Recommendation ITU-R RS.1813-2

(12/2023)

RS Series: Remote sensing systems

Reference antenna pattern for passive sensors operating in the Earth exploration-satellite service (passive) to be used in compatibility analyses in the frequency range 1.4-450 GHz

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.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from http://www.itu.int/ITU-R/go/patents/en where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Recommendations

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

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
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 RS.1813-2

Reference antenna pattern for passive sensors operating in the Earth exploration-satellite service (passive) to be used in compatibility analyses in the frequency range 1.4-450 GHz

(2009-2011-2023)

Scope

This Recommendation provides a reference antenna pattern for Earth exploration-satellite service (EESS) passive sensors to be used in compatibility studies in the frequency range 1.4-450 GHz when no other information is available on actual sensor antennas.

The ITU Radiocommunication Assembly,

considering

a) that reference satellite antenna patterns, which reflect to the maximum extent possible the actual antenna gain, are desirable for use in compatibility studies in the case of aggregate interference from multiple sources;

b) that antennas used for spaceborne passive sensors in the Earth exploration-satellite service (EESS) (passive) are usually designed to maximize main beam efficiency and minimize energy received through antenna side lobes;

c) that the impact of a dominating interference source on single pixel measurements or peak interference assessments may require consideration of maxima in the antenna side lobe pattern,

noting

that characteristics of passive sensors operating between 1.4 GHz and 450 GHz have been taken into account for the derivation of the proposed antenna pattern,

recommends

1 that, in the absence of an actual antenna pattern, the following equations for the average antenna pattern of a spaceborne passive sensor should be used, for antenna diameters greater than 2 times the wavelength:

$$G(\varphi) = G_{max} - 1.8 \times 10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{for} \quad 0° \le \varphi \le \varphi_m$$

$$G(\varphi) = \max\left(G_{max} - 1.8 \times 10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2, 33 - 5\log\left(\frac{D}{\lambda}\right) - 25\log(\varphi)\right) \quad \text{for} \quad \varphi_m < \varphi \le 69°$$

$$G(\varphi) = -13 - 5\log\left(\frac{D}{\lambda}\right) \quad \text{for} \quad 69° < \varphi \le 180°$$

In the case of $G(\varphi) < -23$ dBi, the value −23 dBi is to be used for circular antenna reflector, where:

$$G_{max} = 10\log\left(\eta\pi^2\frac{D^2}{\lambda^2}\right)$$

$$\varphi_m = \frac{22\lambda}{D}\sqrt{5.5 + 5\log\left(\frac{D}{\lambda}\eta^2\right)}$$

G_{max}: maximum antenna gain (dBi)

$G(\varphi)$: gain (dBi) relative to an isotropic antenna

φ: off-axis angle (degrees)

D: antenna diameter (m)

λ: wavelength (m)

η: antenna efficiency (if η is unknown, 60% can be assumed as a representative value);

2 that in cases where a few interference sources dominate, or where peak interference values are required in the analysis, the following equations for the antenna pattern for spaceborne passive sensors should be used, for antenna diameters greater than 2 times the wavelength:

$$G(\varphi) = G_{max} - 1.8 \times 10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{for} \quad 0° \le \varphi \le \varphi_m$$

$$G(\varphi) = \max\left(G_{max} - 1.8 \times 10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2, 40 - 5\log\left(\frac{D}{\lambda}\right) - 25\log(\varphi)\right) \quad \text{for} \quad \varphi_m < \varphi \le 69°$$

$$G(\varphi) = -6 - 5\log\left(\frac{D}{\lambda}\right) \quad \text{for} \quad 69° < \varphi \le 180°$$

In the case of $G(\varphi) < -23$ dBi, the value -23 dBi is to be used for circular antenna reflector, where:

$$G_{max} = 10\log\left(\eta\pi^2\frac{D^2}{\lambda^2}\right)$$

$$\varphi_m = \frac{22\lambda}{D}\sqrt{5.5 + 5\log\left(\frac{D}{\lambda}\eta^2\right)}$$

3 that in cases where the antenna reflector is elliptically-shaped, the maximum antenna gain and antenna diameter from *recommends* 1 and 2 should be replaced with the following equations, allowing for the antenna gain to be parameterized as a function of φ and α:

$$G_{max} = 10\log\left(\eta\pi^2\frac{D_{max}D_{min}}{\lambda^2}\right)$$

$$D = \sqrt{D_{max}^2\cos^2(\alpha) + D_{min}^2\sin^2(\alpha)} \quad \text{for} \quad 0° \le \alpha \le 90°$$

G_{max}: adjusted maximum antenna gain (dBi)

D: effective antenna diameter (m)

α: angle in the plane that is perpendicular to the antenna boresight vector and between the intended direction of emission and the antenna beam's major axis (degrees). See Figs 1 and 2 for additional clarity

D_{max}: antenna aperture major axis (m)

D_{min}: antenna aperture minor axis (m).

FIGURE 1

Definition of 3D coordinate system for elliptically-shaped reflectors

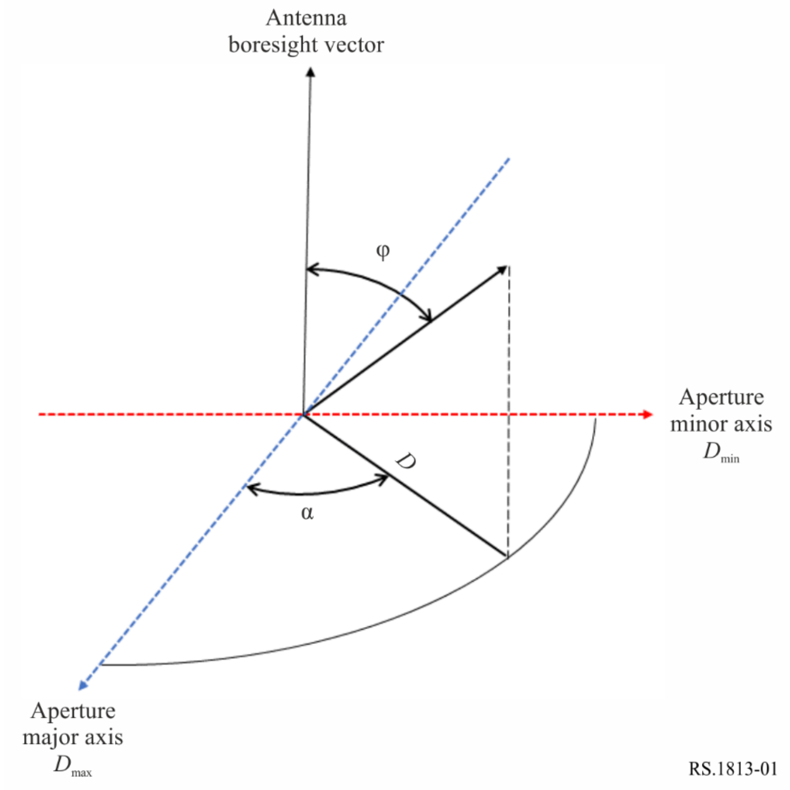
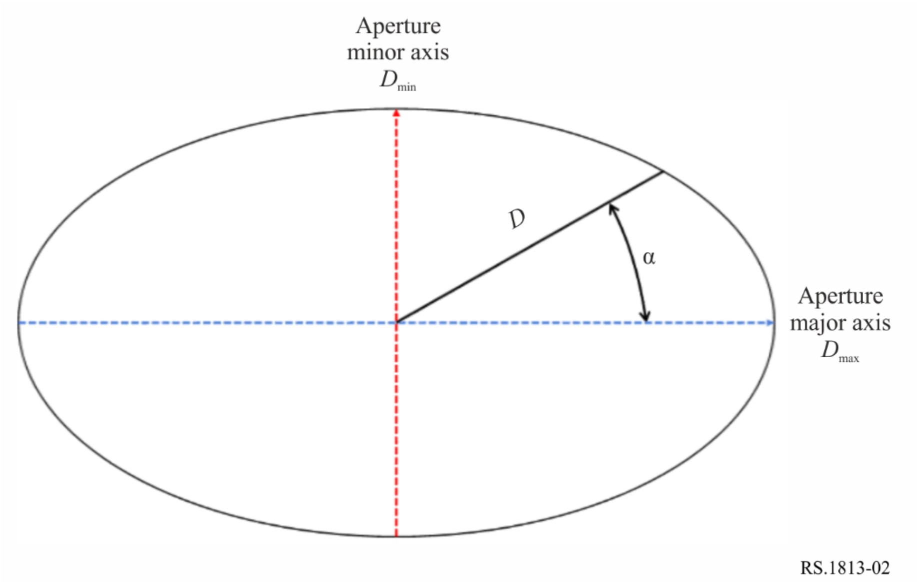


FIGURE 2

2D projection into perpendicular plane for elliptically-shaped reflectors



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