International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R SA.509-3
(12/2013)

Space research earth station and radio astronomy reference antenna radiation pattern for use in interference calculations, including coordination procedures, for frequencies less than 30 GHz

SA Series

Space applications and meteorology

International
Telecommunication
Union

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.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of 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 http://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.*

Electronic Publication
Geneva, 2014

RECOMMENDATION ITU-R SA.509-3

Space research earth station and radio astronomy reference antenna radiation pattern for use in interference calculations, including coordination procedures, for frequencies less than 30 GHz

(1978-1990-1998-2013)

Scope

This Recommendation gives reference antenna radiation patterns for space research and radio astronomy services for calculating interference from a single source or from multiple sources for frequencies less than 30 GHz.

The ITU Radiocommunication Assembly,

considering

a) that the application of coordination procedures between space research earth stations or radio astronomy observatories and stations of other services is dependent upon specific antenna radiation patterns;

b) that where this information does not exist, it may be desirable to use a reference antenna radiation pattern which represents the side-lobe gain levels that are not expected to be exceeded at most off-axis angles in the majority of antennas used in the service;

c) that measured data from some large ($D/\lambda \geq 100$) parabolic Cassegrain antennas used in the Space Research Service indicate an off-axis discrimination that is as good as, or better than, that of the reference antenna radiation pattern;

d) that, in the case of aggregate interference from multiple interferers, using the peak envelope radiation pattern could overestimate the interference,

recommends

1 that in the absence of measured data on the levels of main-lobe or side-lobe response of a space research earth station or radio astronomy antenna which is subject to interference analyses or coordination procedures, the following reference antenna radiation patterns be used only for large parabolic antennas with $D/\lambda \geq 100$ and for frequencies between about 1 and 30 GHz:

1.1 in cases of a single entry interference, to predict the worst-case interference from this source, the following reference antenna radiation pattern (see Fig. 1) be used:

$$G(\varphi) = \begin{cases} G_0 - 3(\varphi/\varphi_0)^2 & : \quad 0 \leq \varphi < \varphi_1 \\ G_0 - 17 & : \quad \varphi_1 \leq \varphi < \varphi_2 \\ 32 - 25\log\varphi & : \quad \varphi_2 \leq \varphi < 48 \\ -10 & : \quad 48 \leq \varphi < 80 \\ -5 & : \quad 80 \leq \varphi < 120 \\ -10 & : \quad 120 \leq \varphi \leq 180 \end{cases}$$

where:

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

φ: off-axis angle (degrees)

G_0: maximum boresight gain of the antenna (dBi)

φ_0: ½ of the 3-dB beamwidth of the antenna (degrees)

$\varphi_1 =$ $\varphi_0\sqrt{17/3}$ (degrees)

$\varphi_2 =$ $10^{(49-G_0)/25}$ (degrees);

1.2 in cases of multiple entry interference, to predict the aggregate interference from these multiple sources, the following reference antenna radiation pattern (see Fig. 2) be used:

$$G(\varphi) = \begin{cases} G_0 - 3(\varphi/\varphi_0)^2 & : \quad 0 \le \varphi < \varphi_1 \\ G_0 - 20 & : \quad \varphi_1 \le \varphi < \varphi_2 \\ 29 - 25\log\varphi & : \quad \varphi_2 \le \varphi < 48 \\ -13 & : \quad 48 \le \varphi < 80 \\ -8 & : \quad 80 \le \varphi < 120 \\ -13 & : \quad 120 \le \varphi \le 180 \end{cases}$$

where:

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

φ: off-axis angle (degrees)

G_0: maximum boresight gain of the antenna (dBi)

φ_0: ½ of the 3-dB beamwidth of the antenna (degrees)

$\varphi_1 =$ $\varphi_0\sqrt{20/3}$ (degrees)

$\varphi_2 =$ $10^{(49-G_0)/25}$ (degrees);

1.3 if the actual G_0 and φ_0 parameters are not available, then the following equations be used to estimate them:

$$G_0 = 10\log\left[\eta\left(\frac{\pi D}{\lambda}\right)^2\right] \quad \text{(dBi)}$$

$$\varphi_0 = \frac{20\sqrt{3}}{D/\lambda} \quad \text{(degrees)}$$

where:

η: aperture efficiency of the antenna

D: antenna diameter (m)

λ: wavelength (m);

2 that administrations be invited to submit measured antenna radiation patterns (see Annex) which may be used, if necessary, to revise the reference antenna radiation patterns of *recommends* **1**.

FIGURE 1

Reference antenna radiation pattern to be used in the absence of measured data (single entry interference)

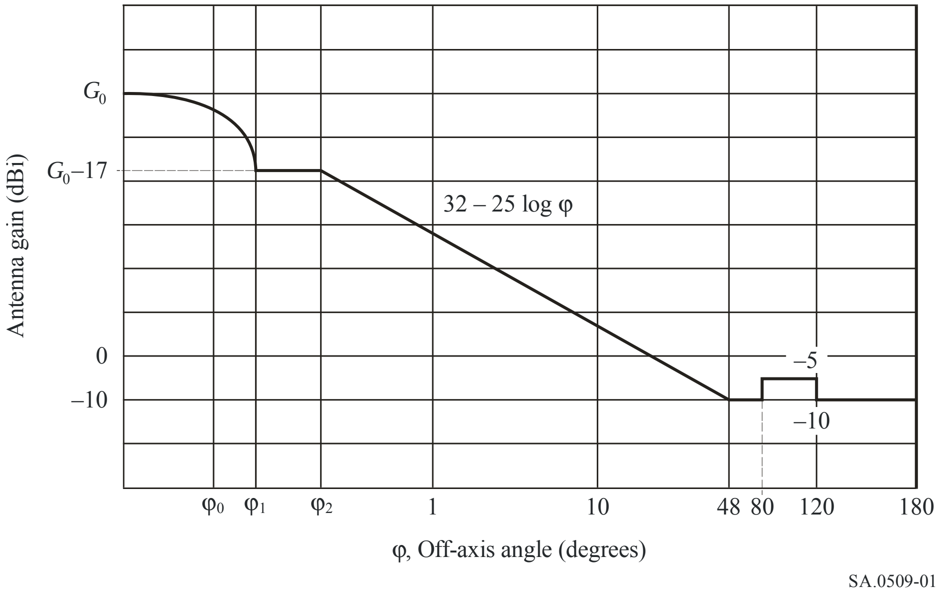
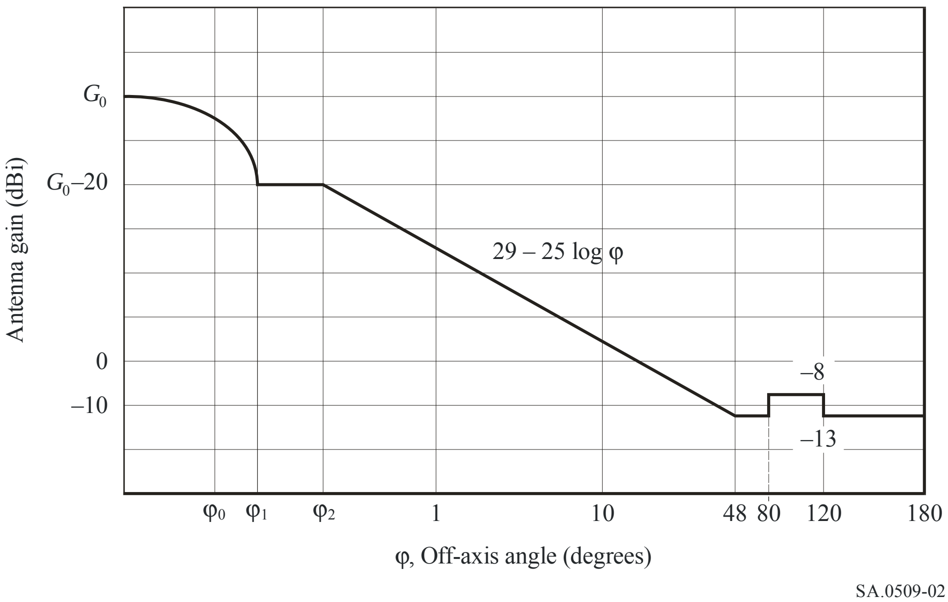


FIGURE 2

Reference antenna radiation pattern to be used in the absence of measured data (multiple entry interference)



Annex

Measured radiation patterns of space research earth station and radio astronomy antennas

1 Lovell Mk1A radio astronomy antenna

Figure A.1 below shows the measured gain of the Lovell Mk1A radio astronomy antenna at 1 420 MHz. This antenna has a single reflector of circular aperture and a diameter of 76.2 m. The peak in the measured response at around 95° is due to spillover.

FIGURE A.1

Measured side-lobe pattern at 1 420 MHz