CEPT ECC
Electronic Communications Committee

ERC Recommendation 74-01

Unwanted emissions in the spurious domain

Approved 1998

Amended 29 May 2019

Updated 1 October 2021

Edition October 2021

INTRODUCTION

This Recommendation specifies the limits of the unwanted emissions in the spurious domain (spurious domain emission limits) for different services and types of equipment. It should be used as a generic guide when drafting new and revising ETSI standards, and also for administrations in the absence of relevant standards. It should not be used as a stand-alone document for the purpose of placing products on the market under the Directive 2014/53/EU (Radio Equipment Directive) [1].

This Recommendation has been developed within a broader context of Recommendations ITU-R, dealing with unwanted emissions that are summarised by the ECC Recommendation (02)05 "Unwanted emissions". In particular, those ITU-R documents contain information and guidance on the applicability and measurement of limits reported in this Recommendation.

The limits contained within ERC Recommendation 74-01 are for generic families of Services/Systems and do not prevent that specific systems, for specific reasons, might require tighter limits in ETSI standards. It is also recognised that certain ETSI standards (including draft standards) might not fully align with this Recommendation which may be as a consequence of new technologies emerging.

Where a difference between the limits for a particular standard and this Recommendation might exist, in particular if the limits are less stringent, the iterative, consultative procedure given in the ETSI/ECC Memorandum of Understanding[1] should be followed. This procedure should consider the interaction between technical parameters, spectrum efficiency, regulatory and economic aspects. More specifically CEPT/ECC assumes the following procedure would be useful:

1. The relevant technical bodies in ETSI[2] and CEPT/ECC[3] will agree to exchange liaison statements to each other whenever they believe changes to this Recommendation or an ETSI 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. In addition, 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: effective use of the spectrum, requirements of existing services, sharing/adjacent band 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 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 or revision of the appropriate standard.

It is considered appropriate that this Recommendation should be reviewed at least every three years, in the light of changing technologies and regulatory requirements. This review should involve consultation with the relevant technical and Working Groups within CEPT/ECC and ETSI.

[1] https://cept.org/ecc/mous-and-lous-between-ceptecc-former-erc-and-other-organisations
[2] Currently ETSI TC ERM.
[3] Currently CEPT/ECC WG SE.

ERC RECOMMENDATION 74-01 OF 1998 ON UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN, AMENDED IN 1999, 2002, 2005, 2011 AND 29 MAY 2019, UPDATED 1 OCTOBER 2021

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that the radio frequency spectrum is a common resource, and it is necessary to keep it as un-polluted as possible, making the best use of the most modern and cost-effective techniques;

b) that it is important for CEPT countries to define common limits of unwanted emissions in the spurious domain for all services that may be placed in operation;

c) that detailed and specific sharing or compatibility studies may lead to different limits for the unwanted emissions in the spurious domain than in this Recommendation; however these are not in the scope of this Recommendation which aims to provide a minimum requirement;

d) that other CEPT/ECC deliverables may in some cases contain lower limits than those in this Recommendation for particular frequency ranges and specific services/systems;

e) that the typical levels of emission from modern digital radio equipment could be lower than the limits in this Recommendation (see ECC Report 249 [2]). For the purposes of specific sharing or compatibility studies, lower levels for the unwanted emissions in the spurious domain could be used to enhance spectrum efficiency see ECC Recommendation (19)02 "Unwanted Emissions – Guidance and methodologies when using typical equipment performance in sharing/compatibility studies" [3];

f) that Recommendation ITU-R SM.329 [4] provides limits for unwanted emissions in the spurious domain, as well as measurement methods of spurious domain emissions; it provides in recommends 2.3 some degree of freedom to administrations for determination of the frequency boundary between the out-of-band and spurious domains;

g) that Recommendation ITU-R SM.1539 [5] and Appendix 3 of the ITU Radio Regulations [6] deal with variation of the boundary between the out-of-band and spurious domains, other than the specific ± 250% of the Necessary Bandwidth (NB) from the centre frequency of the emission;

h) that Appendix 3 of the ITU Radio Regulations contains maximum permitted power levels for unwanted emissions in the spurious domain for service categories or equipment types;

i) that ECC Recommendation (02)05 [14] recommends to also use a set of ITU-R Recommendations of the SM series dealing with various aspects of unwanted emissions as general guidance;

j) that the Radio Astronomy Service, the Earth Exploration-Satellite Service and the Meteorological-Satellite Service using passive sensors are particularly sensitive to interference due to their wide frequency coverage and the weakness of the signals they detect. Their protection limits are far lower than the spurious domain emission limits considered practicable at the antenna port of most transmitters, therefore the protection of these services depends on additional mitigating factors such as antenna decoupling and spatial separation. Threshold levels of interference detrimental to the radio astronomy service, Earth exploration-satellite and meteorological-satellite services using passive sensors can be found in Recommendations ITU-R RA.769 [7] and RS.2017 [8];

k) that there may be cases where a permanent source of interference, for example a radar or broadcast transmitter in the near vicinity, or spurious emissions generated at the radio transmitter site due to the interaction amongst various transmitters operating at the same time, cause unacceptable performance degradation to a victim receiver. These cases are considered site engineering problems and are not in the scope of this Recommendation provided that it is possible to use special protection applied to either the source of interference, or the victim, or both;

l) that CEPT and ETSI have developed a Memorandum of Understanding describing the relative responsibilities of the two bodies. The MoU text is available from the ECO[4];

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

m) that limits for unwanted emissions in the out-of-band and spurious domains are usually reflected in the ETSI Harmonised Standards;

n) that within CEPT/ECC, a statistical simulation methodology based on the 'Monte Carlo' method has been developed and accepted as the basis for the development of a software simulation tool SEAMCAT, which enables assessment of the effect of spurious domain emission limits in terms of probability of interference. The latest version of SEAMCAT tool is available from the ECO web site[5];

o) that unwanted emissions may be delivered to the antenna port with consequent radiation from the antenna or produced by direct unwanted radiation from the system enclosure, due to insufficient shielding; however the latter effect is outside the scope of this Recommendation;

p) that fast switching transients of burst transmission systems may produce specific spurious emission patterns with high peak factor, which may affect victim receivers more severely than that due only to the spurious emissions associated with the average power during the burst duration;

q) that transmission systems may be coupled to, or be part of, an "Active Antenna System" which may further contribute to generation of spurious emissions;

Note 1: An "Active Antenna System" (AAS) is an antenna with embedded capability for electronic amplification and/or other RF processing. The total gain of an AAS may be functionally split into an "active" gain of the electronic functions (AG) and a conventional "passive" gain/loss (directivity) due to the geometrical design performance of the antenna (PG).

Note 2: In the context of Mobile/Fixed Communication Networks (MFCN), in addition to the above Note 1, AAS also refers to a base station or mobile station and antenna system where the amplitude and/or phase of the signals from the various antenna elements is continually adjusted resulting in an antenna pattern that varies in response to short-term changes in the radio environment. This is intended to exclude long-term beam shaping such as fixed electrical down tilt.

r) that receivers may also radiate spurious components from the antenna, which are presently not covered by Recommendation ITU-R SM.329 [4].

recommends

1. that limits of unwanted emissions in the spurious domain normally apply at frequencies beyond the limit of 250% of the necessary bandwidth above and below the centre frequency of the emission. However, this frequency separation may be dependent on the type of modulation used, the maximum bit rate in the case of digital modulation, the type of transmitter, and frequency co-ordination factors. For example, where practical the ± 250% of the relevant Channel Separation (CS) may be used. In certain cases the frequency separation may be greater or less than ± 250%.

Note 1: According to the Radio Regulations §1.152, the necessary bandwidth is, for a given class of emission, the width of the frequency band, which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions. However, the necessary bandwidths of most digital modulation formats are presently not referred to in Recommendations ITU-R of SM series.

Note 2: It is recognised that the 250% figure may be appropriate for medium bandwidth systems, while the physical constraint of filtering in the narrow-band systems and the resulting amount of spectrum polluted by wide-band systems may require further adaptation (e.g. by a wider or a reduced percentage, respectively) noting the flexibility allowed by Recommendation ITU-R SM.329 [4] on the 250% boundary definition. Recommendation ITU-R SM.1539 [5] and Appendix 3 of the ITU Radio Regulations [6] give guidance on the boundary variation in these cases.

---

[5] https://www.cept.org/eco/eco-tools-and-services/seamcat-spectrum-engineering-advanced-monte-carlo-analysis-tool

Note 3: According to Annex 1 of Appendix 3 of the Radio Regulations, for multichannel or multicarrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the centre frequency of the emission is taken to be the centre of the –3 dB bandwidth of the transmitter or transponder, and the transmitter or transponder bandwidth is used in place of the necessary bandwidth for determining the boundary between the out-of-band and spurious domains. For multicarrier satellite systems, guidance on the boundary between the out-of-band and spurious domains is provided in Recommendation ITU-R SM.1541. Similar provision also applies for multicarrier base stations and mobile stations in the Mobile Service; further guidance is given in Annex 2 of this Recommendation.

Note 4: In Article 1 of the ITU Radio Regulations [6] (No. 1.146B) and in recommends 1.3ter of Recommendation ITU-R SM.329 [4], the spurious domain (of an emission) is defined as the frequency range beyond the out-of-band domain in which spurious emissions generally predominate.

2. that for the purpose of this Recommendation, only unwanted emissions in the spurious domain conducted to the antenna port or subsequently radiated by any integral antenna, are subject to the established limits;

3. that the spurious domain emission limits for radio equipment are considered here to be applicable for the range 9 kHz to 300 GHz. However, for practical measurement purposes only, the frequency range of spurious emissions measurements may be restricted. As guidance for practical purposes, the frequency ranges of measurement as given in Table 1 are normally recommended:

Table 1: Frequency range for measurement of unwanted emissions

Fundamental frequency range	Frequency range for measurements	
	Lower frequency	Upper frequency (F_{UPPER})*
9 kHz - 100 MHz	9 kHz	1 GHz
100 - 300 MHz	9 kHz	10th harmonic
300 - 600 MHz	30 MHz	3 GHz
600 MHz - 5.2 GHz	30 MHz	5th harmonic
5.2 - 13 GHz	30 MHz	26 GHz
13 - 150 GHz	30 MHz	2nd harmonic
150 - 300 GHz	30 MHz	300 GHz

*The test should include the entire harmonic band and not be truncated at the precise upper frequency limit stated.

Note 1: The parameters in Table 1 reflect the increasing difficulty in undertaking real tests at higher frequencies, taking into account such factors as availability and usability of suitable measurement equipment. In such cases, when systems with an integral antenna would require a radiated measurement, their antenna gain should be taken into account either with a separate test or with an appropriate theoretical calculation. In some circumstances, it may be necessary to extend the range of test frequencies in order to facilitate better protection of other services, including passive services. In any case, systems having an integral antenna incorporating a waveguide section, or with an antenna connection in such form, and of length equal to at least twice the cut-off wavelength, should not require spurious emissions measurement below 0.7 times the waveguide cut-off frequency;

Note 2: Although measurements are outside the scope of this Recommendation, it is recognised that testing at higher frequency may not have a defined measurement uncertainty due to absence of primary references. In addition further simplifications of measuring techniques to achieve time/cost savings, while still guaranteeing with fair confidence the fulfilment of the requirement may be possible.

4. that the following reference bandwidths should be used:
   - 1 kHz between 9 and 150 kHz
   - 10 kHz between 150 kHz and 30 MHz
   - 100 kHz between 30 MHz and 1 GHz
   - 1 MHz above 1 GHz

   Note 1: A reference bandwidth is a bandwidth in which the spurious domain emission level is specified;

   Note 2: Some types of equipment may use reference bandwidth values different from the above close to the carrier; these differences are quoted in the Annex for the relevant service;

   Note 3: As a special case, the reference bandwidth of all space services spurious domain emissions should be 4 kHz;

   Note 4: The reference bandwidths for specifying spurious emissions in case of radar systems are provided in Appendix 3 of the Radio Regulations [6] (see § 9). The bandwidths required for proper measurement of radar spurious domain emissions should be calculated for each particular radar system, and the measurement methods should be guided by Recommendation ITU-R M.1177 [9];

   Note 5: As a general guideline, the resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in this recommend. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the reference bandwidth. When the resolution bandwidth is smaller than the reference bandwidth, the result should be integrated over the reference bandwidth. When the resolution bandwidth is greater than the reference bandwidth, the result for broadband spurious emissions should be normalised to the bandwidth ratio. For discrete spurious emissions, normalisation is not applicable, while integration over the reference bandwidth is still applicable.

5. that the levels of spurious domain emissions should be defined within a reference bandwidth;

6. that the appropriate spurious domain emission limits should be applicable to all services/equipment as detailed by Table 2. Unless the Peak Envelope Power (PEP) is explicitly quoted in this Recommendation the spurious domain emission limits specified from the transmitter into the antenna port are in terms of mean power. The mean power (P) of any spurious domain transmission from a burst transmitter is the mean power averaged over the burst duration;

   Note 1: In special cases, such as those referred in considering k), tighter limits may be required;

   Note 2: It is recognised that in some cases of narrow-band and/or high power transmitters for all categories of services, there may be difficulties in meeting limits close to ± 250% of the necessary bandwidth. These cases are reported in the specific annexes referred to in Table 2.

   Note 3: When a system is coupled to an Active Antenna System, the limits of Table 2 should be met by the entire system; therefore compliance should be verified through an e.i.r.p. measurement (either near-field or far-field) and subsequent conversion to absolute power/attenuation values delivered to the transmission line, taking into account only the conventional "passive" gain (directivity) of the antenna, or as a TRP measurement (either near-field or far-field) as described in Annex 2.

7. that for the fast switching induced spurious domain emissions, an additional limit for their peak power will be necessary, however further study should be carried out to investigate the nature of the phenomenon prior to fixing specific limits;

8. that the limits specified within this Recommendation should be considered for new ETSI standards developed after the date at which the Recommendation is approved;

   Note 1: In the case where the limits referred to in this Recommendation are found to be more stringent than existing ETSI Harmonised Standards (EN) a revision process may need to be considered. If revised, the standard should, whenever technically and economically feasible, meet the limits in this Recommendation;

   Note 2: Where either CEPT/ECC or ETSI consider that the limits defined in this Recommendation are inappropriate for a particular standard, an agreement on alternative limits should be reached by application of the MoU between ETSI and ECC.

9. that for all cases not covered in this Recommendation, the Recommendation ITU-R SM.329 [4] should apply; however, where applicable, ETSI standards or Recommendations ITU-R, if any, should be taken into account for methods of measurement of spurious emissions of specific services/equipment;

10. that administrations should afford all practical protection to the frequency bands utilised by the services using passive sensors, referred to in *considering j)* (interference threshold values for these services are established by the relevant ITU-R Recommendations). When bringing new services into operation, administrations are urged to note that transmitters can cause severe interference to other services through their spurious and out-of-band emissions including remote side-bands;

11. that, when measuring spurious emissions of receivers, no frequency range exclusion, such as the 250% of the necessary bandwidth limit, quoted in *recommends 1* should apply. Measurements should be made in accordance with *recommends 3*, where the fundamental frequency range should include the highest oscillator frequency used in the receiver and the harmonics are those of the highest oscillator frequency;

12. that the active state of a transmission station is defined as the state which produces the authorised emission;

13. that the idle/standby state of a transmission station is defined as the state where the transmitter is available for traffic but is not in the active state.

Table 2: Spurious domain emission limits

Type of service/equipment (Note 1)	Limits
Fixed service	See Annex 1
Land Mobile service, Maritime Mobile service and Short Range Devices (Note 2)	See Annex 2
Space services	See Annex 3
Broadcasting service	See Annex 4
Radar systems in the Radiodetermination service	See Annex 5
Amateur service	See Annex 6
▪ Emergency position-indicating radio beacon ▪ Emergency locator transmitter ▪ Personal location beacon ▪ Search and rescue transponder ▪ Ship emergency, lifeboat, and survival craft transmitters; and ▪ Land, aeronautical or maritime transmitters	No limit

Type of service/equipment (Note 1)		Limits
when used in emergency.		
All other services, except those quoted above:	Transmitters	Limits specified in Appendix 3 of the Radio Regulations apply
	Receivers and idle/standby transmitters	- 57 dBm, for 9 kHz ≤ *f* ≤ 1 GHz - 47 dBm, for 1 GHz < *f* ≤ F_{UPPER} (see recommends 11) where f = frequency of the spurious domain emission
Note 1: In the relevant annexes mentioned in Table 2, reference is made to “analogue” and “digital” systems. For this purpose, systems employing any modulation scheme that uses digital processing to quantise the carrier modulation are classified as “digital” systems. Note 2: Annex 2 contains limits for land mobile systems (e.g. Mobile/Fixed Communication Networks (MFCN), professional mobile radio and radio local area networks) and also contains limits applicable to systems using similar technologies (e.g. Short Range Devices, CB (citizens band), cordless telephones, radio microphones, maritime mobile service).		

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: FIXED SERVICE SPECIFIC REQUIREMENTS

A1.1 INFORMATIVE BACKGROUND

Fixed Service digital radio systems cover a very wide range of frequency bands of emission, traffic capacity, channel separations and modulation formats of which typical parameters are as follows:

- frequency band — from below 1 GHz to 175GHz;
- traffic capacity — from 9.6 kbit/s up to Multi-Gigabit transport;
- channel separations — from 25 kHz up to ~ 5 GHz in the highest bands;
- modulation formats — from 2 to 2048 states (amplitude and/or phase and/or frequency states).

Broadband Wireless Access (BWA) systems are used for the deployment of radio access networks in both the fixed service and the mobile service. They typically operate at frequencies up to 6 GHz and are considered to use terminal stations with antenna gain less than about 20 dBi.

A1.2 LIMITS

The necessary bandwidth (NB) for digital Fixed Service systems is defined in Recommendation ITU-R F.1191 [10], which requires that, for digital radio systems, operating on a specific radio-frequency channel arrangement, the NB is considered equal to the relevant Channel Separation (CS); therefore, the frequency boundary between spurious and out-of-band domains is normally set at ± 250% of the relevant CS.) (recommends 2.7 and 2.8 of Recommendation ITU-R F.1191). Therefore, for the purpose of this Recommendation, the frequency boundaries for spurious domain emissions of digital fixed service systems are taken, whenever applicable, as ± 250% of the relevant CS of the radio-frequency channel arrangement where the system is to be placed.

According to Recommendation ITU-R F.1191, the CS is taken as *XS*/2 for alternated frequency channel arrangements and *XS* for co-channel and interleaved frequency channel arrangements. *XS* is defined in Recommendation ITU-R F.746 as the radio-frequency separation between the centre frequencies of adjacent radio-frequency channels on the same polarisation and in the same direction of transmission. [14].

In addition for systems with CS > 500 MHz, the boundary, according to Recommendations ITU-R SM.1539 [5] and F.1191 [11], should be reduced to ± (500 MHz + 150% of the relevant CS).

Table 3 establishes the spurious domain emission limits for systems in the fixed service.

Table 3: Spurious domain emission limits for systems in the fixed service

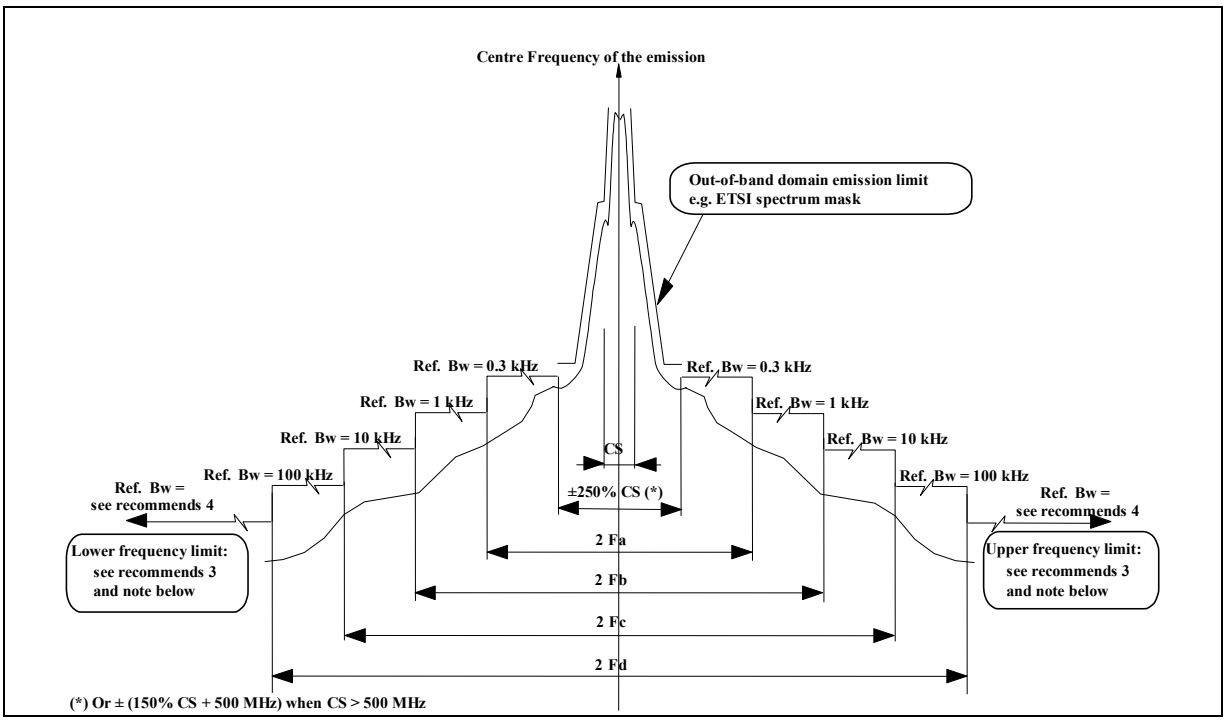
Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during bursts duration in the applicable reference bandwidth (see *recommends 4*)
1.1.1	Fixed Service - Transmitters (all stations except those below)	9 kHz ≤ *f* ≤ 21.2 GHz (note 1)	-50 dBm
		21.2 GHz < *f* ≤ F_{UPPER} (see *recommends 3*) (note 1) (note 3)	-30 dBm
1.1.2	Fixed Service – Terminal stations (remote stations with subscriber equipment interfaces)(note 2)	9 kHz ≤ *f* ≤ 21.2 GHz (note 1)	-40 dBm
		21.2 GHz < *f* ≤ F_{UPPER} (see *recommends 3*) (note 1)	-30 dBm
1.1.3	BWA systems operating between 1 GHz and 6 GHz (all transmitting stations)	9 kHz ≤ *f* ≤ 1 GHz (note 1)	-36 dBm
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 3*) (note 1)	-30 dBm
1.1.4	Fixed Service - Receivers and idle/standby transmitters, except those in reference number 1.1.5	The same limits as for the transmitters in reference number 1.1.3.	
1.1.5	BWA systems operating between 1 GHz and 6 GHz - Receivers and idle/standby transmitters	9 kHz ≤ *f* ≤ 1 GHz	-57 dBm
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 11*)	-47 dBm

Note 1: For digital systems, it is necessary to provide one or more steps of reference bandwidth to produce a suitable transition area for the spectral density to manage the required limit because in some frequency bands and/or applications narrow-band RF filters are not technically or economically feasible.
Consequently, just outside ± 250% of the relevant CS or ± (150% of the relevant CS + 500 MHz), as appropriate, the limit of spurious domain emissions are defined with reference bandwidths as detailed by Figure 1 and related Table 4, and for BWA systems operating between 1 GHz and 6 GHz by Figure 2 and the related Table 5. When "channel aggregation" (multicarrier) systems are concerned, the specific adaptation of section A1.3 of this annex applies.

Note 2: Point-to-Multipoint systems used in CEPT countries foresee three kind of stations:
-BS Base (Master) Station (referred to in Recommendation ITU-R SM.329 [4])
-TS Terminal Station (referred to in in Recommendation ITU-R SM.329 [4])
-RS Repeater Station (not referred to in Recommendation ITU-R SM.329 [4]);

Repeater Stations of Point-to-multipoint systems will be considered as TS when they are intended for use only in remote stations not co-located with any other Fixed radio equipment classified as a Central station.

When considering Multipoint-to-Multipoint (mesh) access systems, Multipoint-to-Multipoint stations providing co-frequency coverage to a defined area, without addressing any specific TS (in terms of antenna radiation pattern), should be considered as a BS.



Note: ± Fd is not applicable below 1 GHz (and recommends 3 and 4 apply)
± Fc is not applicable below 30 MHz (and recommends 3 and 4 apply)
± Fb is not applicable below 150 kHz (and recommends 3 and 4 apply)

Figure 1: Specific mask for spurious domain emission limits with reference bandwidths (see Table 4)

Table 4: Values of Fa, Fb, Fc and Fd in Figure 1

Fundamental Emission Frequency	Channel Separation (CS) (MHz)	Typical Symbol Frequency (~Mbit/s)	Ref. BW 0.3 kHz	Ref. BW 1 kHz	Ref. BW 10 kHz	Ref. BW 100 kHz
			Fa* (MHz)	Fb* (MHz)	Fc* (MHz)	Fd* (MHz)
Below 21.2 GHz (Terminal stations) (Note 1)	0.01 ≤ CS <1	Fs ≅ 0.006–0.8	-	-	14	70
	1 ≤ CS < 10	Fs ≅ 0.6–8	-	-	28	70
	10 ≤ CS	6~< Fs ~>	-	-	49 (**)	70 (**)
Below 21.2 GHz (Other stations) (Note 1) (Note 2) (Note 3)	0.01 ≤ CS <1	Fs ≅ 0.006–0.8	3.5	7	14	70
	1 ≤ CS < 10	Fs ≅ 0.6–8	-	14 (**)	28	70
	10 ≤ CS ≤ 14	Fs ≅6–11	-	-	49 (**)	70
	14 < CS	10~< Fs ~>	-	-	-	Minimum of 5 x CS and 500
Above 21.2 GHz (All stations)	1 ≤ CS < 10	Fs ≅ 0.6–8	-	-	-	70
	10 ≤ CS	6~< Fs > ~	-	-	-	-

(*): The frequency limits are defined with respect to the centre frequency of the emissions. For measurement purposes, the reference bandwidth given in Table 4 applies to the frequency range extending from the ±250% CS (or ± (150% CS + 500 MHz) as appropriate) to the frequency limit indicated, i.e. from 250% CS to Fa, then from Fa to Fb, and, from Fb to Fc, and finally from Fc to Fd.

(**): Not applicable for CS where the 250% point exceeds these values.

Note 1: Excluding BWA systems operating between 1 GHz and 6 GHz for which limits of Figure 2 and Table 5 apply.

Note 2: Excluding Channel aggregation (multicarrier) systems for which limits in section A1.3 and Figure 4 apply.

Note 3: It is recognised that the actual power density associated with the out of band domain limit provided by the ETSI mask at the boundary of ± 250% (or ± (150% + 500 MHz) as appropriate) of the relevant Channel Separation, when evaluated in the reference bandwidth of one or more steps of Table 3, may be lower than the spurious domain emission limit mask of Figure 1 itself. In such cases, the limit of the first spurious domain emission reference bandwidth step refers to the power density equal to that evaluated with the ETSI mask in the same reference bandwidth extended to the next step (examples of this concept are shown in Figure 3).

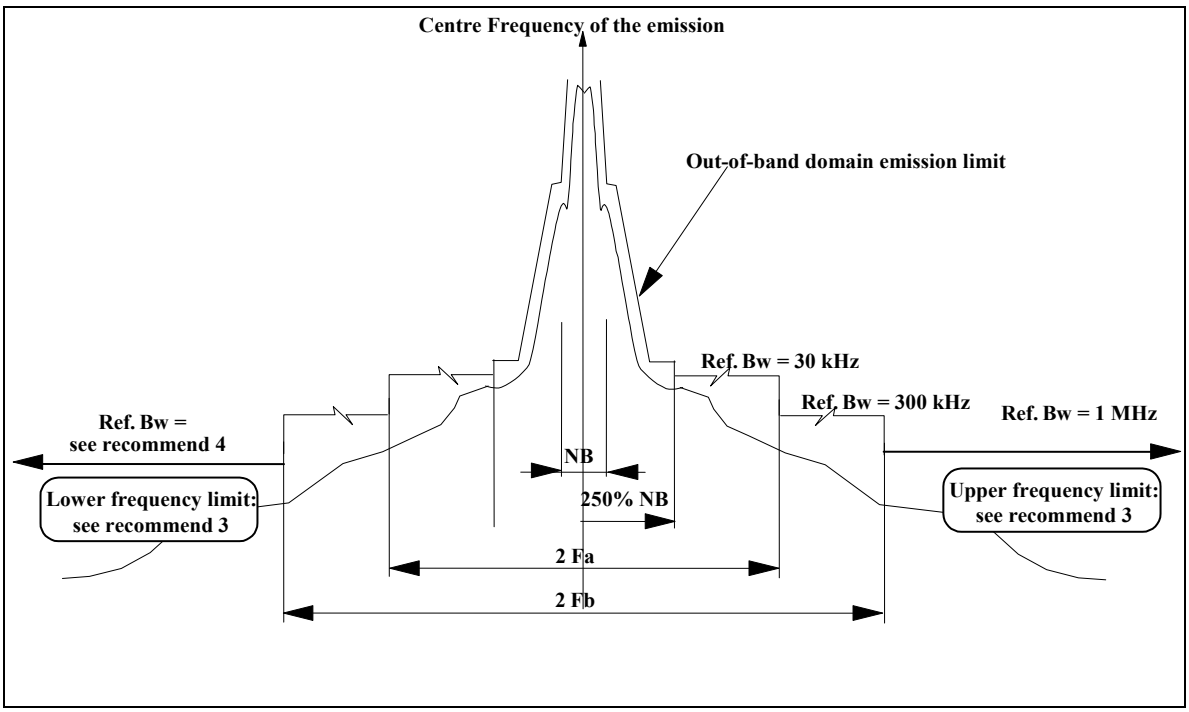


Figure 2: Specific mask for spurious domain emissions with reference bandwidths for BWA systems operating between 1 GHz and 6 GHz (see Table 5)

Table 5: Values of Fa and Fb in Figure 2

Parameter	Value
Fa*	500 kHz or 10 times NB, whichever is the greater
Fb*	1 MHz or 12 times NB, whichever is the greater
(*): The frequency limits are defined with respect to the centre frequency of the emissions. For measurement purposes, the reference bandwidth given in Figure 2 applies to the frequency range extending from the ±250% NB points to the first frequency limit indicated or from Fa to Fb as appropriate.	

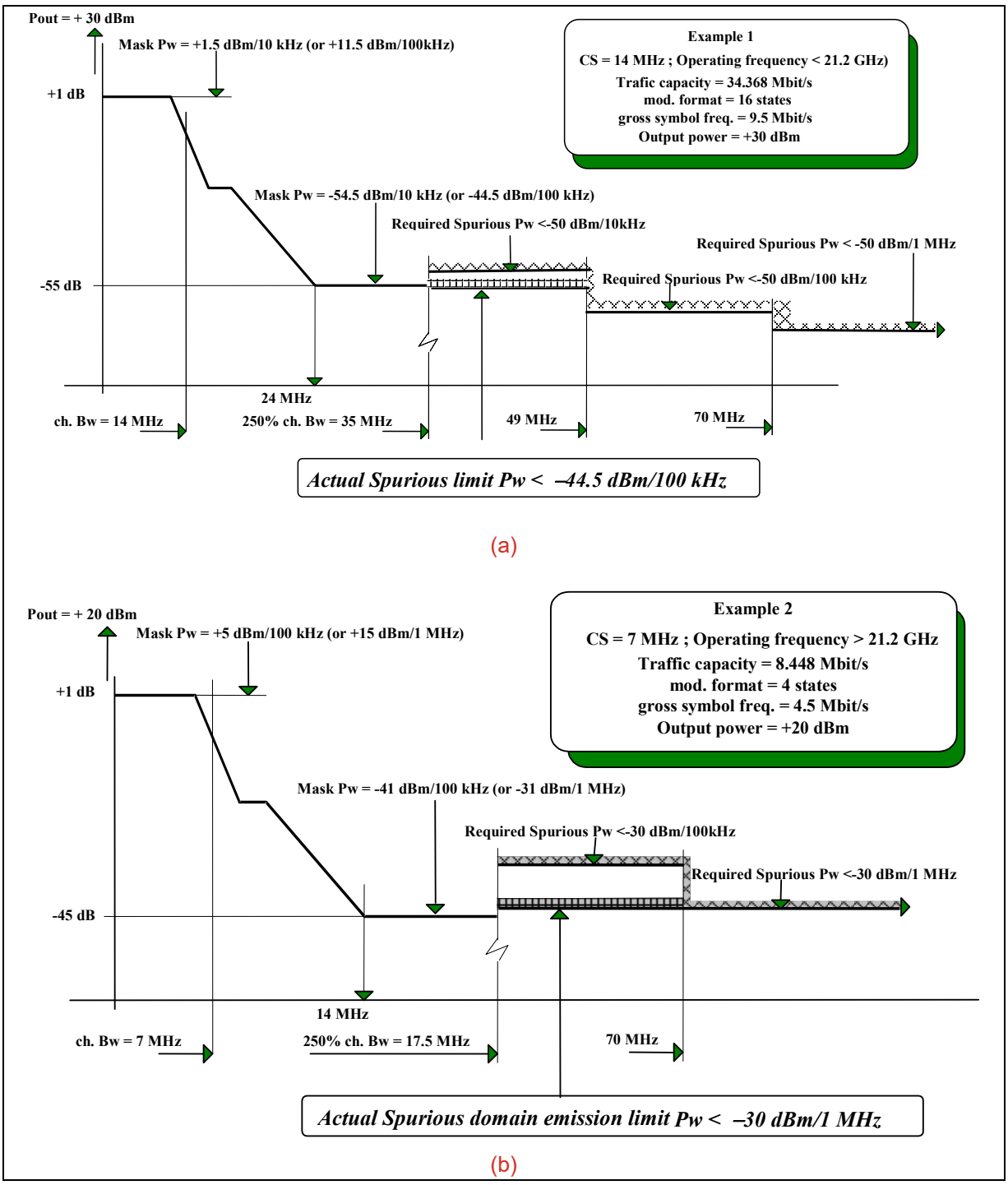


Figure 3: Examples of spectrum power density masks[6] being more stringent than the spurious domain emission limits in the reference bandwidth (refer to Note 3 to Table 4)

A1.3 LIMITS FOR CHANNEL AGGREGATION TRANSMITTERS OPERATING BELOW 21.2 GHZ

A channel aggregation transmitter (or equipment) is intended to operate only within a single contiguous allocation to fixed service.

The two (or more) aggregated radio channels are transmitted/received by the radio equipment within a single contiguous portion (operating range) of a band allocated to the fixed service. The channels

[6] Typical ETSI masks from EN 302 217-2 [10]

may be transmitted through a combination of different antenna ports (either "single channel" or "multiple channel" ports) serving different polarisation and/or different links directions and/or different FS bands.

When "single channel antenna ports" (i.e. only one channel can be transmitted through that port) are concerned, the limits remain those specified in section A1.2.

A1.3.1 Boundary between the out-of-band and spurious domains for channel aggregation transmitters applicable to multiple channel antenna ports

For point-to-point stations in the fixed service with channel aggregation transmitters, the transmitter operating range bandwidth is used instead of the necessary bandwidth for determining the boundary between the out-of-band and spurious domains. In the context of channel aggregation point-to-point fixed stations in the fixed service, the transmitter bandwidth is defined as the width of the frequency band covering the envelope of the transmitted channels.

A1.3.2 Limits for channel aggregation transmitters applicable to multiple channel antenna ports

Figure 4a shows how the requirement to consider the tuning range bandwidth instead of NB is applied to any elementary channel of the channel aggregation system, when transmitted through the same antenna port.

The tuning range is defined as the envelope of the number of contiguous RF channels in a radio frequency channel arrangement, as defined in ECC recommendations, that can be generated by equipment, from which the operating channels can be selected. In addition, the tuning range is always a fraction (or maximum one) of the go or return sub-bands (i.e. less than half of the FS allocated band).

When all channels are activated, the emission limit shown in Figure 4a) also applies in the intermediate frequency range between the ± 250% of CS of each channel to the 150% of the tuning range, (see example in Figure 4b)

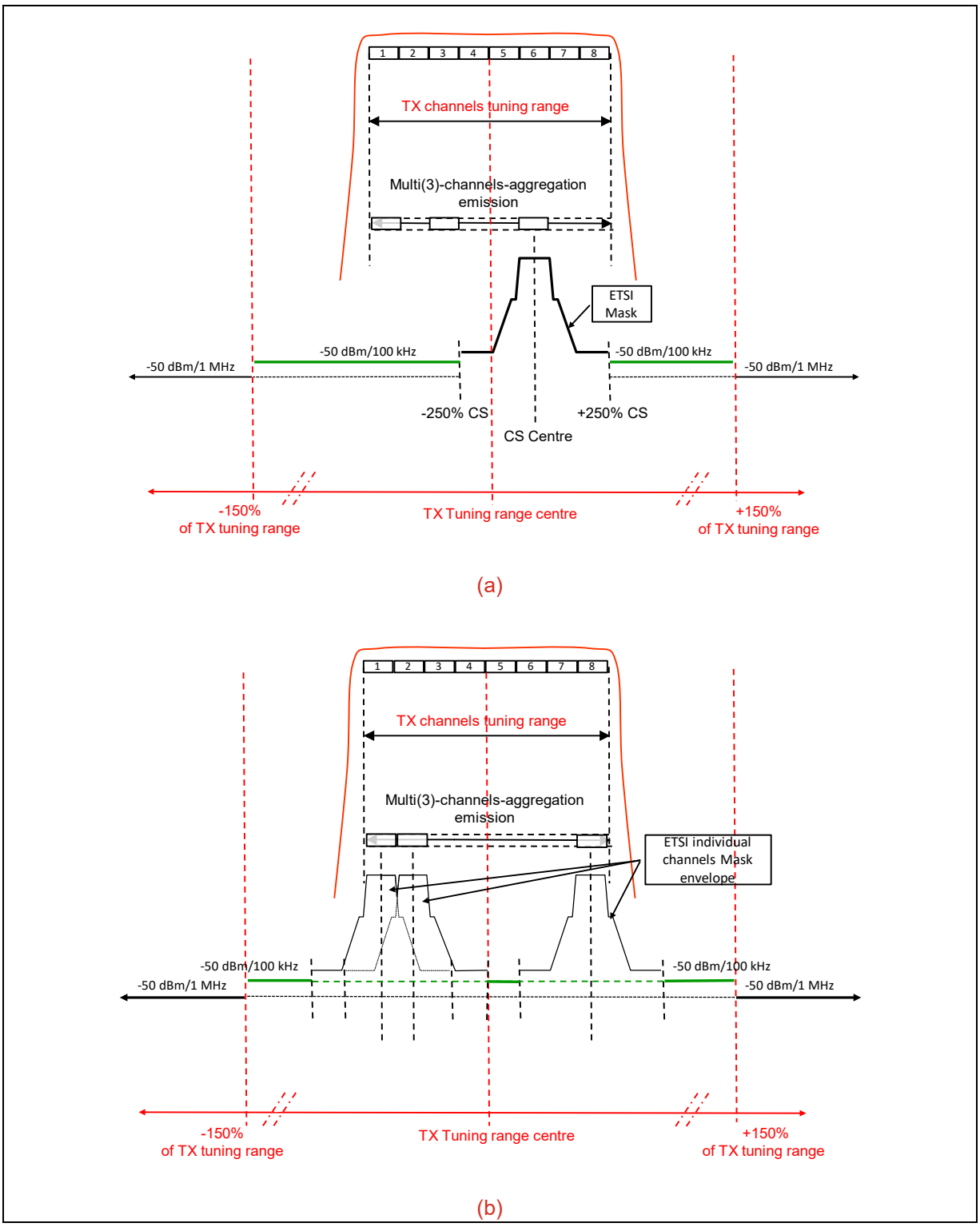


Figure 4: (a) Specific mask for spurious domain emissions for channel aggregation (single band/multiple channels port) systems operating below 21.2 GHz (example with 3 channels) (b): Example with combined limits for channel aggregation (single band/multiple channels port) systems operating below 21.2 GHz (example with 3 channels)

ANNEX 2: LAND MOBILE SERVICE, MARITIME MOBILE SERVICE AND SHORT RANGE DEVICES REQUIREMENTS

Table 6: Spurious domain emission limits for the land mobile service, maritime mobile service and short range devices

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during bursts duration in the reference bandwidth
2.1.1	Terminals and Base Stations (in transmit mode), except the equipment specified below	9 kHz ≤ *f* ≤ 1 GHz	-36 dBm
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-30 dBm
2.1.2	▪ Short range devices; ▪ RLAN; ▪ CB; ▪ Cordless Telephones; ▪ Radio Microphones (all systems in transmit mode)	*f* within the bands: 87.5-118 MHz, 174-230 MHz, 470-694 MHz	-54 dBm
		9 kHz ≤ *f* ≤ 1 GHz (except 87.5–118 MHz, 174–230 MHz, 470–694 MHz)	-36 dBm
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-30 dBm
2.1.3	Short range inductive devices operating below 30 MHz (in transmit mode) (Note 3)	9 kHz ≤ *f* ≤ 10 MHz	27 dBμA/m (at 9 kHz then decreasing by 10 dB/decade) (Note 4)
		10 MHz < *f* ≤ 30 MHz	-3.5 dBμA/m (Note 4)
		f within the bands: 87.5-118 MHz, 174-–230 MHz, 470-–694 MHz	-54 dBm
		30 MHz < *f* ≤ 1 GHz (except 87.5–118 MHz, 174–230 MHz, 470–694 MHz)	-36 dBm
		1GHz < *f* ≤ F_{UPPER} (see *recommend 3*)	-30 dBm
2.1.4	Receivers and idle/standby transmitters except the equipment specified below	9 kHz ≤ *f* ≤ 1 GHz	- 57 dBm
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 11*)	- 47 dBm

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during bursts duration in the reference bandwidth
2.1.5	Short range inductive receivers and idle/standby transmitters operating below 30 MHz	9 kHz ≤ *f* < 4.78 MHz	5.5 dBµA/m, decreasing by 3 dB/octave (Note 4)
		4.78 MHz ≤ *f* < 30 MHz	-22 dBµA/m (Note 4)
		30 MHz ≤ *f* < 1 GHz	-57 dBm
2.1.6	Base Stations using AAS and beamforming with integrated antennas operating below 6 GHz (Note 5)	9 kHz ≤ *f* ≤ 1 GHz	-36 dBm(Note 6)
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-30 dBm (Note 6)
2.1.7	Base Stations using AAS and beamforming with integrated antennas operating above 24.25 GHz (Note 5)	9 kHz ≤ *f* ≤ 1 GHz	-36 dBm (Note 5) (Note 6)
		1 GHz < *f* ≤ 18 GHz	-30 dBm (Note 5) (Note 6)
		18 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-20 dBm/10 MHz (other limits apply for specific frequency separations, see Figure 7) (Note 6)
2.1.8	Terminals operating above 24.25 GHz using AAS and beamforming with integrated antennas	9 kHz ≤ *f* ≤ 1 GHz	-36 dBm (Note 6)
		1 GHz < *f* ≤ 7.25 GHz	-30 dBm (Note 6)
		7.25 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-13 dBm/MHz and -10 dBm/100 MHz (Note 6) (Note 7) (Note 8)

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during bursts duration in the reference bandwidth

Note 1: *f* is the frequency of the spurious domain emission

Note 2: For systems that use digital modulation and narrow-band high power (≥1 Watt) analogue modulated systems, the reference bandwidth is specified in section 2 of this annex, while for any other analogue modulation the reference bandwidth specified in *recommend 4* is applicable.

Note 3: Limits for Wireless Power Transmission for Electric Vehicles systems are under study and may need further consideration.

Note 4: Levels are H-field limit at 10 m distance, measured by shielded loop antenna as specified by CISPR.

Note 5 : There is currently no information on base stations using AAS and beamforming with integrated antennas operating between 6 and 24.25 GHz. These could be considered in a future revision as necessary.

Note 6: For Terminals and Base Stations using AAS and beamforming with integrated antennas, the metric for unwanted emission is defined as Total Radiated Power (TRP): and applies separately for the transmitting and receiving phases of operation.

$$TRP = \int_{4\pi}\int P_D(r,\theta,\varphi) r^2 \sin(\theta) d\theta d\varphi$$

where $P_D(r,\theta,\varphi)$ is the power density in W/m^2 at a distance *r* of two orthogonal polarizations.

Over-the-air spatial parameters are specified in a Cartesian coordinate system (x, y, z) using spherical coordinates (r, θ,φ). φ is the angle in the x/y plane and it is between the x-axis and the projection of the vector onto the x/y plane and is defined between -180° and +180°. θ is the angle between the projection of the vector in the x/y plane and the vector and is defined between -90° and +90.

The TRP measurement procedure for emissions in the spurious domain with large frequency separation is slightly different from that of the wanted signal and unwanted emissions closer to the wanted signal.

For the wanted signal, if the directivity is known, it is enough to measure the peak e.i.r.p. and adjust it with the directivity to obtain TRP. Care must be taken for using this method for unwanted emissions since its directivity can be different from the wanted signal directivity, in particular at large frequency separations from the carrier. If the directivity is not known but it can be verified that the emission is from the antenna array, TRP can be obtained by measuring e.i.r.p. in the cardinal cuts and using pattern multiplication to extrapolate the e.i.r.p. values in other directions. Pattern multiplication exploits the fact that the array factor of a rectangular array can be separable in two factors along the two symmetry planes. If none of the above options are applicable, the final option is to measure the e.i.r.p. on a full-sphere grid with the reference angular step. The measured values can then be integrated to obtain the TRP. All the above options are accurate methods for TRP assessment provided that the mentioned pre-conditions are fulfilled.

For spurious emissions at larger frequency separations from the carrier, it is important to first identify the frequencies with notable emissions for further measurement. This is achieved through a pre-scan which can be performed on a very sparse grid. If no notable emission is identified at a certain frequency during the pre-scan, no further investigation is needed for that frequency. For frequencies which are identified for further measurement, a number of orthogonal cuts (two or three) or a sparse spherical grid can be used. These methods are based on the assumption that spurious emissions at larger frequency separation are not fully correlated and are less directive. For spurious emissions, an upper bound assessment for TRP is enough to ensure the compliance and the exact TRP value is of less importance. Therefore, a systematic correction factor is added to the estimated TRP value in order to ensure an overestimate with a certain confidence. The systematic correction factor is dependent on the chosen grid type and angular step. Orthogonal cut measurements should be measured with the reference angular steps. The sparse full sphere measurement can be performed on angular steps larger than the reference step and smaller than 15 degrees. A larger angular step results in a shorter measurement time while it imposes a larger systematic correction.

For studies, the TRP needs to be reflected in terms of conducted power (P). The link between conducted power and TRP is based on antenna efficiency that could be transformed in terms of additional losses (L). The relation between these terms are P=TRP+L. (L needs to be defined with a positive number)

Note 7: Both limits are simultaneously applicable.

Note 8: Limits in the frequency band 8.5-10.5 GHz might be reconsidered, if necessary when this Recommendation is revised.

A2.1 APPLICATION OF REFERENCE BANDWIDTHS TO DIGITALLY MODULATED AND NARROW-BAND HIGH POWER ANALOGUE MODULATED SYSTEMS

Narrow-band analogue modulated systems, with output power higher than 1 Watt and operated above 30 MHz, as well as digitally modulated systems are, although generally providing good spectrum efficiency, unable to comply with the above limits for nearby the centre frequencies due to the wideband noise generated by such systems. It is therefore necessary to provide specific steps of reference bandwidth in order to produce suitable transition area for the spectral density.

The specific mask with reference bandwidths is shown in Figure 5 for frequencies between 30 MHz and 1 GHz and in Figure 6 for frequencies above 1 GHz, with frequency limits which are a function of the channel separation or the necessary bandwidth (NB).

As an alternative for mobile services operating in a band assigned for MFCN in particular for bandwidths of 5 MHz and above and defined with specific frequency arrangements and technical conditions (referred to as the “operating band”), the transition points in the reference bandwidth masks below can be set relative to the operating band edges instead of relative to the centre frequency of emission. In this case, the offsets should consider spectrum management aspects and allow for reasonable transmitter implementation, accounting for the largest necessary bandwidth possible in the operating band.

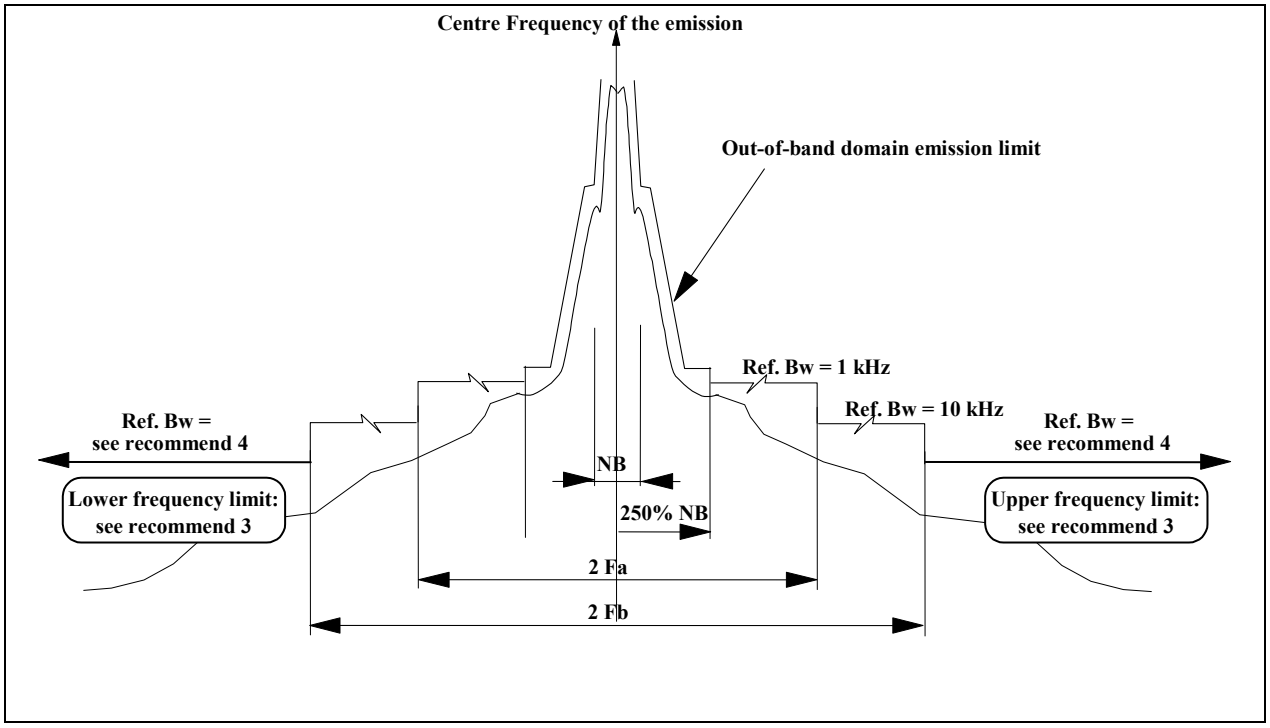


Figure 5: Specific mask for spurious domain emissions with reference bandwidths for mobile services operating between 30 MHz and 1 GHz (see Table 7)

Table 7: Frequency references for Figure 5

Parameter	Value
Fa*	100 kHz or 4 times NB, whichever is the greater
Fb*	500 kHz or 10 times NB, whichever is the greater
(*): The frequency limits are defined from the centre frequency of the emission. For measurement purposes, the reference bandwidths given in Figure 5 apply to the frequency range extending from the 250% NB point to the first frequency limit indicated, or from Fa to Fb as appropriate.	

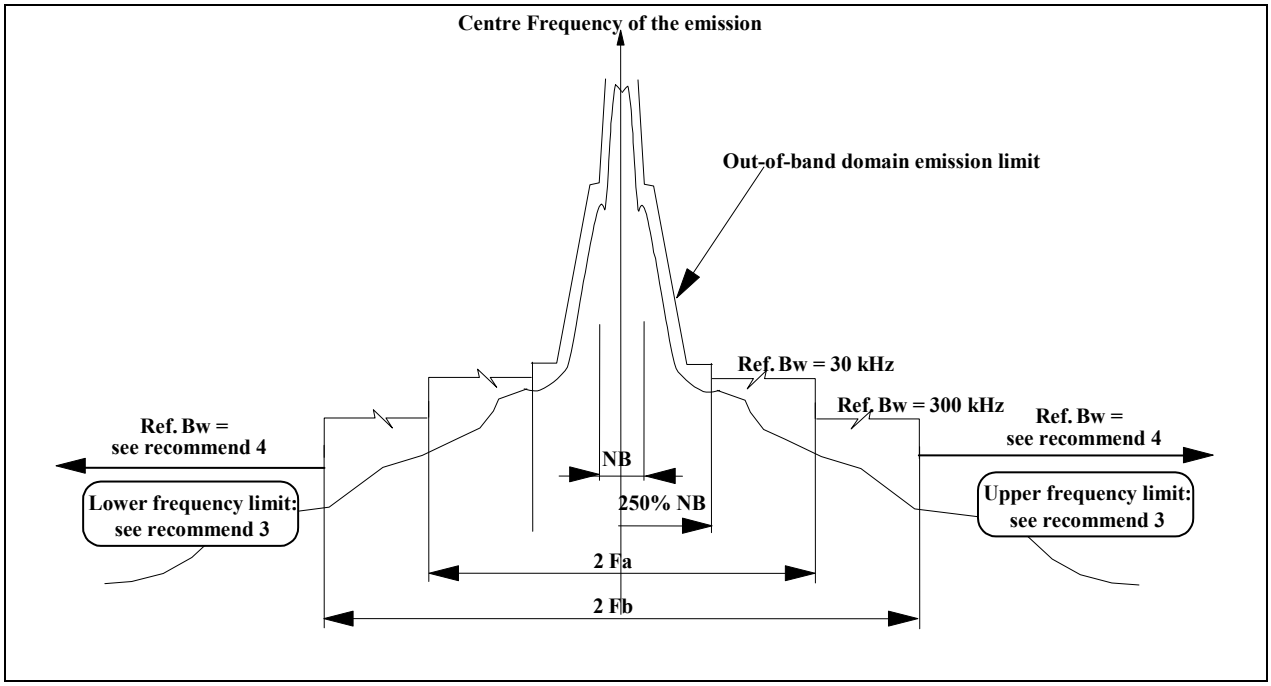


Figure 6: Specific mask for spurious domain emissions with reference bandwidths for mobile services operating above 1 GHz (see Table 8)

Table 8: Frequency references for Figure 6

Parameter	Value
Fa*	500 kHz or 10 times NB, whichever is the greater
Fb*	1 MHz or 12 times NB, whichever is the greater
(*): The frequency limits are defined from the centre frequency of the emission. For measurement purposes, the reference bandwidths given in Figure 6 apply to the frequency range extending from the 250% NB point to the first frequency limit indicated, or from Fa to Fb as appropriate.	

Base stations in the mobile services using AAS and beamforming operating above 24.25 GHz although generally providing good spectrum efficiency, are unable to comply with the limits in Table 6, reference number 2.1.7 nearby the assigned operating band (with bandwidth W_B) due to the wideband noise generated by such systems. It is therefore necessary to provide specific steps of the limits at certain offsets from the operating band in order to produce suitable transition range for the spectral density.

The specific limits are shown as a mask in Figure 7.

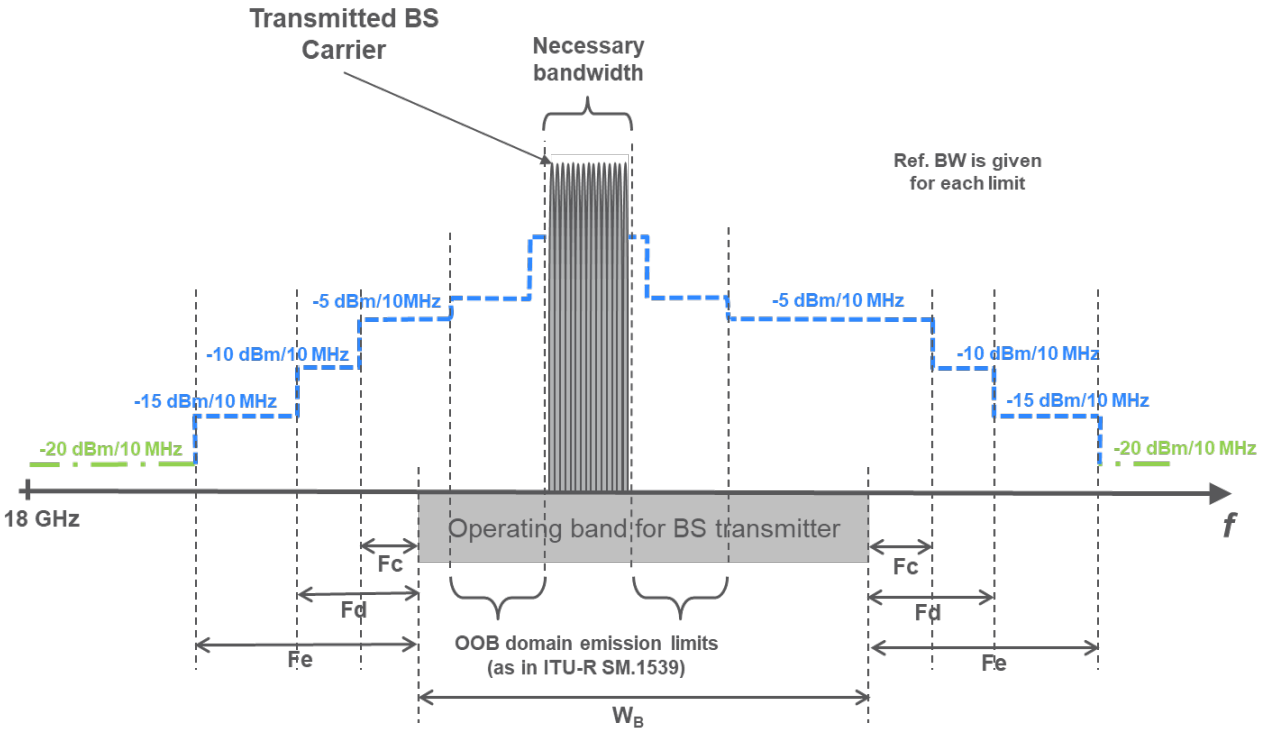


Figure 7: Specific mask for spurious domain emissions with reference bandwidths for Base Stations using AAS and beamforming operating above 24.25 GHz (see Table 9)

Table 9: Frequency references for Figure 7

Parameter	Value
Fc*	1 GHz or 0.5 times W_B , whichever is the greater
Fd*	2 GHz or W_B , whichever is the greater
Fe*	10 GHz or 4 times W_B or, whichever is the greater
(*): The frequency limits are defined from the edge of the AAS Base Station transmitter operating band emission. Regardless of the offset Fc, Fd and Fe as derived from the table, the limits do not apply for f ≤ 18 GHz.	

A2.2 BOUNDARY BETWEEN THE OUT-OF-BAND AND SPURIOUS DOMAINS FOR MULTICARRIER TRANSMITTERS[7]

A multicarrier transmitter is intended to operate only within a single contiguous allocation to a service and application.

For base stations and mobile stations in the mobile service with multicarrier transmitters, the transmitter bandwidth is used instead of the necessary bandwidth for determining the boundary between the out-of-band and spurious domains. In the context of multicarrier base stations and mobile stations in the mobile service, the transmitter bandwidth is defined as the width of the frequency band covering the envelope of the

[7] In the case of multicarrier PMR transmitters further studies are needed. For the time being the above provisions may apply for these transmitters only on a case-by-case basis.

transmitted carriers, which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions for all transmitted carriers.

For wide-band transmitters, Note 2 of *recommends 1* identifies that Recommendation ITU-R SM.1539 [5] and Appendix 3 of the ITU Radio Regulations [6] give further guidance on the boundary between the out-of-band and spurious domains. However, for multicarrier base stations and mobile stations in the mobile service, operating up to 6 GHz, using the definitions of B_U and B_N in Annex 1 of Recommendation ITU-R SM.1539[8], the upper threshold value for applying the 250% boundary definition should be B_U = 10 MHz and the necessary bandwidth B_N should be the transmitter bandwidth.

[8] Definition of B_U from Recommendation ITU-R SM.1539: B_U is the upper threshold value for B_N (necessary bandwidth) above which the frequency separation between the centre frequency and the spurious boundary equals 1.5 * B_N + B_U.

ANNEX 3: SPACE SERVICE SPECIFIC REQUIREMENTS

Table 10: Spurious domain emission limits for space services

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during burst duration in the reference bandwidth	Notes
3.1.1	VSAT (Very Small Aperture Terminal) and related terminals (see note 1), SNG (Satellite News Gathering) or transportable fixed Earth Stations each transmitting in the Fixed Satellite Service (FSS) above 3 GHz	30 MHz < *f* ≤ 230 MHz	30 dBµV/m (Note 2)	Values are in e.i.r.p., see notes 3, 4, 4bis, 4ter and 5
		230 MHz < *f* ≤ 1 GHz	37 dBµV/m (Note 2)	
		1 GHz < *f* ≤ 3.4 GHz	49 dBpW/100 kHz	Values are in e.i.r.p., see notes 3, 4, 4bis, 4ter and 5
		3.4 GHz < *f* ≤ 10.7 GHz	55 dBpW/100 kHz	
		10.7 GHz < *f* ≤ 21.2 GHz	61 dBpW/100 kHz	
		21.2 GHz < f ≤ F_{UPPER} (see *recommends 3*)	67 dBpW/100 kHz	
3.1.2	VSAT and related terminals (see note 1), SNG or transportable fixed Earth Stations each operating in the FSS above 3 GHz: transmitters in the transmission disabled state or receive only VSAT	30 MHz < *f* ≤ 230 MHz	30 dBµV/m (Note 2)	Values are in e.i.r.p., see note 3
		230 MHz < *f* ≤ 1 GHz	37 dBµV/m (Note 2)	
		1 GHz < *f* ≤ 10.7 GHz	48 dBpW/100 kHz	Values are in e.i.r.p., see note 3
		10.7 GHz < *f* ≤ 21.2 GHz	54 dBpW/100 kHz	
		21.2 GHz < f ≤ F_{UPPER} (see *recommends 11*)	60 dBpW/100 kHz	

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during burst duration in the reference bandwidth	Notes
3.1.3	Mobile Earth Stations (MES) (see Note 1bis) each transmitting below 1 GHz	9 kHz ≤ *f* ≤ 1 GHz	-36 dBm	The mask in Figure 5 and Table 7 applies. In order to evaluate the 250% boundary as well as Fa and Fb, the minimum necessary bandwidth shall be considered as 30 kHz for all emissions.
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-30 dBm	
3.1.4	Mobile Earth Stations (MES) (see Note 1bis) transmitting in the Mobile Satellite Service between 1 GHz and 3 GHz	9 kHz ≤ *f* ≤ 1 GHz	-36 dBm	
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 3*)	-30 dBm	
3.1.5	Mobile Earth Stations (MES) (see Note 1bis) operating below 3 GHz: receivers, receive only MES and transmitters in the carrier-off state	9 kHz ≤ *f* ≤ 1 GHz	- 57 dBm	
		1 GHz < *f* ≤ F_{UPPER} (see *recommends 11*)	- 47 dBm	
3.1.6	LMES (Land Mobile Earth Stations) or MMES (Maritime Mobile Earth Stations) each transmitting in the MSS above 3 GHz	30 MHz < *f* ≤ 230 MHz	30 dBµV/m (Note 2)	Quasi peak limits measured at a distance of 10 metres. The lower limit shall apply at the transition frequency
		230 MHz < *f* ≤ 1 GHz	37 dBµV/m (Note 2)	
		1 GHz < *f* ≤ 3.4 GHz	49 dBpW/100 kHz	Values are in e.i.r.p., see note 3bis
		3.4 GHz < *f* ≤ 10.7 GHz	55 dBpW/100 kHz	
		10.7 GHz < *f* ≤ 21.2 GHz	61 dBpW/100 kHz	

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during burst duration in the reference bandwidth	Notes
		21.2 GHz < f ≤ F_{UPPER} (see *recommends 3*)	67 dBpW/100 kHz	
3.1.7	LMES (Land Mobile Earth Stations) or MMES (Maritime Mobile Earth Stations) each operating in the MSS above 3 GHz: transmitters in the carrier-off state	30 MHz < *f* ≤ 230 MHz	30 dBµV/m (Note 2)	Quasi peak limits measured at a distance of 10 metres. The lower limit shall apply at the transition frequency
		230 MHz < *f* ≤ 1 GHz	37 dBµV/m (Note 2)	
		1 GHz < *f* ≤ 10.7 GHz	48 dBpW/100 kHz	Values are in e.i.r.p., see note 3bis
		10.7 GHz < *f* ≤ 21.2 GHz	54 dBpW/100 kHz	
		21.2 GHz < *f* ≤ F_{UPPER} (see *recommends 11*)	60 dBpW/100 kHz	
3.1.8	Other Fixed Earth Stations	Relative attenuation limits in Appendix 3 of the Radio Regulations [6] apply.		
3.1.9	Space stations (excluding Amateur Satellite Services which are covered under Annex 6), other Maritime Mobile Earth Stations and Aeronautical Mobile Earth Stations that are not covered by any of the above categories	Relative attenuation limits reported in Appendix 3 of the Radio Regulations [6] apply.		

Reference number	Type of equipment	Frequency of the spurious domain emission *f*	Limits: mean power or, when applicable, average power during burst duration in the reference bandwidth	Notes

Note 1: For the purpose of this Recommendation, the following satellite earth stations fall within the category of VSAT:

- Satellite terminals (STs) including both satellite user terminals (SUT) and satellite interactive terminals (SIT) transmitting in the frequency bands 27.50 to 29.50 GHz and 29.50 to 30.00 GHz, as defined in relevant ETSI standards;
- Aeronautical earth stations (AES) transmitting in the frequency bands 14.00 to 14.50 GHz as defined in relevant ETSI standards;
- Earth Stations on board Vessels (ESV) transmitting in the frequency bands within the ranges 5850 to 6650 MHz and 14.00 to 14.50 GHz as defined in relevant ETSI standards.

Note 1bis: For the purpose of this Recommendation the category of Mobile Earth Station (MES) includes handheld, portable, transportable, vehicle-mounted, host connected, semi-fixed or fixed equipment.

Note 2: Levels are expressed as electric field strength at 10 m

Note 3: As a special case, the limits for VSAT, SNG or transportable fixed Earth Stations are expressed in terms of e.i.r.p. for off-axis angles greater than 7°.

Note 3bis: These e.i.r.p. limits for LMES and MMES apply in any direction.

Note 4: In the frequency band of operation ± 150 MHz, an e.i.r.p. limit of 78 dBpW/100 kHz applies. This limit may be exceeded in a frequency band which shall not exceed 80 MHz, centred on the carrier frequency, provided that the on-axis e.i.r.p. density at the considered frequency is 50 dB below the maximum on-axis e.i.r.p. density of the signal expressed in dBW/100 kHz.

The frequency band of operation is the set of contiguous transmit frequency bands allocated to the FSS of the concerned region, or a continuous part of it, within which the equipment is designed to transmit, for use in accordance with the Radio Regulations.

Note 4bis: As an exception to note 4, an e.i.r.p. limit of 95 dBpW/10 MHz applies in the frequency bands 5700-5850 MHz, 6650-6800 MHz for VSAT transmitting within the frequency band 5850 to 6650 MHz, and in the frequency bands 13.75-14.00 GHz and 14.25-14.75 GHz for VSAT transmitting within the frequency band 14.00-14.5 GHz. This limit may be exceeded in a frequency band which shall not exceed 50 MHz, centred on the carrier frequency, provided that the on-axis e.i.r.p. density at the considered frequency is 50 dB below the maximum on-axis e.i.r.p. density of the signal (within the necessary bandwidth) expressed in dBW/100 kHz. No e.i.r.p. limit is set in the frequency band 14.00-14.25 GHz.

Note 4ter: As an exception to note 4, an e.i.r.p. limit of 85 dBpW/1 MHz applies in the frequency bands 29.35 GHz to 29.50 GHz and 30.00 GHz to 30.15 GHz for Satellite Terminal (ST) transmitting within the frequency band 29.5-30 GHz, and in the frequency bands 27.35 GHz to 29.50 GHz and 30.00 GHz to 30.15 GHz for ST transmitting within the frequency band 27.5-29.5 GHz. This limit may be exceeded in a frequency band which shall not exceed 50 MHz, centred on the carrier frequency, provided that the on-axis e.i.r.p. density measured in 100 kHz at the frequency of the considered spurious is 50 dB below the maximum on-axis e.i.r.p. density of the signal measured in 100 kHz. This limit may not apply in frequency bands exclusively designated to FSS in regions where those bands have been adopted. For STs operating in these bands, no e.i.r.p. limit is set in the frequency band 29.50 GHz to 30.00 GHz.

Note 5: In the second harmonic of the frequency band of operation +/- 400 MHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit are present, then the power of each of those spurious signals exceeding the limit shall be added in watts, and the sum shall not exceed 78 dBpW.

ANNEX 4: BROADCASTING SERVICE SPECIFIC REQUIREMENTS

Table 11: Spurious domain emission limits for the broadcasting service

Reference number	Type of equipment	Limits: Mean power absolute levels (dBm) or attenuation (dBc) below the power(note 1) supplied to the antenna port in the reference bandwidth
4.1.1	Broadcasting transmitters below 30 MHz	Limits of Radio Regulations Appendix 3 apply: 50 dBc, without exceeding the absolute mean power of 17 dBm
4.1.2	All types of broadcasting transmitters above 30 MHz	For frequencies 9kHz ≤ *f* ≤ F_{UPPER} (see recommend 3): -36 dBm, for P ≤ 9 dBW 75 dBc, for 9 dBW < P ≤ 29 dBW -16 dBm, for 29 dBW < P ≤ 39 dBW 85 dBc, for 39 dBW < P ≤ 50 dBW -5 dBm, for 50 dBW < P
4.1.3	Broadcasting receivers	See Table 12,Table 13 and Table 14
Note 1: Mean power (P), in accordance with RR 1.158 [6], at antenna port in watts.		

Table 12: Broadcast receiver spurious domain emission limits (see notes 2 and 3)

Frequency range (note 1)	Measurement Facility	Measurement distance	Detector type / bandwidth	Limit (dBµV/m)
30-230 MHz	OATS/SAC	10 m	Quasi peak / 120 kHz	30
230-1000 MHz				37
30-230 MHz	OATS/SAC	3 m		40
230-1000 MHz				47
30-230 MHz	FAR	10 m	Quasi peak / 120 kHz	32 to 25
230-1000 MHz				32
30-230 MHz	FAR	3 m	Quasi peak / 120 kHz	42 to 35
230-1000 MHz				42
1000-3000 MHz	FSOATS	3 m	Average / 1 MHz	50
3000- 6000 MHz				54
1000-3000 MHz	FSOATS		Peak / 1 MHz	70
3000-6000 MHz				74
Note 1: The highest frequency requirement is calculated using table 1 of EN 55032 [9]. It is determined from the highest frequency generated or used excluding the local oscillator and tuned frequencies. Note 2: These requirements are not applicable to the local oscillator and harmonics frequencies of equipment covered by Table 13. Note 3: From 30 MHz to 1000 MHz apply only i) OATS/SAC at 10 m, or ii) OATS/SAC at 3 m, or iii) FAR at 10 m, or iv) FAR at 3 m.				

Table 13: FM Broadcast receiver spurious domain emission limits (see notes 1 and 2)

Frequency range	Measurement Facility	Measurement distance	Detector type/ bandwidth	Fundamental Limit (dBµV/m)	Harmonic Limit (dBµV/m)
30-230 MHz	OATS/SAC	10 m	Quasi peak / 120 kHz	50	42
230-300 MHz					42
300-1000 MHz					46
30-230 MHz	OATS/SAC	3 m		60	52
230-300 MHz					52
300-1000 MHz					56
30-230 MHz	FAR	10 m	Quasi peak / 120 kHz	52 to 45	44 to 37
230-300 MHz				45	37
300-1000 MHz				45	41
30-230 MHz	FAR	3 m		62 to 55	54 to 47
230-300 MHz				55	47
300-1000 MHz				55	51

Note 1: These relaxed limits apply only to emissions at the fundamental and harmonic frequencies of the LO. Signals at all other frequencies shall be compliant with the limits given in Table 12.

Note 2: Apply only i) OATS/SAC at 10 m, or ii) OATS/SAC at 3 m, or iii) FAR at 10 m, or iv) FAR at 3 m across the entire frequency range.

Table 14: conducted differential voltage emissions limits for broadcast receivers

Frequency range (Note 1)	Detector type/ bandwidth	Limits (dBµV 75 Ω)			Applicability
		Other (Note 2)	Local Oscillator Fundamental	Local Oscillator Harmonics	
30-950 MHz	For $f \leq 1$ GHz: Quasi peak / 120 kHz For $f > 1$ GHz: Peak / 1 MHz	46	46	46	Television receivers (analogue or digital), video recorders and PC TV broadcast receiver tuner cards working on channels between 30 MHz and 1 GHz, and digital audio receivers
950-2150 MHz			54	54	
30-300 MHz		46	54	50	Frequency modulation audio receivers and PC tuner cards
300-1000 MHz				52	
30-300 MHz		46	66	59	Frequency modulation car radios
300-1000 MHz				52	
30-950 MHz		46	76	46	EUTs with RF modulator output ports (e.g. DVD equipment, video recorders, camcorders and decoders etc.) designed to connect to TV broadcast receiver tuner ports. Limits specified for the LO are for the RF modulator carrier signal and harmonics
950-2150 MHz			N/A	54	

Note 1: The measurement shall cover the entire frequency range.
Note 2: The term 'other' refers to all emissions other than the fundamental and harmonics of the LO.

ANNEX 5: SPECIFIC REQUIREMENTS FOR RADAR SYSTEMS IN THE RADIODETERMINATION SERVICE

The term "radiodetermination" includes radionavigation and radiolocation for terrestrial and satellite services, examples are given in Figure 8. The radar systems used in these various services use extremely high peak e.i.r.p.s to perform their mission and consequently require specific limits for spurious domain emissions in order to ensure compatibility with other services in adjacent bands.

Spurious domain emissions limit for radiodetermination systems should take into consideration the platform type, mission of the radar and obvious technical and operational considerations. Limits for radiodetermination are divided into those for fixed stations and those for mobile stations as indicated in the Table 15 below.

Owing to the different types of modulation (fixed frequency radars, non-pulse-coded radars, phase-coded pulsed radars and swept-frequency such as FM or chirp radars) the spurious domain emission limits should be measured at the antenna output (radiated) as guided by the methods set out in Recommendation ITU-R M.1177 [10]. The measurement methods and spurious domain emission limits shall take account of the attenuation of spurious domain emissions by the antenna. The necessary reference bandwidths of the spurious emissions are indicated in the Recommendation ITU-R M.1177.

The limits in Table 15 below are minimum levels applicable to radars for radiodetermination. Except where otherwise provided by special recommendations, the limits for "navigation aids" in the radionavigation service are the same as for those in the (aeronautical and maritime) mobile services.

Note: Radiolocation low power radars considered as SRD are not subject to the requirements of this annex; SRD limits in Annex 2 should apply.

Table 15: Spurious domain emissions limits for radar systems in the radiodetermination service (Note 1)

Reference number	Type of Radars for radiodetermination	Limits: Absolute levels (dBm in PEP in the reference bandwidth) or Attenuation (dB) below the power (PEP) supplied to the antenna port: (whichever is less stringent)
5.1.1	Fixed stations (Note 2) (except multi-frequency, active array radars (Note 3) and meteorological radars)	-30 dBm or 100 dB
5.1.2	Meteorological radars (except wind profiler radars)	-30 dBm or 100 dB, for PEP ≤ 150 kW; -30 dBm or 90 dB, for PEP > 150 kW (Note 4)
5.1.3	All other types of radar for radiodetermination	(43 + 10·log(PEP)), or 60 dB, these limits may be expressed as: -13 dBm, where PEP ≤ 50 W (10·log(PEP) - 30) dBm, where PEP > 50 W
5.1.4	Radar systems operating in standby mode	- 57 dBm, for 9 kHz ≤ f ≤ 1 GHz - 47 dBm, for 1 GHz < f ≤ F_{UPPER} (see recommend 3) - no limit within ±250% of the necessary bandwidth

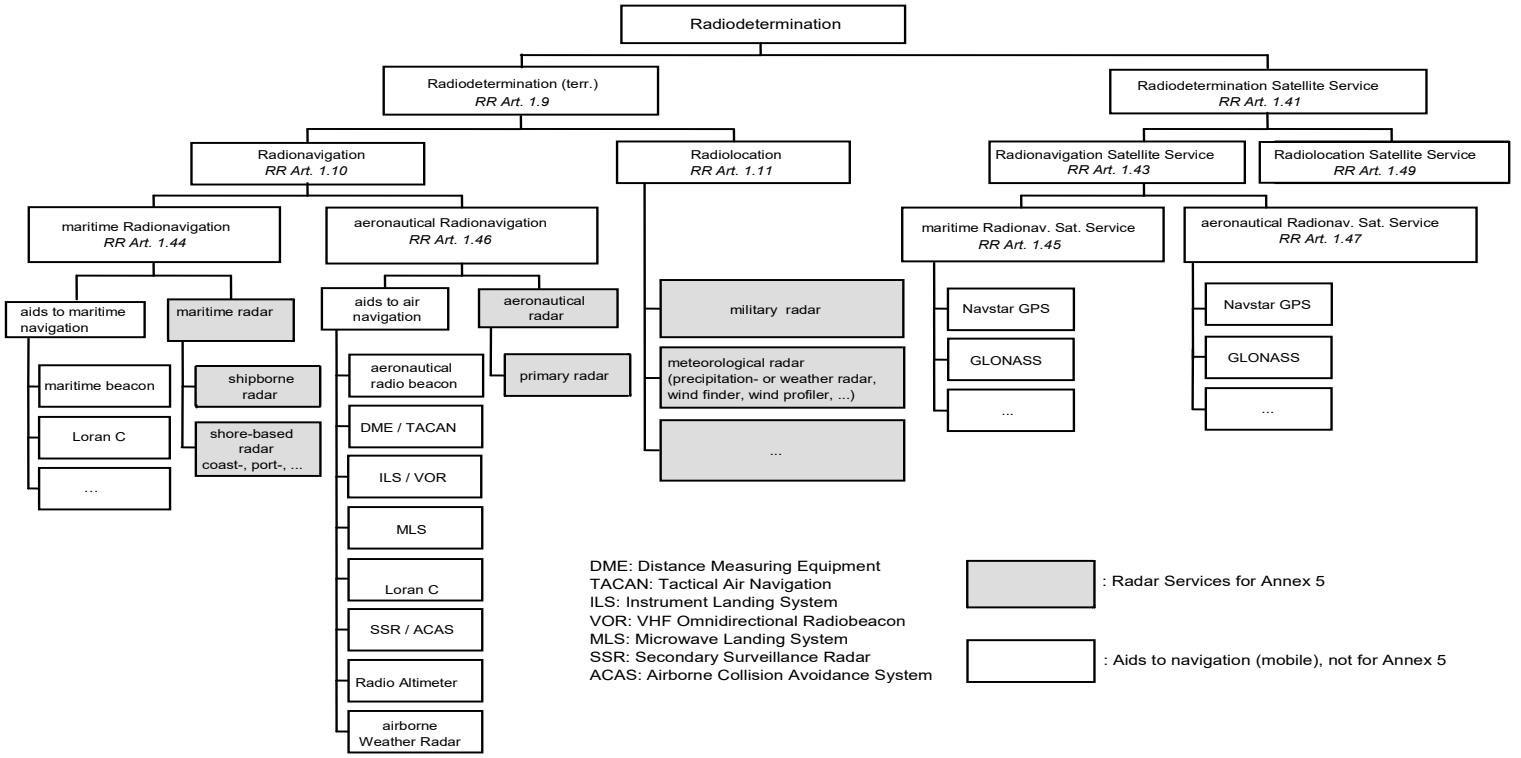
Note 1: Spurious domain emission limits in Table 15 above apply to transmitters installed after 1 January 2006, except for the limits in row 5.1.2 for which an application date is 1 January 2012.

Note 2: On a site by site basis, administrations may permit the use of maritime mobile radar equipment in fixed installations (e.g. Vessel Traffic Services radar), using the appropriate limits for mobile radars.

Note 3: Further study is needed, any interference will be handled on a case-by-case basis.

Note 4: After 1 January 2012, on a site by site basis, an Administration may decide, taking into account potential cross-border compatibility issues where relevant, to deploy meteorological radars in the band 2700-2900 MHz with a peak envelope power above 750 kW with relaxed spurious emission limits . Further studies are required to determine the possible relaxation relative to the 90 dB spurious emission limit.

Figure 8: Overview of Services in the Radiodetermination Service



ANNEX 6: SPECIFIC REQUIREMENTS FOR AMATEUR SERVICES (INCLUDING AMATEUR SATELLITE SERVICE)

Table 16: Spurious domain emission limits for amateur service

Reference number	Type of equipment	Limits Attenuation (dB) below the power supplied to the antenna port
6.1.1	Amateur equipment operating below 30 MHz (including SSB) (Note 1)	The following limit for PEP level in the reference bandwidth will be applicable: 43 + 10·log(PEP), or 50 dB, whichever is less stringent. The minimum necessary bandwidth used to evaluate the 250% boundary shall be considered as 4 kHz for all emissions.
6.1.2	SSB from mobile stations (Note 1)	PEP attenuation in the reference bandwidth: 43 dB below PEP. The minimum necessary bandwidth used to evaluate the 250% boundary shall be considered as 4 kHz for all emissions.
6.1.3	All equipment in the band 30 MHz to 1 GHz :	Limit for level in the reference bandwidth: 43 + 10·log(P), or 70 dBc, whichever is less stringent. The minimum necessary bandwidth used to evaluate the 250% boundary shall be considered as 25 kHz for all emissions.
6.1.4	All equipment between 1 GHz and 26 GHz	Limit for level in the reference bandwidth: 43 + 10·log(P), or 70 dBc, whichever is less stringent. The minimum necessary bandwidth used to evaluate the 250% boundary shall be considered as 100 kHz for all emissions.
6.1.5	All equipment above 26 GHz	Limit for level in the reference bandwidth: 43 + 10 log(P), or 70 dBc, whichever is less stringent. The minimum necessary bandwidth used to evaluate the 250% boundary shall be considered as 1 MHz for all emissions.
6.1.6	Space based Amateur satellite stations	Relative attenuation limits specified in Appendix 3 of Radio Regulations apply.
6.1.7	Receivers and idle/standby transmitters	- 57 dBm, for 9 kHz ≤ f ≤ 1 GHz - 47 dBm, for 1 GHz < f ≤ F_{UPPER} (see recommend 11)
Note 1: All classes of emission using Single Side Band (SSB) are included in the category "SSB"."		

Definitions used:
- PEP - peak envelope power in watts at the antenna port, in accordance with RR 1.157 [6].

- P - mean power in watts at the antenna port, in accordance with RR 1.158 [6]. When burst transmission is used, the mean power P and the mean power of any spurious emissions are measured using power averaging over the burst duration.

- dBc - decibels relative to the unmodulated carrier power of the emission. In the cases, which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power P.

ANNEX 7: LIST OF ABBREVIATIONS

Table 17: List of abbreviations

Abbreviation	Explanation
AAS	Active Antenna System
AES	Aeronautical Earth Station
AG	Active Gain
BS	Base Station
BWA	Broadband Wireless Access
CB	Citizens Band
CEPT	European Conference of Postal and Telecommunications Administrations
CISPR	Comité International Spécial des Perturbations Radioélectriques
CS	Channel Separation
ECC	Electronic Communications Committee
ECO	European Communications Office
e.i.r.p.	Equivalent Isotropically Radiated Power
ERC	former European Radio Committee in CEPT, now ECC
ESV	Earth Stations on board Vessels
ETSI	European Telecommunications Standards Institute
ETSI TC ERM	ETSI Technical Committee Electromagnetic Compatibility & Radio Spectrum Matters
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FSOATS	Free Space Open Area Test Site
FSS	Fixed Satellite Service
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
LMES	Land Mobile Earth Service
MES	Mobile Earth Station
MFCN	Mobile/Fixed Communication Networks
MMES	Maritime Mobile Earth Station
MoU	Memorandum of Understanding
NB	Necessary Bandwidth

Abbreviation	Explanation
OATS/SAC	Open Area Test Site/Open Area Test Site
PEP	Peak Power Envelope
PG	Performance of antenna Geometrical design
PMR	Private Mobile Radio
RLAN	Radio Local Access Network
RS	Repeater Station
SIT	Satellite Interactive Terminal
SNG	Satellite News Gathering
SRD	Short Range Device
SSB	Single Side Band
ST	Satellite Terminal
SUT	Satellite User Terminal
TRP	Total Radiated Power
TS	Terminal Station
VHF	Very High Frequency
VSAT	Very Small Aperture Terminal
WG SE	Working Group Spectrum Engineering in CEPT/ECC

ANNEX 8: LIST OF REFERENCES

[1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC; (Radio Equipment Directive (RED)"

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

[3] ECC Recommendation (19)02: "Unwanted Emissions – Guidance and methodologies when using typical equipment performance in sharing/compatibility studies", approved May 2019

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

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

[6] ITU Radio Regulations, Edition of 2016

[7] Recommendation ITU-R RA.769: "Protection criteria used for radio astronomical measurements"

[8] Recommendation ITU-R RS.2017: "Performance and interference criteria for satellite passive remote sensing"

[9] CENELEC EN 55032:2015: "Electromagnetic compatibility of multimedia equipment - Emission Requirements"

[10] Recommendation ITU-R M.1177: "Techniques for measurement of unwanted emissions of radar systems"

[11] Recommendation ITU-R F.1191: "Necessary and occupied bandwidths and unwanted emissions of digital fixed service systems"

[12] ETSI EN 301 390: "Fixed Radio Systems; Point-to-point and Multipoint Systems; Unwanted emissions in the spurious domain and receiver immunity limits at equipment/antenna port of Digital Fixed Radio Systems"

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

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

[15] Recommendation ITU-R F.746: "Radio-frequency arrangements for fixed service systems".