Electronic Communications Committee (ECC)

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

Revised ECC RECOMMENDATION (02)05

UNWANTED EMISSIONS

Recommendation approved by the Working Group "Spectrum Engineering" (SE)

INTRODUCTION

Between 1996 and 2003, ITU-R Study Group 1 has developed and adopted a number of new or revised Recommendations dealing with unwanted emissions. These Recommendations cover spurious and out-of-band (OOB) emissions, the boundary between the spurious and out-of-band domains, intermodulation, OOB falling into adjacent bands, a description of spectra and bandwidth of emissions for modern modulation schemes. Special attention was also paid to the protection of Passive and Safety Services from unwanted emissions.

The aim of this Recommendation is to give guidance about the use of the whole package of ITU-R Recommendations and their relation to the ERC Recommendation 74-01 on spurious emissions. This Recommendation on Unwanted Emissions does not contain special limits for spurious or OOB domain emissions except those in Annex 2. Fig. 2 illustrates the frame or "roof" concept of this Recommendation.

Unwanted emissions are composed of OOB and spurious emissions. Definition relating to unwanted emission, out-of-band domain and spurious domain are given in Article 1, No. **1.144, 1.146bis**, and **1.146ter** of the RR. OOB and spurious emissions as defined there are outside the necessary bandwidth. Appendix 3 of the RR (WRC-2003) provides limits for unwanted emissions falling into the spurious domain and describes the variation of the boundary between the out-of-band and the spurious domains. Terminology and relevant definitions are given in Recommendation ITU-R SM.329. They are reproduced in Annex 1 for information and are illustrated in Figure 1 below.
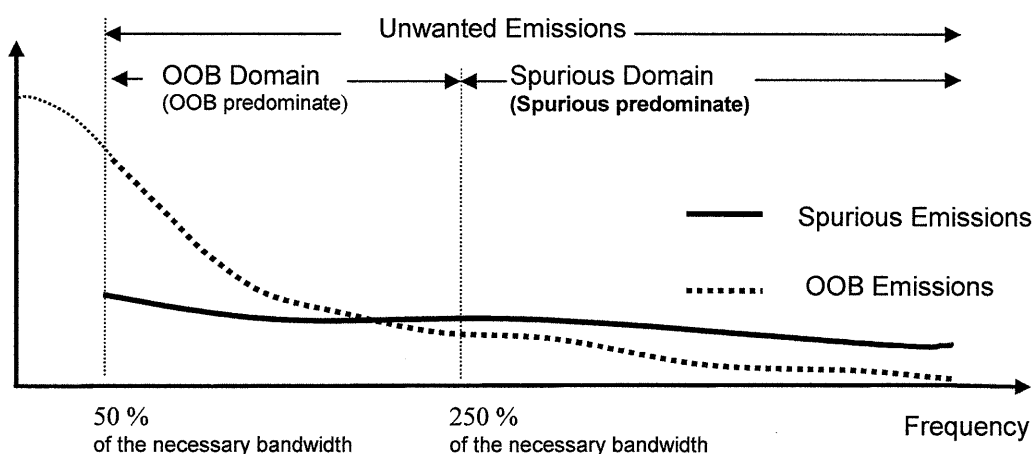
Figure 1: Illustration of the OOB and Spurious Domains (not part of Rec. ITU-R SM.329)

Note: The crossover point between OOB and Spurious emissions is not defined and Figure 1 shows only an example.

Additionally, Resolution 739 (WRc-07) provides threshold levels for the unwanted emissions of space services to ensure compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands based on results given in Recommendation ITU-R SM.1633.

These definitions reflect more exactly the scope of the ITU-R Rec. SM.329 and Rec. SM.1541, which address "unwanted emissions in the spurious domain" and "unwanted emissions in the out-of-band domain" respectively.
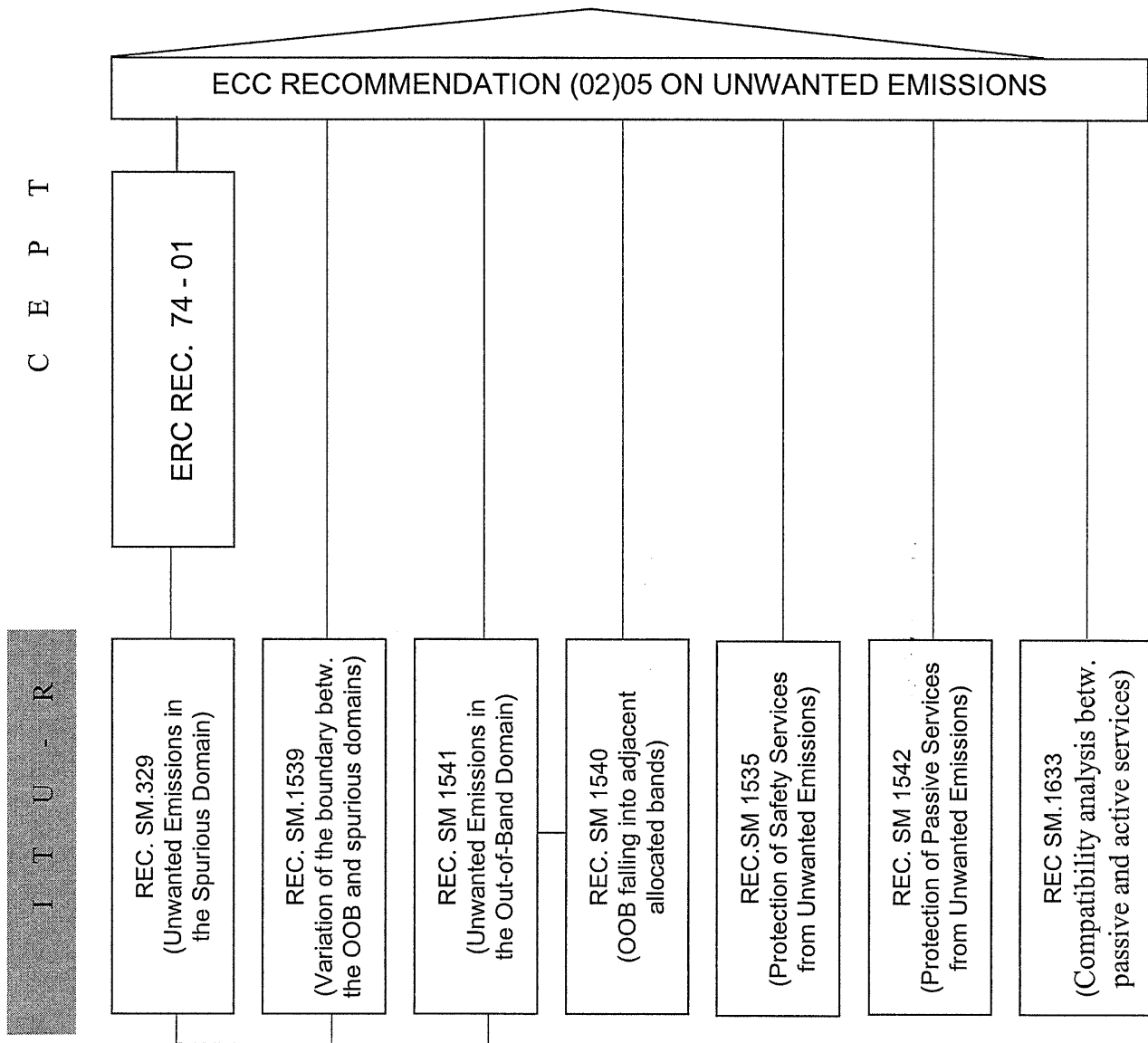

Figure 2: Frame or "roof" structure of this ECC Recommendation

"The European Conference on Postal and Telecommunications Administrations,

considering

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

b) that a number of ITU-R Recommendations are available for protection of other radio systems and services from unwanted emissions;

c) that Recommendation ITU-R SM.329 (Unwanted Emission in the Spurious Domain) relates to effects, measurements, generic and specific regional limits to be applied to unwanted emissions in the spurious domain;

d) that Recommendation ITU-R SM.1541 (Unwanted Emissions in the Out-of-band Domain) relates to effects, measurements and broadly generic limits to be applied to unwanted emissions in the out-of-band domain;

e) that Recommendations ITU-R SM.329 and SM.1541 provide guidance for determining the boundary between the out-of-band and spurious domains in a transmitted radio frequency spectrum;

f) that Recommendation ITU-R SM.1539 deals with variation of the boundary between the out-of-band and spurious domains required for the application of the Recommendations ITU-R SM.329 and SM.1541;

g) that Recommendation ITU-R SM.1540 covers unwanted emissions in the out-of-band domain falling into adjacent allocated bands;

h) that the protection of Passive Services is covered by Recommendation ITU-R SM.1542;

i) that the protection of Safety Services is covered by Recommendation ITU-R SM.1535;

j) that Recommendations ITU-R SM.1633 addresses a number of compatibility analyses between active and passive services;

k) that Recommendation ITU-R SM.326 deals with intermodulation products generated in amplitude-modulated radio transmitters;

l) that Recommendation ITU-R SM.1446 deals with definition and measurement of intermodulation products in transmitters using frequency, phase or complex modulation techniques and related background information and mitigation techniques are provided in the ITU-R Report SM.2021;

m) that Recommendation ITU-R SM.328 gives definitions and explanatory notes which should be used when dealing with spectra and bandwidth of emissions;

noting

that the limits for unwanted emissions in the out-of-band domain (out-of-band domain emission limits) as given in Rec. ITU-R SM 1541, are only generic "safety net limits", since they generally constitute the least restrictive out-of-band domain emission limits that have been successfully implemented in national or regional regulations.

recommends

1) that the ITU-R Recommendations on unwanted emissions should be used as general guidance;

2) that the limits for unwanted emissions in the spurious domain (spurious domain emission limits) should be according to the ERC Recommendation 74-01 that corresponds to the Category B limits in Rec. ITU-R SM.329 and has been derived taking into account ETSI standards;

3) that the variation of the boundary between out-of-band and spurious domains should be established according to Rec. ITU-R SM.1539, with the exception of Radar systems designed for Category B spurious domain emission limits, for which guidance is provided in Annex 2 of this recommendation;

4) that Rec. ITU-R SM.1535 and SM.1542 should be used for guidance on generic mitigation techniques for reduction of unwanted emissions;

5) that Resolution 739 (WRC-03) should be used to provide threshold levels for the unwanted emissions of space services to ensure compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands, and to provide a consultation procedure between concerned administrations in case these levels were not met;

6) that Recommendation ITU-R SM.1633 should be used for compatibility analyses between passive services and active space services in certain adjacent and nearby frequency bands and for mitigation techniques to ensure compatibility between these services."

Note:
Please check the Office web site(http//:www.ero.dk) for the up to date position on the implementation of this and other ERC / ECC recommendations.

Annex 1 (informative)

TERMINOLOGY AND DEFINITIONS USED IN ITU-R REC. SM.329

The following terms and definitions complement those already defined in the Radio Regulations (RR). Definitions shown in *italics* are a direct quotation from the RR.

1   Spurious emission (Article 1, No. 1.145 of the RR)

Emission on a frequency, or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

1.1   Harmonic emissions

Spurious emissions at frequencies which are whole multiples of the centre frequency emissions.

1.2   Parasitic emissions

Spurious emissions, accidentally generated at frequencies which are independent both of the carrier or characteristic frequency of an emission and of frequencies of oscillations resulting from the generation of the carrier or characteristic frequency.

1.3   Intermodulation products

Spurious intermodulation products result from intermodulation between:

- the oscillations at the carrier, characteristic, or harmonic frequencies of an emission, or the oscillations resulting from the generation of the carrier or characteristic frequency; and

- oscillations of the same nature, of one or several other emissions, originating from the same transmitting system or from other transmitters[1] or transmitting systems.

1.4   Frequency conversion products

Spurious emissions, not including harmonic emissions, at the frequencies, or whole multiples thereof, or sums and differences of multiples thereof, of any oscillations generated to produce the carrier or characteristic frequency of an emission.

2   Out-of-band emission (Article 1, No. 1.144 of the RR)

Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

3   Unwanted emissions (Article 1, No. 1.146 of the RR)

Consist of spurious emissions and out-of-band emissions.

4   Out-of-band and Spurious domains

Out-of-band and spurious domain emission limits apply, respectively, to all unwanted emissions in the out-of-band and spurious domains.

4.1   Out-of-band domain (Article 1, No. 1.146 bis of the RR)

(of an emission): The frequency range, immediately outside the necessary bandwidth but excluding the spurious domain, in which out-of-band emissions generally predominate.

4.2   Spurious domain (Article 1, No. 1.146 ter of the RR)

(of an emission): *The frequency range beyond the out-of-band domain in which spurious emissions generally predominate.*

NOTE – Out-of-band *emissions*, defined based on their source, occur in the out-of-band domain and, to a lesser extent, in the spurious domain. Spurious emissions likewise may occur in the out-of-band domain as well as in the spurious domain.

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[1] Signals coupled through the antenna radiation system.

5   Necessary bandwidth (Article 1, No. 1.152 of the RR)

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.

For application to multi-channel or multi-carrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the necessary bandwidth is taken to be the transmitter's or transponder's 3 dB bandwidth. This does not apply to base stations in the mobile service or to fixed wireless access base stations using mobile technology.

For fixed service, Recommendation ITU-R F.1191 is to be used to calculate the necessary bandwidth in the case of fixed digital radio multi-carrier systems.

For the radiodetermination service, the necessary bandwidth of frequency-agile radars is taken to be the part of the allocated band over which the carrier frequencies of those radars tune.

Annex 2

BOUNDARY AND LIMITS FOR PRIMARY RADAR EMISSIONS

This Annex defines limits for unwanted emissions in the out-of-band domain for fixed radar stations for which ERC Rec. 74-01 applies the more stringent Category B Limits of ITU-R Recommendation SM.329. By providing these limits the boundary between the out-of-band domain and the spurious domain is also hereby defined for this type of systems.

The limits of unwanted emissions in the out-of-band domain for any other radar systems are given in Annex 8 of ITU-R SM.1541.

Two spectrum masks are given in Fig. A2.1, one based on the roll-off of 20 dB/decade and one based on the design objective; both are taken from the Rec. ITU-R SM.1541. The mask based on an initial 20 dB roll-off is applicable to all radars, which fall under the definition of this Annex. New radar designs should aim to meet the design objectives as soon as possible. In the future it is intended to apply a more stringent mask based upon the design objective limits.
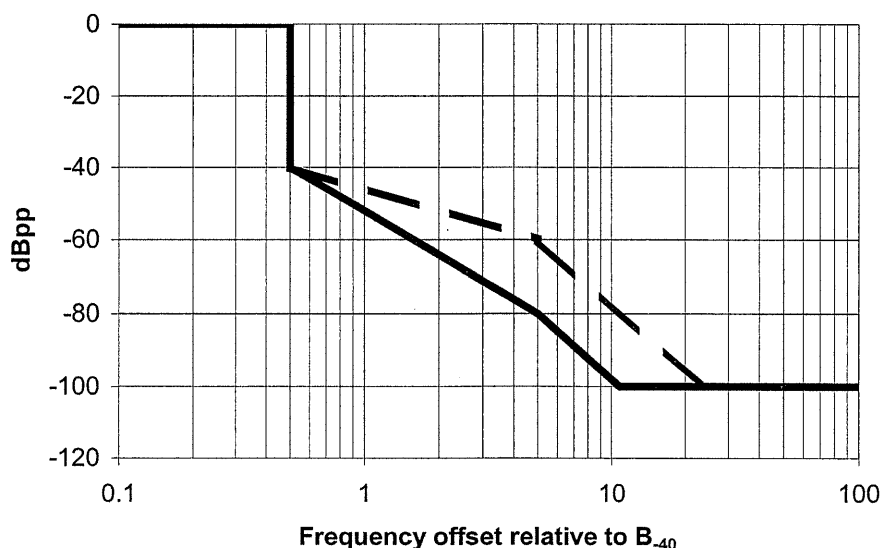
Figure A2.1: Emission masks for radars

(The dashed line shows the limit for unwanted emissions in the out-of-band domain.
The solid line represents the proposed design objective)

For the ITU-R Rec. SM.329 Category B limit the mask has a roll-off at 20 dB/dec from the calculated 40 dB bandwidth (B_{-40}) to a level of -60 dB_{pp}. The mask then continues to roll-off at 60 dB/dec to the -100 dB level. For the design objective the mask has a roll-off at 40 dB/dec from the calculated B_{-40} to a level of -80 dB_{pp}. The mask then continues to roll-off at 60 dB/dec to the -100 dB level. The equations for determining the B_{-40} bandwidth are given in Annex 8 of ITU-R SM.1541.

The first mask limit will result in the out-of-band emission domain width of 46.4 times B_{-40}. The design objective mask limits will reduce the out-of-band emission domain to the width of 21.5 times B_{-40}.

These two masks have the characteristics listed in the following Tables 1 and 2. The limits are specified for the offset frequencies being multiple of the B_{-40} bandwidth.

Table 1: Limits for unwanted emissions

Offset Frequency x B_{-40}	Limit dB	Slope dB/decade
0 to 0.5	0	0
0.5	40	∞
0.5 to 5	40 to 60	20
5 to 23.2	60 to 100	60
23.2 to ∞	100	0

Table 2: Design objective limits for unwanted emissions

Offset Frequency x B_{-40}	Limit dB	Slope dB/decade
0 to 0.5	0	0
0.5	40	∞
0.5 to 5	40 to 80	40
5 to 10.75	80 to 100	60
10.75 to ∞	100	0