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(05/2000)

Interference criteria to protect the fixed service from time varying aggregate interference from other services sharing the 10.7-12.75 GHz band on a co-primary basis

F Series

Fixed service

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R F.1494*

INTERFERENCE CRITERIA TO PROTECT THE FIXED SERVICE FROM TIME VARYING AGGREGATE INTERFERENCE FROM OTHER SERVICES SHARING THE 10.7-12.75 GHz BAND ON A CO-PRIMARY BASIS

(2000)

Scope

This Recommendation specifies the protection criteria for the fixed service from time varying aggregate interference from other radio services sharing the 10.7-12.75 GHz band on a co-primary basis. The criteria are defined for both the short term in I/N and the long term in fractional degradation in performance (FDP).

The ITU Radiocommunication Assembly,

considering

a)   that it is desirable to determine the protection criteria of fixed service (FS) systems operating in the 11/12 GHz (10.7-12.75 GHz) band with respect to aggregate interference from systems operating co-primary, especially short-term interference;

b)   that in interference situations involving non-geostationary satellites (non-GSO) space stations, FS systems are potentially exposed to high levels of interference for short periods of time which could affect the performance or availability of these systems;

c)   that the FS link design in the 11/12 GHz band is controlled by multipath fading, which can be modelled using Recommendation ITU-R P.530;

d)   that in the 11/12 GHz band, some administrations employ automatic transmit power control (ATPC) on some FS links and that the use of ATPC will increase the susceptibility of FS systems especially with regard to short-term interference;

e)   that some FS systems employing small net fade margins may not be fully protected from interference from non-GSO satellite systems without unduly constraining those services;

f)   that typical FS links using ATPC will require tighter protection criteria than those needed for FS links with large fade margin that do not use ATPC;

g)   that it is desirable to derive the aggregate FS protection criteria based on the calculation of the allowable degradation of error performance objective (EPO) due to interference, considering typical FS links using ATPC features,

recognizing

a)   that the application of the criteria in this Recommendation may be subject to further consideration within sharing studies with other services;

b)   that any further development of this Recommendation that may be necessary is unlikely to require further study of the appropriateness of the non-GSO satellite fixed satellite service (FSS) power flux-density (pfd) limits in this band;

c)   that the determination of the maximum degradation of EPO allowable to interference from other services sharing the same frequency band on a co-primary basis is given in Recommendation ITU-R F.1094;

d)   that Recommendation ITU-R F.1668 gives the EPO allowable for real digital fixed wireless links which may form part of the international and national portion of a 27 500 km hypothetical reference paths (HRP) and hypothetical reference connections (HRC);

e)   that the allowable degradation in performance of FS systems due to interference from other services sharing the same frequency bands on a primary basis, expressed as a permissible fraction of the total EPO is defined in Recommendations ITU-R F.1565 for the real FS systems which may form part of the international and national portion of a 27 500 km HRP,

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*   Radiocommunication Study Group 5 made editorial amendments to this Recommendation in 2009 in accordance with Resolution ITU-R 1.

recommends

1   that the following interference criteria should be used to protect the FS from time varying aggregate interference from other services in the 10.7-12.75 GHz band on a co-primary basis:

1.1   for the short term, the I/N at the input of the FS receiver should not exceed +20 dB;

1.2   for the long term, the FDP (fractional degradation of performance as described in Recommendation ITU-R F.1108) or D_{ltEPO} (long-term degradation on error performance objectives), should not exceed 10%:

$$D_{ltEPO} \approx \left(0,89 \times \int_{10^{-6}}^{1} \frac{I(t)}{N} \, \mathrm{d}t \right) \times 100 \qquad \%$$

2   that the information contained in Annex 1 should be used as guidance for the use of this Recommendation.

ANNEX 1

Derivation of FS aggregate protection criteria in the 11/12 GHz band

1   Introduction

This Annex aims to give numerical examples concerning the assessment of interference criteria in the 11/12 GHz band.

The interference is considered to be aggregate from all co-primary services.

These examples (see Recommendation ITU-R P.530) are based on the following typical FS links (the fade margins are given for a 1×10^{-3} BER):

– link with 37 dB fade margin, part of the international portion of the hypothetical reference path (HRP) ($q_t = 4.2$);

– link with 47 dB fade margin, part of the international portion of the HRP ($q_t = 2.2$);

– link with 37 dB fade margin, part of the national portion of the HRP ($q_t = 2.2$).

The methodology proposes to calculate the performance degradation due to a given short-term criterion (i.e. $I/N = 20$ dB for 1×10^{-4}% of the time) in order to verify its adequacy and then to give the rest of the interference allowance to the long term on the basis of an integration of the interference distribution with the fading.

2   Short-term criterion

The degradation due to a given interference short-term criterion (i.e. $I/N = 20$ dB for not more than 1×10^{-4}% of the time) is the probability of the simultaneous effect of this criterion and a fading higher than the net fade margin (F), defined as follows:

$$F = FM - ATPC_{range} - I/N \qquad \text{dB}$$

where, for example:

    FM: fade margin

    $ATPC_{range} = 13$ dB

    $I/N = 20$ dB.

Therefore, the degradation due to this short-term interference, D_{stEPO}, is given by the following formula as a percentage of the EPO allowance:

$$D_{stEPO} = A\% \times p(I/N \geq 20 \text{ dB})/EPO$$

where:

    EPO: error performance objective

    F: net fade margin

    $A\% = p(f > F)$: the percentage of time that a fade depth *F* is exceeded (see Recommendation ITU-R P.530).

Tables 1 and 2 give the results of the calculation for the three typical links considering the errored second (ES) and severely errored second (SES) objectives. These calculations show that the proposed short-term interference criterion (i.e. $I/N = 20$ dB for $1 \times 10^{-4}\%$ of the time) never leads to an EPO degradation greater than 10% which is the total EPO degradation allowable to total interference and, except in one case, is much lower than 1% which is representative of an apportionment of 10%/90% for, respectively, short term and long term.

It has to be noted that, for the 37 dB FM international link, which already represents a worst-case calculation as far as it leads to a q_t value of 4.2 dB, the percentage drops to 1.2% when considering an ATPC range of 12 dB instead of 13 dB.

TABLE 1

	Link part of an international portion		Link part of a national portion
FM (SES) (dB)	37	47	37
FM − 1 dB (for SES) (dB)	36	46	36
Net margin (for SES) (dB)	3	13 + 13	3
$A = \%$ fading > net margin (%)	3.3	1.2×10^{-2}	6.7
Probability of event = $A \times 10^{-4}$ (%)	3.3×10^{-6}	1.2×10^{-8}	6.7×10^{-6}
Total EPO allowable to the link (%)	1.2×10^{-4}	1.2×10^{-4}	7.5×10^{-3}
Degradation (D_{stEPO}) (%)	2.7	0.01	0.09

TABLE 2

	Link part of an international portion		Link part of a national portion
FM (ES) (dB)	37	47	37
FM − 5 dB (SES) (dB)	32	42	32
Net margin (ES) (dB)	0	9	0
$A = \%$ fading > net margin (%)	63	5.2×10^{-1}	63
Probability of event = $A \times 10^{-4}$ (%)	6.3×10^{-5}	5.2×10^{-7}	6.3×10^{-5}
Total EPO allowable to the link (%)	9.6×10^{-3}	9.6×10^{-3}	6×10^{-1}
Degradation (D_{stEPO}) (%)	0.65	0.005	0.01

Furthermore, and since the low percentage of time associated to this criterion is equivalent to less than 3 s/month, the *I/N* level (20 dB) of this criterion can be considered as a hard limit.

3 Long-term interference criteria

Based on the above consideration, it is proposed, in the case where *I/N* statistics never reach the maximum short-term interference level (+20 dB), to allocate the full interference allowance (10%) to the long-term interference. In the particular case where the *I/N* statistics reach the +20 dB maximum value (without exceeding it), then it is proposed to

calculate the long-term interference criteria by subtracting the EPO degradation due to short-term interference, i.e. D_{stEPO}, from the full interference allowance (10%). As an example, considering the worst case given in Table 2 (37 dB FM/international link), this leads to a long-term objective of: $10 - 2.7 = 7.3\%$.

The degradation due to a long-term interference D_{ltEPO} could then be estimated using the FDP approach (see Recommendation ITU-R F.1108) or by the following equation:

$$D_{ltEPO} \approx \left(0.89 \times \int_{10^{-6}}^{1} \frac{I(t)}{N} \, dt \right) \times 100 \qquad \%$$

4   Further considerations of ATPC in long-term interference criteria

Although FDP as provided in Recommendation ITU-R F.1108 may be sufficient for receivers without ATPC, the FDP for receivers employing ATPC may require additional consideration if I/N values exceed the full-power working range, A_w, of the ATPC. The full-power working range of the ATPC is defined as:

$$A_w = FM - A_{Range} - A_{Threshold}$$

For receivers employing ATPC, it can be shown that the FDP may be expressed as:

$$FDP = FDP_0 + \Delta FDP$$

where FDP_0 is the usual FDP as derived in Recommendation ITU-R F.1108 and given here as:

$$FDP_0 = \sum_{All\ k} f_k \, (i/n)_k$$

and the contribution due to ATPC and interference is given by:

$$\Delta FDP = (10^{0.1 A_w} - 1) \sum_{k > k_c} f_k \, (1 + (i/n)_k)$$

It is assumed here that $(i/n)_{k+1}$ is greater than $(i/n)_k$ and that k_c is the largest index for which:

$$10 \log \left(1 + (i/n)_k \right) < A_w$$

Some calculations show that, for the cases considered, an additional long-term I/N criterion of I/N to exceed 15 dB for no more than 0.001% of the time would lead to an additional degradation, ΔFDP, of about 1%. Thus, this I/N criterion would limit the sharing burden of receivers employing ATPC to about 1%.

An alternative approach to determining D_{ltEPO} for receivers employing ATPC is given as follows:

$$D_{ltEPO} \approx \left[0.89 \times \left(\int_{t_f}^{1} \frac{I(t)}{N} \, dt + 10^{0.1 A_w} \int_{10^{-6}}^{t_f} \frac{I(t)}{N} \, dt \right) \right] \times 100 \qquad \%$$

where:

   $I(t)$:   interference power (W) that is exceeded for the fraction of time t

   t_f :   fraction of time that $I(t)/N$ (dB) exceeds A_w.

It should be noted that in some of these cases where high I/N values are considered, the long-term criteria as described in § 3 may provide the required FS protection.