European Radiocommunications Committee (ERC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

CEPT/ERC/RECOMMENDATION 74-01E (Siófok 98, Nice 99, Sesimbra 02, Hradec Kralove 05, Cardiff 11)

UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

Recommendation adopted by the Working Group "Spectrum Engineering" (WGSE)

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 guidance to administrations in the absence of relevant standards. It should not be used as a stand-alone document for the purpose of type approval. The limits are set for generic families of Services and do not prevent that specific systems, for specific reasons, might require tighter limits reported in ETSI standards.

This Recommendation is to be used within a broader context of Recommendations ITU-R, dealing with unwanted emissions that are summarised by the ECC/REC/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.

It is recognised that certain existing ETSI standards and a limited number of those in an advanced stage of preparation might not fully align with this Recommendation. Where, for historical reasons, such existing standards do not align with this Recommendation, the spurious domain emission limits should be reviewed if revisions are considered. It is also recognised that, largely as a consequence of new technologies emerging, it may be acceptable that specific standards adopt limits which differ from this Recommendation.

Where a difference between the limits for a particular standard and this Recommendation might exist, the limits should be agreed following the iterative, consultative procedure given in the ETSI/ECC Memorandum of Understanding[1]. This procedure should consider the interaction between technical parameters, spectrum efficiency, regulatory and economic aspects.

Where there is a difference between the limits for a particular standard and this Recommendation CEPT assumes the following procedure would be useful:

- The relevant technical bodies in ETSI[2] and CEPT[3] will agree to exchange liaison statements to each other whenever they believe changes to this Recommendation or an ETSI standard, are required;

- 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;

- The CEPT 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;

- 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 6 months.

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

[1] This is available from the ECO (many CEPT documents are available on the ECO web site http://www.cept.org/eco).
[2] Currently ETSI TC ERM.
[3] Currently CEPT WG SE.

- 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 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 and ETSI.

"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 and definitions for the unwanted emissions in the spurious domain from the systems concerned; however these are not in the scope of this Recommendation which aims to provide a specific minimum requirement;

d) that Recommendation ITU-R SM.329 provides options for different categories of limits for unwanted emissions in the spurious domain; moreover it provides some degree of freedom to administrations, for definition of frequency boundaries of spurious domain and the detailed transition of the limits nearby the fundamental emission; in particular it allows, for digital modulations, different definition of spurious emissions frequency boundaries;

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

f) that Appendix 3 of the ITU Radio Regulations contains general spurious emissions limits, with the time scales for their implementation;

g) that the Radioastronomy 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 and RS.1029;

h) 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;

i) 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;

j) 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;

k) 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;

l) 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;

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

> Note: 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).

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

recommends

1) that limits of unwanted emissions in the spurious domain 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.

> Note 1: According to the Radio Regulations, 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: Considering the flexibility allowed by Recommendation ITU-R SM.329 on the 250% boundary definition, it is recognised that this 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). Recommendation ITU-R SM.1539 and Appendix 3 of the ITU Radio Regulations give guidance on the boundary variation in these cases.
>
> Note 3: According to the Radio Regulations, for satellite services 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. Similar provision also applies for multicarrier base stations and mobile stations in the Mobile Service; further guidance is given in Annex 2.
>
> Note 4: In Article 1 of the ITU Radio Regulations (No. 1.146B) and in Recommendation ITU-R SM.329 the spurious domain (of an emission) is defined by the frequency range, beyond the out-of-band domain, in which spurious emissions generally dominate.

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 still ensuring that the limits are met. As guidance for practical purposes, the following measurement parameters are normally recommended:

Table 1

Fundamental frequency range	**Frequency range for measurements**	
	Lower frequency	Upper frequency (The test should include the entire harmonic band and not be truncated at the precise upper frequency limit stated)
9 kHz - 100 MHz	**9 kHz**	1 GHz
100 MHz - 300 MHz	**9 kHz**	10th harmonic
300 MHz - 600 MHz	30 MHz	3 GHz
600 MHz - 5.2 GHz	30 MHz	5th harmonic
5.2 GHz - 13 GHz	30 MHz	26 GHz
13 GHz - 150 GHz	30 MHz	2nd harmonic
150 GHz - 300 GHz	30 MHz	300 GHz

Note 1: These parameters reflect the increasing difficulty in undertaking real tests, especially at frequencies approaching or beyond 110 GHz, taking into account such factors as availability and usability of suitable measurement equipment. In such cases, when systems with integral antenna would require radiated measurement, their antenna gain should be taken into account either with separate test or with 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 services may use, close to the carrier, reference bandwidth values different from the above; these differences are quoted in the relevant service Annex.

Note 3: As a special case, the reference bandwidth of all space stations' 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 (see § 10). 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 the Recommendation ITU-R M.1177.

Note 5: As a general rule, 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 as detailed by Table 2. Unless the Peak Envelope Power (PEP) is explicitly quoted, the spurious domain emission limits specified in this Recommendation 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 h), tighter limits may be required.

Note 2: It is recognised that, in principle, in some cases of narrowband 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 service 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 combined 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.

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 adopted.

Note 1: In the case where the limits referred to in this Recommendation are found to be more stringent than existing ETSI Standards (TBR/ETS/EN/ES), 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 or ETSI consider 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 CEPT.

9) that for all cases not covered in this Recommendation, the Recommendation ITU-R SM.329 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;

10) that administrations should afford all practical protection to the frequency bands utilised by the services using passive sensors, referred to in *considering g)* (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 (Note 1)		**Limits**
Fixed Service		See Annex 1
Land Mobile Service (Note 2) and Maritime Mobile Service (VHF) (mobile and base stations)		See Annex 2
Space Services		See Annex 3
Broadcasting		See Annex 4
Radar Systems in the Radiodetermination Service		See Annex 5
Amateur services		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 when used in emergency.		No limit
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 recommend 11)

Note 1: In the relevant annexes referenced in Table 2, “analogue” and “digital” systems are referred to; 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. public cellular radio, 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).”

Note:
Please check the ECO web site (http//:www.cept.org/eco) for the *up to date position on the implementation of this and other ECC/ERC Recommendations.*

Annex 1

FIXED SERVICE SPECIFIC REQUIREMENTS

1. Informative background

Fixed Service Digital Radio Systems presently referred to in the specific ETSI TM4 work programmes, and used in CEPT countries, 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 95 GHz;
- 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 1024 states (amplitude and/or phase and/or frequency states).

Analogue TV distribution systems are the main analogue Radio Relay Systems of practical interest still in operation in some countries. The necessary bandwidth of such analogue TV distribution systems is not defined in any Recommendation ITU-R, moreover, a wide variety of above-video sub-carriers are usually added to the main TV carrier.

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.

2. Limits

Recommendation ITU-R F.1191 requires that, for Digital Radio Systems, operating on a specific radio-frequency channel arrangement, the frequency boundaries between spurious and out-of-band domains are ± 250% of the relevant Channel Separation (CS). Therefore, for the purpose of this Recommendation, the frequency boundaries for spurious domain emissions of analogue and 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 Channel Separation (CS) is taken as *XS*/2 for alternated frequency channel arrangements and *XS* for co-channel and interleaved frequency channel arrangements as defined by Recommendation ITU-R F.746.

In addition for systems with CS > 500 MHz the boundary, according Recommendation ITU-R SM.1539, should be reduced to ± (500 MHz + 150% of the relevant CS).

Table 1.1 below establishes the spurious domain emission limits for systems in the fixed service.

Table 1.1

SPURIOUS DOMAIN EMISSION LIMITS FOR SYSTEMS IN THE FIXED SERVICE

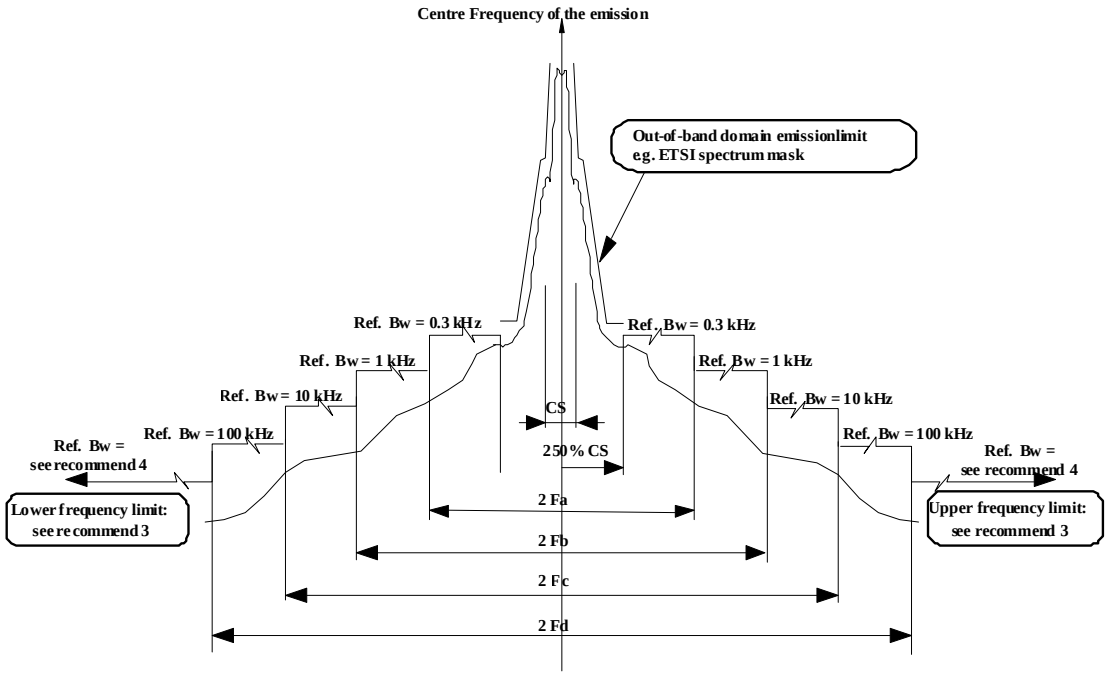
Reference number	**Type of equipment**	**Limits** mean power or, when applicable, average power during bursts duration in the applicable reference bandwidth (see *recommend 4*)
1.1.1	Fixed Service - Transmitters (all stations except those below)	-50 dBm, for 9 kHz ≤ f ≤ 21.2 GHz[note 1] -30 dBm, for 21.2 GHz < f ≤ F_{UPPER} (see *recommend 3*) [note 1] [note 3]
1.1.2	Fixed Service – Terminal stations (remote stations with subscriber equipment interfaces)[note 2]	-40 dBm, for 9 kHz ≤ f ≤ 21.2 GHz[note 1] -30 dBm, for 21.2 GHz < f ≤ F_{UPPER} (see *recommend 3*) [note 1] [note 3]
1.1.3	BWA systems operating between 1 GHz and 6 GHz (all transmitting stations)	-36 dBm, for 9 kHz ≤ f ≤ 1 GHz[note 1] -30 dBm, for 1 GHz < f ≤ F_{UPPER} (see *recommend 3*) [note 1]
1.1.4	Fixed Service - Receivers and idle/standby transmitters, except those below	The same limits as for the transmitters above apply
1.1.5	BWA systems operating between 1 GHz and 6 GHz - 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: For digital systems it is necessary to provide one or more steps of reference bandwidth to produce 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 the ± 250% of the relevant Channel Separation, the limit of spurious domain emissions are defined with reference bandwidths as detailed by the specific Figure 1.1 and the related Table 1.2 and for BWA systems the specific Figure 1.2 and related Table 1.3.

Note 2: Point-to-Multipoint systems used in CEPT countries foresee three kind of stations:
-MS Master (Central) Station (clearly identifiable in Recommendation ITU-R SM.329)
-TS Terminal Station (also clearly identifiable in Recommendation ITU-R SM.329)
-RS Repeater Station (which is not referred in Recommendation ITU-R SM.329);
Repeater Stations of Point-to-multipoint systems will be considered as Terminal stations when they are intended for use only in Remote stations not co-located with any other Fixed radio equipment classified as 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 Terminal Station (in terms of antenna radiation pattern), should be considered as Master Station.

Note 3: It is recognised that, for Multipoint systems, with fundamental operating frequency higher than 21.2 GHz, ETSI EN 301 390 identifies that the limits, reported in this CEPT Recommendation, developed at earlier stage, are not enough stringent in the HDFS bands (21.2 GHz to 43.5 GHz) in order to safely deploy the large foreseen number of systems.
Therefore, in developing the Harmonised Standards under 1999/05/EC Directive (R&TTE Directive) for Multipoint systems, the more stringent limits, reported in ETSI EN 301 390 for those bands, have been adopted among essential requirements under article 3.2 of the R&TTE Directive.

In extreme cases, typically above 26 GHz and mostly due to the use of external mixers in the test set-up, it still may not be possible to achieve enough sensitivity to verify that the Equipment Under Test (EUT) conforms to the specification requirement under modulated condition. In these cases, the measurement may be carried out in un-modulated (CW) conditions. The spurious domain in the CW condition may be corrected for those emissions that are subject to the modulation process, by an amount equal to the modulation loss of the EUT (i.e. the difference in dB between the power output and the power measured in the reference bandwidth at centre frequency of the carrier).



Note: ± Fd frequency steps are not applicable if lower than 1 GHz
± Fc frequency steps are not applicable if lower than 30 MHz
± Fb frequency steps are not applicable if lower than 150 kHz

Figure 1.1: Specific mask for spurious domain emission limits (see Table 1.2)

Table 1.2

VALUES OF Fa, Fb, Fc and Fd in Fig. 1.1.						
Fundamental Emission Frequency	**Channel Separation (CS)** (MHz)	**Typical Symbol Frequency** (~Mbit/s)	**Ref. BW 0.3 kHz** Fa* (MHz)	**Ref. BW 1 kHz** Fb* (MHz)	**Ref. BW 10 kHz** Fc* (MHz)	**Ref. BW 100 kHz** Fd* (MHz)
Below 21.2 GHz (Terminal stations) (Note1)	0.01≤CS<1	Fs≅0.006–0.8	-	-	14	70
	1≤CS<10	Fs≅0.6–8	-	-	28	70
	CS ≥10	Fs~>6	-	-	49 (**)	70 (**)
Below 21.2 GHz (Other stations) (Note1)	0.01≤CS<1	Fs≅0.006–0.8	3.5	7	14	70
	1≤CS<10	Fs≅0.6–8	-	14 (**)	28	70
	CS ≥10	Fs~>6	-	-	49 (**)	70 (**)
Above 21.2 GHz (All stations)	1≤CS<10	Fs≅0.6–8	-	-	-	70
	CS ≥10	Fs>~6	-	-	-	-
Note 1: Excluding BWA systems operating between 1 GHz and 6 GHz for which limits of Figure 1.2 and Table 1.3 apply.						

(*): The frequency limits are defined with respect to the centre frequency of the emissions. For measurement purposes, the reference bandwidth given in Table 1.2 apply to the frequency range extending from the ±250% CS points to the first frequency limit indicated, from Fa to Fb, from Fb to Fc, or from Fc to Fd as appropriate.
(**): Not applicable for CS where the 250% point exceeds these values.

Note: It is recognised that, depending on the characteristic of the domains, the actual power density relative to the ETSI mask at the ± 250% boundary, when evaluated in the reference bandwidth of one or more steps of Table 1.1, may be lower than the spurious domain emission limit itself. In such cases these steps are not applicable and the first applicable spurious domain emission reference bandwidth step, which corresponds to a power density equal or lower than that evaluated with the ETSI mask in the same reference bandwidth should be extended back to the ± 250% boundary (examples of this concept are shown in Figure 1.3.)

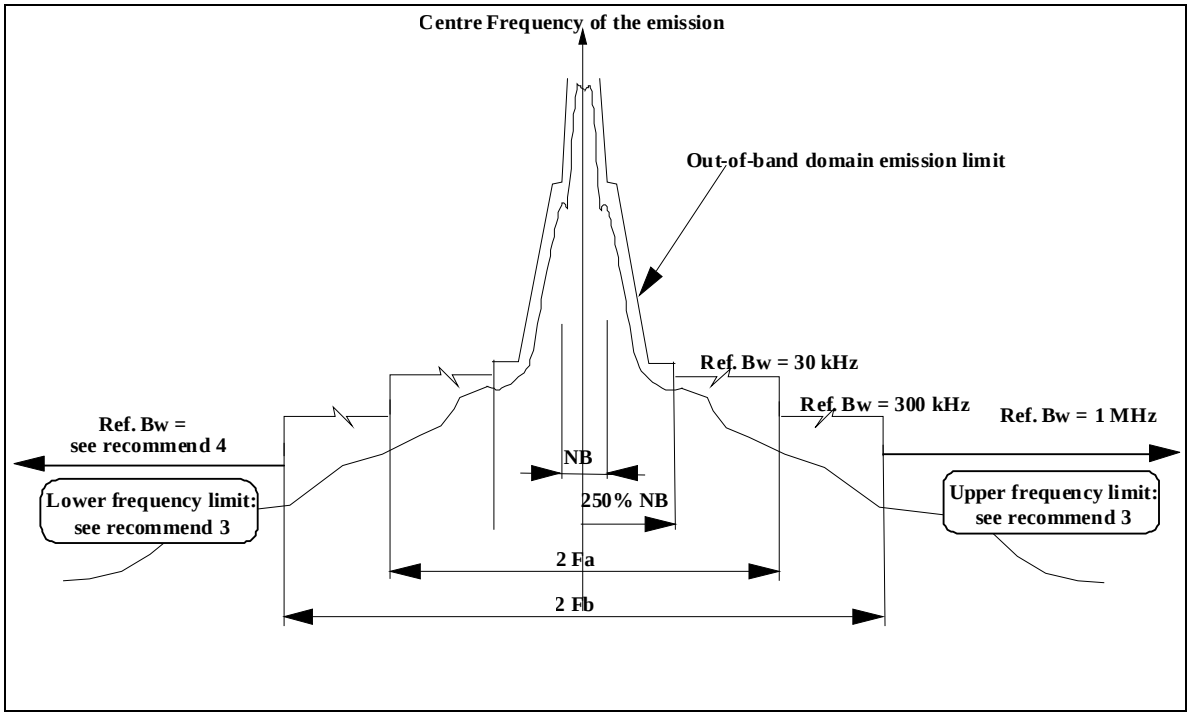
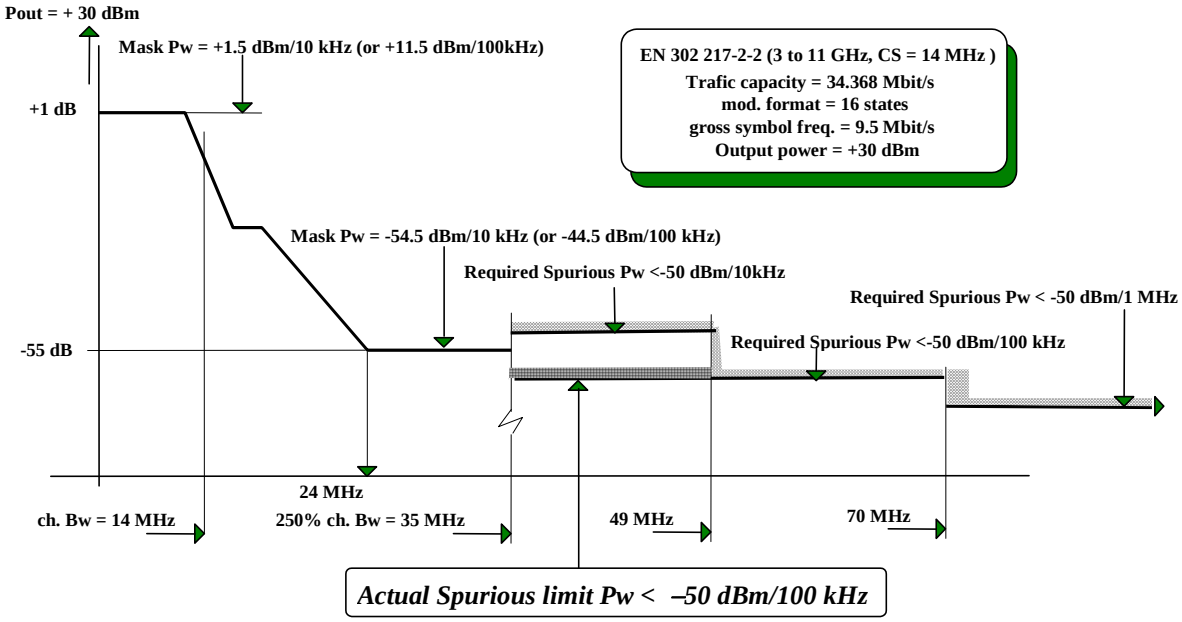


Figure 1.2: Specific mask for spurious domain emissions for BWA systems operating between 1 GHz and 6 GHz
(see Table 1.3)

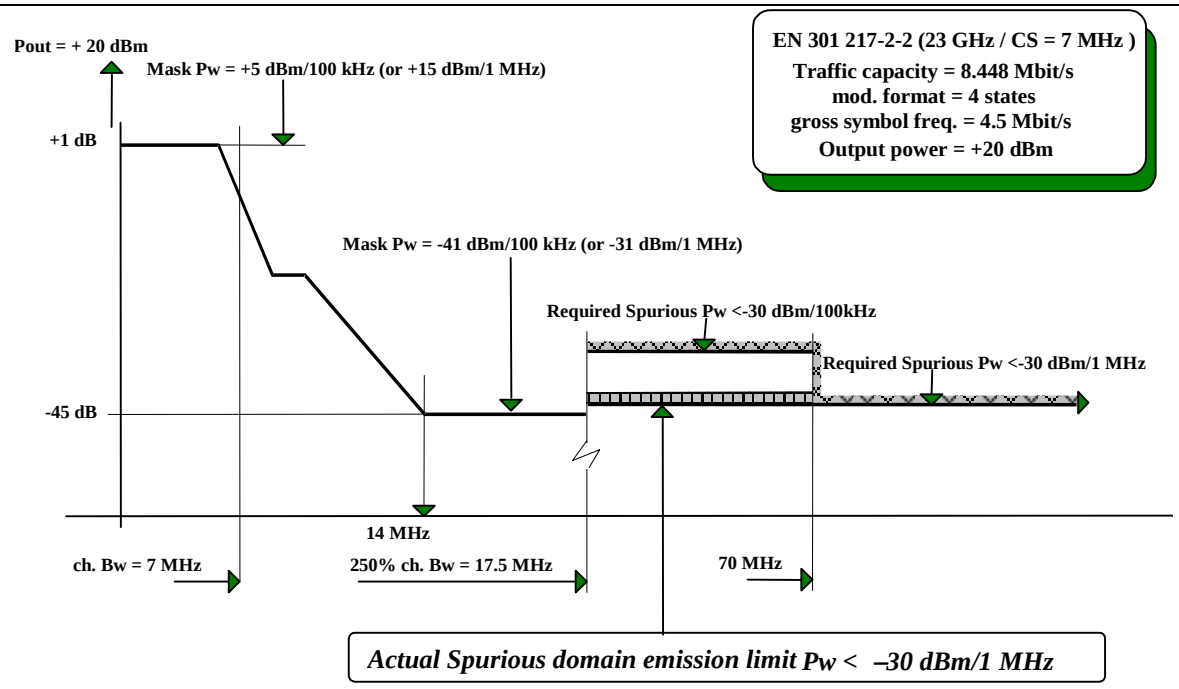
Table 1.3

Fa*	**500 kHz or 10 times NB, whichever is the greater**
Fb*	**1 MHz or 12 times NB, whichever is the greater**

Frequency references for Figure 1.2



a) ETSI mask power density higher than -50 dBm/1 MHz



b) ETSI mask power density lower than -30 dBm/1 MHz

Figure 1.3: Examples of ETSI mask being more stringent than the spurious domain emission limits in the reference bandwidth (ref. to Note to Table 1.2)

Annex 2

LAND MOBILE SERVICE AND MARITIME MOBILE SERVICE (VHF) SPECIFIC REQUIREMENTS

1 Limits

Table 2.1

SPURIOUS DOMAIN EMISSION LIMITS FOR THE LAND MOBILE SERVICE AND MARITIME MOBILE SERVICE (VHF)		
Reference number	**Type of equipment**	**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	-36 dBm, for 9 kHz ≤ *f* ≤ 1 GHz -30 dBm, for 1 GHz < *f* ≤ F_{UPPER} (see *recommend 3*)
2.1.2	- Short range devices; - RLAN; - CB; - Cordless Telephones; - Radio Microphones (all systems in transmit mode)	-54 dBm, for *f* within the bands : 47–74 MHz, 87.5–118 MHz, 174–230 MHz, 470–862 MHz -36 dBm, for 9 kHz ≤ *f* ≤ 1 GHz (except above frequency bands) -30 dBm , for 1GHz < *f* ≤ F_{UPPER} (see *recommend 3*)
2.1.3	Short range inductive devices operating below 30 MHz (in transmit mode)	27 dBµA/m, for (at 9 kHz then decaying by 10 dB/decade) (Note 1) 9 kHz ≤ *f* ≤ 10 MHz -3.5 dBµA/m, for 10 MHz < *f* ≤ 30 MHz (Note 1) -54 dBm , for *f* within the bands : 47–74 MHz, 87.5–118 MHz, 174–230 MHz, 470–862 MHz -36 dBm , for 30 MHz < *f* ≤ 1 GHz (except above frequency bands) -30 dBm , for 1GHz < *f* ≤ F_{UPPER} (see *recommend 3*)
2.1.4	Receivers and idle/standby transmitters	- 57 dBm, for 9 kHz ≤ *f* ≤ 1 GHz - 47 dBm, for 1 GHz < *f* ≤ F_{UPPER} (see *recommend 11*)
2.1.5	Short range inductive receivers and idle/standby transmitters operating below 30 MHz	5.5 dBµA/m, descending 3 dB/octave, for 9 kHz ≤ f < 4.78 MHz -22 dBµA/m, for 4.78 MHz ≤ f < 30 MHz -57 dBm, for 30 MHz ≤ f < 1 GHz
Notes : - *f* is the frequency of the spurious domain emission - 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 1: Levels are H-field limit at 10 m distance, measured by shielded loop antenna as specified by CISPR.		

2 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, and digitally modulated systems although generally providing good spectrum efficiency, are 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 reference bandwidth mask is shown in Figure 2.1 for frequencies below 1 GHz and in Figure 2.2 for frequencies above 1 GHz, with frequency limits which are a function of the channel separation or the necessary bandwidth (NB).

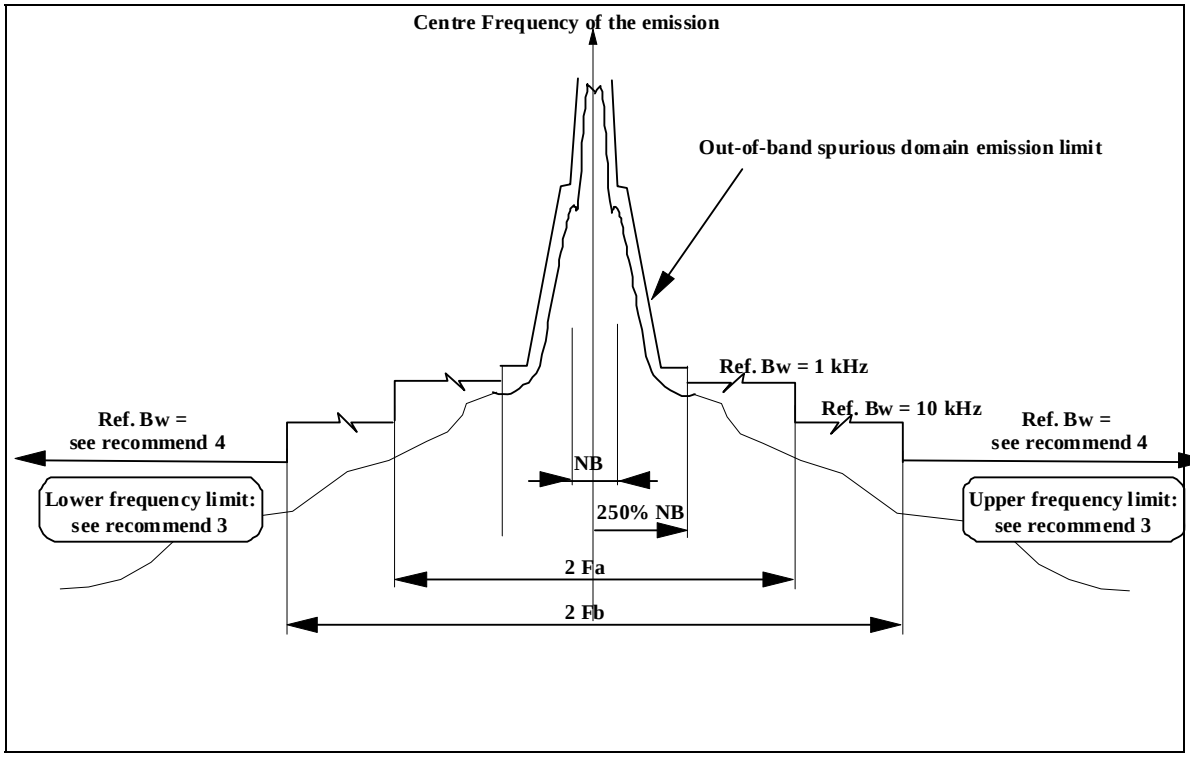


Figure 2.1: Specific mask for spurious domain emissions for mobile services operating between 30 MHz - 1 GHz (see Table 2.2)

Table 2.2

Fa*	**100 kHz or 4 times NB, whichever is the greater**
Fb*	**500 kHz or 10 times NB, whichever is the greater**

Frequency references for Figure 2.1

(*): The frequency limits are defined from the centre frequency of the emission. For measurement purposes, the reference bandwidths given in Table 2.2 apply to the frequency range extending from the 250% CS point to the first frequency limit indicated, or from Fa to Fb as appropriate.

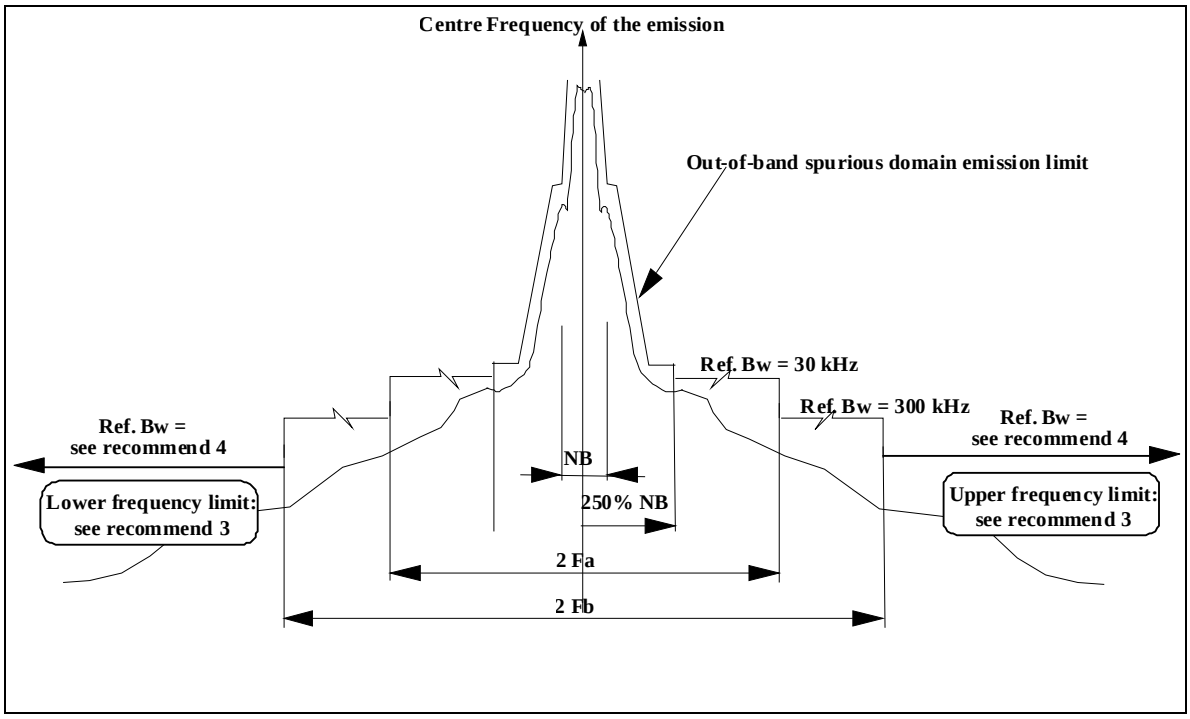


Figure 2.2: Specific mask for spurious domain emissions for mobile services operating above 1 GHz
(see Table 2.3)

Table 2.3

Fa*	**500 kHz or 10 times NB, whichever is the greater**
Fb*	**1 MHz or 12 times NB, whichever is the greater**

Frequency references for Figure 2.2

(*): The frequency limits are defined from the centre frequency of the emission. For measurement purposes, the reference bandwidths given in Table 2.3 apply to the frequency range extending from the 250% CS point to the first frequency limit indicated, or from Fa to Fb as appropriate.

3 Boundary between the out-of-band and spurious domains for multicarrier transmitters[4]

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

For base 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 and mobile stations in the mobile service, the transmitter bandwidth is defined as the width of the frequency band covering the envelope of the 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 and Appendix 3 of the ITU Radio Regulations give further guidance on the boundary between the out-of-band and spurious domains. However, for multicarrier base 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[5], 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.

[4] 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.

[5] 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 3.1

SPURIOUS DOMAIN EMISSION LIMITS FOR SPACE SERVICES		
Reference number	**Type of equipment**	**Limits** mean power or, when applicable, average power during burst duration in the reference bandwidth
3.1.1	VSAT (Very Small Aperture Terminal) and related terminals (see note 4), SNG (Satellite News Gathering) or transportable fixed Earth Stations each transmitting in the Fixed Satellite Service (FSS) above 3 GHz	EN55022 Class B limits, for f ≤ 1 GHz 49 dBpW/100 kHz, for 1 GHz < f ≤ 3.4 GHz 55 dBpW/100 kHz, for 3.4 GHz < f ≤ 10.7 GHz 61 dBpW/100 kHz, for 10.7 GHz < f ≤ 21.2 GHz 67 dBpW/100 kHz, for 21.2 GHz < f ≤ F_{UPPER} (see *recommend 3*) (Values are in e.i.r.p., see notes 1, 2, 2bis, 2ter and 3)
3.1.2	VSAT and related terminals (see note 4), SNG or transportable fixed Earth Stations each operating in the FSS above 3 GHz: transmitters in the transmission disabled state or receive only VSAT	EN55022 Class B limits, for f ≤ 1 GHz 48 dBpW/100 kHz, for 1 GHz < f ≤ 10.7 GHz 54 dBpW/100 kHz, for 10.7 GHz < f ≤ 21.2 GHz 60 dBpW/100 kHz, for 21.2 GHz < f ≤ F_{UPPER} (see *recommend 11*) (Values are in e.i.r.p., see note 1)
3.1.3	Mobile Earth Stations (MES) (see Note 4bis) each transmitting below 1 GHz	-36 dBm, for 9 kHz ≤ *f* ≤ 1 GHz -30 dBm, for 1 GHz < *f* ≤ F_{UPPER} (see *recommend 3*) The mask in Figure 2.1 and Table 2.2 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.
3.1.4	Mobile Earth Stations (MES) (see Note 4bis) transmitting in the Mobile Satellite Service between 1 GHz and 3 GHz	Appropriate limits for these categories of terminals are defined in the applicable ETSI standards or equivalent. For cases not covered by such standards, the limits for generic terrestrial land mobile systems apply : -36 dBm, for 9 kHz ≤ *f* ≤ 1 GHz -30 dBm, for 1 GHz < *f* ≤ F_{UPPER} (see *recommend 3*) The frequency offsets at which these limits apply are to be determined in appropriate standards.
3.1.5	Mobile Earth Stations (MES) (see Note 4bis) operating below 3 GHz: receivers, receive only MES and transmitters in the carrier-off state	- 57 dBm, for 9 kHz ≤ *f* ≤ 1 GHz - 47 dBm, for 1 GHz < *f* ≤ F_{UPPER} (see *recommend 11*)
3.1.6	LMES (Land Mobile Earth Stations) or MMES (Maritime Mobile Earth Stations) each transmitting in the MSS above 3 GHz	EN55022 Class B limits, for f ≤ 1 GHz 49 dBpW/100 kHz, for 1 GHz < f ≤ 3.4 GHz 55 dBpW/100 kHz, for 3.4 GHz < f ≤ 10.7 GHz 61 dBpW/100 kHz, for 10.7 GHz < f ≤ 21.2 GHz 67 dBpW/100 kHz, for 21.2 GHz < f ≤ F_{upper} (see *recommend 3*) (Values are in e.i.r.p., see note 1bis)
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	EN55022 Class B limits, for f ≤ 1 GHz 48 dBpW/100 kHz, for 1 GHz < f ≤ 10.7 GHz 54 dBpW/100 kHz, for 10.7 GHz < f ≤ 21.2 GHz 60 dBpW/100 kHz, for 21.2 GHz < f ≤ F_{upper} (see *recommend 11*) (Values are in e.i.r.p., see note 1bis)
3.1.8	Other Fixed Earth Stations	Relative attenuation limits in Appendix 3 of the Radio Regulations 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 apply.

Note 1: 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 1bis: These e.i.r.p. limits for LMES and MMES apply in any direction.

Note 2: 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 2bis: As an exception to note 2, 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 2ter: As an exception to note 2, 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 3: 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.

Note 4: 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 4bis: 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.

Annex 4

BROADCASTING SERVICE SPECIFIC REQUIREMENTS

Table 4.1

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	Limits of EN55013 apply

Note 1: Mean power (P), in accordance with RR 1.158, at antenna port in watts. For analogue television, the mean power level is defined with a specified video signal modulation. This video signal has to be chosen in such a way that the maximum mean power level (e.g. video signal blanking level for NTSC and PAL and maximum video level "white" for SECAM) is provided by the equipment.

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 5.1. 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 5.1 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. 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 5.1 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 requirements of this annex; SRD limits in Annex 2 should apply.

Table 5.1

SPURIOUS DOMAIN EMISSIONS LIMITS FOR RADAR SYSTEMS IN THE RADIODETERMINATION SERVICE[6]		
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[7] (except multi-frequency, active array radars[8] 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[9]
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

PEP - peak envelope power, in Watts, at the antenna port in accordance with RR 1.157.

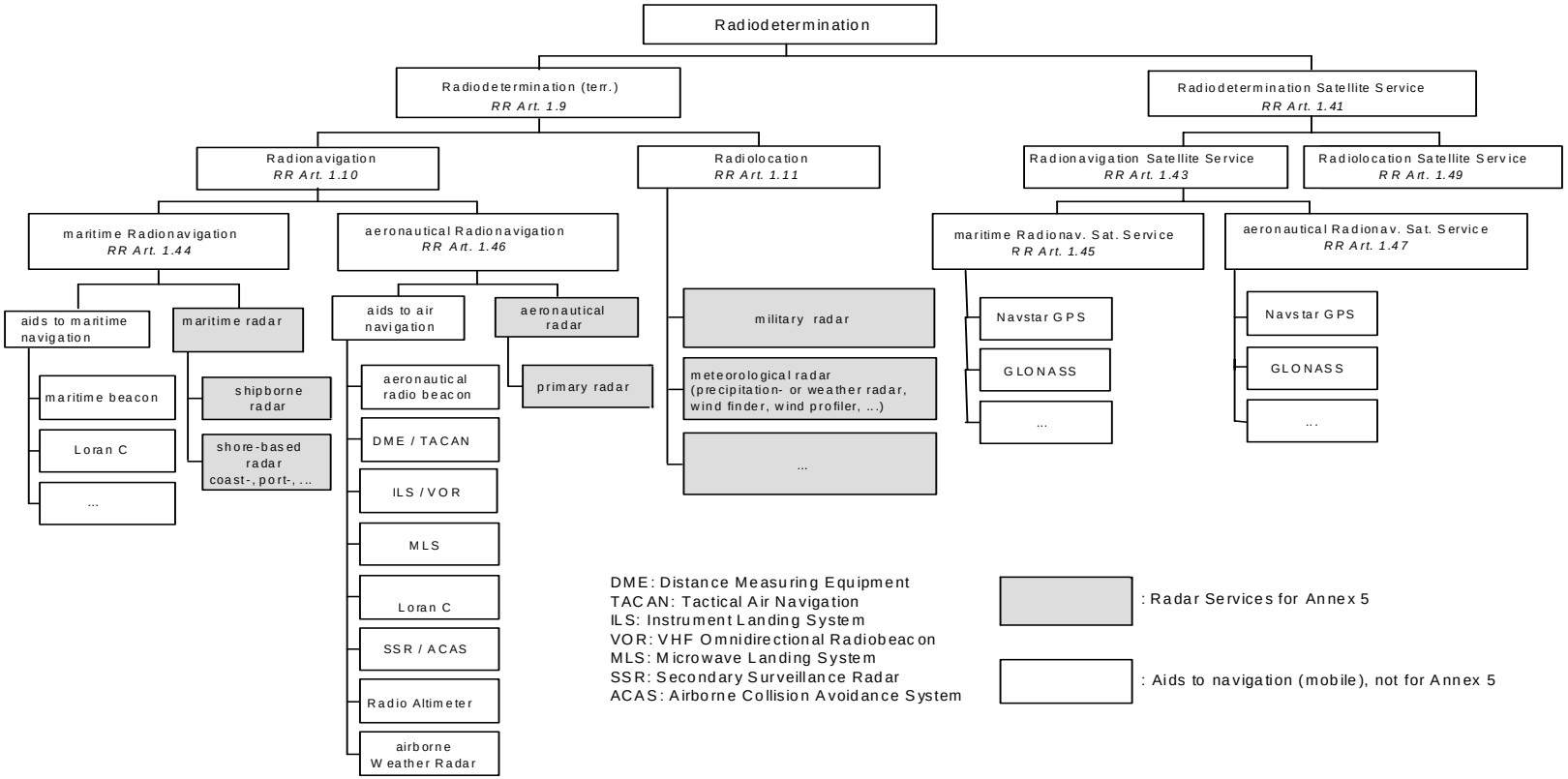
6 Spurious domain emission limits in Table 5.1 above apply to transmitters installed after 1 January 2006, except for the limits in row 5.1.2 for which an application date is 1 January 2012.

7 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.

8 Further study is needed, any interference will be handled on a case by case basis.

9 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 2 700-2 900 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 5.1: Overview of Services in the Radiodetermination Service



Annex 6

SPECIFIC REQUIREMENTS FOR AMATEUR SERVICES (INCLUDING AMATEUR SATELLITE SERVICE) *(No change)*

Table 6.1

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)

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

- P - mean power in watts at the antenna port, in accordance with RR 1.158. 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.

Note 1: All classes of emission using Single Side Band (SSB) are included in the category "SSB".

Annex 7

Abbreviations

Table 7.1

AAS	Active Antenna System
AES	Aeronautical Earth Station
AG	Active Gain
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
CW	Continuous Wave
ECC	Electronic Communications Committe
ECO	European Communications Office of CEPT
EESS	Earth Exploration Satellite Service
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
ETSI TM4	Technical Group 4 within ETSI TC ATTM responsible for “Fixed Radio Systems”
FSS	Fixed Satellite Service
GPS	Global Positioning System
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
LMES	Land Mobile Earth Service
Mask Pw	Mask Power
MES	Mobile Earth Station
MMES	Maritime Mobile Service
MMS	Maritime Mobile Service
MoU	Memorandum of Understanding
MS	Master Station
NB	Necessary Bandwidth
PEP	Peak Power Envelope
PG	Performance of antenna Geometrical design
RAS	Radioastronomy Service
RLAN	Radio Local Access Network
RS	Repeater Station
SECAM	Séquentiel Couleur à Mémoire
SIT	Satellite Interactive Terminal
SNG	Satellite News Gathering
SRD	Short Range Device
SSB	Single Side Band
ST	Satellite Terminal
SUT	Satellite User Terminal
TS	Terminal Station
VHF	Very High Frequency
VSAT	Very Small Aperture Terminal
WG SE	Working Group Spectrum Engineering in CEPT/ECC