

RECOMMENDATION ITU-R BO.1293-2

**Protection masks and associated calculation methods for
interference into broadcast-satellite systems
involving digital emissions**

(Question ITU-R 223/11)

(1997-2000-2002)

The ITU Radiocommunication Assembly,

considering

- a) that protection ratios and associated protection masks are essential characteristics for the television signals in the broadcasting-satellite service (BSS) and associated feeder links;
- b) that the Radio Regulations (RR) Appendices 30 and 30A Plans have been developed by using values of protection ratio and interference calculation methods based on fixed frequency offsets and given types of signal;
- c) that new systems submitted to the Radiocommunication Bureau (BR) for implementation in these plans propose to use new types of signals for which no protection masks and only limited interference calculation methods are available;
- d) that the BR has requested Radiocommunication Study Group 6 to provide additional methodologies and protection criteria to assess interference from and to these new types of signals;
- e) that the definition of protection masks and associated calculation methods provides very useful technical information when revising the RR Appendices 30 and 30A Plans for Regions 1 and 3;
- f) that several studies have now been carried out by various administrations and organisations that validate the proposed interference calculation method,

recognizing

- a) that protection masks extend the usefulness of protection ratios, which are themselves associated with fixed frequency offsets;
- b) that appropriate protection masks for interference calculation between digital emissions can be derived by using the methodology provided in Annex 3;
- c) that the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000) has established new BSS and associated feeder-link plans for Regions 1 and 3, based on digital modulation, and new Regions 1 and 3 Lists, thus updating Appendices 30 and 30A;
- d) that Administrations are entitled to implement their Plan assignments at any time without any further restrictions with respect to the characteristics on which the plans are based,

recommends

1 that for any EPM/OEPM compatibility analysis carried out under Articles 4 and 5 of Appendices 30 and 30A, Annex 1 should be applied;

2 that the associated interference calculation methods of EPM/OEPM provided in Annex 2, should be used for the compatibility analyses referred to in *recommends* 1.

NOTE 1 – The calculation method to generate protection masks provided in Annex 3 for BSS networks employing all types of digital phase shift keyed emissions may be applied in compatibility analyses for bilateral coordination between administrations.

NOTE 2 – Further studies are needed to develop masks for interference between other types of emission (i.e. for analogue into analogue, digital into analogue and analogue into digital interference). Until such time as these masks are available, the method described in Annex 1 should be used when calculating interference between emissions when the interference is digital.

ANNEX 1

Calculation of digital interference in the absence of appropriate protection masks

When applying the calculation method of Annex 2, it is desirable to apply the most appropriate protection mask for the digital interference situation under consideration (i.e. the most appropriate value for $D_i(f_o)$ in Annex 2). For example, for digital interference into a digital emission, this mask can be derived using the calculation method given in Annex 3.

Further studies are required to derive suitable generic protection masks for the case of digital into analogue interference.

Until such time as these masks are available, the method given below should be used to calculate the interference between two emissions, where the interferer is a digital emission.

The value for $D(f_o)$ is calculated as follows:

$$D(f_o) = 10 \log_{10}(B/b(f_o)) + K$$

where:

$b(f_o)$: overlapping bandwidth between the interfering carrier and the wanted carrier (MHz)

B : necessary bandwidth of the interfering digital carrier (MHz)

K : positive weighting coefficient.

In general, a protection mask calculation method such as that given in Annex 3 quantifies the value K which may vary depending upon the wanted and interfering signal parameters and the frequency offset between the two signals (in fact, the method of Annex 3 does not explicitly calculate the factor K but rather calculates directly the value $-D(f_o)$).

In the absence of suitable protection masks which quantify the factor K , either directly or indirectly, it should be assumed that $K = 0$ which corresponds to the worst case.

ANNEX 2

Interference calculation methods associated with Annexes 1 and 3*

1 Introduction

The purpose of this Annex is to define a generic method to calculate the interference situation in the BSS Plans, taking into account different categories of interference (e.g. co-channel, adjacent-channel, etc.).

The generic interference calculation method defined below, associated with the appropriate protection mask calculation methods, should be applied to establish the values necessary to assess the interference situation between different emissions of the BSS Plans.

2 Terminology, symbols and operators

In order to simplify this Annex and to facilitate its understanding, the following terminology, symbols and operators are defined:

Single entry, se: a single interfering carrier is considered

Aggregate, ag: all interfering carriers are considered

Equivalent, eq: combination of co-frequency and frequency offset interference

Overall, ov: combination of feeder-link (up) and downlink (dn) interference

f_o : frequency offset = difference between the centre frequencies of two carriers

C/I : carrier-to-interference ratio (dB)

PR: protection ratio (dB)

EPM: equivalent protection margin (dB)

OEPM: overall equivalent protection margin (dB)

* This method has been developed to carry out the compatibility analysis of assignments, submitted to the BR under the provision of RR Appendices 30 and 30A, with parameters different from those used in the establishment of the Plans (channel bandwidth, centre frequency, type of emission, etc.).

X : reduction of the overall C/I due to interference in the feeder link (dB)

Operator $\oplus$: $A \oplus B = -10 \log \left(10^{-A/10} + 10^{-B/10} \right)$

Operator $\odot$: $A \odot B = -10 \log \left(10^{-A/10} - 10^{-B/10} \right)$

Operator $\Sigma\oplus$: $\sum_{n=1}^N \oplus A_n = -10 \log \left(10^{-A_1/10} + 10^{-A_2/10} + \dots + 10^{-A_n/10} \right)$

3 Interference calculation methods

In order to calculate the interference situation of an assignment, two major elements are needed:

- the equivalent aggregate carrier to interference ratio, $C/I_{eq, ag}$, on both up and downlinks, $C/I_{eq, ag, up}$, $C/I_{eq, ag, dn}$, respectively;
- the overall co-channel (or co-frequency) protection ratios of the wanted carrier, PR_{ov} .

In addition, definitions for the EPM (see Note 1) and OEPM are required.

NOTE 1 – EPM is not needed in case of application of this method to the Region 2 BSS Plan.

3.1 The first elements, i.e. the equivalent aggregate carrier to interference ratios, are calculated as follows for both the up and downlinks:

$$C/I_{eq, ag, up} = \sum_{i=1}^m \oplus \left(C/I_{i, se, up} + D_i(fo_i) \right)$$

$$C/I_{eq, ag, dn} = \sum_{i=1}^n \oplus \left(C/I_{i, se, dn} + D_i(fo_i) \right)$$

where:

m : number of interfering carriers on the feeder link

n : number of interfering carriers on the downlink

fo : frequency offset between the centre frequencies of the wanted carrier and one interfering carrier; a positive or negative value (MHz)

$D(fo)$: difference (dB) between the appropriate protection mask's value with no frequency offset (i.e. the centre value at 0 MHz) and the protection mask's value with a frequency offset of fo MHz.

For the case of a digital wanted carrier and a digital interfering carrier, the value $D(fo) = -I(fo)$, where $I(fo) (\equiv I(\Delta f))$ is defined in Annex 3 assuming a linear or non-linear channel.

For other combinations of wanted and interfering carrier types (digital into analogue interference) appropriate masks remain to be defined. Until such time as these masks are available, the model given in Annex 1 should be applied to evaluate $D(fo)$.