

RECOMMENDATION ITU-R SA.1273*

**POWER FLUX-DENSITY LEVELS FROM THE SPACE RESEARCH, SPACE OPERATION
AND EARTH EXPLORATION-SATELLITE SERVICES AT THE SURFACE
OF THE EARTH REQUIRED TO PROTECT THE FIXED SERVICE
IN THE BANDS 2 025-2 110 MHz AND 2 200-2 290 MHz**

(Questions ITU-R 118/7 and ITU-R 113/9)

(1997)

The ITU Radiocommunication Assembly,

considering

- a) that systems in the space research service (SRS), space operation service (SOS) and Earth exploration-satellite service (EESS) and the fixed service (FS) share the bands 2 025-2 110 MHz and 2 200-2 290 MHz;
- b) that the FS operates and plans to operate a variety of point-to-point and point-to-multipoint (P-MP) systems employing analogue and digital techniques in these bands;
- c) that, because of such sharing, it is necessary to ensure that emissions from satellites do not cause unacceptable interference to FS systems;
- d) that FS systems can be satisfactorily protected from the emissions from satellites by placing suitable limits on the power flux-density (pfd) produced at the surface of the Earth, in a reference bandwidth;
- e) that, nevertheless, any limitations of the pfd produced at the surface of the Earth should not be such as to place undue restrictions on the design of systems in the SRS, SOS and EESS services;
- f) that the performance degradation for a fixed service system depends on the sum of the degradations due to emissions from all space stations that are visible to it;
- g) that the band 2 025-2 110 MHz is used for Earth-to-space links for both low-Earth orbiting (LEO) and geostationary satellite orbit (GSO) spacecraft; the band is also used for space-to-space links, typically for radiocommunications from data relay satellite (DRS) spacecraft to LEO spacecraft;
- h) that the band 2 200-2 290 MHz is used for space-to-Earth links for both LEO and GSO spacecraft; this band is also used for space-to-space links, typically for radiocommunications from LEO spacecraft to DRS spacecraft;
- j) that for systems in the SRS, SOS and EESS, techniques are employed to reduce the radio-frequency spectral power density of satellite emissions,

recommends

- 1 that in the band 2 200-2 290 MHz the maximum pfd produced at the surface of the Earth by emissions from a space station operating in the space-to-Earth direction, for all conditions and methods of modulation, should not exceed:
 - $-130 \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival less than 5° above the horizontal plane;
 - $-130 + 0.5 (\delta - 5) \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival δ (degrees) between 5° and 25° above the horizontal plane;
 - $-120 \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival between 25° and 90° above the horizontal plane;

* This Recommendation was jointly developed by Radiocommunication Study Groups 7 and 9, and future revisions should be undertaken jointly.

2 that in the band 2 200-2 290 MHz the maximum pfd produced at the surface of the Earth by emissions from a space station in LEO operating in the space-to-space direction, for all conditions and methods of modulation, should not exceed:

- $-127 \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival less than 5° above the horizontal plane;
- $-127 + 0.5 (\delta - 5) \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival δ (degrees) between 5° and 25° above the horizontal plane;
- $-117 \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival between 25° and 90° above the horizontal plane;

3 that in the band 2 025-2 110 MHz the maximum pfd produced at the surface of the Earth by emissions from a DRS in GSO, for all conditions and methods of modulation, should not exceed:

- $-130 \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival less than 5° above the horizontal plane;
- $-130 + 0.5 (\delta - 5) \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival δ (degrees) between 5° and 25° above the horizontal plane;
- $-120 \text{ dB(W/m}^2\text{)}$ in any 1 MHz for angles of arrival between 25° and 90° above the horizontal plane;

3.1 that the value of $-130 \text{ dB(W/m}^2\text{)}$ in any 1 MHz may need to be exceeded in rare occasions by up to 6 dB but for not more than 5% of the time to compensate for background interference;

4 that the above limits relate to the pfd and angles of arrival which would be obtained under free-space propagation conditions;

5 that Annex 1 should be referred to for additional guidance relating to this Recommendation.

NOTE 1 – In deriving § 2 of *recommends*, it has been determined that space-to-space transmissions of the space radiocommunication services control the sharing environment with the FS.

ANNEX 1

Interference considerations from the SRS, SOS and EESS into the FS in the bands 2 025-2 110 MHz and 2 200-2 290 MHz

1 Introduction

This Annex provides additional consideration in support of the pfd values given in § 1, 2 and 3 of *recommends*. The values presented in this Annex have been derived either from a calculation of the effects of continuous interference from the emissions of geostationary DRS or from Monte Carlo simulations of the effect of emissions from geostationary DRS satellites and LEO satellites on FS stations using the principles of Recommendations ITU-R F.1107 and ITU-R F.1108. Orbital locations for DRS satellites were obtained from Recommendation ITU-R SA.1275; FS system parameters were obtained from Recommendations ITU-R M.1143 and ITU-R F.759, and the orbital characteristics of the LEO satellite space science services satellites were derived from the Report of the Space Science Services Steering Group (Annex 4 to Document 7B/26-9D/54 dated 16 November 1994).

Paragraph 2 summarizes the results applicable to the emissions of GSO satellites in the band 2 200-2 290 MHz. Paragraph 3 summarizes the results applicable to the emissions of LEO satellites in the band 2 200-2 290 MHz, and § 4 applies to the emissions of DRS satellites in the band 2 025-2 110 MHz. Each paragraph contains its own conclusion that supports the value of pfd in the associated *recommends*.

2 Pfd levels applicable to geostationary satellite emissions in the band 2 200-2 290 MHz

A number of GSO satellites operating in the ground network of the space science services use the band 2 200-2 290 MHz (space-to-Earth) for tracking, telemetry and command verification (TTC) either on an operational or on a contingency basis. Scientific satellites tend to use the band operationally, whereas if the band is used by application satellites, such as fixed-, broadcasting-, or mobile-satellites, it tends to be on a contingency basis. Data gathered on a number of such GSO satellites have indicated that their numbers vary over a ten year span to the year 2005 between 87 and 117. At a particular orbit location there will only be a few assignments and there will be significant spans of the GSO orbit where there are no assignments existing or planned. The e.i.r.p. of 96% of existing GSO satellite assignments is less than +10 dBW, resulting in a total pfd of less than -153 dB(W/m²) on the surface of the Earth. Taking into account the necessary bandwidths of the GSO satellites, with the exception of only a few assignments, the e.i.r.p. density of the GSO satellite transmissions is less than -10 dB(W/4 kHz), resulting in a pfd on the surface of the Earth of less than -173 dB(W/m²) in any 4 kHz (-149 dB(W/m²) in any 1 MHz) for all angles of arrival.

Based on this data, it may be concluded that emissions from GSO satellites in the band 2 200-2 290 MHz are not significant sources of potential interference to the FS. To ensure that sufficient flexibility is afforded DRS applications in future while also protecting the FS, a pfd level equivalent to -154/-144 dB(W/(m² · 4 kHz)) as identified in the Radio Regulations No. S21.16, Table S21-4 for the band 2 200-2 300 MHz (Mask A) and referenced to 1 MHz will be adequate for sharing of this band.

3 Pfd levels applicable to LEO satellite emissions in the band 2 200-2 290 MHz

3.1 Simulation studies considered the downlink interference from 24 DRS-LEO combinations, where each DRS was treated as transmitting/receiving simultaneously to/from two LEOs (while they were visible). All DRS-LEO combinations were considered as operating together and co-channel. The transmission parameters used for the modelling are summarized in Table 1.

TABLE 1

Satellite transmission parameters used for the modelling

	DRS	LEO
Power density into antenna (dB(W/Hz))	-57.7	-83.5 ⁽¹⁾
Transmit gain (dBi)	34.7	28.5
Receive gain (dBi)	36.0	28.5
Antenna pattern	Recommendation ITU-R S.672 (-20 dB sidelobe)	Recommendation ITU-R S.672 (-20 dB sidelobe)

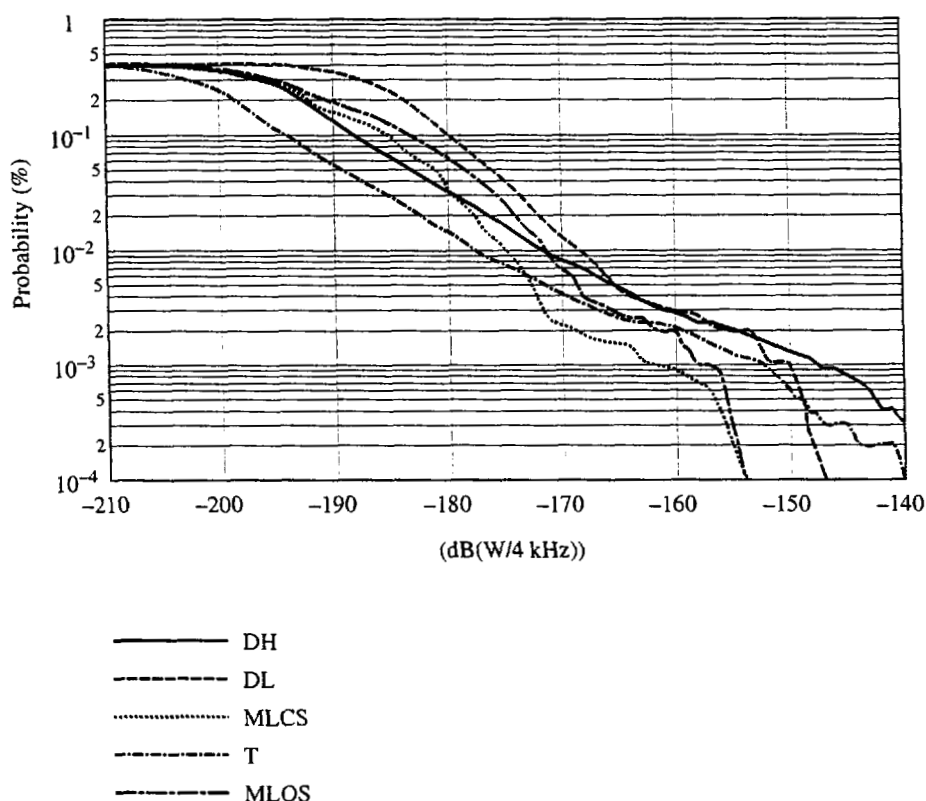
(1) Based on a quoted e.i.r.p. density of -55 dB(W/Hz).

The interference was simulated into a variety of fixed systems. As the only element of the receive system that will alter the value of received interference is the antenna, it was necessary only to model interference into each antenna type, rather than each system type. Consequently interference was modelled only into system types DH (digital high capacity), DL (digital low capacity), MLCS (digital point-to-multipoint central station), MLOS (digital point-to-multipoint out station) and T (analogue or digital tropospheric), representing 33 dBi dish, Yagi, omnidirectional, flat-plate and 45 dBi dish antennas, respectively.

Interference was calculated at each of 60 locations (at 20° and 50° North, and at 30° longitude increments) and for 8 FS antenna azimuths at each location. For the results presented, the two worst-case results were then selected for each system type (excluding those locations far from land).

Figure 1 shows that the Yagi antenna (DL system) experiences the most severe interference at approximately -184 dB(W/4 kHz) for 20% of the time. This is, however, well within the long-term performance objective (20%) for most fixed link systems, i.e., around -170 dB(W/4 kHz) . This protection level corresponds to a degradation in FS receiver threshold of approximately 1 dB (see Recommendation ITU-R F.759).

FIGURE 1
Interference from LEO into various FS systems



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The long-term interference into the 33 dBi dish, omnidirectional and flat-plate antennas is similar, at around 9 dB less than that into the Yagi.

The narrow beamwidth of the 45 dBi gain tropospheric antenna ensures that it receives very low levels of long-term interference, but occasional alignments result in high short-term interference levels.

These low levels of interference generally would be expected as the LEO antenna will point away from the earth for the majority of the orbit.

3.2 Deterministic simulations (see Fig. 2) have also shown that, with 24 LEO spacecraft at 800 km altitude (98° inclination) and at 350 km altitude (28.5° inclination) working to 12 DRS satellites, and with unfavourable FS antenna azimuth pointings, the long-term (20% of the time) FS protection criteria are marginally met using a pfd mask with levels approximately 2 to 3 dB greater than $-154/-144 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$. Low-power P-MP systems, which employ relatively low-gain antennas, are marginally protected in both the long and short term at these pfd levels.