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Fixed Radio Systems;
Point-to-Multipoint Antennas;
Antennas for point-to-multipoint fixed radio systems in the 3 GHz to 11 GHz band

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The purpose of the present document is to define the antenna performance standards necessary to ensure optimum frequency co-ordination between the systems and/or different services by the Regulatory Authorities in the 3 GHz to 11 GHz band. These nominal frequency limits have been chosen to reflect the WRC 2000 Final Acts [6] and the frequency plans as given in CEPT Recommendation T/R 13-02 [1] and ITU-R Recommendation F.748 [5].

Point-to-multipoint antennas, whether integrated within station equipment or not, may need to meet environmental, mechanical and electrical characteristics not covered by the present document, in order that the systems will operate as intended. Additional parameters and characteristics may be subject to agreement between the equipment purchaser and the supplier; these are considered and guidance is provided in annex A.

National transposition dates	
Date of adoption of this EN:	4 July 2003
Date of latest announcement of this EN (doa):	31 October 2003
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Date of withdrawal of any conflicting National Standard (dow):	30 April 2004

Introduction

The purpose of the present document is to define the requirements for antennas used in conjunction with Point-to-MultiPoint (P-MP) systems necessary to facilitate frequency co-ordination between services in the frequency bands 3 GHz to 11 GHz.

1 Scope

The present document specifies the essential electrical requirements for linear polarization, fixed beam antennas to be utilized with new Point-to-Multipoint (P-MP) systems, including central station and terminal station applications, operating in frequency bands from 3 GHz to 11 GHz. These systems use various multiple access schemes. Electronically steerable antennas and circularly polarized antennas are not considered in the present document.

Only in exceptional circumstances, and after a consultation period with operators and manufacturers, the Regulatory Authority may impose the use of tighter requirements than the minimum values given in the present document, in order to maximize the use of scarce spectrum resources.

For some high gain, point-to-multipoint requirements, antennas may be used having performance as per the appropriate point-to-point antenna standard. For these antennas, minimum requirements are given in EN 300 833 [8].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] CEPT Recommendation T/R 13-02: "Preferred channel arrangements for fixed services in the range 22.0 - 29.5 GHz".

[2] CEPT/ERC/REC 12-05: "Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.0 - 10.68 GHz".

[3] CEPT/ERC/REC 14-03: "Harmonised radio frequency channel arrangements for low and medium capacity systems in the band 3400 MHz to 3600 MHz".

[4] ITU-R Recommendation F.747: "Radio-frequency channel arrangements for fixed wireless systems operating in the 10 GHz band".

[5] ITU-R Recommendation F.748: "Radio-frequency arrangements for systems of the fixed service operating in the 25, 26 and 28 GHz bands".

[6] Final Acts - WRC - 2000, Istanbul.

[7] ETSI ETS 300 019-1-4: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weatherprotected locations".

[8] ETSI EN 300 833: "Fixed Radio Systems; Point-to-point antennas; Antennas for point-to-point fixed radio systems operating in the frequency band 3 GHz to 60 GHz".

[9] ETSI EN 301 126-3-2: "Fixed Radio Systems; Conformance testing; Part 3-2: Point-to-Multipoint antennas - Definitions, general requirements and test procedures".

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

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

[12] IEC 60169 (part 1 and applicable subparts): "Radio-frequency connectors. Part 1: General requirements and measuring methods".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

antenna: that part of the transmitting or receiving system that is designed to transmit or receive electromagnetic radiation

boresight: axis of the main beam in a directional antenna

Central Station (CS): base station which communicates each way with many terminal stations and, in many cases, repeater stations

co-polar pattern: diagram representing the radiation pattern of a test antenna when the reference antenna is similarly polarized, scaled in dBi or dB relative to the measured antenna gain

cross-polar pattern: diagram representing the radiation pattern of a test antenna when the reference antenna is orthogonally polarized, scaled in dBi, or dB relative to the measured antenna gain

cross-polar discrimination: difference between the peak of the co-polarized main beam and the maximum cross-polarized signal over an angle measured within a defined region

fixed beam: radiation pattern in use is fixed relative to a defined mechanical reference plane

gain: ratio of the radiation intensity in a given direction to the radiation intensity that would be obtained if the power accepted by the antenna was radiated isotropically

Half Power BeamWidth (HPBW): angle, relative to the main beam axis, between the two directions at which the measured co-polar pattern is 3 dB below the value on the main beam axis

inter-port isolation: ratio in dB of the power level applied to one port of a multi-port antenna to the power level received in any other port of the same antenna as a function of frequency

isotropic radiator: hypothetical, lossless antenna having equal radiation intensity in all directions

input port(s): flange(s) or connector(s) through which access to the antenna is provided

main beam axis: direction for which the radiation intensity is a maximum

main beam: radiation lobe containing the direction of maximum radiation

mechanical tilt: fixed angular shift in elevation of the antenna main beam axis by a change to the physical mounting

Radiation Pattern Envelope (RPE): envelope within which the radiation pattern shall fit

radiation pattern: diagram relating power flux density at a constant distance from the antenna to the direction relative to the notional antenna main beam axis. Specifically referenced in EN 302 085 to the zero degree reference direction.

radome: cover, of dielectric material, intended for protecting an antenna from the effects of its physical environment

Repeater Station (RS): radio station providing the connection via the air to both the central station and the terminal station(s). The remote station may also provide the interfaces to the subscriber equipment, if applicable.

sector angle: declared angle of coverage in azimuth of a sectored antenna, defined as 2α in EN 302 085

Terminal Station (TS): remote (out) station which communicates with a central station

tilt: fixed, angular shift of the antenna main beam axis (boresight) in the elevation plane by either electrical, electronic or mechanical means

zero degree (0°): declared direction as referenced to the antenna

reference direction: mechanical characteristics, used as reference for the RPE

reference beam direction: mechanical characteristics, used as reference for every beam RPE (applicable only to multi-beam antennae)

3.2 Symbols

For the purposes of the present document, the following symbols apply:

α	Alpha (= half the sector angle)
ε	reference beam direction
dBi	Decibels relative to an isotropic source
f_0	Nominal centre frequency of declared antenna operating range
GHz	GigaHertz
MHz	MegaHertz
ROUND ( )	Round up or down to nearest integer
ABS( )	Absolute value of the number

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CS	Central Station
HPBW	Half Power BeamWidth
P-MP	Point-to-MultiPoint
PIM	Passive InterModulation
RPE	Radiation Pattern Envelope
RS	Repeater Station
TS	Terminal Station
VSWR	Voltage Standing Wave Ratio

4 Frequency bands

The present document applies to a number of frequency ranges within the 3 GHz to 11 GHz frequency bands considered within CEPT/ERC and ETSI for allocation to the fixed services. Suitable sub-bands for allocation to point-to-multipoint use are subject to channel plans described in references CEPT/ERC/REC 12-05 [2], CEPT/ERC/REC 14-03 [3] and ITU-R Recommendation F.747 [4].

For the purpose of the present document, the overall frequency bands 3 GHz to 11 GHz are divided into three ranges as follows:

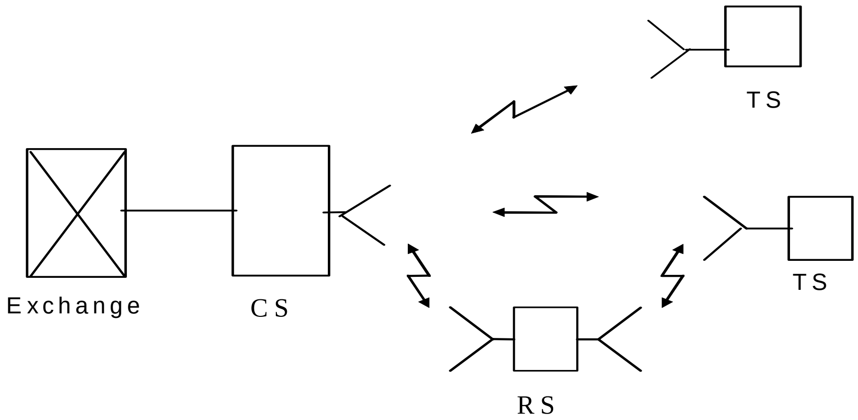
- range 1: 3,0 GHz to 5,9 GHz;
- range 2: 5,9 GHz to 8,5 GHz;
- range 3: 8,5 GHz to 11,0 GHz.

5 Types and classification of antennas

5.1 Antenna types

The present document addresses fixed beam antennas used in the Central (CS) and Terminal (TS) stations including Repeaters (RS).

The antennas are used in a system which can generally be described as in figure 1.



CS: Central Station, which is linked to all remote stations (repeater or terminal stations) by microwave transmission paths.
TS: Terminal Station (outstation with subscriber interfaces).
RS: Repeater Station (radio repeater outstation with or without subscriber interfaces). A RS may serve one or more TSs.

Figure 1: General point-to-multipoint system architecture

These antennas shall be grouped into the following types:

Central and repeater stations:

- Omni-directional;
- Sectored:
  - Single-beam;
  - Multi-beam;
- Directional, conforming to the requirements for TS antennas.

Terminal stations: Directional.

Repeater antennas can be of either Central (CS) or Terminal (TS) station types.

5.2 Antenna classifications

5.2.1 CS classes

With respect to the **azimuthal** Radiation Pattern Envelope (RPE), three classes may be identified in different frequency sub-ranges for Central Station (CS) **sectored** antennas (CS1,CS2,CS3) and two classes may be identified for multi-beam antennas (CSMB1,CSMB2):

- class CS 1;

- class CS 2;
- class CS 3;
- class CSMB1;
- class CSMB2.

These classes allow flexibility for a variety of different systems, and may be generally appropriate for low, medium and higher density deployments respectively.

With respect to the **azimuthal** RPE for **omni-directional** CS antennas, no requirement for separate classes has been identified.

5.2.2 TS classes

With respect to the radiation pattern envelope (RPE), a number of classes have been identified for Terminal Station (TS) **directional** antennas:

- class TS 1;
- class TS 2;
- class TS 3;
- etc...

These classes allow flexibility for a variety of different systems and deployment conditions.

6 Electrical characteristics

For the purpose of the present document, an antenna is specific to Type, Class, Range, the frequency band of operation and the mid-band gain. An antenna which employs a radome shall meet the requirements of the present document with the radome in place.

A 0° reference direction shall be defined for each antenna. The radiation characteristics in the present document are all referred to this 0° reference direction.

6.1 Terminal Station (TS) antennas

The RPEs and gain parameters apply for both horizontal and vertical linearly polarized antennas.

6.1.1 TS Radiation Pattern Envelope (RPE)

The co-polar and cross-polar radiation patterns for both azimuth and elevation (see figure 2) shall not exceed the RPEs defined in the following list:

- range 1 (3,0 GHz to 5,9 GHz):
  - class TS 1: table 1;
  - class TS 2: table 2;
  - class TS 3: table 3;
  - class TS 4: table 4;
  - class TS 5: table 5.

- range 2 (5,9 GHz to 8,5 GHz):
    - class TS 1: table 6;
    - class TS 2: table 7;
    - class TS 3: table 8.
- range 3 (8,5 GHz to 11,0 GHz):
    - class TS 1: table 9;
    - class TS 2: table 10;
    - class TS 3: table 11;
    - class TS 4: table 12.

The gain values defined are all relative to **maximum, actual** gain at the measured frequency.

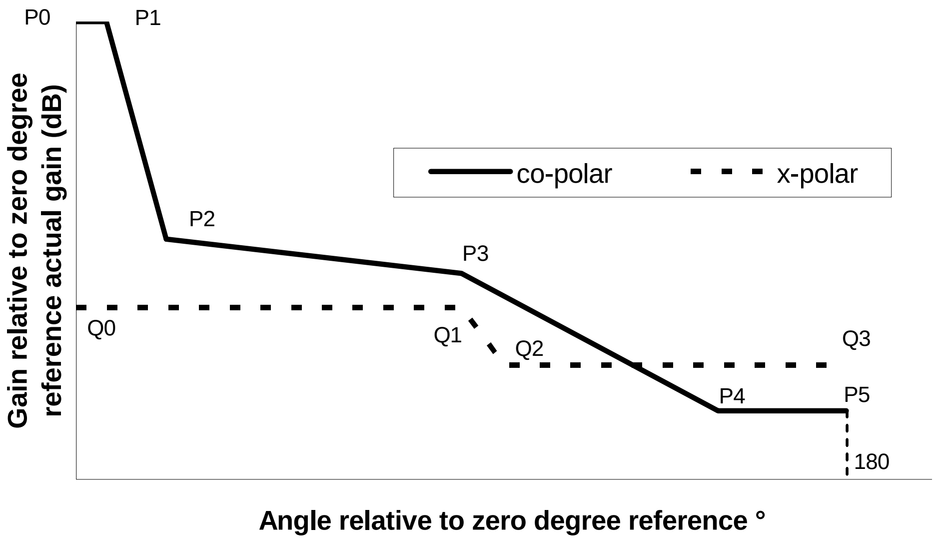


Figure 2: Normalized RPE for TS azimuth and elevation

6.1.1.1 Range 1 (3,0 GHz to 5,9 GHz)

Table 1: TS1, Range 1

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	90	0
P2	90	-10
P3	180	-10
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-15
Q1	180	-15

Table 2: TS2, Range 1

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	12	0
P2	30	-10
P3	90	-15
P4	150	-20
P5	180	-20
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-15
Q1	90	-15
Q2	150	-20
Q3	180	-20

Table 3: TS3, Range 1

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	10	0
P2	20	-12
P3	70	-14
P4	150	-29
P5	180	-29
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-19
Q1	90	-19
Q2	150	-25
Q3	180	-25

Table 4: TS4, Range 1

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	10	0
P2	30	-17
P3	90	-17
P4	150	-30
P5	180	-30
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-20
Q1	90	-20
Q2	150	-30
Q3	180	-30

Table 5: TS5, Range 1

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	12	0
P2	30	-17
P3	90	-17
P4	150	-30
P5	180	-30
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-20
Q1	90	-20
Q2	100	-25
Q3	180	-25

6.1.1.2 Range 2 (5,9 GHz to 8,5 GHz)

Table 6: TS1, Range 2

Co-polar	**Angle (°)**	**Gain (dB)**
P0	0	0
P1	9	0
P2	22	-12
P3	90	-17
P4	150	-25
P5	180	-25
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-17
Q1	90	-17
Q2	150	-25
Q3	180	-25

Table 7: TS2, Range 2

Co-polar	**Angle (°)**	**Gain (dB)**
P0	0	0
P1	8	0
P2	20	-20
P3	90	-22
P4	150	-35
P5	180	-35
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-25
Q1	90	-25
Q2	150	-35
Q3	180	-35

Table 8: TS3, Range 2

Co-polar	**Angle (°)**	**Gain (dB)**
P0	0	0
P1	9	0
P2	22	-18
P3	90	-21
P4	150	-33
P5	180	-33
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-25
Q1	90	-25
Q2	100	-30
Q3	180	-30

6.1.1.3 Range 3 (8,5 GHz to 11,0 GHz)

Table 9: TS1, Range 3

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	7	0
P2	15	-13
P3	90	-20
P4	130	-30
P5	180	-30
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-20
Q1	90	-20
Q2	130	-30
Q3	180	-30

Table 10: TS2, Range 3

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	5	0
P2	15	-20
P3	90	-30
P4	130	-40
P5	180	-40
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-30
Q1	90	-30
Q2	130	-40
Q3	180	-40

Table 11: TS3, Range 3

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	6	0
P2	15	-13
P3	90	-24
P4	150	-36
P5	180	-36
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-28
Q1	90	-28
Q2	100	-33
Q3	180	-33

Table 12: TS4, Range 3

Co-polar	Angle (°)	Gain (dB)
P0	0	0
P1	10	0
P2	30	-10
P3	90	-15
P4	150	-20
P5	180	-20
Cross-polar	**Angle (°)**	**Gain (dB)**
Q0	0	-12
Q1	90	-12
Q2	130	-17
Q3	180	-17

6.1.2 TS minimum boresight gain

The TS RPEs specified in tables 1 to 12 inclusive are for maximum allowed co- and cross-polar gains, relative to boresight actual gain.

The TS antenna shall meet the minimum boresight gain described by the following expression:

- Minimum boresight gain = ROUND (0,85 f_0 + 5) dBi;

where f_0 is the nominal centre frequency in GHz and ROUND ( ) means rounded to the nearest integer value.

Antenna boresight (and associated gain) does not necessarily correspond to the 0° reference direction (and its associated gain).

6.2 Central Station (CS) sectored single beam antennas

6.2.1 CS azimuth Radiation Pattern Envelope (RPE), sectored

The Central Station **azimuth** RPEs for **sectored** (i.e. not for multi-beam and not for omni-directional) antennas are defined in the following list for sector beamwidths in the range 15° to 180°:

- class CS 1: table 13;
- class CS 2: table 14;
- class CS 3: table 15.

Both co-polar and cross-polar patterns are defined. The sector angle defined as 2α shall be declared by the supplier. The three azimuth patterns defined below apply for all combinations of frequency and sector angle within the ranges addressed by the present document. The gain values defined are all relative to the maximum gain in the declared sector angle.

a) Co-Polar RPE

Point P0 is fixed whereas the positions of P1 to P5 are dependent on centre frequency and/or sector angle. Tables 13a to 15a summarize the expressions which describe all these co-polar azimuth RPE points for classes 1 to 3 respectively.

b) Cross-Polar RPE

Tables 13b to 15b summarize the expressions which describe the four points which define the cross-polar azimuth RPE. Point Q0 is fixed whereas the positions of Q1 to Q3 are dependent on centre frequency and/or sector angle.

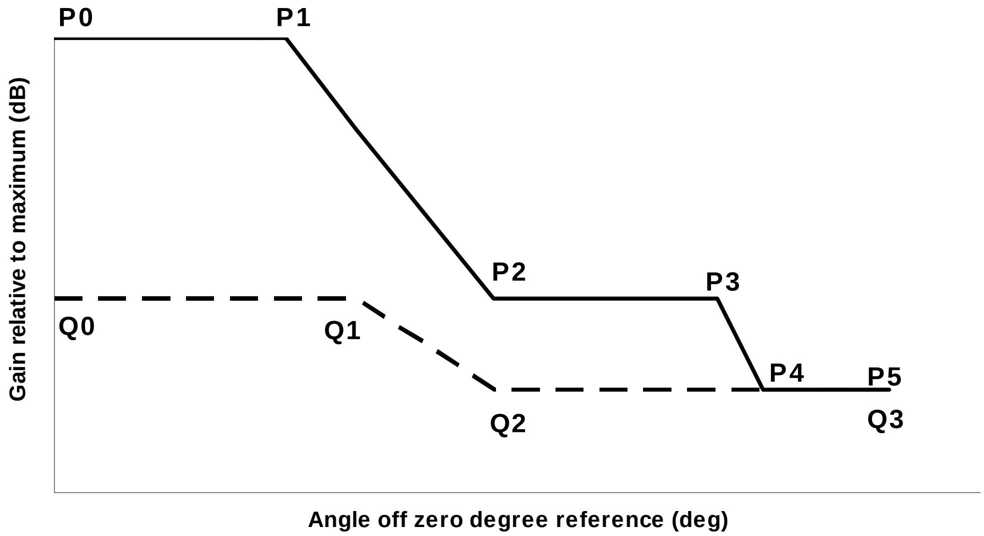


Figure 3: Normalized CS sector antenna template for azimuth

These tables shall apply for all frequencies in the 3 GHz to 11 GHz band, and where f_0 is the nominal centre frequency in GHz and all expressions are rounded to the nearest integer value.

6.2.1.1 Class CS 1

Table 13a: CS Class 1

Co-polar	Angle (°)	Relative gain (dB)
P0	0	0
P1	$\alpha + 5$	0
P2	160	-20
P3	160	-20
P4	160	-20
P5	180	-20

Table 13b: CS Class 1

Cross-polar	Angle (°)	Relative gain (dB)
Q0	0	-12
Q1	$\alpha + 5$	-15
Q2	160	-20
Q3	180	-20

6.2.1.2 Class CS 2

Table 14a: CS Class 2

Co-polar	Angle (°)	Relative gain (dB)
P0	0	0
P1	$\alpha + 5$	0
P2	$\alpha + (105 - 7f_0)$	-20
P3	$195 - 7f_0$	-20
P4	$186 - 4,4\ f_0$	-25
P5	180	-25

Table 14b: CS Class 2

Cross-polar	Angle (°)	Relative gain (dB)
Q0	0	-20
Q1	α + (57,5 - 5f_0)	-20
Q2	α + (87,5 - 5f_0)	-25
Q3	180	-25

6.2.1.3 Class CS 3

Table 15a: CS Class 3

Co-polar	Angle (°)	Relative gain (dB)
P0	0	0
P1	α + (20 - 1,4 f_0)	0
P2	α + (75 - 4,3 f_0)	-23
P3	165 - 4,3 f_0	-23
P4	150	-1,4 f_0 -20
P5	180	-1,4 f_0 -20

Table 15b: CS Class 3

Cross-polar	Angle (°)	Relative gain (dB)
Q0	0	-0,7 f_0 -17,5
Q1	α + (20 - 1,4 f_0)	-0,7 f_0 -17,5
Q2	α + (75 - 4,3 f_0)	-1,4 f_0 -20
Q3	180	-1,4 f_0 -20

6.2.2 Minimum boresight gain, sectored

The CS antenna boresight gain shall exceed the values defined in figure 4 as a function of sector angle, 2α, in the range 15° to 180° and for all frequencies in the 3 GHz to 11 GHz bands.

Antenna boresight gain does not necessarily correspond to the 0° reference gain.

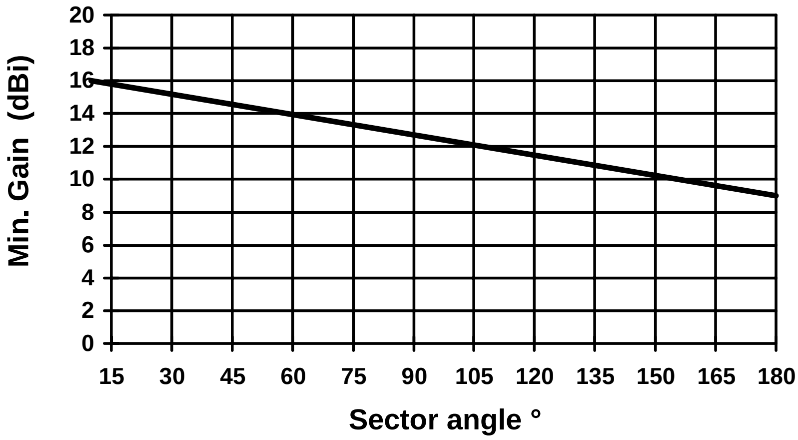


Figure 4: CS sector antenna boresight min gain

Table 16: Minimum boresight gain

Angle (°)	Gain (dBi)
15	16
180	8,5

6.3 Central Station (CS) sectored multi-beam antennas

A sector multi-beam antenna comprises two or more beams at different azimuth angles, sharing a common aperture.

Such antennas are provided with ports for each of the beams, all the beams may be active at the same time while using different frequencies. Each beam may be used with a different radio covering a specific sector.

Such antennas are typically used in order to have several narrow beams at a smaller form factor, for aesthetic, mechanical (such as space or wind loading) or cost reasons. This clause focuses on sector multibeam antennas in which the aggregate of all beams covers up to 180°.

6.3.1 CS azimuth Radiation Pattern Envelope (RPE), sectored

The Central Station **azimuth** RPEs for multi-beam antennas as function of reference beam direction (ε) are defined for antenna aggregate beam-widths in the range 15° to 180° and for constituent beam-widths in the range 5° to 45°. For each class is defined a specific RPE template.

- Class CSMB 1: co-polar templates according to figure 5, co-polar patterns according to table 17, (Range 1); cross-polar template according figure 3, cross-polar patterns according to table 18 (Range 1).
- Class CSMB 2: co-polar template according to figure 6, co-polar patterns according to table 19 (Range 1); cross-polar template according figure 3, cross-polar patterns according to table 20 (Range 1).

The sector angle, the beamwidth (defined as 2α) and the reference beam direction (ε) shall be declared by the supplier. The azimuth patterns defined below apply for all combinations of frequency and sector angle within the ranges addressed by the present document. The gain values defined are all relative to the maximum gain in the considered reference beam/sector angle.

6.3.1.1 Range 1 (3 GHz to 5,9 GHz)

6.3.1.2 Class CSMB 1

a) Co-Polar RPE

Figure 5 indicates the reference RPE points. Table 17 summarizes the expressions, which describe all these co-polar azimuth RPE points. The angular value for the points P0, P1, P2 and P7, P8, P9 are fixed, whereas the angular positions of P3 to P6 are dependent of beam position and its angular beamwidth.

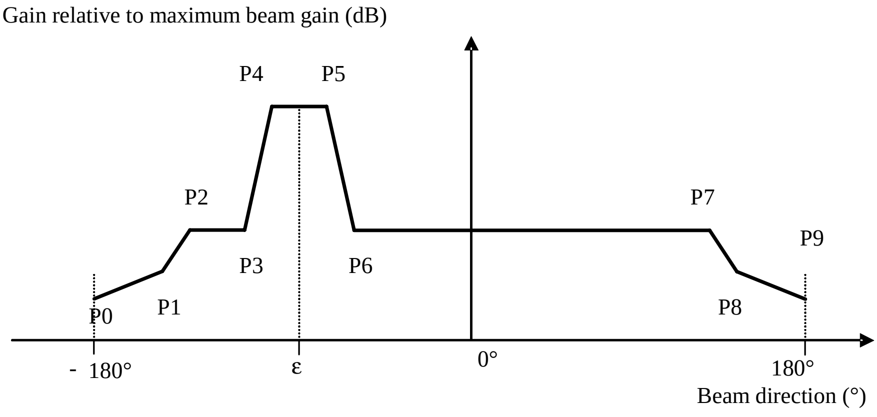


Figure 5: Normalized Class CSMB 1-beam antenna template for co-polar azimuth

Table 17: Class CSMB1 beam co-polar RPE

Co-polar	Angle (°)	Relative gain (dB) (note)
P0	-180	-25
P1	-120	-20
P2	-90	-15
P3	ε-3*α	-15
P4	ε-1,5*α	0
P5	ε+1,5*α	0
P6	ε + 3*α	-15
P7	+90	-15
P8	+120	-20
P9	+180	-25
NOTE: Relative to the gain at the reference beam direction.		

b) Cross-Polar RPE

Figure 3 indicates the reference RPE points (Q0, Q1, Q2, Q3), symmetric across ε.

Table 18 summarize the expressions which define the cross-polar azimuth RPE. Point Q0 is set as reference beam direction (ε) whereas the positions of Q1 to Q3 are dependent on centre frequency and/or sector angle.

Table 18: Class CSMB1 beam cross-polar RPE

Cross-polar	Angle (°)	Relative gain (dB) (note)
Q0	ε	-15
Q1	$\varepsilon + \text{abs}(\alpha + (57{,}5 - 5f_0))$	-15
Q2	$\varepsilon + \text{abs}(\alpha + (87{,}5 - 5f_0))$	-20
Q3	ε + 180	-20
NOTE: Relative to the gain at the reference beam direction.		

6.3.1.3 Class CSMB 2

a) Co-Polar RPE

Figure 6 indicates Class CSMB2 reference RPE points. Table 19 summarizes the expressions, which describe all these co-polar azimuth RPE points. The angular value for the points P0, P1, P2 and P11, P12, P13 are fixed, whereas the angular positions of P3 to P10 are dependent on beam position and its angular beamwidth.

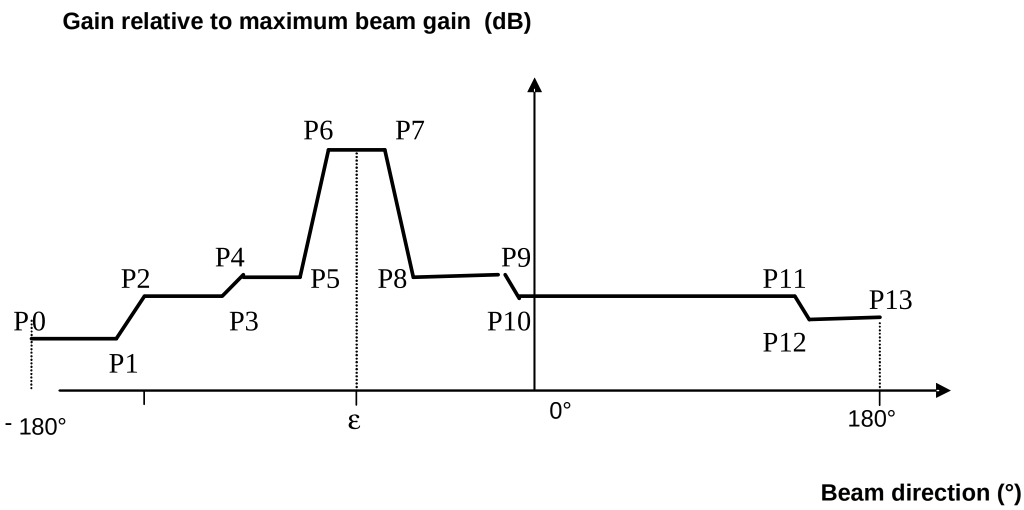


Figure 6: Normalized Class CSMB 2 -beam antenna template for co-polar RPE

Table 19: Class CSMB 2 beam co-polar RPE

Co-polar	Angle (°)	Relative gain (dB)(note)
P0	-180	-35
P1	-135	-35
P2	-60	-20
P3	ε - 6*α	-20
P4	ε - 5*α	-17
P5	ε - 3,3*α	-17
P6	ε - 1,6*α	0
P7	ε + 1,6*α	0
P8	ε + 3,3*α	-17
P9	ε + 5*α	-17
P10	ε + 6*α	-20
P11	60	-20
P12	135	-35
P13	180	-35
NOTE: Relative to the gain at the reference beam direction.		

b) Cross-Polar RPE

Figure 3 indicates the reference RPE points (Q0, Q1, Q2, Q3), symmetric across ε.

Table 20 summarize the expressions which define the cross-polar azimuth RPE. Point Q0 is set as reference beam direction (ε) whereas the positions of Q1 to Q3 are dependent on centre frequency and/or sector angle.

Table 20: Class CSMB 2 beam cross-polar RPE

Cross-polar	Angle (°)	Relative gain (dB) (note)
Q0	ε	-15
Q1	ε + abs(α + (20 - 1,4 f_0))	-15
Q2	ε + abs(α + (75 - 4,3 f_0))	-20
Q3	ε + 180	-20
NOTE: Relative into the gain at the reference beam direction.		

6.3.2 Minimum boresight gain, multi-beam

The CS antenna boresight gain, for each beam, shall exceed the values defined in figure 7 as a function of beamwidth 2α , in the range 10° to 90°.

Antenna boresight gain does not necessarily correspond to the 0 reference gain.

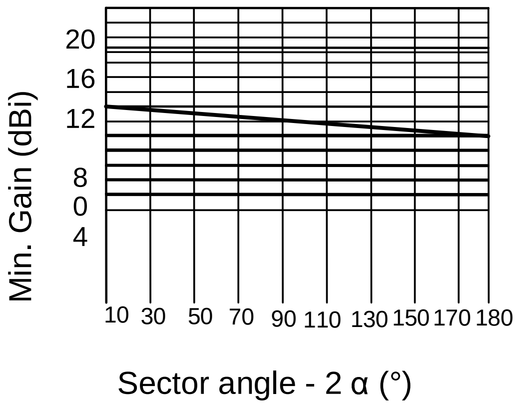


Figure 7: CS central-beam, multi-beam antenna, boresight min gain

Table 21: Minimum boresight gain

Angle (2α) (°)	Gain (dBi)
10	12
180	11

6.4 Central Station (CS) omni-directional antennas

For omni-directional CS antennas the following parameters shall apply for all frequencies in the 3 GHz to 11 GHz bands:

- min. nominal gain: 8 dBi;
- gain ripple (azimuth): 3 dB maximum (peak-to-peak);
- cross-polar discrimination: 20 dB minimum.

6.5 Central Station (CS) omni and sectored elevation RPEs

Two CS antenna elevation RPEs are defined:

- one for antennas designed to exhibit symmetric RPEs about the 0° reference direction (figure 8); and
- one for antennas designed for asymmetric RPEs (figure 9).

For antennas designed without any tilt the zero degree reference direction normally corresponds to boresight.

It may be necessary in practical deployments to use electrical or mechanical tilt, or a combination of these two, to achieve the required cell coverage, taking into account the surrounding terrain, for example.

These elevation patterns are considered appropriate to the commonly used range of 0° to -10° for electrical downtilt. For sector antennas only, further mechanical tilt of up to ±10° may be suitable for some situations.

An electrical tilt is translated onto the corresponding pattern as a ± shift along the elevation angle axis.

NOTE 1: Positive angles are for above boresight (up) and negative angles are for below (down).

NOTE 2: Elevation RPE for multibeam antennas is under study.

6.5.1 Symmetric elevation RPEs

For **omni-symmetric** antennas the co-polar limits in figure 8 shall apply, with a uniform value of -20 dB for the cross-polar limit.

For **sectored symmetric** antennas only, the co-polar limit in figure 8 shall be linearly interpolated beyond the -19 dB, +90° point out to the point defined at 180° by the appropriate azimuth class of antennas per tables 13a to 15a.

The **cross-polar** limit shall be linearly interpolated between the 0° and the 180° points taken from the appropriate azimuth class of antennas as defined in tables 13b to 15b.

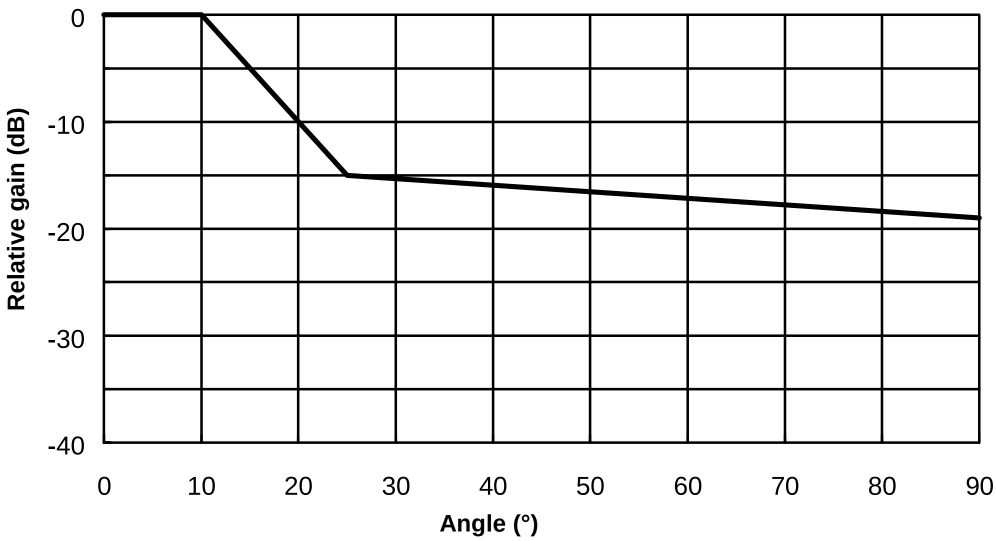


Figure 8: Symmetric CS antenna elevation pattern

Table 22: Symmetric CS antenna elevation pattern

Angle (°)	Relative gain (dB)
0	0
10	0
25	-15
90	-19

6.5.2 Asymmetric elevation patterns

For **omni-asymmetric** antennas the **co-polar and cross-polar** limits in figure 9 shall apply; outside the ±4° range the **cross-polar** limit shall be taken as the same as the co-polar limit.

For **sectored asymmetric** antennas only, the **co-polar limit** in figure 9 shall be linearly interpolated:

a) beyond the -3 dB, -30° point (down) out to the point defined at 180° for the appropriate azimuth class of antennas as taken from tables 13a to 15a; and

b) beyond the -8 dB, +90°point (up) out to the point defined at 180° for the appropriate azimuth class of antennas as taken from tables 13a to 15a.

The **cross-polar** limit shall be linearly interpolated:

a) beyond the -8 dB, -30° point (down) out to the point defined at 180° for the appropriate azimuth class of antennas as taken from tables 13b to 15b; and

b) beyond the -8 dB, +90° point (up) out to the point defined at 180° for the appropriate azimuth class of antennas as taken from tables 13b to 15b.

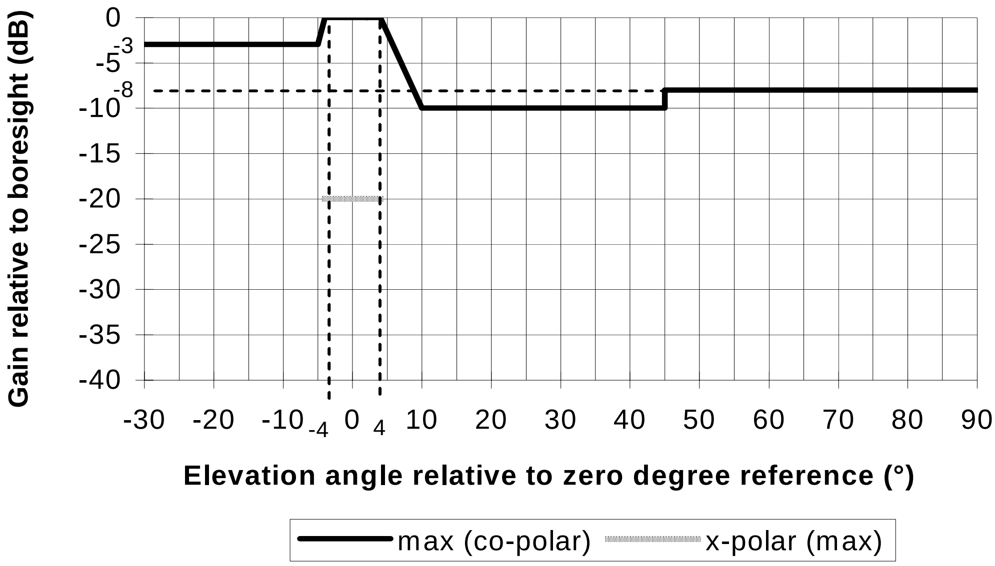


Figure 9: Asymmetric CS antenna elevation patterns

Table 23: Asymmetric CS antenna elevation patterns

Angle (°)	Co-Polar (dB)	Cross-Polar (dB)
-30	-3	-3
-5	-3	-3
-4	0	0
-4	0	-20
4	0	-20
4	0	0
10	-10	-10
45	-10	-10
45	-8	-8
90	-8	-8

6.6 Polarization, Terminal (TS) and Central (CS) Stations

The antenna shall radiate a linearly polarized wave.

6.7 Radomes

Antennas adopting radomes shall conform to the absolute gain and radiation pattern values stipulated in the clauses above, with the radome in place.

7 Conformance tests

EN 301 126-3-2 [9] shall apply.

Additional parameters appropriate to system implementation may be subject to agreement between the equipment purchaser and supplier. Further guidance is provided in annex A.

Annex A (informative): Antenna characteristics

A.1 Mechanical characteristics

A.1.1 Environmental characteristics

The antennas should be designed to operate within a temperature range of -45°C to +45°C with a relative humidity up to 100 % for environmental conditions specified in ETS 300 019-1-4 [7].

The temperature range could be divided in two parts where at least one of the following ranges could be covered:

1) -33°C to +40°C;

2) -45°C to +45°C.

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

Table A.1

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

A.1.2 Antenna stability

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

For installation purposes, the deviation of the antenna main beam axis should not be more than 0,3 times the smaller of the two azimuthal and elevation HPBW, as a general guide, under the conditions specified in table A.2.

Table A.2

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

Further guidance can be obtained from ETS 300 019-1-4 [7].

A.2 Antenna input connectors

When flanges are provided at the input port of the antenna they should be in accordance with IEC 60154-1 [10] and IEC 60154-2 [11].

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

For antennas using coaxial input ports the impedance should be nominally 50 Ω and the connectors should conform to IEC 60169 [12].

The input connector on the antenna should be mechanically compatible with the radio equipment. This should be agreed between the equipment supplier and purchaser in line with the overall system design requirements. In such cases a suitable test fixture should be agreed and used for test purposes.

A.3 VSWR at the input port(s)

The maximum VSWR should be agreed between the equipment supplier and purchaser in line with the overall system design requirements. For guidance, antennas with a Voltage Standing Wave Ratio (VSWR) in the range 1,9 to 1,1 are typical.

A.4 Inter-port isolation

The isolation between the input ports of a dual polarized antenna should be agreed between the equipment supplier and the purchaser in line with the overall system design requirements. For guidance inter-port isolation better than 25 dB is typical.

The isolation between the input ports of a multi-beam antenna should be agreed between the equipment supplier and the purchaser, in line with the overall system design requirements. For guidance, in multi-beam antenna case, inter-port isolation is typically 15 dB to 20 dB.

A.5 Antenna labelling

Antennas should be clearly identified with a weather-proof and permanent label(s) showing the manufacturer's name, antenna type, polarization direction, serial number(s) and type approval reference where appropriate.

NOTE: Integrated antennas may share a common label with the outdoor equipment.

A.6 Passive intermodulation performance

For some P-MP access methods the minimum Passive InterModulation (PIM) performance of the antenna may need to be taken into account. In such cases the PIM should be agreed between the equipment supplier and the purchaser in line with the overall system design requirements. For guidance, PIM product limits can often exceed -100 dBc.

Annex B (informative): Bibliography

ETSI ETS 300 019-1-2: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-2: Classification of environmental conditions; Transportation".

CEPT/ERC/DEC(95)04: "On the Procedures for Mutual Recognition of Type Approval of Radio (terminal) Equipment".

IEC 60050-712: "International Electrotechnical Vocabulary - Chapter 712: Antennas".

DIN 45.030, Part 1, Part 2: "Definitions/concepts, antennas".

ITU-R Recommendation F.699-4: "Reference radiation patterns for line-of-sight radio-relay system antennas for use in coordination studies and interference assessment in the frequency range from 1 to about 40 GHz".

IEC 60835-2-2: "Methods of measurement for equipment used in digital microwave transmission systems - Part 2: Measurements on terrestrial radio-relay systems - Section 2: Antenna".

(US -) ANSI/EIA -195 -C (1985): "Terrestrial microwave relay antennas".

(US-) MIL -G-24.211: "Gaskets for waveguide flanges".

IEEE Standard 145 (1993): "IEEE Standard Definitions of Terms for Antennas".

IEEE Standard 149 (1975): "IEEE Standard Test Procedure for Antennas".

History

Document history		
V1.1.1	June 2000	Publication
V1.1.2	February 2001	Publication
V1.2.1	March 2003	One-step Approval Procedure OAP 20030704: 2003-03-05 to 2003-07-04
V1.2.2	August 2003	Publication