



Recommendation ITU-R F.1245-3
(01/2019)

**Mathematical model of average and related
radiation patterns for point-to-point fixed
wireless system antennas for use in
interference assessment in the frequency
range from 1 GHz to 86 GHz**

F Series
Fixed service



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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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Series	Title
BO	Satellite delivery
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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 F.1245-3*

**Mathematical model of average and related radiation patterns
for point-to-point fixed wireless system antennas for use
in interference assessment in the frequency range
from 1 GHz to 86 GHz**

(Question ITU-R 110-3/5)

(1997-2000-2012-2019)

Scope

This Recommendation provides average and related reference radiation patterns for point-to-point fixed wireless system (FWS) antennas in the frequency range from 1 GHz to 86 GHz. The analysis in this Recommendation may be used in interference assessments when particular information concerning the FWS antenna is not available.

Keywords

Antenna, azimuth and elevation beamwidths, cross polarization, fixed service, frequency sharing, radio-relay station, reference radiation pattern, side-lobe envelope, statistical interference analyses

Abbreviations/Glossary

FWS Fixed wireless system

Related ITU Recommendations

Recommendation ITU-R F.699 – Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to 86 GHz

Recommendation ITU-R F.1336 – Reference radiation patterns of omnidirectional, sectoral and other antennas for the fixed and mobile service for use in sharing studies in the frequency range from 400 MHz to about 70 GHz

The ITU Radiocommunication Assembly,

considering

- a) that the reference radiation pattern of point-to-point fixed wireless system (FWS) antennas stated in Recommendation ITU-R F.699 provides the peak envelope of side-lobe patterns;
- b) that if the peak envelope radiation pattern is used in the assessment of the aggregate interference consisting of many interference entries, the predicted interference will result in values that are greater than values that would be experienced in practice;
- c) that, therefore, it is necessary to use the antenna radiation pattern representing average side-lobe levels in the following cases:
 - to predict the aggregate interference to a geostationary or non-geostationary satellite from numerous radio-relay stations;
 - to predict the aggregate interference to a radio-relay station from many geostationary satellites;

* This Recommendation should be brought to the attention of Radiocommunication Study Groups 4 and 7.

- to predict interference to a radio-relay station from one or more non-geostationary satellites under the continuously variable angle which should be averaged;
 - in any other cases where the use of the radiation pattern representing average side-lobe levels is appropriate;
- d) that a simple mathematical formula is preferable to the radiation pattern representing average side-lobe levels;
- e) that a mathematical model is also required for generalized radiation patterns of antennas for statistical interference analyses involving a few interference entries such as from geostationary satellites into systems in the fixed service,

recommends

1 that, in the absence of particular information concerning the radiation pattern of the FWS antenna involved, the mathematical model of the average radiation pattern as stated below should be used for the applications referred to in *considering c*);

2 that the following mathematical model of the average radiation pattern should be used for frequencies in the range 1-86 GHz;

2.1 in cases where the ratio between the antenna diameter and the wavelength is greater than 100 ($D/\lambda > 100$), the following equation should be used (see Notes 1 and 7):

2.1.1 for frequencies in the range 1 GHz to 70 GHz, the antenna gain G (dBi):

$$\begin{aligned}
 G(\varphi) &= G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 & \text{for } 0^\circ < \varphi < \varphi_m \\
 G(\varphi) &= G_1 & \text{for } \varphi_m \leq \varphi < \max(\varphi_m, \varphi_r) \\
 G(\varphi) &= 29 - 25 \log \varphi & \text{for } \max(\varphi_m, \varphi_r) \leq \varphi < 48^\circ \\
 G(\varphi) &= -13 & \text{for } 48^\circ \leq \varphi \leq 180^\circ
 \end{aligned}$$

2.1.2 for frequencies in the range 70 GHz to 86 GHz, the antenna gain G (dBi):

$$\begin{aligned}
 G(\varphi) &= G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 & \text{for } 0^\circ < \varphi < \varphi_m \\
 G(\varphi) &= G_1 & \text{for } \varphi_m \leq \varphi < \max(\varphi_m, \varphi_r) \\
 G(\varphi) &= 29 - 25 \log \varphi & \text{for } \max(\varphi_m, \varphi_r) \leq \varphi < 120^\circ \\
 G(\varphi) &= -23 & \text{for } 120^\circ \leq \varphi \leq 180^\circ
 \end{aligned}$$

where:

- G_{max} : maximum antenna gain (dBi) (see Note 2)
- $G(\varphi)$: gain (dBi) relative to an isotropic antenna
- φ : off-axis angle (degrees)
- D : antenna diameter
- λ : wavelength
- } expressed in the same unit
- G_1 : gain of the first side lobe
- = $2 + 15 \log(D/\lambda)$