

International Telecommunication Union

**ITU-R**  
Radiocommunication Sector of ITU

**Recommendation ITU-R SA.1810-1**  
(07/2017)

**System design guidelines for Earth  
exploration-satellites operating  
in the band 8 025-8 400 MHz**

**SA Series**  
**Space applications and meteorology**

## 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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### Series of ITU-R Recommendations

(Also available online at <http://www.itu.int/publ/R-REC/en>)

Series	Title
<b>BO</b>	Satellite delivery
<b>BR</b>	Recording for production, archival and play-out; film for television
<b>BS</b>	Broadcasting service (sound)
<b>BT</b>	Broadcasting service (television)
<b>F</b>	Fixed service
<b>M</b>	Mobile, radiodetermination, amateur and related satellite services
<b>P</b>	Radiowave propagation
<b>RA</b>	Radio astronomy
<b>RS</b>	Remote sensing systems
<b>S</b>	Fixed-satellite service
<b>SA</b>	<b>Space applications and meteorology</b>
<b>SF</b>	Frequency sharing and coordination between fixed-satellite and fixed service systems
<b>SM</b>	Spectrum management
<b>SNG</b>	Satellite news gathering
<b>TF</b>	Time signals and frequency standards emissions
<b>V</b>	Vocabulary and related subjects

*Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

Electronic Publication  
Geneva, 2017

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## RECOMMENDATION ITU-R SA.1810-1

**System design guidelines for Earth exploration-satellites operating  
in the band 8 025-8 400 MHz**

(Question ITU-R 139/7)

(2007-2017)

**Scope**

The use of the 8 025-8 400 MHz band by Earth exploration-satellite service (EESS) satellites operated by various entities for data downlink operations is increasing and could result in harmful interference between these operators. Potential difficulties in sharing the heavily occupied 8 GHz spectrum may be avoided, if EESS satellite designers carefully select which of the mitigation methods are appropriate for the satellite's intended operations. In addition to improving the sharing conditions for EESS satellites, many of the mitigation methods can also be beneficial in reducing or eliminating potential coordination with the extremely sensitive space research service (deep space) operating in the adjacent 8 400-8 450 MHz band. This Recommendation provides guidance in the form of a list of possible mitigation methods, shown in recommends, for consideration to reduce the potential for interference by and to EESS satellites given the growing interest in the use of the 8 025-8 400 MHz band by the EESS.

**Keywords**

Earth Exploration-Satellite Service, system design

**Related Recommendations and Reports**

Recommendation ITU-R SA.1157

The ITU Radiocommunication Assembly,

*considering*

- a)* that Earth exploration-satellite service (EESS) satellites are an increasingly important tool for acquiring information about the Earth and its environment;
- b)* that use of the band by EESS operated by commercial interests, governmental organizations and space agencies is increasing and could result in harmful interference among EESS systems;
- c)* that proper selection of orbital parameters for sun-synchronous satellites can be a very effective interference mitigation technique which in general requires coordination at an early stage of system development;
- d)* that homogeneity among a set of technical parameters, and in particular power flux-density (pfd) levels, will lead to a more efficient use of the orbit/spectrum resource by the EESS;
- e)* that high-gain antennas on EESS satellites typically radiate power only towards a limited portion of the Earth's surface but the higher obtained e.i.r.p. may be a disadvantage for co-located stations;
- f)* that isoflux antennas have a more uniform pfd distribution across the surface of the Earth as compared to omnidirectional antennas;
- g)* that broadcast modes generally cause higher levels of interference due to continuous transmissions and relatively high power spectral densities but have typically lower bandwidth requirements;

- h) that more than 90% of all EESS satellites operate at pfd levels below  $-147\text{dB}(\text{W}/\text{m}^2 \cdot 4 \text{ kHz})$  for high angles of arrival at the surface of the Earth;
- i) that the interference risk is more significant in high latitude areas since most of Earth exploration-satellites use polar orbits;
- j) that tropospheric propagation effects in high latitude areas are generally limited;
- k) that proper selection of bandwidth/power efficient modulation and coding techniques could result in smaller occupied bandwidths and lower adjacent channel interference;
- l) that higher order advanced modulation schemes, such as 16 PSK and above, need less bandwidth than currently used QPSK and 8-PSK but generally require higher pfd's;
- m) that a number of other interference mitigation techniques such as polarization discrimination, earth station separation and earth station antenna discrimination may also result in lower interference levels;
- n) that receiving earth stations in the space research service (SRS) (deep-space), operated in the adjacent 8 400-8 450 MHz band, are extremely sensitive and potentially susceptible to interference from out-of-band emissions of EESS (space-to-Earth) satellite transmissions in the 8 025-8 400 MHz band;
- o) that time-critical events occur in both SRS (deep-space) and EESS operations;
- p) that most of the mitigation techniques proposed to reduce interference between EESS data transmission links also reduce out-of-band emissions received by SRS (deep-space) stations in the adjacent 8 400-8 450 MHz band,

*recognizing*

- a) that the increasing possibility of congestion in the 8 025-8 400 MHz band and requirements for higher data rates will lead to increasing levels of interference;
- b) that guidelines for EESS (space-to-Earth) operations in the 8 025-8 400 MHz band are desirable to maximize the capacity of the band and to minimize harmful interference;
- c) that different mitigation methods may be required to resolve potential difficulties in the sharing of the band 8 025-8 400 MHz by different combinations of EESS systems,

*recommends*

that the following guidelines should be considered when designing EESS systems operating in the 8 025-8 400 MHz band:

- 1 that EESS satellites operating in a non-broadcasting mode should radiate only when transmitting data to one or more earth stations;
- 2 that phasing of the orbital parameters for sun-synchronous satellites with existing and planned satellites should be considered;
- 3 that, whenever practicable, low side-lobe, high-gain satellite antennas should be used and if not practicable, isoflux antennas should be considered instead of omnidirectional antennas;
- 4 that broadcast modes should be avoided whenever practicable or, if unavoidable, the use of a portion of the lower half of the band 8 025-8 400 MHz be considered;
- 5 that bandwidth efficient modulation and coding techniques should be used to the extent practicable, to reduce the potential for adjacent channel interference by simultaneously limiting pfd, out-of-band emissions and occupied bandwidth;

6 that, to reduce the possibility of intersystem interference, due consideration should also be given to other interference mitigation techniques such as polarization discrimination, geographical separation of earth stations and large earth station antennas with off-axis gains that do not exceed  $32-25 \log \theta$  dBi for  $1^\circ \leq \theta \leq 48^\circ$ ;

7 that EESS spacecraft using directional antennas be designed to limit the power flux-density on the Earth's surface in all areas with latitudes above  $55^\circ$  or below  $-55^\circ$  to less than  $-145$  dB(W/m<sup>2</sup>) for a reference bandwidth equal to 4 kHz;

8 that EESS spacecraft using isoflux antennas be designed to limit the power flux-density on the Earth's surface to less than  $-150$  dB(W/m<sup>2</sup>) for a reference bandwidth equal to 4 kHz;

9 that EESS spacecraft not using directional or isoflux antennas should be designed to limit the power flux density on the Earth's surface to less than  $-147$  dB(W/m<sup>2</sup>) for a reference bandwidth equal to 4 kHz;

10 that, in order to minimize the need for operational coordination, EESS satellites should utilize appropriate techniques to prevent, to the extent possible, unwanted emissions exceeding the ITU-R space research service (deep-space) protection criterion<sup>1</sup> in the band 8 400-8 450 MHz, including one or more of the applicable techniques given in *recommends* 1 through 8, on-board filtering, large geographical separation between EESS and space research service (deep-space) earth stations and/or low-sideband modulations;

11 that the use of the 25.5-27 GHz band by Earth exploration-satellites should be considered in particular if the techniques given in *recommends* 1 through 10 cannot adequately resolve potential spectrum-sharing and/or unwanted emission issues.

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<sup>1</sup> See relevant SA-series of ITU-R Recommendations.