Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

ECC RECOMMENDATION (01)05 (revised, Rottach Egern, February 2010)

LIST OF PARAMETERS OF DIGITAL POINT-TO-POINT FIXED RADIO LINKS USED FOR NATIONAL PLANNING

Recommendation adopted by the Working Group “Spectrum Engineering" (SE)

INTRODUCTION

The regulation framework for the fixed service has been considered for a long time in ITU-R and a comprehensive set of ITU-R Recommendations is now available. These Recommendations provide a unified technical framework allowing a common frequency planning methodology.

This methodology is based on agreed performance objectives and acceptable levels of degradation by interference.

Digital technology allows a common method to calculate the contribution of interference to be implemented, whatever the design characteristics of the considered equipment. This method is based on the availability of a limited number of parameters, which are used to aggregate, within the effective bandwidth of each receiver, the contributions of interfering power delivered by all the interferers. Although this method is widely used, some national deviations may occur.

There are still cases where the frequency planning is made by the network operator, where a band (or a part of a band) is assigned on an exclusive basis, or by planning among different network operators whom neighbour frequency channels are assigned to. However, in most cases, the frequency planning is undertaken by the Administration, on a link-by-link basis, providing the frequency assignment by use of an interference limited criteria to ensure a predefined degree of propagation related availability/performance for the link.

For the purpose of unifying, among different administrations, the general criteria of link-budget evaluation, this Recommendation provides a list of parameters to be used for frequency planning of digital point-to-point fixed radio links. These parameters should be associated to any application for assignment of frequency to one point-to-point radio station in the fixed service.

"The European conference of Postal and Telecommunications Administrations,

considering

a) that in Europe requirements were identified for the provision of frequency planning (Note 1) methodology for point-to-point fixed links;

b) that most administrations make a link-by-link frequency planning, on the basis of interference limited criteria for ensuring a predefined degree of propagation related availability/performance of the link.

c) that, in such cases, agreement on a common maximum acceptable level of threshold degradation due to an increase of the spectral noise power, by aggregation of all interference coming from the relevant sources of the Fixed Service is necessary;

d) hat also agreement on a common maximum acceptable level of threshold degradation due to an increase of the spectral noise power, by a single source of interference from the Fixed Service is necessary;

e) that definition of a list of parameters allows commonality, among administrations, of frequency planning methodology of digital point-to-point fixed radio links;

f) that in some cases the frequency planning is made by the network operators, where they are exclusively assigned a whole band or a portion of a band, or because planning among different network operators assigned with neighbouring frequency channels, may be required by the administration in the licensing agreement.

g) that in some cases cross-border co-ordination may be required by bilateral or multilateral agreements among administrations concerned.

Note 1: Frequency planning in the context of this Recommendation is a link-by-link planning, based on an interference limited criteria only, resulting in a frequency assignment that ensures a predefined degree of propagation related availability/performance for the link.

recommends

1. that the level of threshold degradation of a victim receiver be evaluated as the increase of the noise power in the receiver bandwidth resulting from the aggregation of all interference coming from the relevant sources of the fixed service, weighted by the victim receiver selectivity (Note 1);

2. that frequency planning of digital point-to-point fixed radio links be based on the definition of :

2.1 the maximum acceptable level of threshold degradation, evaluated according to recommend 1), due to the aggregation of the relevant interfering signals, (Note 2), (Note 4), (Note 5) see Annex 2,

2.2 the maximum acceptable level of threshold degradation, evaluated according to recommend 1), due to any single interfering signal, (Note 3), (Note 4), (Note 5) see Annex 2,

3. that frequency planning of digital point-to-point fixed radio links, according recommends 1), and 2), are based on the list of parameters defined in Annex 1.

Note 1: The power aggregation of any interfering source is evaluated as the integral, within the receiver bandwidth, of its power density referenced to any 1 MHz slot, weighted by the victim receiver averaged selectivity on that slot. In theory the integral should be extended to all spectrum, but in practice the evaluation may be limited to ± 250% of the victim receiver channel separation. Very far frequency interfering sources are assumed not to affect any receiver designed according fixed system common practice. Annex 2 shows a typical simplified methodology for interfering power evaluation.

Note 2: Adequate values of such aggregate threshold degradation are usually in the range 2 to 3 dB.

Note 3: Adequate values of such single entry threshold degradation are usually in the range 0.2 to 1 dB.

Note 4: these values of acceptable level of threshold degradation are given as guidance where administrations have not defined different value(s) for the band under consideration.

Note 5: After consultation of the concerned operators by the administration, higher threshold degradation could be accepted (e.g. for dense network deployment), if performance and availability objectives can still be met and increased degradation can be compensated in the link budget."

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

Annex 1

LIST OF PARAMETERS
OF DIGITAL POINT-TO-POINT FIXED RADIO LINKS USED FOR NATIONAL PLANNING

- Transmit and Receive centre frequencies;
- Maximum transmitter in band spectral power density, referenced to 1 MHz (Note 1) expressed in dBm/MHz (Note 2), and ATPC range, where applicable;
- Transmitter spectral power density mask referenced to 1 MHz (Note 1) (Note 3), up to the complete out-of-band emission domain, ie up to +- 250% of the channel separation removed from the centre frequency of the channel (Note 4);
- Equivalent receiver noise power referenced at receiver input (Note 5), at the same reference point where interference will be referred to;
- Receiver selectivity mask (Note 6);
- Antenna radiation pattern envelope, gain (all values in dBi) and cross polarisation discrimination.

Note 1: the exact evaluation of the interference levels requires the calculation of an integral function; nevertheless for practical reasons this function is generally discretised; the 1 MHz reference bandwidth is generally suitable for channel separations equal or higher to 1.75 MHz; for lower channel separations a smaller value should be used as reference bandwidth.

Note 2: this value in dBm/MHz is 90 dB higher than expressed in dBW/Hz.

Note 3: it should be noted that in general masks in ETSI standards are referenced to a lower bandwidth; however for the purpose of this recommendation that mask can be taken unchanged as referenced to 1 MHz.

Note 4: with reference to Recommendation ITU-R SM.1539-1 “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”. Narrowband / wideband radio systems may have a different definition for the Out-of-Band domain boundary.

Note 5: the noise power can be calculated from Noise Figure and Equivalent Receiver Noise Bandwidth:
$N = (-114 + Nf + 10 \log B)$ dBm

where:

Nf is the noise figure of the receiver (in dB);
B is the Equivalent Receiver Noise Bandwidth (in MHz).

Note 6: when actual receiver selectivity is not known and the equipments concerned refer to ETSI WG TM4 standards, guidance on defining conservative or more realistic values may be found in ETSI TR 101 854 "Fixed Radio Systems; Point-to-point equipment; Derivation of receiver interference parameters useful for planning fixed service point-to-point systems operating different equipment classes and/or capacities", provided that the capacity of the link and the class of the equipment are known.

Annex 2

EXAMPLE OF A METHODOLOGY FOR THE EVALUATION OF THE INTERFERENCE POWER

Co-existence studies between transmitters and receivers of different symbol rate and modulation formats commonly evaluate the total interfering power (TIP) derived from the Tx and RX masks and other parameters listed in Annex 1.

$$TIP\ [dBm] = 10\log\left(\sum_{i=1}^{i=n} 10^{(Pc_i/10)} + \sum_{j=1}^{j=m} 10^{(Pa_j/10)}\right) \quad (1)$$

Where: Pc_i is the total power (in dBm) received after co-channel RF, IF and baseband filtering of the i^{th} co-channel interfering signal.
Pa_j is the total power (in dBm) received after offset RF, IF and baseband filtering of the j^{th} adjacent channel interfering signal (Note 1).

The evaluation of Pc_i and Pa_j is made starting from the actual interfering signal level at the victim receiver input reference point, including any external decoupling (e.g. antenna discrimination, XPD).
An estimation of Pc_i and Pa_j can be made using the following series of calculations. (Reference to the diagrams in Figure 1 will help the reader to understand the procedure):

(1) Pc_i evaluation:

1. With Tx and Rx attenuation masks aligned in the co-channel configuration. (See left hand side of diagram in Figure 1), sample the transmitter spectrum mask and receiver selectivity mask. Step size will be 1 MHz as required by note 2 of recommend 1 of this recommendation; however this value is likely to be reduced depending on the bandwidth of the narrowest system.
2. Add corresponding samples of Rx selectivity and Tx mask.
3. Add the maximum transmitter in band spectral power density (in dBm/MHz) of the interferer, reduced by ATPC range in dB (where applicable) and by the link losses ($L_i \equiv$ effective antenna gains in the direction defined by the interferer and the victim/decoupling, XPD and free space/gas losses). In order to scale the calculation to the absolute level.
4. Convert the decibel sum calculated in 3) to real number.
5. Sum the real number values calculated in 4)
6. Convert into dBm the result in 5 to obtain the absolute level of interferer (in dBm).

(2) Paj evaluation:

Offset the Tx mask, as necessary for the j^{th} adjacent channel evaluation, and repeat actions 1) to 6)

The actions above for Pc_i and Pa_j evaluations can be summarised in the following formulas:

$$Pc_i = 10\times\log\left[\sum_{k=0}^{k=n-1} 10^{(P_{out,i} - ATPC_i - L_i + Tc_i k + Rck)/10}\right] \quad (2\ a)$$

$$Pa_j = 10\times\log\left[\sum_{k=0}^{k=n-1} 10^{(P_{out,j} - ATPC_j - L_j + To_j k + Rck)/10}\right] \quad (2\ b)$$

where: n = number of samples in the receiver bandwidth
$P_{out,i\,(j)}$ = i_{th} (j^{th}) interferer maximum transmitter in band spectral power density (dBm/MHz)
$ATPC_{i\,(j)}$ = i_{th} (j^{th}) interferer ATPC range (dB)
$L_{j\,(j)}$ = Link losses from the i_{th} (j^{th}) TX interferer antenna port to the victim receiver input reference point (dB)
($L_i \equiv$ TX and RX effective antenna gains in the direction defined by the interferer and the victim/decoupling, XPD and free space/gas losses, feeder losses)

Tc_ik = i_{th} interferer transmission mask sampled at the k^{th} defined step frequency - co-channel (dB)
To_jk = j_{th} interferer transmission mask sampled at the k_{th} defined step frequency - offset (dB)
Rck = Receiver mask sampled at the k_{th} defined step frequency - co-channel (dB)

THRESHOLD DEGRADATION ASSESSMENT FOR EXAMPLE VALUES:

For assessing recommend 2.1, introduce the values of Pc_i and Pa_j estimated in (2a) and (2b) in formula(1) and the result should be checked against the requirement.

$$10\log\left[10^{(TIP-N)/10}+1\right]\leq X$$

where X = aggregate threshold degradation.

Adequate values of X, aggregate threshold degradation are usually in the range 2 to 3 dB

For assessing recommend 2.2, each value of Pc_i and Pa_j estimated in (2a) and (2b) should be separately checked against the requirement.

$\forall$ *i, j:*

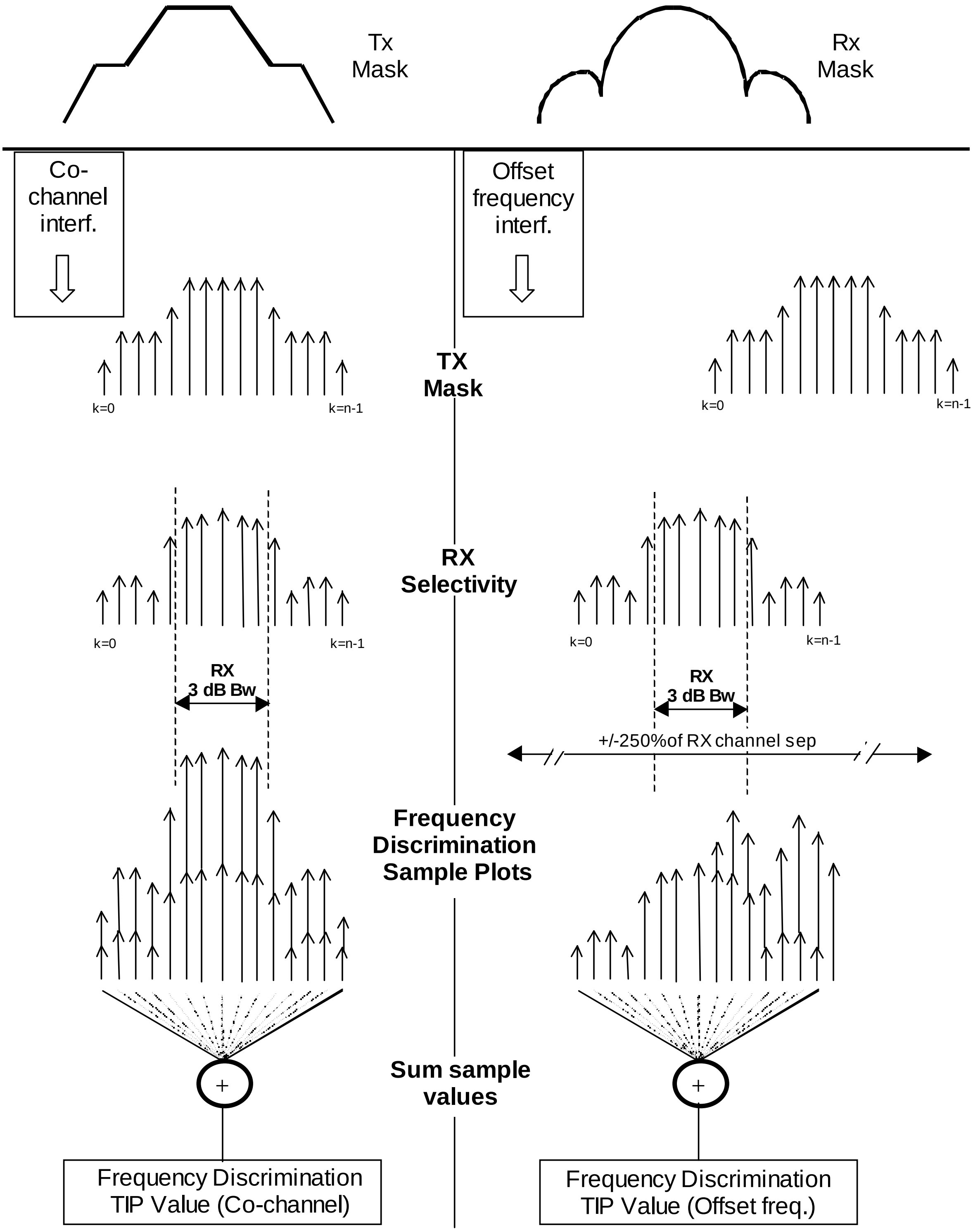
$$10\log\left[10^{(P_{ci}-N)/10}+1\right]\leq Y$$
$$10\log\left[10^{(P_{aj}-N)/10}+1\right]\leq Y$$

where:

N = Receiver Noise Power
Y = entry threshold degradation

Adequate values of Y, single entry threshold degradation are usually in the range 0.2 to 1 dB.

Note 1: Adjacent channel interfering signals means all interfering signals which have an offset frequency from the victim receiver centre frequency.


Tx
Mask
Rx
Mask
Co-
channel
interf.
Offset
frequency
interf.
TX
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k=0
k=n-1
k=0
k=n-1
RX
Selectivity
k=0
k=n-1
k=0
k=n-1
RX
3 dB Bw
RX
3 dB Bw
+/-250%of RX channel sep
Frequency
Discrimination
Sample Plots
Sum sample
values
+
+
Frequency Discrimination
TIP Value (Co-channel)
Frequency Discrimination
TIP Value (Offset freq.)

Figure 1