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EUROPEAN STANDARD

Fixed Radio Systems;
Characteristics and requirements
for point-to-point equipment and antennas;
Part 4: Antennas

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 4 of a multi-part deliverable covering the Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas. Full details of the entire series can be found in part 1 [2].

National transposition dates	
Date of adoption of this EN:	2 July 2025
Date of latest announcement of this EN (doa):	31 October 2025
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Date of withdrawal of any conflicting National Standard (dow):	30 April 2026

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document defines the characteristics and requirements of antennas for point-to-point radio equipment operating in the frequency range from 1 GHz to 174,8 GHz falling within the scope (see note) of ETSI EN 302 217-2 [i.2].

For technical commonalities that range is here divided into sub-ranges as follows:

Range 0: 1 GHz to 3 GHz;

Range 1: 3 GHz to 14 GHz;

Range 2: 14 GHz to 20 GHz;

Range 3: 20 GHz to 24 GHz;

Range 4: 24 GHz to 30 GHz;

Range 5: 30 GHz to 47 GHz;

Range 6: 47 GHz to 71 GHz;

Range 7: 71 GHz to 86 GHz;

Range 8: 92 GHz to 114,25 GHz;

Range 9: 130 GHz to 174,8 GHz.

The present document is applicable to fixed radio equipment with *integral* (see note) or *dedicated antennas*.

NOTE: For information, ETSI EN 302 217-2 [i.2] includes in its scope only the use of *detachable integral antennas*; *undetachable integral antennas* are not considered due to the present lack of radiated test procedures for the radio equipment parameters.

The present document also applies to *stand-alone antennas*, placed separately on the market. In this case the present document is to be used by radio equipment manufacturers to provide guidance as to the information for the user, as required by article 10 paragraph 8 of Directive 2014/53/EU [i.1], regarding the antenna characteristics required so as the radio equipment, supplied without antenna, can operate as intended in its *technical documentation*.

The present document is applicable to fixed beam antennas, as well as to "*self-alignment tracking*" antenna, with limited tracking range, so that all requirements in the present document are respected throughout the *tracking angle* indicated in the *technical documentation*.

The main body of the present document specifies the characteristics that define the various antenna classes, whilst the annexes provide additional information that is useful to both antenna manufacturers and user/installers.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found in the ETSI docbox.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 301 126-3-1 (V1.1.2): "Fixed Radio Systems; Conformance testing; Part 3-1: Point-to-Point antennas; Definitions, general requirements and test procedures".

[2] ETSI EN 302 217-1 (V3.4.1): "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 1: Overview, common characteristics and requirements not related to access to radio spectrum".

[3] IEC 60154-1: "Flanges for waveguides - Part 1: General requirements".

[4] IEC 60154-2: "Flanges for waveguides - Part 2: Relevant specifications for flanges for ordinary rectangular waveguides".

[5] IEC 60169-1: "Radio-frequency connectors - Part 1: General requirements and measuring methods".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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[i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.2] ETSI EN 302 217-2 (V3.4.1): "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2: Digital systems operating in frequency bands from 1 GHz to 174,8 GHz; Harmonised Standard for access to radio spectrum".

[i.3] 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 about 86 GHz".

[i.4] Recommendation ITU-R F.1245: "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".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 302 217-1 [2] apply.

In the present document those "terms", when used, are given in "*italic*" font.

3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 302 217-1 [2] apply.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 302 217-1 [2] apply.

4 Technical requirements specifications

4.1 Introduction

The electrical characteristics are given as function of specific classification of the antennas according to the principles referred to in clause 4.2.

The antenna manufacturer shall indicate (e.g. in the *technical documentation* or other public documentation), for each antenna type, the *operating frequency band*, the antenna *nominal gain* and its maximum deviation over the *operating frequency band* (alternatively, at least the *gain* at the frequency band edges and at mid-band).

An antenna, which employs a radome, shall meet the requirements of the present document with the radome in place.

Self-alignment tracking antennas, shall meet all requirements in the present document throughout their tracking angle indicated in the *technical documentation*.

The antenna system shall radiate a linear (single or dual) polarized wave.

4.2 Templates for definition of Radiation Pattern Envelope (RPE) classes

The RPE directional characteristic (co-polar and cross-polar) impacts the interference situation in the network planning and a trade-off between a highly demanding RPE and the cost/size/weight of the antennas, compatible with the constraints given by present and future networks is then advisable.

With respect to the Radiation Pattern Envelope (RPE), four classes (RPE classes 1 to 4) have been identified according to the "limit templates"; a "limit template" is intended as the maximum co-polar *gain* that any actual RPE mask of that class (referred in clauses 4.4.2 to 4.4.11) should not exceed, in the significant range of off-axis azimuth angles, for being considered within a class. The templates for subdivision in those classes are also depending on given frequency ranges of operation according to figures 1 to 4 and table 1.

When more than one actual standardized RPE falls within the same class template, a sub-class indicative (A, B, C, etc.) shall be used according to their more demanding RPE limit in angles closer to the intended direction.

NOTE: Figures 1 to 4 report limit templates for any actual RPE mask of classes 2, 3 and 4 antennas; class 1 antennas are defined as those which actual RPE mask exceeds class 2 limit template.

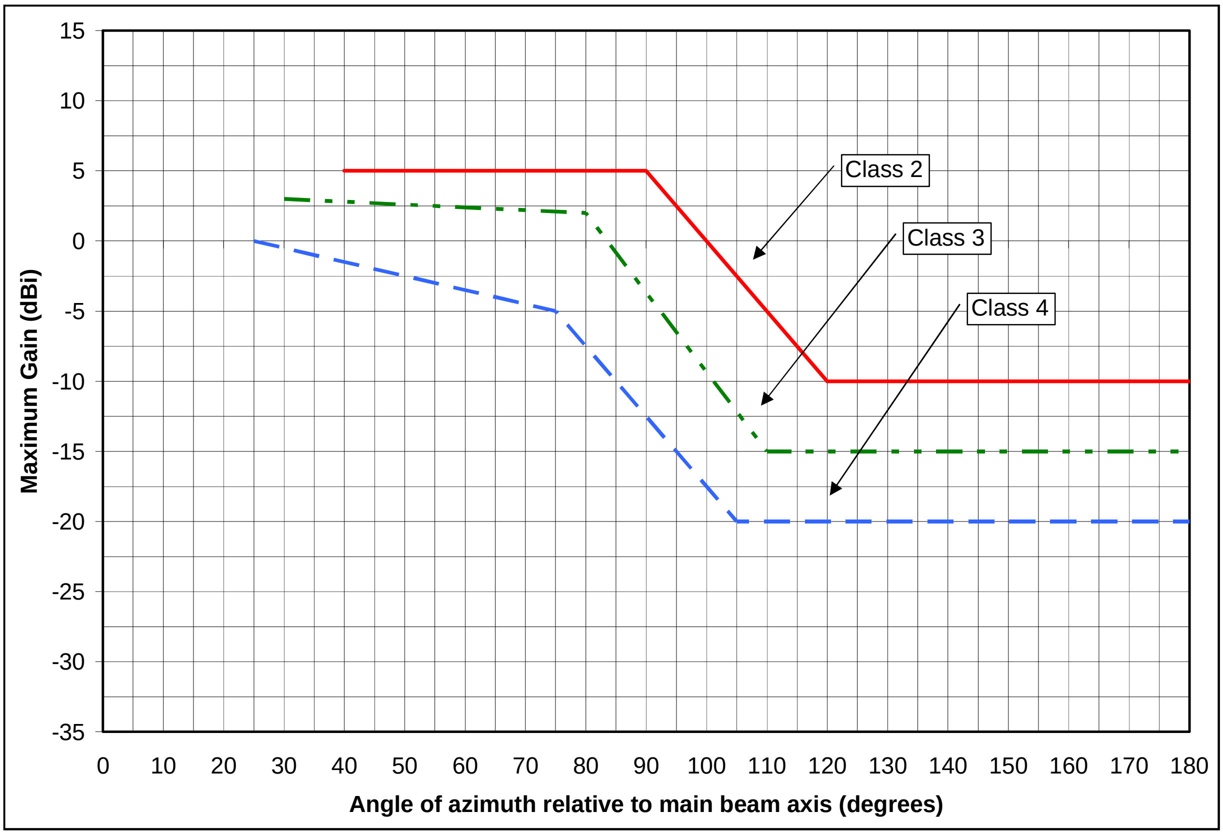


Figure 1: Co-polar limit templates for actual RPE masks of antenna classes in the range 1 GHz to 3 GHz (see table 1)

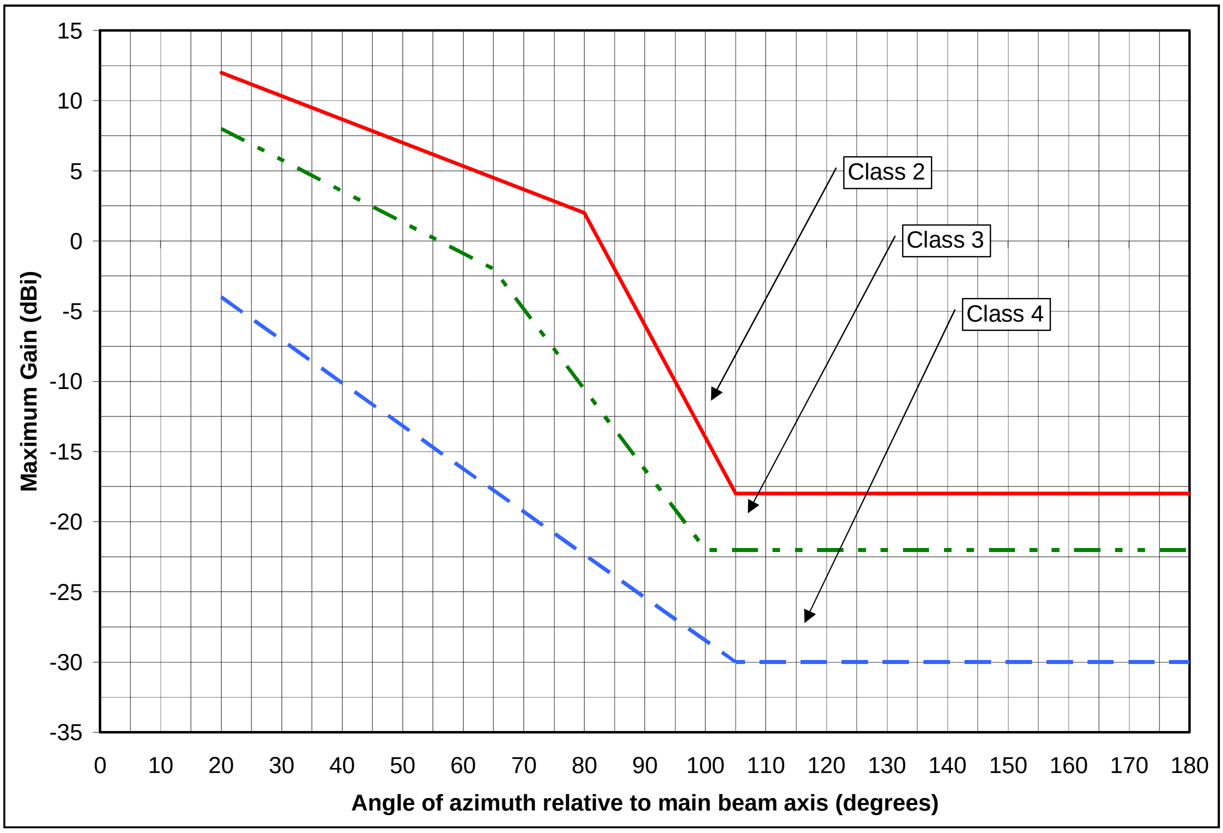


Figure 2: Co-polar limit templates for actual RPE masks of antenna classes in the range 3 GHz to 30 GHz (see table 1)

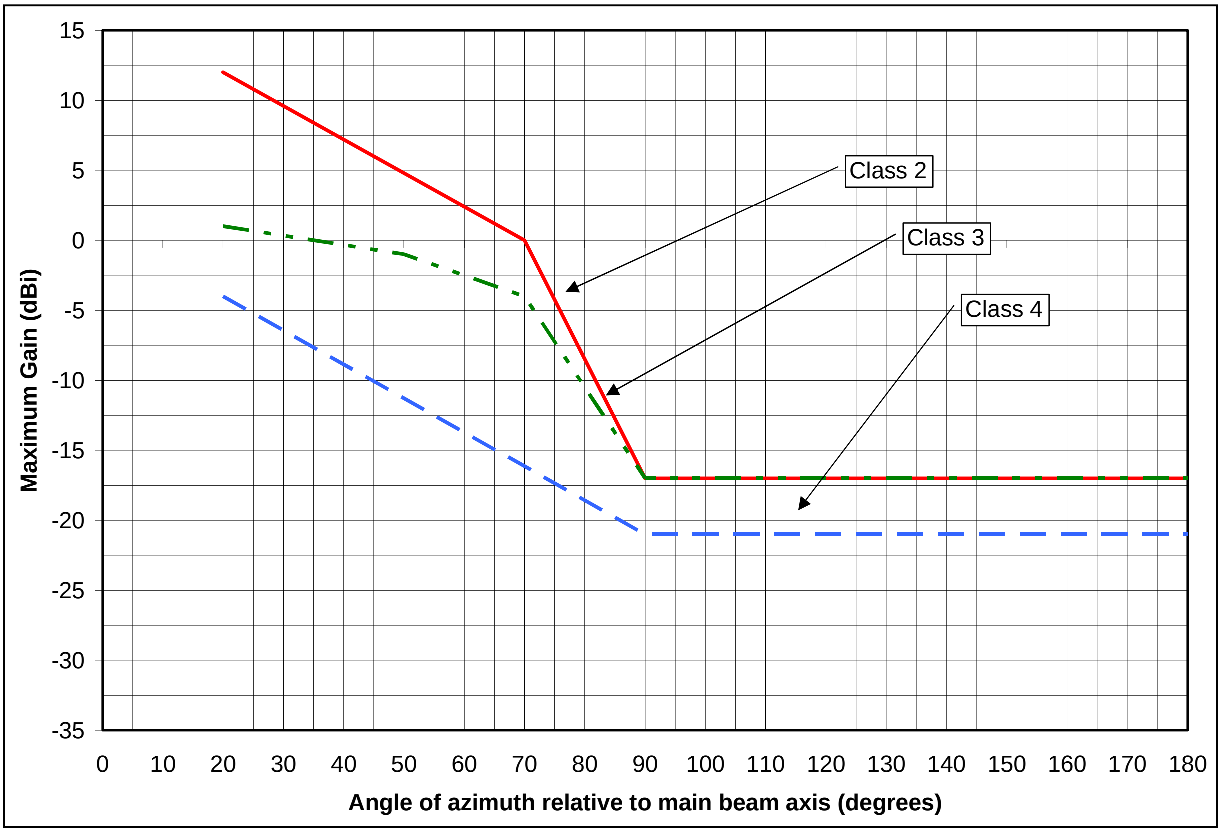


Figure 3: Co-polar limit templates for actual RPE masks of antenna classes in the range 30 GHz to 71 GHz (see table 1)

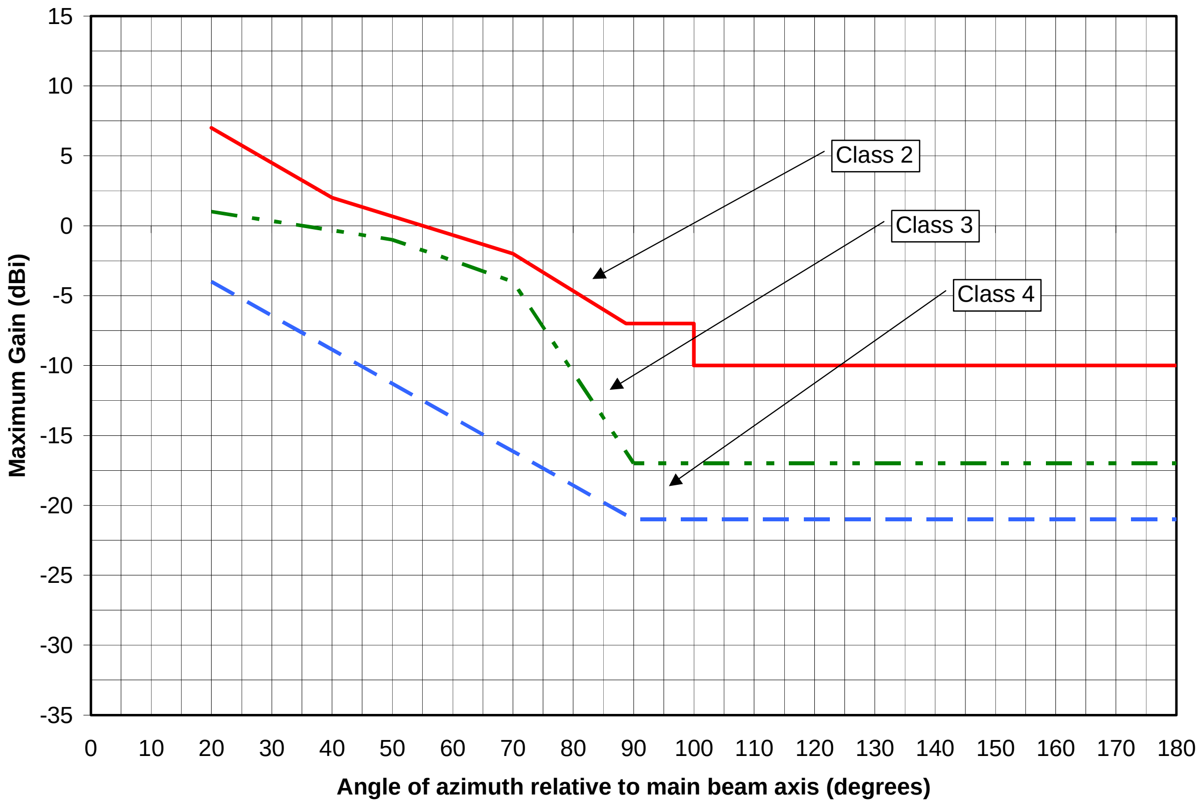


Figure 4: Co-polar limit templates for actual RPE masks of antenna classes in the range 71 GHz to 174,8 GHz (see table 1)

Table 1: Corner points of co-polar limits for actual RPE templates (see figures 1, 2, 3 and 4)

RPE classes (see note 1)	Co-polar maximum limit templates for actual RPEs							
	Range 1 GHz to 3 GHz (see note 2)		Range 3 GHz to 30 GHz		Range 30 GHz to 71 GHz (see note 3)		Range 71 GHz to 174,8 GHz	
	Azimuth angle (°)	Maximum gain (dBi)	Azimuth angle (°)	Maximum gain (dBi)	Azimuth angle (°)	Maximum gain (dBi)	Azimuth angle (°)	Maximum gain (dBi)
2	40	5	20	12	20	12	20	7
	90	5	80	2	70	0	40	2
	120	-10	105	-18	90	-17	70	-2
	180	-10	180	-18	180	-17	88,75	-7
							100	-7
							100	-10
							180	-10
3	30	3	20	8	20	1	20	1
	80	2	65	-2	50	-1	50	-1
	110	-15	100	-22	70	-4	70	-4
	180	-15	180	-22	90	-17	90	-17
					180	-17	180	-17
4	25	0	20	-4	20	-4	20	-4
	75	-5	105	-30	90	-21	90	-21
	105	-20	180	-30	180	-21	180	-21
	180	-20						

NOTE 1: Class 1 antennas are defined as those which actual RPE exceeds class 2 template limit.
NOTE 2: No specific class 4 antenna RPE is defined for this frequency range; the corresponding limit template in table 1 is set for possible future use.
NOTE 3: No specific class 4 antenna RPE is defined for the frequency range 47 GHz to 71 GHz; the corresponding limit template in table 1 is set for possible future use.

4.3 Environmental profile

For *stand-alone* antennas, the required environmental profile for operation of the antenna shall be indicated by the manufacturer in its technical characteristics; in all cases, including *integral* or *dedicated antennas* the environmental profile shall be equal or more demanding than that of the outdoor part of associated equipment, as required by clause 5.1.1.3 of ETSI EN 302 217-2 [i.2]. The antenna shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile. For testing the compliance to technical requirements refer also to clause 5 in the present document.

4.4 Radiation Pattern Envelope (RPE)

4.4.1 Introduction

The present document defines all currently available Antenna RPE classes; both co-polar and cross-polar RPE are described (see note). An overview of which is given in table 2.

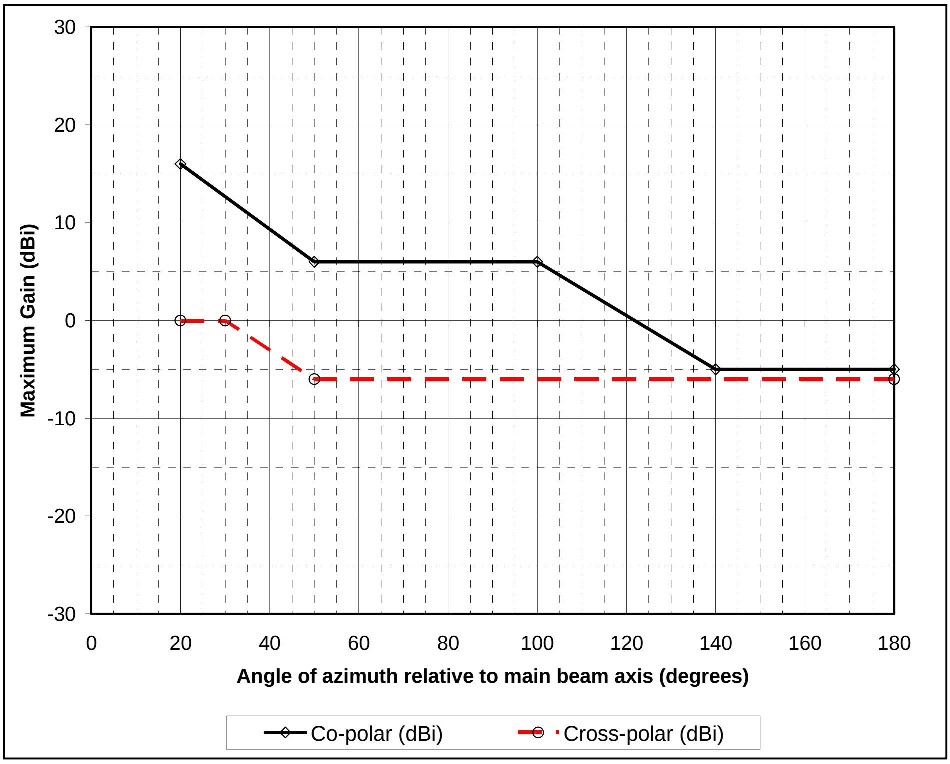
Table 2: Summary of RPE classes represented in the present document

Frequency range (GHz)	Antenna Radiation Pattern Envelope (RPE) classes
1 to 3	1A, 1B, 1C, 2, 3
3 to 14	1, 2, 3, 4
14 to 20	1, 2, 3, 4
20 to 24	1, 2, 3, 4
24 to 30	1, 2, 3, 4
30 to 47	1, 2, 3A, 3B, 3C, 4
47 to 71	1, 2, 3A, 3B
71 to 86	1, 2, 3, 4
92 to 114,25	2, 3, 4
130 to 174,8	2, 3, 4

NOTE: For information, antenna matching certain co-polar RPE class, may offer a cross-polar RPE of higher class (e.g. co-polar class 3 with cross-polar class 4).

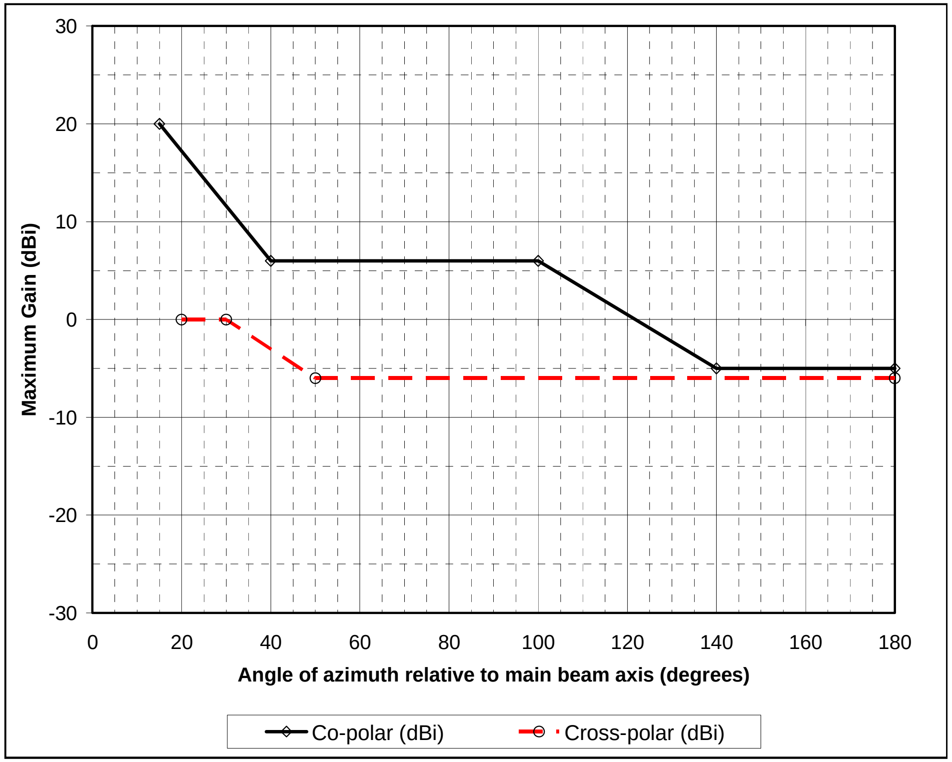
4.4.2 Frequency range 0: 1 GHz to 3 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 5 to 10 give the RPEs for antenna classes 1, 2 and 3.



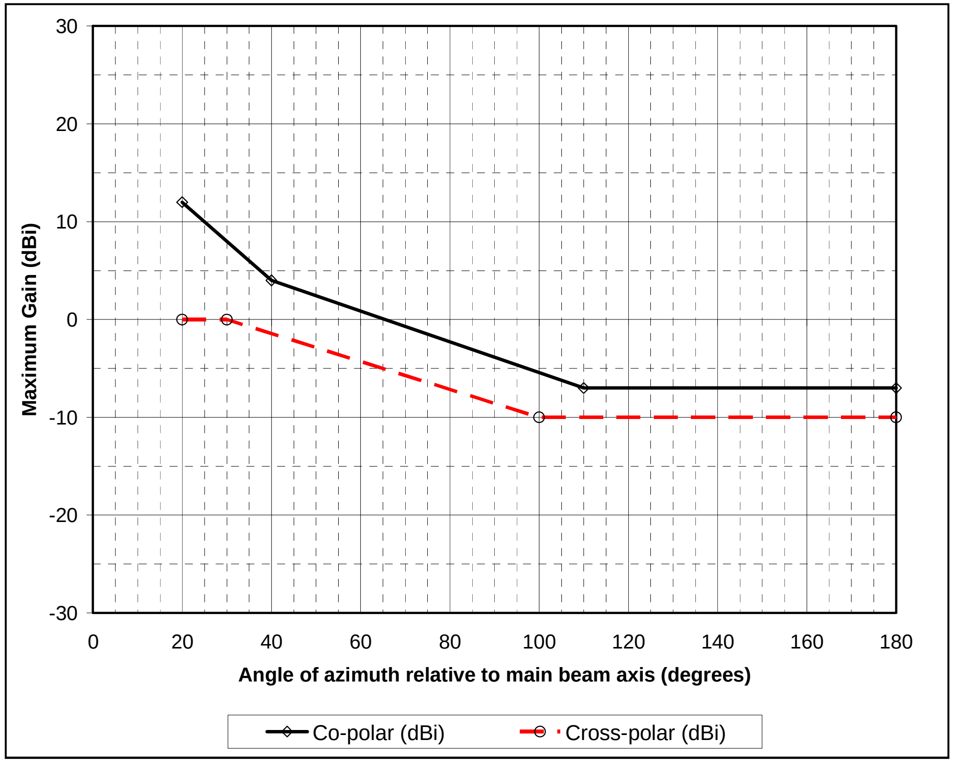
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
20	16	20	0
50	6	30	0
100	6	50	-6
140	-5	180	-6
180	-5		

Figure 5: Class 1A antenna RPE (1 GHz to 3 GHz)



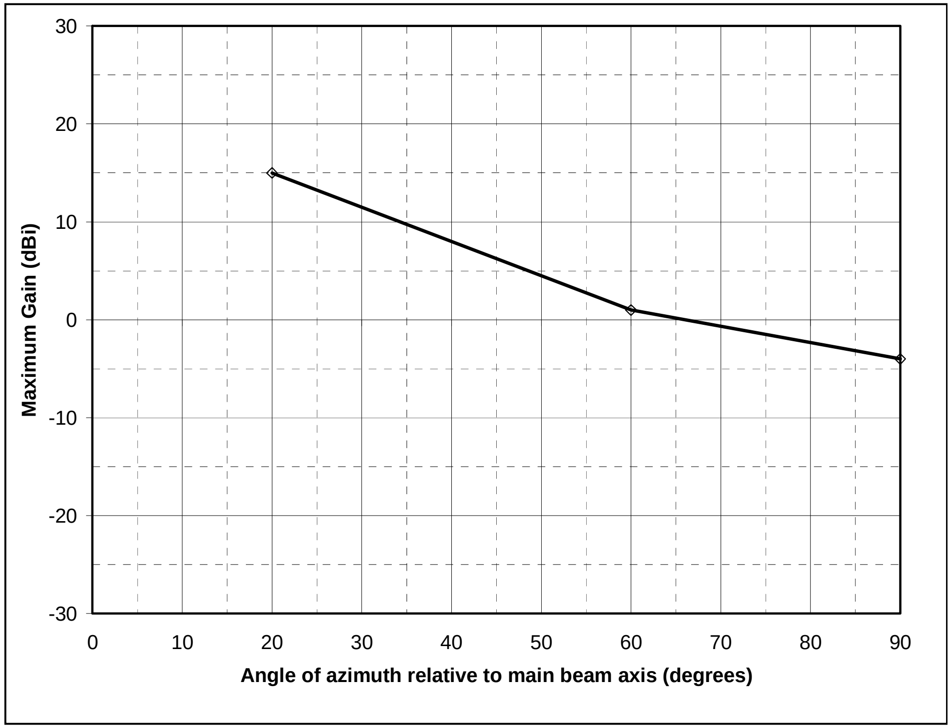
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
15	20	20	0
40	6	30	0
100	6	50	-6
140	-5	180	-6
180	-5		

Figure 6: Class 1B antenna RPE (1 GHz to 3 GHz)



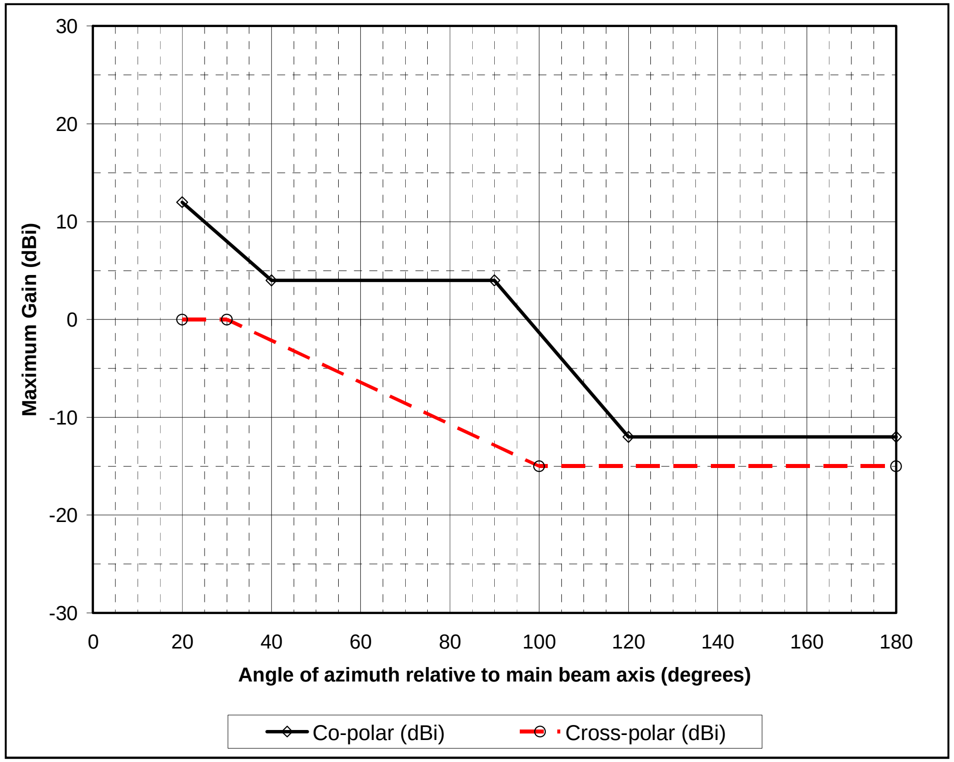
Azimuth angle (°)	Co-polar (dBi)	Azimuth angle (°)	Cross-polar (dBi)
20	12	20	0
40	4	30	0
110	-7	100	-10
180	-7	180	-10

Figure 7: Class 1C antenna RPE (1 GHz to 3 GHz, azimuth plane)



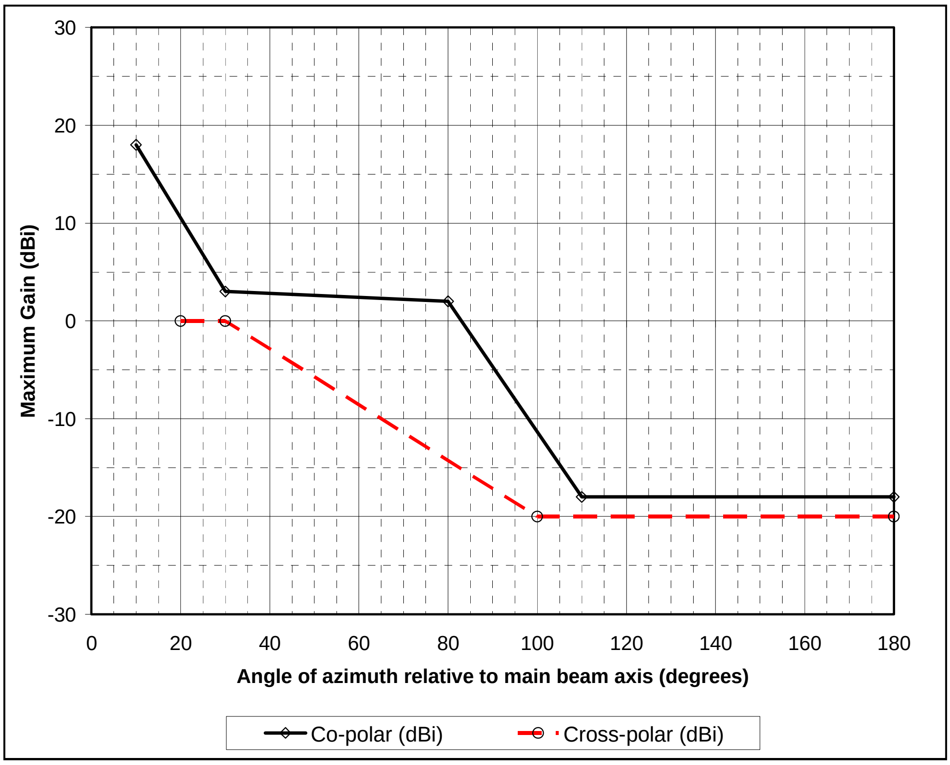
Elevation angle (°)	dBi
20	15
60	1
90	-4

Figure 8: Class 1C antennas RPE (1 GHz to 3 GHz, elevation plane)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
20	12	20	0
40	4	30	0
90	4	100	-15
120	-12	180	-15
180	-12		

Figure 9: Class 2 antenna RPE (1 GHz to 3 GHz)

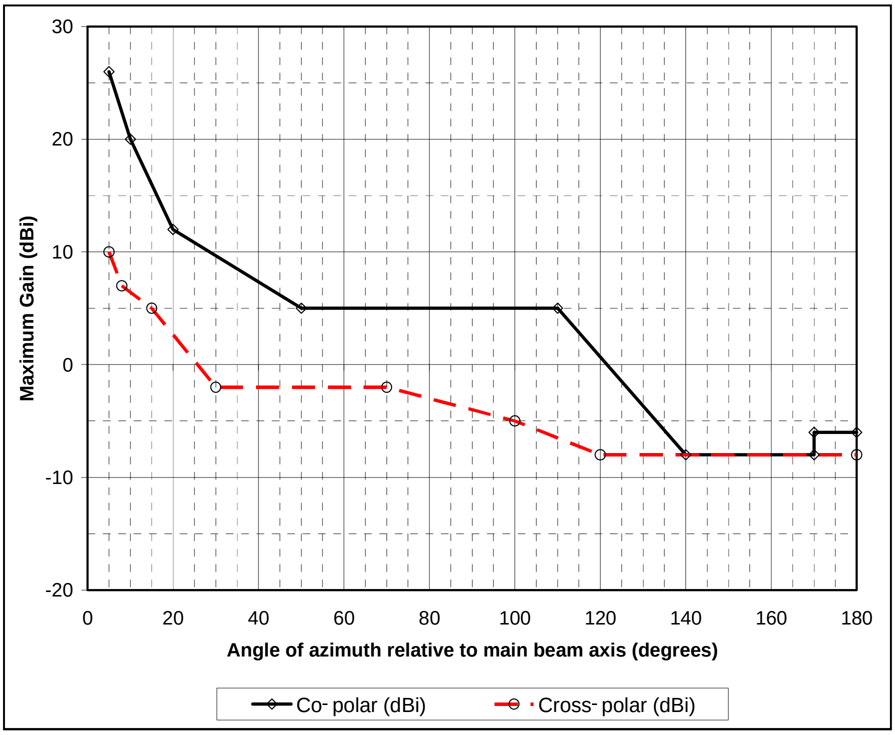


Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
10	18	20	0
30	3	30	0
80	2	100	-20
110	-18	180	-20
180	-18		

Figure 10: Class 3 antenna RPE (1 GHz to 3 GHz)

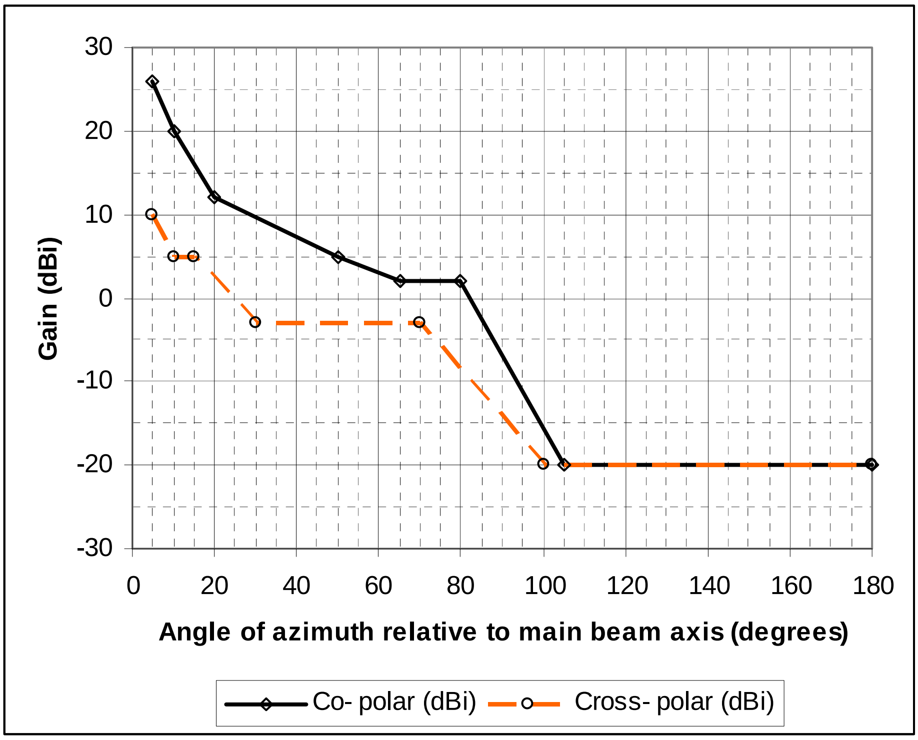
4.4.3 Frequency range 1: 3 GHz to 14 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 11 to 14 give the RPEs for antenna classes 1, 2, 3 and 4.



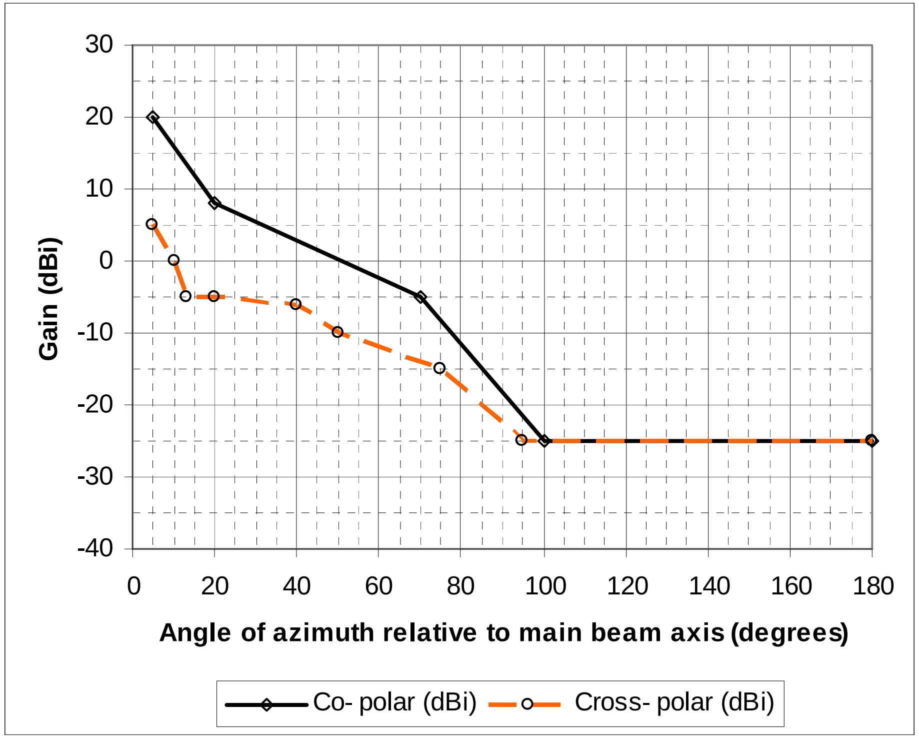
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	26	5	10
10	20	8	7
20	12	15	5
50	5	30	-2
110	5	70	-2
140	-8	100	-5
170	-8	120	-8
170	-6	180	-8
180	-6		

Figure 11: Class 1 antennas RPE (3 GHz to 14 GHz)



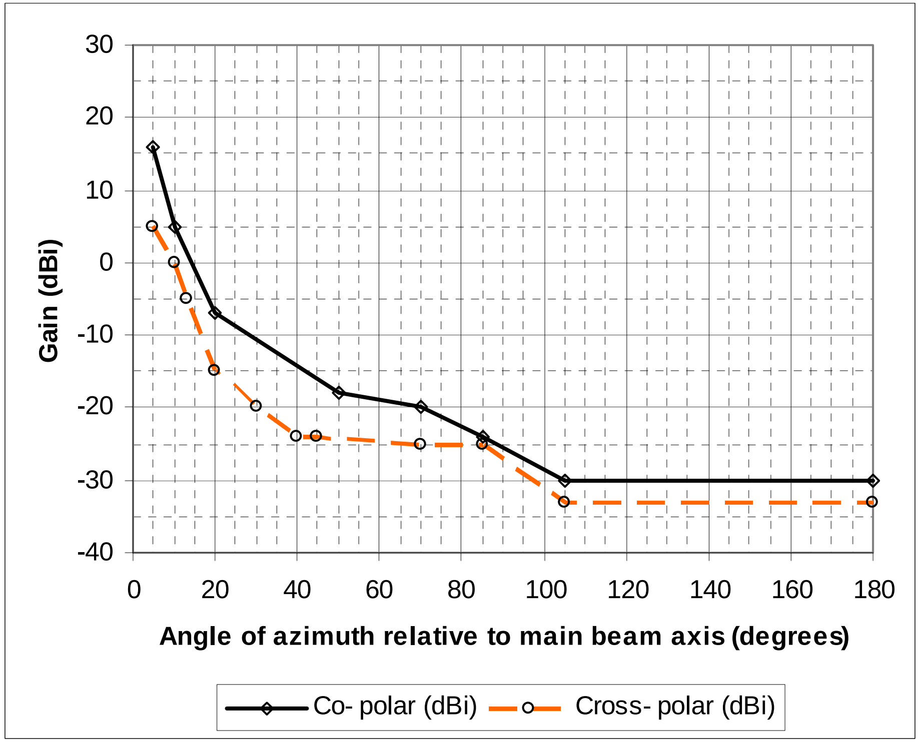
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	26	5	10
10	20	10	5
20	12	15	5
50	5	30	-3
65	2	70	-3
80	2	100	-20
105	-20	180	-20
180	-20		

Figure 12: Class 2 antennas RPE (3 GHz to 14 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	5
20	8	10	0
70	-5	13	-5
100	-25	20	-5
180	-25	40	-6
		50	-10
		75	-15
		95	-25
		180	-25

Figure 13: Class 3 antennas RPE (3 GHz to 14 GHz)

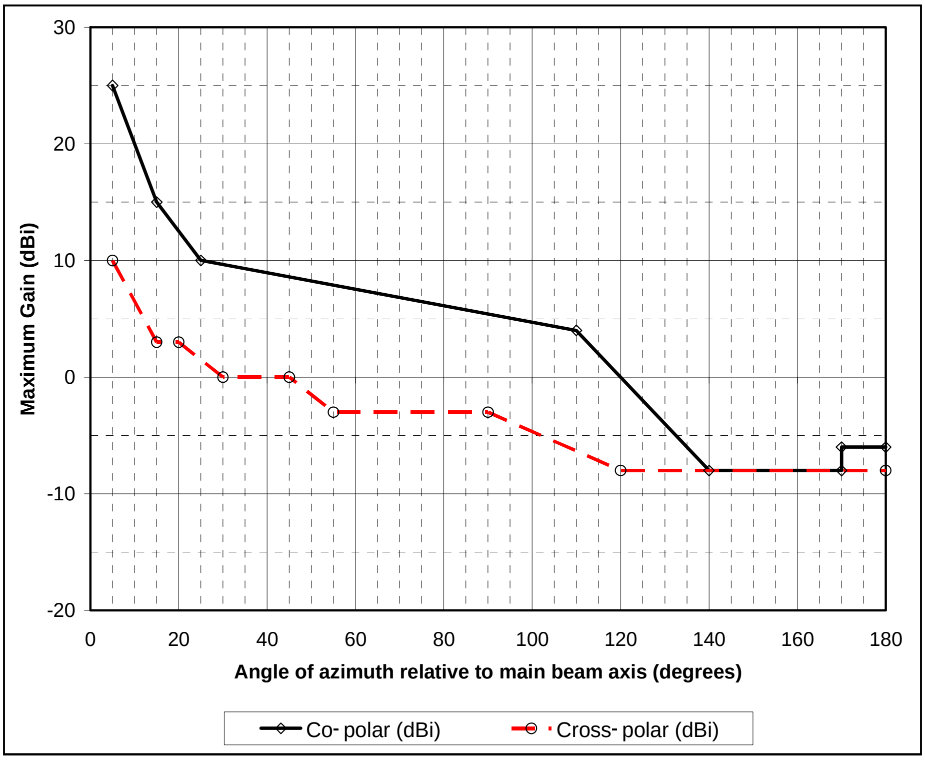


Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	5
10	5	10	0
20	-7	13	-5
50	-18	20	-15
70	-20	30	-20
85	-24	40	-24
105	-30	45	-24
180	-30	70	-25
		85	-25
		105	-33
		180	-33

Figure 14: Class 4 antennas RPE (3 GHz to 14 GHz)

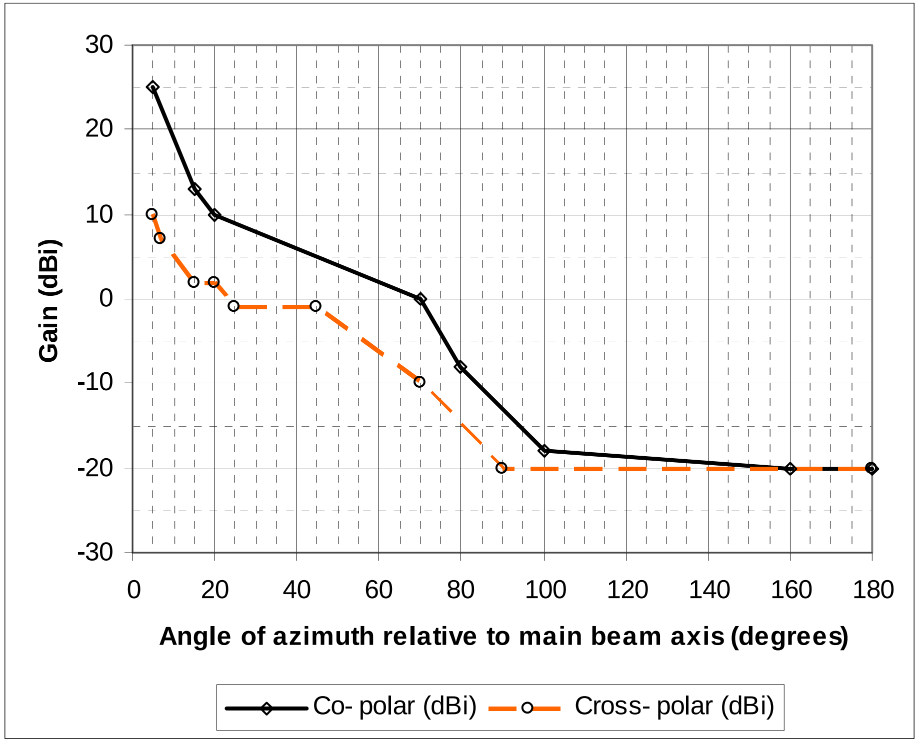
4.4.4 Frequency range 2: 14 GHz to 20 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 15 to 18 give the RPEs for antenna classes 1, 2, 3 and 4.



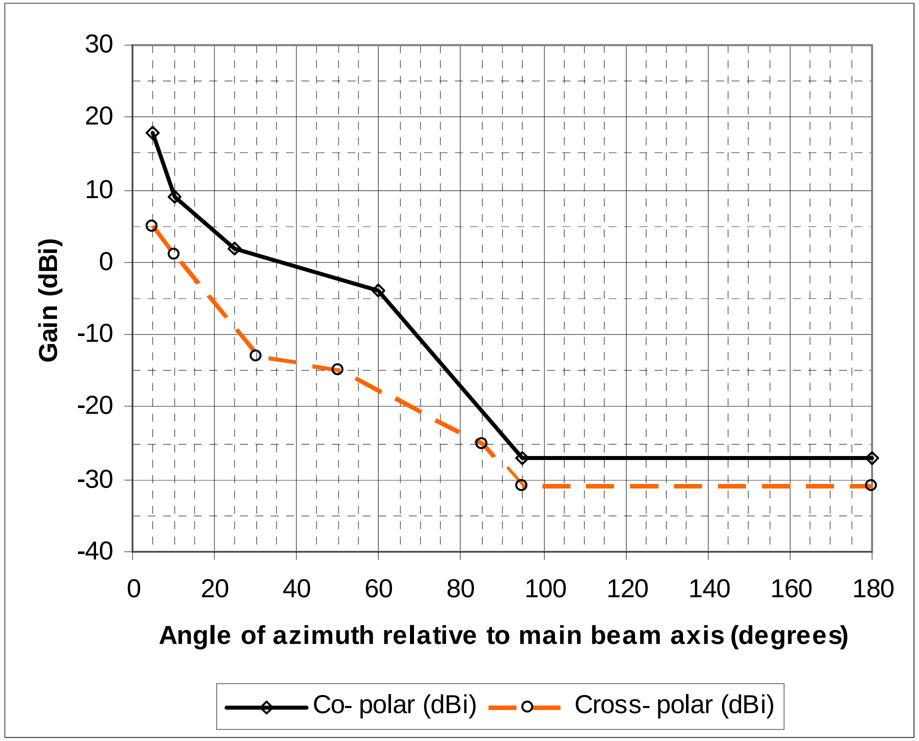
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	10
15	15	15	3
25	10	20	3
110	4	30	0
140	-8	45	0
170	-8	55	-3
170	-6	90	-3
180	-6	120	-8
		180	-8

Figure 15: Class 1 antennas RPE (14 GHz to 20 GHz)



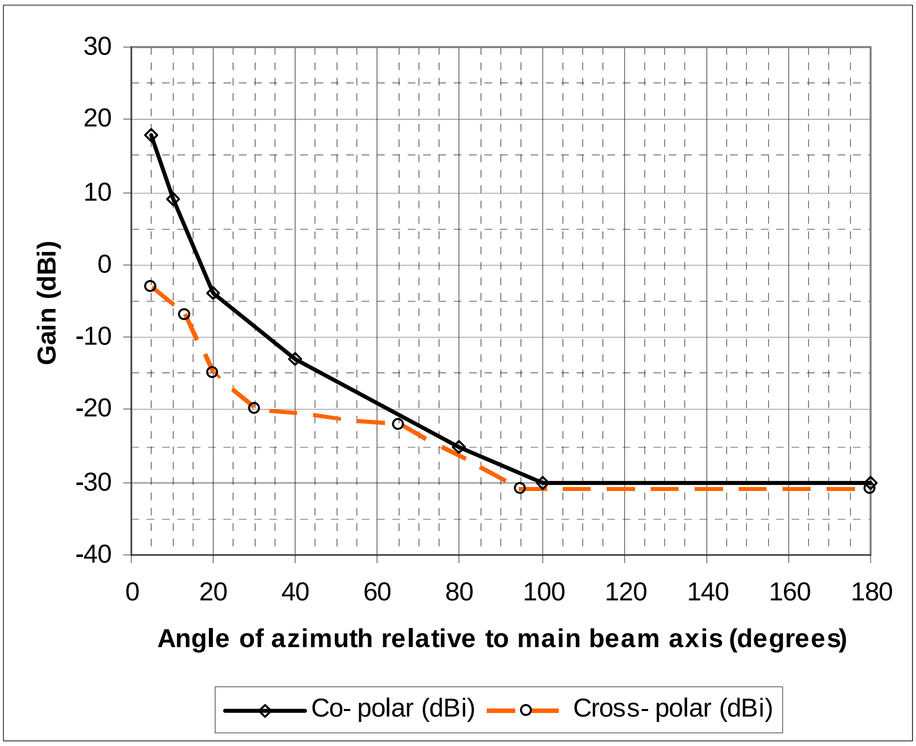
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	10
15	13	7	7
20	10	15	2
70	0	20	2
80	-8	25	-1
100	-18	45	-1
160	-20	70	-10
180	-20	90	-20
		180	-20

Figure 16: Class 2 antennas RPE (14 GHz to 20 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	18	5	5
10	9	10	1
25	2	30	-13
60	-4	50	-15
95	-27	85	-25
180	-27	95	-31
		180	-31

Figure 17: Class 3 antennas RPE (14 GHz to 20 GHz)

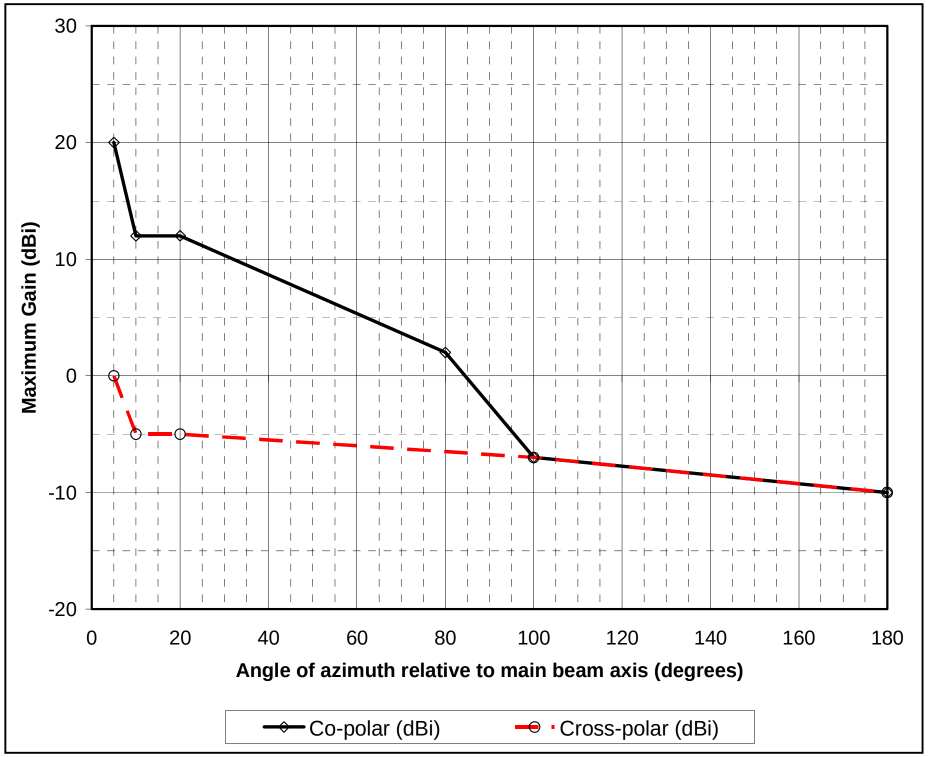


Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	18	5	-3
10	9	13	-7
20	-4	20	-15
40	-13	30	-20
80	-25	65	-22
100	-30	95	-31
180	-30	180	-31

Figure 18: Class 4 antennas RPE (14 GHz to 20 GHz)

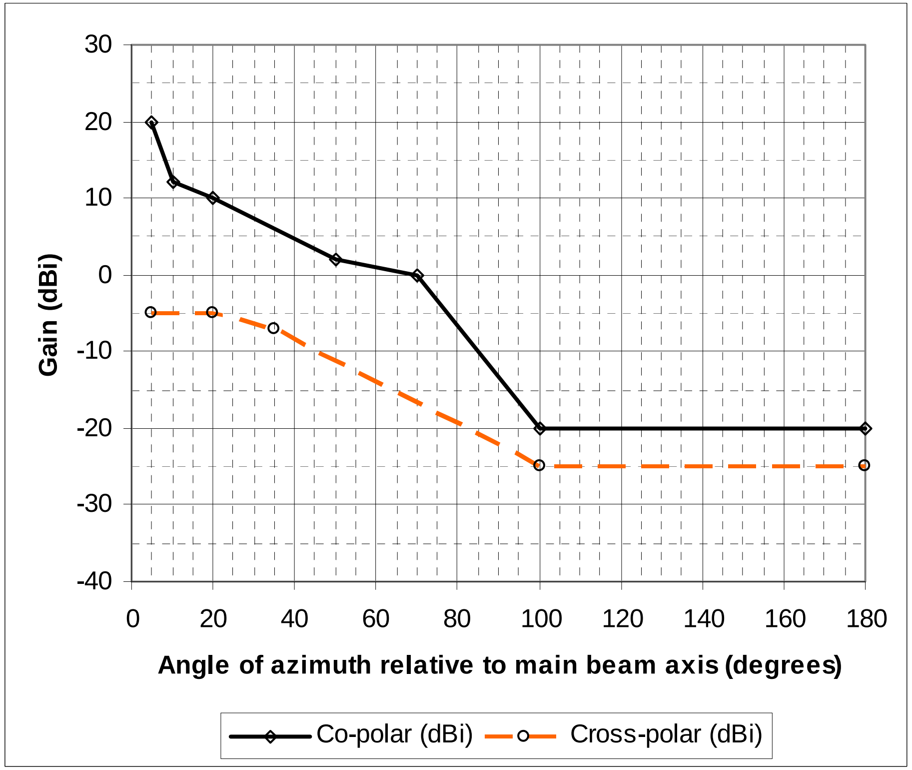
4.4.5 Frequency range 3: 20 GHz to 24 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 19 to 22 give the RPEs for antenna classes 1, 2, 3 and 4.



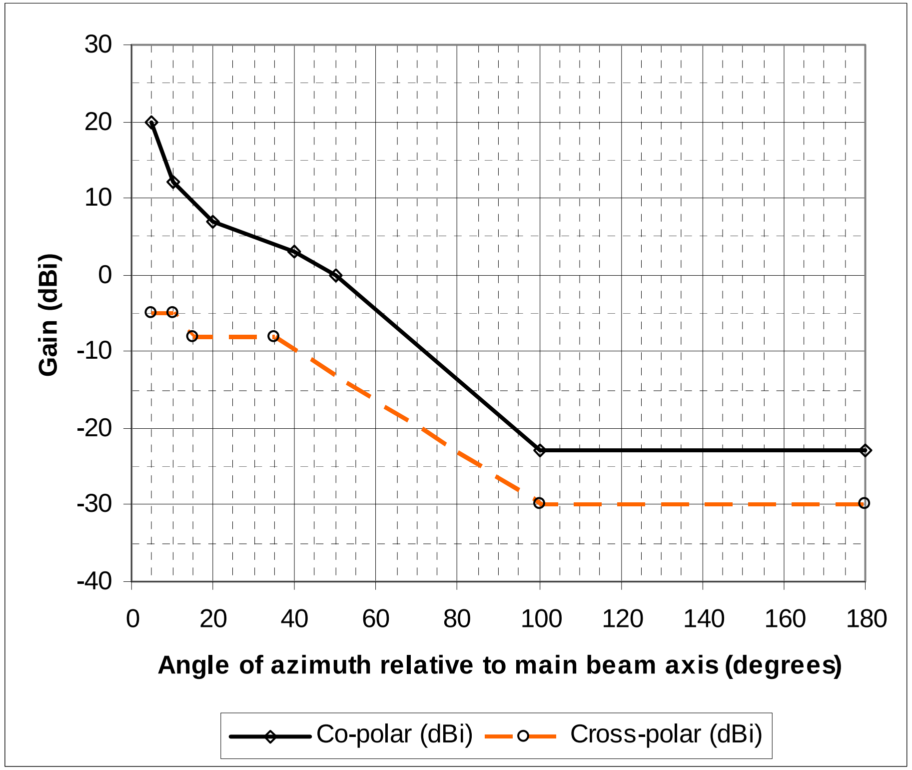
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	0
10	12	10	-5
20	12	20	-5
80	2	100	-7
100	-7	180	-10
180	-10		

Figure 19: Class 1 antennas RPE (20 GHz to 24 GHz)



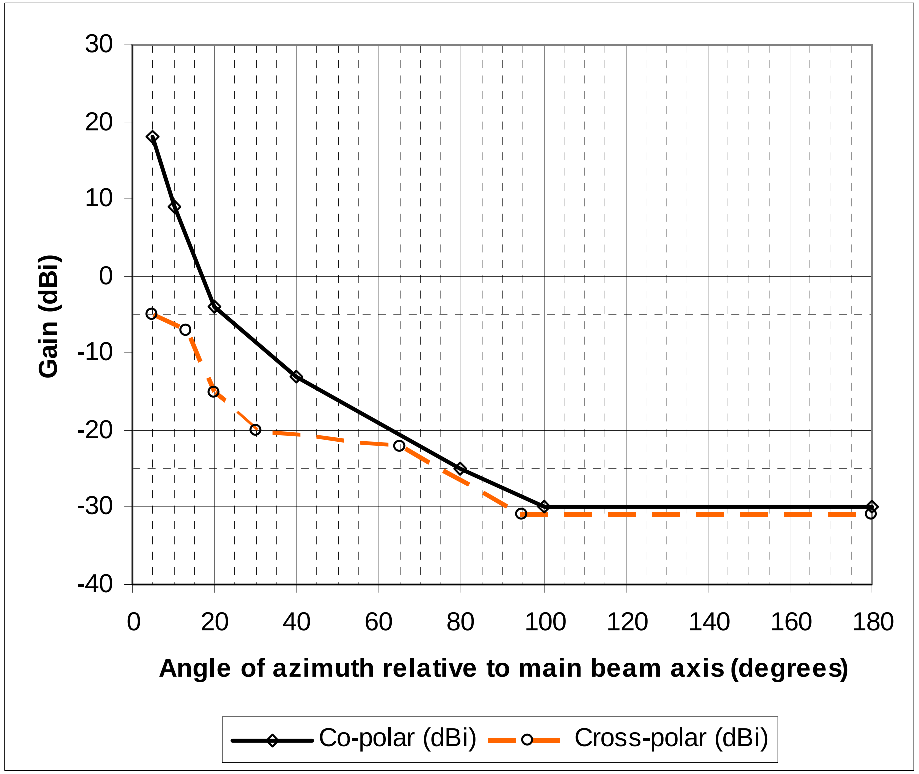
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	-5
10	12	20	-5
20	10	35	-7
50	2	100	-25
70	0	180	-25
100	-20		
180	-20		

Figure 20: Class 2 antennas RPE (20 GHz to 24 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	-5
10	12	10	-5
20	7	15	-8
40	3	35	-8
50	0	100	-30
100	-23	180	-30
180	-23		

Figure 21: Class 3 antennas RPE (20 GHz to 24 GHz)

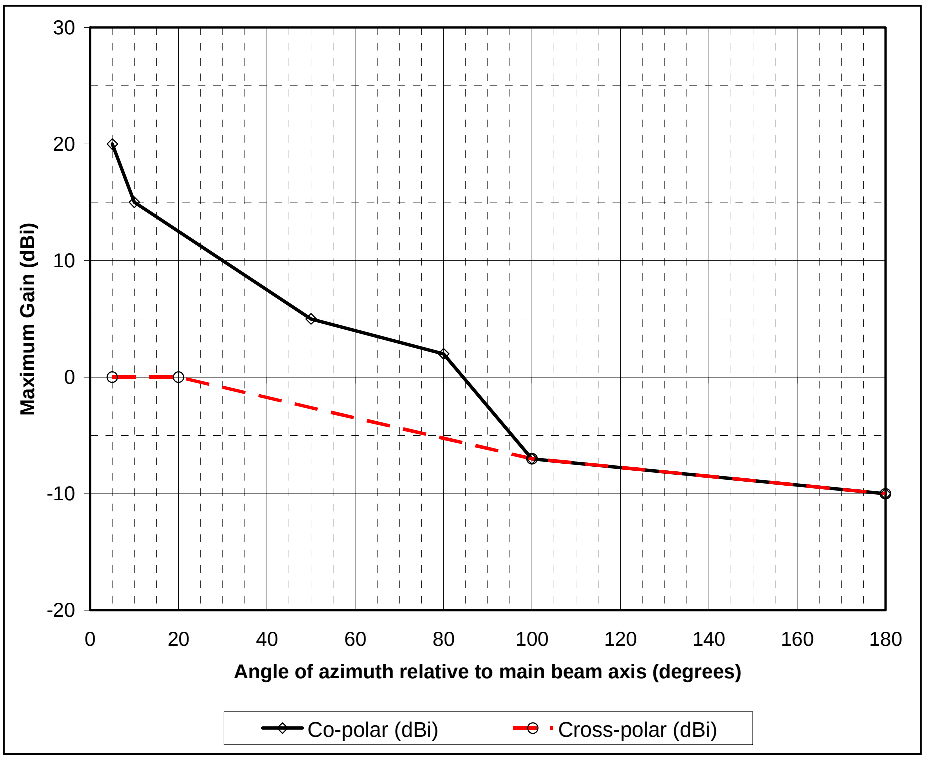


Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	18	5	-5
10	9	13	-7
20	-4	20	-15
40	-13	30	-20
80	-25	65	-22
100	-30	95	-31
180	-30	180	-31

Figure 22: Class 4 antennas RPE (20 GHz to 24 GHz)

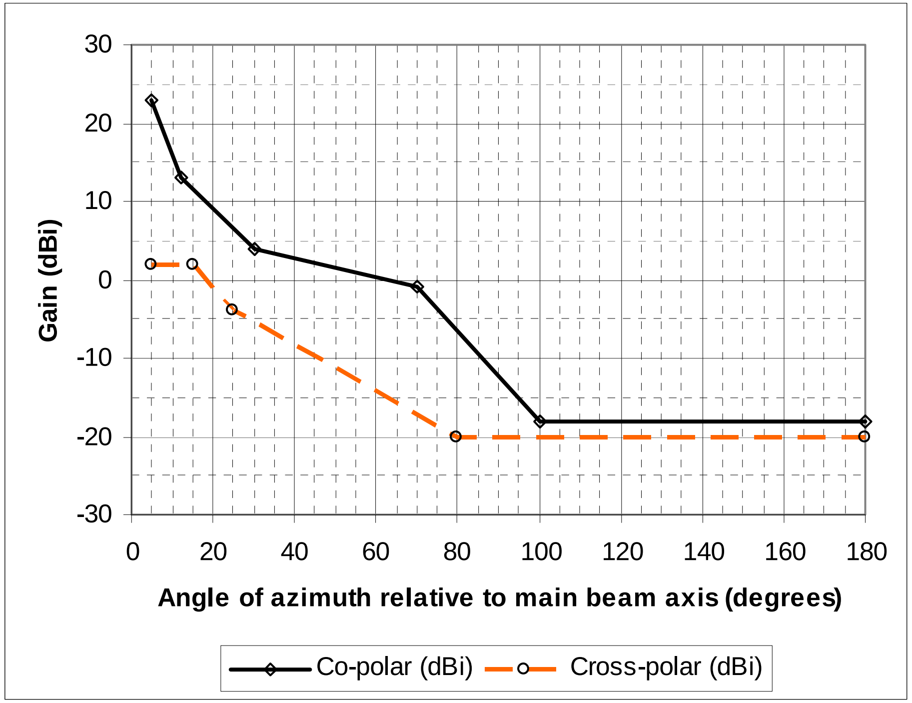
4.4.6 Frequency range 4: 24 GHz to 30 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 23 to 26 give the RPEs for antenna classes 1, 2, 3 and 4.



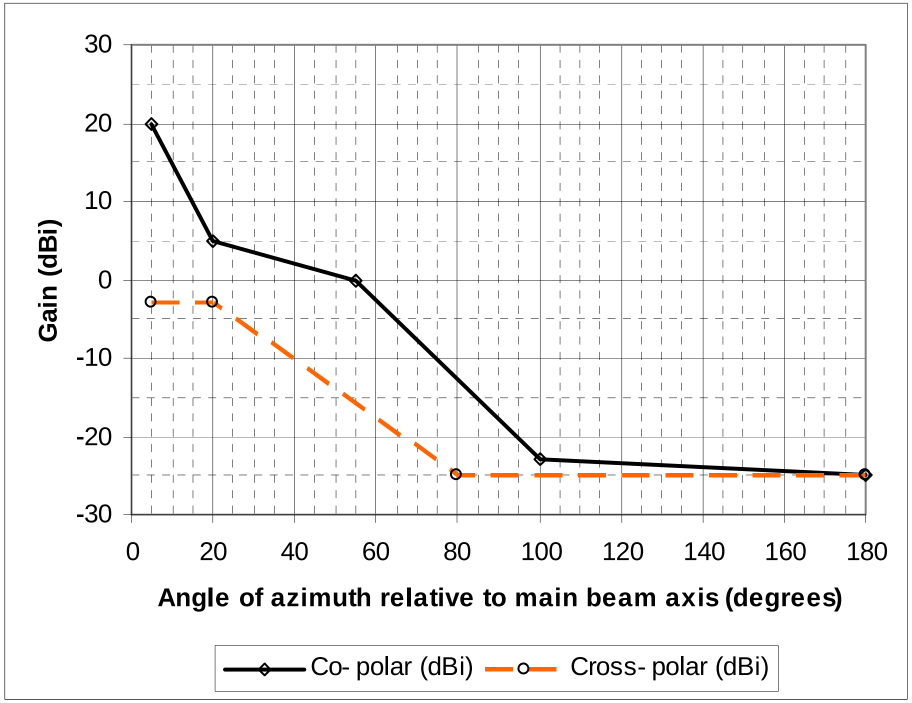
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	0
10	15	20	0
50	5	100	-7
80	2	180	-10
100	-7		
180	-10		

Figure 23: Class 1 antennas RPE (24 GHz to 30 GHz)



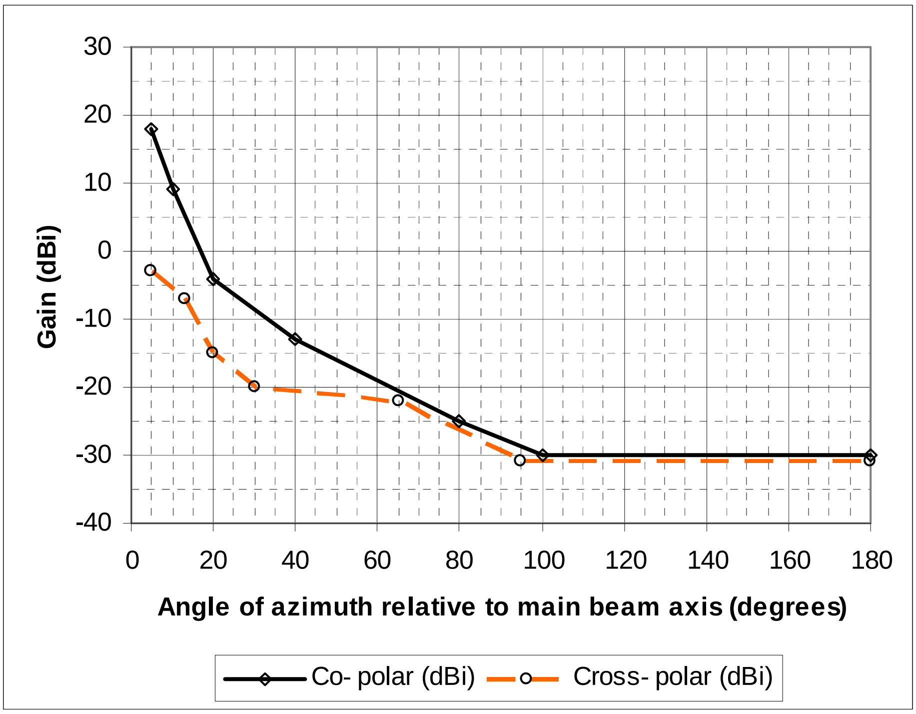
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	23	5	2
12	13	15	2
30	4	25	-4
70	-1	80	-20
100	-18	180	-20
180	-18		

Figure 24: Class 2 antenna RPE (24 GHz to 30 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	-3
20	5	20	-3
55	0	80	-25
100	-23	180	-25
180	-25		

Figure 25: Class 3 antennas RPE (24 GHz to 30 GHz)

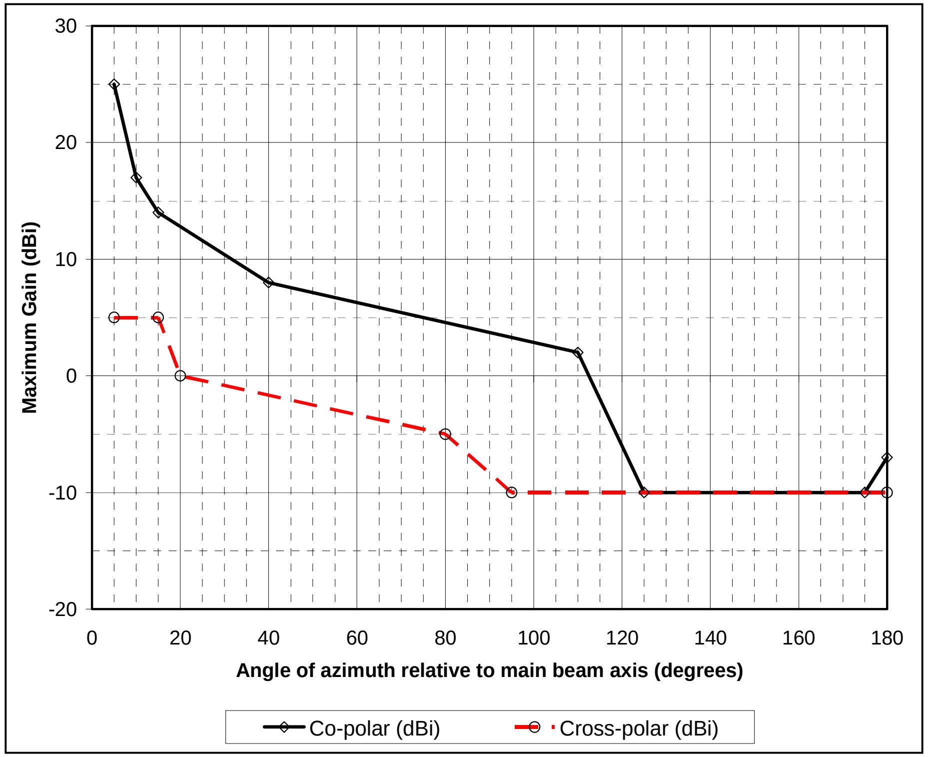


Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	18	5	-3
10	9	13	-7
20	-4	20	-15
40	-13	30	-20
80	-25	65	-22
100	-30	95	-31
180	-30	180	-31

Figure 26: Class 4 antennas RPE (24 GHz to 30 GHz)

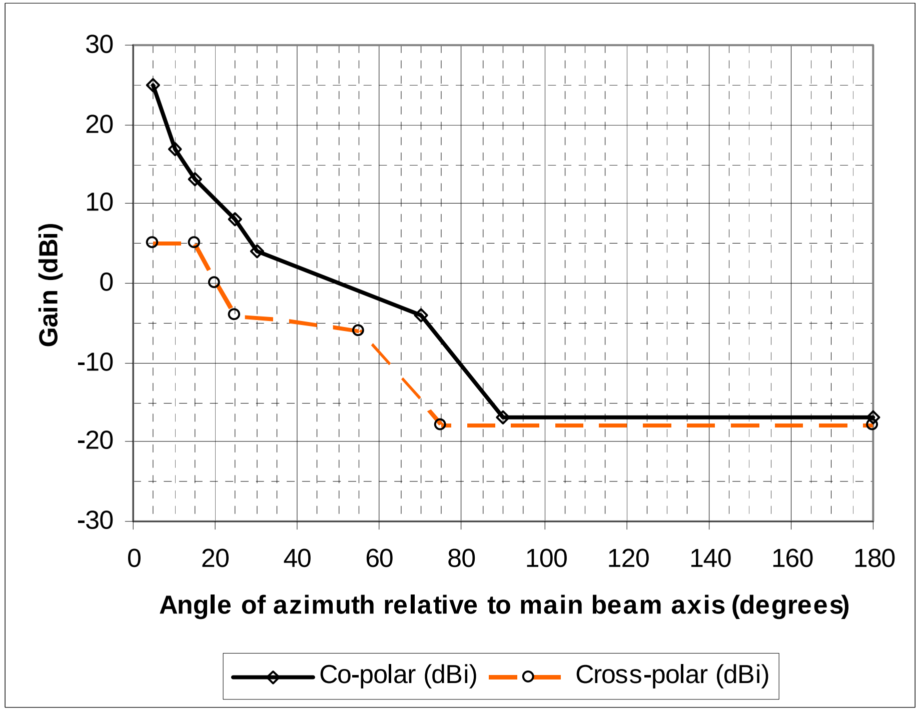
4.4.7 Frequency range 5: 30 GHz to 47 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 27 to 32 give the RPEs for antenna classes 1, 2, 3 and 4.



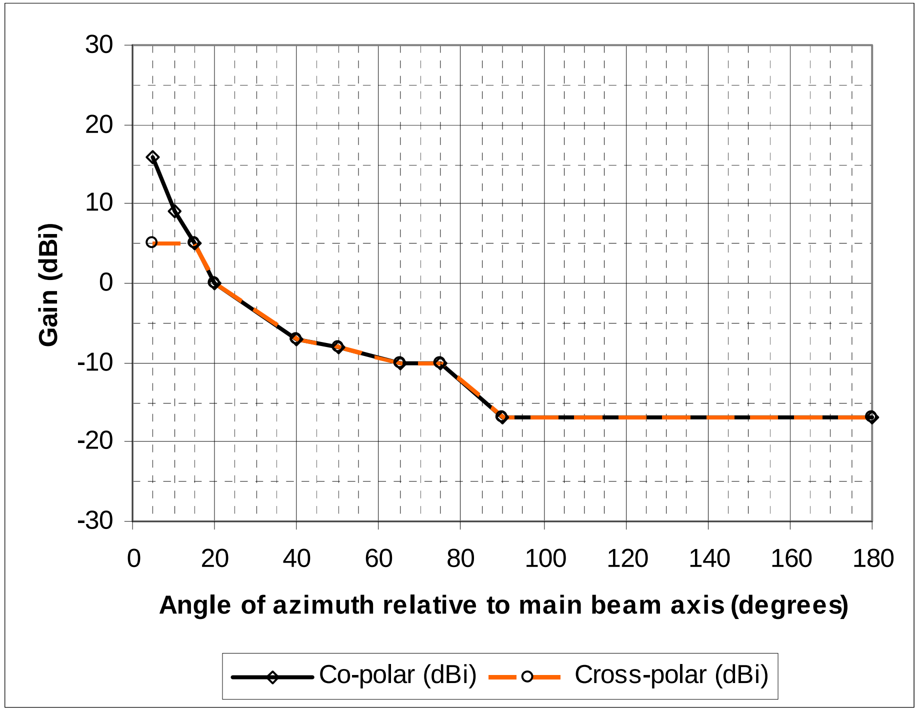
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
10	17	15	5
15	14	20	0
40	8	80	-5
110	2	95	-10
125	-10	180	-10
175	-10		
180	-7		

Figure 27: Class 1 antennas RPE (30 GHz to 47 GHz)



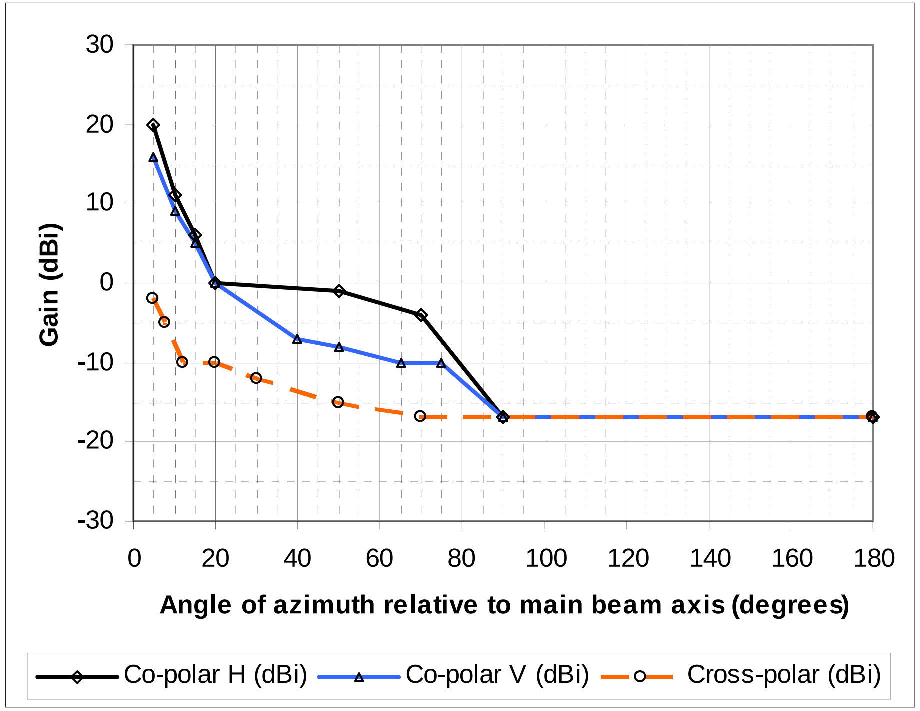
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
10	17	15	5
15	13	20	0
25	8	25	-4
30	4	55	-6
70	-4	75	-18
90	-17	180	-18
180	-17		

Figure 28: Class 2 antennas RPE (30 GHz to 47 GHz)



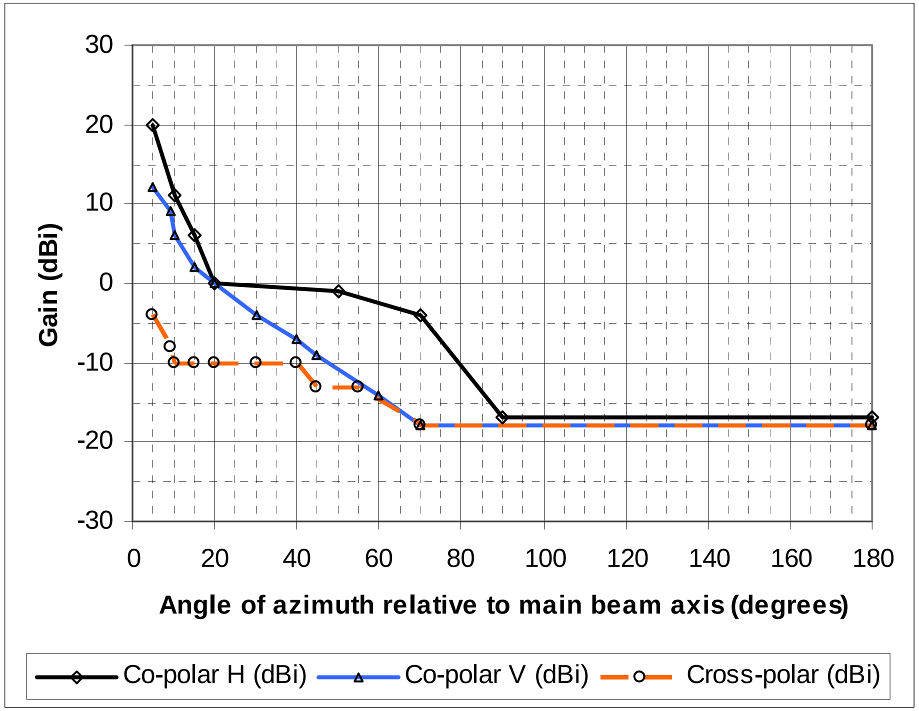
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	5
10	9	15	5
15	5	20	0
20	0	40	-7
40	-7	50	-8
50	-8	65	-10
65	-10	75	-10
75	-10	90	-17
90	-17	180	-17
180	-17		

Figure 29: Class 3 A antennas RPE
(30 GHz to 47 GHz, applicable to single vertical polarized antennas only)



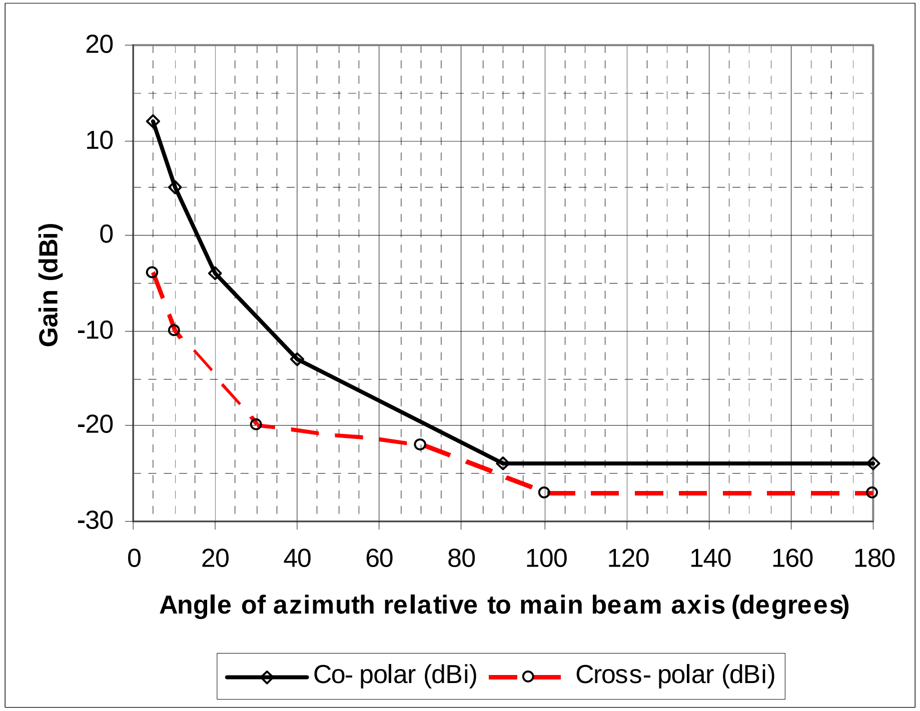
Angle (°)	Co-polar H (dBi)	Angle (°)	Co-polar V (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	16	5	-2
10	11	10	9	8	-5
15	6	15	5	12	-10
20	0	20	0	20	-10
50	-1	40	-7	30	-12
70	-4	50	-8	50	-15
90	-17	65	-10	70	-17
180	-17	75	-10	180	-17
		90	-17		
		180	-17		

Figure 30: Class 3B antennas RPE (30 GHz to 47 GHz)



Angle (°)	Co-polar H (dBi)	Angle (°)	Co-polar V (dBi)	Angle (°)	Cross-polar (dBi)
5	20	5	12	5	-4
10	11	9	9	9	-8
15	6	10	6	10	-10
20	0	15	2	15	-10
50	-1	20	0	20	-10
70	-4	30	-4	30	-10
90	-17	40	-7	40	-10
180	-17	45	-9	45	-13
		60	-14	55	-13
		70	-18	70	-18
		180	-18	180	-18

Figure 31: Class 3C antennas RPE (30 GHz to 47 GHz)

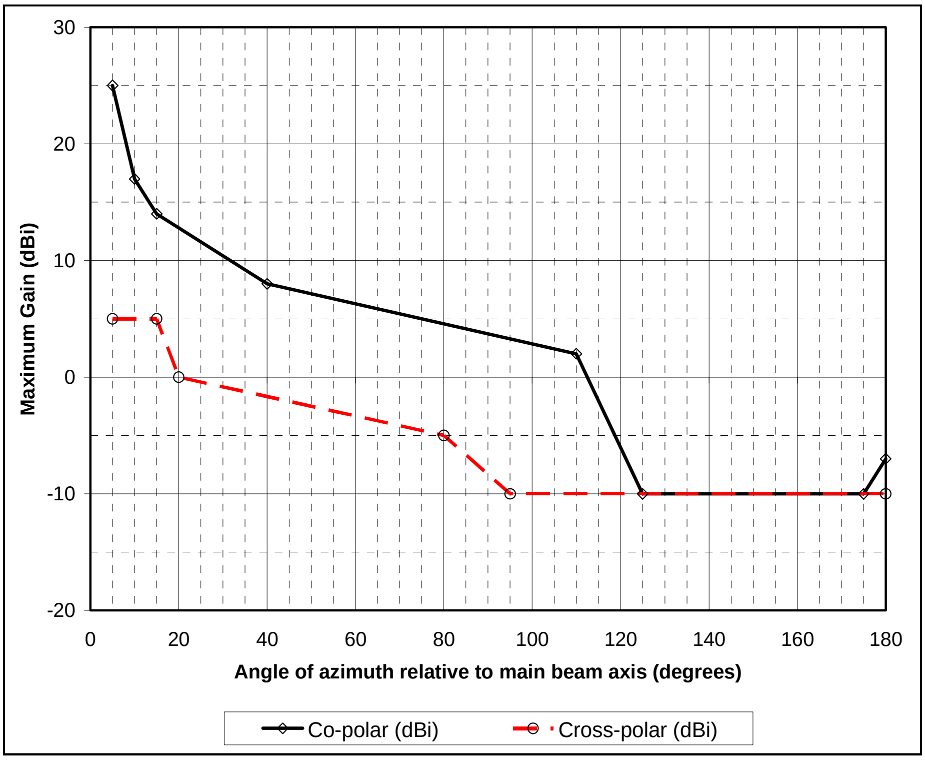


Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	12	5	-4
10	5	10	-10
20	-4	30	-20
40	-13	70	-22
90	-24	100	-27
180	-24	180	-27

Figure 32: Class 4 antennas RPE (30 GHz to 47 GHz)

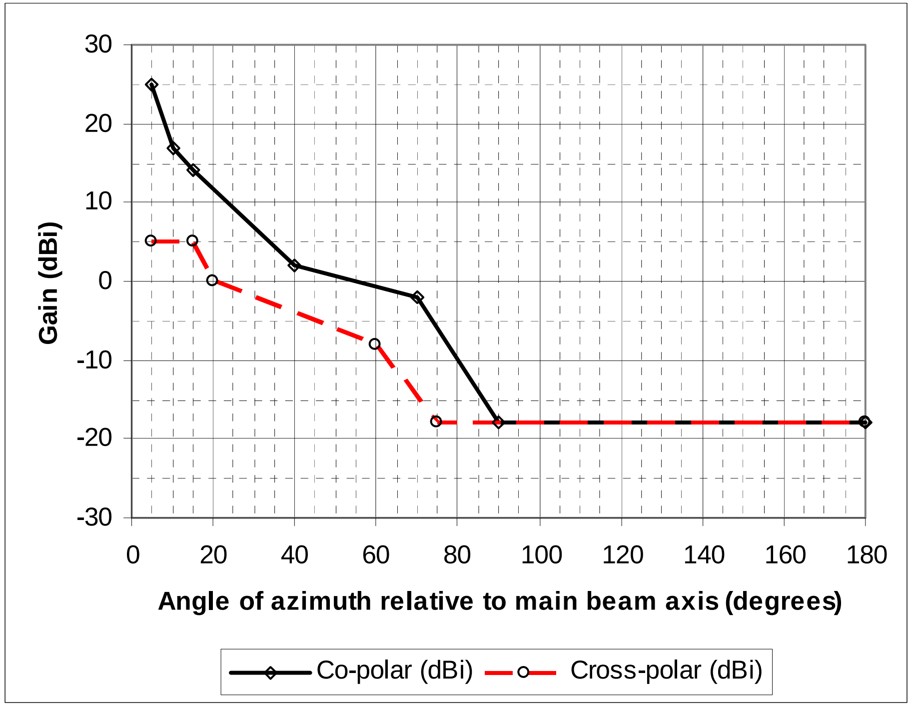
4.4.8 Frequency range 6: 47 GHz to 71 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 33 to 36 give the RPEs for antenna classes 1, 2 and 3.



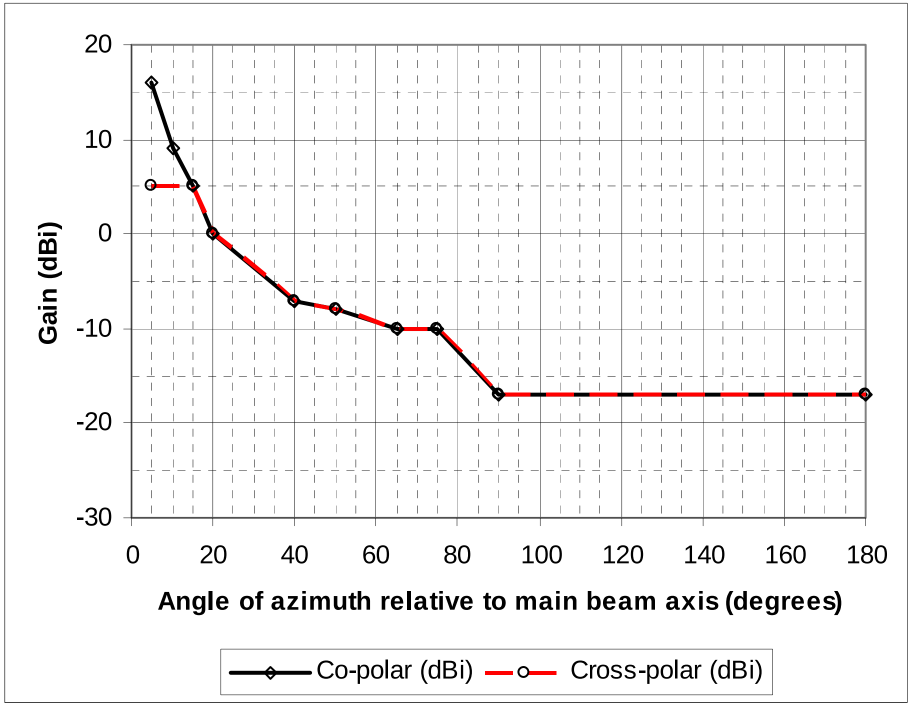
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
10	17	15	5
15	14	20	0
40	8	80	-5
110	2	95	-10
125	-10	180	-10
175	-10		
180	-7		

Figure 33: Class 1 antennas RPE (47 GHz to 71 GHz)



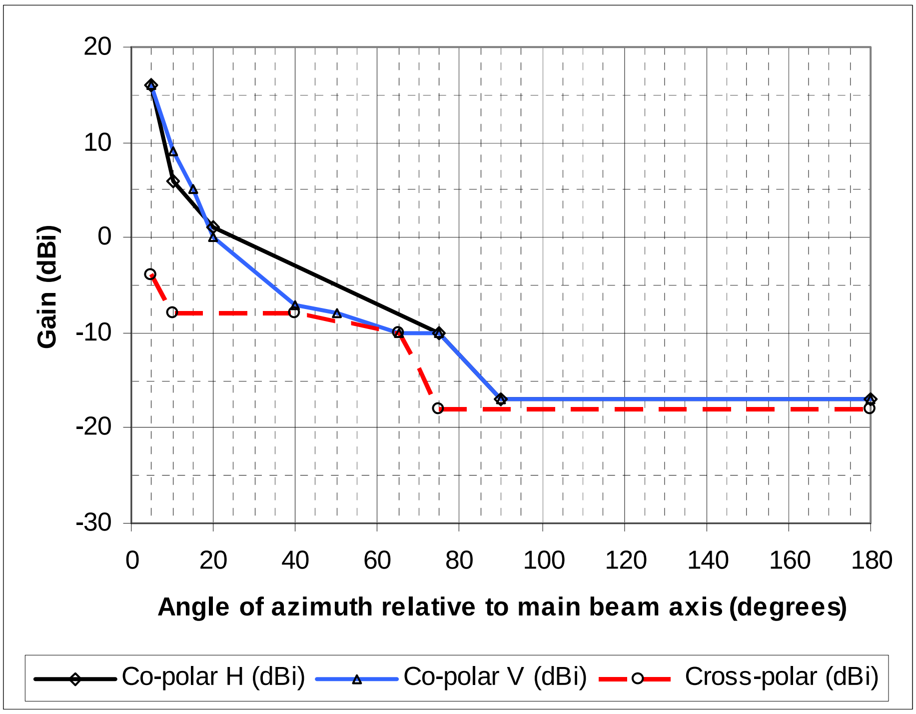
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
10	17	15	5
15	14	20	0
40	2	60	-8
70	-2	75	-18
90	-18	180	-18
180	-18		

Figure 34: Class 2 antennas RPE (47 GHz to 71 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	5
10	9	15	5
15	5	20	0
20	0	40	-7
40	-7	50	-8
50	-8	65	-10
65	-10	75	-10
75	-10	90	-17
90	-17	180	-17
180	-17		

Figure 35: Class 3A antennas RPE (47 GHz to 71 GHz, vertically polarized only)

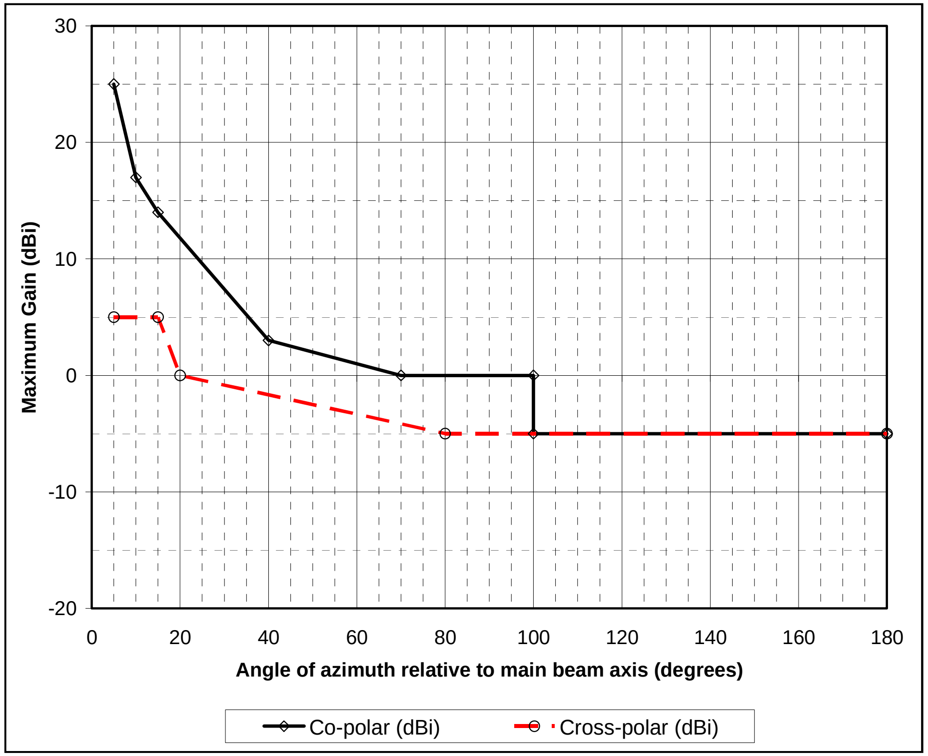


Angle (°)	Co-polar H (dBi)	Angle (°)	Co-polar V (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	16	5	-4
10	6	10	9	10	-8
20	1	15	5	40	-8
75	-10	20	0	65	-10
90	-17	40	-7	75	–18
180	-17	50	-8	180	-18
		65	-10		
		75	-10		
		90	-17		
		180	-17		

Figure 36: Class 3B antennas RPE (47 GHz to 71 GHz range)

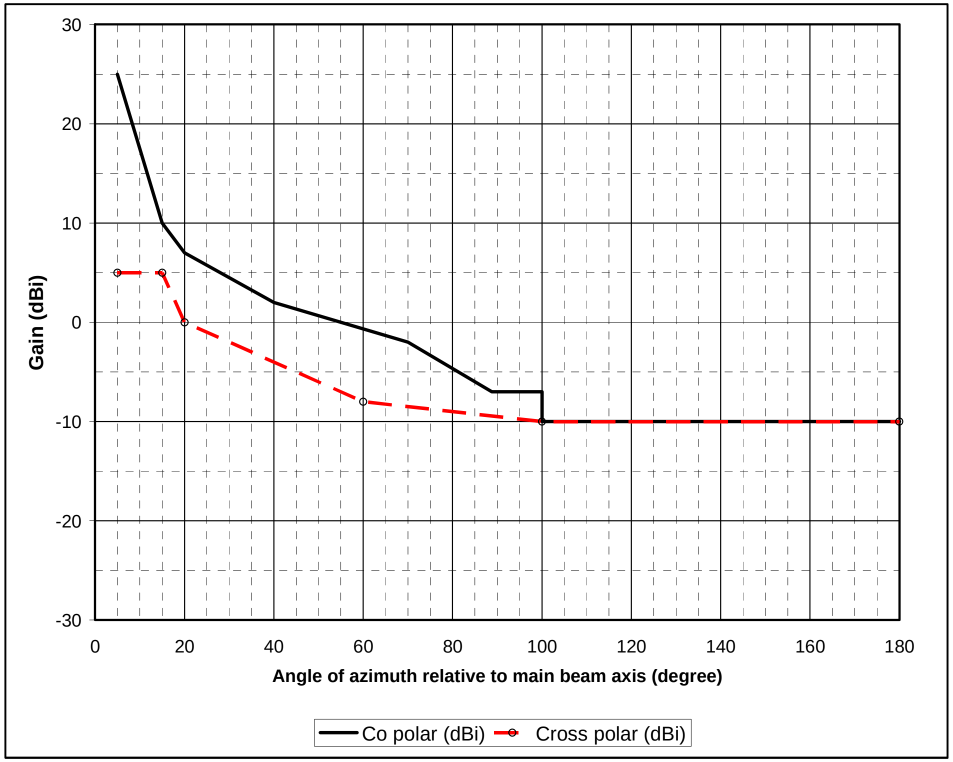
4.4.9 Frequency range 7: 71 GHz to 86 GHz

The choice of antenna depends on the application planned for this band, requirements of the operators and the responsible administration. Figures 37 to 40 give the RPEs for antenna classes 1, 2, 3 and 4.



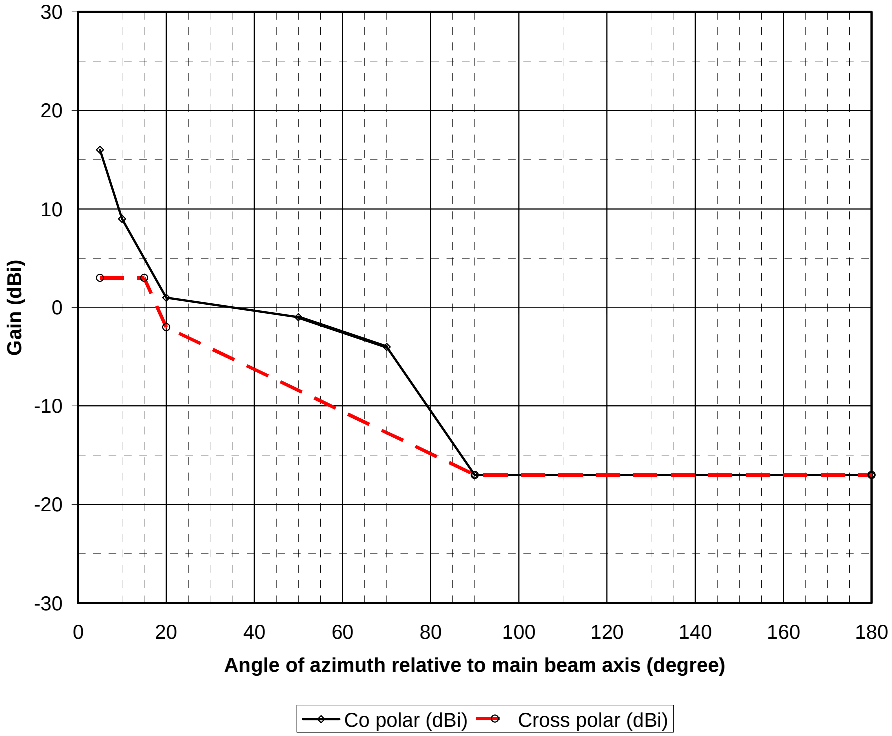
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
10	17	15	5
15	14	20	0
40	3	80	-5
70 to 100	0	180	-5
100 to 180	-5		

Figure 37: Class 1 antennas RPE (71 GHz to 86 GHz)



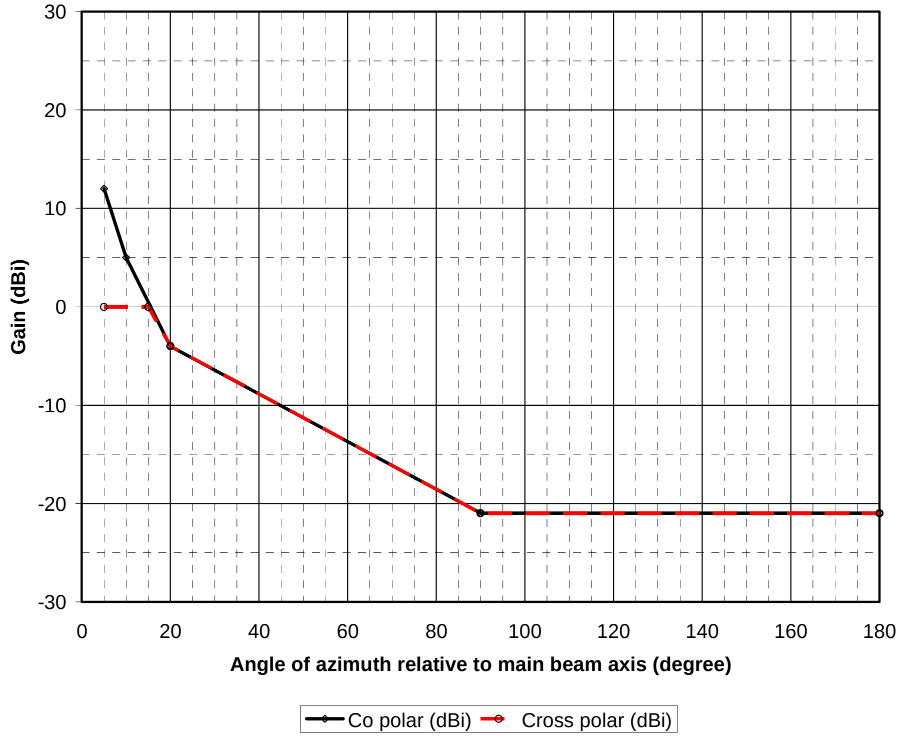
Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
15	10	15	5
20	7	20	0
40	2	60	-8
70	-2	100	-10
88,75	-7	180	-10
100	-7		
100	-10		
180	-10		

Figure 38: Class 2 antenna RPE (71 GHz to 86 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	3
10	9	15	3
20	1	20	-2
50	-1	60	-10
70	-4	90	-17
90	-17	180	-17
180	-17		

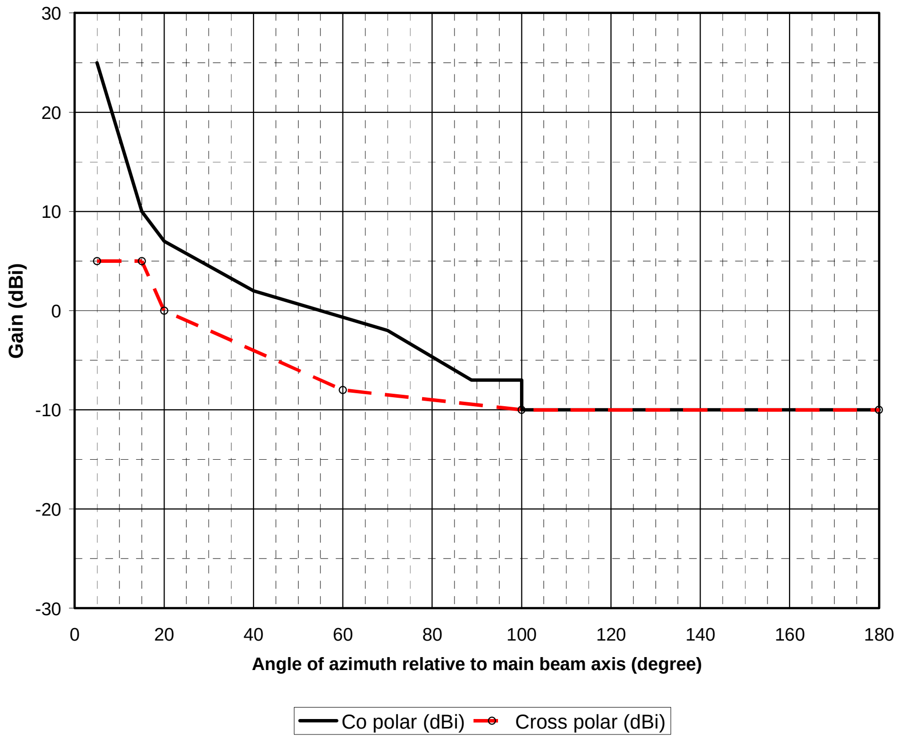
Figure 39: Class 3 antenna RPE (71 GHz to 86 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	12	5	0
10	5	15	0
20	-4	20	-4
90	-21	90	-21
180	-21	180	-21

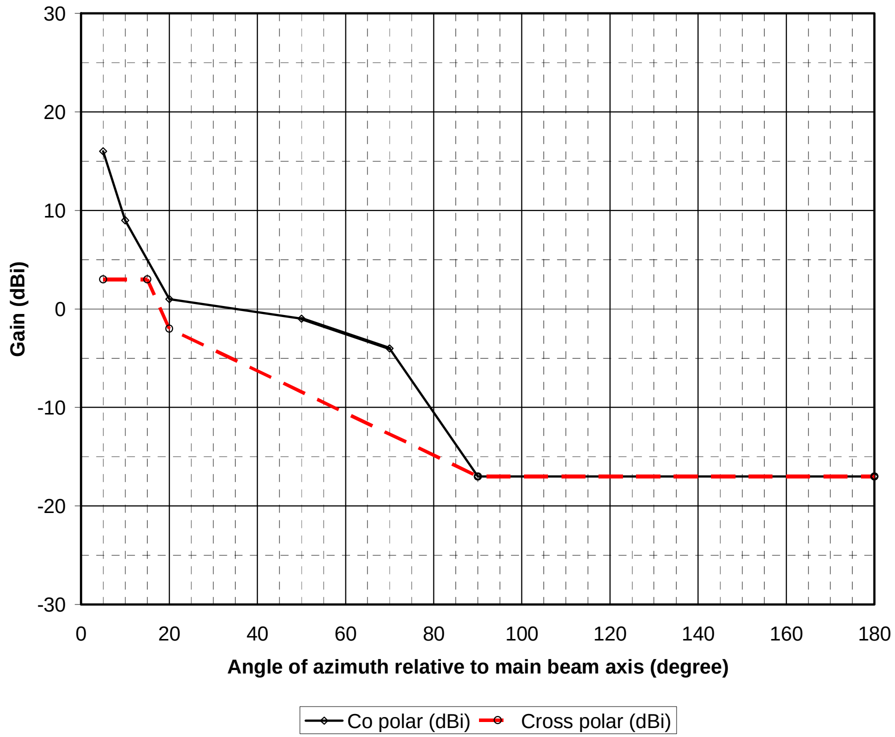
Figure 40: Class 4 antenna RPE (71 GHz to 86 GHz)

4.4.10 Frequency range 8: 92 GHz to 114,25 GHz



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
15	10	15	5
20	7	20	0
40	2	60	-8
70	-2	100	-10
88,75	-7	180	-10
100	-7		
100	-10		
180	-10		

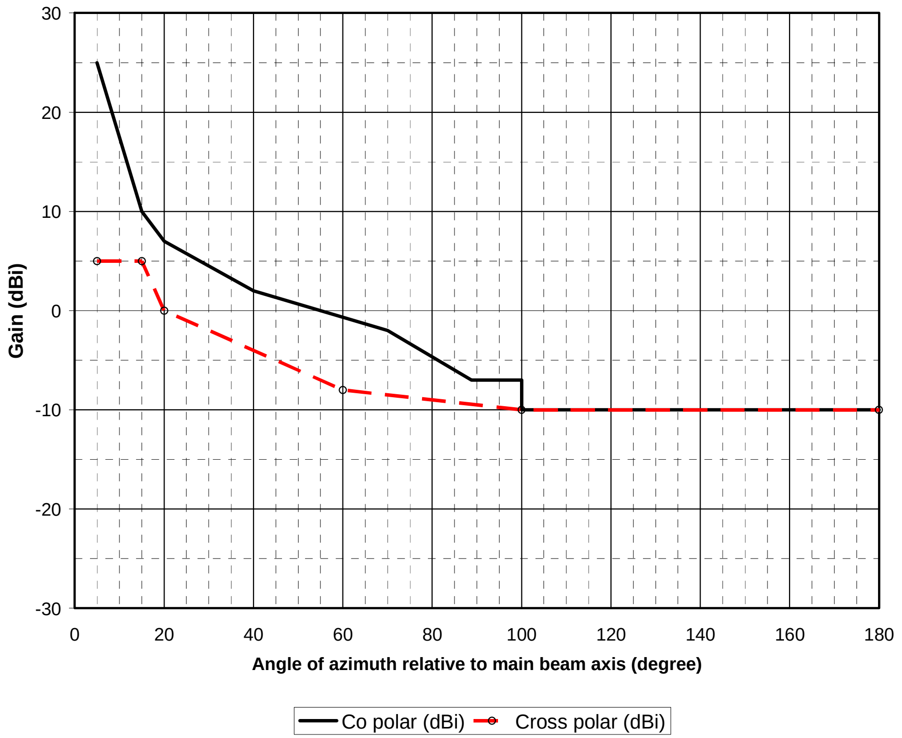
Figure 41: Class 2 antenna RPE (92 GHz to 114,25 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	3
10	9	15	3
20	1	20	-2
50	-1	60	-10
70	-4	90	-17
90	-17	180	-17
180	-17		

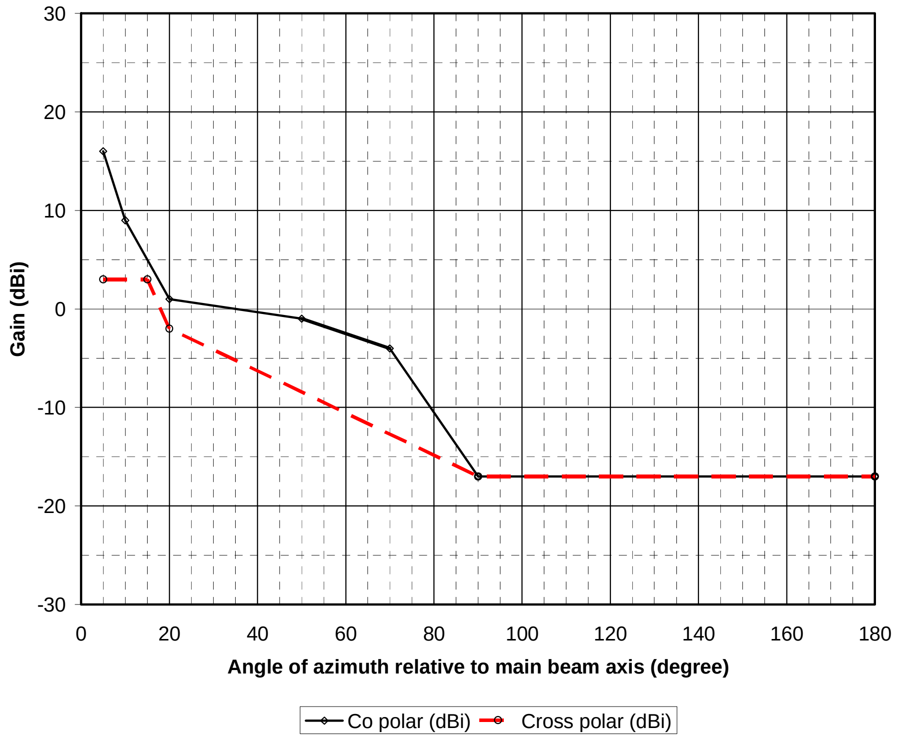
Figure 42: Class 3 antenna RPE (92 GHz to 114,25 GHz)

4.4.11 Frequency range 9: 130 GHz to 175,8 GHz



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	25	5	5
15	10	15	5
20	7	20	0
40	2	60	-8
70	-2	100	-10
88,75	-7	180	-10
100	-7		
100	-10		
180	-10		

Figure 43: Class 2 antenna RPE (130 GHz to 175,8 GHz)



Angle (°)	Co-polar (dBi)	Angle (°)	Cross-polar (dBi)
5	16	5	3
10	9	15	3
20	1	20	-2
50	-1	60	-10
70	-4	90	-17
90	-17	180	-17
180	-17		

Figure 44: Class 3 antenna RPE (130 GHz to 175,8 GHz)

4.5 Cross-Polar Discrimination (XPD)

4.5.1 XPD categories

The XPD characteristics have impact on the link performance (e.g. when CCDP or ACAP operation is foreseen for systems using highly sensitive modulation formats).

With respect to cross-Polar Discrimination (XPD), three XPD performance categories (XPD categories 1 to 3) have been identified:

- XPD category 1: those antennas required to have standard cross-polar discrimination. Limits are reported in clause 4.5.2.
- XPD category 2: those antennas required to have high cross-polar discrimination. Limits are reported in clause 4.5.3.
- XPD category 3: those antennas required to have high cross-polar discrimination through an extended angular region. Limits are reported in clause 4.5.3.

4.5.2 XPD category 1

Table 3 reports the XPD limits for all frequency ranges.

Table 3: Minimum XPD requirement per frequency range and category

Frequency ranges	Standard XPD Category 1 (dB) (see note)
Range 1 (3 GHz to 14 GHz)	27
Range 2 (14 GHz to 20 GHz)	27
Range 3 (20 GHz to 24 GHz)	27
Range 4 (24 GHz to 30 GHz)	27
Range 5 (30 GHz to 47 GHz)	27
Range 6 (47 GHz to 57 GHz)	27
Range 6 (57 GHz to 71 GHz)	No requirement
Range 7 (71 GHz to 86 GHz)	25
Range 8 (92 GHz to 114,25 GHz)	25
Range 9 (130 GHz to 174,8 GHz)	No requirement
NOTE: XPD values intended to be met with respect to the azimuth plane only and within the 1 dB beamwidth of the co-polarized main beam.	

4.5.3 XPD categories 2 and 3

4.5.3.1 Frequency range 1 GHz to 3 GHz

Category 2 is applicable to the frequency range 1 GHz to 3 GHz:

- Category 2: High XPD with 25 dB minimum requirement.
- Category 3 is not presently standardized for this frequency range.

The XPD corresponding to the RPEs classes referenced in clause 4.4 of the present document shall be equal to or higher than those values defined in table 4.

Table 4: Minimum XPD for each antenna class

Class	Minimum XPD (dB)
1A and 1B	25 (XPD category 2)
2	25 (XPD category 2)
3	25 (XPD category 2)
NOTE: XPD values are intended to be met with respect to the azimuth plane only and within an angle twice the half power beamwidth of the co-polarized main beam.	

4.5.3.2 Frequency range 3 GHz to 174,8 GHz

In the frequency range 3 GHz to 86 GHz, the two categories are defined according to sub-ranges of frequency and minimum requirements as defined in table 5. The manufacturer shall declare which XPD Category the antenna refers to.

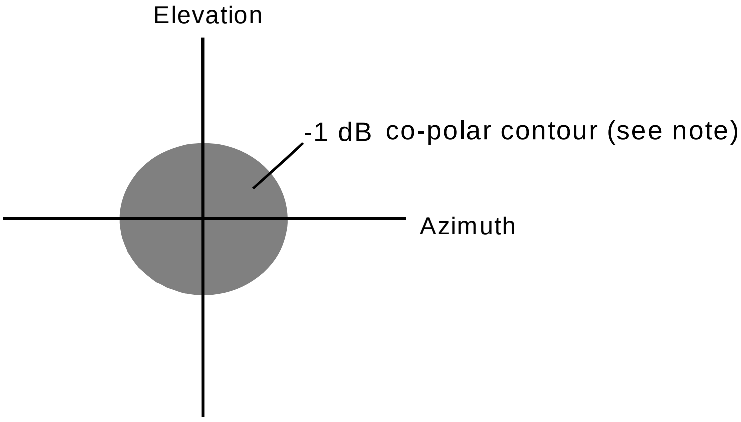
The XPD shall be equal to or greater than those values defined in table 5.

In figures 41 and 42, masks are given for XPD measurements around the main beam axis.

Table 5: Minimum XPD requirement per frequency range and category

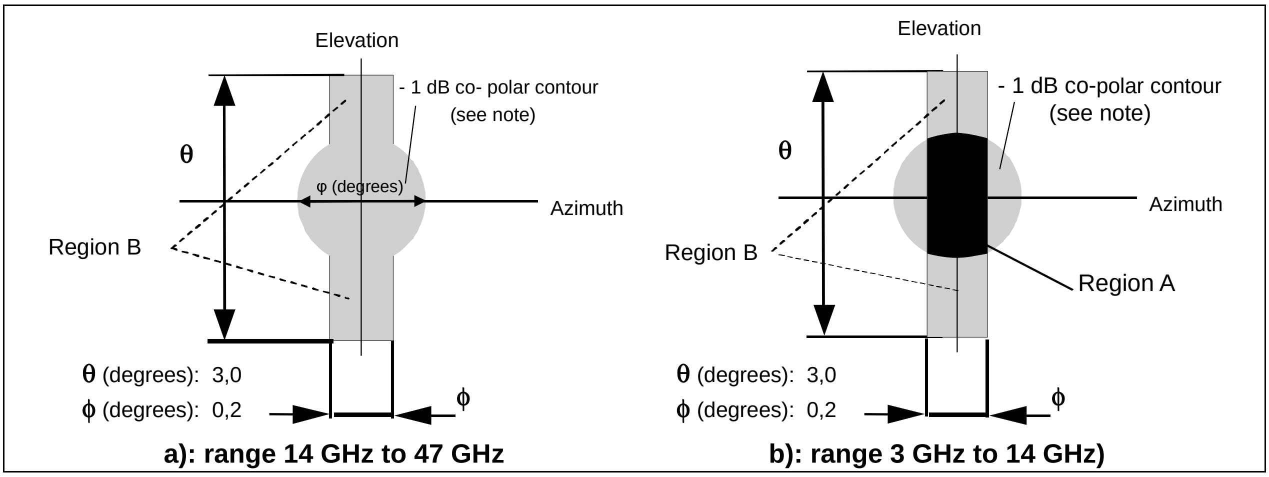
Frequency Ranges	High XPD	
	Category 2 (dB) (see note 1)	Category 3 (dB) (see note 2)
Range 1 (3 GHz to 14 GHz)	30	35 40 (see note 3)
Range 2 (14 GHz to 20 GHz)	27	30
Range 3 (20 GHz to 24 GHz)	27	30
Range 4 (24 GHz to 30 GHz)	27	30
Range 5 (30 GHz to 47 GHz)	27	30
Range 6 (47 GHz to 71 GHz)	Not applicable	Not applicable
Range 7 (71 GHz to 86 GHz)	27	Not applicable
Range 8 (92 GHz to 114,25 GHz)	27	Not applicable
Range 9 (130 GHz to 174,8 GHz)	Not applicable	Not applicable
NOTE 1: XPD values intended to be met within the 1 dB co-polar *gain* contour referred in figure 45. NOTE 2: XPD values for category 3 intended to be met within the 1 dB co-polar gain contour and the region B referred in figure 46 a). Note that the 1 dB contour aperture (φ) is intended that of 1 dB gain drop of the radiation pattern of the actual antenna; it depends on actual antenna boresight gain (it could become higher or lower than region B aperture, ϕ = 0,2°). NOTE 3: Higher additional XPD values intended to be met within region A referred in figure 46 b). Note that region A might be intended as subarea within region B (if 1 dB contour φ < ϕ = 0,2°), or a subarea of 1 dB contour (if 1 dB contour φ > ϕ = 0,2°).		

In figures 45 and 46, masks are given for XPD measurements around the main beam axis.



NOTE: For the dual band antennas the -1 dB *gain* contour (φ) for the highest for the highest frequency band shall be used.

Figure 45: Category 2 mask for XPD measurements around the main beam axis



NOTE: For the dual band antennas the -1 dB *gain* and other contours for the highest frequency band shall be used.

Figure 46: Category 3 masks for XPD measurements around the main beam axis (case for 1 dB contour aperture φ > ϕ)

4.6 Antenna gain

The actual antenna gain contributes to the EIRP value, which is the basic parameter that shall be taken account of in order to control interference on the network. Therefore, the antenna manufacturer shall declare the nominal gain and its tolerance.

For frequency bands above 57 GHz there may be an impact in terms of minimum antenna gain when meeting the requirements of ETSI EN 302 217-2 [i.2].

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

The technical requirements of the present document apply under the environmental profile for intended operation of the antenna, which shall be indicated:

- In case of *integral* or *dedicated antenna*, the *technical documentation*, by the radio manufacturer.
- In case of *stand-alone antenna*, in the technical characteristics of that antenna product, by the antenna manufacturer.

The environmental profile (see note) may be determined, as a minimum, by the environmental class of the radio equipment, intended for outdoor usage, specified in clause 5.1.1.3 of ETSI EN 302 217-2 [i.2].

NOTE: For the purpose of the present document, the environmental profile is intended as range of temperature/humidity conditions. Other environment phenomena (e.g. wind, ice, chemical effects) are not in the scope of the present document (some information may be found in informative annex A).

The antenna shall comply with all the requirements of the present document at all times when operating within the boundary limits of its operational environmental profile.

Any test, requested to generate the test report for assessment of point-to-point radio equipment, for integral, dedicated or stand-alone DFRS antennas (technical requirements of clause 4), shall be carried-out at reference environmental conditions of the test field according to clause 4.1 of ETSI EN 301 126-3-1 [1].

5.2 General test prescription

5.2.1 Wide radio-frequency band covering antennas specification and tests

DFRS antennas commonly cover an operating frequency range. The antenna parameters shall comply with all the requirements of the present document at any possible operating frequency.

The tests, for the antenna directional parameters covered in the present document, requested to generate the test report shall be carried-out at the highest and the lowest possible operating frequency (see note).

NOTE: When *undetachable integral antenna* are concerned, the test procedure for testing the gain is not yet defined.

5.2.2 *Self-alignment tracking* antennas

When *self-alignment tracking* antennas are concerned the test shall also be done at least at three alignment angle positions, centre (C), max positive (M+) and max negative (M-) as indicated in the *technical documentation*.

Annex A (informative): Additional information

A.1 Mechanical characteristics

A.1.1 Environmental characteristics

The principles for defining the operational environment profile are reported in ETSI EN 302 217-1 [2].

For commercially available antennas, the following additional information might be relevant.

The antennas are usually designed to operate within a temperature range of -45 °C to +45 °C with a relative humidity up to 100 % with salt mist, industrial atmosphere, solar and UV-radiation, etc.

The operational temperature range is sometimes divided into two parts for application in different climatic areas:

1) -33 °C to +40 °C;

2) -45 °C to +45 °C.

A.1.2 Wind ratings

The antennas should be designed to meet wind survival ratings specified in table A.1.

Table A.1

Antenna type	Wind velocity		Ice load (density 7 kN/m^3)
Normal duty	55 m/s	200 km/h	25 mm radial ice
Heavy duty	70 m/s	252 km/h	25 mm radial ice

A.1.3 Antenna stability

The antenna equipment should be stable under the most severe operational conditions at the site of intended application.

For installation on trellis or towers, this results in a maximum angular deviation of the antenna main beam axis not higher than 0,3 times the -3 dB beam width under the conditions specified in table A.2.

Table A.2

Antenna type	Wind velocity		Ice load (density 7 kN/m^3)
Normal duty	30 m/s	110 km/h	25 mm radial ice
Heavy duty	45 m/s	164 km/h	25 mm radial ice

A.2 Antenna port connectors

When flanges are provided at the input port of the antenna, they should be in accordance with IEC 60154-1 [3] and IEC 60154-2 [4].

For antennas, which are integrated to the radio equipment, proprietary connection designs may be utilized.

For antennas using coaxial input ports, the connectors should conform to IEC 60169-1 [5].

Other interconnection design should be agreed between the equipment manufacturer and the user in line with the overall system design requirements.

A.3 Return loss at the port connectors

A.3.1 Background

Besides the additional reflection loss (see note), when full indoor radio systems are connected to the antenna through long waveguide feeder, the Return Loss (RL) of the antenna, combined with that of the equipment antenna port, would produce reflection echo and amplitude and phase distortion more and more severe when lower RL is combined to longer feeder.

High capacity analogue Frequency Division Multiplexing (FDM) systems (in general deployed full indoor) were quite sensitive to such distortion. In principle, in full indoor deployment also digital systems with high modulation formats might present sensitivity to that distortion.

However, modern digital equipment provides powerful digital equalizers for any distortion that highly mitigate the impact of feeder length and RL combination.

Moreover, most digital radio transmitter/receiver are deployed outdoor, with *integral* or *dedicated antenna*; the nearly null or very short waveguide connection, would produce, in all cases, negligible distortion. Therefore, a high RL value is not necessary.

NOTE: Reflection loss is less than about 0,1 dB for RL higher than about 15 dB.

A.3.2 Typical RL guidelines

The minimum return loss should be agreed between the equipment and antenna manufacturer(s) and the user in line with the overall system design requirements. For guidance refer to equipment port return loss requirement in ETSI EN 302 217-1 [2], clause 8.1.2, for fully indoor digital systems, which are generally deployed with longer feeder connections to an external antenna, it is assumed that the return loss of the feeder + antenna assembly is approximately of the same order.

For guidance, depending on the applications, antennas with a Voltage Standing Wave Ratio (VSWR) in a range of 1,06 (RL ≅ 30,7 dB) to 1,3 (RL ≅ 17,7 dB) are typical.

A.4 Inter-port isolation

The isolation between the input ports of a dual polarized antenna should be agreed between the equipment manufacturer and the user in line with the overall system design requirements.

For guidance the isolation between ports may be between 25 dB and 35 dB (range 1 GHz to 3 GHz) and between 35 dB to 50 dB (3 GHz to 86 GHz).

A.5 Antenna labelling

It is recommended that the antennas should be clearly identified with a weather-proof and permanent label showing the manufacturers name, antenna type and serial number.

Annex B (informative): Antenna gain and radiation pattern information

B.1 Impact of antenna gain on the frequency planning

When frequency planning is applied, it generally results in setting the EIRP level required by a link for meeting the performance and availability objectives.

The longest possible hop length is limited by the technology adopted (i.e. maximum output power and maximum possible antenna gain); however most of the links are shorter and a trade-off between two parameters, output power and antenna gain, is possible for obtaining the same EIRP level.

From the frequency planning point of view it is obvious that, for each antenna RPE class selected, the best condition from the spectral use point of view (i.e. the higher protection to nearby links) is when the required EIRP is obtained with the highest antenna gain and the lowest output power.

However both parameters have physical and technological constraints:

- Power output may be reduced through RTPC function; however, the range of attenuation available is limited by the requirement of meeting the spectrum mask through all RTPC range.
  Fixed RF attenuators might also be used; however, the high integration sought today for fulfilling market requirements (i.e. size and cost) hardly allows room for such link-by-link RF attenuation selection.

- Antenna gain is related to reflector size that has become one of the most binding requirements in urban areas for their ambient impact.

For the above reason further trade-off should be taken into account between maximizing efficiency in frequency planning and typical equipment and antenna technology available/imposed by external market constraint.

B.2 Typical Gain and Radiation Pattern for circular-symmetric antennas

B.2.1 Introduction

The present document gives Radiation Pattern Envelopes (RPEs) that are "absolute worst case" not to be exceeded in 100 % of cases; however the typical behaviour of antennas might be quite different. Also gain values are not standardized, due to the large variety of sizes required by the market and for keeping the standard open to potential new technologies; the gain is required only as declaration from the manufacturer.

Point-to-Point applications, in bands above 1 GHz, typically use antennas with circular symmetry (e.g. parabolic, horn, grid, etc.).

Following clauses B.2.2 and B.2.3 wish to add information on the typical gain and radiation pattern, in particular for the main lobe radiation, of these antenna types and is not intended to limit new technologies development, the characteristics of which might substantially diverge from the evaluation made in this annex B.

B.2.2 Gain

The gain for circular antennas is strictly related to geometrical size of the reflector area and the construction technology has only marginal effect (sometimes referred to as "efficiency") on the actual gain value.

In Recommendation ITU-R F.699 [i.3], the bore-sight gain is related to the antenna diameter by the simple relationship:

$$20\log\frac{D}{\lambda} \approx G_{max} - 7{,}7$$

where G_{max} is the main lobe antenna gain (dBi).

B.2.3 Radiation pattern

Side lobes attenuation of actual antennas depends on specific shielding (shroud) technology used, which in general impacts the size (deepness) of the antenna; however, Recommendations ITU-R F.699 [i.3] and ITU-R F.1245 [i.4] recommends formulas for defining typical gain and radiation pattern (in term of main lobe and of side lobe patterns). These formulas are for use in sharing studies whenever the actual antenna RPE is not known and are currently valid from 1 GHz to 86 GHz. Recommendation ITU-R F.699 [i.3] is used generally considered in coexistence studies when single interference to single FS station is considered, Recommendation ITU-R F.1245 [i.4] is generally considered when aggregation of multiple interferers to FS station is considered.

Recommendations ITU-R F.699 [i.3] and F.1245 [i.4] provide two sets of formulas, one for antennas with D/λ ratio greater than 100 and a second for antennas with D/λ ratio equal to or less than 100.

The RPE provided in the present document are hard limits used for regulatory and planning purpose; depending on their class may have angular portions better or worse than the "typical" value given by Recommendation ITU-R F.699 [i.3]. In addition, they are not defined for angles < 5°.

Nevertheless, when appropriate, it is desired to use the RPE provided in the present document, it is common practice the integration of these RPE with the Recommendation ITU-R F.699 [i.3] radiation pattern for angles less than 5°.

Annex C (informative): Change history

Date	Version	Information about changes
January 2010	V1.4.1	Publication as ETSI EN 302 217 part 4-1
January 2010	V1.5.1	Publication as ETSI EN 302 217 part 4-2
May 2017	V2.1.1	Former parts 4-1 and 4-2 combined into a single Part 4 and editorially revised
April-2025	V2.2.1	Added new bands W (92 GHz to 114,25 GHz) and D (130 GHz to 147,8 GHz); Inclusion of *self-alignment tracking* antenna type. Clarified the text in the XPD requirement. Improvement of terminology for better legal certainties.

History

Document history		
V1.1.3	December 2004	Publication as ETSI EN 302 217 parts 4-1 and 4-2
V1.2.1	June 2006	Publication as ETSI EN 302 217 part 4-2
V1.2.1	October 2007	Publication as ETSI EN 302 217 part 4-1
V1.3.1	October 2007	Publication as ETSI EN 302 217 part 4-2
V1.3.1	March 2009	Publication as ETSI EN 302 217 part 4-1
V1.4.1	March 2009	Publication as ETSI EN 302 217 part 4-2
V1.4.1	January 2010	Publication as ETSI EN 302 217 part 4-1
V1.5.1	January 2010	Publication as ETSI EN 302 217 part 4-2
V2.1.1	May 2017	Publication
V2.2.0	April 2025	EN Approval Procedure AP 20250702: 2025-04-03 to 2025-07-02
V2.2.1	July 2025	Publication