



Report ITU-R S.2174
(07/2010)

**Guidelines that may be used in the design
of satellite networks for assessing
the impact of rain attenuation
on the carrier to noise plus
interference ratios of the
FSS Plan allotments**

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***Note:** This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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1 Introduction

In 2007, the World Radiocommunication Conference (WRC-07) adopted a revised FSS Plan (contained in Appendix 30B to the Radio Regulations), in which a number of technical parameters and criteria were modified. The above-mentioned Plan provides all ITU Members with protected orbital-frequency resources. In the FSS Plan, the criterion for the carrier-to-noise ratio (C/N) is defined under rain-faded conditions but the criterion for the carrier-to-interference (C/I) is defined in clear-sky conditions. In some cases, as a consequence of approved technical criteria and unavoidable signal attenuation due to rain, the energy balance of planned allotments in the 13/10-11 GHz frequency bands may become substantially worse.

All mathematical computations made in this Report are based on the assumption that the uplink power is designed to strictly achieve a C/N ratio of 21 dB under rain-faded conditions. It should be noted that test points of some allotments have higher faded C/N values in the uplink (i.e. greater than 21 dB).

Throughout this Report, the following notation is used:

$$X_{dB} = A_{dB} \oplus B_{dB} \Leftrightarrow X_{dB} = -10 \log(10^{-A_{dB}/10} + 10^{-B_{dB}/10})$$

Annex 1 to this Report provides supplementary information which examines two additional impacts of rain attenuation on system margin which are not taken into account by the FSS Plan. Annex 2 contains all the terms and their respective definitions used in the Report and in Annex 1.

2 The criteria approved in the FSS Plan

The overall link C/N is set to 14 dB (on the basis of the following balance: an uplink C/N ratio set to 21 dB and a downlink C/N ratio set to 15 dB) for 99.9% of the year on both uplink and downlink directions in the 13/10-11 GHz bands. It should be noted that these values are guaranteed for the carrier-to-thermal noise ratios and not for the carrier-to-noise-plus-interference ratios ($C/(N+I)$).

As decided by WARC Orb-88 and confirmed by WRC-07, to increase homogeneity between various allotments, the increase of the space and earth transmitter power, necessary to compensate for the attenuation, is limited to 8 dB. For achieving the same purpose, the minimum earth station transmitter power density was limited to -60 dB(W/Hz) averaged over the necessary bandwidth of the modulated carrier. Therefore, on the uplink, while some allotments may not be guaranteed a minimum C/N ratio of 21 dB for 99.9% of the year, others may exhibit a C/N ratio strictly greater than 21 dB even under rain-faded conditions.

The carrier to interference ratio C/I for the overall communication link should not be lower than 21 dB for aggregate interference and 25 dB for single-entry interference under free-space conditions.

An allotment or an assignment is considered as being affected by a proposed new allotment or assignment if at least one of the following three conditions is not satisfied:

1. the calculated Earth-to-space single-entry carrier-to-interference ratio $(C/I)_{up, SE}$ must be greater than or equal to a reference value of 30 dB;
2. the calculated space-to-Earth single-entry carrier-to-interference ratio $(C/I)_{down, SE}$ must be greater than or equal to a reference value of 26.65 dB;
3. the calculated overall aggregate carrier-to-interference ratio $(C/I)_{agg}$ must be greater than or equal to a reference value that is 21 dB.