# International Telecommunication Union

# ITU-R
Radiocommunication Sector of ITU

**Recommendation ITU-R S.1717-1**
(09/2015)

# Electronic data file format for earth station antenna patterns

**S Series**

**Fixed-satellite service**

## Foreword

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

RECOMMENDATION ITU-R S.1717-1

# Electronic data file format for earth station antenna patterns

(Questions ITU-R 42-1/4 and ITU-R 280/4)

(2005-2015)

**Scope**

Although the standard reference patterns for FSS and BSS earth station antenna main-beam and side-lobe gain, such as those in Recommendations ITU-R S.465, ITU-R S.580, ITU-R BO.1213 or ITU-R BO.1900 among many others are adequate for many interference studies, cases sometimes arise where more detailed gain patterns for specific antennas, or antenna types are needed in ITU-R studies. Also, the gain data for particular antennas are used in the refinement of existing reference patterns and/or the development of new reference patterns. Annex 1 to this Recommendation details a format in which gain data on specific FSS and BSS earth station antennas may be submitted by administrations in electronic form, and includes examples. Annex 2 includes a format for the capture of measured gain data of earth station antennas when only elevation and azimuth data is available.

**Keywords**

FSS, BSS, electronic data file format, earth station antenna patterns

**Related ITU Recommendations, Reports**

| | |
|---|---|
| Recommendation ITU-R BO.1213-1 | Reference receiving earth station antenna pattern for the broadcasting-satellite service in the 11.7-12.75 GHz band |
| Recommendation ITU-R BO.1900-0 | Reference receive earth station antenna pattern for the broadcasting-satellite service in the band 21.4-22 GHz in Regions 1 and 3 |
| Recommendation ITU-R S.465-6 | Reference radiation pattern of earth station antennas in the fixed-satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz |
| Recommendation ITU-R S.580-6 | Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites |
| 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 |

The ITU Radiocommunication Assembly,

*considering*

*a)*     that efficient utilization of the radio spectrum is a primary factor in the management of the GSO;

*b)*     that the side-lobe characteristic of earth station antennas is one of the main factors in determining the minimum spacing between satellites and therefore the extent to which the radio spectrum can be efficiently used;

*c)*     that the collection of measured earth station antenna pattern data would allow a continuous improvement of the ITU-R mathematical models for use in sharing studies or as reference patterns for antenna side-lobe limits or off-axis e.i.r.p. levels;

*d)*       that a defined file format for the submission of measured earth station antenna pattern data would be useful for the analysis of these data by the Radiocommunication Study Groups;

*e)*       that this file format should be sufficiently general to support data on different cut planes, angular ranges and polarization types of antenna patterns,

   *recommends*

**1**       that the file format contained in Annex 1 may be used for the collection of electronic data containing information on FSS or BSS earth station antenna radiation patterns for further studies concerning the modelling of the radiation patterns;

**2**       that the file format in Annex 2 may be used for cases when measurement data are only available in the azimuth and elevation planes.

NOTE 1 – Recommendation ITU-R S.732 may be used as guidance for the choice of an adequate number of points to achieve the necessary angular resolution in each electronic data file.

NOTE 2 – Further studies may be required for the establishment of antenna measurement procedures.

NOTE 3 – The electronic databank containing antenna measurements submitted to ITU-R is available at http://www.itu.int/itu-r/go/rsg4/recs1717data/.

# Annex 1

# Electronic file format for earth station antenna pattern data

## 1       Generic description

The basic file types considered here are block structured. These data blocks are detailed in the next sections.

In all files, HEADER has to be formatted in accordance with:

| Line | Description/content |
|:----:|---------------------|
| 1 | Title |
| 2 | Comments |
| 3 | Comments |
| 4 | File identification code |

Maximum number of characters:

–       title: 52 characters

–       comments: 80 characters.

NOTE 1 – Such comments lines are reserved for information related to the content of the file and or its purpose (e.g. antenna model or configuration).

## 1.1 File identification code

| Code | File type |
|------|-----------|
| 200 | 3D fields – co-polar, cross-polar |

NOTE 2 – Different codes can be further proposed to identify other field representations.

## 1.2 Block-structured files

For the block-structured files a fifth row has to be used containing the total number of blocks.

| Line | Description/content |
|------|---------------------|
| 5 | Total number of blocks |

After row five the sequence of blocks is included with the main function data.

A single file block has a generic structure as following:

$$
\begin{array}{llll}
\textit{Control line} & & & \\
n & m & & \\
a_{1,1} & a_{1,2} & \dots & a_{1,m} \\
a_{2,1} & a_{2,2} & \dots & a_{2,m} \\
\dots\dots & \dots & \dots & \\
\dots\dots & \dots & \dots & \\
a_{n,1} & a_{n,2} & \dots & a_{n,m}
\end{array}
$$

where:

$\textit{Control line}$: contains relevant data concerning the specific block (see details in the following sections)

$n$: number of block rows

$m$: number of block columns.

### 1.2.1 File general structure

The general structure of a block-structured file is described as following:

$$
\left.
\begin{array}{l}
1\,\textit{Title} \\
2\,\textit{Comments} \\
3\,\textit{Comments} \\
4\,\textit{File identification}
\end{array}
\right\} \quad \textit{header}
$$

$$
\begin{array}{l}
5\,\textit{Number of blocks}
\end{array}
$$

$$
\left.
\begin{array}{llll}
\textit{control line of block } 1 & & & \\
n_1 & m_1 & & \\
a_{1,1} & a_{1,2} & \dots & a_{1,m} \\
\dots & \dots & \dots & \dots \\
\dots & \dots & \dots & \dots \\
a_{n,1} & a_{n,2} & \dots & a_{n,m}
\end{array}
\right\} \quad \textit{block } 1
$$

$$
\begin{array}{l}
\dots\dots\dots \\
\dots\dots\dots
\end{array}
$$

$$
\left.
\begin{array}{llll}
\textit{control line of block f} & & & \\
n_f & m_f & & \\
a_{1,1} & a_{1,2} & ... & a_{1,mf} \\
... & ... & ... & ... \\
... & ... & ... & ... \\
a_{nf,1} & a_{nf,2} & ... & a_{nf,mf}
\end{array}
\right\} \textit{final block}
$$

## 2      3D fields – block-structured files

In this section the content of field data is described for the file type 200 (**3D fields – co-polar and cross-polar**). See Fig. 1 as a reference for parameters described below:

*Title*

*Comments*

*Comments*

*id pol orientation freq*

*Number of blocks*

$$
\left.
\begin{array}{lllllll}
\varphi_k & r_j & & & & & \\
n\ m & & & & & & \\
\theta_1 \colon & \left|Co(\theta_1,\varphi_k,r_j)\right| & \angle Co(\theta_1,\varphi_k,r_j) & \left|X(\theta_1,\varphi_k,r_j)\right| & \angle X(\theta_1,\varphi_k,r_j) & \\
.. & . & . & . & . & . & ... & . & .. \\
.. & . & . & . & . & . & . & . & .. \\
\theta_n \colon & \left|Co(\theta_n,\varphi_k,r_j)\right| & \angle Co(\theta_n,\varphi_k,r_j) & \left|X(\theta_n,\varphi_k,r_j)\right| & \angle X(\theta_n,\varphi_k,r_j)
\end{array}
\right\} block
$$

where:

id: file identification, is 200

pol: antenna polarization, assumes values 1 (linear); 2 (circular/elliptical) or 0 (non-determined),

orientation:

when *pol* = 1, *orientation* indicates plane $\varphi$ which contains the main component of the electric field (preferably 0° for horizontal polarization and 90° for vertical polarization);

when *pol* = 2, *orientation* is 1 (for left-hand circular/elliptical polarization), or 2 (for right-hand circular/elliptical polarization);

For non-determined cases use *pol* = 0 and *orientation* = 0.

freq: frequency (GHz). Not relevant in case of general side-lobe masks or envelops.

$\varphi_k$: pattern cut half plane angle $\varphi$ (degrees), related to block data, (use $\varphi$ = 90° for upper elevation cut). Varies from 0° to 360°.

$\theta_i$: Angular direction (degrees) relative to the antenna boresight ($\theta_i$ = 0°) which shall indicate satellite pointing and maximum gain direction.

$r_j$: radial distance *r* (m) related to specific block, (this value can be suppressed if data relates to far-field region).

$n$: number of block rows, i.e., number of $\theta_i$ samples (where $\theta$ varies from 0° to 180°). Value of $n$ shall be adequate to allow pattern resolution for data plotting or for use in coordination and interference calculations.

$m$: number of block columns (for the 200 type file $m = 5$),

$|Co(\theta_i, \varphi_k, r_j)|$: co-polar field amplitude (dB or dBi), at the point $(\theta_i, \varphi_k, r_j)$,

$\angle Co(\theta_i, \varphi_k, r_j)$: co-polar field phase (degrees), at the point $(\theta_i, \varphi_k, r_j)$,

$|X(\theta_i, \varphi_k, r_j)|$: cross-polar field amplitude (dB or dBi), at the point $(\theta_i, \varphi_k, r_j)$,

$\angle X(\theta_i, \varphi_k, r_j)$: cross-polar field phase (degrees), at the point $(\theta_i, \varphi_k, r_j)$,

When amplitudes are indicated in dB, the antenna maximum gain (dBi) value must be supplied (use comments lines). When phase values are not available or not relevant, insert 0.0 (not blanks).

FIGURE 1

**Example of reflector antenna in a spherical coordinate system as per the proposed standard file format**
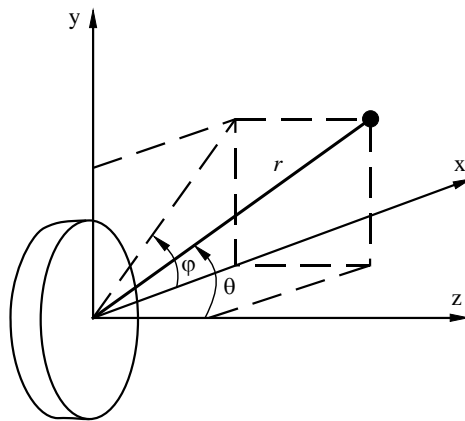


*Note 1* – Antenna upper elevation half-plane shall be coincident with +yz half-plane ($\varphi = 90°$)

S.1717-01

## 3 Examples

In this section a pattern data file is illustrated as an example as well as some resulting applications.

Table 1 shows some parts of the example file containing four blocks with $n = 360$ rows in each and representing the radiation pattern cut planes $\varphi_k$ equal to 0°, 90°, 180° and 270° respectively.

TABLE 1

**Example of a measured radiation pattern file in the proposed format**

| | | | | | |
|---|---|---|---|---|---|
| *Title* | **Offset antenna XXX – 1.8 m  Measured frequency 14 GHZ – EL/H – Pol H** | | | | |
| *Comments* | **Model BO 05355** | | | | |
| *Comments* | **Original MI – 2095 file:F:\XXX\HCOHELTX.TXT** | | | | |
| *id pol orientation freq* | 200 | 1 | 0 | 14.000 | |
| *Number of blocks* | 4 | | | | |
| | 0 | | | | |
| | 360 | 5 | | | |
| | 0 | 46.13 | 132.131 | −1.976 | 48.183 |
| | 0.5 | 42.503 | 119.138 | 3.083 | −63.6 |
| | 1 | 29.327 | 86.983 | 3.126 | −48,484 |
| | 1.5 | 20.601 | 9.116 | −5.148 | −7.781 |
| | 2 | 15.948 | 81.549 | −23.206 | 86.305 |
| | 2.5 | 7.158 | 60.242 | −17.033 | 89.719 |
| | ... | | | | |
| | 177.5 | −5.305 | −143.914 | −34.487 | −175.838 |
| | 178 | −5.006 | −14.855 | −17.404 | 86.68 |
| | 178.5 | −5.433 | 130.715 | −20.464 | 158.715 |
| | 179 | −5.928 | −77.425 | −29.24 | −9.018 |
| | 179.5 | −5.846 | 65.336 | −30.317 | 123.385 |
| | 90 | | | | |
| | 360 | 5 | | | |
| | 0 | 46.13 | 38.426 | 14.575 | −14.098 |
| | 0.5 | 43.405 | 40.238 | 22.746 | 165.781 |
| | 1 | 32.697 | 24.047 | 20.087 | 168.983 |
| | 1.5 | 22.179 | −36.461 | 0.228 | 71.216 |
| | 2 | 2.554 | 17.435 | 4.258 | 99.239 |
| | 2.5 | 15.386 | −165.509 | 0.391 | 161.129 |
| | ... | | | | |

Figure 2 illustrates the graphical representation of the co-polar field pattern measured in the cut plane $\varphi_k = 0°$ (1st block/2nd row). In this case, this cut-plane corresponds to one side of the azimuth plane and the polarization is horizontal. In Fig. 2 a reference pattern envelope is represented based on Recommendations ITU-R S.580 and ITU-R S.465 for the co-polar pattern side-lobes.

FIGURE 2

**Co-polar field measured pattern example in the $\varphi_k = 0°$ (Az/Pol H)**
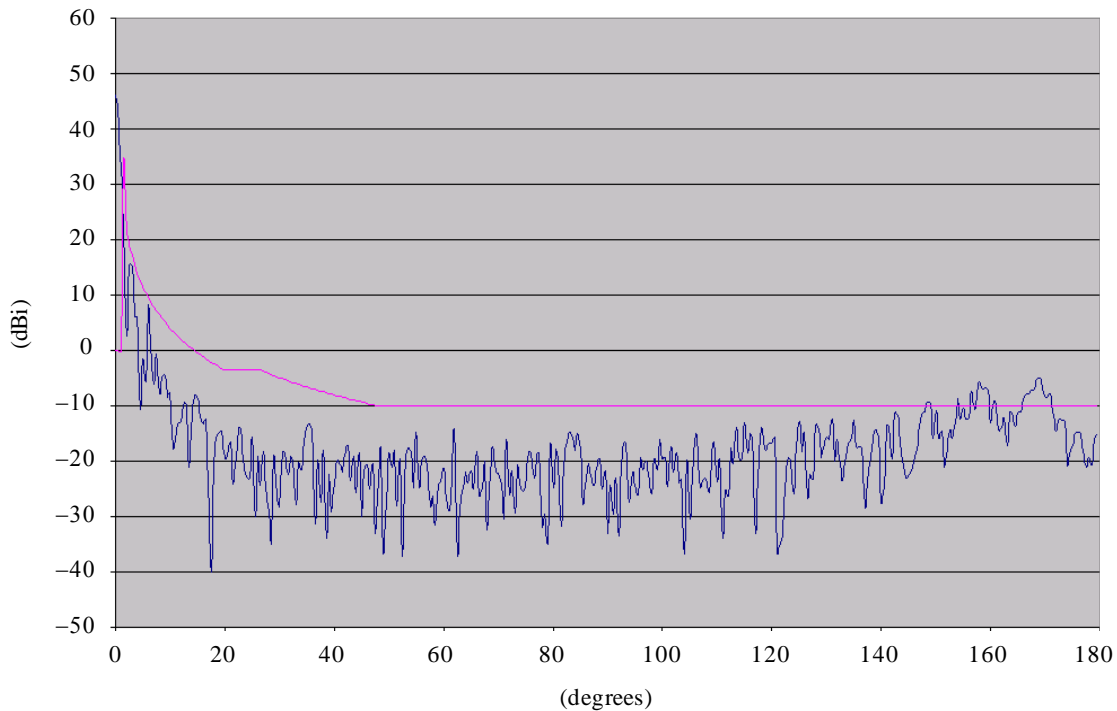


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# Annex 2

# Recommended electronic file format for receiving earth station antenna pattern data when measurement data is only available in the azimuth and elevation planes

The file type 200 described in § 2 of Annex 1 is applicable for a pattern data file with some simplifications as illustrated below by an example in Table 2:

1)      Radiation pattern cut planes $\varphi_k$ equal to 0° and 90° are fully sufficient assuming an approximate symmetry of the radiation diagram that is why the pattern data files may consist of two blocks.

2)      Each block may contain rows $n = 200$ to 220 instead of 360 when measurements cover only the angular sector $\theta$ from 0° to 100° (110°) as the back lobes in most of the cases are not relevant.

3)      Measured data relates to far-field region.
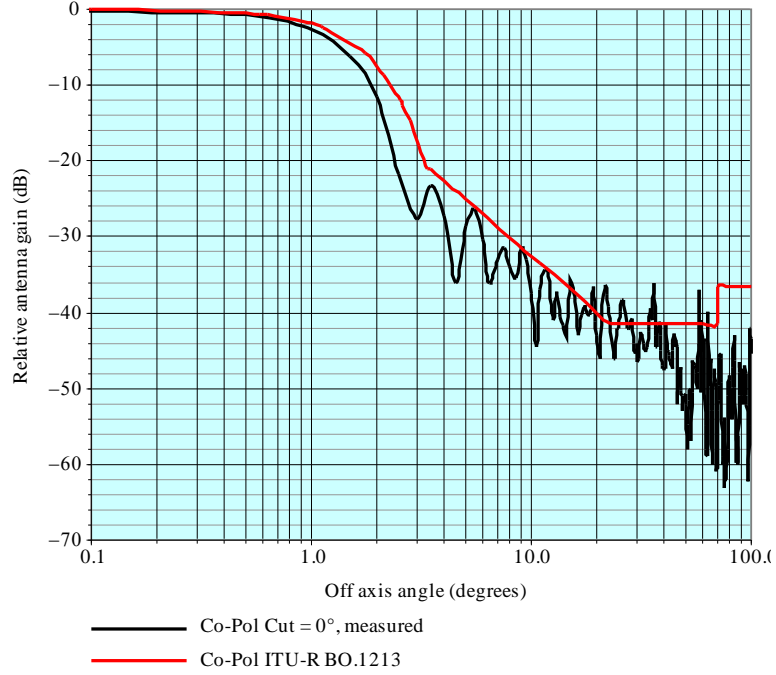
4)      Phase values are not relevant.

TABLE 2

**Example of a measured radiation pattern file in the proposed format**

| | | | | | |
|---|---|---|---|---|---|
| *Title* | **Offset antenna DCE-73 – 0.7 m × 0.5 m Measured frequency 11.725 GHz – Pol V** | | | | |
| *Comments* | **Type: Single off-set system  Max gain: 35.6 dBi** | | | | |
| *Comments* | **Original file: BUL BSS antenna  patterns.xls** | | | | |
| *id pol orientation freq* | 200 | 1 | 90 | 11.725 | |
| *Number of blocks* | 2 | | | | |
| | 0 | | | | |
| | 201 | 5 | | | |
| | 0 | 0 | 0.0 | −39.6 | 0.0 |
| | 0.5 | −0.7 | 0.0 | −26.9 | 0.0 |
| | 1 | −2.7 | 0.0 | −22.1 | 0.0 |
| | 1.5 | −6.2 | 0.0 | −20.6 | 0.0 |
| | 2 | −11.5 | 0.0 | −21.2 | 0.0 |
| | 2.5 | −21.6 | 0.0 | −23.8 | 0.0 |
| | ... | | | | |
| | 98 | −42 | 0.0 | −52.8 | 0.0 |
| | 98.5 | −42.1 | 0.0 | −54.9 | 0.0 |
| | 99 | −42.6 | 0.0 | −50.5 | 0.0 |
| | 99.5 | −43.4 | 0.0 | −54 | 0.0 |
| | 100 | −45.4 | 0.0 | −54.5 | 0.0 |
| | 90 | | | | |
| | 201 | 5 | | | |
| | 0 | 0 | 0.0 | −39.2 | 0.0 |
| | 0.5 | −0.6 | 0.0 | −42.5 | 0.0 |
| | 1 | −2 | 0.0 | −52.8 | 0.0 |
| | 1.5 | −4.6 | 0.0 | −54.9 | 0.0 |
| | 2 | −7.8 | 0.0 | −53.3 | 0.0 |
| | 2.5 | −11 | 0.0 | −52.9 | 0.0 |
| | ... | | | | |

The submission to the databank associated to this recommendation of more recent patterns (co- and cross-polar) measured data (tabular and graphical) of small antennas with different design is important for studies on improving the reference antenna patterns for different services and frequency bands. It is advisable that the graphical representation of the co-polar/cross-polar field pattern measured in both cut planes includes the applicable reference pattern envelope. Figure 3 illustrates the graphical representation of the co-polar field pattern measured in the cut plane $\varphi_k = 0°$ (1st block/2nd row) corresponding to the example measured data in Table 2. In Fig. 3 a reference pattern envelope is represented based on Recommendation ITU-R BO.1213.

FIGURE 3

Co-polar mesured pattern in the cut plane $\varphi_k = 0°$ (Az/Pol V)
of BSS earth station antenna DCE-73 at 11.725 GHz



Co-Pol Cut = 0°, measured

Co-Pol ITU-R BO.1213

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