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

CEPT/ERC/RECOMMENDATION 74-01E (Siófok 1998, Nice 1999, Sesimbra 2002)

SPURIOUS EMISSIONS[1]

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

Foreword

This Recommendation specifies the limits of the unwanted emission 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 ITU-R recommendations, dealing with unwanted emissions that are summarised by the CEPT 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.

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; these are listed in **Annex 8**.

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/ERC Memorandum of Understanding[2] (ref. ETSI Collective Letter no. 866 of 26 Jan. 94). 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[3] and CEPT[4] will agree to exchange liaison statements to each other whenever they believe changes to this recommendation, an ETSI standard, or the inclusion of a standard into **Annex 8** are required;

1 Note – The scope of this Recommendation is more exactly "unwanted emissions in the spurious domain", since the limits also apply to any out-of-band emissions in the spurious domain, but do not apply to spurious emissions in the out-of-band domain.
2 This is available from the ERO (many CEPT documents are available on the ERO web site http://www.ero.dk).
3 Currently ETSI WG ERM-RM (or ETSI TC ERM).
4 Currently CEPT WG SE.

Edition of October, 2002

- 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 CEPT/ETSI 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;

- 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 ITU-R Recommendation 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 ITU-R Recommendation SM.1539 deals 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 a revised Appendix 3 of the ITU Radio Regulations has been approved at WRC'2000, containing new 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;

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 ERO;

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 ERO;

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 ITU-R Recommendation 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 ITU-R Recommendations of SM series.

Note 2: Considering the flexibility allowed by ITU-R Recommendation 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). ITU-R Recommendation SM.1539 gives guidance on the boundary variation in these cases.

Note 3: In ITU-R Recommendation 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 may be restricted. As guidance for practical purposes, the following measurement parameters are normally recommended:

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	10^{th} harmonic
300 MHz - 600 MHz	30 MHz	3 GHz
600 MHz - 5.2 GHz	30 MHz	5^{th} harmonic
5.2 GHz - 13 GHz	30 MHz	26 GHz
13 GHz - 150 GHz	30 MHz	2^{nd} 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 some circumstances, it may be necessary to extend the range of test frequencies in order to facilitate better protection of other services such as Radioastronomy. 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: Further simplifications of measuring techniques to achieve time/cost savings, while still guaranteeing the fulfillment of the requirement, are outside the scope of this Recommendation, but may be taken from the relevant system EN or Conformance Test Standards when available.

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 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 ITU-R Recommendation 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 1**. 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 1**.

   Note 3: When a system is coupled to an "Active Antenna System", the limits of **Table 1** 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. A list of such prior agreements is given in Informative Annex 8;

9) that for all cases not covered in this recommendation, the ITU-R Recommendation SM.329 should apply; however, where applicable, ETSI standards or ITU-R Recommendations, 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) (Annex 7 presents interference threshold values for these services, as 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 1

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) (mobiles and base stations)		See Annex 2
Space Services		See Annex 3
Broadcasting		See Annex4
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 this table, “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 ERO web site (http//:www.ero.dk) for the up to date position on the implementation of this and other 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 58 GHz;
- traffic capacity — from 9.6 kbit/s to 622 Mbit/s;
- channel separations — from 25 kHz to 220 MHz;
- 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. The necessary bandwidth of such analogue TV distribution systems is not defined in any ITU-R Recommendation and, moreover, a wide variety of above-video sub-carriers are usually added to the main TV carrier.

2. Limits

ITU-R Recommendation 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 ITU-R Recommendation 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 ITU-R Recommendation F.746.

The 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	
Type of equipment	**Limits** mean power or, when applicable, average power during bursts duration in the reference bandwidth
Fixed Service - Transmitters (all stations except those below)	-50 dBm, for 9 kHz[(note 3)] $\leq f \leq$ 21.2 GHz[(note 1)] -30 dBm, for 21.2 GHz $< f \leq F_{UPP}$ (see recommend 3) [(note 1) (note 4)]
Fixed Service - Terminal stations (remote stations with subscriber equipment interfaces)[(note 2)]	-40 dBm, for 9 kHz[(note 3)] $\leq f \leq$ 21.2 GHz[(note 1)] -30 dBm, for 21.2 GHz $< f \leq F_{UPP}$ (see recommend 3) [(note 1) (note 4)]
Fixed Service – Receivers	The same limits as for the transmitters above apply

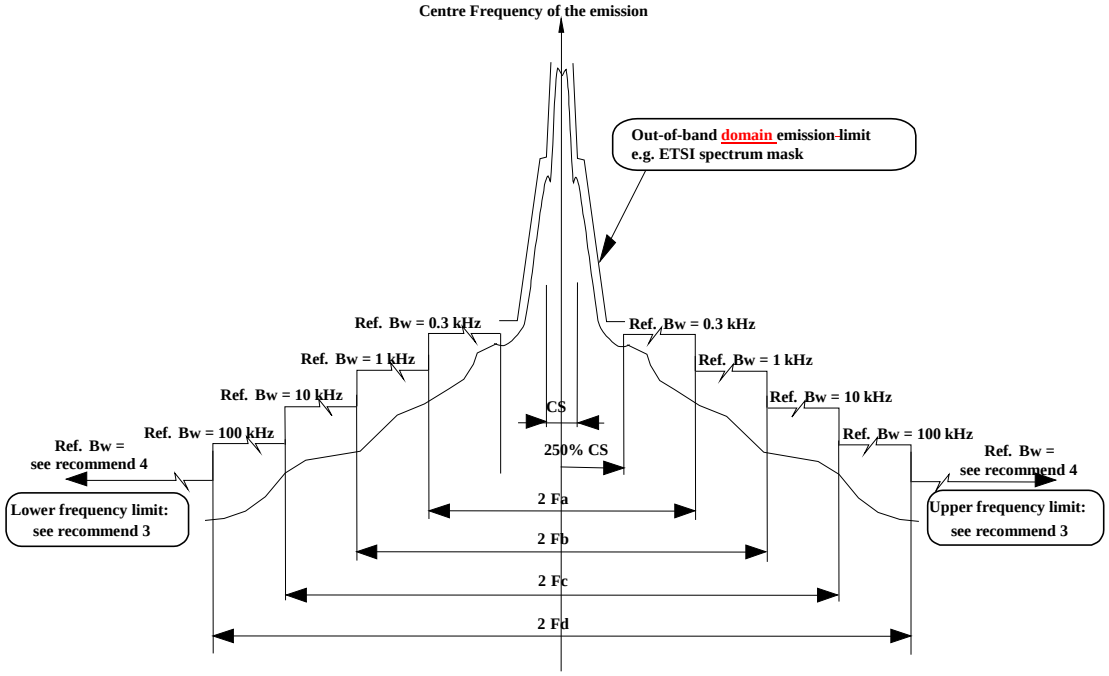
Note 1: For digital systems it is necessary to provide one or more steps of reference bandwidth to produce suitable transition area for the spectral density to manage the required limit because in some frequency bands and/or applications narrow-band RF filters are not technically or economically feasible.
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;

Note 2: Point-to-Multipoint systems used in CEPT countries foresee three kind of stations:
-MS Master (Central) Station (clearly identifiable in SM.329)
-TS Terminal Station (also clearly identifiable in SM.329)
-RS Repeater Station (which is not referred in 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: In ITU-R Recommendation SM.329 from 9 kHz to 30 MHz only Category A limits (i.e. -13 dBm) apply also when Category B is selected, however CEPT will propose revision to SM.329 in order to extend Category B limits down to 9 kHz.

Note 4: 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

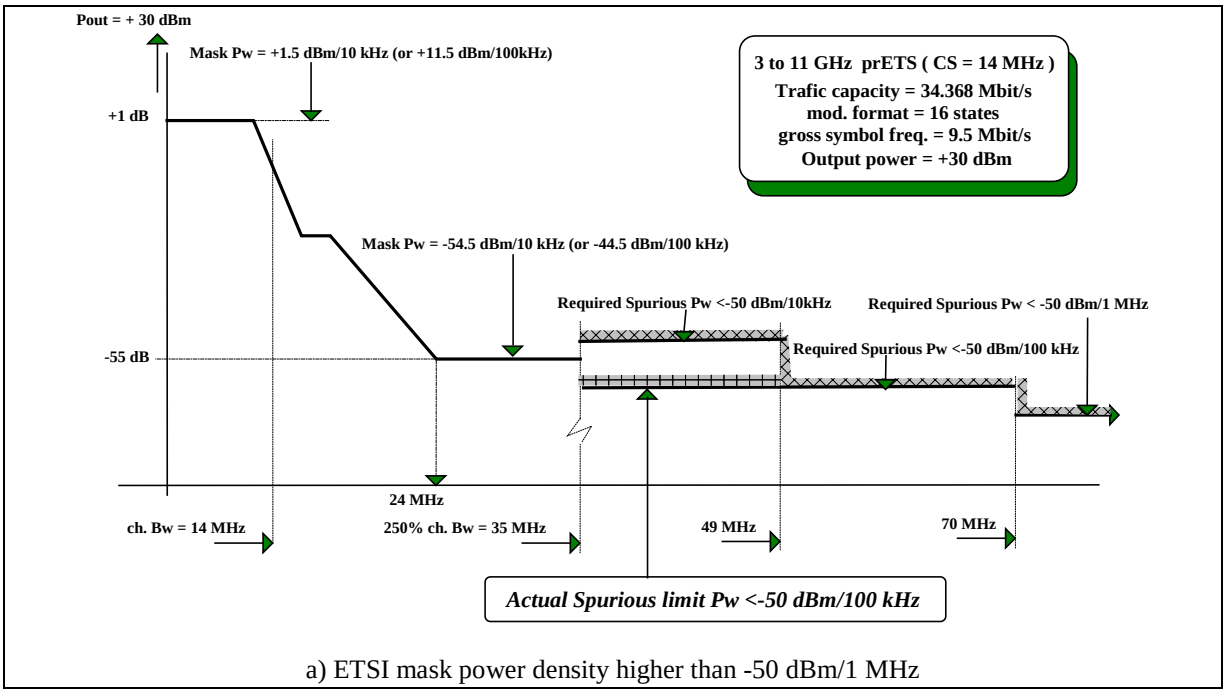
Figure 1.1: Specific mask for spurious domain emission limits (see table 1.2)

Table 1.2

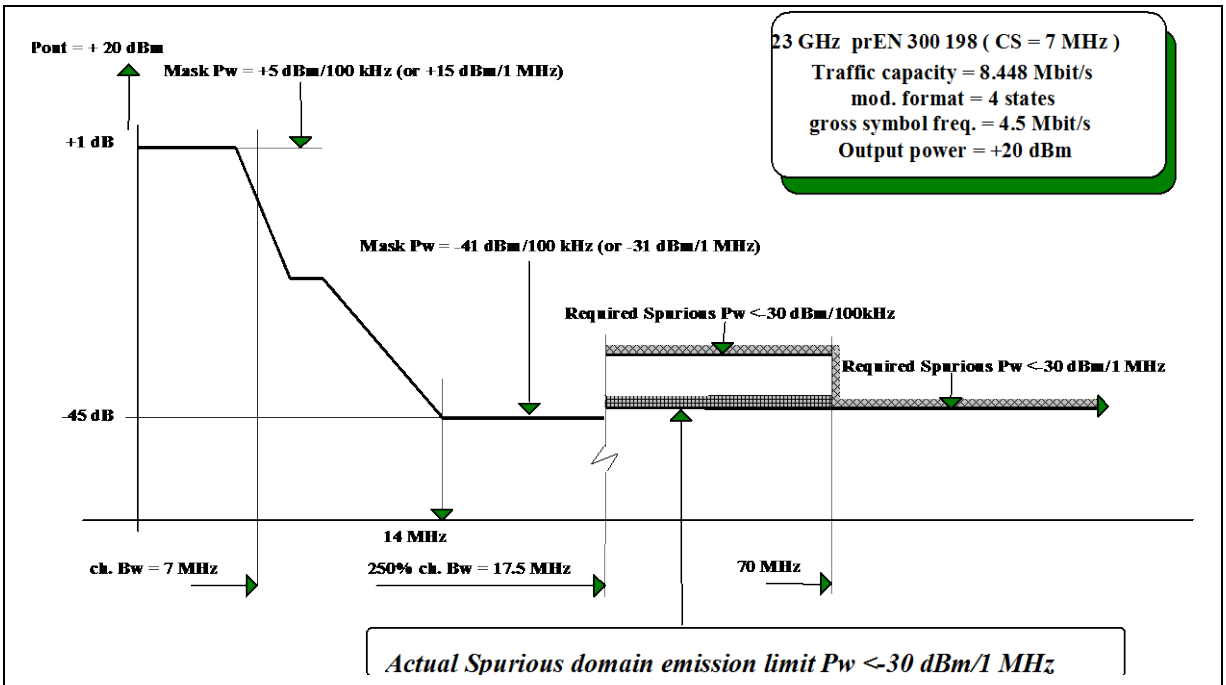
VALUES OF Fa, Fb, Fc AND Fd in Fig. 1.1.						
Fundamental Emission Frequency	**Channel Separation (CS)** (MHz)	**Typical Symbol Frequency** (~Mbit/s)	**Ref. BW 0.3 kHz** Fa* (MHz)	**Ref. BW 1 kHz** Fb* (MHz)	**Ref. BW 10 kHz** Fc* (MHz)	**Ref. BW 100 kHz** Fd* (MHz)
Below 21.2 GHz (Terminal stations)	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)	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	-	-	-	-

(*) : 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 1.2.)



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



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

Figure 1.2: 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)	
Type of equipment	**Limits** mean power or, when applicable, average power during bursts duration in the reference bandwidth
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)
Short range devices, 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)
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)
Receivers and idle/standby transmitters	- 57 dBm, for 9 kHz ≤ f ≤ 1 GHz - 47 dBm, for 1 GHz < f ≤ F_{UPPER} (see recommend 11)
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 mobile services

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 close-in 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).

These masks apply to both mobile terminals and base stations.

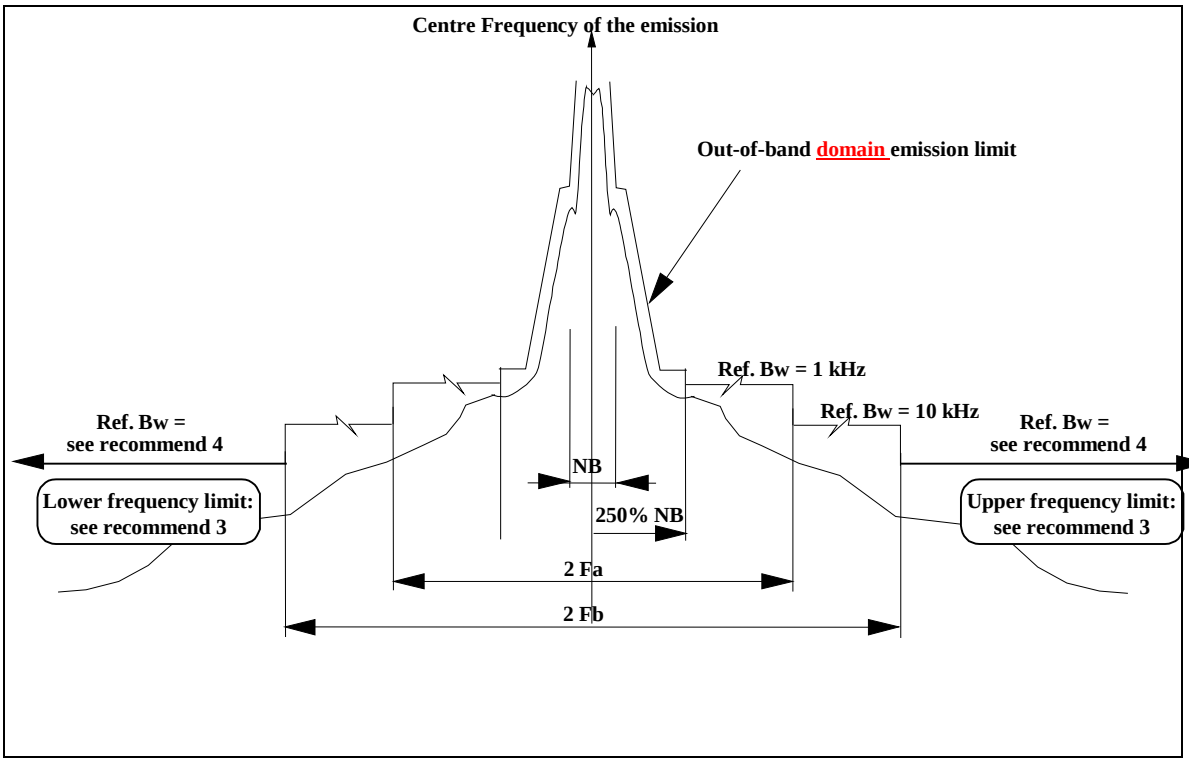


Figure 2.1: Specific mask for spurious domain emissions for mobile services operating between 30 MHz-1 GHz (see Table 2.2)

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

Table 2.2: 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.

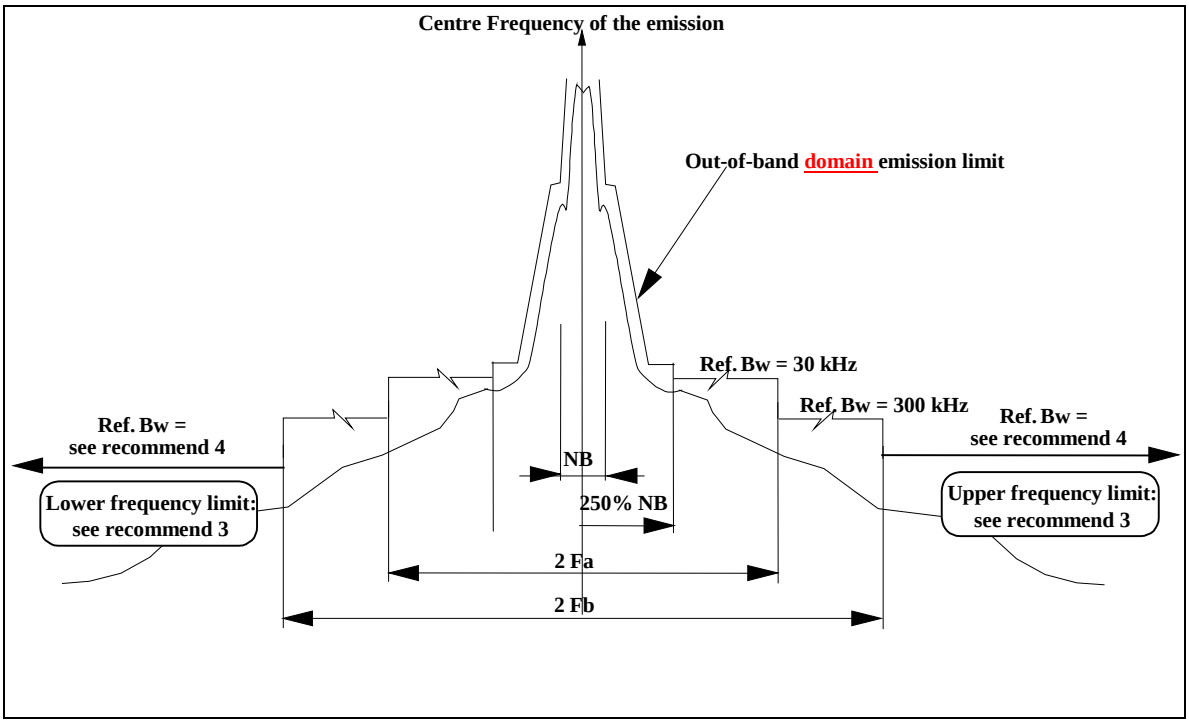


Figure 2.2. Specific mask for spurious domain emissions for mobile services operating above 1 GHz (see Table 2.3)

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

Table 2.3: 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.

ANNEX 3

SPACE SERVICE SPECIFIC REQUIREMENTS

TABLE 3.1

SPURIOUS DOMAIN EMISSION LIMITS FOR SPACE SERVICES	
Type of equipment	**Limits** mean power or, when applicable, average power during burst duration in the reference bandwidth
VSAT (Very Small Aperture Terminal), SNG (Satellite News Gathering) or transportable fixed Earth Stations	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 EIRP, see notes 1, 2 and 3)
VSAT, SNG or transportable fixed Earth Stations in 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 EIRP, see note 1)
Land Mobile Earth Stations 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.
Land Mobile Earth Stations above 1 GHz	The limits for generic terrestrial land mobile systems generally 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.;
Transportable Land Mobile Earth Stations	Under Study
Land Mobile Earth Stations : receivers and standby/idle mode	- 57 dBm, for 9 kHz ≤ f ≤ 1 GHz - 47 dBm, for 1 GHz < f ≤ F_{UPPER} (see recommend 11)
Other Fixed Earth Stations	Relative attenuation limits in Appendix 3 of the Radio Regulations apply. Alignments with VSAT and SNG limits are under consideration.
Space stations (excluding Amateur Satellite Services which are covered under **Annex 6**), Maritime Mobile Earth Stations, Aeronautical Mobile Earth Stations	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 EIRP for off-axis angles greater than 7°.

Note 2: In the frequency band of operation +/- 150 MHz, an EIRP 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 EIRP density at the considered frequency is 50 dB below the maximum on-axis EIRP 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 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.

ANNEX 4

BROADCASTING SERVICE SPECIFIC REQUIREMENTS

TABLE 4.1

SPURIOUS DOMAIN EMISSION LIMITS FOR THE BROADCASTING SERVICE	
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
Broadcasting transmitters below 30 MHz	Limits of Radio Regulations Appendix 3 apply: 50 dBc, without exceeding the absolute mean power of 17 dBm
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
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 require special limits for spurious domain emissions.

Radars used in the radiodetermination service often require high e.i.r.p. to perform their missions and therefore special care is necessary to fulfil the requirements of other services in order to ensure compatibility with services in adjacent bands.

Spurious domain emissions limit for radiodetermination systems should take into consideration the platform type and mission of the radar. 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 ITU-R Recommendation 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 ITU-R Rec. M.1177.

The limits in the 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 radars, which are considered being SRD, are not subject to requirements of this annex; SRD limits in Annex 2 should apply.

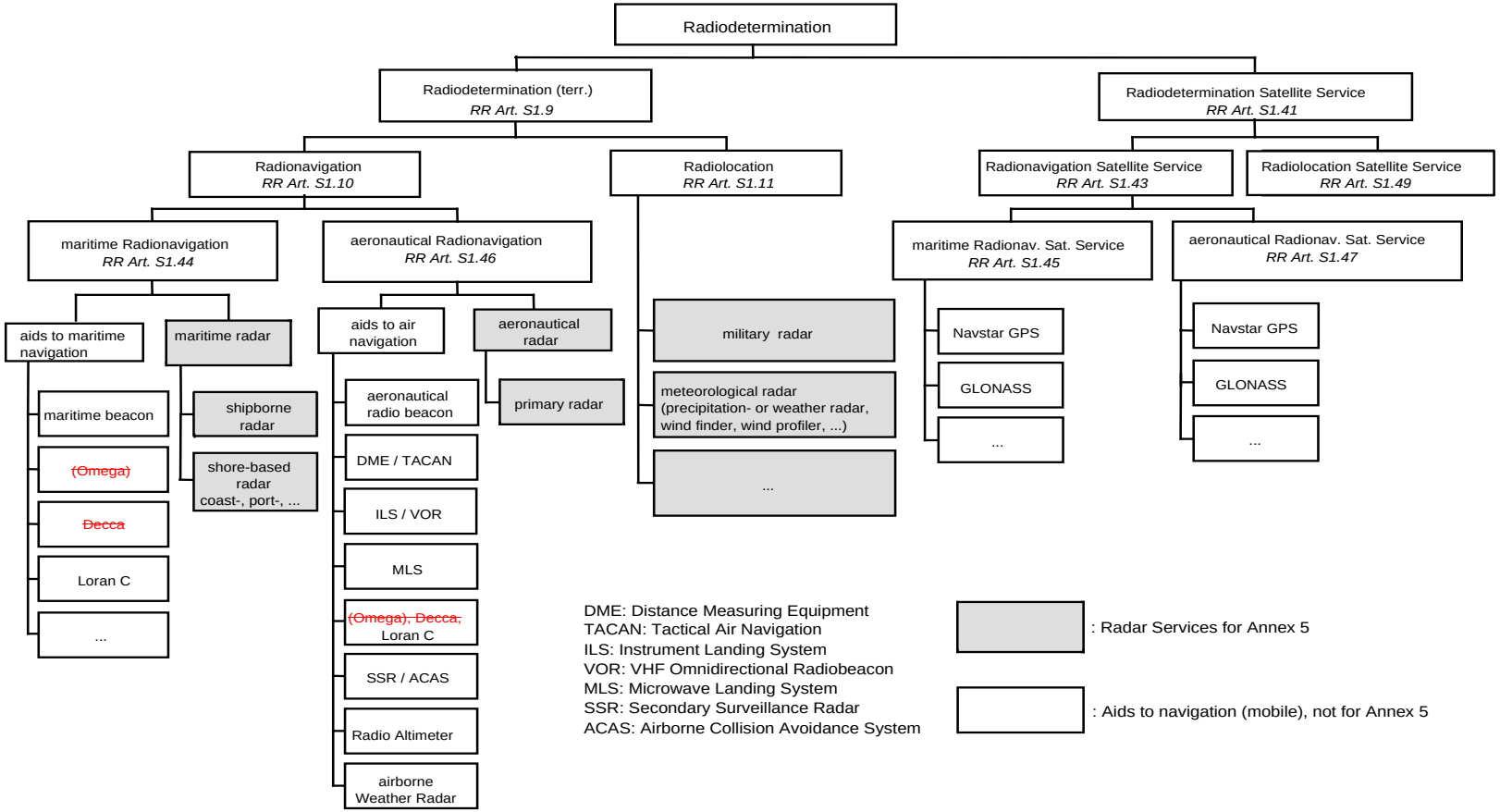
Table 5.1

SPURIOUS DOMAIN EMISSIONS LIMITS FOR RADAR SYSTEMS IN THE RADIODETERMINATION SERVICE[5]	
Type of Radars for radiodetermination	**Limits** Absolute levels (dBm) or Attenuation (dB) below the power supplied to the antenna port
Fixed stations[6] (wind profiler, multi-frequency, and active array radars are excluded[7])	PEP in the reference bandwidth: -30 dBm or 100 dB , whichever is less stringent
All other types of radar for radiodetermination	(43 + 10·log(PEP)), or 60 dB, whichever is less stringent these limits may be expressed in absolute PEP level in the reference bandwidth as: -13 dBm, where PEP ≤ 50 W (10·log(PEP) - 30) dBm, where PEP > 50 W
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.

5 Spurious domain emission limits in table 5.1 above apply to transmitters installed after 1 January 2006.
6 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.
7 Further study is needed, any interference will be handled on a case by case basis.

Fig. 5.1 Overview of Services in the Radiodetermination Service



ANNEX 6

SPECIFIC REQUIREMENTS FOR AMATEUR SERVICES (INCLUDING AMATEUR SATELLITE SERVICE)

Table 6.1

SPURIOUS DOMAIN EMISSION LIMITS FOR AMATEUR SERVICE	
Type of equipment	**Limits** Attenuation (dB) below the power supplied to the antenna port
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.
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.
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.
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.
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.
Space based Amateur satellite stations	Relative attenuation limits specified in Appendix 3 of 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)

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 SSB are included in the category "SSB".

ANNEX 7 (INFORMATIVE)

THRESHOLD LEVELS OF INTERFERENCE FOR THE RADIO ASTRONOMY SERVICE AND SPACE SERVICES USING PASSIVE SENSORS

This annex reproduces the content of **Annex 3** of ITU-R Recommendation SM.329. When further information is required, the latest version of that Recommendation should be consulted.

1 Introduction

Threshold levels of interference for the radio astronomy service, Earth exploration-satellite and meteorological-satellite services using passive sensors can be found in Recommendations ITU-R RA.769 and SA.1029. This Annex summarises the levels provided in these Recommendations.

2 Radio astronomy service (Recommendation ITU-R RA.769)

Table 7.1 gives the threshold levels of power flux density (pfd) and spectral power flux density (spfd) for interference detrimental to the radio astronomy service. These are calculated for observations with a single antenna and reception in sidelobes of gain 0dBi and an integration time of 2000 sec. The values of pfd and spfd given in **Table 7.1** apply generally, except for GSO satellites for which the pfd is 15 dB more stringent than shown (see Recommendation ITU-R RA.769-1).

Annex 1 to Recommendation ITU-R RA.769 describes the methodology for calculating the sensitivity of various radio astronomy systems currently in use. It also provides, for assumed values of system parameters, tabulated levels of aggregate interference which are detrimental to both continuum and spectral-line measurements for various bands allocated to the radio astronomy service.

The assumed parameters used to derive these levels are representative of many types of radio astronomy systems and measurements and are an agreed acceptable standard within the radio astronomy service. However, there may be circumstances in coordination with a specific radio astronomy system, operating at a particular time and location in a particular band, where other values of these parameters may be used with the same methodology to derive a more appropriate level of detrimental interference. In addition, for consideration of interference from specific types of systems (e.g. GSO satellites or multiple-satellite systems) a systematic adjustment of the levels in Recommendation ITU-R RA.769 may be warranted. Accordingly, when the levels contained in Table 7.1 are applied or referred to, account should be taken of the assumptions used to derive them.

	Continuum observations		Spectral lines observations	
Radio astronomy band[1] (MHz)	PFD (dB(W/m[2])	Assumed bandwidth (MHz)	PFD (dB(W/m[2])	Assumed spectral line channel bandwidth (kHz)
13.36-13.41	–201	0.05	[2]	[2]
25.55-25.67	–199	0.120	[2]	[2]
73.0-74.6	–196	1.6	[2]	[2]
150.05-153.0	–194	2.95	[2]	[2]
322.0-328.6	–189	6.6	–204	10
406.1-410.0	–189	3.9	[2]	[2]
608-614	–185	6	[2]	[2]
1 400-1 427	–180	27	–196	20
1 610.6-1 613.8	[3]	[3]	–194	20
1 660-1 670	–181	10	–194	20
2 690-2 700	–177	10	[2]	[2]
4 990-5 000	–171	10	[2]	[2]
(GHz)				
10.6-10.7	–160	100	[2]	[2]
15.35-15.4	–156	50	[2]	[2]
22.21-22.5	[3]	[3]	–162	250
23.6-24.0	–147	400	–161	250
31.3-31.8	–141	500	[2]	[2]
42.5-43.5	–137	1 000	–153	500
86-92	–125	6 000	–144	1 000
105-116	–121	11 000	–141	1 000
164-168	–120	4 000	[2]	[2]
182-185	[3]	[3]	–136	1 500
217-231	–114	14 000	–133	2 500
265-275	–113	10 000	–131	2 500

Table 7.1: Threshold levels of power flux density and spectral power flux density of interference detrimental to the radio astronomy service

* The levels are calculated under specific assumptions given in Recommendation ITU-R RA.769, in particular with an integration time of 2 000 s.

(1) These are the frequency bands listed in Recommendation ITU-R RA.769; eight further bands are allocated to the radio astronomy service on a primary basis via RR No. S5.555. Allocation to the RAS above 71 GHz have been changed by WRC-00. Rec ITU-R RA.769 is under revision and will contain the new allocation in future. The bands and the pfd values contained in the lower 6 lines of the Table are an information of the trend, only.

(2) Not listed in Table 2 of Recommendation ITU-R RA.769.

(3) Not listed in Table 1 of Recommendation ITU-R RA.769.

The conversion from power flux density to other power units may be found in **Table 7.3.**

3 Earth Exploration-Satellite and Meteorological-Satellite passive sensing (ITU-R Rec. SA.1029)

The permissible interference levels given in Table 7.2 are based on Recommendation ITU-R SA.1029. They refer to power levels at the receiver input and do not include characteristics of the receiving antenna. The gain of the receiving antenna may be inferred from the values of resolution (km) given in Table 2 of Recommendation ITU-R SA.515 and the knowledge that a typical orbital altitude for spaceborne remote sensors can be taken as 500 km. Note that for spaceborne remote sensing, the sensor antenna is normally directed at the Earth's surface. Note that the levels in Table 7.2 are described as permissible in the context that they meet the interference criteria of passive sensors. However, use of permissible may not necessarily conform with a strict regulatory definition.

Frequency (GHz)	Interference level (dBW)	Interference reference bandwidth (MHz)
1.4-1.427	–171	27
2.69-2.7	–174	10
4.2-4.4	–161	100
6.5-6.7	–164	100
10.6-10.7	–163	20
15.2-15.4	–166	50
18.6-18.8	–155(1)	100
21.2-21.4	–163	100
22.21-22.5	–160	100
23.6-24	–163	100
31.3-31.8	–163	100
36-37	–156	100
50.2-50.4	–161/–166(2)	100
52.6-59	–161/–166(2)	100
60.3-61.3	–161/–166(2)	100
86-92	–153	200
100-102	–160	200
105-126	–160	200
150-151	–160	200
155.5-158.5	–160	200
164-168	–160	200
175-192	– 160	200
200-202	– 160	200
217-231	– 160	200
235-238	– 160	200
250-252	– 160	200
275-277	– 160	200
300-302	– 160	200
324-326	– 160	200
345-347	– 160	200
363-365	– 160	200
379-381	– 160	200

Table 7.2 : Permissible interference level at the receiver input

(1) This value is under study.

(2) Second number for push-broom sensors.

4 Conversion table for radiated power

EIRP	EIRP	EIRP	EIRP	ERP	E field Free Space	E field max OATS*	pfd Free Space	pfd max OATS*
dBm	nW	dBpW	dBW	dBm	dBµV/m at 10 m	dBµV/m at 10 m	dBW/m² at 10 m	dBW/m² at 10 m
-90	0.001	0	-120	-92.15	-5.2	-1.2	-151.0	-147.0
-80	0.01	10	-110	-82.15	4.8	8.8	-141.0	-137.0
-70	0.1	20	-100	-72.15	14.8	18.8	-131.0	-127.0
-60	1	30	-90	-62.15	24.8	28.8	-121.0	-117.0
-50	10	40	-80	-52.15	34.8	38.8	-111.0	-107.0
-40	100	50	-70	-42.15	44.8	48.8	-101.0	-97.0
-30	1000	60	-60	-32.15	54.8	58.8	-91.0	-87.0
-20	10000	70	-50	-22.15	64.8	68.8	-81.0	-77.0
-10	100000	80	-40	-12.15	74.8	78.8	-71.0	-67.0
0	1000000	90	-30	-2.15	84.8	88.8	-61.0	-57.0

Table 7.3: Correspondence between EIRP, ERP, field strength E and power flux density PFD

* OATS = Open Area Test Site

Note: For background on conversion relationships, see Annex 1 of ITU-R SM.329-9.

ANNEX 8 (INFORMATIVE)

AGREEMENTS FOR ETSI STANDARDS OUTSIDE THE SCOPE OF THIS RECOMMENDATION

1. **Systems designed under the assumption of draft EN301166: "Electromagnetic compatibility and Radio Matters (ERM); Land Mobile Service; Technical characteristics and test conditions for radio equipment for analogue and/or digital communication (speech and/or data) and operating on narrowband channels and having an antenna connector".**

   For these narrow band systems the value of the frequency limit Fa referred in **Figure 2.1**, may be extended to a value not exceeding 250 kHz.

   This special case is allowed until 2003. At this date, CEPT and ETSI will review, and if necessary revise, the standard in line with recommends 8 and the CEPT/ETSI MoU before removing the special case.

2. **The ETSs reported below have fixed masks which were based upon first generation, narrowband techniques and which are now impossible to re-define in the form of variable masks of the table 3.1:**

   2.1 Satellite Earth Stations and Systems (SES); Low data rate Land Mobile satellite Earth Stations (LMES) operating in the 1,5/1,6 GHz frequency bands.

   The limits in ETS 300 254, and any TBRs and CTRs based on this ETS, do not have to comply with the limits given in the **Table 3.1**.

   2.2 Satellite Earth Stations and Systems (SES); Land Mobile Satellite Earth Stations (LMESs) operating in the 1,5/1,6 GHz bands providing voice and/or data communications.

   The limits in ETS 300 423, and any TBRs and CTRs based on this ETS, do not have to comply with the limits given in the **Table 3.1**.

3. **Until appropriate limits for Mobile Earth Stations above 1 GHz are defined, the limits given in the ETSs reported below should be applied in the relevant bands. It is anticipated that the limits in these ETSs will form the starting point for the development of appropriate limits and in due course these special cases will be removed:**

   3.1 Satellite Earth Stations and Systems (SES); Satellite Personal Communications Networks (S-PCN); Mobile Earth Stations (MESs) including handheld earth stations, for S-PCN in the 1,6/2,4 GHz bands, providing voice and/or data communications under the Mobile Satellite Service (MSS).

   The limits in ETS 300 733, and any TBRs and CTRs based on this ETS, do not have to comply with the limits given in the **Table 3.1**.

   3.2 Satellite Earth Stations and Systems (SES); Satellite Personal Communications Networks (S-PCN); Mobile Earth Stations (MESs) including handheld earth stations, for S-PCN in the 2.0 GHz bands, providing voice and/or data communications under the Mobile Satellite Service (MSS).

   The limits in ETS 300 734, and any TBRs and CTRs based on this ETS, do not have to comply with the limits given in the **Table 3.1**.