ECC Recommendation (24)01

Receiver resilience to transmission on adjacent frequency ranges

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INTRODUCTION

This Recommendation provides a framework for continuous improvement of receiver resilience in the spectrum domain for a wide range and category of receivers to facilitate the reliable functioning of receivers in spectrum that will become more densely occupied over time[1]. The methodology in this Recommendation is intended to apply to all frequency bands in the radio spectrum[2]. Example receiver resilience values and recommended levels for specific radio frequency ranges are listed in the individual annexes[3] .

The increasing demand for systems and applications for existing services and the introduction of new services has led to a corresponding increase in demand for spectrum. As a result, administrations need all services to use the scarce spectrum resource more efficiently. To facilitate the efficient use of spectrum, the characteristics and resilience of receivers are considered in assessing the possibilities for sharing and compatibility between radiocommunication devices, services, systems and applications.

Receiver characteristics are as important as transmitter characteristics for enabling efficient spectrum usage. Receiver resilience characteristics are a basic requirement to carry out sharing and compatibility studies between services using the same or other frequency bands. Improving receiver resilience will facilitate increased compatibility between systems as the spectrum becomes more densely occupied.

This Recommendation specifies values of receiver resilience to transmission on adjacent frequency ranges that should be considered by CEPT/ECC groups for use in compatibility studies. This Recommendation additionally specifies recommended levels of receiver resilience which should be considered by ETSI when developing the Harmonised Standard.

ETSI Harmonised Standards contain limits that are minimum conformance requirements to allow market access. In practice receivers have better levels of resilience to transmission on adjacent frequency ranges than the limits in the relevant standards.

When there is a difference between the receiver resilience limits defined in a relevant standard and the recommended receiver resilience levels given in this Recommendation, in particular if the limits in the standard are less stringent, the iterative, consultative procedure given in the ETSI/ECC Memorandum of Understanding[4] should be followed. This procedure should consider the interaction between technical parameters, physical limitations, spectrum efficiency, regulatory and economic aspects. More specifically CEPT/ECC assumes the following procedure would be useful:

1. The relevant technical bodies in ETSI[5] and CEPT/ECC[6] can liaise with each other whenever they believe changes to this Recommendation or an ETSI Harmonised Standard, are required;

2. The ETSI liaison statement should be supported by appropriate technical justification and other relevant information. This should include information on economic and market related issues concerning the proposal. ETSI should also provide any information on system spectrum efficiency that they may have available to support their case;

3. The CEPT/ECC liaison statement should include the implications of the proposal on spectrum engineering parameters such as: efficient use of the spectrum, requirements of existing services, sharing and compatibility, and other regulatory issues;

4. The proposal should be considered in the spirit of the ETSI/ECC MoU with dialogue, full consultation and an iterative process if necessary. Ideally, this process should be completed within six months. The

[1] The recommended receiver resilience levels defined in this Recommendation are for receivers which are covered by ETSI Harmonised Standards, or other ETSI deliverables used to achieve the effective use of the spectrum, or equivalent national provisions (referred to in this Recommendation as “the relevant standards”).

[2] Radio spectrum is above 9 kHz, see the ITU Radio Regulations.

[3] The recommended receiver resilience levels defined in this first version of the Recommendation focus on the systems and frequencies in annexes 2 to 6 (these systems operate in certain bands between 30 MHz and 5725 MHz).

[4] https://cept.org/ecc/mous-and-lous-between-ceptecc-former-erc-and-other-organisations

[5] Currently ETSI TC ERM.

[6] Currently CEPT/ECC WG SE.

conclusions should be mutually acceptable and neither party should feel that its views have been disregarded;

5. When consensus is achieved the results should be recorded in a revision of this Recommendation and/or revision of the appropriate relevant standard.

This Recommendation should be reviewed regularly, typically every three years and at least once every five years, considering changing spectrum use and needs, technologies and regulatory requirements. This review should involve consultation with the relevant technical and Working Groups within CEPT/ECC and ETSI.

ECC RECOMMENDATION (24)01 OF 10 MAY 2024 ON RECEIVER RESILIENCE TO TRANSMISSION ON ADJACENT FREQUENCY RANGES

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that the demand for spectrum is increasing, with increasing demand for both existing and new services, systems and applications;

b) that the ECC Strategic Plan for the period 2020-2025 in 3.2 states that the ECC will develop or update ECC Recommendations on appropriate characterisations of both transmitters and receivers, and in undertaking this work, the ECC will seek to intensify its co-operation with ETSI in order to foster the development of efficient sharing conditions in the future;

c) that the RF environment will change with the evolution of services and applications over time;

d) that receiver resilience means adjacent channel protection ratio (in the out-of-band domain) and blocking level (in the reciprocal spurious blocking domain (RSBD), as defined later in these considerings) of the receiver;

e) that like transmitter characteristics, receiver resilience can directly affect the efficient use of spectrum and it is necessary to have resilient receivers to have high immunity against adjacent interference, not just co-channel interference;

f) that using equipment with more resilient blocking levels enables more efficient use of spectrum in compatibility situations;

g) that higher values of frequency offset selectivity (FOS) for providing better receiver resilience to transmissions on adjacent frequency ranges need to be considered together with receiver sensitivity to provide a balanced requirement;

h) that to achieve outcomes that enable the efficient use of spectrum it is necessary to make realistic assumptions on receiver resilience for sharing and compatibility studies;

i) that efficient use of spectrum is primarily achieved by technical requirements including for receiver resilience as specified in industry specifications, relevant standards and in other legal instruments in the context of permitting radio equipment to be made available on the market;

j) that the present version of Annexes 2 to 6 of this Recommendation defines recommended receiver resilience levels within the frequency range 30 MHz-5725 MHz;

k) that comparison of tables of A5.1 suggests that, for certain SRD equipment, receiver resilience may be improved;

l) that receivers operating outside their linear range are not in the scope of this Recommendation;

m) that there is a need to consider the fundamental characteristics of the receiver defined by a set of inter-related parameters and, for this purpose, the following parameters are used in the linear range (i.e. below the overloading threshold) of the receiver to define its resilience: "N", "M", "ILR" and "FOS" as described in Annex A1.1;

n) that more sophisticated models may be developed expanding on this set of parameters in the future or if required on a case-by-case basis;

o) that, when receiver resilience levels are not defined in this Recommendation, the receiver resilience levels of some receivers may be found in ECC/CEPT deliverables, relevant standards or ITU-R deliverables and can also be considered for compatibility studies;

that Annex 1 of Appendix 3 of the Radio Regulations [1] and Recommendation ITU-R SM.1539 [3] defines the boundaries between the out-of-band and spurious domains of a transmitter (i.e. the spurious domain applies at a frequency separation of more than ±250% of the transmitter bandwidth from its centre frequency

p) that in this Recommendation the out-of-band and spurious domains definitions, usually applied to transmitters, are also applied to the related receiver (i.e. the recommended levels are applied at a frequency separation of more than ±250% of the receiver channel bandwidth from its centre frequency when operating at the receiver operating band edge, see Figure 4 in section A7.3.2);

q) that for some systems in Annexes 2 to 6, the Reciprocal spurious blocking domain may be defined using alternative approaches, with frequency offsets relative to the “tuning range” or “operating band” of the system, in the same way as done for transmitters in ERC Recommendation 74-01;

r) that, for channelised systems, the concept of “reciprocal spurious blocking domain” implies that the victim receiver channel is in the spurious domain of the interfering transmitter and reciprocally the interfering transmitter channel is in the spurious domain of the wanted signal received by the victim system. For non-channelised systems, the definition in section A7.3.2 applies;

s) that ECC Report 310 [2] evaluated receiver parameters and the future role of receiver characteristics in spectrum management, including how they are used in sharing and compatibility studies;

t) that several Recommendations (ERC Recommendation 74-01 [4] and ECC Recommendation (19)02 [5]) and ECC Report 249 [6], were developed, based on assumptions about transmitter characteristics, to enable efficient spectrum usage;

u) that as noted in ECC Recommendation (19)02 [5], using ‘worst case’ or ‘minimum’ assumptions based on conformance limits for receivers in sharing and compatibility studies can lead to pessimistic results and consequently less efficient use of spectrum;

v) that typical receiver resilience, in practice, may be better than the values specified in the relevant standards, for example, adjacent channel protection ratios or the blocking levels. Therefore, those values may also be used as inputs to sharing and compatibility studies.;

w) that measurements for sharing and compatibility studies should take into account a sufficient number and range of typical devices over their full expected working range of frequencies and signal levels as far as possible in order to capture the most relevant usage scenarios (e.g. medical devices are a use case of 1 and 2 MHz WDTS);

x) that additional values of receiver resilience, e.g. based on measurements, are intended to be provided in a dedicated annex in a future update of this Recommendation;

y) that devices for medical applications and their accessories, as specified in Regulation (EU) 2017/745, are subject to implementation constraints requiring special consideration which may result in separate tables in future versions of this Recommendation;

z) that receiver resilience is one of the important considerations in the design of the device and contributes to minimising the impact of harmful interference;

aa) that CEPT and ETSI have developed a Memorandum of Understanding describing the relative responsibilities of the two bodies[4];

bb) that the impact of pulse modulated, high peak to average power ratio transmissions, for example transmissions from radar systems, on receivers, is not in the scope of this Recommendation;

cc) that ETSI needs a transition period to implement this Recommendation on future revisions of relevant standards and on future devices for which new relevant standards will be developed;

recommends

1. that this Recommendation should be used as a framework for continuous improvement of receiver resilience to transmission on adjacent frequency ranges to help enhance efficient use of spectrum;

2. that the methodology and levels of receiver resilience in this Recommendation should be used in compatibility studies.

3. that the general method defined in ANNEX 1: which is used to derive the minimum levels of receiver resilience in the relevant annexes of this Recommendation, should also be used when annexes are added or updated in the course of the regular review of this Recommendation.

4. that receivers which are covered by relevant standards or equivalent national provisions, should be considered when adding to or updating the tables of Recommended receiver resilience values.

5. that the recommended levels of receiver resilience only apply in the reciprocal spurious blocking domain and should be considered for relevant standards developed or revised after the date at which this Recommendation has been approved;

   NOTE 1: in the case where these recommended levels are more stringent than the limits given in existing relevant standards, a revision of those limits in the relevant standards may need to be considered by ETSI;

   NOTE 2: when CEPT/ECC or ETSI considers that the recommended levels are inappropriate for a particular service, system or application, then an agreement on alternative recommended levels should be reached in accordance with the MoU between CEPT/ECC and ETSI.;

   NOTE 3: when a relevant standard is updated with new limits for receiver resilience, then, under the ETSI/ECC MoU, ETSI is invited to inform CEPT/ECC of the relevant changes on a liaison basis.

6. that the values of receiver resilience in the out-of-band domain specified in the relevant annexes, are for compatibility studies (Note 3 of recommends 5 also applies to this recommends);

7. that additional receiver resilience values, e.g. based on measurement data, can be used as alternative inputs for compatibility studies (also see *considering* x));

8. that when CEPT/ECC conducts sharing and compatibility studies and identifies that interference may occur and the receiver resilience is a limiting factor, then improving the receiver resilience should always be investigated as a possible mitigation in the study;

9. that, where an ECC deliverable or communication providing specific requirements from CEPT defining further constraints for a particular technology or application exists, the relevant values contained therein should take precedence over values in the present Recommendation.”

Table 1: List of annexes

Annex Title	Annex Number
Method for receiver resilience (MRR) used to derive blocking and selectivity levels	ANNEX 1:
Receiver resilience values in the adjacent band (out-of-band domain) and recommended blocking levels (reciprocal spurious blocking domain) for:	
Broadcasting service	ANNEX 2:
Fixed service	ANNEX 3:
Land Mobile service	ANNEX 4:
Short Range Devices	ANNEX 5:
Wireless Access Systems (WAS)/Radio Local Area Networks (RLAN)	ANNEX 6:
Reference interfering signal and a single interference scenario to be used in the calculation of recommended receivers resilience levels using MRR	ANNEX 7:
Practical generation of the reference interferer	ANNEX 8:
Derivation of the method for receiver resilience (MRR)	ANNEX 9:
Note: it is intended that this list of annexes will in the future contain an annex with additional levels of receiver resilience for use in compatibility studies	

Note:

Please check the Office documentation database https://docdb.cept.org/ for the up to date position on the implementation of this and other ECC Recommendations.

ANNEX 1: METHOD FOR RECEIVER RESILIENCE (MRR) USED TO DERIVE BLOCKING AND FREQUENCY OFFSET SELECTIVITY LEVELS

A1.1 BASICS OF THE METHOD

The definitions below, with the exception of “Receiver desensitisation (M)” and "Reciprocal spurious blocking domain (RSBD)”, are taken from ECC Report 310 [2] with some small modifications and are used in this Recommendation for receivers working in their linear range.

Table 2: Definitions used in this Recommendation

Term	Definition
Blocking	A measure of the receiver capability to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency other than those of the spurious responses or of the adjacent channels and it is defined as the maximum interfering signal level expressed in dBm reducing the specified receiver sensitivity by a certain number of dBs (desensitisation).
Frequency Offset Selectivity (FOS)	A measure of the receiver ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted adjacent signal at a given frequency offset from the centre frequency of the assigned channel. In this context, it is defined as the ratio of the receiver filter attenuation on the offset frequency to the receiver filter attenuation on the assigned channel frequency (normally a positive number in dB). FOS is of general use for any mixed wanted and unwanted signal situation.
Interference Leakage Ratio (ILR)	The ratio of the filtered mean power centred on the assigned channel frequency to the similarly filtered mean power centred on a given frequency offset.
Receiver Interference Ratio (RIR)	The ratio of the in-channel interference power on a given frequency offset to the interference power received by the victim receiver.
Receiver desensitisation (M)	Reduction in the signal to noise ratio of the receiver or a reduction in the effective sensitivity in the presence of an interfering signal, given in dB. It corresponds to the ‘noise rise’ due to the interfering signal.
Receiver noise floor (N)	The total noise power at the receiver including the effect of thermal noise and the receiver noise figure.
Reciprocal spurious blocking domain (RSBD)	Implies that the victim receiver channel is in the spurious domain of the interfering transmitter and reciprocally the interfering transmitter channel is in the spurious domain of the victim receiver.

MRR derives the frequency offset interfering signal level ($I_{in\text{-}ch}$) at the receiver input and consequently the blocking level (I_{blk}) and the adjacent channel protection ratio ($C/I_{adj\text{-}ch}$) of the receiver, for given values of M, N, ILR and FOS. $I_{in\text{-}ch}$ is referred as I_{blk} when calculating the blocking level and as $I_{adj\text{-}ch}$ when calculating the adjacent channel protection ratio (PR), where:

- $I_{in\text{-}ch}$: frequency offset interfering signal power measured in the interferer channel bandwidth at the receiver input before RF/IF/BB filtering. Note that when defining the resilience levels of a receiver, $I_{in\text{-}ch}$ is often referred to as $I_{adj\text{-}ch}$ or I_{blk} depending on the frequency offset between the useful and interfering signals;
- I_{blk}: blocking interfering signal power measured in the interferer channel bandwidth at the receiver input before RF/IF/BB filtering;
- $I_{adj\text{-}ch}$: adjacent channel interfering signal power measured in the interferer channel bandwidth at the receiver input before RF/IF/BB filtering.

The bandwidth of the wanted received signal and the bandwidth of the interfering signal need to be determined in advance (see ANNEX 7: for more information on defining receiver and transmitter bandwidth). The frequency offset is the offset between the centre frequency of the wanted received signal bandwidth and the centre frequency of the interfering signal bandwidth.

For the frequency offsets beyond the second adjacent channel, the blocking level ($I_{in-ch} = I_{blk}$):

$$I_{in\_ch}(dBm) = I_{blk}(dBm) = 10log\left(10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}\right) - 10log\left(10^{\frac{-ILR\,(dB)}{10}} + 10^{\frac{-FOS\,(dB)}{10}}\right) \quad (1)$$

Or, for first and second adjacent channels frequency offsets, the carrier to interference ratio ($C/I_{in-ch} = C/I_{adj-ch}$) as follows:

$$C/I_{in-ch} = C/I_{adj-ch}(dB) = C(dBm) - I_{adj-ch}(dBm) \quad (2)$$
$$= C_{sens}(dBm) + M(dB) - I_{adj-ch}(dBm)$$

Where:

- *N*: Noise floor of the victim receiver;
- *M*: Victim receiver maximum acceptable desensitisation when the interferer is at a given frequency offset from the receiver;
- *FOS:* Frequency offset selectivity of the victim receiver;
- *ILR*: Leakage power ratio of the interfering signal at offset frequency;
- *C*: useful signal level received by the victim receiver;
- C_{sens}: receiver sensitivity level, specified for the victim receiver.

The definitions of ILR and FOS can be found at the beginning of this section.

A1.2 APPLICATION OF THE METHOD

The steps below should be followed to derive the receiver blocking level (I_{blk}) or the adjacent channel protection ratio (PR_{adj-ch}=C/I_{adj-ch}):

Step 1 Calculate the noise floor (N) of the receiver:

Every radio receiver is subject to a noise floor that can be described using the following equation expressed in dBm:

$$N(dBm) = 10log_{10}(kTB)(dBW) + NF(dB) + 30\ dB \quad (3)$$

Where:

- *N*: receiver noise floor (dBm);
- k: Boltzmann constant in Joules per Kelvin (1.381×10^{-23});
- *T*: temperature in degrees Kelvin (for common terrestrial radio receivers, 290 K can be used);
- *B*: receiver bandwidth in Hertz;
- *kTB*: receiver thermal noise in Watts;
- *NF*: receiver Noise Figure (dB).

In cases where the noise figure is not known, the noise floor may also be derived from the receiver sensitivity provided that the interference signal bandwidth is equal to that of the receiver signal bandwidth:

$$N(dBm) = Receiver\ sensitivity(dBm) - \mathrm{C/I_{co-ch}} \quad (4)$$

Step 2 Calculate the receiver desensitisation (M) (go to Step 3 if M is known):

M is often found in relevant standards, either explicitly mentioned, or calculated from the required "Receiver sensitivity" (in absence of interference) and the "Minimum wanted received signal level" required in the blocking test through the equation:

$$M(dB) = Minimum\ wanted\ received\ signal\ level(dBm) - Receiver\ sensitivity(dBm) \quad (5)$$

Care should be taken such that the value of M is chosen based on the expected linear range of the receiver to prevent overloading.

If it is not possible to find/calculate M from the relevant standards as above, the following typical values: M = 3 dB or M = 15 dB could be used; the M = 3 dB value may be used for systems deployed in a "noise limited" operational environment, while M = 15 dB could be used for systems deployed in an "interference limited" operational environment.

Step 3 Determine the ILR value to be used in Step 4:

a) *Identify the interfering signal and interference scenario:*

The relevant interfering signal and interference scenario can be identified based on:

- the existing or planned deployment of victim and interfering systems and the compatibility studies presented in various CEPT/ECC, ETSI and ITU-R technical reports;
- or, if the information in the previous paragraph is not available, information may be sourced from either of the following:
  - from the intra/inter-system interfering signals and interference scenarios defined in relevant standards; or
  - from the reference interfering signal[7] and interference scenario defined in ANNEX 7:.

b) *Determine the ILR value*

Once the relevant interfering signal and interference scenario are identified, the following approach can be used to determine the appropriate ILR value:[8]

- If the victim receiver channel is fully or partially in the out-of-band (OOB) domain of the interfering signal (see A7.3.2) use either of the following:
  - the ILR (ACLR) value defined in existing EC/ECC Decisions, ECC/ITU-R Recommendations, CEPT/ECC Reports and relevant standards/technical specifications/reports;
  - the ILR value determined by measurements.
- If the victim receiver channel is in the reciprocal spurious blocking domain (RSBD) (see A7.3.2) use either of the following:
  - the ILR value derived from the reference interfering signal defined in ANNEX 7:.
  - the ILR value derived from the in-channel power of the interfering signal and the spurious emission levels defined in external documents including: the existing EC/ECC Decisions, and relevant standards/technical specifications/reports, ECC/ITU-R Recommendations (e.g. ERC Recommendation 74-01 [4] and Recommendation ITU-R SM.329-12 [7]);

Step 4 Define the frequency offset selectivity (FOS) of the receiver based on the following options:

Depending on the scenario, FOS can either be derived directly from the relevant standard, or according to:

$$FOS\ (dB)\ \geq\ ILR\ (dB)\ +\ X\ dB \quad (6)$$

where the value of X depends on the maximum acceptable increase of the interfering signal power (I_r) at the receiver input due to I^r_{in-ch} *e.g.:*

- X = 0 dB would correspond to $I_r = I^r_{oo-ch} + 3\ dB$;
- X = 10 dB would correspond to $I_r = I^r_{oo-ch} + 0.4\ dB$

[7] In this version of the Recommendation, the reference interfering signal, defined in Annex 7, has been applied to the calculation of the recommended receiver resilience levels in the reciprocal spurious blocking domain

[8] The way in which the ILR was derived is described in each annex.

Where:

- $I_r = I^r_{oo-ch} + I^r_{in-ch}$;
- I^r_{oo-ch}: frequency offset interfering signal out-of-channel power received by the victim receiver;
- I^r_{in-ch}: frequency offset interfering signal in-channel power received by the victim receiver.

The FOS is defined based on the scenario as follows:

- If the victim receiver channel is in the OOB domain of the interfering signal, and the interfering signal and interference scenario are identified based on a relevant standard (i.e. from Step 3):
  - if the interfering signal is an unmodulated continuous wave (CW) signal, the value of FOS can be determined based on the adjacent channel interfering signal limit defined in relevant standards as follows, noting that this is a rearrangement of equation (1) and the value may have already been available:

$$FOS(dB) = -10log\left(\frac{10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}}{10^{\frac{I_{adj-ch}(dBm)}{10}}} - 10^{\frac{-ILR(dB)}{10}}\right) \quad (7)$$

  - if the interfering signal is similar to the wanted signal, the value of FOS is determined according to equation (6) with the value of X defined according to the relevant standard;

    In this interference configuration the impact of the interfering signal OOBE falling into the receiver channel, added to the interfering signal in-channel emission received by the receiver after filtering, is important. As the emissions falling into the receiver channel cannot be reduced by filtering, it is sensible to reduce as much as possible the interfering signal in-channel emission at the receiver input by filtering to reduce the impact of the interfering signal on the receiver performance. Therefore, setting X = 10 such that FOS=ILR + 10 dB would be an appropriate choice when deriving the adjacent-channel protection ratio of a receiver.
- For all other cases (i.e. the reciprocal spurious blocking domain or interfering signal/scenario not based on a relevant standard), the value of FOS is determined by equation (6) with the value of X set according to the maximum acceptable increase of the interfering signal power.

  In most cases with the spurious emissions (SE) level of the interfering signal being low, X=0 dB such that FOS=ILR can be used in the calculation in order to avoid unnecessary constraint on the receiver. X=10 such that FOS=ILR+10 dB would be an appropriate choice if higher selectivity is required

  If a CW interfering signal is used, instead of the RI signal, to calculate the blocking level of a victim receiver, the receiver FOS value should be equal to the FOS value specified for the blocking level calculation with the RI signal, since the ILR value of the CW signal is assumed to be very high or infinite (≥130 dB).

Step 5 Derive the receiver blocking level (I_{blk}) or adjacent channel protection ratio (PR_{adj-ch}):

In the RSBD:

$$I_{blk}(dBm) = 10log\left(10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}\right) - 10log\left(10^{\frac{-ILR\,(dB)}{10}} + 10^{\frac{-FOS\,(dB)}{10}}\right) \quad (8)$$

Or if the *ILR* of the interfering signal can be considered infinite (very high):

$$I_{blk}(dBm) = 10log\left(10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}\right) + FOS(dB) \quad (9)$$

In the OOB domain:

Calculate PR_{adj-ch} (dB) as follows, with I_{adj_ch} evaluated from Equation (8) by replacing I_{blk} with I_{adj-ch}:

$PR_{adj-ch} = C/I_{adj-ch}$ by replacing I_{blk} with I_{adj-ch}:

$$PR_{adj-ch} = C/I_{adj-ch}(dB) = C(dBm) - I_{adj-ch}(dBm) \quad (10)$$

$$= C_{sens}(dBm) + M(dB) - I_{adj-ch}(dBm)$$

The method is illustrated in the following flowchart.

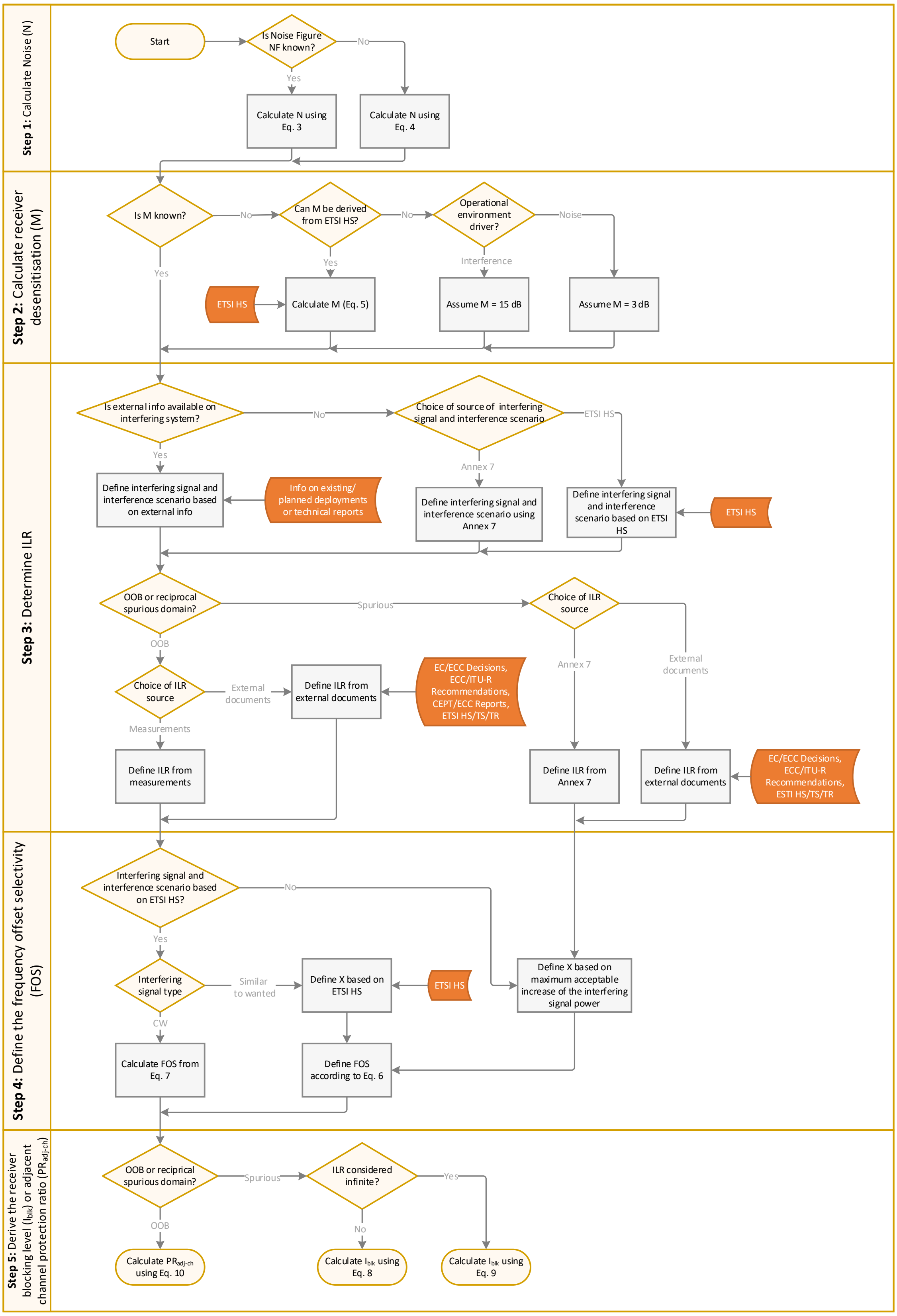

Figure 1: Flowchart describing the method for receiver resilience for a given Rx bandwidth

ANNEX 2: RESILIENCE TO TRANSMISSION ON ADJACENT FREQUENCY RANGES FOR THE BROADCASTING SERVICE

A2.1 DIGITAL AUDIO BROADCASTING (DAB) RECEIVERS OPERATING IN THE FREQUENCY RANGE 174 – 240 MHZ (VHF III)

A2.1.1 Receiver resilience values in the out-of-band domain

Table 3: Receiver resilience to transmission in the out-of-band domain for DAB (1.712 MHz DAB VHF band III, wanted signal level = -70 dBm as defined in ETSI EN 303 345-4 [10])

Victim Rx type	Interferer Tx type	Values used in calculations			Values to be used in compatibility studies				
		Freq offset (MHz)	N (dBm) (Note 1)	Rx M (dB) (Note 2)	ILR (dB) (Note 3)	Rx FOS (dB)	I (dBm) (Note 5)	C/I (dB)	C/I (dB) defined in ETSI EN 303 345-4 [10]
DAB	Wanted signal like	1.712	-106	24	55	55 (Note 4)	-30	-40	-35
DAB	Wanted signal like	3.424	-106	24	80	55	-27	-43	-40

Note 1: Value calculated as shown in Table 5
Note 2: M (dB) = Wanted signal level (dBm) - Rx sens (dBm) = -70 dBm - (-94 dBm) = 24 dB
Note 3: Value calculated by numerical integration from the spectrum mask for DAB VHF transmitters in critical areas for adjacent channel interference in ETSI EN 300 401 [11]
Note 4: FOS = ILR is assumed
Note 5: Value calculated using MRR

A2.1.2 Recommended receiver resilience levels in the reciprocal spurious blocking domain

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 4: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for DAB (1.712 MHz DAB VHF band III, wanted signal level = -70 dBm as defined in ETSI EN 303 345-4 [10])

<table>
<tr><th rowspan="2">Victim Rx type</th><th rowspan="2">Interferer Tx type</th><th colspan="5">Values used in calculations</th><th>Values recommended for Harmonised Standard</th><th rowspan="2">I (dBm) calculated from ETSI EN 303 345-4 [10]</th></tr>
<tr><th>Freq offset (MHz) (Note 1)</th><th>N (dBm) (Note 2)</th><th>Rx M (dB) (Note 3)</th><th>ILR (dB) (Note 4)</th><th>Rx FOS (dB) (Note 5)</th><th>I (dBm) Recommended (Note 6)</th></tr>
<tr><td>1.712 MHz DAB</td><td>5 MHz RI</td><td>≥13.4</td><td>-106</td><td>24</td><td>75</td><td>75</td><td>-10</td><td>N/A</td></tr>
<tr><td>1.712 MHz DAB</td><td>CW (Note 7)</td><td>≥13.4</td><td>-106</td><td>24</td><td>130</td><td>75</td><td>-7
(Note 8)</td><td>-30</td></tr>
<tr><td colspan="9">Note 1: Value calculated as described in section A7.3.2
Note 2: Value calculated as shown in Table 5
Note 3: M (dB) = Wanted signal level (dBm) - Rx sens (dBm) = -70 dBm - (-94 dBm) = 24 dB
Note 4: Value calculated by numerical integration from the spectrum mask of the reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions
Note 5: FOS = ILR is assumed except when ILR=130 dB
Note 6: Value calculated using MRR
Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note 8: For DAB receivers, if an AM modulated 1 kHz sine wave signal with 80% modulation is used for blocking tests, the blocking level defined in this table should be reduced by 5 dB.
Note: RI – Reference interfering signal</td></tr>
</table>

Table 5: DAB VHF band III receiver noise floor, signal to noise ratio and sensitivity

Receiver parameter	Value	Comment
Channel BW (MHz)	1.712	
Effective BW (MHz)	1.54	
Noise figure NF (dB)	6	Value defined in ETSI TR 101 758 [12]
Noise power N (dBm)	-106.10	According to Equation (3)
Sensitivity (Rx sens) (dBm)	-94	Value defined in ETSI EN 303 345-4 [10]
Signal to noise ratio C/N (dB)	12.10	$\frac{\mathrm{C}}{\mathrm{N}}(\mathrm{dB}) = \mathrm{Rx\ sens\ (dBm)} - \mathrm{N\ (dBm)}$

A2.2 DIGITAL TERRESTRIAL TV BROADCAST RECEIVERS (DTTB) OPERATING IN THE FREQUENCY RANGES 174-30 MHZ (VHF III) AND 470-694 MHZ

A2.2.1 Receiver resilience levels in the out-of-band domain

Table 6: Receiver resilience to transmission in the out-of-band domain for DTTB (8 MHz DTTB UHF band IV, wanted signal level - see Table 8)

Victim Rx type	Interferer Tx type	Values used in calculations					Values to be used in compatibility studies		
		Freq offset (MHz)	DVB-T/T2 N (dBm) (Note 1)	Rx M (dB) (Note 2)	ILR (dB)	Rx FOS (dB) (Note 3)	I (dBm) (Note 4)	C/I (dB)	C/I (dB) defined in ETSI EN 303 340 [13]
DVB-T	Wanted signal like	8	-101/-100	27	47	47	-30/-29	-26	-25
DVB-T	LTE700 UE	18	-101/-100	19	60	60	-25/-24	-39	-33 (Note 5) / -38

Note 1: Value calculated as shown in Table 9
Note 2: M (dB) = Wanted signal level (dBm) - Rx sens (dBm), see Table 8 and Table 9
Note 3: FOS = ILR is assumed
Note 4: Value calculated using MRR
Note 5: ILR=51 dB is used in ETSI EN 303 340 [13] for DVB-T instead of ILR=60 dB

A2.2.2 Recommended receiver resilience levels in the reciprocal spurious blocking domain

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 7: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for DTTB (8 MHz DTTB UHF band IV, wanted signal level - see Table 8)

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for Harmonised Standard	I (dBm) defined in ETSI EN 303 340 [13]
		Freq offset (MHz) (Note 2)	DVB-T/T2 N (dBm) (Note 3)	Rx M (dB) (Note 4)	ILR (dB) (Note 5)	Rx FOS (dB) (Note 6)	I (dBm) Recommended (Note 7)	
8 MHz DTTB	5 MHz RI (Note 8)	≥22.5	-101/-100	13	68	68	-23	-25
8 MHz DTTB	CW	≥22.5	-101/-100	13	130	68	-20	N/A

Note 1: Value calculated as described in section A7.3.2
Note 2: Value calculated using MRR (Frequency offset (MHz) ≥ 2.5BWRx (MHz) + BWRI/2 (MHz))
Note 3: Value calculated as shown in Table 9
Note 4: M (dB) = Wanted signal level (dBm) - Rx sens (dBm), see Table 8 and Table 9
Note 5: Value calculated by numerical integration from the spectrum mask of the reference interfering signal
Note 6: FOS = ILR is assumed
Note 7: Value calculated using MRR
Note 8: CW interfering signal is not used in conformance tests for DTTB in the relevant standard.
Note: RI – Reference interfering signal

Table 8: 8 MHz DTTB wanted signal levels

Frequency offset (MHz)	DVB-T2 (dBm) (Note 1)	DVB-T (dBm) (Note 2)
± 8	-55	-57
18	-63	-65
22.5 (Blocking)	-69	-71
Note 1: Level defined in ETSI EN 303 340 [13] Note 2: Level defined for DVB-T2 in ETSI EN 303 340 [13] decreased by 2 dB (see Table 9)		

Table 9: DTTB receiver noise floor, signal to noise ratio and sensitivity

Receiver parameter	Value	Value	Comment
Receiver type	DVB-T	DVB-T2	
Channel BW (MHz))	8	8	
Effective BW (MHz)	7.61	7.77	
Noise figure NF (dB)	4	5	Value from measurements (see ECC Report 310 [2])
Noise power N (dBm)	-101.16	-100.07	According to Equation (3)
Signal to noise ratio C/N (dB)	17	18	Value from measurements (see ECC Report 310 [2])
Sensitivity (Rx sens) (dBm)	-84.16	-82.07	$Rx\ sens\ (dBm) = N\ (dBm) + \frac{C}{N}(dB)$

ANNEX 3: RECEIVER RESILIENCE TO TRANSMISSION ON ADJACENT FREQUENCY RANGES FOR THE FIXED SERVICE

A3.1 FIXED SERVICE OPERATING IN THE FREQUENCY RANGE 1.4 GHZ TO 2.6 GHZ

A3.1.1 Receiver resilience values in the out-of-band domain

Table 10: Receiver resilience to transmission in the out-of-band domain for the fixed service (Digital Fixed Radio Systems (DFRS) Class 1, Class 2 and Class 4L, wanted signal level = Rx sens + Rx M)

Victim Rx type	Interferer Tx type	Values used in calculations					Values to be used in compatibility studies		
		Freq offset (MHz)	N (dBm)	Rx M (dB) (Note 1)	ILR (dB) (Note 2)	Rx FOS (dB) (Note 3)	I (dBm) (Note 4)	C/I (dB)	C/I (dB) defined in ETSI EN 302 217-2 [14]
1.75 MHz DFRS Class 1 / 2 / 4L	Wanted signal like	1.75	See Table 12	1	26 / 26 / 30 (Note 5)	36 / 26 / 30 (Note 5)	-86 / -90 / -85 (Note 5)	0	0
1.75 MHz DFRS Class 1 / 2 / 4L	Wanted signal like	1.75	See Table 12	3	26 / 26 / 30 (Note 5)	36 / 26 / 30 (Note 5)	-80 / -85 / -80 (Note 5)	-4	-4
7 MHz DFRS Class 2 / 4L	Wanted signal like	7	See Table 12	1	26 / 30 (Note 5)	26 / 30 (Note 5)	-87 / -80 (Note 5)	-1	0
7 MHz DFRS Class 2 / 4L	Wanted signal like	7	See Table 12	3	26 / 30 (Note 5)	26 / 30 (Note 5)	-81 / -74 (Note 5)	-4	-4
14 MHz DFRS Class 2 / 4L	Wanted signal like	14	See Table 12	1	26 / 30 (Note 5)	26 / 30 (Note 5)	- 81 / -76 (Note 5)	-1	0
14 MHz DFRS Class 2 / 4L	Wanted signal like	14	See Table 12	3	26 /30 (Note 5)	26 / 30 (Note 5)	- 76 / - 71 (Note 5)	-4	-4

Note 1: Value defined in ETSI EN 302 217-2 [14]
Note 2: Value calculated by numerical integration from the transmitter (RF) spectrum masks defined in ETSI EN 302 217-2 [14] improved by 6 dB.
Note 3: FOS = ILR is assumed, except FOS = ILR+ 10 dB for DFRS Class 1 1.75 MHz
Note 4: Value calculated using MRR
Note 5: the „/“ is placed to differentiate the values between types of interferer. Example: ILR=26/26/30 dB leads to $ILR_{DFRS\ Class\ 1}$ = 26 dB, $ILR_{DFRS\ Class\ 2}$ = 26 dB and $ILR_{DFRS\ Class\ 4L}$ = 30 dB. Same type of logic will be applied in all cases.

A3.1.2 Recommended receiver resilience levels in the reciprocal spurious blocking domain

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 11: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for the fixed service (DFRS Class 1, Class 2 and Class 4L, wanted signal level = Rx sens + Rx M)

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) calculated from ETSI EN 302 217-2 [14]
		Freq offset (MHz)	N (dBm)	Rx M (dB) (Note 1) (Note 6)	ILR (dB) (Note 2)	Rx FOS (dB) (Note 3)	I (dBm) Recommended (Note 4) (Note 6)	
Class 1								
1.75 MHz DFRS	5 MHz RI	≥13.4	-105.5	1	78	78	-51	N/A
1.75 MHz DFRS	CW (Note 5)	≥13.4	-105.5	1	130	78	-48	-56
Class 2								
1.75 MHz DFRS	5 MHz RI	≥13.4	-107.5	1	78	78	-53	N/A
1.75 MHz DFRS	CW (Note 5)	≥13.4	-107.5	1	130	78	-50	-63
7 MHz DFRS	5 MHz RI	≥20	-101.5	1	71	71	-54	N/A
7 MHz DFRS	CW (Note 5)	≥20	-101.5	1	130	71	-51	-57
14 MHz DFRS	5 MHz RI	≥37.5	-98.5	1	71	71	-51	N/A
14 MHz DFRS	CW (Note 5)	≥37.5	-98.5	1	130	71	-48	-54
Class 4L								
1.75 MHz DFRS	5 MHz RI	≥13.4	-106.5	1	78	78	-52	N/A
1.75 MHz DFRS	CW (Note 5)	≥13.4	-106.5	1	130	78	-49	-56
7 MHz DFRS	5 MHz RI	≥20	-106.5	1	71	71	-53	N/A
7 MHz DFRS	CW (Note 5)	≥20	-100.5	1	130	71	-50	-50
14 MHz DFRS	5 MHz RI	≥37.5	-100.5	1	71	71	-50	N/A
14 MHz DFRS	CW (Note 5)	≥37.5	-100.5	1	130	71	-47	-47

Note 1: Value defined in ETSI EN 302 217-2 [14]
Note 2: Value calculated by numerical integration from the spectrum mask of the reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions.
Note 3: FOS = ILR is assumed except when ILR=130 dB
Note 4: Value calculated using MRR
Note 5: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note 6. For practicability M=1 dB is used for conformance tests in the related relevant standard, however, it is not the value used as protection criterion in compatibility studies; therefore, M=0.041 dB is used in the calculations of I level to take into account the deployment of Fixed service in a noise limited operational environment.
Note: RI – Reference interfering signal

Table 12: Fixed service operating in the frequency range 1.4 GHz to 2.6 GHz receiver noise floor, signal to noise ratio and sensitivity for DFRS interference

Receiver parameter	DFRS Class 1	DFRS Class 2			DFRS Class 4L			Comment
Channel BW (MHz)	1.75	1.75	7	14	1.75	7	14	
Effective BW (MHz)	1.75	1.75	7	14	1.75	7	14	
Noise figure NF (dB)	6	4	4	4	5	5	5	Value in line with those provided in ETSI TR 101 854 [15]
Noise power N (dB)	-105.5	-107.5	-101.5	-98.5	-106.5	-100.5	-97.5	According to Equation (3)
Signal to noise ratio C/N (dB)	18.5	13.5	13.5	13.5	19.5	19.5	19.5	Value in line with those provided in ETSI TR 101 854 [15]
Sensitivity (Rx sens) (dBm)	-87	-94	-88	-85	-87	-81	-78	Value calculated as defined in ETSI EN 302 217-1 V3.2.2 [16]

ANNEX 4: RECEIVER RESILIENCE TO TRANSMISSION ON ADJACENT FREQUENCY RANGES FOR THE LAND MOBILE SERVICE

A4.1 MFCN IN BANDS HARMONISED FOR USE IN CEPT IN THE FREQUENCY RANGE 410 MHZ TO 5725 MHZ

A4.1.1 Receiver resilience values in the out-of-band domain for IMT BS

Table 13: Receiver resilience to transmission in the out-of-band domain for IMT (1.4, 3, 5, 10, 15 and 20 MHz E-UTRA BS channel bandwidths)

Victim Rx type	Interferer Tx type (Note 1)	Values used in calculations					Values to be used in compatibility studies	
		Freq offset (MHz) (Note 2)	N (dBm)	Rx M (dB) (Note 3)	ILR (dB)	Rx FOS (dB)	I (dBm) (Note 6)	I (dBm) defined in ETSI EN 301 908-14 [17]
Wide Area BS	E-UTRA signal	$BW_{Rx}/2 + BW_{Tx}/2$	See Table 17	11 (Note 4), 8 (Note 5) and 6	See Table 14	See Table 14	-52	-52
Local Area BS	E-UTRA signal	$BW_{Rx}/2 + BW_{Tx}/2$	See Table 17	11 (Note 4), 8 (Note 5) and 6	See Table 14	See Table 14	-44	-44
Home BS	E-UTRA signal	$BW_{Rx}/2 + BW_{Tx}/2$	See Table 17	27 (Note 43), 24 (Note 5) and 22	See Table 14	See Table 14	-28	-28
Medium Range BS	E-UTRA signal	$BW_{Rx}/2 + BW_{Tx}/2$	See Table 17	11 (Note 4), 8 (Note 5) and 6	See Table 14	See Table 14	-47	-47

Note 1: Value calculated as described in section A7.3.2
Note 2: BW_{Rx}= receiver bandwidth, BW_{Tx}= receiver bandwidth
Note 3: M (dB) = Wanted signal level (dBm) - Rx sens (dBm)
Note 4: For BW_{Rx}=1.4 MHz
Note 5: For BW_{Rx}=3 MHz
Note 6: Value calculated using MRR

Table 14: FOS and ILR values used to define the IMT (E-UTRA) BS receiver selectivity (I) in the out-of-band domain (values defined in or derived from ETSI TS 136 141 [18])

BW_{Rx}	1.4 MHz		3 MHz		5 MHz		10 MHz		15 MHz		20 MHz	
Interferer Tx type	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)
E-UTRA signal (Selectivity)	56	46	56	46	56	46	53	43	51	41	50	40

Note: According to ETSI TS 136 141 [18] the contribution from the test equipment ACLR is calculated to give a 0.4 dB additional rise in interference. This corresponds to a test equipment ACLR which is 10.2 dB better than the BS ACS (10 dB instead of 10.2 dB is used in this table)

A4.1.2 Recommended levels of receiver resilience in the reciprocal spurious blocking domain for IMT BS

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 15: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for IMT (E-UTRA BS)

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard				I (dBm) defined in ETSI EN 301 908-14 [17]
							I (dBm) Recommended levels (Note 5)				
		Freq offset (MHz) (Note 1)	N (dBm)	Rx M (dB) (Note 2)	ILR (dB) (Note 3)	Rx FOS (dB) (Note 4)	Wide area BS	Local area BS	Medium range BS	Home BS	
BS (1.4, 3, 5 and 10 MHz)	5 MHz RI	≥23.2, ≥24, ≥25 and ≥27.5	See Table 17	6 / 14 (Note 7)	See Table 16	See Table 16	-28	-22	-24	-14	N/A
BS (1.4, 3, 5 and 10 MHz)	CW (Note 6)	≥20.7, ≥21.5, ≥22.5≤ and ≥25	See Table 17	6 / 14 (Note 7)	See Table 16	See Table 16	-18	-18	-18	-11	-15
BS (15 MHz)	5 MHz RI	≥30	See Table 17	6 / 14 (Note 7)	See Table 16	See Table 16	-26	-20	-22	-12	N/A
BS (15 MHz)	CW (Note 6)	≥27.5	See Table 17	6 / 14 (Note 7)	See Table 16	See Table 16	-16	-16	-16	-9	-15
BS (20 MHz)	5 MHz RI	≥32.5	See Table 16	6 / 14 (Note 7)	See Table 16	See Table 16	-25	-19	-21	-11	N/A
BS (20 MHz)	CW (Note 6)	≥30	See Table 17	6 / 14 (Note 7)	See Table 16	See Table 16	-15	-15	-15	-8	-15

Note 1: BW_{Rx} (MHz) /2 + $BW_{Tx(RI)}$ (MHz) /2 + 20 MHz in line with the IMT relevant standard [17]
Note 2: M (dB) = Wanted signal level (dBm) – Rx sens (dBm)
Note 3: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions
Note 4: FOS = ILR+10, +5, +2 and +0 are assumed for WA, MR, LA and H BS respectively, except when ILR=130 dB
Note 5: Value calculated using MRR
Note 6: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note 7 Only for Home BS

Table 16: FOS and ILR values used to define the IMT (E-UTRA) BS receiver resilience levels (I) in the reciprocal spurious blocking domain (ILR values derived from the 5 MHz RI signal)

Wide area BS; FOS = ILR + 10 dB (Note 1)												
BW_{Rx}	1.4 MHz		3 MHz		5 MHz		10 MHz		15 MHz		20 MHz	
Interferer Tx type	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)	ILR (dB)	FOS (dB)
Wide area BS; FOS = ILR + 10 dB (Note 1)												
5 MHz RI	76	86	72	82	70	80	67	77	67	77	67	77
CW	130	86	130	82	130	80	130	77	130	77	130	77
Medium range BS; FOS = ILR + 5 dB (Note 1)												
5 MHz RI	76	81	72	77	70	75	67	72	67	72	67	72
CW	130	81	130	77	130	75	130	72	130	72	130	72
Local area BS; FOS = ILR + 2 dB (Note 1)												
5 MHz RI	76	78	72	74	70	72	67	69	67	69	67	69
CW	130	78	130	74	130	72	130	69	130	69	130	69
Home BS; FOS = ILR (Note 2)												
5 MHz RI	76	76	72	72	70	70	67	67	67	67	67	67
CW	130	76	130	72	130	70	130	67	130	67	130	67

Note 1: Upper limit of FOS (FOS=ILR+10 dB) is used for “Wide range BS“ that has the highest selectivity according to ETSI EN 301 908-14 [17]. This value is reduced by :
5 dB for “Medium range BS“, which is the difference between the sensitivity of “Wide range BS“ and “Medium range BS“;
8 dB for “Local area BS“, which is the difference between the sensitivity of “Wide range BS“ and “Local area BS“.
Note 2: Lower limit of FOS (FOS=ILR)) is used for “Home BS“ that has the lowest selectivity according to ETSI EN 301 908-14 [17].

Table 17: IMT BS noise floor, signal to noise ratio and sensitivity

IMT BS receiver N, SNR and sensitivity								
Receiver parameter	**Value**							**Comment**
Channel BW (MHz)	1.40	3	5	10	15	20		
Number of RB used	6	15	25	50	75	100		
RB BW (MHz)	0.18	0.18	0.18	0.18	0.18	0.18		
Carrier offset (MHz)	0.02	0.02	0.02	0.02	0.02	0.02		
Effective BW (MHz)	1.095	2.715	4.515	9.015	13.515	18.015		
Wide Area BS								
Noise figure NF (dB)	5	5	5	5	5	5		Value defined in ETSI TS 136 141 [18]
Noise power N (dBm)	-108.58	-104.64	-102.43	-99.43	-97.67	-96.42		According to Equation (3)
Signal to noise ratio C/N (dB)	2.5	2.3	1.6	-1.4	-3.1	-4.4		Calculated (Rx sens - N)
Sensitivity (Rx sens) (dBm)	-106.08	-102.34	-100.83	-100.83	-100.77	-100.82		Values defined in ETSI EN 301 908-14 [17]
Local Area and Home BS								
Noise figure NF (dB)	13	13	13	13	13	13		Calculated from the Wide Area BS reference NF of 5 dB according to the relative sensitivity degradation
Noise power N (dBm)	-100.58	-96.64	-94.43	-91.43	-89.67	-88.42		According to Equation (3)
Signal to noise ratio C/N (dB)	2.5	2.3	1.6	-1.4	-3.1	-4.4		Calculated (Rx sens - N)
Sensitivity (Rx sens) (dBm)	-98.08	-94.34	-92.83	-92.83	-92.77	-92.82		Values defined in ETSI EN 301 908-14 [17]
Medium Range BS								
Noise figure NF (dB)	10	10	10	10	10	10		Calculated from the Wide Area BS reference NF of 5 dB according to the relative sensitivity degradation
Noise power N (dBm)	-103.58	-99.64	-97.43	-94.43	-92.67	-91.42		According to Equation (3)
Signal to noise ratio C/N (dB)	2.5	2.3	1.6	-1.4	-3.1	-4.4		Calculated (Rx sens - N)
Sensitivity (Rx sens) (dBm)	-101.08	-97.34	-95.83	-95.83	-95.77	-95.82		Values defined in ETSI EN 301 908-14 [17]

A4.2 GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS RECEIVERS OPERATING IN THE FREQUENCY RANGE 873 TO 1880 MHZ

The receiver resilience and recommended blocking levels below are applicable to GSM 900, ER-GSM 900 and DCS 1800 Normal BTS, but are not applicable to Multi-carrier BTS (MCBTS) or Multi-Standard Radio (MSR) BS supporting GSM.

A4.2.1 Receiver resilience values in the out-of-band domain for GSM BTS

Table 18: Receiver resilience to transmission in the out-of-band domain for GSM BTS (GSM 900 and ER-GSM 900 Normal BTS, circuit switched channels (Gaussian Minimum Switched Keying - GMSK))

Victim Rx type	Interferer Tx type	Values used in calculations					Values to be used in compatibility studies	
		Freq offset (MHz)	N (dBm)	Rx M (dB) (Note 1)	ILR (dB) (Note 2)	Rx FOS (dB) (Note 3)	C/I (dB) (Note 4)	C/I (dB) defined in ETSI EN 301 502 [19]
Normal and Micro-BTS (M1, M2 and M3)	GMSK modulated	0.2	See Table 22	20	21	21	-9	-9
Normal and Micro-BTS (M1, M2 and M3)	GMSK modulated	0.4	See Table 22	20	53	53	-41	-41
Pico-BTS (P1)	GMSK modulated	0.2	See Table 22	20	21	21	-9	-5
Pico-BTS (P1)	GMSK modulated	0.4	See Table 22	24	53	53	-41	-37
Note 1: M (dB) = Wanted signal level (dBm) - Rx sens (dBm) Note 2: Values defined in ECC Report 146 [8]increased by 3 dB Note 3: FOS = ILR is assumed Note 4: Value calculated using MRR								

Table 19: Receiver resilience to transmission in the out-of-band domain for GSM BTS (GSM 900 and ER-GSM 900 Normal BTS GSM - Packet switched channels (8-PSK) - TU 50 (No FH))

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations					Values to be used in compatibility studies		
		Freq offset (MHz)	N (dBm) (See Table 22)	Rx M (dB) (Note 2)	ILR (dB) (Note 3)	Rx FOS (dB) (Note 4)	I (dBm) (Note 5)	C/I (dB)	C/I (dB) defined in ETSI EN 301 502 [19]
PDTCH/ MCS-5	GMSK modulated	0.2	-113	20	21	21	-75	-2.5	-2
PDTCH/ MCS-5	GMSK modulated	0.4	-113	20	53	53	-43	-34.5	-34.5
PDTCH/ MCS-6	GMSK modulated	0.2	-113	20	21	21	-75	0	1
PDTCH/ MCS-6	GMSK modulated	0.4	-113	20	53	53	-43	-32	-32
PDTCH/ MCS-7	GMSK modulated	0.2	-113	20	21	21	-75	6	8.5
PDTCH/ MCS-7	GMSK modulated	0.4	-113	20	53	53	-43	-26	-26
PDTCH/ MCS-8	GMSK modulated	0.2	-113	20	21	21	-75	12	9
PDTCH/ MCS-8	GMSK modulated	0.4	-113	20	53	53	-43	-20	-20
PDTCH/ MCS-9	GMSK modulated	0.2	-113	20	21	21	-75	15	13.5
PDTCH/ MCS-9	GMSK modulated	0.4	-113	20	53	53	-43	-17	-17

Note 1: PDTCH = Packet Data Traffic Channel, MCS = Modulation and Coding Scheme
Note 2: M (dB) = Wanted signal level (dBm) - Rx sens (dBm)
Note 3: Values defined in ECC Report 146 [8] increased by 3 dB
Note 4: FOS = ILR is assumed
Note 5: Value calculated using MRR

Table 20: Receiver resilience to transmission in the out-of-band domain for GSM BTS (DCS 1800 Normal BTS- Packet switched channels (8-PSK) - TU 50 (No FH))

Victim Rx type	Interferer Tx type	Values used in calculations					Values to be used in compatibility studies		
		Freq offset (MHz)	N (dBm) (See Table 24)	Rx M (dB) (Note 1)	ILR (dB) (Note 2)	Rx FOS (dB) (Note 3)	I (dBm) (Note 4)	C/I (dB)	C/I (dB) defined in ETSI EN 301 502 [19]
PDTCH /MCS-5	GMSK modulated	0.2	-113	20	21	21	-75	-3	-2
PDTCH /MCS-5	GMSK modulated	0.4	-113	20	53	53	-43	-35	-35
PDTCH /MCS-6	GMSK modulated	0.2	-113	20	21	21	-75	0	1.5
PDTCH /MCS-6	GMSK modulated	0.4	-113	20	53	53	-43	-32.5	-32.5
PDTCH /MCS-7	GMSK modulated	0.2	-113	20	21	21	-75	8	10.5
PDTCH /MCS-7	GMSK modulated	0.4	-113	20	53	53	-43	-24	-24
PDTCH /MCS-8	GMSK modulated	0.2	-113	20	21	21	-75	7	10
PDTCH /MCS-8	GMSK modulated	0.4	-113	20	53	53	-43	-25	-25
PDTCH /MCS-9	GMSK modulated	0.2	-113	20	21	21	-75	11	16
PDTCH /MCS-9	GMSK modulated	0.4	-113	20	53	53	-43	-20	-21

Note 1: M (dB) = Wanted signal level (dBm) - Rx sens (dBm)
Note 2: Values defined in ECC Report 146 [8] increased by 3 dB
Note 3: FOS = ILR is assumed
Note 4: Value calculated using MRR

A4.2.2 Recommended levels of receiver resilience in the reciprocal spurious blocking domain for GSM BTS

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 21: Recommended receiver resilience values (dBm) to transmission in the reciprocal spurious blocking domain for GSM BTS (GSM 900, ER-GSM 900 and DCS 1800 Normal Micro/Pico BTS (TCH/FS))

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 301 502 [19]
		Freq offset (MHz) (Note 1)	N (dBm) (See Table 22)	Rx M (dB) (Note 2)	ILR (dB) (Note 3)	Rx FOS (dB) (Note 4)	I (dBm) Recommended value (Note 5)	
GSM 900 and ER-GSM 900	5 MHz RI	≥12.6	-113	3	84	94	-29	N/A
GSM 900 and ER-GSM 900	CW (Note 6)	≥12.6	-113	3	130	94	-19	8
DCS 1800	5 MHz RI	≥12.6	-113	3	88	98	-25	N/A
DCS 1800	CW (Note 6)	≥12.6	-113	3	130	98	-15	0
GSM 900 and ER-GSM 900 Micro (M1)	5 MHz RI	≥12.6	-106	3	84	94	-22	N/A
GSM 900 and ER-GSM 900 Micro (M1)	CW (Note 6)	≥12.6	-106	3	130	94	-12	-8
DCS 1800 Micro (M2)	5 MHz RI	≥12.6	-106	3	88	98	-18	N/A
DCS 1800 Micro (M2)	CW (Note 6)	≥12.6	-106	3	130	98	-8	-0
GSM 900 and ER-GSM 900 Micro (M2)	5 MHz RI	≥12.6	-101	3	84	94	-17	N/A
GSM 900 and ER-GSM 900 Micro (M2)	CW (Note 6)	≥12.6	-101	3	130	94	-7	8
DCS 1800 Micro (M3)	5 MHz RI	≥12.6	-101	3	88	98	-13	N/A
DCS 1800 Micro (M3)	CW (Note 6)	≥12.6	-101	3	130	98	-3	0
GSM 900 and ER-GSM 900 Micro (M3)	5 MHz RI	≥12.6	-96	3	84	94	-12	N/A
GSM 900 and ER-GSM 900 Micro (M3)	CW (Note 6)	≥12.6	-96	3	130	94	-2	8
DCS 1800 Micro (M1)	5 MHz RI	≥12.6	-111	3	88	98	-23	N/A
DCS 1800 Micro (M1)	CW (Note 6)	≥12.6	-111	3	130	98	-13	0

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 301 502 [19]
		Freq offset (MHz) (Note 1)	N (dBm) (See Table 22)	Rx M (dB) (Note 2)	ILR (dB) (Note 3)	Rx FOS (dB) (Note 4)	I (dBm) Recommended value (Note 5)	
GSM 900 and ER-GSM 900 Pico (P1)	5 MHz RI	≥12.6	-97	3	84	94	-13	N/A
GSM 900 and ER-GSM 900 Pico (P1)	CW (Note 6)	≥12.6	-97	3	130	94	-3	8
DCS 1800 Pico (P1)	5 MHz RI	≥12.6	-104	3	88	98	-16	N/A
DCS 1800 Pico (P1)	CW (Note 6)	≥12.6	-104	3	130	98	-6	0

Note 1: $2.5BW_{Tx}$ (MHz) + BW_{Rx} (MHz)/2 for $BW_{Tx} \geq BW_{Rx}$
Note 2: M (dB) = Wanted signal level (dBm) - Rx sens (dBm)
Note 3: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions

Note 4: FOS = ILR + 10 dB is assumed except when ILR=130 dB

Note 5: Value calculated using MRR

Note 6: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.

Note: RI – Reference interfering signal

Table 22: GSM BTS noise floor, signal to noise ratio and sensitivity (GSM 900/ER-GSM 900/DCS 1800 Normal BTS (CS))

Receiver parameter	GSM 900/ DCS 1800 BTS	GSM 900 micro-BTS M1 and DCS 1800 micro-BTS M2	GSM 900 micro-BTS M2 and DCS 1800 micro-BTS M3	GSM 900 micro-BTS M3	GSM 900 pico-BTS P1	DCS 1800 micro-BTS M1	DCS 1800 pico-BTS P1	Comment
Channel BW (MHz)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Effective BW (MHz)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	
Noise figure NF (dB)	8	15	20	25	24	10	17	Derived from Equation (3)
Noise power (N) (dBm)	-113	-106	-101	-96	-97	-111	-104	Calculated (Rx sens – C/N)
Signal to noise ratio C/N (dB)	9	9	9	9	9	9	9	$C/N=C/I_{co-ch}$ is assumed. C/I_{co-ch} values are defined in ETSI TS 145 005 [27]
Sensitivity (Rx sens) (dBm)	-104	-97	-92	-87	-88	-102	-95	Values defined in ETSI EN 301 502 [19]

Table 23: GSM BTS noise floor, signal to noise ratio and sensitivity (GSM 900 and ER-GSM 900 Normal BTS (PS) TU 50 (No FH))

Receiver parameter	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	Comment
Channel BW (MHz)	0.20	0.20	0.20	0.20	0.20	
Effective BW (MHz)	0.18	0.18	0.18	0.18	0.18	
Noise figure NF (dB)	8	8	8	8	8	GSM 900/ DCS 1800 reference NF of 8 dB
Noise power N (dBm)	-113	-113	-113	-113	-113	According to Equation (3)
Signal to noise ratio C/N (dB)	15.5	18	24	30	33	$C/N=C/I_{co\text{-}ch}$ is assumed. $C/I_{co\text{-}ch}$ values are defined in ETSI EN 301 502 [19]
Sensitivity (Rx sens) (dBm)	-98	-95	-89	-83	-80	Calculated $Rx\ sens\ (dBm) = N\ (dBm) + \frac{C}{N}(dB)$

Table 24: DCS noise floor, signal to noise ratio and sensitivity (TU 50 (No FH))

Receiver parameter	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	PDTCH/ MCS -5 TU 50 (No FH)	Comment
Channel BW (MHz)	0.20	0.20	0.20	0.20	0.20	
Effective BW (MHz)	0.18	0.18	0.18	0.18	0.218	
Noise figure NF (dB)	8	8	8	8	8	GSM 900/ DCS 1800 reference NF of 8 dB
Noise power N (dBm)	-113	-113	-113	-113	-113	According to Equation (3)
Signal to noise ratio C/N (dB)	15	17.5	26	25	29	$C/N=C/I_{co\text{-}ch}$ is assumed. $C/I_{co\text{-}ch}$ values are defined in ETSI EN 301 502 [19]
Sensitivity (Rx sens) (dBm)	-98	-95	-87	-88	-84	Calculated $Rx\ sens\ (dBm) = N\ (dBm) + \frac{C}{N}(dB)$

ANNEX 5: RECEIVER RESILIENCE TO TRANSMISSION ON ADJACENT FREQUENCY RANGES FOR SHORT RANGE DEVICES

A5.1 SHORT RANGE DEVICES (SRD) OPERATING IN THE FREQUENCY RANGE 30 MHZ TO 1000 MHZ

A5.1.1 Receiver resilience values in the out-of-band domain for SRDs

Table 25: Receiver resilience to transmission in the out-of-band domain for Category 1 SRDs (Wanted signal level = Rx sens + Rx M)

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations				Values to be used in compatibility studies			
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm)	C/I (dB)	I (dBm) defined in ETSI EN 300 220-3-1 [29] and EN 303 406 [32] (Note 6)
0.025 MHz SRD	CW	0.025	-125	3	130	75	-50	-50	-50
0.05 MHz SRD	CW	0.05	-122	3	130	78	-44	-53	-44
0.1 MHz SRD	CW	0.1	-119	3	130	75	-44	-50	-44
0.2 MHz SRD	CW	0.2	-116	3	130	72	-44	-47	-44

Note: Receivers in EN 300 220 [29] are categorised on a different basis to the those in EN 300 328 [21]. Therefore Category 1, 1.5 and 2 in Annex 5 bears no relationship to Category 1, 2, 3 in Annex 6
Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this Recommendation.
Note 2: Value calculated as shown in Table 29
Note 3: Value defined in ETSI EN 300 220-1 [20]
Note 4: Value assumed for CW
Note 5: Value calculated using MRR formula (7)
Note 6: Only for social alarm unidirectional communication/Mode A message responder from EN 300 220-3-1 [29] and EN 303 406 [32]

A5.1.2 Recommended receiver resilience levels in the reciprocal spurious blocking domain

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 26: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for Short Range Devices Category 1 (Wanted signal level = Rx sens + Rx M)

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 300 220-3-1 [29] (Note 8)
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm) Recommended (Note 6)	
0.01 MHz SRD	5 MHz RI	≥12.505	-129	3	97	107.00	-32	N/A
0.01 MHz SRD	CW (Note 7)	≥12.505	-129	3	130	107.00	-22	-20
0.025 MHz SRD	5 MHz RI	≥12.5125	-125	3	93	103.00	-32	N/A
0.025 MHz SRD	CW (Note 7)	≥12.5125	-125	3	130	103.00	-22	-20
0.05 MHz SRD	5 MHz RI	≥12.525	-122	3	90	100.00	-33	N/A
0.05 MHz SRD	CW (Note 7)	≥12.525	-122	3	130	100.00	-22	-20
0.1 MHz SRD	5 MHz RI	≥12.55	-119	3	87	97	-33	N/A
0.1 MHz SRD	CW (Note 7)	≥12.55	-119	3	130	97	-22	-20
0.2 MHz SRD	5 MHz RI	≥12.6	-116	3	84	94	-32	N/A
0.2 MHz SRD	CW (Note 7)	≥12.6	-116	3	130	94	-22	-20

Note: RI – Reference interfering signal
Note: Receivers in EN 300 220 [29] are categorised on a different basis to the those in EN 300 328 [21]. Therefore Category 1, 1.5 and 2 in Annex 5 bears no relationship to Category 1, 2, 3 in Annex 6
Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this Recommendation
Note 2: Value calculated as shown in Table 29
Note 3: Value defined in ETSI EN 300 220-1 [20]
Note 4: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions, see ANNEX 7:
Note 5: FOS = ILR + 10 dB is assumed except when ILR≥130 dB
Note 6: Value calculated using MRR
Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note 8: Only for social alarm unidirectional communication/Mode A message responder from EN 300 220-3-1 [29] and EN 303 406 [32]

Table 27: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for Short Range Devices Category 1.5 (Wanted signal level = Rx sens + Rx M)

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 300 220-3-1 [29] (Note 8)
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm) Recommended (Note 6)	
0.025 MHz SRD Category 1.5	5 MHz RI	≥12.5125	-125	3	93	93	-35	N/A
0.025 MHz SRD Category 1.5	CW (Note 7)	≥12.5125	-125	3	130	93	-32 (Note 8)	-33 (Note 7)
0.05 MHz SRD Category 1.5	5 MHz RI	≥12.525	-122	3	90	90	-35	N/A
0.05 MHz SRD Category 1.5	CW (Note 7)	≥12.525	-122	3	130	90	-32 (Note 8)	-33 (Note 7)
0.1 MHz SRD Category 1.5	5 MHz RI	≥12.55	-119	3	87	87	-35	N/A
0.1 MHz SRD Category 1.5	CW (Note 7)	≥12.55	-119	3	130	87	-32 (Note 8)	-33 (Note 7)
0.2 MHz SRD Category 1.5	5 MHz RI	≥12.6	-116	3	84	84	-35	N/A
0.2 MHz SRD Category 1.5	CW (Note 7)	≥12.6	-116	3	130	84	-32 (Note 8)	-33 (Note 7)

Note: RI – Reference interfering signal
Note: Receivers in EN 300 220 [29] are categorised on a different basis to the those in EN 300 328 [21]. Therefore Category 1, 1.5 and 2 in Annex 5 bears no relationship to Category 1, 2, 3 in Annex 6

Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this ECC Recommendation
Note 2: Value calculated as shown in Table 29
Note 3: Value defined in ETSI EN 300 220-1 [20]
Note 4: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions, see ANNEX 7:
Note 5: FOS = ILR is assumed except when ILR= 130 dB
Note 6: Value calculated using MRR
Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note 8: Only for social alarm bi-directional communication on a single frequency/Mode B1 message responder from EN 300 220-3-1 [29] and EN 303 406 [32]

Table 28: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for Short Range Devices Category 2 (Note 8) (Wanted signal level = Rx sens + Rx M)

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 300 220-2 [28] (Note 9)
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm) Recommended (Note 6)	
0.025 MHz SRD	5 MHz RI	≥12.5125	-125	3	93	81	-44	N/A
0.025 MHz SRD	CW (Note 7)	≥12.5125	-125	3	130	81 (Note 8)	-44 (Note 8)	-44 (Note 7)
0.05 MHz SRD	5 MHz RI	≥12.525	-122	3	90	78	-44	N/A
0.05 MHz SRD	CW (Note 7)	≥12.525	-122	3	130	78 (Note 8)	-44 (Note 8)	-44 (Note 7)
0.1 MHz SRD	5 MHz RI	≥12.55	-119	3	87	75	-44	N/A
0.1 MHz SRD	CW (Note 7)	≥12.55	-119	3	130	75 (Note 8)	-44 (Note 8)	-44 (Note 7)
0.2 MHz SRD	5 MHz RI	≥12.6	-116	3	84	72	-44	N/A
0.2 MHz SRD	CW (Note 7)	≥12.6	-116	3	84	72 (Note 8)	-44 (Note 8)	-44 (Note 7)
0.5 MHz SRD	5 MHz RI	≥12.75	-112	3	80	68	-44	N/A
0.5 MHz SRD	CW (Note 7)	≥12.75	-112	3	130	68 (Note 8)	-44 (Note 8)	-44 (Note 7)
1.7 MHz SRD	5 MHz RI	≥13.35	-107	3	74	63	-44	N/A
1.7 MHz SRD	CW (Note 7)	≥13.35	-107	3	130	63 (Note 8)	-44 (Note 8)	-44 (Note 7)

Note: RI – Reference interfering signal

Note: Receivers in EN 300 220 [28] are categorised on a different basis to the those in EN 300 328 [21]. Therefore Category 1, 1.5 and 2 in Annex 5 bears no relationship to Category 1, 2, 3 in Annex 6

Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this Recommendation

Note 2: Value calculated as shown in Table 29

Note 3: Value defined in ETSI EN 300 220-1 [20]

Note 4: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions, see ANNEX 7:

Note 5: FOS calculated using MRR

Note 6: Value calculated using MRR

Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.

Note 8: The Blocking level is determined in line with ECC Report 207 [24]. The FOS value is calculated using Equation (7). The blocking levels for SRD Category 1.5 (as defined in Table 27) are preferred to be used for compatibility studies to those for SRD Category 2, since SRD Category 1.5 has more resilient blocking levels than SRD Category 2.

Note 9: Receiver category 2 is available in the harmonised standards EN 300 220-2 [28], EN 300 220-3-2 [30], EN 300 220-4 [31] and EN 303 406 [32]

Table 29: SRD in the frequency range 30 MHz to 1000 MHz receiver noise floor, signal to noise ratio and sensitivity

Receiver Parameter	Value							Comment
Channel BW (MHz)	0.01	0.025	0.05	0.10	0.20	0.50	1.70	The bandwidths shown are not an exhaustive list of what is used on the market. More bandwidths could be added in a future revision of this Recommendation
Effective BW (MHz)	0.01	0.025	0.05	0.10	0.20	0.50	1.70	
Noise figure NF (dB)	5	5	5	5	5	5	5	Value considered
Noise power N (dBm)	-129	-125	-122	-119	-116	-112	-107	According to Equation (3)
Sensitivity (Rx sens) (dBm)	-107	-103	-100	-97	-94	-90	-85	Value calculated as defined in ETSI EN 300 220-1 [20]
Signal to noise ratio C/N (dB)	22	22	22	22	22	22	22	Rx sens (dBm) – N (dBm)

ANNEX 6: RECEIVER RESILIENCE TO TRANSMISSION ON ADJACENT FREQUENCY RANGES FOR WIDEBAND DATA TRANSMISSION SYSTEMS (WDTS) INCLUDING WIRELESS ACCESS SYSTEMS (WAS)/RADIO LOCAL AREA NETWORKS (RLAN)

A6.1 WDTS INLCUDING WAS/RLAN OPERATING IN THE 2400 TO 2483.5 MHZ BAND

A6.1.1 Recommended receiver resilience levels in the reciprocal spurious blocking domain

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 30: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for 2.4 GHz WAS/RLAN Access Points (Wanted signal level = Rx sens + Rx M; Bandwidth = 20 MHz (Note 1))

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	*I (dBm) defined in ETSI EN 300 328 [21]*
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm) Recommended (Note 6)	
Category 1	5 MHz RI	≥ 52.5	-91	6	71	59	-28	N/A
Category 1	CW (Note 7)	≥ 52.5	-91	6	130	59	-28	-34 (Note 8)

Note: RI – Reference interfering signal
Note: Receivers in EN 300 328 [21] are categorised on a different basis to the those in EN 300 220 [29]. Therefore Category 1, 2, 3 in Annex 6 bears no relationship to Category 1, 1.5 and 2 in Annex 5

Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this Recommendation (taking into account that the 5 MHz RI signal as defined in this Recommendation applies to bandwidths up to 20 MHz for calculating realistic spurious emission levels as described in section A7.2.1.)
Note 2: Value calculated as shown in Table 32
Note 3: Value defined in ETSI EN 301 893 [22] (see also note 8)
Note 4: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions
Note 5: For this particular application, FOS = ILR – 12 dB has been used instead of the general rule of FOS = ILR (except when ILR = 130 dB). This assumption should be actively reviewed at next update of this Recommendation with the aim towards improving the “I (dBm) Recommended“ value and industry is expected to contribute towards improving the blocking performance.
Note 6: Value calculated using MRR
Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note 8: EN 300 328 [21] Notes for Cat1 for different frequency offsets: NOTE 2 for 20 MHz frequency offset from the band edge: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3 for ≥40 MHz frequency offset from the band edge: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 20 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

Table 31: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for 2.4 GHz wideband data transmitting systems (WDTS) excluding WAS/RLAN Access Points (Wanted signal level = Rx sens + Rx M (Note 1))

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 300 328 [21]
		Freq offset (MHz) (Note 2)	N (dBm) (Note 3)	Rx M (dB) (Note 4)	ILR (dB) (Note 5)	Rx FOS (dB) (Note 6)	I (dBm) Recommended (Note 7)	
1 MHz Category 1	5 MHz RI (Note 12)	>=23	-106	18	81	54	-34	N/A
1 MHz Category 1	CW (Note 8)	>= 20.5	-106	18	130	54	-34	-34
1 MHz Category 2	5 MHz RI (Note 12)	>=23	-104	20	81	50	-34	N/A
1 MHz Category 2	CW (Note 8)	>= 20.5	-104	20	130	50	-34	-34
1 MHz Category 3	5 MHz RI (Note 12)	>=23	-100	26	81	40	-34	N/A
1 MHz Category 3	CW (Note 8)	>= 20.5	-100	26	130	40	-34	-34
2 MHz Category 1	5 MHz RI (Note 12)	>=23.5	-103	18	78	51	-34	N/A
2 MHz Category 1	CW (Note 8)	>=21	-103	18	130	51	-34	-34
2 MHz Category 2	5 MHz RI (Note 12)	>=23.5	-101	20	78	47	-34	N/A
2 MHz Category 2	CW (Note 8)	>=21	-101	20	130	47	-34	-34
2 MHz Category 3	5 MHz RI (Note 12)	>=23.5	-97	26	78	37	-34	N/A
2 MHz Category 3	CW (Note 8)	>=21	-97	26	130	37	-34	-34
20 MHz Category 1	5 MHz RI	≥ 52.5	-91	6	71	53	-34	N/A
20 MHz Category 1	CW (Note 8)	≥ 52.5	-91	6	130	53	-34	-34 (Note 9)
20 MHz Category 2	5 MHz RI	≥ 52.5	-91	6	71	43	-44	N/A
20 MHz Category 2	CW (Note 8)	≥ 52.5	-91	6	130	43	-44	-34 (Note 10)
20 MHz Category 3	5 MHz RI	≥ 52.5	-91	6	71	33	-54	N/A
20 MHz Category 3	CW (Note 8)	≥ 52.5	-91	6	130	33	-54	-34 (Note 11)

Victim Rx type (Note 1)	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	I (dBm) defined in ETSI EN 300 328 [21]
		Freq offset (MHz) (Note 2)	N (dBm) (Note 3)	Rx M (dB) (Note 4)	ILR (dB) (Note 5)	Rx FOS (dB) (Note 6)	I (dBm) Recommended (Note 7)	

Note: RI – Reference interfering signal

Note: Receivers in EN 300 328 [21] are categorised on a different basis to the those in EN 300 220 [29]. Therefore Category 1, 2, 3 in Annex 6 bears no relationship to Category 1, 1.5 and 2 in Annex 5

Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this ECC Recommendation. (taking into account that the 5 MHz RI signal as defined in this Recommendation applies to bandwidths up to 20 MHz for calculating realistic spurious emission levels as described in section A7.2.1.).

Note 2: Frequency separation is derived from the WDTS relevant standard for 1 and 2 MHz victim Rx types and using the MRR for 20 MHz Rx types

Note 3: Value calculated as shown in Table 32.

Note 4: Value defined in ETSI EN 301 893 [22] (see also Notes 8 – 10)

Note 5: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions

Note 6: FOS is derived following equation (7) in Annex 1 based on the blocking value given in ETSI EN 300 328. .

Note 7: Value derived from EN 300 328 (scaling with Pmin + 6 dB for 20 MHz Victim Rx types)

Note 8: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.

Note 9: EN 300 328 [21] Notes for Cat1 for different frequency offsets: NOTE 2 for 20 MHz frequency offset from the band edge: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3 for ≥40 MHz frequency offset from the band edge: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 20 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

Note 10: EN 300 328 [21] Note for Cat2: NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

Note 11: EN 300 328 [21] Note for Cat3: NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative the test may be performed using a wanted signal up to Pmin + 30 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal

Note 12: The blocking levels using the RI are to be reviewed considering new studies which should include measurements in the next revision of this Recommendation with the aim towards improving the "I (dBm) Recommended" value and industry is expected to contribute towards improving the blocking performance.

Table 32: WDTS including WAS/RLAN operating in the 2.4 GHz receiver noise floor, signal to noise ratio and sensitivity.

Receiver parameter	2.4 GHz WAS/RLAN	2.4 GHz WDTS with Bandwidth = 1 MHz			2.4 GHz WDTS with Bandwidth = 2 MHz			Comment
Category (Note 1)	Cat. 1 to 3	Cat. 1	Cat. 2	Cat. 3	Cat. 1	Cat. 2	Cat. 3	
Channel BW (MHz)	20	1			2			The bandwidths shown are not an exhaustive list of what is used on the market. More bandwidths could be added in a future revision of this Recommendation
Effective BW (MHz)	18	1			2			
Noise figure NF (dB)	10	8	10	14	8	10	14	ECC Report 325 for WAS/RLAN [9] Typical values for 1 and 2 MHz WDTS. The difference in Rx NF for Cat1, Cat 2 and Cat 3 is due to the practical implementations of very low-power radio design, especially in the RFIC and the short range personal area network use cases they serve. This results in compromise in the practically achievable Rx NF.
Noise power N (dBm)	-91	-106	-104	-100	-103	-101	-97	According to Equation (3)
Signal to noise ratio C/N (dB)	11	15	15	15	15	15	15	$Rx\ sens(dBm) - N(dBm)$
Sensitivity (Rx sens) (dB)	-80	-91	-89	-85	-88	-86	-82	ECC Report 325 for WAS/RLAN [9]
Wanted signal level C (dBm)	-74	-73	-69	-59	-70	-66	-56	**WAS/RLAN** (-139 dBm + 10 × $\log_{10}$(OCBW)) or -74 dBm whichever is lower for Category 1 **1 and 2 MHz WDTS** (-133 dBm + 10 × $\log_{10}$(OCBW)) or -68 dBm whichever is lower for Category 1 (-139 dBm + 10 × $\log_{10}$(OCBW)+ 10 dB) or -74 dBm + 10 dB whichever is lower for Category 2 (-139 dBm + 10 × $\log_{10}$(OCBW)+ 20 dB) or -74 dBm + 20 dB whichever is lower for Category 3

Note 1: Receivers in EN 300 328 are categorised on a different basis to the those in EN 300 220. Therefore Category 1, 2, 3 in Annex 6 bears no relationship to Category 1, 1.5 and 2 in Annex 5

Note: It should be noted that for certain systems, receivers may have fairly different noise floors due to implementation choices. The noise floor selected for MRR should be a lower figure among the receiver population, so as not to unduly constrain receivers with a low noise figure with high FOS figures.

A6.2 WAS/RLAN OPERATING IN THE FREQUENCY RANGES 5150 MHZ - 5350 MHZ AND 5470 MHZ - 5725 MHZ

A6.2.1 Receiver resilience levels in the out-of-band domain

Table 33: Receiver resilience to transmission in the out-of-band domain for 5 GHz RLAN (Wanted signal level = Rx sens + Rx M; Bandwidth = 20 MHz)

Victim Rx type	Interferer Tx type	Values used in calculations					Values to be used in compatibility studies		
		Freq offset (MHz)	N (dBm) (Note 1)	Rx M (dB) (Note 2)	ILR (dB) (Note 3)	Rx FOS (dB) (Note 4)	I (dBm) (Note 5)	C/I (dB)	C/I (dB) defined in IEEE Std 802.11-2020 [26]
RLAN BPSK (1/2)	Wanted signal like	20	-87.00	6	26	26	-59	-17	-16
RLAN QPSK (1/2)	Wanted signal like	20	-86.50	6	26	26	-59	-14	-13
RLAN QPSK (3/4)	Wanted signal like	20	-87.00	6	26	26	-59	-12	-11
RLAN 16-QAM (1/2)	Wanted signal like	20	-86.50	6	26	26	-59	-9	-8
RLAN 16-QAM (3/4)	Wanted signal like	20	-85.00	6	26	26	-57	-7	-4
RLAN 64-QAM (2/3)	Wanted signal like	20	-83.50	6	26	26	-56	-4	0
RLAN 64-QAM (3/4)	Wanted signal like	20	-85.00	6	26	26	-57	-2	1

Note 1: Value calculated as shown in Table 34
Note 2: Value defined in ETSI EN 301 893 [22]
Note 3: Value calculated by numerical integration from the spectrum mask for RLAN for interference in ETSI EN 301 893 [22].
Note 4: FOS = ILR is assumed
Note 5: Value calculated using MRR

A6.2.2 Recommended receiver resilience levels in the reciprocal spurious blocking domain

A 5 MHz OFDM interfering signal (RI signal) has been used in this Recommendation to define the recommended blocking level of receivers in the reciprocal spurious blocking domain (RSBD). In addition, the blocking level when using a CW interferer has also been derived which provides an equivalent level of receiver blocking performance. ETSI should, based on its technical assessment, select only one of these signals when developing blocking level requirements in an individual relevant standard.

Table 34: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for 5 GHz RLAN Primary Devices or Secondary Devices with radar detection (typically access points) (Wanted signal level = Rx sens + Rx M; Bandwidth = 20 MHz (Note 1))

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard	*I (dBm) defined in ETSI EN 301 893 [22]*
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm) Recommended (Note 6)	
RLAN BPSK (1/2)	5 MHz RI	≥80	-87	6	71	48	-34	N/A
RLAN BPSK (1/2)	CW (Note 7)	≥80	-87	6	130	48	-34	-53
RLAN QPSK (1/2)	5 MHz RI	≥80	-86.5	6	71	48	-34	N/A
RLAN QPSK (1/2)	CW (Note 7)	≥80	-86.5	6	130	48	-34	-53
RLAN QPSK (3/4)	5 MHz RI	≥80	-87	6	71	48	-34	N/A
RLAN QPSK (3/4)	CW (Note 7)	≥80	-87	6	130	48	-34	-53
RLAN 16-QAM (1/2)	5 MHz RI	≥80	-86.5	6	71	48	-34	N/A
RLAN 16-QAM (1/2)	CW (Note 7)	≥80	-86.5	6	130	48	-34	-53
RLAN 16-QAM (3/4)	5 MHz RI	≥80	-85	6	71	46	-34	N/A
RLAN 16-QAM (3/4)	CW (Note 7)	≥80	-85	6	130	46	-34	-53
RLAN 64-QAM (2/3)	5 MHz RI	≥80	-83.5	6	71	45	-34	N/A
RLAN 64-QAM (2/3)	CW (Note 7)	≥80	-83.5	6	130	45	-34	-53
RLAN 64-QAM (3/4)	5 MHz RI	≥80	-85	6	71	46	-34	N/A
RLAN 64-QAM (3/4)	CW (Note 7)	≥80	-85	6	130	46	-34	-53

Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this Recommendation (taking into account that the 5 MHz RI signal as defined in this Recommendation applies to bandwidths up to 20 MHz for calculating realistic spurious emission levels as described in section A7.2.1.)
Note 2: Value calculated as shown in Table 33
Note 3: Value defined in ETSI EN 301 893 [22]
Note 4: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions
Note 5: For this particular application, FOS = ILR – 23…26 dB has been used instead of the general rule of FOS = ILR (except when ILR = 130 dB). This assumption should be actively reviewed at next update of this Recommendation with the aim towards improving the "I (dBm) Recommended" value and industry is expected to contribute towards improving the blocking performance.
Note 6: Value calculated using MRR
Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
Note: RI – Reference interfering signal

Table 35: Recommended receiver resilience to transmission in the reciprocal spurious blocking domain for 5 GHz RLAN Secondary Devices without radar detection (typically client devices) (Wanted signal level = Rx sens + Rx M; Bandwidth = 20 MHz (Note 1))

Victim Rx type	Interferer Tx type	Values used in calculations					Values recommended for relevant standard (Note 6)	I (dBm) defined in ETSI EN 301 893 [22]
		Freq offset (MHz)	N (dBm) (Note 2)	Rx M (dB) (Note 3)	ILR (dB) (Note 4)	Rx FOS (dB) (Note 5)	I (dBm) Recommended (Note 6)	
RLAN BPSK (1/2)	5 MHz RI	≥80	-87	6	71	23	-59	N/A
RLAN BPSK (1/2)	CW (Note 7)	≥80	-87	6	130	23	-59	-59
RLAN QPSK (1/2)	5 MHz RI	≥80	-86.5	6	71	23	-59	N/A
RLAN QPSK (1/2)	CW (Note 7)	≥80	-86.5	6	130	23	-59	-59
RLAN QPSK (3/4)	5 MHz RI	≥80	-87	6	71	23	-59	N/A
RLAN QPSK (3/4)	CW (Note 7)	≥80	-87	6	130	23	-59	-59
RLAN 16-QAM (1/2)	5 MHz RI	≥80	-86.5	6	71	23	-59	N/A
RLAN 16-QAM (1/2)	CW (Note 7)	≥80	-86.5	6	130	23	-59	-59
RLAN 16-QAM (3/4)	5 MHz RI	≥80	-85	6	71	21	-59	N/A
RLAN 16-QAM (3/4)	CW (Note 7)	≥80	-85	6	130	21	-59	-59
RLAN 64-QAM (2/3)	5 MHz RI	≥80	-83.5	6	71	20	-59	N/A
RLAN 64-QAM (2/3)	CW (Note 7)	≥80	-83.5	6	130	20	-59	-59
RLAN 64-QAM (3/4)	5 MHz RI	≥80	-85	6	71	21	-59	N/A
RLAN 64-QAM (3/4)	CW (Note 7)	≥80	-85	6	130	21	-59	-59

Note 1: The channel bandwidths listed above are not exhaustive. More bandwidths could be added in a future revision of this ECC Recommendation (taking into account that the 5 MHz RI signal as defined in this Recommendation applies to bandwidths up to 20 MHz for calculating realistic spurious emission levels as described in section A7.2.1.)
Note 2: Value calculated as shown in Table 33
Note 3: Value defined in ETSI EN 301 893 [22]
Note 4: Value calculated by numerical integration from the spectrum mask of reference interfering signal. ILR=130 dB is assumed in the absence of spurious emissions
Note 5: FOS is derived following equation (7) in Annex 1 based on the blocking value given in ETSI EN 301 893
Note 6: Value derived from EN 301 893
Note 7: The equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.
RI – Reference interfering signal

Table 36: 5 GHz RLAN receiver noise floor, signal to noise ratio and sensitivity

Receiver parameter	Value							Comment
Modulation	BPSK	QPSK	QPSK	16-QAM	16-QAM	64-QAM	64-QAM	From ECC Report 325 [9]
Coding	1/2	1/2	3/2	1/2	3/4	2/3	3/4	From ECC Report 325 [9]
Channel BW (MHz)	20	20	20	20	20	20	20	The bandwidths shown are not an exhaustive list of what is used on the market. More bandwidths could be added in a future revision of this Recommendation
Effective BW (MHz)	18	18	18	18	18	18	18	From ECC Report 325 [9]
Noise figure NF (dB)	14.4	14.9	14.4	14.9	16.4	17.9	16.4	Calculated
Noise power N (dBm)	-87	-86.5	-87	-86.5	-85	-83.5	-85	$Rx\ sens(dBm) - C/N(dB)$ From ECC Report 325 [9]
Signal to noise ratio C/N (dB)	5	7.5	10	12.5	15	17.5	20	From ECC Report 325 [9]
Sensitivity (Rx sens) (dBm)	-82	-79	-77	-74	-70	-66	-65	Value defined in ECC Report 325 [9] and IEEE Std 802.11-2016 [26]

ANNEX 7: REFERENCE INTERFERING SIGNAL AND A SINGLE INTERFERENCE SCENARIO TO BE USED IN THE CALCULATION OF RECOMMENDED RECEIVER RESILIENCE LEVELS USING MRR

A7.1 INTRODUCTION

When using MRR to define the adjacent channel protection ratio (PR) and the blocking level of receivers, the relevant interfering signal and interference scenario are determined from existing or planned deployment of victim and interfering systems and the compatibility studies presented in various CEPT/ECC, ETSI and ITU-R technical reports, or, if the information in the previous reports is not available, from the intra/inter-system interfering signals and interference scenarios defined in relevant standards or from the reference interfering signal and interference scenario defined in this annex.

The blocking levels defined in this Recommendation are calculated using MRR and based on the reference interfering signal (RI) described in this section. Consequently, the RI signal can be used to check the conformity of receivers with the related blocking levels. Additionally, the equivalent blocking levels for a CW interfering signal are derived in the Recommendation to allow the conformance tests to be done with a CW signal as an alternative.

A7.2 APPROACH USED TO DEFINE A REFERENCE INTERFERING SIGNAL

In nearly all relevant standards, a wanted signal like modulated adjacent channel interfering signal is used to define receiver resilience levels for intra-system compatibility.

On the other hand, for large frequency offsets going beyond the operating band of a given system/service, in most cases an unmodulated continuous wave (CW) interfering signal is used to define receiver resilience levels for inter-system compatibility based on the assumption that beyond at a large frequency offset the victim receiver FOS is constant, thus independent of the interfering signal bandwidth. This approach avoids the difficulty of identifying the most relevant interfering signal on a case-by-case basis, which is not an easy task due to the increasingly densely used radio spectrum.

As most standards use a CW test signal, a representative interfering signal is necessary to define receiver resilience levels for inter-system/service compatibility and to calculate receiver resilience levels using MRR.

Note: In this version of the ECC Recommendation , in order to have a consistent approach, the 5 MHz OFDM interfering signal has been used to define the receiver resilience levels in the reciprocal spurious blocking domain in Annexes 2-6.

A7.2.1 Proposed reference interfering signal

The proposed reference interfering signal has been derived based on an OFDM signal generated using an RF signal generator and has the following characteristics:

- Signal type: OFDM 3GPP continuous, fully-loaded, FDD-LTE DL. OFDM is the most common modulation type (e.g., IMT (LTE), DVB-T, DAB, DRM, Wireless LAN, WiMAX, etc.);

  OFDM signal generators are available on the market, and such a signal can be generated using the practical approaches explained in Annex 8 for test purposes, as part of a larger test configuration;
- Channel Bandwidth: 5 MHz. This is a good compromise between potential narrowband and wideband OFDM interfering signals.

  Note: other bandwidths may be needed for frequencies outside of the range considered in Annexes 2 – 6 (30 MHz and 5725 MHz).
- Transmission bandwidth configuration: highest transmission bandwidth allowed for uplink or downlink in a given channel bandwidth, expressed in MHz. For downlink: BW_Config = 15 kHz + NRB × 180 kHz in the downlink (See also Figure 3.1-1 in ETSI EN 301 908-14 V15.1.1 (2021-09));
- OOBD/SD boundary: at ± 12.5 MHz offset from the centre frequency of the interfering signal (± 250% of the interfering signal bandwidth).

  OOBE level joins spurious emission (SE) level at the OOBD/SD boundary;
- ILR/out-of-band (OOB) domain:

- 1st adjacent channel ILR (ACLR) = 48 dB/5 MHz.

  Value approximated for IMT BS (44 dB) in ETSI EN 301 908-14 [17] + 3 dB margin (see Figure 3).
- 2nd adjacent channel ILR = 67 dB/5 MHz and 68 dB/5MHz, for frequency ranges of 9 kHz ≤ *f* ≤ 1 GHz and 1 GHz < *f* ≤ 5725 MHz respectively.

  Value obtained by the method described in section A7.2.2;
- 1st adjacent channel ILR to OOBD/SD boundary = 70 dB/5 MHz and 74 dB/5 MHz, for frequency ranges of 9 kHz ≤ *f* ≤ 1 GHz and 1 GHz < *f* ≤ 5725 MHz respectively.

  Value obtained by the method described in section A7.2.2 based on the SE (spurious emissions) limits defined in ERC Recommendation 74-01 (Annex 2, Table 6, line 2.1.1) [4]– 3 dB margin.
- Spurious domain:
- -39 dBm/100 kHz for 9 kHz ≤ *f* ≤ 1 GHz, and
- -33 dBm MHz for 1 GHz < *f* ≤ 5725 MHz

  as defined in ERC Recommendation 74-01 – 3 dB margin, (ERC Recommendation 74-01, Annex 2, Table 6, 2.1.1).

  These limits are the most common limits to radio transmitters including IMT base stations. Note that the maximum SE integration BW is limited to 2 times of the BW of the reference interfering signal (2*BW_{RI}) to prevent from calculating non-realistic spurious emission levels for a 5 MHz interference signal over a wide frequency range.

A7.2.2 Derivation of the 5 MHz bandwidth reference interference signal spectrum mask

The spectrum mask of the reference interfering signal described in section A7.2.1 has been derived according to the following steps:

Step 1: A 5 MHz OFDM signal having a 1st adjacent channel ILR (ACLR) of 47 dB/5 MHz was generated using an OFDM signal generator. The value of 47 dB/5 MHz is the IMT BS 1st adjacent ILR (ACLR) defined in ETSI EN 301 908-14 [17] increased by 3 dB. The 2nd adjacent channel ILR of this signal is 64 dB/(5 MHz) as shown in Figure 2.

The ILR value measured for a given receiver channel bandwidth should be equal to the ILR value calculated from the reference interfering signal spectrum mask ±1 dB.

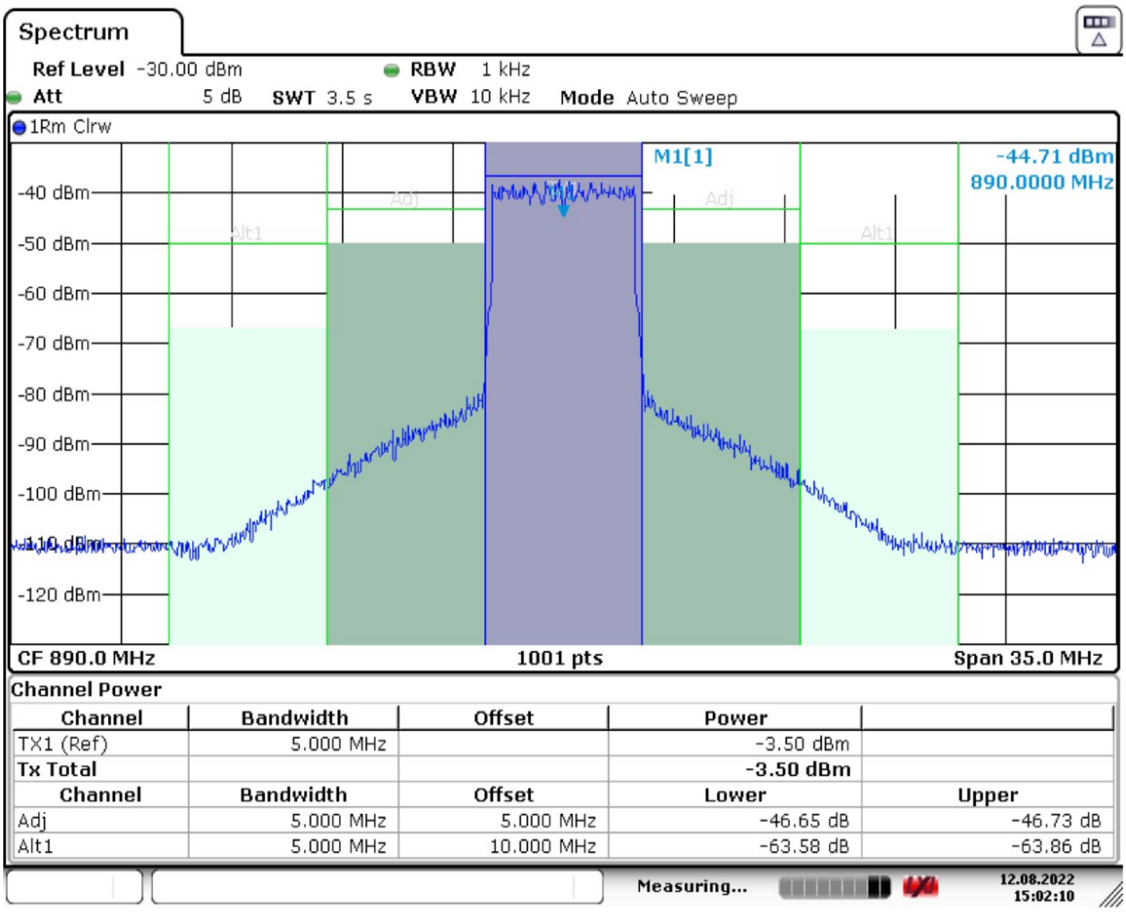

Figure 2: 5 MHz OFDM signal (QPSK/4-QAM modulation, PAPR = 11 dB, Spectrum analyser noise floor = -117.5 dBm/kHz, generator output power = 18 dBm RMS, external attenuation 21.5 dB)

A numerical integration method based on the trapezoidal rule has been used to calculate the ILR of the spectrum mask of the reference interfering signal as follows:

$$ILR(dB) = 10\log_{10}\left(\frac{I_{in-ch}}{I^{r}_{oo-ch}}\right) = 10\log_{10}\left(\frac{I_{in-ch}}{\int_{f_{ov}-B_v/2}^{f_{ov}+B_v/2} sd_I(f)df}\right) \quad (11)$$

Where:

- I_{in-ch}: frequency offset interfering signal in-channel power at the receiver input;
- B_v: victim receiver bandwidth;
- f_{ov}: centre frequency of the victim receiver channel;
- $sd_I(f)$: frequency offset interfering signal spectral density in the linear domain.

$$\int_{f_{ov}-B_v/2}^{f_{ov}+B_v/2} sd_I(f)df = \Delta f\left(\sum_{k=1}^{N-1} sd_I(f_k) + \frac{sd_I(f_N) + sd_I(f_0)}{2}\right) \quad (12)$$

Where:

$$\Delta f = \frac{B_v/2 - (-B_v/2)}{N} = \frac{B_v}{N} \quad (13)$$

The validity of the integration method was checked as presented in Table 37.

Table 37: Comparison of measurements and numerical integration results (Measurement BW=5 MHz / Integration BW (5 MHz)

Offset type	Integration BW (MHz)	ILR obtained by measurement (dB)	ILR obtained by numerical integration (dB)	Difference (dB)
Co-channel	5 MHz	0	0	0
1st adjacent channel	5 MHz	46.73	47.27	0.54
2nd adjacent channel	5 MHz	63.86	63.80	-0.06
> 2nd adjacent channel	5 MHz	70	70.28	0.28

Step 2 (for 30 MHz < f ≤ 1 GHz): A reference interfering (RI) signal mask has been derived from the measured 5 MHz OFDM signal spectrum of which 4.5 MHz is the transmission bandwidth configuration (60 W/(4.5 MHz), 47.78 dBm/(4.5 MHz), Normalisation factor (F_{Norm}) = Power in transmission bandwidth (dBm) – 10*log (transmission bandwidth (Hz)/1000) = 11.25 dBm/kHz, normalising the whole mask to the in-band power spectral density of 0 dBm/kHz. For the spurious emissions, -39 dBm/(100 kHz) = -59 dBm/kHz and then normalised by applying the 11.25 dB to give -70.25 dBm/kHz) using linear interpolation to join the OOBE level to SE level of -36 dBm/(100 kHz) decreased by 3 dB at the OOBD/SD boundary. The derived spectrum mask has a set of break points as shown in Figure 3. The ILR of the RI signal has been calculated by numerical integration of its power (W) in a BW of 5 MHz, as described above, at three different frequency offsets as shown in Table 38.

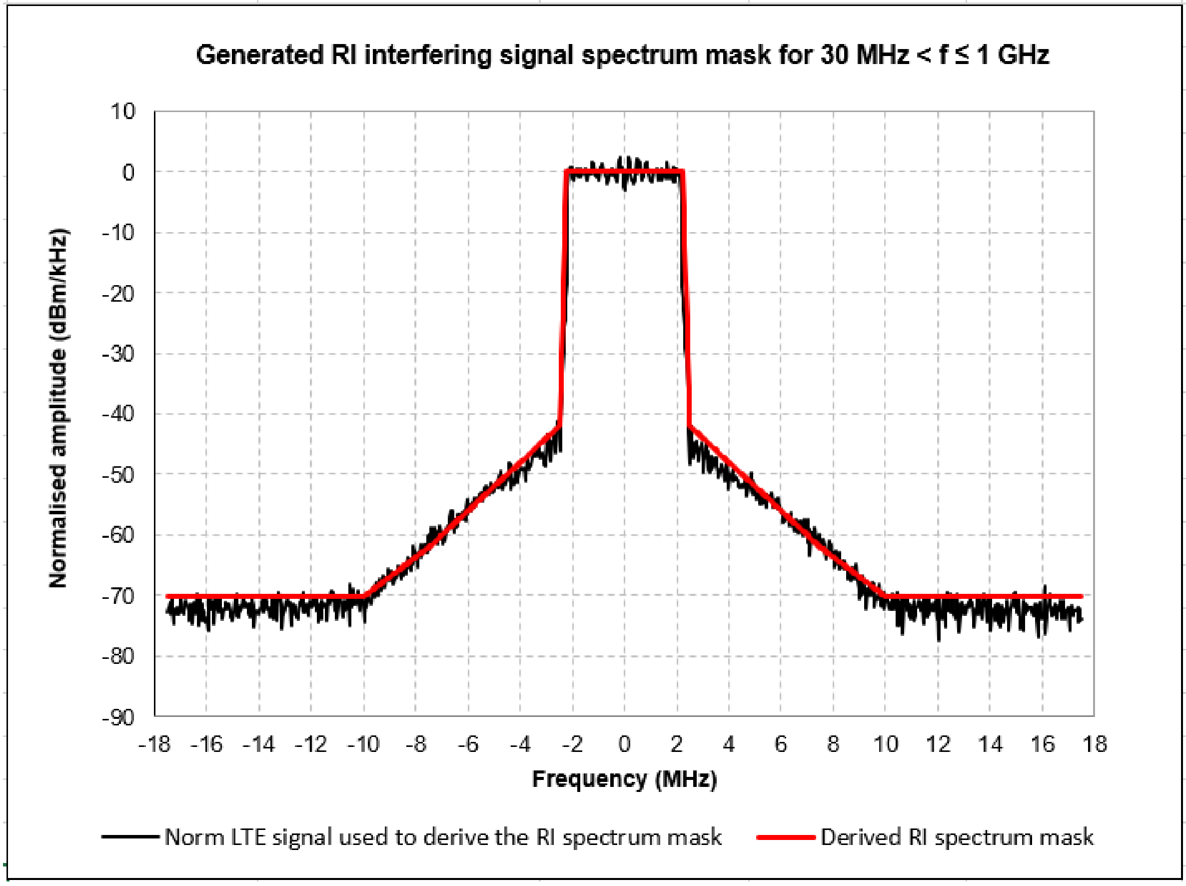

Figure 3: Approximation of the 5 MHz OFDM signal to a reference interfering signal for 30 MHz < f ≤ 1 GHz

Table 38: ILR of the reference interfering signal for 30 MHz < f ≤ 1 GHz (60 W/5 MHz conducted Tx power normalised to 0 dBm/kHz; F_{Norm}=11.25 dB)

Channel BW (MHz)	Power per channel BW (W)	Power per channel BW (dBm)	Offset type	ILR of the RI signal (dB)	ILR of the measured signal (dB)
5	4.54E+00	36.57	Co-channel	0	0
5	6.61E-05	-11.80	1st adjacent channel	48	48
5	9.25E-07	-30.34	2nd adjacent channel	67	66
5	4.69E-07	-33.29 (Note 1)	1st adjacent channel to OOBD/SD boundary in the SD	70	71
Note 1 : -33.29 dBm/(5 MHz)+11.25 dB =-39dBm/(100 kHz), which is the spurious limit of -36dBm/(100 kHz) minus a 3 dB margin					

Step 3 (for 1 GHz < f ≤ 5.725 GHz**):** A reference interfering signal mask has been derived from the measured 5 MHz OFDM signal spectrum used in Step 2 (see that step for how the normalisation was calculated) using linear interpolation to join the OOBE level to SE level of -30 dBm/MHz decreased by 3 dB at the OOBD/SD boundary. The ILR of the RI signal has been calculated by numerical integration of its power (W) in its bandwidth of 5 MHz at three different frequency offsets as shown in Table 39.

Table 39: ILR of the reference interfering signal for 1 GHz < f ≤ 5.725 GHz (60 W/5 MHz conducted Tx power normalised to 0 dBm/kHz; F_{Norm}=11.25 dB)

Channel BW (MHz)	Power per channel BW (W)	Power per channel BW (dBm)	Offset type	ILR of the RI signal (dB)	ILR of the measured signal (dB)
5	4.54E+00	36.57	Co-channel	0	0
5	6.61E-05	-11.80	1st adjacent channel	48	48
5	7.22E-07	-31.41	2nd adjacent channel	68	66
5	1.87E-07	-37.29 (Note 1)	1st adjacent channel to OOBD/SD boundary in the SD	74	71
Note 1: -37.29 dBm/(5 MHz)+11.25 dB =-33dBm/MHz, which is the spurious limit of -30dBm/MHz minus a 3 dB margin					

A7.3 APPROACH USED TO DEFINE A SINGLE INTERFERENCE SCENARIO

A7.3.1 Rationale

The rationale behind the idea to have a single interference scenario is:

- To treat all the services, systems and applications with a common methodology
- To define the recommended receiver resilience levels only for the most relevant frequency offsets, thus to keep the size of the future Recommendation on receivers reasonable.

A7.3.2 Detailed description of the proposed interference scenario

According to the rationale presented in section A7.3.1, it is proposed to define the receiver resilience level for different frequency offsets between the interfering transmitter and the victim receiver:

- In the OOB domain, the first adjacent channel to the interfering signal, for the purpose of receiver adjacent channel PR calculation/measurement;
- In the RSBD of the interfering signal, provided that the interfering signal is beyond the second adjacent channel of the victim receiver, for the purpose of recommended receiver blocking level calculation/measurement.

The frequency offsets between the reference interfering signal (RI) centre frequency and the victim receiver (Rx) centre frequency are calculated as follows:

- In the OOB domain:

  Frequency offset (MHz) = $BW_{RI}/2$ (MHz) + $BW_{Rx}/2$ (MHz)
- In the RSBD:

  If $BW_{RI} > BW_{Rx}$

  Frequency offset (MHz) ≥ $2.5BW_{RI}$ (MHz) + $BW_{Rx}/2$ (MHz)

  Else

  Frequency offset (MHz) ≥ $2.5BW_{Rx}$ (MHz) + $BW_{RI}/2$ (MHz)

For channelised systems, the above calculations define that the victim receiver channel is in the spurious domain of the interfering transmitter and reciprocally the interfering transmitter channel is in the spurious domain of the wanted transmitter of the victim system, whatever their channel bandwidth (BW) is.

For single carrier and multi-carrier receivers the bottom channel at the lower edge and the top channel at the upper edge of the receiver operating band is to be defined and tested. For receivers supporting multiple channel bandwidths, the smallest and the largest channel bandwidths should be defined and tested.

For non-channelised systems the occupied bandwidth is considered as a single channel. Figure 4 illustrates this for both channelised and non-channelised systems.

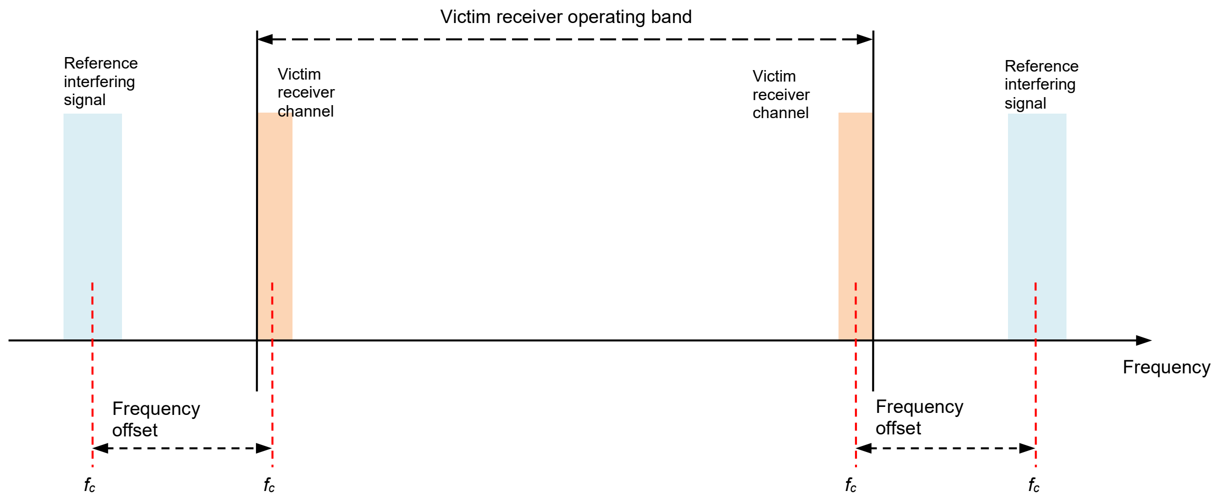

Figure 4: Channel of the receiver to be defined and tested

This interference scenario including the reference interferer (RI) and the two offset frequencies is depicted in Figure 5 for the example of a victim receiver having a bandwidth of 2 MHz ($BW_{RI} > BW_{Rx}$).

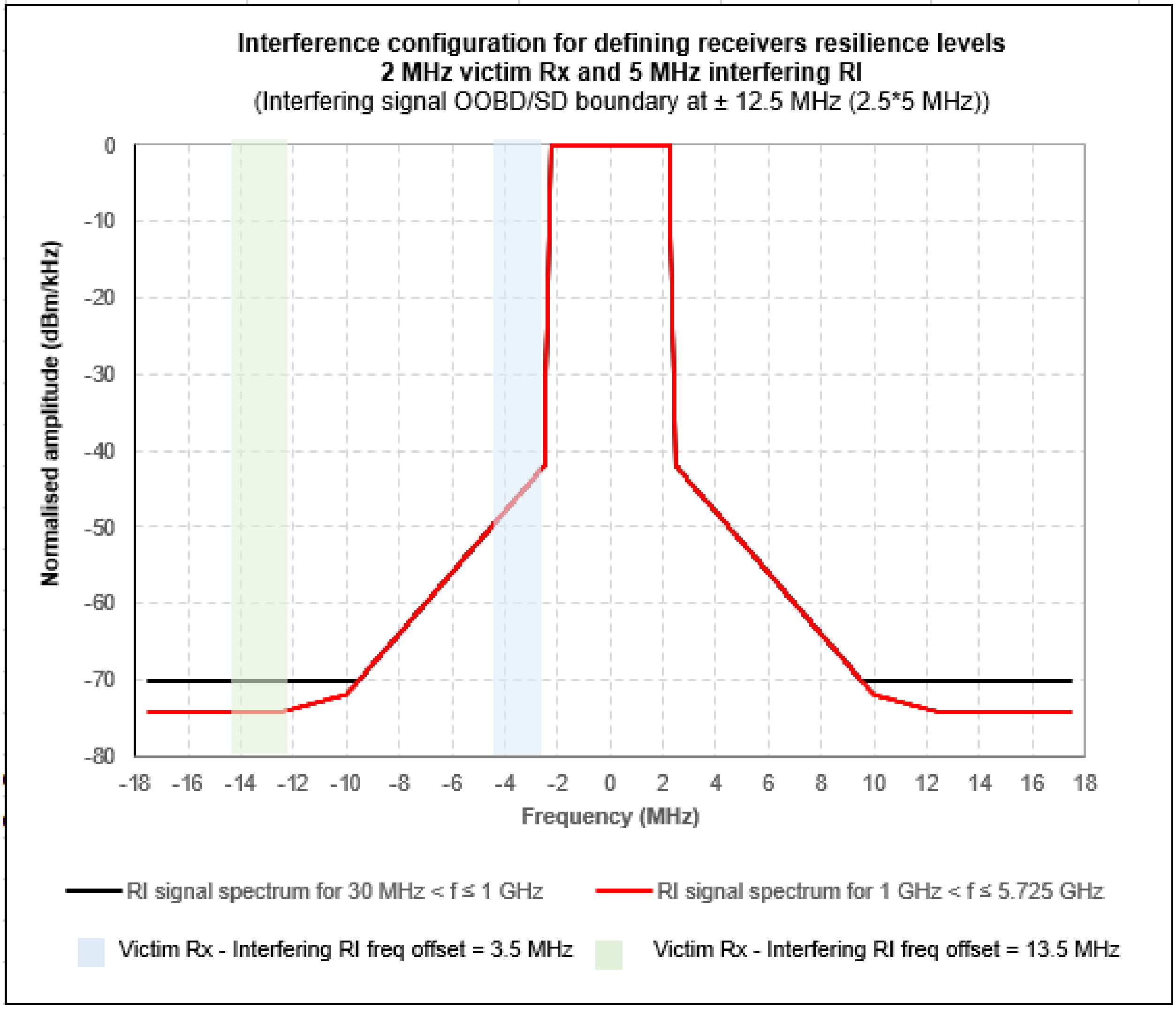

Figure 5: Proposed single interference scenario to be used for all systems/services when calculating receiver resilience levels using MRR

The resulting offset frequencies from the centre of the RI to the centre frequency of the victim receiver are for the 2 MHz receiver:

- 3.5 MHz: 2.5 MHz (BW_{RI}/2)) + 1 MHz (BW_{Rx}/2);
- 13.5 MHz: 12.5 MHz (2.5xBW_{RI})) + 1 MHz (BW_{Rx}/2).

The ILR values for the two offset frequencies are then to be derived by numerical integration from the spectrum masks defined in Table 40 depending on the victim receiver bandwidth according to Equation (11). Note that the maximum SE integration bandwidth (BW) of the RI signal is assumed to be 10 MHz (2BW_{RI}). This can be implemented by using the equation: $10\log_{10}(BW_{Rx}$ (MHz)/10 (MHz)).

Table 40: Reference interfering signal relative spectrum mask

Offset MHz	RI signal relative spectrum mask for frequencies of 30 MHz < f ≤ 1 GHz (dB/kHz)	RI signal relative spectrum mask for frequencies of 1 GHz < f ≤ 5.725 GHz (dB/kHz)
-17.5	-70.25	-74.25
-12.5	-70.25	-74.25
-10	-70.25	-72
-7.5	-62	-62
-2.5	-42	-42
-2.25	0	0
+2.25	0	0
+2.5	-42	-42
+7.5	-62	-62
+10	-70.25	-72
+12.5	-70.25	-74.25
+17.5	-70.25	-74.25

For measurement purpose, the reference interfering signal can be generated using an OFDM 3GPP FDD LTE RF signal generator which is capable to produce the necessary distortion to the pure OFDM signal so that the desired spectrum mask is achieved. The recommended modulation schemes are QPSK/4-QAM (data rate ≅ 8 Mbps, sub-carrier spacing ≅ 15 kHz), with preferably a PAPR =11 ± 3 dB at the RF generator output. Higher constellations and data rates can also be used provided that the generated signal meets the ILR values calculated from the interfering signal spectrum mask defined in this table as well as the PAPR value. In all the cases, the ILR value measured for a given receiver channel bandwidth should be equal (± 1 dB) to the ILR value calculated from the reference interfering signal spectrum mask defined in the table.

Alternatively, the RI signal can also be generated using a synthesised signal provided in a file that can be read by most of the modern RF signal generators. The practical generation of the RI signal is described in detail in ANNEX 8:.

Some calculation examples of RI signal ILR values are provided in the following section.

A7.3.3 Derivation of the reference interfering signal ILR to be used in the calculation of receiver resilience levels using MRR

The ILR values of the reference interfering signal to be used to calculate the receiver resilience levels for some systems/applications have been derived by using numerical integration. These systems are DAB, DTT, IMT, Fixed service, GSM, 2.4 GHz and 5 GHz RLAN and 30 MHz-1GHz SRD. The results obtained are presented for information in section A7.3.5.

A7.3.4 Choice of the FOS value

Based on the definition of the reference interfering signal, it is proposed to choose the value of FOS to be used in the calculation, when using MRR to calculate the receiver resilience levels, as follows:

- *FOS = ILR + 10 dB*, when the victim receiver channel is adjacent to the interfering transmitter channel (see Figure 5)

Reason: This configuration is critical since the interfering transmitter channel is very close to the victim receiver channel resulting in a high level of OOB emission level falling into the receiver passband, which therefore cannot be reduced by receiver filtering. Consequently, good filtering of other adjacent signals present at the receiver input is recommended in order to minimise the total interfering power received.

- *FOS* = *ILR dB*, when the victim receiver channel is adjacent to the OOBD/SD boundary of the interfering signal in its SD (see Figure 5). If a CW interfering signal is used, instead of the RI signal, to calculate the blocking level of a victim receiver, the receiver FOS value should be equal to the FOS value specified for the blocking level calculation with the RI signal, since the ILR value of the CW signal is assumed to be very high or infinite (≥130 dB).

  Reason: This configuration is less critical compared to the first configuration, since the interfering transmitter channel is far away from to the victim receiver channel resulting in a lower OOB emission level in the receiver input. Consequently, it is sensible to put less constraint on the receiver FOS.

A7.3.5 Derived reference interfering signal ILR to be used in the calculation of receiver resilience levels

Table 41: ILR values for systems/applications as a function of the victim channel bandwidth and frequency offset 30 MHz < f ≤ 1 GHz

System	Victim channel BW (MHz)	Power (W)	Power (dBm)	Offset	ILR (dB)
RI	4.97	4.54	36.57	Co-channel	0
DAB (1.54)	1.54	5.05E-05	-12.97	1st adjacent channel	50
DAB (1.54)	1.54	1.45E-07	-38.37	1st adjacent channel to OOBD/SD boundary in the SD	75
DTT (8 MHz)	7.60	5.70E-05	-12.44	1st adjacent channel	49
DTT (8 MHz)	7.60	7.17E-07	-31.44	1st adjacent channel to OOBD/SD boundary in the SD	68
IMT (1.4 MHz)	1.09	4.21E-05	-13.76	1st adjacent channel	50
IMT (1.4 MHz)	1.09	1.02E-07	-39.90	1st adjacent channel to OOBD/SD boundary in the SD	76
IMT (3 MHz)	2.70	6.12E-05	-12.13	1st adjacent channel	49
IMT (3 MHz)	2.70	2.54E-07	-35.94	1st adjacent channel to OOBD/SD boundary in the SD	73
IMT (5 MHz)	4.52	2.91E-05	-15.36	1st adjacent channel	52
IMT (5 MHz)	4.52	4.26E-07	-33.70	1st adjacent channel to OOBD/SD boundary in the SD	70
IMT (10 MHz)	9.00	4.43E-05	-13.54	1st adjacent channel	50
IMT (10 MHz)	9.00	8.49E-07	-30.71	1st adjacent channel to OOBD/SD boundary in the SD	67
IMT (15 MHz)	13.51	3.26E-05	-14.86	1st adjacent channel	51
IMT (15 MHz)	10.01	9.45E-07	-30.25	1st adjacent channel to OOBD/SD boundary in the SD	67
IMT (20 MHz)	18.03	2.92E-05	-15.34	1st adjacent channel	52
IMT (20 MHz)	10.01	9.45E-07	-30.25	1st adjacent channel to OOBD/SD boundary in the SD	67
GSM (0.2 MHz)	0.18	9.88E-06	-20.05	1st adjacent channel	57
GSM (0.2 MHz)	0.18	1.65E-08	-47.82	1st adjacent channel to OOBD/SD boundary in the SD	84
SRD (0.1 MHz)	0.11	6.12E-06	-22.13	1st adjacent channel	59
SRD (0.1 MHz)	0.11	9.91E-09	-50.04	1st adjacent channel to OOBD/SD boundary in the SD	87
SRD (0.5 MHz)	0.49	2.41E-05	-16.17	1st adjacent channel	53
SRD (0.5 MHz)	0.49	4.63E-08	-43.35	1st adjacent channel to OOBD/SD boundary in the SD	80
SRD (1.7 MHz)	1.68	5.25E-05	-12.80	1st adjacent channel	49
SRD (1.7 MHz)	1.68	1.59E-07	-38.00	1st adjacent channel to OOBD/SD boundary in the SD	75
SRD (0.05 MHz)	0.04	2.63E-06	-26.77	1st adjacent channel	62
SRD (0.05 MHz)	0.04	4.13E-09	-54.81	1st adjacent channel to OOBD/SD boundary in the SD	90
SRD (0.025 MHz)	0.04	1.32E-06	-28.81	1st adjacent channel	65
SRD (0.025 MHz)	0.04	2.06E-09	-56.85	1st adjacent channel to OOBD/SD boundary in the SD	93

Table 42: ILR values for systems/applications as a function of the victim channel bandwidth and frequency offset 1 GHz < f ≤ 5.725 GHz

System	Victim channel BW (MHz)	Power (W)	Power (dBm)	Offset	ILR (dB)
RI	4.97	4.54	36.57	Co-channel	0
DAB (1.54 MHz)	1.54	5.05E-05	-12.97	1st adjacent channel	50
DAB (1.54 MHz)	1.54	5.79E-08	-42.37	1st adjacent channel to OOBD/SD boundary in the SD	79
DTT (8 MHz)	7.60	5.69E-05	-12.45	1st adjacent channel	49
DTT (8 MHz)	7.60	2.85E-07	-35.44	1st adjacent channel to OOBD/SD boundary in the SD	72
IMT (1.4 MHz)	1.09	4.21E-05	-13.76	1st adjacent channel	50
IMT (1.4 MHz)	1.09	4.08E-08	-43.90	1st adjacent channel to OOBD/SD boundary in the SD	80
IMT (3 MHz)	2.70	6.12E-05	-12.13	1st adjacent channel	49
IMT (3 MHz)	2.70	1.01E-07	-39.94	1st adjacent channel to OOBD/SD boundary in the SD	77
IMT (5 MHz)	4.52	2.91E-05	-15.36	1st adjacent channel	52
IMT (5 MHz)	4.52	1.70E-07	-37.70	1st adjacent channel to OOBD/SD boundary in the SD	74
IMT (10 MHz)	9.00	4.41E-05	-13.56	1st adjacent channel	50
IMT (10 MHz)	9.00	3.38E-07	-34.71	1st adjacent channel to OOBD/SD boundary in the SD	71
IMT (15 MHz)	13.51	3.22E-05	-14.92	1st adjacent channel	51
IMT (15 MHz)	10.01	3.76E-07	-34.25	1st adjacent channel to OOBD/SD boundary in the SD	71
IMT (20 MHz)	18.03	2.85E-05	-15.45	1st adjacent channel	52
IMT (20 MHz)	10.01	3.76E-07	-34.25	1st adjacent channel to OOBD/SD boundary in the SD	71
FS (1.4 MHz)	1.75	5.34E-05	-12.73	1st adjacent channel	49
FS (1.4 MHz)	1.75	6.58E-08	-41.82	1st adjacent channel to OOBD/SD boundary in the SD	78
FS (1.4 MHz)	7.00	6.67E-05	-11.76	1st adjacent channel	48
FS (1.4 MHz)	7.00	2.63E-07	-35.80	1st adjacent channel to OOBD/SD boundary in the SD	72
FS (1.4 MHz)	14.00	6.70E-05	-11.74	1st adjacent channel	48
FS (1.4 MHz)	10.01	3.76E-07	-34.25	1st adjacent channel to OOBD/SD boundary in the SD	71
SRD (0.1 MHz)	0.11	6.12E-06	-22.13	1st adjacent channel	59
SRD (0.1 MHz)	0.11	3.95E-09	-54.04	1st adjacent channel to OOBD/SD boundary in the SD	91
WDTS (1 MHz)	1.02	3.79E-05	-14.21	1st adjacent channel	51
WDTS (1 MHz)	1.02	3.82E-08	-44.18	1st adjacent channel to OOBD/SD boundary in the SD	81
WDTS (2 MHz)	2	5.61E-05	-12.51	1st adjacent channel	49
WDTS (2 MHz)	2	7.50E-08	-41.25	1st adjacent channel to OOBD/SD boundary in the SD	78
WAS/RLAN (20 MHz)	19.99	4.45E-05	-13.52	1st adjacent channel	50
WAS/RLAN (20 MHz)	10.01	3.78E-07	-34.23	1st adjacent channel to OOBD/SD boundary in the SD	71
DCS (0.2 MHz)	0.18	9,88E-06	-20,05	1st adjacent channel	57
DCS (0.2 MHz)	0.18	6,58E-09	-51,82	1st adjacent channel to OOBD/SD boundary in the SD	88

ANNEX 8: PRACTICAL GENERATION OF THE REFERENCE INTERFERING TEST SIGNAL

The reference interfering signal described in Section A7.2.1 can be generated using an RF signal generator:

- equipped with an option to generate LTE signals;
- be able to read signal files with extension ".WV" and generate the synthetic reference interfering signal "Golden waveform" developed by the Joint Research Centre (JRC) and can be found here.

A8.1 REFERENCE INTERFERENCE SIGNAL GENERATED USING A DIGITAL SIGNAL PROCESSING TOOL TO OBTAIN TWO "GOLDEN WAVEFORM" SIGNAL FILES

In this example the RI signal has been generated using an RF signal generator, which was able to read signal files with extension "WV" and the "Golden waveforms" developed by the Joint Research Centre (JRC) and provided in the files below. This method is expected to be easier to implement than that in A8.2.

The two "Golden waveforms (GW)" have been generated using a digital signal processing tool, one for frequencies below 1 GHz (GW1) and one for frequencies above 1 GHz (GW2). In both waveforms, a central 5 MHz part was allocated within a 20 MHz LTE DL structure. Each subcarrier, that was defined in this central part, was QPSK modulated with random symbols. A transition window of 10 µs was used to minimize the discontinuities between two consecutive symbols. Then, a power amplifier distortion was added to the generated signal to obtain the desired adjacent channel ILR values. In the case of GW1, an additive white Gaussian noise was added to increase the ILR value in the spurious domain. The comparison between the generated RI signal spectrum and the RI mask defined in this Recommendation is presented in Figure 6 for GW1 (30 MHz < f ≤ 1 GHz) and Figure 7 for GW2 (1 GHz < f ≤ 5725 MHz):

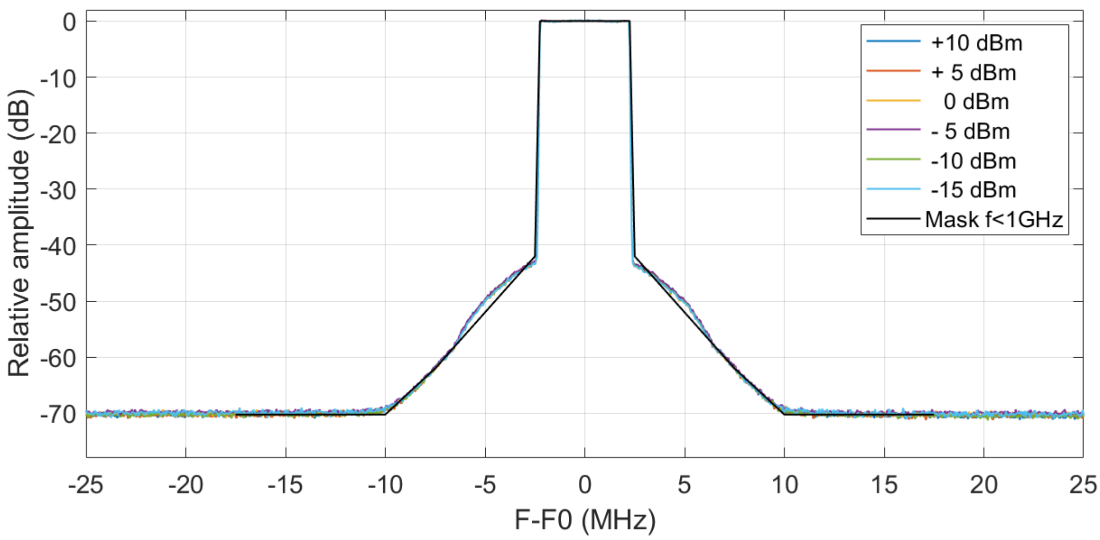

Figure 6: Comparison between the generated RI signal spectrum (GW1) and the RI signal spectrum mask defined in this recommendation (30 MHz < f ≤ 1 GHz)

Table 43: Measured ILR values of the generated RI signal (30 MHz < f ≤ 1 GHz)

Measurement BW (MHz)	Offset type	Target Values (note 1) (dB)	Measurement results (dB)	Difference (dB)
5	Co-ch	0	0	0

Measurement BW (MHz)	Offset type	Target Values (note 1) (dB)	Measurement results (dB)	Difference (dB)
5	1st adj-ch	48	48	0
5	2nd adj-ch	67	67	0
5	3rd adj-ch <	70	70	0
Note 1: Values calculated from the RI signal spectrum mask defined in Table 38				

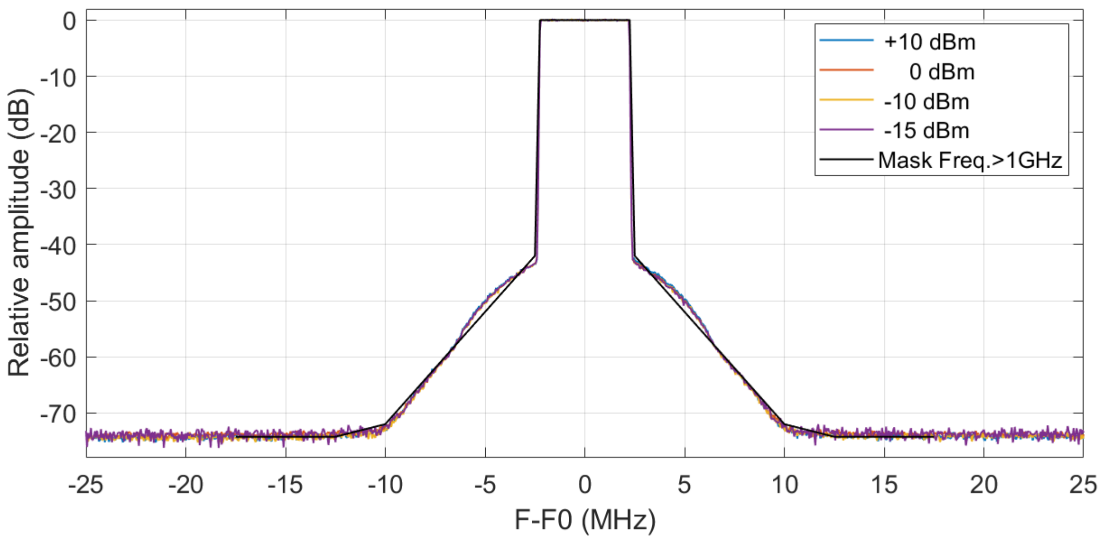

Figure 7: Comparison between the generated RI signal spectrum (GW2) and the RI signal spectrum mask defined in this recommendation (1 GHz < f ≤ 5725 MHz)

Table 44: Measured ILR values of the generated RI signal (1 GHz < f ≤ 5725 MHz)

Measurement BW (MHz)	Offset type	Target Values (note 1) (dB)	Measurement results (dB)	Difference (dB)
5	Co-ch	0	0	0
5	1st adj-ch	48	48	0
5	2nd adj-ch	68	68	0
5	3rd adj-ch <	74	74	0
Note 1: Values calculated from the RI signal spectrum mask defined in Table 39				

A8.2 REFERENCE INTERFERENCE SIGNAL GENERATED USING AN RF SIGNAL GENERATOR EQUIPPED WITH AN OPTION TO GENERATE LTE SIGNALS

In this example the RI signal has been generated using an RF signal generator equipped with an option to generate LTE signals. The LTE parameters used to generate the RI signal are the followings:

- System: 5 MHz Eutra LTE;
- Modulation QPSK, 16-QAM and 64-QAM;
- Link: FDD/DL;
- Number of used frames/allocations: 10/4;
- Filtering / Clipping: Balanced EVM and ACP / off;
- Signal generator output power: 17 dBm (PAPR=11 dB).

The comparison between the generated RI signal spectrum and the RI mask defined in this recommendation is presented in Figure 8:

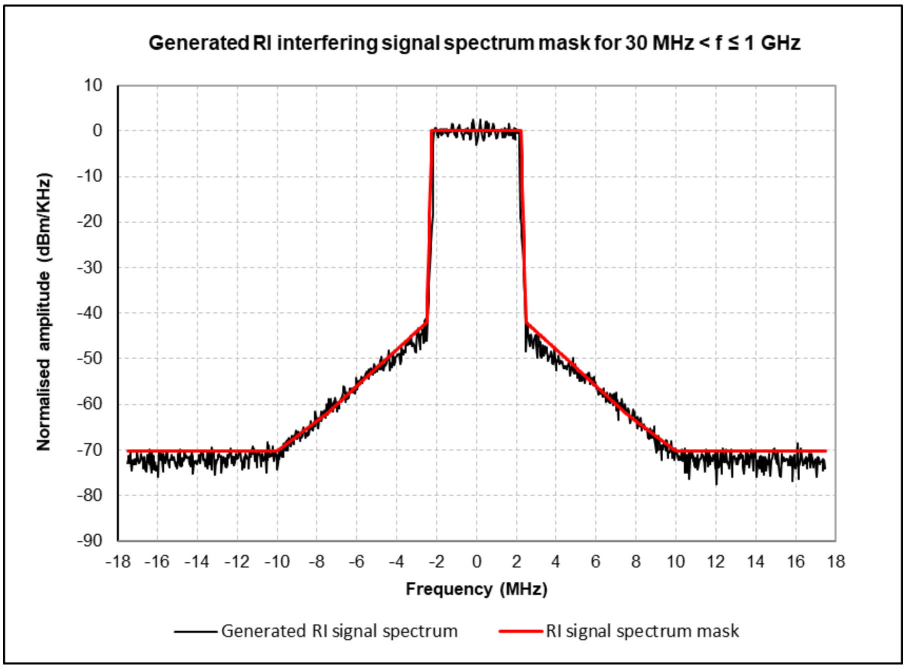

Figure 8: Comparison between the generated RI signal spectrum and the RI signal spectrum mask defined in this Recommendation (30 MHz < f ≤ 1 GHz)

Table 45: Measured ILR values of the generated RI signal (30 MHz < f ≤ 1 GHz)

Generated 5 MHz RI signal ILR values (30 MHz < f ≤ 1 GHz)				
Measurement BW (MHz)	**Offset type**	**Target Values** (Note 1:) **(dBm)**	**Measurement results (dB)**	**Difference (dB)**
5	Co-ch	0	0	0
5	1st adj-ch	48	48	0
5	2nd adj-ch	67	66	1
5	3rd adj-ch <	70	71	1
Note 1: Values calculated from the RI signal spectrum mask defined in Table 38				

ANNEX 9: DERIVATION OF THE METHOD FOR RECEIVER RESILIENCE (MRR)

The basic equation of MRR shown below allows to calculate the receiver blocking level as a function of *N*, *M*, *ILR* and *FOS:*

$$I_{in-ch}(dBm) = 10log\left(10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}\right) - 10log\left(10^{\frac{-ILR\,(dB)}{10}} + 10^{\frac{-FOS\,(dB)}{10}}\right) \quad (14)$$

This equation has been derived through the following steps. Note that the derivation is carried out in the linear domain and only the final result is transformed from the linear domain to the logarithmic domain.

The victim receiver receives both the interfering signal in-channel emissions ($I_{in\text{-}ch}$) attenuated by *FOS* and the interfering signal out-of-channel emissions ($I_{oo\text{-}ch}$) falling into its channel, which are defined by $I_{in\text{-}ch}$/*ILR*.

$$\begin{aligned} I_r &= I_{oo-ch}^r + I_{in-ch}^r \\ &= \frac{I_{in-ch}}{ILR} + \frac{I_{in-ch}}{FOS} \end{aligned} \quad (15)$$

where:

- I_r: frequency offset interfering signal power received by the victim receiver;
- I_{in-ch}: frequency offset interfering signal power measured in its channel bandwidth at the receiver input before RF/IF/BB filtering;
- I_{oo-ch}^r: frequency offset interfering signal out-of-channel power received by the victim receiver;
- I_{in-ch}^r: frequency offset interfering signal in-channel power received by the victim receiver. Note that when defining the resilience levels of a receiver, $I_{in\text{-}ch}$ is often referred to as $I_{adj\text{-}ch}$ or I_{blk} depending on the frequency offset between the useful and interfering signals.

The received interfering signal power causing a receiver desensitisation of *M* can be calculated as follows, where *N* is the noise floor of the receiver:

$$I_r = NM - N \quad (16)$$

By equating Equations (15) and (16):

$$\frac{I_{in-ch}}{ILR} + \frac{I_{in-ch}}{FOS} = NM - N \quad (17)$$

The above equation can be rewritten as:

$$I_{in-ch}\left(\frac{1}{ILR} + \frac{1}{FOS}\right) = NM - N \quad (18)$$

and then:

$$I_{in-ch} = \frac{NM - N}{\left(\frac{1}{ILR} + \frac{1}{FOS}\right)} \quad (19)$$

Transforming from the linear domain to the logarithmic domain results in:

$$I_{in-ch}(dBm) = 10\log_{10}(NM - N) - 10\log_{10}\left(\frac{1}{ILR} + \frac{1}{FOS}\right) \quad (20)$$

As the values of N, M, ILR and FOS are always defined in the logarithmic domain, the above equation can be rewritten as:

$$I_{in-ch}(dBm) = 10\log_{10}\left(10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}\right) - 10\log_{10}\left(10^{\frac{-ILR\,(dB)}{10}} + 10^{\frac{-FOS\,(dB)}{10}}\right) \quad (21)$$

which is the basic equation of MRR.

Note that the receiver frequency offset selectivity can also be expressed as a function of N, M, $I_{in\text{-}ch}$ and ILR from Equation (18):

$$\frac{1}{ILR} + \frac{1}{FOS} = \frac{NM - N}{I_{in-ch}} \tag{22}$$

and

$$\frac{1}{FOS} = \frac{NM - N}{I_{in-ch}} - \frac{1}{ILR} \tag{23}$$

then

$$FOS = \frac{1}{\frac{NM - N}{I_{in-ch}} - \frac{1}{ILR}} \tag{24}$$

Transforming from the linear domain to the logarithmic domain results in:

$$FOS(dB) = -10\log_{10}\left(\frac{NM - N}{I_{in-ch}} - \frac{1}{ILR}\right) \tag{25}$$

and finally*:*

$$FOS(dB) = -10\log_{10}\left(\frac{10^{\frac{N(dBm)+M(dB)}{10}} - 10^{\frac{N(dBm)}{10}}}{10^{\frac{I_{in-ch}(dBm)}{10}}} - 10^{\frac{-ILR(dB)}{10}}\right) \tag{26}$$

Note that when defining the resilience levels of a receiver, $I_{in\text{-}ch}$ is often referred as $I_{adj\text{-}ch}$ or I_{blk} depending on the frequency offset between the useful and interfering signals.

ANNEX 10: LIST OF REFERENCES

[1] ITU Radio Regulations, Edition of 2020

[2] ECC Report 310; "Evaluation of receiver parameters and the future role of receiver characteristics in spectrum management, including in sharing and compatibility studies", approved January 2020

[3] Recommendation ITU-R SM. 1539-1 "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"

[4] ERC Recommendation 74-01: "Unwanted Emissions in the Spurious Domain, approved 1998, latest corrected May 2022"

[5] ECC Recommendation (19)02: "Guidance and methodologies when considering typical unwanted emissions in sharing/compatibility studies", approved May 2019

[6] ECC Report 249: "Unwanted emissions of common radio systems: measurements and use in sharing/compatibility studies", approved April 2016 and latest amended October 2022

[7] Recommendation ITU-R SM. 329-12 "Unwanted emissions in the spurious domain"

[8] ECC Report 146: "Compatibility between GSM MCBTS and other services (TRR, RSBN/PRMG, HC-SDMA, GSM-R, DME, MIDS, DECT) operating in the 900 and 1800 MHz frequency bands", approved July 2010

[9] ECC Report 325: "Compatibility and technical feasibility of coexistence studies for the potential introduction of new terrestrial applications operating in the 2483.5-2500 MHz frequency band with existing services / applications in the same band and adjacent bands", approved April 2021

[10] ETSI EN 303 345-4 V1.1.1 "Broadcast Sound Receivers; Part 4: DAB broadcast sound service; Harmonised Standard for access to radio spectrum"

[11] ETSI EN 300 401 V2.1.1 "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers"

[12] ETSI TR 101 758 V2.1.1"Digital Audio Broadcasting (DAB); Signal strengths and receiver parameters; Targets for typical operation"

[13] ETSI EN 303 340 V1.2.1"Digital Terrestrial TV Broadcast Receivers; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU"

[14] ETSI EN 302 217-2 V3.3.1 "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2: Digital systems operating in frequency bands from 1,3 GHz to 86 GHz; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU"

[15] ETSI TR 101 854 V2.1.1"Fixed Radio Systems; Point-to-point equipment; Derivation of receiver interference parameters useful for planning fixed service point-to-point systems operating different equipment classes and/or capacities"

[16] ETSI EN 302 217-1 V3.2.2"Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 1: Overview, common characteristics and system-dependent requirements"

[17] ETSI EN 301 908-14 V15.1.1"IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 14: Evolved Universal Terrestrial Radio Access (E-UTRA) Base Stations (BS)"

[18] ETSI TS 136 141 V12.12.0"LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (3GPP TS 36.141 version 15.4.0 Release 15)"

[19] ETSI EN 301 502 V12.5.2 "Global System for Mobile communications (GSM); Base Station (BS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU"

[20] ETSI EN 300 220-1 V3.1.1 "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 1: Technical characteristics and methods of measurement"

[21] ETSI EN 300 328 V2.2.2"Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz band; Harmonised Standard for access to radio spectrum"

[22] ETSI EN 301 893 V2.1.1"5 GHz RLAN; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU"

[23] ECC Recommendation (02)05: "Unwanted emissions", approved February 2002, latest amended 30 March 2012

[24] ECC Report 207: "Adjacent band co-existence of SRDs in the band 863-870 MHz in light of the LTE usage below 862 MHz", approved January 2014

[25] EN 301 908-18 "IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 18: E-UTRA, UTRA and GSM/EDGE Multi-Standard Radio (MSR) Base Station (BS) Release 15"

[26] IEEE Std 802.11-2020: Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

[27] ETSI TS 145 005 V 16.1.0 (2020-11) "Digital cellular telecommunications system (Phase 2+) (GSM); GSM/EDGE Radio transmission and reception (3GPP TS 45.005 version 16.1.0 Release 16)

[28] EN 300 220-2 V3.2.1 "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 2: Harmonised Standard for access to radio spectrum for non specific radio equipment"

[29] EN 300 220-3-1 V2.1.1 "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 3-1: Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Low duty cycle high reliability equipment, social alarms equipment operating on designated frequencies (869,200 MHz to 869,250 MHz)"

[30] EN 300 220-3-2 V1.1.1 "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 3-2: Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Wireless alarms operating in designated LDC/HR frequency bands 868,60 MHz to 868,70 MHz, 869,25 MHz to 869,40 MHz, 869,65 MHz to 869,70 MHz"

[31] EN 300 220-4 V1.1.1 "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 4: Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Metering devices operating in designated band 169,400 MHz to 169,475 MHz"

[32] EN 303 406 V1.1.1 "Short Range Devices (SRD); Social Alarms Equipment operating in the frequency range 25 MHz to 1 000 MHz; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU"