



Recommendation ITU-R SA.1016-1
(08/2019)

**Sharing considerations relating to space
research service (deep space)**

SA Series
Space applications and meteorology



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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 SA.1016-1

Sharing considerations relating to space research service (deep space)

(1994-2019)

Scope

This Recommendation gives the frequency sharing considerations relating to space research service (deep space) in the 2 GHz, 7 GHz, and 34 GHz bands.

Keywords

Frequency sharing, deep space, SRS earth stations, SRS space stations

Relevant ITU-R Recommendations and Reports

Recommendations ITU-R SA.509, ITU-R SA.684, ITU-R SA.1014, ITU-R SA.1015, ITU-R SA.1157

Report ITU-R SA.2066

The ITU Radiocommunication Assembly,

considering

- a) that the feasibility of frequency sharing between stations of space research service (deep space) and stations of other services is presented in Annex 1 and Annex 2;
- b) that earth stations of space research service (deep space) can cause harmful interference to receiving aeronautical mobile stations, receiving space stations, and receiving microwave sensor stations that come within line-of-sight;
- c) that earth stations of space research service (deep space) can cause harmful interference to receiving mobile stations that are not separated sufficiently;
- d) that high power transmissions from terrestrial stations can interfere with the space stations of space research service (deep space), especially during the near-Earth operations of space stations;
- e) that earth stations of space research service (deep space) can receive harmful interference from transmitting aeronautical mobile stations, transmitting space stations, and active microwave sensor stations that come within line-of-sight;
- f) that earth stations of space research service (deep space) can receive harmful interference from transmitting mobile stations that are not separated sufficiently;
- g) that space stations of space research service (deep space) can adversely affect stations of radio astronomy service,

recommends

- 1 that, with successful operational coordination, space research service (deep space) should be able to share frequency bands in the Earth-to-space direction with stations in the services already allocated in the same band, except the following stations for which sharing is not feasible:
 - receiving aeronautical mobile stations, receiving space stations, and microwave sensor satellites, when any of these may come within line-of-sight;

- receiving mobile stations that come within the separation distance required for interference protection;
- transmitting terrestrial stations having an average e.i.r.p. exceeding 82 dBW in the bands near 2 GHz, 85 dBW in the bands near 7 GHz, and 84 dBW in the bands near 34 GHz (see Note 1);

2 that, with successful operational coordination, space research service (deep space) should be able to share frequency bands in the space-to-Earth direction with stations in the services already allocated in the same band, except the following stations for which sharing is not feasible:

- transmitting aeronautical mobile stations, transmitting space stations, and active microwave sensor satellites, when any of these may come within line-of-sight;
- transmitting mobile stations that come within the separation distance required for interference protection;
- the radio astronomy service;

3 that the following Note should be regarded as part of this Recommendation.

NOTE – For transmitters in the fixed and mobile services, Article **21** of ITU Radio Regulations specifies much lower e.i.r.p. limits.

Annex 1

Sharing considerations relating to space research service (deep space)

1 Sharing considerations in the frequency bands allocated to the space research service (deep space) in the Earth-to-space direction

The ITU Radio Regulations (RR) identifies the frequency bands 2 110-2 120 MHz, 7 145-7 190 MHz, and 34.2–34.7 GHz for use by the space research service (deep space) in the Earth-to-space direction. In addition, the frequency band 16.6–17.1 GHz is identified as a secondary allocation for use by space research service (deep space). Table 1 and the following subsections consider the possibility of interference to the space research service (deep space) in these frequency bands.

TABLE 1

Potential interference in Earth-to-space bands

Source	Receiver
Deep space earth station	Terrestrial or earth station
Deep space earth station	Earth orbiting satellite
Terrestrial or earth station	Deep space station
Near-earth station	Deep space station

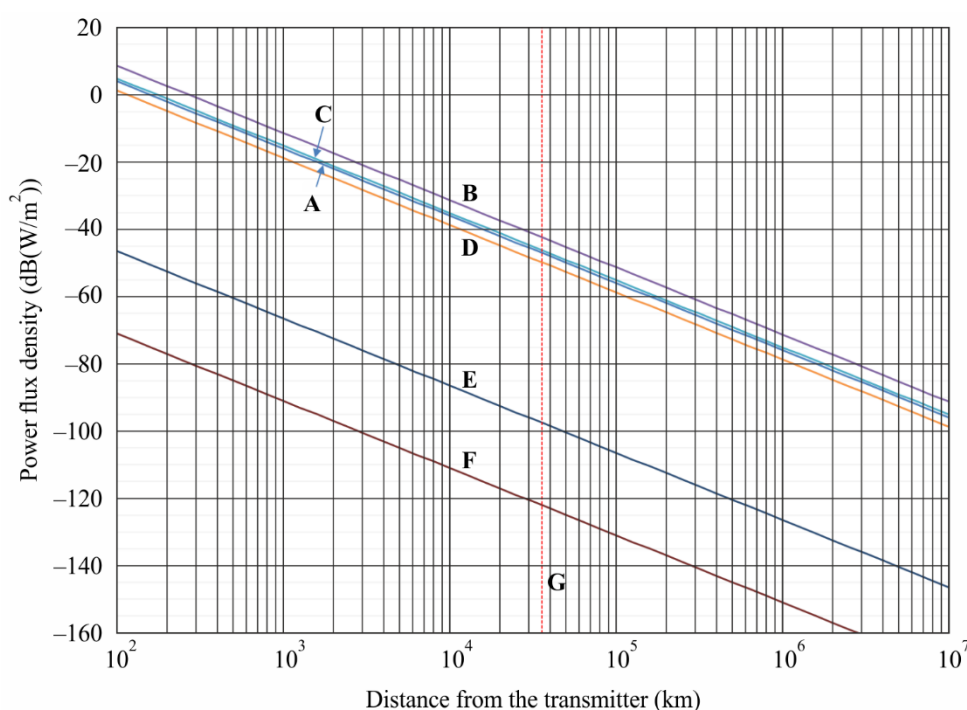
1.1 Potential interference to terrestrial/aircraft receivers or earth station receivers from deep space earth station transmitters

The normal total transmitter power for current deep space earth stations is 43 dBW in 2 GHz and 7 GHz bands, and 30 dBW in 34 GHz band (see Recommendation ITU-R SA. 1014). For a minimum elevation angle of 10 degrees, the e.i.r.p. directed towards the horizon does not exceed 50 dB (W/4 kHz) in 2 GHz and 7 GHz bands, and 37 dB (W/4 kHz) in 34 GHz band, assuming the reference earth station antenna radiation pattern of Recommendation ITU-R SA. 509. Thus the e.i.r.p. towards the horizon meets the requirements of Nos. **21.10** and **21.11** of the RR. For higher SRS earth station transmitting powers, the elevation angles need to be increased accordingly to meet the Radio Regulations e.i.r.p. limits towards the horizon.

Aircraft stations within line-of-sight of a deep space earth station may encounter total power flux-densities as shown below in Fig. 1. For an aircraft altitude of 12 km, the maximum line-of-sight distance to an earth station is 391 km. In this case, assuming 100 kW earth station transmit power and -10 dBi transmit antenna gain (Recommendation ITU-R SA. 509), the total power flux-density (pfd) at the aircraft can never be lower than -83 dB (W/m²). As the separation distance and earth station antenna direction change, the aircraft station may experience much higher pfd and interference levels. Therefore, coordination with airborne stations is generally not practicable.

FIGURE 1

Power flux-density versus distance from SRS earth station



SA.1016-01

Transmitter: Deep space earth station, 70 m diameter antenna

A: main beam, 34.5 GHz, 1 kW

B: main beam, 17 GHz, 10 kW

C: main beam, 7 170 MHz, 20 kW

D: main beam, 2 115 MHz, 100 kW

E: 5 deg off-axis (14.5 dBi gain, Rec. ITU-R SA.509), 2 115 MHz, 100 kW

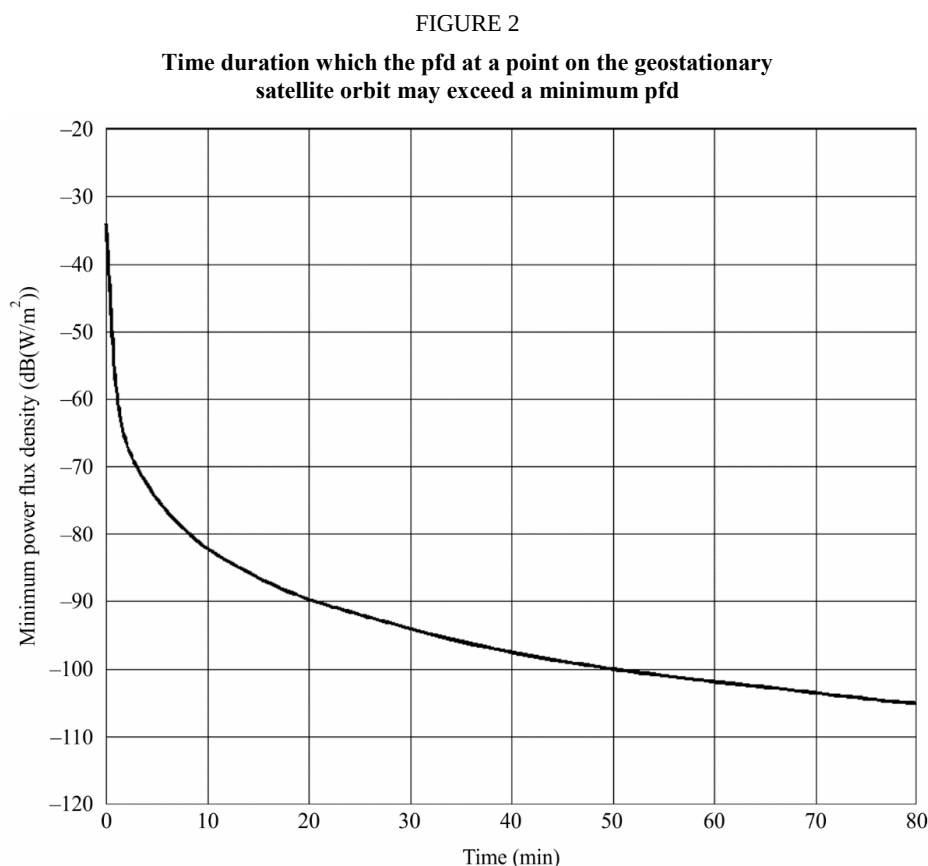
F: > 48 deg off-axis (-10 dBi gain, Rec. ITU-R SA.509), 2 115 MHz, 100 kW

G: geostationary orbit altitude: 35 800 km

Furthermore, propagation mechanisms of super refraction, ducting, and precipitation scatter may couple emissions from deep space earth station transmitters into terrestrial receivers and into receivers of other earth stations. However, except for airborne terrestrial receivers, coordination for these cases is generally practicable. See § 2.3 for discussion of interference from airborne transmitters, and see § 3 for coordination considerations.

1.2 Potential interference to satellite receivers from deep space earth station transmitters

Satellites that come within the deep space earth station beam will encounter pfd as shown in Fig. 1. When the earth station is tracking a spacecraft whose direction is such that the antenna beam passes through the geostationary satellite orbit (GSO), the pfd at that point on the orbit will vary with time as shown in Fig. 2. For example, the total pfd will be -95 dB (W/m^2) or higher for 32 minutes. The Figure assumes a transmitter power of 50 dBW, a 70-m antenna, and the reference earth station antenna pattern of Recommendation ITU-R SA.509. An important observation is that the minimum pfd at the GSO within line-of-sight of a deep space earth station is at least -122 dB (W/m^2), regardless of antenna pointing direction.



SA.1016-02

Transmitter: Deep space earth station, 100 kW, 70 m diameter antenna, 34.5 GHz

Additionally, the duration and magnitude of signals from deep space earth station transmitters, which may interfere with satellites in non-geostationary orbits, depends upon those orbits and the direction in which the earth station antenna is pointing.