

RECOMMENDATION ITU-R S.1066^{*,**}**Ways of reducing the interference from the broadcasting-satellite service of one Region into the fixed-satellite service of another Region around 12 GHz**

(1994)

The ITU Radiocommunication Assembly,

considering

- a) that the World Administrative Radio Conference (Geneva, 1979) (WARC-79) allocated common frequency bands around 12 GHz to the fixed-satellite service (FSS) and broadcasting-satellite service (BSS) in different Regions, creating the potential for interference from BSS space stations in one Region into fixed-satellite earth stations in another Region;
- b) that Appendix S30 of the Radio Regulations (RR) contains the parameters and provisions for the BSS Plans, and the limits for determining whether an administration of another Region is affected or where their agreement must be sought;
- c) the need to ameliorate any sharing difficulties arising from a) or b) above;
- d) the analyses contained in Annex 1 hereto,

further considering

- e) that Annex 1 of RR Appendix S30 provides a power flux-density level which if not exceeded by a BSS assignment of Region 2 (12.2-12.7 GHz), or of Regions 1 and 3 (11.7-12.2 GHz), into the territory of an administration of Regions 1 and 3, or Region 2 respectively, that administration of the other Region shall be considered as not being affected,

recommends

1 that the method described in § 1 and 2 of Annex 1 may be employed to determine the potential levels of interference from the BSS space stations in an adjacent Region when planning new FSS networks, but using the actual link parameters of those FSS networks, and the actual satellite e.i.r.p.s and side-lobe gains of the relevant BSS networks where known;

2 that, to the degree practicable, the interference reduction techniques listed in § 4 of Annex 1 may be employed in the design of FSS and BSS networks in adjacent Regions which use locations in the geostationary-satellite orbit (GSO) which are not widely separated.

* This Recommendation should be brought to the attention of Radiocommunication Study Group 6.

** Radiocommunication Study Group 4 made editorial amendments to this Recommendation in 2001 in accordance with Resolution ITU-R 44 (RA-2000).

ANNEX 1

**An analysis of the interference from the broadcasting-satellite service
of one Region into the fixed-satellite service
of another Region around 12 GHz**

1 System assumptions

1.1 The fixed-satellite service (FSS)

For the FSS, three systems have been postulated with the characteristics identified in Table 1.

TABLE 1*

Relevant parameter	System A	System B	System C
Antenna diameter/wavelength: D/λ	60	60	≥ 100
Antenna side-lobe gain (dBi)	$34 - 25 \log \phi$	$34 - 25 \log \phi$	$32 - 25 \log \phi$
Transmission mode	Digital SCPC	Digital SCPC	Wideband data
Reference bandwidth	40 kHz	40 kHz	2 MHz
Clear-sky receiving system noise temperature (K)	200	400	100
Clear-sky carrier-to-noise ratio (dB)	12	16	–
Carrier-to-interference ratio ⁽¹⁾ (dB)	20.5 ⁽²⁾	20.5 ⁽²⁾	–
Interference-to-noise ratio ⁽³⁾ (dB)	–	–	13.5 ⁽³⁾
Acceptable level of interference ⁽¹⁾ (dBW)	–168.1	–161.1	–159.0

* This Table, and the calculations based on it, will be reviewed from time to time in the light of improvements to other Radiocommunication Study Group 4 Recommendations (e.g. Recommendation ITU-R S.523).

(1) Between two systems in the FSS.

(2) This is based on an interference criterion of $C/I = 27.5 + 6 \log \delta$ for “frame rate” dispersal of an interfering video carrier.

(3) This is based on the presence of thermal only internal noise, and a 4% single entry pre-demodulation interference increment.

1.2 The broadcasting-satellite service (BSS)

For the BSS, an e.i.r.p. of 63 dBW has been assumed for the purposes of this study as representative for beam centre emissions.

In addition, it has been postulated that, in most cases, the broadcasting-satellite antenna gain towards the “other” Region may be held at or below the –30 dB “first side-lobe plateau” of the relevant antenna reference pattern. With these assumptions, the broadcasting-satellite power radiated towards the “other” Region will be about 33 dBW.

It should be noted that Region 2 reference patterns do not have this plateau. By the use of shaped beam antennas, the side-lobe characteristics of Region 2 space stations can be improved to meet or exceed this criterion. In some situations, where very large antenna discriminations are required over small areas, the use of nulling horns has been shown to be effective.

With regard to energy dispersal, the Plan for Regions 1 and 3 imposes a value of 600 kHz of peak-to-peak “frame rate” triangular energy dispersal (this, with the assumptions on reference bandwidth in § 1.1 yields $\delta = 0.067$). The Plan for Region 2 imposes an energy dispersal in order to produce a spectral power flux-density in any 40 kHz band 12 dB below the unmodulated carrier power. The peak-to-peak frequency deviation due to the energy dispersal signal is then 634 kHz which is slightly higher than that adopted by Regions 1 and 3: the very slight reductions in interference obtained have not been taken into account in the remainder of the study.

Table 2 shows relevant parameters involving broadcasting-satellite characteristics.

TABLE 2
Levels of interference from the BSS

Interfered-with FSS system	System A	System B	System C
Interfering system e.i.r.p. (dBW)	63-30	63-30	63-30
Interference into FSS systems (dBW)	$-138.5 - 25 \log \phi$	$-138.5 - 25 \log \phi$	$-140.5 - 25 \log \phi$

2 Interference potential assessment

The level of interference into fixed-satellite systems is a function of the topocentric angle of separation between the fixed satellite and broadcasting satellite. To assess the compatibility of the broadcasting-satellite emissions with the postulated fixed-satellite systems, it is convenient to equate the acceptable levels of interference (see Table 1) with the interference produced by a broadcasting satellite (see Table 2) which would yield the following equations for the required inter-satellite spacing for the three fixed-satellite systems:

- for FSS systems of type A,

$$-138.5 - 25 \log \phi = -168.1 - M$$
or

$$25 \log \phi = 29.6 + M$$
- for FSS systems of type B,

$$-138.5 - 25 \log \phi = -161.1 - M$$
or

$$25 \log \phi = 22.6 + M$$
- for FSS systems of type C,

$$-140.5 - 25 \log \phi = -159.0 - M$$
or

$$25 \log \phi = 18.5 + M$$

where M is an inter-service margin below the permissible single-entry level of interference between networks in the FSS. The resultant separation angles ϕ are shown in Fig. 1 for systems A, B and C for margins M between +3 dB and +10 dB. Further study is required to determine the most appropriate value of M .

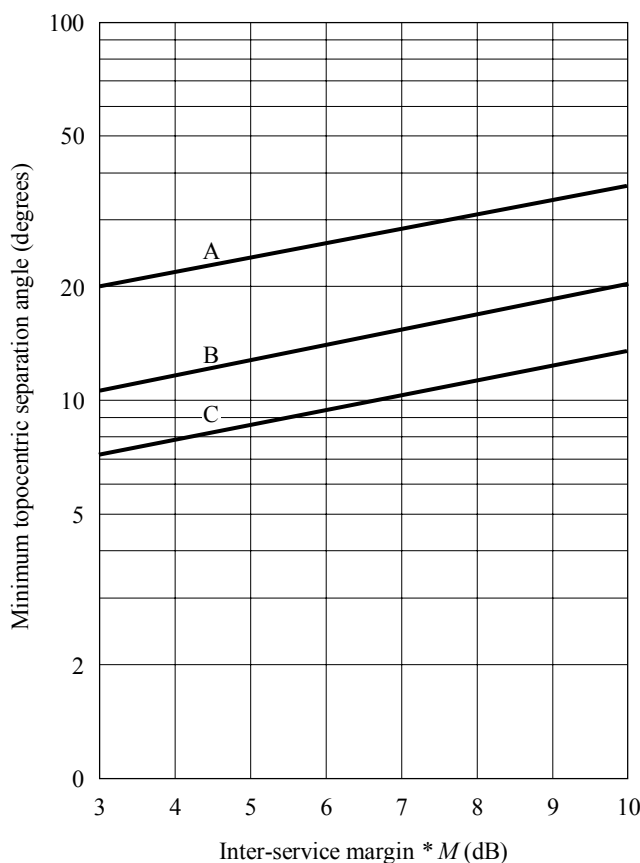
3 The BSS Plans

The practical implication of the inter-regional sharing situation described in the preceding sections is that some networks of the FSS serving one Region will find it difficult to locate their space stations close to or within those Regions of the GSO which have been systematically assigned to the BSS.

Thus, for example, the Region 1 BSS Plan, with its orbit location assignments every 6° , sets up an interference pattern for an FSS receiving earth station located at Recife (Brazil) which is illustrated in Fig. 2. Figure 2 shows the wanted-to-unwanted carrier ratio (C/I) at the Recife location as a function of the orbit location of an FSS space station transmitting in the band 11.7-12.2 GHz. The wanted signal is characterized by a 13.2 dBW satellite e.i.r.p. as received by a 49.9 dB gain earth-station antenna with a side-lobe radiation pattern of $32 - 25 \log \phi$. For the small angular differences between BSS and FSS satellite locations, it should be noted that the unwanted carrier is within the main beam of the FSS earth-station antenna.

FIGURE 1

**Minimum topocentric separation angles between BSS and FSS systems
as a function of acceptable interference inter-service margin below
the single-entry fixed-satellite interference level**



A: System A
B: System B
C: System C

* The values used here are chosen only to illustrate the relationships involved. Further study is required to determine the value of M to be used in estimating required separation angles.

Figure 3 shows a similar example involving the Region 2 (1983) BSS Plan and an FSS receiving earth-station location at Lisbon (Portugal), the common frequency band being the band 12.5-12.7 GHz.

An analogous situation exists in the Pacific Ocean area where the Region 2 FSS may encounter difficulties with the Regions 1 and 3 BSS Plan in the band 11.7-12.2 GHz, the Region 1 FSS with the Region 2 BSS Plan at 12.5-12.7 GHz, and the Region 3 FSS with Region 2 BSS Plan at 12.2-12.7 GHz. Figure 4 shows an example of the Pacific Ocean area interference situation between the Region 2 BSS Plan and the Region 3 FSS. The test point for this case is Hong Kong.

In Figs. 2, 3 and 4 it should be noted that, at each BSS orbit location, not all frequencies in the shared band are subject to the maximum interference that is implied by the curves. Furthermore, the simplistic broadcasting-satellite coverage area and antenna radiation pattern models used for establishing the plans and used in the derivation of these Figures are, in general, pessimistic and coordination with actual broadcasting satellites will be considerably easier than the illustrations indicate particularly if the broadcasting-satellite antenna design takes into account the inter-regional interference potential.

FIGURE 2
Typical variation of worst-case channel aggregate downlink C/I for 64 kbit/s digital carriers versus nominal orbital location of an FSS space station serving Region 2 in the band 11.7-12.2 GHz

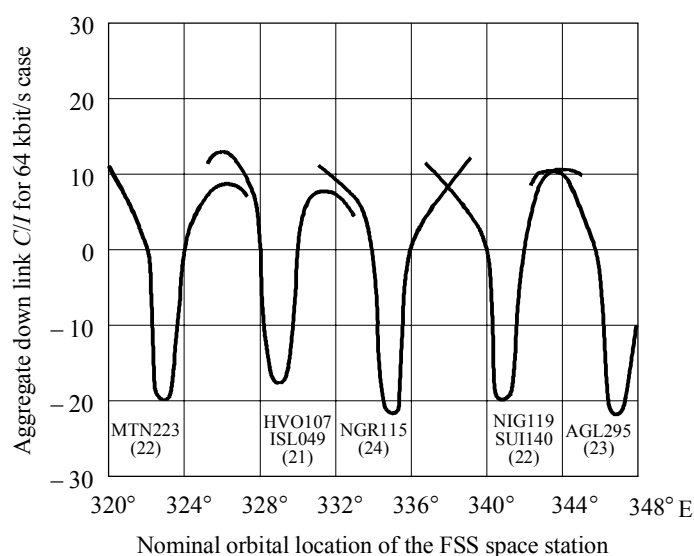
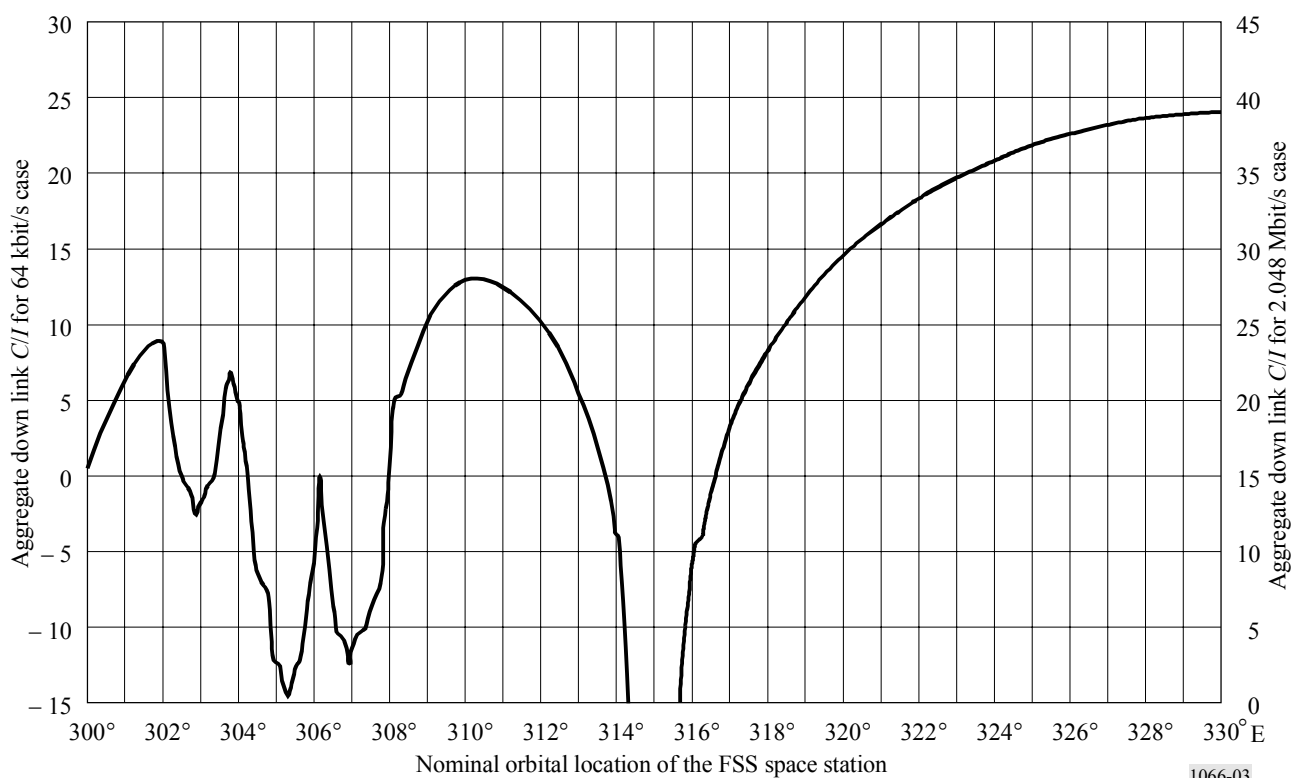


FIGURE 3

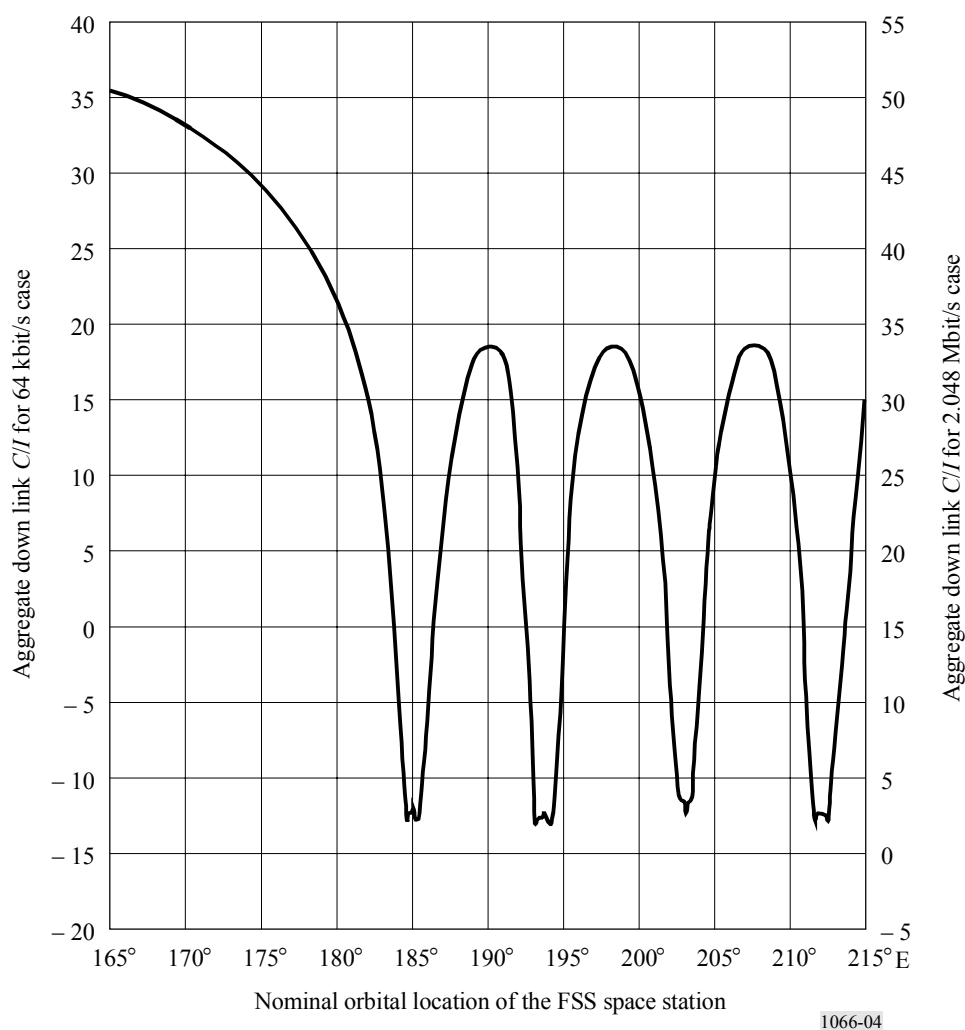
Typical variations of worst-case channel aggregate downlink C/I for 64 kbit/s and 2.048 Mbit/s digital carriers versus nominal orbital location of an FSS space station serving Region 1 in the band 12.5-12.7 GHz



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FIGURE 4

Typical variations of worst-case channel aggregate downlink C/I for 64 kbit/s and 2.048 Mbit/s digital carriers versus nominal orbital location of an FSS space station serving Region 3 in the band 12.2-12.7 GHz



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It should also be noted that provisions have been made for the implementation of interim BSS systems in Region 2. As interim BSS systems may be implemented using parameters outside of the nominal plan assignment parameters, this may compound the sharing difficulties described previously.

4 Amelioration of sharing difficulties

It is apparent that an FSS network which is to provide service in the Atlantic Ocean area to both Region 1 at 12.5-12.7 GHz and Region 2 at 11.7-12.2 GHz will be faced with difficulties. A temporary avoidance of these difficulties would be possible if affected BSS operations were to activate first those channels which would not overlap frequencies used by the FSS. In the long run, however, it will be necessary to resort to a number of mitigating measures or techniques, if feasible.

Thus, FSS satellite operators and designers might be able to utilize several techniques to reduce the amount of interference received from BSS satellites, if feasible:

- choose orbit locations of FSS satellites taking into account the orbital locations of BSS assignments in a Plan;
- avoid assigning sensitive FSS carriers on frequencies with BSS FM-TV carriers;
- use power compensation techniques within transponders where possible. Greater power can be assigned to carrier frequencies subject to greater interference from BSS channels;
- use FSS earth-station antennas with an improved side-lobe pattern in the orbital plane; e.g. $29 - 25 \log \phi$;
- relax the relevant interference criteria to take into account the fact that BSS carriers are unmodulated by a video signal for only a small percentage of time;
- use frequencies for FSS operations that are not likely to be implemented by BSS operators during the lifetime of the FSS satellite or during the lifetime of the Plan.

BSS satellite operators and designers in all three Regions, on the other hand, can employ only a limited number of interference mitigating techniques to reduce the amount of interference to FSS operations in other Regions. These techniques, if found to be feasible, are:

- employ improved BSS satellite transmitting antenna patterns to reduce the amount of energy in the side-lobes compared with that assumed in the Plan;
 - employ improved forms of energy dispersal in the absence of programming material;
 - employ a BSS satellite e.i.r.p. less than that specified in the Plan where consistent with system requirements and with possible interactions with other BSS assignments.
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