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ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R SF.674-3

(12/2013)

Determination of the impact on the fixed service operating in the 11.7-12.2 GHz band when geostationary fixed-satellite service networks in Region 2 exceed power flux-density thresholds for coordination

SF Series

Frequency sharing and coordination between fixed-satellite and fixed service systems

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.

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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.*

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RECOMMENDATION ITU-R SF.674-3

Determination of the impact on the fixed service operating in the 11.7-12.2 GHz band when geostationary fixed-satellite service networks in Region 2 exceed power flux-density thresholds for coordination

(1990-1997-2002-2013)

Scope

This Recommendation provides a methodology that can be used to determine the interference levels that would be caused to fixed service systems by GSO fixed-satellite service systems operating at power flux-density levels above the coordination threshold specified in the Radio Regulations.

The ITU Radiocommunication Assembly,

considering

a) that the band 11.7-12.2 GHz is allocated to the fixed service (FS) on a worldwide basis and the fixed-satellite service (FSS) (space-to-Earth) in Region 2;

b) that the use of this band by geostationary-satellite networks in the FSS in Region 2 is subject to threshold levels for coordination specified in Table 5-1 of Appendix **5** of the Radio Regulations;

c) that frequency sharing between the FS and FSS would be facilitated by the establishment of a methodology to evaluate the interference levels from the FSS to the FS when the pfd values exceed the threshold for coordination,

recommends

that the methodology presented in Annex 1 should be used as a means for determining the interference levels caused to FS systems by the FSS when the pfd levels exceed the threshold referred to in *considering* b) above.

Annex 1

Determining interference into FS systems

Introduction

This Annex expands upon the methodology that is used in Recommendations ITU-R F.1107 and ITU-R F.1108 for digital FS systems. Recommendation ITU-R F.1108 uses the concept of fractional degradation in performance (FDP) for digital FS stations. The FDP is the fractional increase in the percentage of time that the controlling performance criterion will not be met because of the presence of interference. Recommendation ITU-R F.1108 suggests a value of 10% for FDP as appropriate for sharing studies. Accordingly, the methodologies described here will determine the fraction of FS receivers for which the FDP will exceed 10%. The FDP should exceed 10% for no more than an agreed small percentage of the terrestrial stations. Attachment 1 discusses the methodology used to analyse interference into digital systems. It should be noted that the methodology presented here does not make use of any orbital avoidance.

Attachment 1 contains the details of the methodology used and some results. The analysis presented in Attachment 1 shows that the increased performance degradation in digital FS systems, due to FSS systems that exceed that pfd thresholds referred to in *considering* b) is dependent on the chosen parameters. The results are based on a noise temperature of 1 100 K for digital FS stations. This value is taken from Table 7b of Annex 7 of Appendix 7 of the RR.

The methodology also takes into account the effects of attenuation by atmospheric gases, using the methodology of Recommendation ITU-R SF.1395.

The methodology applied in this Annex does not take account of the loss due to the spreading of the satellite antenna beam on the Earth-space path. According to Fig. 1 of Recommendation ITU-R P.834, the average long-term beam spreading loss could be 2.5 dB at a 0.1° elevation angle, 0.85 dB at a 1° elevation angle and 0.45 dB at a 2° elevation angle.

One interference mitigation technique that may be applicable to existing FS receiving antennas is to implement a slight antenna reorientation to reduce the main-beam coupling to the satellite emissions. Theoretical analyses suggest that the improvements are generally modest, that they depend on the initial off-main-beam angle to the satellite and that they increase with increasing interference-to-noise ratio (I/N). For I/N of +10 dB or greater, improvements of several dB may be possible when the satellite is initially outside of the three-dB beamwidth of the FS antenna. The practical considerations of implementing this mitigation technique have not been considered, and its effectiveness has not been confirmed in field trials.

Attachment 1

to Annex 1

Determining interference into digital FS systems

1 Methodology

The analysis methodology of Recommendation ITU-R F.1107 is summarized as follows. FSS networks are placed in order at equally spaced intervals across the geostationary arc: e.g. 2°. They are assumed to radiate pfd levels onto the surface of the Earth as follows:

pfd_{low} for $0° \leq \theta \leq 5°$

$pfd_{low} + 0.05\,(pfd_{high} - pfd_{low})\,(\theta - 5)$ for $5° \leq \theta < 25°$

pfd_{high} for $25° \leq \theta \leq 90°$.

The methodology used here differs from that of Recommendation ITU-R F.1107 in one important aspect. In order to measure the effect of an FSS satellite exceeding the pfd thresholds, the analysis allows the specification of additional satellites (at any orbital locations) to exceed the pfd thresholds by β dB. The pfds produced by these satellites are all assumed to have the following form:

$pfd_{low} + \beta$ for $0° \leq \theta \leq 5°$

$pfd_{low} + 0.05\,(pfd_{high} - pfd_{low})\,(\theta - 5) + \beta$ for $5° \leq \theta < 25°$

$pfd_{high} + \beta$ for $25° \leq \theta \leq 90°$.

Each digital station is analysed independently of all others. For the purposes of interference analysis, an ensemble of receivers is modelled so that each station has the same latitude, but a longitude whose value is picked randomly over a 60° range (this latter part is similar to the methodology used in Recommendation ITU-R F.1107). Each FS antenna has a 0° elevation angle and a randomly chosen azimuth angle uniformly distributed between 0° and 360°. The interference is converted into an FDP value for each, as in Recommendation ITU-R F.1108. A cumulative distribution is then calculated for the FDP.

2 Results

Figures 1, 2 and 3 present results of an interference analysis of a network of digital FSS GSO satellites spaced 2° apart causing interference into a digital FS network. The FSS system baseline run is performed with $pfd_{low} = –124$ and $pfd_{high} = –114$ dB(W/(m^2 · MHz)). It transmits with a frequency of 11.95 GHz. The FS system latitude is 40°. In this example, each FS site antenna is assumed to have a maximum gain of 44 dB with all receivers having a noise temperature of 1 100 K. A feeder loss of 3 dB is used and the antenna radiation pattern follows Recommendation ITU-R F.1245. In the key, “Nsats” refers to the number of satellites that exceed the pfd baseline by $\beta = 10$ dB: i.e. these satellites have $pfd_{low} + \beta = –114$ and $pfd_{high} + \beta = –104$ dB(W/(m^2 · MHz)). In Fig. 1, the satellites that exceed the pfd threshold were the Nsats satellites closest to the horizon of the FS network (lowest elevation angles). In Fig. 2, the satellites that exceed the pfd threshold were the Nsats satellites closest to the centre of the FS network (highest elevation angles). In Fig. 3, various alternative scenarios are presented. The baseline graph here is for Nsats = 30 and with these satellites closest to the horizon of the FS network.

FIGURE 1

Digital FSS into digital FS, Nsats satellites closest to the horizon

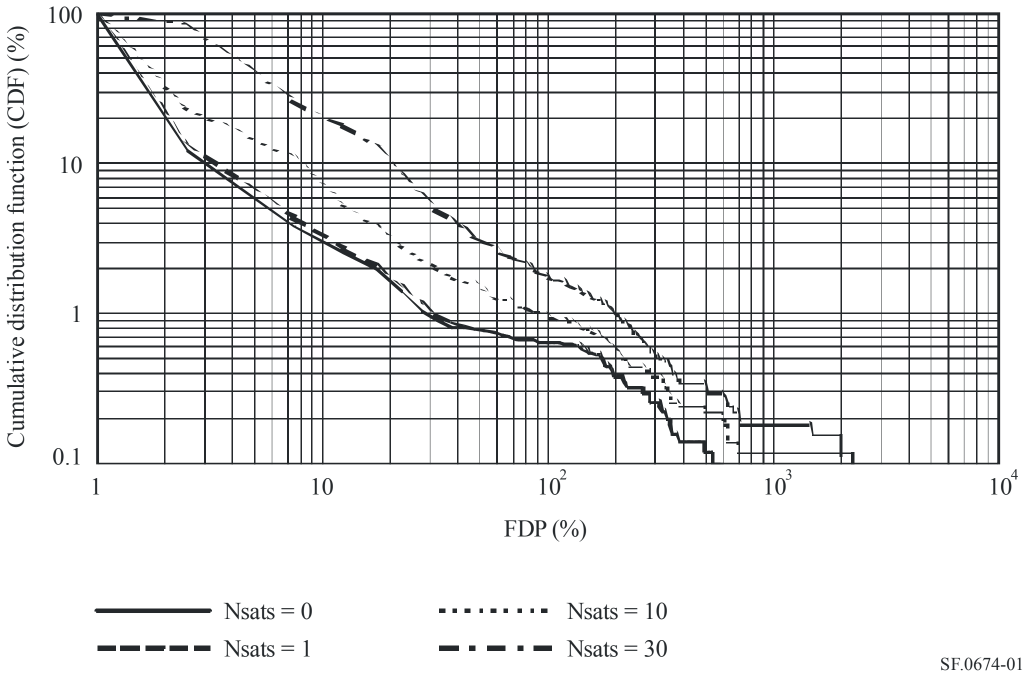

FIGURE 2

Digital FSS into digital FS, Nsats satellites closest to FS network centre

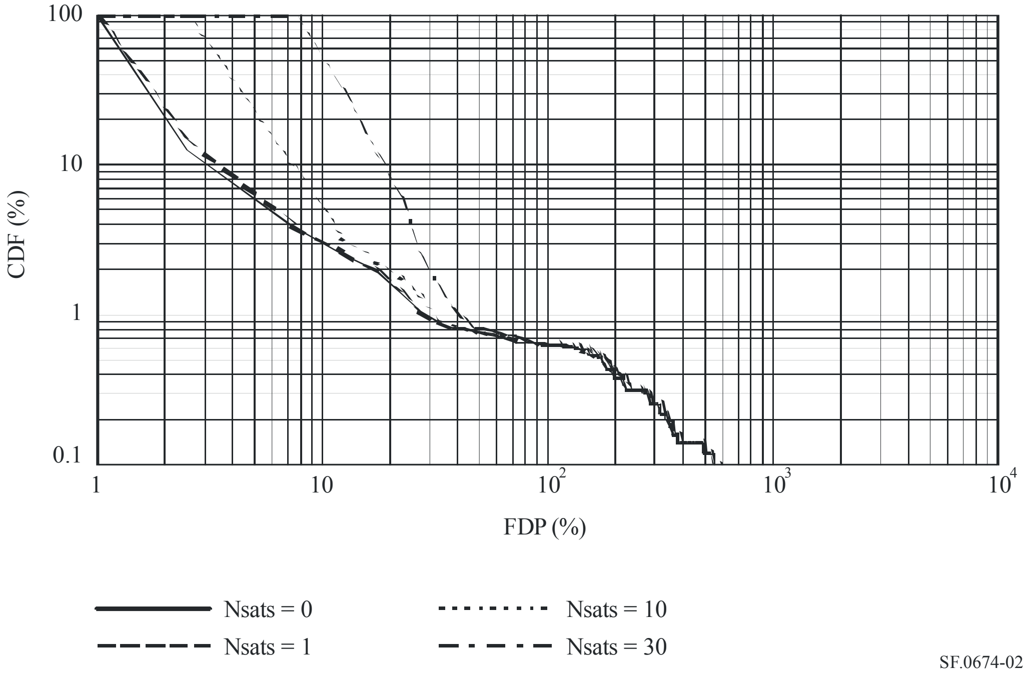

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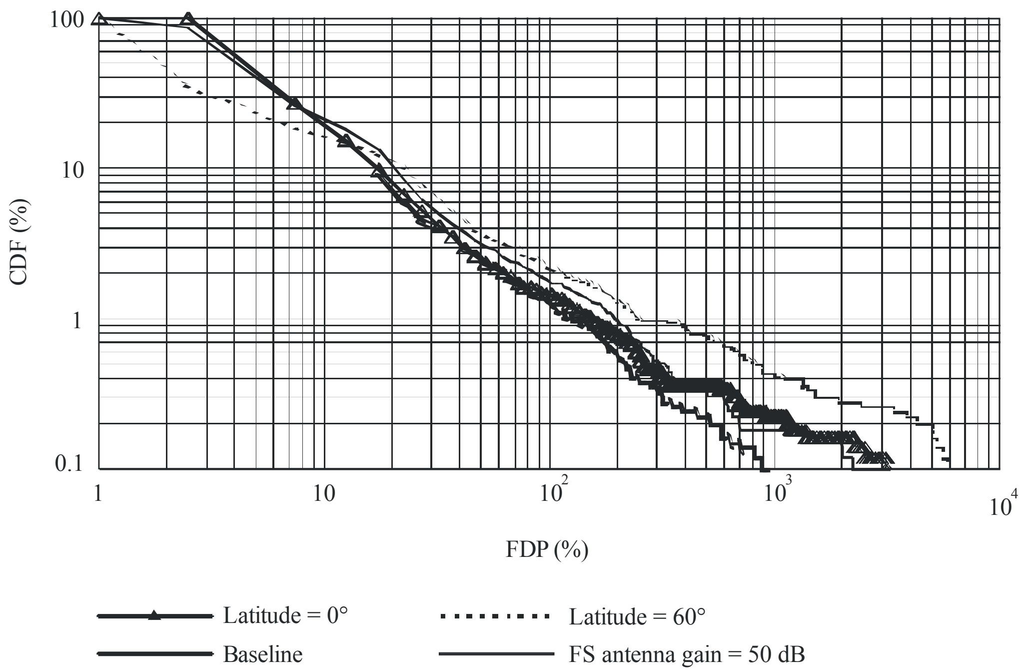
FIGURE 3

Digital FSS into digital FS, alternative scenarios



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The results of Figs 1 and 2 demonstrate that in both cases there would be a negligible increase in interference when a single satellite exceeds the pfd baseline by β = 10 dB, that somewhat less than 10% of the FS stations would experience an FDP exceeding 10% when 10 satellites exceed this baseline, and that all FS stations would experience an FDP exceeding 10% when 30 satellites exceed this baseline. There is, however, a significant difference between the two cases. For the low angle case, it is possible to have significantly higher interference levels when Nsats gets large in comparison to the Nsats = 0 case, although with a low probability. This graph shows that when the FS system latitude is changed to 60° or to 0°, then the interference changes only slightly, except for the 60° case, in which interference increases for low probability values. When the FS maximum antenna gain is increased to 50 dB the interference decreases.