International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R S.732-1
(12/2012)

Method for statistical processing of earth station antenna side-lobe peaks to determine excess over antenna reference patterns and conditions for acceptability of any excess

S Series

Fixed-satellite service

International
Telecommunication
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Foreword

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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 S.732-1

Method for statistical processing of earth station antenna side-lobe peaks to determine excess over antenna reference patterns and conditions for acceptability of any excess

(1992-2012)

Scope

This Recommendation sets forth a method for the statistical processing of earth station antenna side-lobe peaks in order to determine the percentage of side-lobe peaks that exceed antenna reference patterns provided in relevant ITU-R Recommendations. It also recommends conditions under which earth station antenna side-lobe patterns with peaks exceeding recommended envelopes will still be considered as compliant with ITU-R Recommendations that allow a certain percentage of side-lobe peaks to exceed the recommended envelopes.

The ITU Radiocommunication Assembly,

considering

a)   that in determining the coordination distance or for assessing the interference between earth stations and radio-relay stations, and for coordination studies between earth stations and space stations of different satellite systems sharing the same frequency bands, it is necessary that the gain of the earth station antenna be known in the relevant direction;

b)   that in the case of interference calculations between satellite systems, it may be desirable to know the radiation characteristics of the antenna in planes other than the principal plane;

c)   that in calculating mutual interference between radio-relay systems and satellite communication systems, particularly when there is more than one interference source, it is preferable that the statistical properties of antenna side-lobe levels, as well as side-lobe peaks, be known;

d)   that while ITU-R Recommendations on antenna radiation patterns may contain provisions allowing side-lobe peaks to exceed the recommended envelope, these provisions have no connection with the calculation of potential mutual interference in the course of coordination;

e)   that, in compiling statistical data, it is necessary to protect the integrity of such data from experimental errors,

recognizing

a)   that Recommendation ITU-R S.580, which addresses earth station antenna design objectives, allows a certain percentage of side-lobe peaks to exceed the reference pattern;

b)   that Recommendations containing reference antenna patterns used for interference analysis and coordination between geostationary-satellite networks allow side-lobe peaks to exceed the reference pattern only under specified circumstances (e.g. in the spillover regions, as Recommendation ITU-R S.731, and local ground reflections at large off-axis angles, as Recommendations ITU-R S.465 and ITU-R S.1855),

recommends

1   that the following method should be used for processing measured data on side-lobes of earth station antennas in the case where ITU-R recommended reference antenna radiation patterns allow a certain percentage of side-lobe peaks to exceed the pattern:

1.1   that a side-lobe peak be defined as a local gain maximum for which an increase or a decrease in off-axis angle shows a reduction in gain level of at least 2 dB (see Note 1);

1.2   the angular regions (sample windows) within which side-lobe peak samples are taken should be defined as those shown in Table 2;

NOTE 1 – These "peaks" can be either above or below the allowed reference antenna pattern.

2   that measurement samples affected by experimental errors should be disregarded;

3   that the minimum angular resolution of antenna side-lobes measurement in Table 1 should be used so that all side-lobes are captured:

TABLE 1

Minimum measurement resolution

Antenna size	Measurement resolution for off-axis angle φ, $\varphi_{min} \leq \varphi \leq 30°$	Measurement resolution for off-axis angle φ, $30° < \varphi \leq 180°$
$D/\lambda < 25$	0.5°	0.5°
$25 \leq D/\lambda < 50$	0.25°	0.5°
$50 \leq D/\lambda < 250$	0.1°	0.2°
$250 \leq D/\lambda$	0.05° (or 0.1°) (see Note 2)	0.1°

NOTE 2 – In the case of large antennas having $D/\lambda > 250$, when the largest dimension of the physical aperture is greater than 12 m, the required angular measurement resolution is 0.1° for all off-axis angles. Further studies may be necessary to determine the maximum size of the physical antenna aperture above which 0.05° resolution measurements are not practical.

4   that the peak gain value of the side-lobes within each sample windows should not exceed the reference patterns by more than *Y* dB, with *Y* given in Table 2:

TABLE 2

**Angular regions (sample windows) for processing measured
side-lobe peak samples and allowed excesses**

Angular regions/sample windows	Angular limits (°)	Allowed excess (*Y* in dB)
$\Delta\varphi_{W1}$	$\varphi_{min} < \varphi \leq 7$	1
$\Delta\varphi_{W2}$	$7 < \varphi \leq 9.2$	3
$\Delta\varphi_{W_3}$	$9.2 < \varphi \leq 48$	3
$\Delta\varphi_{W_4}$	$48 < \varphi \leq 180$	10

In Table 2, the lower limit of the first angular region $\Delta\varphi_{W1}$ is 1° or $(100\ \lambda/D)$ degrees, whichever is greater;

5 that when the number of side-lobe peaks is less than 10 in the specified angular regions, the percentage of side-lobe peaks of the earth station antenna that do not comply with the reference pattern should be determined using the following expression:

$$X_j = 100 \sum_{i=1}^{N} \Delta\varphi_i / \Delta\varphi_W \quad (\%)$$

where:

j: index of the angular region $\Delta\varphi_W$ analysed, which varies from 1 to 4 according to Table 2

N: number of side-lobe peaks exceeding the reference pattern within angular region j

$\Delta\varphi_i$: width of the ith side-lobe peak sample that exceeds the reference pattern (degrees)

$\Delta\varphi_W$: total sampled angular width of angular region j (degrees);

6 that antennas be deemed to be compliant with the reference antenna pattern if they meet the condition stated in *recommends* 4 and the percentage of side-lobes exceeding the reference antenna pattern does not exceed the allowed limit or, in the cases covered by *recommends* 5, no value of X_j exceeds the allowed percentage of excess.