

RECOMMENDATION ITU-R S.1718

Power flux-density values in the band 11.7-12.7 GHz and associated calculation methodology which may be used when the power flux-density values in § 6 of Annex 1 to Appendix 30 of the Radio Regulations are exceeded

(Question ITU-R 236/4)

(2005)

Scope

Section 6 of Annex 1 to RR Appendix 30 provides power flux-density (pfd) values to determine if a proposed BSS network in one Region needs to coordinate with an FSS network in another Region, in the frequency band 11.7-12.7 GHz. The mask in that section provides the envelope of pfd values to trigger coordination with a wide range of FSS earth station antenna sizes. This Recommendation gives a table of levels equivalent to those in § 6 of Annex 1 to RR Appendix 30 for particular combinations of FSS earth station antenna size and system noise temperature, and also describes the methodology by which these levels were computed and a methodology to determine such levels for other earth station antenna sizes by interpolation.

The ITU Radiocommunication Assembly,

considering

- a) that systems in the FSS and the BSS have allocations in the band 11.7-12.7 GHz;
- b) that the use of this band by the planned BSS is subject to the coordination procedure of Article 4 of Appendix 30 of the Radio Regulations (RR) and to the coordination requirements contained in the “Remarks” column in Article 11 of RR Appendix 30;
- c) that § 6 of Annex 1 to RR Appendix 30 provides thresholds to determine if there is a need to coordinate planned BSS networks in one region with respect to FSS networks in another region in the band 11.7-12.7 GHz,

further considering

- a) that pfd values in § 6 of Annex 1 to RR Appendix 30 are thresholds to determine if coordination is required between a planned BSS network operating in one region with respect to an FSS network in another region;
- b) that such threshold values should necessarily be protective of FSS links with a wide range of technical characteristics;
- c) that § 6 of Annex 1 to RR Appendix 30 also provides a pfd mask which corresponds to the envelope of the permissible interfering pfd into the range of GSO FSS earth station antenna sizes used in the 11.7-12.7 GHz band;
- d) that technical information is needed to address instances when the pfd values in § 6 of Annex 1 to RR Appendix 30 are exceeded and coordination of the corresponding BSS assignments with FSS assignments is necessary,

recommends

1 that in cases where, as a result of the application of Article 4 of RR Appendix 30 or the coordination requirements contained in the “Remarks” column in Article 11 of RR Appendix 30, the pfd values in § 6 of Annex 1 to RR Appendix 30 are exceeded, the pfd values given in Table 1 may be used by administrations, during their bilateral or multilateral coordination of their BSS assignments with FSS assignments, to identify levels equivalent to those in § 6 of Annex 1 to RR Appendix 30 for particular antenna sizes (see also Notes 1 to 10);

2 that, notwithstanding *recommends* 1, the pfd level produced at the surface of the Earth within the service area of the affected FSS assignment by a planned BSS network operating in another region should not exceed $-103.6 \text{ dB(W/(m}^2 \cdot 27 \text{ MHz))}$.

TABLE 1

Applicable pfd values ($\text{dB(W/(m}^2 \cdot 27 \text{ MHz))}$) corresponding to various FSS antenna sizes

Orbital separation between wanted and interfering space stations	Antenna size (cm)							
	45 (see Note 5)	60	80	120	240	500	800	1 100
	pfd values ($\text{dB(W/(m}^2 \cdot 27 \text{ MHz))}$)							
$\theta = 0^\circ$	-134.2	-136.7	-138.7	-141.4	-147.4	-152.5	-155.6	-158.4
$\theta > 0^\circ$	See Note 3 and Table 2 of Annex 1							

NOTE 1 – The applicable pfd value should be derived from Table 1 using the antenna diameters calculated from the maximum antenna gains as given in the RR Appendix 4 information provided to the Bureau under RR No. 9.30 for the affected FSS assignment in question.

NOTE 2 – In calculating the compliance of the pfd levels produced by the interfering BSS network with those given in Table 1, the affected FSS receive earth station antenna should be assumed to be compliant with the antenna pattern specified in Recommendation ITU-R BO.1213, extrapolated to the relevant frequency within the 11.7-12.7 GHz band, for antennas of 2.4 m in diameter or less, and with the antenna pattern specified in § 3 of Annex 3 to RR Appendix 7, for antennas of more than 2.4 m in diameter.

NOTE 3 – In calculating the compliance of the pfd levels produced by the interfering BSS network with those given in Table 1, the minimum orbital separation between the wanted and interfering networks should be assumed, including the station-keeping accuracies. For any value of the orbital separation θ between the wanted and interfering space stations, the applicable pfd should be relaxed from the value corresponding to 0° orbital separation by adding the off-axis antenna discrimination, as calculated under the assumptions in Note 2.

NOTE 4 – For FSS antenna diameters different from those in Table 1, the method given in Annex 2 is an example of possible way to interpolate.

NOTE 5 – The values for less than 60 cm antenna diameter are only applicable for Region 3 FSS networks in the orbital arc $110^\circ \text{ E}-124^\circ \text{ E}$ with respect to assignments in the Regions 1 and 3 List in the orbital arc $105^\circ \text{ E}-129^\circ \text{ E}$:

– for which RR Appendix 4 information for coordination had been received by the Bureau prior to 30 March 2002; and

- which had been brought into use prior to 30 March 2002 and for which the date of bringing into use had been confirmed to the Bureau; and
- for which the complete due diligence information, in accordance with Annex 2 to Resolution 49(Rev.WRC-2000), had been received by the Bureau prior to 30 March 2002.

NOTE 6 – The values in Table 1 may be exceeded by mutual agreement between the concerned administrations.

NOTE 7 – This Recommendation and the associated methodology do not release administrations from their coordination obligation under Articles 4 and 11 of RR Appendix 30.

NOTE 8 – The pfd values in Tables 1 and 2 in Annex 1 were derived using the methodology contained in Annex 1 and assuming a 6% noise increase interference allowance, a frequency of 11.7 GHz, an antenna efficiency of 65%, and total link noise temperature values of 174 K for antennas with up to 60 cm diameter, 198 K for 80 cm diameter, 238 K for 120 cm and 240 cm, 317 K for 500 cm, and 396 K for 800 cm or more. During coordination between concerned administrations, other values for link noise temperature increase and link noise temperature may be considered.

NOTE 9 – As the FSS also uses narrow-band transmissions the pfd should be expressed in units of dB(W/(m² · 40 kHz)). This requires reducing the pfd value by $10 \log(27\,000/40) = 28.3$ dB.

NOTE 10 – This Recommendation is not intended to be used by the Bureau in its analysis of networks to determine whether or not the criteria in Annex 1 of RR Appendix 30 are exceeded.

Annex 1

Methodology to calculate pfd levels for FSS networks using particular earth station antenna sizes for use when the trigger levels in § 6 of Annex 1 to RR Appendix 30 are exceeded

1 Description of the methodology

The pfd required to protect an interfered-with FSS network is related to the receive earth station antenna gain and total link noise temperature of the interfered-with FSS network by the following formula:

$$pfd(\theta) = 10 \log(\Delta T/T) + 10 \log(k T b_{ref}) + 10 \log(4\pi/(0.3/f)^2) - G_a(\varphi) \quad (1)$$

where:

- θ : orbital separation between interfered-with and interfering satellites (see Note 3)
- φ : topocentric angle between the interfered-with and interfering satellites at the wanted receiving antenna (degrees)
- $\Delta T/T$: allowable relative increase in total receive link noise temperature (%)
- k : Boltzmann's constant (10^{-23} J K⁻¹)
- T : total receive link noise temperature (K)
- b_{ref} : reference bandwidth (27 MHz) (see Note 9 of *recommends 2*)

$G_a(\varphi)$: receive antenna gain for topocentric angle of φ° (dBi)

f : frequency of the interfered-with and interfering signals (GHz).

Note that for a specified $(\Delta T/T)$, b_{ref} , and T , the allowable interfering pfd is only a function of the receive antenna gain which is a function of satellite orbital separation.

2 Application of the methodology to obtain the levels of pfd specified in Table 2

This methodology is used for calculating the pfd values that protect FSS networks with antenna sizes ranging from 45 cm to 11 m from interfering BSS networks with given orbital separation angles, with the assumptions given in Notes 2 and 8 of the Recommendation and assuming $\varphi = 1.1 \theta$. The corresponding values for these cases are given in Table 2 below, which correspond to the pfd values given in Table 1 for $\theta = 0$. The link noise temperature values which have been used to derive these values are also given in Table 2.

TABLE 2
Applicable pfd values dB(W/(m² · 27 MHz)) corresponding to various FSS antenna sizes and orbital separations

Separation angles (θ)	45 cm antenna $T=174\text{K}$	60 cm antenna $T=174\text{K}$	80 cm antenna $T=198\text{K}$	120 cm antenna $T=238\text{K}$	240 cm antenna $T=238\text{K}$	500 cm antenna $T=317\text{K}$	800 cm antenna $T=396\text{K}$	1 100 cm antenna $T=396\text{K}$
0.01	-134.2	-136.7	-138.7	-141.4	-147.4	-152.5	-155.6	-158.4
0.10	-134.2	-136.7	-138.7	-141.3	-147.2	-151.4	-152.7	-152.9
0.50	-134.0	-136.3	-137.9	-139.7	-140.8	-132.0	-133.2	-133.2
1.00	-133.3	-135.1	-135.7	-134.8	-127.9	-126.6	-125.7	-125.7
1.50	-132.1	-133.0	-132.1	-126.5	-123.5	-122.2	-121.3	-121.3
2.00	-130.5	-130.1	-126.9	-120.4	-120.4	-119.1	-118.2	-118.2
2.50	-128.4	-126.4	-120.3	-117.9	-117.9	-116.7	-115.7	-115.7
3.00	-125.9	-121.8	-116.8	-116.0	-116.0	-114.7	-113.8	-113.8
3.50	-122.8	-116.5	-115.1	-114.3	-114.3	-113.0	-112.1	-112.1
4.00	-119.3	-114.2	-113.6	-112.8	-112.8	-111.6	-110.6	-110.6
5.00	-111.8	-111.8	-111.2	-110.4	-110.4	-109.2	-108.2	-108.2
6.00	-109.8	-109.8	-109.2	-108.4	-108.4	-107.2	-106.2	-106.2
7.00	-108.1	-108.1	-107.6	-106.8	-106.8	-105.5	-104.6	-104.6
8.00	-106.7	-106.7	-106.1	-105.3	-105.3	-104.1	-103.1 ⁽¹⁾	-103.1 ⁽¹⁾
9.00	-105.4	-105.4	-104.8	-104.0	-104.0	-102.8 ⁽¹⁾	-101.8 ⁽¹⁾	-101.8 ⁽¹⁾
10.00	-104.3	-104.3	-103.7	-102.9 ⁽¹⁾	-102.9 ⁽¹⁾	-101.6 ⁽¹⁾	-100.7 ⁽¹⁾	-100.7 ⁽¹⁾
11.00	-103.2 ⁽¹⁾	-103.2 ⁽¹⁾	-102.7 ⁽¹⁾	-101.9 ⁽¹⁾	-101.9 ⁽¹⁾	-100.6 ⁽¹⁾	-99.6 ⁽¹⁾	-99.6 ⁽¹⁾
12.00	-102.3 ⁽¹⁾	-102.3 ⁽¹⁾	-101.7 ⁽¹⁾	-100.9 ⁽¹⁾	-100.9 ⁽¹⁾	-99.7 ⁽¹⁾	-98.7 ⁽¹⁾	-98.7 ⁽¹⁾

⁽¹⁾ As a result of *recommends* 2, the value of -103.6 dB(W/(m² · 27 MHz)) is applicable in this case.

Annex 2

**Example methodology for determining the pfd ($\theta = 0$) values for
an antenna size not included in Table 1**

Step 1: Determination of closest parameters x_A, y_A, x_B, y_B from Table 1 and the applicable total link noise temperature, T :

If $45 \leq d \leq 60$ cm then $T = 174$ K

If $60 < d < 80$ cm then T is derived using the equation below with $x_A = 60, y_A = 174, x_B = 80, y_B = 198$

If $80 \leq d < 120$ cm then T is derived using the equation below with $x_A = 80, y_A = 198, x_B = 120, y_B = 238$

If $120 \leq d \leq 240$ cm then $T = 238$ K

If $240 < d < 500$ cm then T is derived using the equation below with $x_A = 240, y_A = 238, x_B = 500, y_B = 317$

If $500 < d < 800$ cm then T is derived using the equation below with $x_A = 500, y_A = 317, x_B = 800, y_B = 396$

If $800 < d < 1\,100$ cm then $T = 396$ K:

$$T = y_A + (y_B - y_A)(d - x_A)/(x_B - x_A)$$

Step 2: Determination of the applicable maximum gain, G_{max} :

$$G_{max} = 10 \log(0.65(\pi 0.01d/(0.3/f))^2)$$

Step 3: Determination of the applicable pfd ($\theta = 0$):

$$pfd(\theta = 0) = 10 \log(6/100) - 228.6 + 10 \log(T) + 74.3 + 10 \log(4\pi/(0.3/f)^2) - G_{max}$$

where:

T : total FSS link noise temperature (K)

d : diameter of the interfered-with receiving antenna (cm)

G_{max} : maximum gain of the interfered-with receiving antenna (dBi)

f : frequency of the interfered-with and interfering signals (GHz).