RECOMMENDATION ITU-R SM.1539

Variation of the boundary between the out-of-band and spurious domains required for the application of Recommendations ITU-R SM.1541 and ITU-R SM.329

(Question ITU-R 211/1)

(2001)

The ITU Radiocommunication Assembly,

considering

a) that Recommendations ITU-R SM.1541 and ITU-R SM.329 give the definitions of the terms "out-of-band domain" and "spurious domain", but that these definitions do not precisely specify the boundary between the out-of-band (OoB) and spurious domains;

b) that the boundary between the OoB and spurious domains is important for the application of both Recommendations ITU-R SM.1541 and ITU-R SM.329;

c) that the boundary between the OoB and spurious domains is, in general, a function of the necessary bandwidth, but may be functions of different parameters other than the necessary bandwidth in certain applications;

d) that the boundary between the OoB and spurious domains may require variations, in particular, for narrow-band and wideband transmissions, as well as for primary radars,

noting

that, according to Recommendations ITU-R SM.1541 and ITU-R SM.329, normally the boundary between the OoB and spurious domains is the frequency separated from the centre frequency of the emission by 250% of the necessary bandwidth of the emission (see Note 1),

recommends

1 that Annex 1 should be referred to in the case of variation of the boundary between the OoB and spurious domains which may be required for the application of Recommendations ITU-R SM.1541 and ITU-R SM.329 (see Note 2).

NOTE 1 – Recommendation ITU-R SM.1138, which is incorporated by reference into the Radio Regulations (RR), deals with the determination of necessary bandwidth for various emissions. Recommendation ITU-R SM.853 presents additional information concerning the determination of necessary bandwidth for certain emissions, including unmodulated pulse emissions and some digital modulation.

In addition, Recommendations ITU-R SM.1541 (*recommends* 2.3) and ITU-R SM.329 (*further recommends* 1.4 and 2.3) discuss the necessary bandwidth for certain emissions for the purpose of determining the boundary between the OoB and spurious domains.

NOTE 2 – Further study is required in order to extract elements from Recommendations ITU-R SM.1541 and ITU-R SM.329 which are commonly used for the application of these Recommendations and to transfer them to this Recommendation.

ANNEX 1

Variation of the boundary between the OoB and spurious domains

1 Introduction

As stated in *recommends* 2.3 of Recommendation ITU-R SM.1541 and *further recommends* 2.3 of Recommendation ITU-R SM.329, the boundary between the OoB and spurious domains, which is generally specified as being separated from the centre frequency by 250% of the necessary bandwidth, needs to be modified for narrow-band and wideband (including multicarrier) systems, and certain other situations. This Annex provides:

– a set of guidelines on values of bandwidths across the spectrum at which the general definition needs to be varied; and

– a set of known situations in which additional guidelines are required.

2 Boundary variations for narrow-band and wideband systems

For the definition of necessary bandwidth, its applicability to multichannel or multicarrier transmitters/transponders, and its use in the fixed and radiodetermination services, see *further recommends* 1.4 of Recommendation ITU-R SM.329.

Figure 1 shows the spurious boundary as a function of necessary bandwidth, indicating the boundary variations. The normal separation between the centre frequency and the spurious domain boundary is 250% of the necessary bandwidth, as shown in Fig. 1 between the vertical dashed lines.

For some narrow-band emissions, it is appropriate to avoid specifying OoB and spurious domains in very narrow bandwidths near to the emission, which will usually be under the control of the same operator. On the other hand, it is necessary to restrict the linear growth of the OoB domain versus necessary bandwidth for wideband emissions, in order to restrict the incursion of the OoB domain into adjacent bands.

Figure 1 shows how the boundary is determined for the narrow-band and wideband cases. When the necessary bandwidth of the emission is less than the lower threshold value B_L, the boundary is a constant 2.5 B_L. Conversely, when the necessary bandwidth exceeds the upper threshold value B_U, the boundary increases at a lower rate, having a value of 1.5 B_N + B_U. Table 1 shows the formulae for the narrow-band, normal and wideband cases.

FIGURE 1

Spurious domain boundary as a function of necessary bandwidth

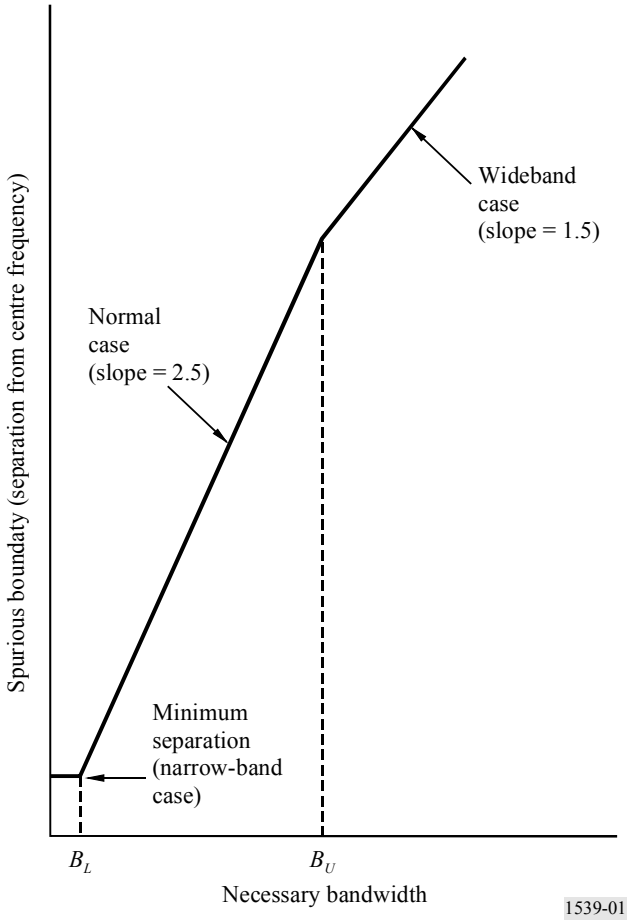

TABLE 1

Type of emission	**If necessary bandwidth B_N is**	**Frequency separation between the centre frequency and the spurious boundary**
Narrow-band case	$< B_L$	2.5 B_L
Normal case	B_L to B_U	2.5 B_N
Wideband case	$> B_U$	$B_U + 1.5\ B_N$

It should be noted that Table 1 can apply to asymmetric emissions, since the offset is specified based on the centre of the necessary bandwidth. For situations where the boundary is not defined in terms of necessary bandwidth, see § 3.

In the case of narrow-band and wideband systems, the variation of the spurious boundary also affects the OoB masks specified in Recommendation ITU-R SM.1541. This is covered in § 5 of *recommends* of Recommendation ITU-R SM.1541.

Table 2 provides guidance for determining general values of separation between the centre frequency of an emission and the beginning of its spurious domain. A minimum separation applies to the narrow-band case, while the normal and wideband cases have separate formulae for determining the boundary.

TABLE 2

Guideline values for frequency separation between the centre frequency and the boundary of the spurious domain

Frequency range	Narrow-band case		Normal separation (B_N)	Wideband case	
	For $B_N <$	Separation		For $B_N >$	Separation
9 kHz < f_c < 150 kHz	250 Hz	625 Hz	2.5	10 kHz	1.5 B_N + 10 kHz
150 kHz < f_c < 30 MHz	4 kHz	10 kHz	2.5	100 kHz	1.5 B_N + 100 kHz
30 MHz < f_c < 1 GHz	25 kHz	62.5 kHz	2.5	10 MHz	1.5 B_N + 10 MHz
1 GHz < f_c < 3 GHz	100 kHz	250 kHz	2.5	50 MHz	1.5 B_N + 50 MHz
3 GHz < f_c < 10 GHz	100 kHz	250 kHz	2.5	100 MHz	1.5 B_N + 100 MHz
10 GHz < f_c < 15 GHz	300 kHz	750 kHz	2.5	250 MHz	1.5 B_N + 250 MHz
15 GHz < f_c < 26 GHz	500 kHz	1.25 MHz	2.5	500 MHz	1.5 B_N + 500 MHz
f_c > 26 GHz	1 MHz	2.5 MHz	2.5	500 MHz	1.5 B_N + 500 MHz

NOTE 1 – In Table 2, f_c is the centre frequency of the emission. If the assigned frequency band of the emissions extends across two frequency ranges, then the values corresponding to the higher frequency range may be used for the whole assignment.

NOTE 2 – For situations in which the above guidelines are not applicable, additional guidelines are provided in § 3.

NOTE 3 – Further studies need to be conducted within the ITU-R to confirm the values of frequency separation in Table 2.

Example 1: The necessary bandwidth of an emission at 26 MHz is 1.8 kHz. Since 2.5 B_N is only 4.5 kHz, the minimum separation applies. The spurious domain begins 10 kHz each side of the centre of the necessary bandwidth.

Example 2: The necessary bandwidth of an emission at 8 GHz is 200 MHz. Since the wideband case applies for B_N > 100 MHz at that frequency, the spurious domain begins 400 MHz each side of the centre of the necessary bandwidth. Using the general separation formula, the OoB domain would have extended to 2.5 × 200 MHz = 500 MHz either side of the centre frequency.

3 Situations where additional guidelines are required

The above guidelines are suitable for general application but specific cases where further guidelines are necessary are given in the following sections.

3.1 Situations where the boundary is not defined in terms of necessary bandwidth

Some systems specify OoB emissions relative to channel bandwidth, or channel spacing. These may be used as a substitute for the necessary bandwidth in § 2, provided they are found in ITU-R Recommendations.

3.2 Particular service types and bands

The values of frequency separation in Table 2 are selected to cover most, but not all situations. Rather than set those values at the worst case in each range, it is more realistic to use a more stringent value, and list those cases requiring different values separately. Tables 3 and 4 show those cases which have been identified.

TABLE 3

Narrow-band variations for systems or services and frequency bands

System or service	Frequency range	Narrow-band case	
		For $B_N <$ (kHz)	Separation (kHz)
Fixed service	14 kHz-1.5 MHz	20(1)	50
Fixed service	1.5-30 MHz	80(2)	200

(1) This is based on an assumption that the maximum value of the necessary bandwidth is about 3 kHz for the frequency range 14 kHz-1.5 MHz. The value of 50 kHz separation is extremely large as compared with the necessary bandwidth. It is because unwanted emissions of high power transmitters under modulated conditions have to be below the spurious limit (70 dBc) at the boundary between the OoB and spurious domains.

(2) This is based on an assumption that the maximum value of the necessary bandwidth is about 12 kHz for the frequency range 1.5-30 MHz. The value of 200 kHz separation is extremely large as compared with the necessary bandwidth. It is because unwanted emissions of high power transmitters under modulated conditions have to be below the spurious limit (70 dBc) at the boundary between the OoB and spurious domains. Also, if future systems in the fixed service operating in this frequency range require a necessary bandwidth larger than 12 kHz, it may become necessary to review the 200 kHz separation. It should be noted that for medium or low power transmitters (e.g. below 1 kW), a smaller value may be appropriate as the minimum separation. This matter requires further study.

TABLE 4

Wideband variations for systems or services and frequency bands

System or service	Frequency range	Wideband case	
		For $B_N >$	Separation
Fixed service	14-150 kHz	20 kHz	1.5 B_N + 20 kHz
FSS	3.4-4.2 GHz	250 MHz	1.5 B_N + 250 MHz
FSS	5.725-6.725 GHz	500 MHz	1.5 B_N + 500 MHz
FSS	7.25-7.75 GHz and 7.9-8.4 GHz	250 MHz	1.5 B_N + 250 MHz
FSS	10.7-12.75 GHz	500 MHz	1.5 B_N + 500 MHz
BSS	11.7-12.75 GHz	500 MHz	1.5 B_N + 500 MHz
FSS	12.75-13.25 GHz	500 MHz	1.5 B_N + 500 MHz
FSS	13.5-14.8 GHz	500 MHz	1.5 B_N + 500 MHz

FSS: fixed-satellite service
BSS: broadcasting-satellite service

3.3 Primary radars in the radiodetermination and other services

According to *further recommends* 2.3 of Recommendation ITU-R SM.329, the spurious domain emission generally begins at a frequency separation equal to 250% of the necessary bandwidth, with exceptions for certain kinds of systems, including those with digital or pulsed modulation. RR Appendix 3 includes similar provisions. However, it is difficult to apply the general boundary concept of 250% of the necessary bandwidth to primary radar stations in the radiodetermination and other services, such as the meteorological aids service, the space research service, and the Earth exploration-satellite service.

For the case of primary radar systems the OoB mask rolls off at 20 dB per decade from the 40 dB bandwidth to the spurious limit specified in Table 2 of Recommendation ITU-R SM.329. The detailed definition of the OoB/spurious domain boundary is contained in Annex 8 of Recommendation ITU-R SM.1541.

The above specification of the boundary is the subject of ongoing ITU studies with a design objective of 40 dB per decade roll-off from the 40 dB bandwidth.

These studies should be completed before the 2006 Radiocommunication Assembly.