

RECOMMENDATION 652-1*

REFERENCE PATTERNS FOR EARTH-STATION AND SATELLITE ANTENNAS
FOR THE BROADCASTING-SATELLITE SERVICE IN THE 12 GHz BAND
AND FOR THE ASSOCIATED FEEDER LINKS** IN THE 14 GHz AND 17 GHz BANDS

(Questions 84/11 and 93/11)

(1986-1992)

The CCIR,

considering

- a) that for broadcasting-satellite service planning purposes, simple antenna reference patterns are necessary;
- b) that for reasons of cost, aesthetics, and ease of installation, antennas for individual reception should be small, simple, and amenable to mass-production techniques, and that within these general guidelines different design options should be possible;
- c) that planning for the broadcasting-satellite service based on individual reception in frequency bands around 12 GHz has taken place and community reception may also be accommodated;
- d) that easily applied antenna reference patterns are desirable to determine the levels of inter-regional interference;
- e) that every effort should be made to avoid unnecessary spill-over into adjacent service areas;
- f) that for the assessment of mutual interference between the 12 GHz broadcasting-satellite service and other services sharing the same frequency bands, it may be necessary to use a reference radiation pattern for both the earth-station receiving antenna and the satellite transmitting antenna;
- g) that the use of antennas with the best achievable radiation pattern will lead to the most efficient use of the radio-frequency spectrum and the geostationary-satellite orbit;
- h) that measured data for the radiation patterns of 12 GHz broadcasting-satellite earth-station receiving antennas and satellite transmitting antennas are available;
- j) that planning for feeder links in frequency bands around 14 GHz and 17 GHz which is used for the 12 GHz broadcasting-satellite service has taken place;
- k) that every effort should be made to avoid interference to adjacent broadcasting satellites;
- l) that for the assessment of mutual interference between the 14 GHz/17 GHz feeder links for satellite broadcasting and other services sharing the same frequency bands, it may be necessary to use reference radiation patterns for both the earth-station transmitting antenna and the satellite receiving antenna for the feeder links;
- m) that reference patterns for 14 GHz and 17 GHz feeder-link earth-station transmitting antennas and satellite receiving antennas are presented in Appendix 30A (Orb-88) of the Radio Regulations (RR),

recommends

- 1. that for earth-station receiving antennas, to ensure that interference up to the limit of the service area should not exceed that envisaged in Plans for the 12 GHz band;

* Note from the Director, CCIR – Reports 810 and 952 were referred to in preparing this Recommendation.

** The part of this Recommendation concerning feeder links should be brought to the attention of Study Group 4.

1.1 in Regions 1 and 3 individual reception receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 1 by curves A and B respectively, taking $\phi_0 = 2^\circ$ (nominal half-power beamwidth);

1.2 in Region 2, individual reception receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 2 by curves A and B respectively, taking $\phi_0 = 1.7^\circ$ (nominal half-power beamwidth);

1.3 in Regions 1 and 3 community reception receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference pattern given in Fig. 1 by curves A' and B respectively taking $\phi_0 = 1^\circ$ (nominal half-power beamwidth);

2. that for satellite transmitting antenna beams with circular or elliptical cross-section:

2.1 in Regions 1 and 3 the radiation pattern should conform to the applicable reference patterns given in Fig. 3;

2.2 in Region 2 the radiation pattern for normal roll-off should conform as a minimum requirement to the applicable reference pattern given in Fig. 4 and, for fast roll-off (Note 1) to the reference pattern given in Fig. 5;

3. that for feeder-link earth-station antennas:

3.1 in Region 2 transmitting antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 6 by curves A and B respectively;

3.2 in Regions 1 and 3 the co-polar and cross-polar radiation patterns of transmitting antennas should not exceed the limits indicated in Fig. 7;

4. that for satellite receiving antennas:

4.1 in Region 2 receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 8 by curves A and B respectively;

4.2 in Region 2 the radiation pattern for fast roll-off receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 9 by curves A and B respectively;

4.3 in Regions 1 and 3 receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 10 by curves A and B respectively;

4.4 in Regions 1 and 3 the radiation pattern for fast roll-off receiving antennas should have co-polar and cross-polar radiation patterns not exceeding the reference patterns given in Fig. 11 by curves A and B respectively.

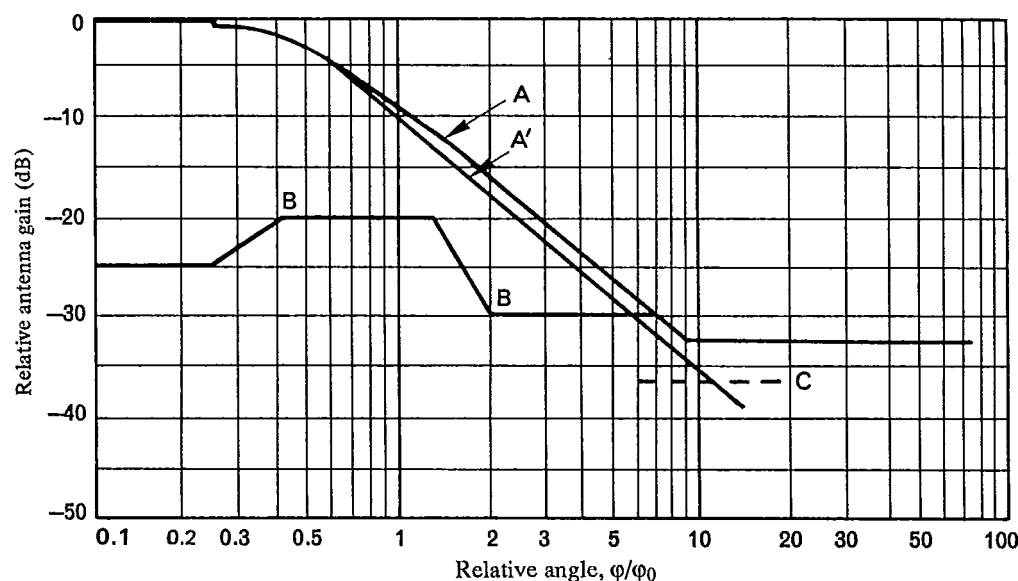
Note 1 – In Region 2, when necessary to reduce interference, the pattern shown in Fig. 5 was used to develop the Plan; this use is indicated in the Plan by an appropriate symbol. This pattern is derived from an antenna producing an elliptical beam with fast roll-off in the main lobe. Three curves for different values of ϕ_0 are shown as examples.

Note 2 – The patterns in Figs. 1-5 and 8-11 are given as functions of the relative angle ϕ/ϕ_0 , where ϕ is the angle measured from the axis of the beam, and ϕ_0 is the angular width of the beam measured between the -3 dB levels. The levels are expressed in dB relative to the maximum (on-axis) gain of the antenna.

Note 3 – Annex 1 provides supporting analytic data for the BSS reference antenna patterns (i.e. transmitting space stations and receiving earth stations).

FIGURE 1

Co-polar and cross-polar receiving earth-station antenna
reference patterns in Regions 1 and 3



Curve A: Co-polar component for individual reception without side-lobe suppression (dB relative to main beam gain):

$$\begin{aligned}
 &0 && \text{for } 0 \leq \varphi \leq 0.25 \varphi_0 \\
 &-12 (\varphi/\varphi_0)^2 && \text{for } 0.25 \varphi_0 < \varphi \leq 0.707 \varphi_0 \\
 &-[9.0 + 20 \log (\varphi/\varphi_0)] && \text{for } 0.707 \varphi_0 < \varphi \leq 1.26 \varphi_0 \\
 &-[8.5 + 25 \log (\varphi/\varphi_0)] && \text{for } 1.26 \varphi_0 < \varphi \leq 9.55 \varphi_0 \\
 &-33 && \text{for } \varphi > 9.55 \varphi_0
 \end{aligned}$$

Curve A': Co-polar component for community reception without side-lobe suppression (dB relative to main beam gain):

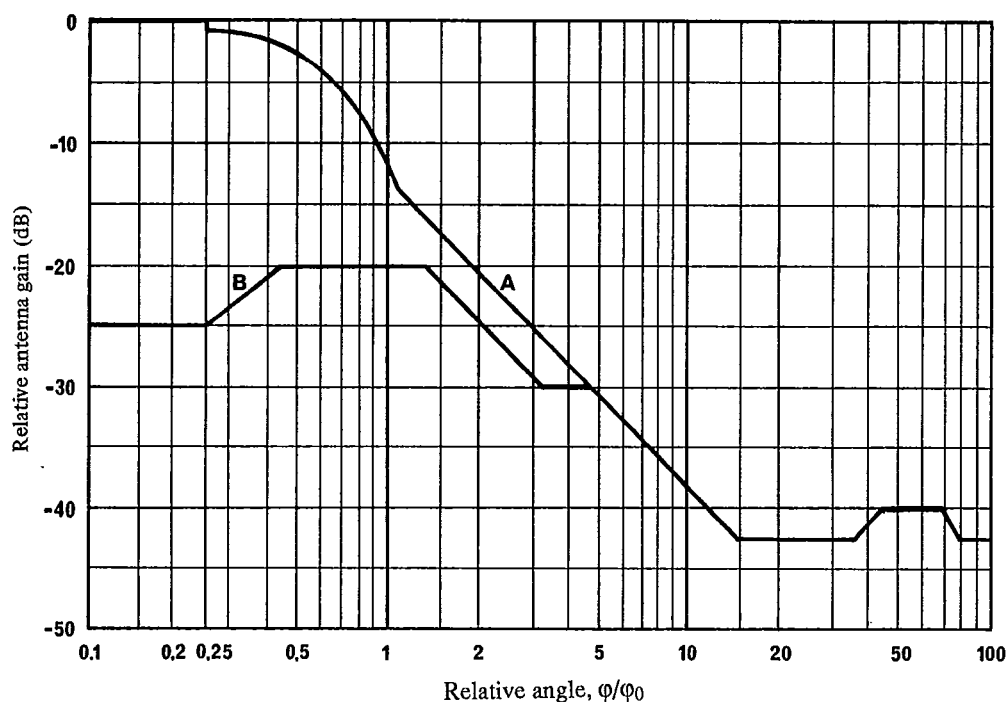
$$\begin{aligned}
 &0 && \text{for } 0 \leq \varphi \leq 0.25 \varphi_0 \\
 &-12 (\varphi/\varphi_0)^2 && \text{for } 0.25 \varphi_0 < \varphi \leq 0.86 \varphi_0 \\
 &-[10.5 + 25 \log (\varphi/\varphi_0)] && \text{for } \varphi > 0.86 \varphi_0 \text{ up to intersection with curve C} \\
 &&& \text{(then curve C)}
 \end{aligned}$$

Curve B: Cross-polar component for both types of reception (dB relative to main beam gain):

$$\begin{aligned}
 &-25 && \text{for } 0 \leq \varphi \leq 0.25 \varphi_0 \\
 &-(30 + 40 \log |\varphi/\varphi_0 - 1|) && \text{for } 0.25 \varphi_0 < \varphi \leq 0.44 \varphi_0 \\
 &-20 && \text{for } 0.44 \varphi_0 < \varphi \leq 1.4 \varphi_0 \\
 &-(30 + 25 \log |\varphi/\varphi_0 - 1|) && \text{for } 1.4 \varphi_0 < \varphi \leq 2 \varphi_0 \\
 &-30 && \text{until intersection with co-polar component curve; then co-polar component curve}
 \end{aligned}$$

Curve C: Minus the on-axis gain (curve C in this figure illustrates the particular case of an antenna with an on-axis gain of 37 dBi)

FIGURE 2
Reference patterns for co-polar and cross-polar components
for receiving earth-station antennas in Region 2



Curve A: Co-polar component without side-lobe suppression (dB relative to main beam gain):

0	for $0 \leq \varphi \leq 0.25 \varphi_0$
$-12 (\varphi/\varphi_0)^2$	for $0.25 \varphi_0 < \varphi \leq 1.13 \varphi_0$
$- \{ 14 + 25 \log (\varphi/\varphi_0) \}$	for $1.13 \varphi_0 < \varphi \leq 14.7 \varphi_0$
-43.2	for $14.7 \varphi_0 < \varphi \leq 35 \varphi_0$
$- \{ 85.2 - 27.2 \log (\varphi/\varphi_0) \}$	for $35 \varphi_0 < \varphi \leq 45.1 \varphi_0$
-40.2	for $45.1 \varphi_0 < \varphi \leq 70 \varphi_0$
$- \{ -55.2 + 51.7 \log (\varphi/\varphi_0) \}$	for $70 \varphi_0 < \varphi \leq 80 \varphi_0$
-43.2	for $80 \varphi_0 < \varphi \leq 180^\circ$

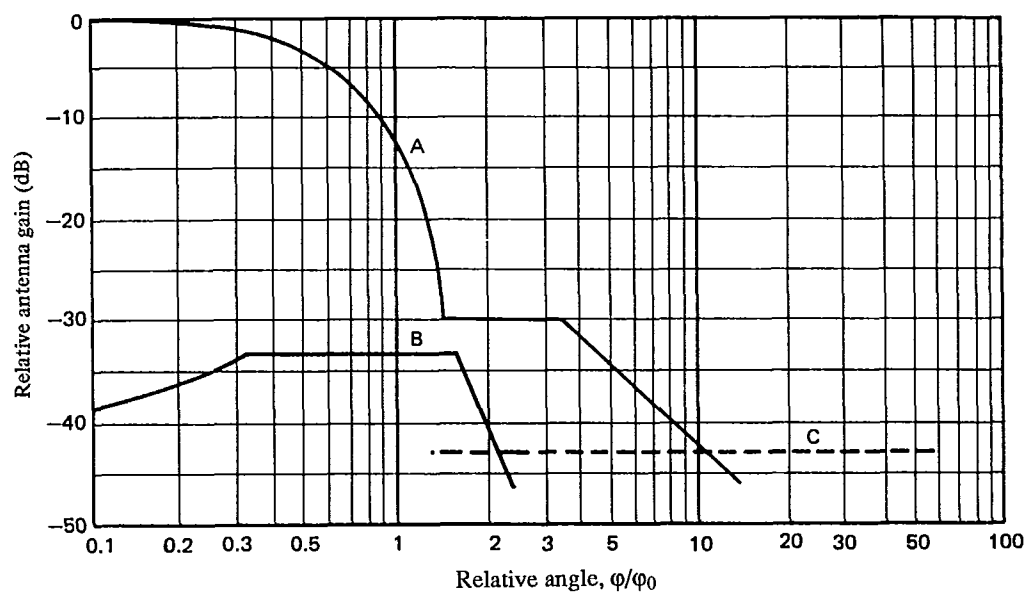
Curve B: Cross-polar component (dB relative to main beam gain):

-25	for $0 \leq \varphi \leq 0.25 \varphi_0$
$- (30 + 40 \log \varphi/\varphi_0 - 1)$	for $0.25 \varphi_0 < \varphi \leq 0.44 \varphi_0$
-20	for $0.44 \varphi_0 < \varphi \leq 1.28 \varphi_0$
$- (17.3 + 25 \log \varphi/\varphi_0)$	for $1.28 \varphi_0 < \varphi \leq 3.22 \varphi_0$
-30	until intersection with co-polar component curve; then co-polar component curve

Note 1 – In the angular range between $0.1 \varphi_0$ and $1.13 \varphi_0$ the co-polar and cross-polar gains must not exceed the reference patterns.

Note 2 – At off-axis angles larger than $1.13 \varphi_0$ and for 90% of all side-lobe peaks in each of the reference angular windows, the gain must not exceed the reference patterns. The reference angular windows are $1.13 \varphi_0$ to $3 \varphi_0$; $3 \varphi_0$ to $6 \varphi_0$; $6 \varphi_0$ to $10 \varphi_0$; $10 \varphi_0$ to $20 \varphi_0$; $20 \varphi_0$ to $40 \varphi_0$; $40 \varphi_0$ to $75 \varphi_0$ and $75 \varphi_0$ to 180° .

FIGURE 3
Reference patterns for co-polar and cross-polar components
for satellite transmitting antennas in Regions 1 and 3



Curve A: Co-polar component (dB relative to main beam gain):

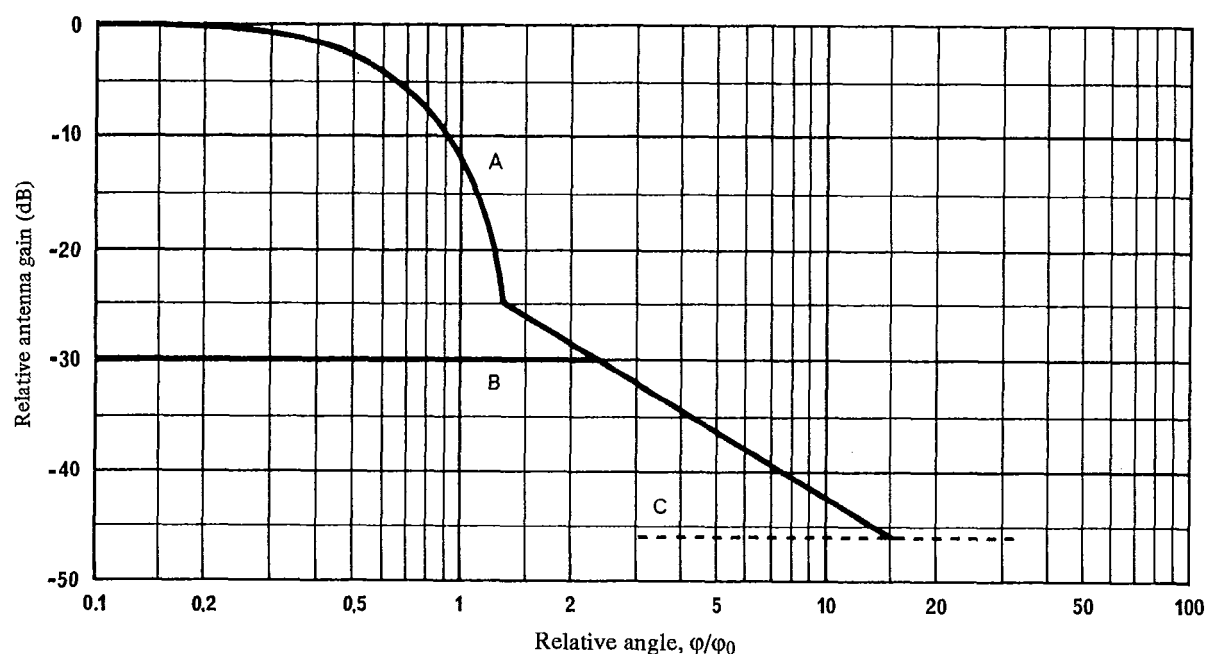
$$\begin{aligned}
 &-12 (\varphi/\varphi_0)^2 && \text{for } 0 \leq \varphi \leq 1.58 \varphi_0 \\
 &-30 && \text{for } 1.58 \varphi_0 < \varphi \leq 3.16 \varphi_0 \\
 &-[17.5 + 25 \log (\varphi/\varphi_0)] && \text{for } \varphi > 3.16 \varphi_0 \\
 &\text{after intersection with curve C: as curve C}
 \end{aligned}$$

Curve B: Cross-polar component (dB relative to main beam gain):

$$\begin{aligned}
 &-(40 + 40 \log |\varphi/\varphi_0 - 1|) && \text{for } 0 \leq \varphi \leq 0.33 \varphi_0 \\
 &-33 && \text{for } 0.33 \varphi_0 < \varphi \leq 1.67 \varphi_0 \\
 &-(40 + 40 \log |\varphi/\varphi_0 - 1|) && \text{for } \varphi > 1.67 \varphi_0 \\
 &\text{after intersection with curve C: as curve C}
 \end{aligned}$$

Curve C: Minus the on-axis gain (curve C in this figure illustrates the particular case of an antenna with an on-axis gain of 43 dBi)

FIGURE 4
Reference patterns for co-polar and cross-polar components
for satellite transmitting antennas in Regions 2



Curve A: Co-polar component (dB relative to main beam gain):

$$-12 (\varphi/\varphi_0)^2 \quad \text{for } 0 \leq \varphi/\varphi_0 \leq 1.45$$

$$-[22 + 20 \log (\varphi/\varphi_0)] \quad \text{for } \varphi/\varphi_0 > 1.45$$

after intersection with curve C: as curve C

Curve B: Cross-polar component (dB relative to main beam gain):

$$-30 \quad \text{for } 0 \leq \varphi/\varphi_0 \leq 2.51$$

after intersection with co-polar pattern: co-polar pattern

Curve C: Minus the on-axis gain (curve C in this figure illustrates the particular case of an antenna with an on-axis gain of 46 dB)