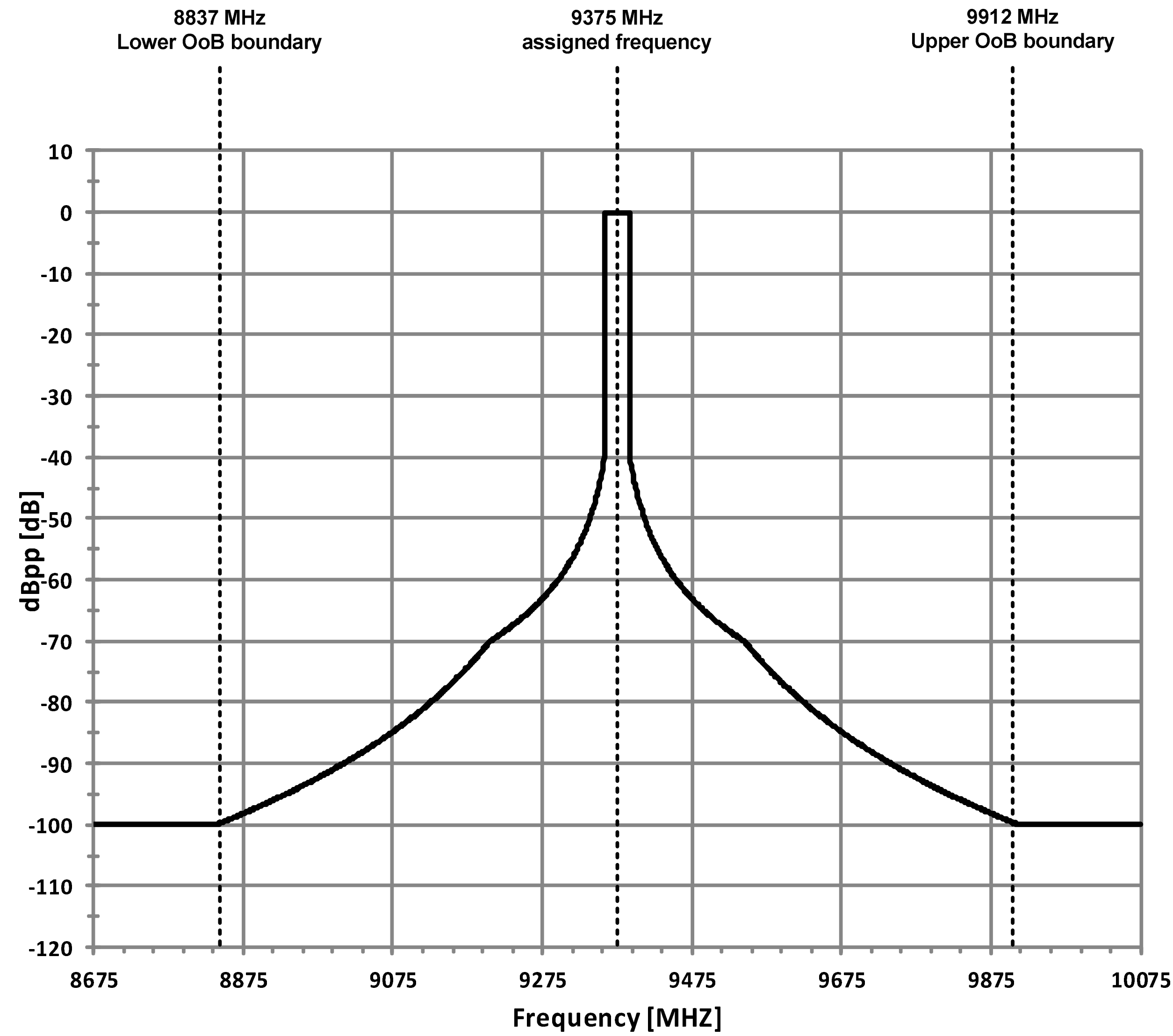

Figure 7: Calculated emissions mask for pulse duration t = 500 ns and rise time t_r = 100 ns at centre frequency of 9 375 MHz

5.4.1.5 Spurious emissions

For the spurious emission measurements the so-called indirect method specified in Annex 2 of Recommendation ITU-R M.1177-4 [3] shall be used. To perform the measurements, the radar system and the measuring equipment shall be set up as displayed in Annex D. The spurious power emissions shall be measured in the frequency ranges outside the OoB emissions boundaries.

NOTE 1: Depending on the setup of the meteorological radar system the location where the measurement setup will be installed may be close to the antenna. This ensures that band-limiting components like circulator, rotary joint or waveguide filter are included in the measurement.

The spurious domain emission limits shall take into account the attenuation of spurious domain emissions by the antenna as indicated in Annex 5 of ERC/Recommendation 74-01 [1].

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 behaviour of the waveguide is no longer unambiguous. In the unambiguous range of a rectangular waveguide, only $TE_{1,0}$ waves are capable of propagation. In the WG18 waveguide the cut-off frequency is 9 486 MHz which is higher than the operating frequency of the X-Band meteorological radar systems. Therefore, at least a 15 cm long WG18 waveguide shall be inserted in the measurement setup in order to protect the measurement device from the operating frequency in the WG16 waveguide bands. The waveguide acts as a high pass in this setup.

NOTE 2: If the operating frequency is close to or higher than 9 486 MHz the WG18 waveguide cut-off frequency will not be applicable and the measurement setup from Figure D.1 needs to be adapted.

Due to the ambiguous propagation modes of the used X-Band waveguide for higher frequencies, smaller waveguides with appropriate linear tapers shall be used for the measurement of higher frequencies. These frequency ranges are also referred to as waveguide bands as can be seen in Table 7.

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 18 GHz to 26 GHz the following setup will be used: a taper from WG16 to WG18, followed by a second taper from WG18 to WG20 waveguide, followed by at least 10 cm of WG20 waveguide terminated with a WG20 to coax transition.

Table 7: Waveguide bands and associated waveguides

Waveguide band	Frequency	Cut-off frequency	Waveguide designation	
			EIA	UK
X	8,2 GHz to 12,4 GHz	6,556 GHz	WR90	WG16
Ku	12,4 GHz to 18,0 GHz	9,486 GHz	WR62	WG18
K	18,0 GHz to 26,5 GHz	14,051 GHz	WR42	WG20

A noise margin of at least 10 dB below the spurious emission levels of -100 dBpp or -90 dBpp shall be achieved. A notch filter for the operating frequency shall be used to achieve the required dynamic amplitude range.

All measurements of Out-of-Band emissions shall be made with a reference bandwidth of 1 MHz.

NOTE 3: In the taper from the WG18 to the WG20 waveguide the operating frequency will be completely reflected, if below 9 486 MHz. If the connected circulator is the internal one and has not been installed purely for the measurement it will transfer the signal to the receiver input. Therefore, the LNFE should be replaced by a high power dummy load.

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.1.5.2 in order to prove compliance with the requirement, further taking into account that the spurious domain emission limits shall take account of the attenuation of spurious domain emissions by the antenna.

Table 8: Spurious emissions measurement bands

Lower measurement band	Upper measurement band
From 6 556 MHz to the lower OoB boundary	From the upper OoB boundary to 26 GHz

The lower boundary is determined by the Cut-off frequency as stipulated in Table 7 and the upper boundary is defined in Table 1 of ERC/Recommendation 74-01 [1].

5.4.1.6 Stand-by Mode Emissions

For the spurious emission measurements, the aforementioned indirect method shall be used. To perform the measurement the radar system and the measuring equipment shall be installed as displayed in Figure D.1 and the radar system shall be placed in stand-by mode but still powered on.

The spurious power emission shall be measured in frequency ranges outside the Out-of-Band emissions boundaries (see Table 8).

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.1.6.2 in order to prove compliance with the requirement.

All measurements of spurious emissions shall be made with a reference bandwidth of 1 MHz.

5.4.2 Receiver Test specification

5.4.2.1 Noise Figure

The receiver noise figure is measured along the complete receiver (as close as possible to the input of the receiver, but excluding antenna & waveguide). It shall be measured using a noise source (which may be built into the system) and a detector (which may be built into the system in as well). The receiver frequency should be tuned to the centre frequency of ground-based radars used for meteorological purposes which is usually at 9 375 MHz. 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 is connected to the radar receiver input port. The receiver 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 results obtained shall be compared and shall remain below the limit specified in clause 4.2.2.1.2 in order to prove compliance with the requirement.

5.4.2.2 Receiver Selectivity

5.4.2.2.1 General

The radar receiver is setup in normal operating mode during the test. The receiver frequency should be tuned to the centre frequency of ground-based radars used for meteorological purposes which is usually at 9 375 MHz. The receiver frequency shall be documented in the test report. The upper and lower frequency limits of the disturbing signal mentioned in clause 4.2.2.2.2 shall be adjusted accordingly.

Compliance shall be tested by applying the test signal into the LNFE input directly, or in conjunction with its connecting waveguide. Depending on the radar setup the waveguide components between the LNFE and the antenna may have bandwidth limiting functions and should be incorporated in the receiver selectivity measurement. The measurement setup from Figure E.1 shall be used.

The LNFE input is defined as the coaxial input port, which is connected directly via a short RF cable to the waveguide-coax transition in normal operation of the radar system. The IF output of the LNFE is defined as the port which is connected directly via a RF connection to the A/D converter of the digital receiver on normal operation of the radar system. Both ports can be seen in Figure E.1.

NOTE: Usually the IF frequency prior the A/D converter is 60 MHz.

If the meteorological radar system has two independent receiving channels for each polarization, the one with the highest sensitivity shall be chosen. If direct conversion receivers with I and Q mixer are used the selectivity shall be measured at both channels.

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.2.2.2 in order to prove compliance with the requirement.

5.4.2.2.2 Receiver OoB selectivity

Frequencies inside the B_{-40} receiver bandwidth need not to be tested at the output of the LNFE because this is the receiving frequency range of the meteorological radar system. No rejection of unwanted signals in the LNFE is possible in this frequency range. The LNFE output power shall be measured at the above mentioned centre or operating frequency in order to get a reference level for the evaluation of rejection levels in the defined bandwidth.

Meteorological radar systems are equipped with digital filters in the processing chain. The bandwidths of these matched filters are smaller than the receiver bandwidth.

NOTE 1: The matched filter bandwidth usually corresponds to the transmitted pulse length and is usually the inverse of the pulse length. For example, a 0,8 µs pulse length will result in a 1,25 MHz matched filter bandwidth.

To measure the matched filter bandwidth the complete receiver chain including A/D converter, digital signal processing and display software shall be included in the measurement. For the measurement of the receiver selectivity the widest matched filter bandwidth shall be used. By using the widest matched filter the worst case scenario is represented. The measurement test setup and the results of the matched filter and the Out-of-Band rejection shall be documented in the test report. Furthermore, the test procedure shall also be documented in the test report.

With modern solid-state radars the emitted signals may be very complicated and include both phase-modulation, frequency-hopping and -sweeping and pulse width modulation. This makes a single definition of the disturbing signal difficult.

The disturbing signal for a modulated pulsed radar shall have the following characteristics:

- The disturbing signal shall be formatted as the emission pattern of the radar under test in order to be detectable by the receiver system and shall increase in the same degree as the permitted emission spectrum with a limit of 90 dBpp. See Figure 4 for an example. A CW signal may be used if it produces the same results as a formatted signal.
- The maximum input level of the receiver shall be 6 dB below the compression level for the given receiver design.
- The discrete frequency steps shall be equal to or lower than 1 MHz.

The selected disturbing signal shall be documented in the test report.

The LNFE output power shall be measured at the above mentioned centre or operating frequency in order to get a reference level for the evaluation of rejection levels in the defined bandwidth.

The disturbance signals shall be applied either directly to the LNFE input or shall be applied to the connecting waveguide of the LNFE as can be seen in Figure E.1. If the disturbance signal is applied to the connecting waveguide the limited frequency range of the X-Band waveguide shall be taken into account. Due to the ambiguous propagation modes of the used X-Band waveguide for higher frequencies, smaller waveguides with appropriate linear tapers shall be used for the measurement of higher frequencies. These frequency ranges are also referred to as waveguide bands as can be seen in Table 7.

It is assumed that all the used receivers in a single or dual polarized system are equivalent. If this is not the case all used receivers shall be measured separately.

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

The disturbing signal for an unmodulated pulsed radar shall have the following characteristics:

- The disturbing signal shall be a sinusoidal CW signal and shall increase in the same degree as the permitted emission spectrum with a limit of 90 dBpp. See Figure 4 for an example.
- The maximum input level of the receiver shall be 6 dB below the compression level for the given receiver design.
- The discrete frequency steps shall be equal to or lower than 1 MHz.

An appropriate measurement device like a spectrum analyser shall be connected to the LNFE output and shall have the following characteristics:

- The frequency span shall be equal to or higher than 1 MHz.

NOTE 2: Due to the huge amount of frequency steps it is recommended to use a computer aided measurement system to decrease the measurement time.

The corresponding output power shall be measured at the LNFE output. This procedure will be repeated for all discrete frequency steps.

After all frequency steps have been applied and its corresponding output powers have been recorded the output power levels shall be set in relation to the output power of the operating frequency.

The output of the signal generator shall be checked to see if spurious signals are present. If spurious signals from the signal generator are present, they shall be documented in the test report.

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.2.2.2 in order to prove compliance with the requirement.

5.4.2.3 Receiver Compression

5.4.2.3.1 General

While the receiver compression level is defined as the 1dB compression point of the receiver chain, it is not possible without knowing the design of the receiver circuits of a radar to define a general measurement circuit. The best way to measure the receiver compression level is to increase the power of a sine wave signal injected into the LNFE and check linearity either at the IF output of the LNFE or by reading digital values at the output of the A/D converter.

The receiver frequency should be tuned to the centre frequency of ground-based radars used for meteorological purposes which is usually at 9 375 MHz. The receiver frequency shall be documented in the test report.

5.4.2.3.2 Receiver Compression Level

A CW test signal shall be injected into the LNFE. The gain response curve of the LNFE shall be measured and the 1 dB compression point shall be noted.

The results obtained shall be compared and shall remain below the limit specified in clause 4.2.2.3.2 in order to prove compliance with the requirement.

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.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 303 347-3					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Frequency Tolerance	3.2	4.2.1.1	U	
2	Transmitter Power	3.2	4.2.1.2	U	
3	Measured B_{-40} Bandwidth	3.2	4.2.1.3	U	
4	Out-of-Band Emissions	3.2	4.2.1.4	U	
5	Spurious Emissions	3.2	4.2.1.5	U	
6	Stand-by Mode Emissions	3.2	4.2.1.6	U	
7	Noise Figure	3.2	4.2.2.1	U	
8	Receiver Selectivity	3.2	4.2.2.2	U	
9	Receiver Compression Level	3.2	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.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

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 -40 dB Bandwidth

Annex 8 of Recommendation ITU-R SM.1541-6 [i.4] specifies the B_{-40} bandwidth for various types of waveforms (e.g. pulsed radar signals).

The B_{-40} bandwidth for non-FM/PM pulse radars is the lesser of:

$$B_{-40} = \frac{K}{\sqrt{t \cdot t_r}} \text{ or } \frac{64}{t} \quad \text{(B.1)}$$

Where:

- The coefficient K is 7,6.
- t is the pulse duration between the 50 % amplitude (voltage) points in seconds.
- t_r is the rise time in the case of a trapezoidal pulse.

NOTE 1: For typical values of a pulse duration of t = 500 ns and a rise time of t_r = 100 ns with a PEP of 100 kW the formula above yields a 40 dB bandwidth value of 34,0 MHz.

For frequency modulated pulse radar systems the B_{-40} bandwidth is:

$$B_{-40} = 1{,}5\left\{B_C + \sqrt{\pi} \cdot [\ln(B_C \cdot \tau)]^{0{,}53} \cdot \left[Min\left(B_{rise}, B_{fall}, B_{rise\&fall}\right) + Max\left(B_{rise}, B_{fall}, B_{rise\&fall}\right)\right]\right\} \quad \text{(B.2)}$$

Where:

- B_C is the bandwidth of the frequency deviation (total frequency shift during the pulse generation).
- τ is the pulse length including rise and fall times.
- $B_{rise} = \frac{1}{\sqrt{\tau \cdot t_r}}$ to account for the rise time.
- $B_{fall} = \frac{1}{\sqrt{\tau \cdot t_f}}$ to account for the fall time.
- $B_{rise\&fall} = \frac{1}{\sqrt[3]{\tau \cdot t_r \cdot t_f}}$ to account for both the rise and fall times combination.
- t_r is the rise time.
- t_f is the fall time.

The equation B.2 above is only valid when the following conditions are met:

1) the product $B_C \cdot$ Minimum (t_r, t_f) is greater than or equal to 0,10 and

2) that the product of $B_C \cdot \tau$ or compression ratio is greater than 10.

In all other cases, the following equations shall be used:

$$B_{-40} = \frac{K}{\sqrt{t \cdot t_r}} + 2\left(B_C + \frac{A}{t_r}\right) \quad \text{(B.3)}$$

Where:

- A is 0,105 when K = 6,2 and 0,065 when K 7,6.

NOTE 2: The term A/t_r adjusts the value of B_{-40} to account for the influence of the rise time, which is substantial when the time-bandwidth product $B_c \cdot t$, is small or moderate and the rise time is short.

For radars with an asymmetrical spectrum, the calculated B_{-40} bandwidth can be offset from the frequency of maximum emission level. The application of this rule is illustrated in Figure B.1.

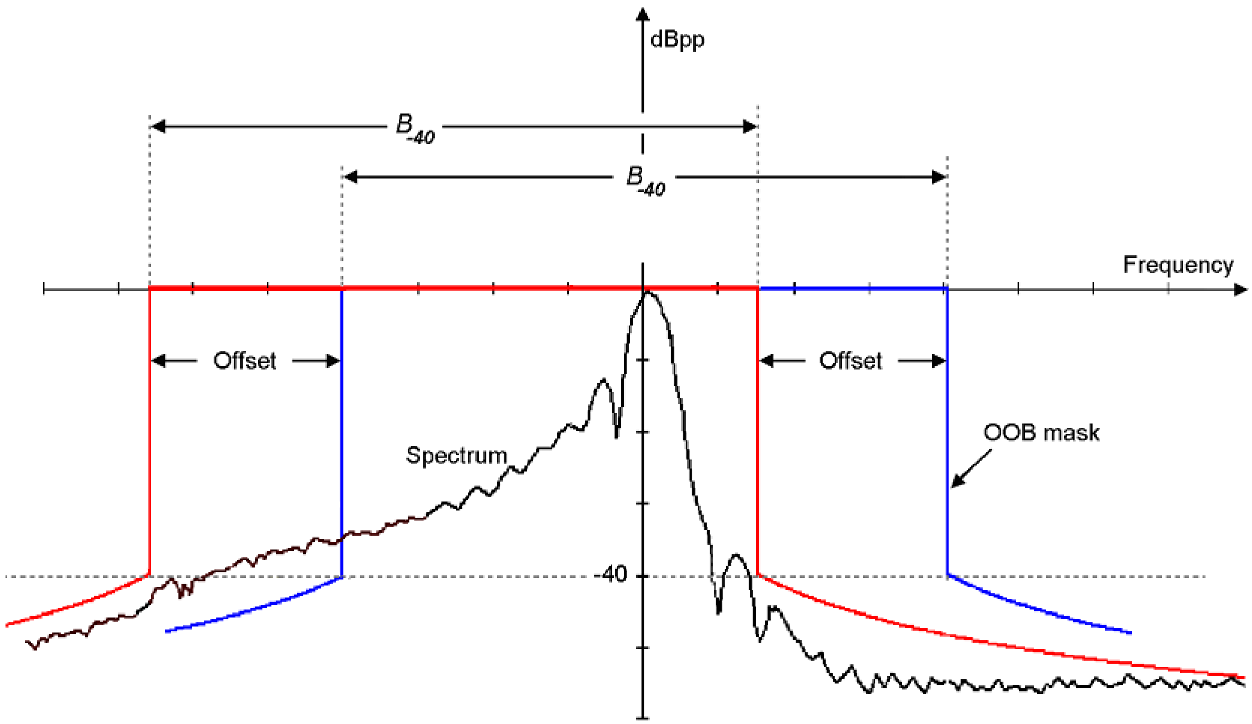

Figure B.1: Application of the offset-rule for the OoB emission limit mask

Annex C (normative): Operating frequency, transmitter power and OoB measurement setup

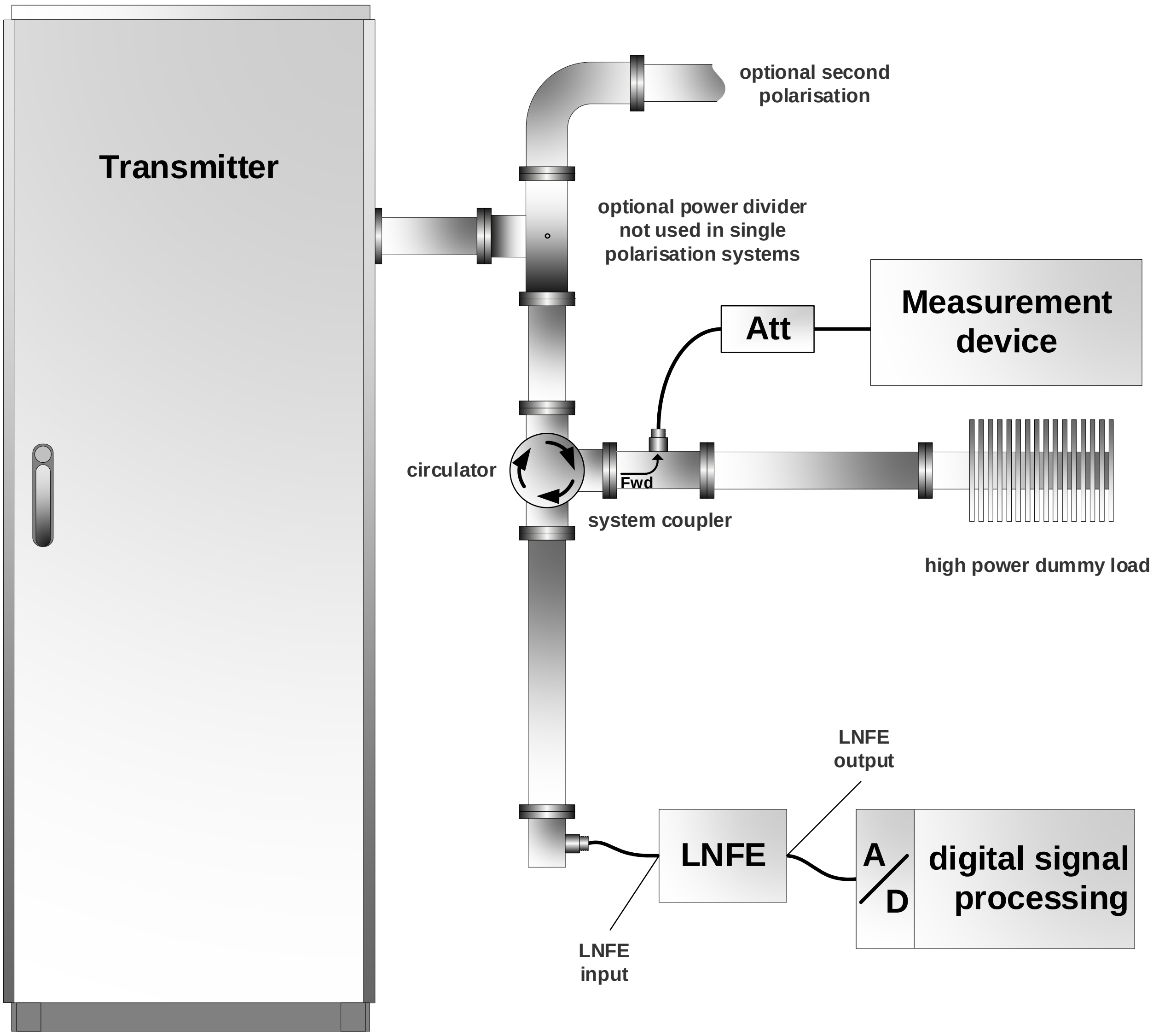

Figure C.1: Indirect method for operating frequency and transmitter power measurement

The method for measurement of the operating frequency and the transmitter power shown in Figure C.1 shall be applied.

Figure C.1 shows a dual polarization meteorological radar system. If a single polarized system is used the power divider will be replaced by a waveguide connecting only the lower part. If the power divider is available, the coupling ratio from the power divider shall be taken into account.

Annex D (normative): Spurious emission measurement setup

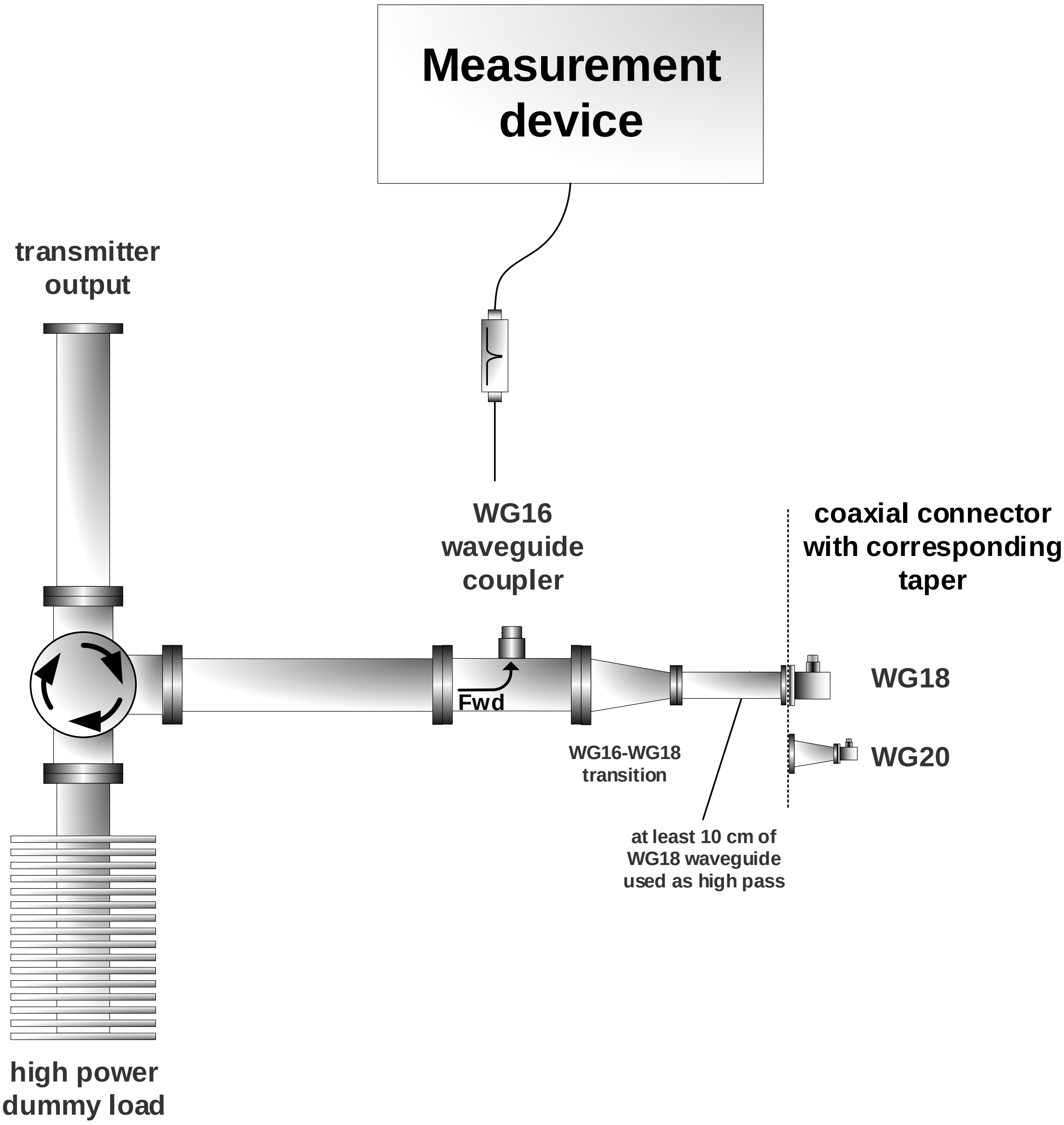

Figure D.1: Indirect method for spurious emission measurement

Figure D.1 shows for simplicity a single polarization meteorological radar system. If a dual polarized system is used the single polarization mode shall be activated. If only permanent dual polarization mode is possible and no coupler in front of the power divider is available, the coupling ratio from the power divider shall be taken into account.

Annex E (normative): Receiver selectivity measurement setup

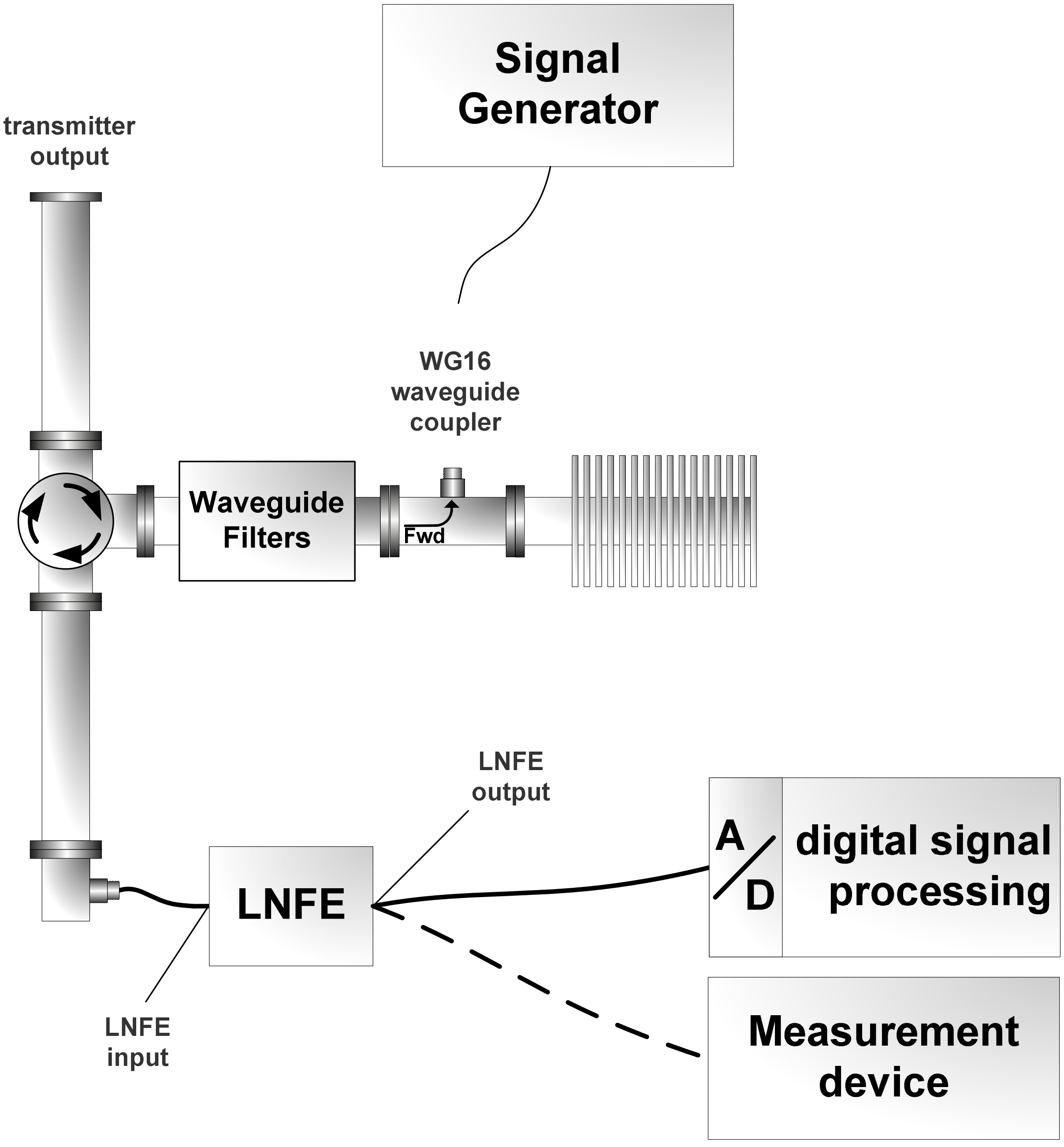

Figure E.1: Measurement method for receiver selectivity measurement

Figure E.1 shows for simplicity a single polarization meteorological radar system. If a dual polarized system is used the single polarization mode shall be activated. It is assumed that both receiving chains in a dual polarization system are equivalent.

Annex F (informative): Maximum Measurement Uncertainty

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

Table F.1: Maximum measurement uncertainty

Parameter	Uncertainty
Transmitter measurements	
Frequency tolerance	± 0,1 ppm
Transmitter power	± 0,75 dB
Out-of-Band emissions	± 4 dB
Spurious emissions	± 4 dB
Receiver measurements	
Noise Figure	± 1 dB
Receiver selectivity	± 4 dB
Receiver compression level	± 3 dB
General	
Temperature	± 1 °C
Humidity	± 5 %
Voltage	± 2 %

When measuring the frequency tolerance for radars with a phase or frequency modulated pulse the tolerance will be measured on the frequency reference used for generating the radar output signal.

History

Document history		
V1.1.0	April 2019	EN Approval Procedure AP 20190714: 2019-04-15 to 2019-07-15