International Telecommunication Union

ITU-R
Radiocommunication Sector of ITU

Recommendation ITU-R F.1495-2
(03/2012)

Interference criteria to protect the fixed service from time varying aggregate interference from other radiocommunication services sharing the 17.7-19.3 GHz band on a co-primary basis

F Series
Fixed service

International Telecommunication Union

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from http://www.itu.int/ITU-R/go/patents/en where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Recommendations

(Also available online at http://www.itu.int/publ/R-REC/en)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	**Fixed service**
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

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

Electronic Publication
Geneva, 2012

RECOMMENDATION ITU-R F.1495-2

Interference criteria to protect the fixed service from time varying aggregate interference from other radiocommunication services sharing the 17.7-19.3 GHz band on a co-primary basis

(2000-2007-2012)

Scope

This Recommendation defines the interference criteria necessary to protect the fixed service from time varying aggregate interference from other radiocommunication services sharing the 17.7-19.3 GHz band on a co-primary basis.

The ITU Radiocommunication Assembly,

considering

a) that it is desirable to determine the protection criteria of FS systems operating in the 18 GHz (17.7-19.3 GHz) band with respect to aggregate interference from systems operating co-primary, especially short-term interference;

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

c) that the FS link design in the 18 GHz band is controlled by rain attenuation, which can be modelled using Recommendation ITU-R P.530;

d) that in the 18 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 the generic long-term criterion assumed for not exceeding the maximum APO apportionment (10%) due to other services sharing the same frequency band on a co-primary basis, is defined as I/N at the input of the FS receiver not exceeding −10 dB for more than 20% of the year (see Recommendation ITU-R F.758); however, when time varying levels of interference are concerned, additional care should be taken for evaluating shorter duration interference contributions;

h) that it is desirable to derive the aggregate FS protection criteria based on the calculation of the allowable apportionment of EPO due to interference, considering typical FS links using ATPC features;

j) that the determination of the maximum apportionment of EPO (10%) allowable to interference from other services sharing the same frequency band on a co-primary basis is given in Recommendation ITU-R F.1094;

k) that Recommendation ITU-R F.1668 gives the EPO allowable for real digital fixed wireless links used in 27 500 km hypothetical reference paths (HRP) and connections;

l) 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 Recommendation ITU-R F.1565 for real digital fixed wireless links used in the international and national portions of a 27 500 km HRP at or above the primary rate,

noting

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 FSS pfd limits in this band,

recommends

1 that the following interference criteria should be used to protect the FS from time varying aggregate interference from other services in the 17.7-19.3 GHz band on a co-primary basis:

1.1 for the long-term evaluation of the APO apportionment, the I/N at the input of the FS receiver should be considered not exceeding –10 dB for more than 20% of the time in any year (Note 1);

1.2 for the evaluation of the long-term interference contribution to EPO apportionment, the same assumption of *recommends* 1.1 should be used also for any month;

1.3 for the short-term, the I/N at the input of the FS receiver should not exceed +14 dB for more than 0.01% of the time in any month;

1.4 for the short-term, the I/N at the input of the FS receiver should not exceed +18 dB for more than 0.0003% of the time in any month;

2 that total apportionment of EPOs from long- and short-term interference should not exceed 10% (see Recommendation ITU-R F.1094);

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

NOTE 1 – When time varying interference is concerned, AP apportionment may, in principle, be experienced at any time the I/N exceeds this value for more than 10 consecutive seconds; complex time/level integration might be needed for an overall evaluation. However, in the case considered in this Recommendation, the EP apportionment is considered predominant and the AP impact is not further considered.

Annex 1

Derivation of FS aggregate protection criteria in the 17.7-19.3 GHz band

1 Introduction

The methodology presented in this Annex is based on the assumptions that the fading in the 18 GHz band is dominated by rain and that, therefore, even if long-term interference has an effect on the error performance of the link, the main way to produce severely errored seconds (SES) events on the FS link is to have an interference level higher than the noise level by more than the fade margin of the link, whatever the propagation conditions may be. Errored seconds (ES) events can be experienced also with lower interference levels.

On this basis, the following apportionment of the effect of interference on the EPO apportionment of the link has been assumed:

– 20% of FS link apportionment due to long-term interference;

– 80% of FS link apportionment due to short-term interference.

2 Error performance objective

The allowable degradation in performance of FS systems due to interference from other services sharing the same frequency bands on a primary basis are expressed as a permissible fraction (10%) of the total EPO and are defined in Recommendation ITU-R F.1565 for the real FS systems which may form part of the national portion of a 27 500 km HRP, assumed to be representative of the 18 GHz FS links, usually used in the access networks or mobile telephone infrastructure networks.

The corresponding values are given in Table 1, and correspond to the following assumptions:

– short haul inter-exchange network section (see Table 7 (previously named Table 4a) of Recommendation ITU-R F.1565) composed of five hops of 8 km;

– rate from 15 to 55 Mbit/s;

– B = 8%.

TABLE 1

	EPO (fraction of any month)		
	Total allowable to interference	**Long-term interference (20%)**	**Short-term interference (80%)**
Errored second ratio (ESR)	1.2×10^{-4}	2.4×10^{-5}	9.6×10^{-5}
Severely errored seconds ratio (SESR)	3.2×10^{-6}	6.4×10^{-7}	2.6×10^{-6}
Background block error ratio (BBER)	3.2×10^{-7}	6.4×10^{-8}	2.6×10^{-7}

3 Short-term criteria

As explained in § 1, the main way to produce SES events on the FS link considering short-term interference is to have an interference level higher than the noise level by more than the fade margin of the link, whatever the propagation conditions may be, and ES events can be experienced also with lower interference levels.

The definition of short-term criteria is then linked to both values of fade margins (or net fade margins considering ATPC (see Note 1)) and EPO allocated to short-term interference as defined in Table 1, considering that the fade margin is allocated to the short-term criteria.

The following criteria definition has been based on a 19 dB (for a BER of 1×10^{-3}) fade margin. In the United Kingdom and France there are respectively 23% and 20% of the 18 GHz links with fade margins (or net fade margin (see Note 1)) lower than 19 dB.

NOTE 1 – For an FS link using ATPC, the net fade margin = total fade margin – ATPC range.

As this fade margin is given for a BER of 1×10^{-3} which is a triggered SES event in Recommendation ITU-T G.821 and as the EPO are referenced to Recommendation ITU-T G.826 definition, it is necessary to extrapolate the fade margin corresponding to ES and SES levels. On the basis of the agreed assumptions that the fade margins (FM) for ES and SES are respectively 5 dB and 1 dB lower than the FM referenced to the BER 1×10^{-3} level which is 2 dB higher than the FM referenced to the BER 1×10^{-6} level, Table 2 summarizes these different values of fade margins and, associated with the correspondent EPO ratios, allows to define two short-term criteria for the FS in the bands.

TABLE 2

	Fade margin (dB)	**EPO ratio**
ES	**14**	9.6×10^{-5}
BER 1×10^{-6}	17	
SES	**18**	2.6×10^{-6}
BER 1×10^{-3}	19	

Thus, the short-term criteria proposed to be used in the 18 GHz band have been defined associating the ES and SES EPO (see Table 2) and the corresponding *I*/*N* as defined in Table 3.

TABLE 3

	***I/N* (dB)**	**Percentage of time not to be exceeded (%)**
Criterion 1	14	0.01
Criterion 2	18	0.0003

4 Long-term criteria

4.1 The long-term criterion specified in Recommendation ITU-R F.758 to be used for the 18 GHz band is $I/N = -10$ dB (which gives a 0.5 dB degradation of the fade margin) not to be exceeded for more than 20% of the time. But in some cases only one threshold point for the long-term criterion is not enough to protect FS systems and the I/N distribution up to the first short-term criterion should be also taken into account to be sure that total apportionment of EPOs will not exceed 10%.

Finally, considering low net fade margin, and based on the information provided by Radiocommunication Working Party 3M that, under clear air conditions, multipath effects would have to be considered, it has been acknowledged that some performance degradation could occur due to the simultaneous effect of interference and multipath fading using, for example, the fractional degradation in performance (FDP) approach (see Recommendation ITU-R F.1108) or the following formula:

$$D_{ltEPO} \approx \left(0.89 \times \int_{10^{-4}}^{1} \frac{I(t)}{N} dt \right) \times 100\%$$

where:

D_{ltEPO}: apportionment on error performance objectives.

The significance of degradation to availability may also need to be assessed.

4.2 Although FDP as provided in Recommendation ITU-R F.1108 may be sufficient for receivers without ATPC, the FDP for receivers employing ATPC requires additional consideration.

Consider a system equipped with ATPC. It operates at a reduced transmit power until the desired signal fades more than a threshold amount, A_T (dB). For fading beyond the threshold value, the transmit power is increased to maintain essentially a constant power level at the receiver until the signal is faded by A_M (dB). For fade depths greater than A_M the transmitter operates at maximum power. Thus, the ATPC range is A_R where $A_R = A_M - A_T$. Denoting the fade margin as A_{FM}, the difference between the fade margin and the full-power fade depth is denoted as $A_W = A_{FM} - A_M$.

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:

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

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:

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

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

$$D_{ltEPO} \approx \left[0.89 \times \left(\int_{t_f}^{1} \frac{I(t)}{N} \mathrm{d}t + 10^{0.1A_w} \int_{10^{-4}}^{t_f} \frac{I(t)}{N} \mathrm{d}t \right) \right] \times 100 \qquad \%$$

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.

4.3 It should be noted that in some of these cases where high I/N values are considered, the long-term criteria as described in § 4.1 may provide the required FS protection. Reallocation of degradations from long- and short-term interference inside the total allowable EPOs apportionment of 10% also could be considered.