

## RECOMMENDATION ITU-R S.1433

**UPLINK AND INTER-SATELLITE EQUIVALENT POWER FLUX-DENSITY  
RADIATED BY NON-GSO FSS SYSTEMS**

(2000)

The ITU Radiocommunication Assembly,

*considering*

- a) the limits on the power flux-density (pfd) received at the GSO from Earth-to-space or space-to-Earth transmission within non-GSO FSS networks in the frequency band covered by Resolution 130 (WRC-97) should provide protection for GSO FSS networks;
- b) that such limits should be established taking into account the geostationary satellite receiving antenna characteristics;
- c) that these limits should take account of all the earth stations or space stations, as appropriate, of a non-GSO FSS network within visibility of the geostationary satellite;
- d) that the discriminating characteristics of the geostationary satellite antenna should be included in the definition of the limit;
- e) that such limits to the uplink equivalent power flux-density ( $\text{epfd}_{\text{up}}$ ) should apply in FSS (Earth-to-space) allocations at 12.5-13.25 GHz, 13.75-14.5 GHz, 27.5-28.6 GHz and 29.5-30.0 GHz in accordance with Resolution 130 (WRC-97);
- f) that such limits to the inter-satellite equivalent power flux-density ( $\text{epfd}_{\text{is}}$ ) should apply in FSS (space-to-Earth) allocations used by non-GSO FSS which are shared with GSO FSS Earth-to-space in the bands 10.7-11.7 GHz, 12.5-12.75 GHz and 17.8-18.4 GHz;
- g) that designers of non-GSO FSS systems need a definition of the limits of their transmissions at the GSO arc;
- h) that the operators of GSO FSS satellites will accept interference from non-geostationary co-channel systems when they meet certain  $\text{epfd}_{\text{up}}$  or  $\text{epfd}_{\text{is}}$  limits,

*recommends*

- 1** that when considering the design of non-GSO FSS systems the definition for  $\text{epfd}_{\text{up}}$  or  $\text{epfd}_{\text{is}}$  should be used as indicated in Annex 1;
- 2** that when determining  $\text{epfd}_{\text{up}}$  or  $\text{epfd}_{\text{is}}$  radiated by their systems, non-GSO system designers should consider that the normalized GSO FSS space station receive antenna pattern is:
  - 2.1** for the frequency bands 10.7-11.7 GHz, 12.5-13.25 GHz, 13.75-14.5 GHz and 17.8-18.4 GHz: Recommendation ITU-R S.672 with a gain of 32.4 dBi, a side-lobe level of -20 dB, and a half-power beamwidth of 4°;
  - 2.2** for the frequency bands 27.5-28.6 GHz and 29.5-30.0 GHz: Recommendation ITU-R S.672 with a gain of 40.7 dBi, a side-lobe level of -10 dB, and a half-power beamwidth of 1.55°;
- 3** that the  $\text{epfd}_{\text{up}}$  and  $\text{epfd}_{\text{is}}$  limits indicated in Annex 2 should not be exceeded by non-GSO FSS systems using the allocations indicated in *considering* e) and f) above and are considered by GSO FSS systems as meeting the requirements of Article S22 of the RR;
- 4** that in designing GSO FSS networks, administrations should take into account interference from non-GSO FSS systems produced at the levels in Annex 2 so that this interference is acceptable.

## ANNEX 1

**Common definition of  $epfd_{up}$  and  $epfd_{is}$** 

The  $epfd_{up}$  is defined as the weighed sum of the pfd produced at the geostationary orbit by all the transmit earth stations within a non-geostationary-satellite system.  $epfd_{is}$  is defined as the weighed sum of the pfd produced at transmit space station within a non-GSO system. In both definitions the off-axis discrimination of a reference receiving antenna assumed to be pointing in its nominal direction is taken into account. The  $epfd$  is calculated using the following formula:

$$epfd = 10 \log_{10} \left[ \sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \times \frac{G_t(\theta_i)}{4\pi d_i^2} \times \frac{G_r(\phi_i)}{G_{r,max}} \right]$$

where:

$epfd$ :	computed equivalent power flux-density (dB(W/m <sup>2</sup> )) in the reference bandwidth
$N_a$ :	number of transmit stations in the non-geostationary-satellite system that are visible from the GSO receive space station, considered on the Earth's surface or in the geostationary orbit, as appropriate
$i$ :	index of the transmit station considered in the non-geostationary-satellite system
$P_i$ :	RF power at the input of the antenna of the transmit station, that gets radiated, considered in the non-geostationary-satellite system (dBW) in the reference bandwidth
$\theta_i$ :	off-axis angle between the boresight of the transmit station considered in the non-geostationary-satellite system and the direction of the GSO receive station
$G_t(\theta_i)$ :	transmit antenna gain (as a ratio) of the station considered in the non-geostationary-satellite system in the direction of the GSO receive station
$d_i$ :	distance (m) between the transmit station considered in the non-geostationary-satellite system and the GSO receive station
$\phi_i$ :	off-axis angle between the boresight of the antenna of the GSO receive station and the direction of the $i^{\text{th}}$ transmit station considered in the non-geostationary-satellite system
$G_r(\phi_i)$ :	receive antenna gain (as a ratio) of the GSO receive station in the direction of the $i^{\text{th}}$ transmit station considered in the non-geostationary-satellite system
$G_{r,max}$ :	maximum gain (as a ratio) of the antenna of the GSO receive station.

## ANNEX 2

 **$epfd_{up}$  and  $epfd_{is}$  limits for certain FSS allocations**

The  $epfd_{up}$  produced at any point in the GSO by emissions from all the earth stations in a non-geostationary-satellite system in the FSS in the frequency bands listed in Table 1, for all conditions and for all methods of modulation, should not exceed the limits given in Table 1 for the specified percentages of time. These limits relate to the  $epfd$  which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in RR Table S22-1, for all pointing directions towards the Earth's surface visible from the GSO.

TABLE 1

**Limits to the  $\text{epfd}_{\text{up}}$  radiated by non-GSO FSS systems  
in certain frequency bands**

Frequency band (GHz)	$\text{epfd}_{\text{up}}$ (dB(W/m <sup>2</sup> ))	Percentage of time during which $\text{epfd}$ level may not be exceeded	Reference bandwidth (kHz)	Reference GSO space station antenna beamwidth and reference radiation pattern
12,5-12,75 12,75-13,25 13,75-14,5	-160	100	40	4° Rec. ITU-R S.672, $L_s = -20^{(1)}$
27.5-28.6 29.5-30.0	-162	100	40	1.55° Rec. ITU-R S.672, $L_s = -10^{(1)}$

<sup>(1)</sup> For the case of  $L_s = -10$ , the values  $a = 1.83$  and  $b = 6.32$  should be used in the equations in Annex 1 of Recommendation ITU-R S.672 for single-feed circular beams. In all cases of  $L_s$ , the parabolic main beam equation should start at zero.

The  $\text{epfd}_{\text{is}}$ , produced at any point in the GSO orbit by emissions from all the space stations in a non-geostationary-satellite system in the FSS in the frequency bands listed in Table 2, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, should not exceed the limits given in RR Table S22-2 for the specified percentages of time. These limits relate to the  $\text{epfd}$  which would be obtained under free-space propagation conditions into a reference antenna and in the reference bandwidth specified in Table 2, for all pointing directions towards the Earth's surface visible from the GSO.

TABLE 2

**Limits to the  $\text{epfd}_{\text{is}}$  radiated by non-GSO FSS systems  
in certain frequency bands**

Frequency band (GHz)	$\text{epfd}_{\text{is}}$ (dB(W/m <sup>2</sup> ))	Percentage of time during which $\text{epfd}$ level may not be exceeded	Reference bandwidth (kHz)	Reference GSO space station antenna beamwidth and reference radiation pattern
10.7-11.7 in Region 1 12.5-12.75 in Region 1 12.7-12.75 in Region 2 17.8-18.4	-160	100	40	4° Rec. ITU-R S.672, $L_s = -20$