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Candidate Harmonized European Standard (Telecommunications series)

Fixed Radio Systems;
Multipoint Equipment and Antennas;
Part 3: Harmonized EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Multipoint Radio Antennas

Reference

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Foreword

This Candidate Harmonized European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 98/34/EC (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity ("the R&TTE Directive" [1]).

This multi-part deliverable covers characteristics and requirements for fixed multipoint radio equipment and antennas, using a variety of access and duplex methods and operating at a variety of bit rates in frequency bands as specified in the present document.

The present document is part 3 of a multi-part deliverable covering the Fixed Radio Systems; Multipoint Equipment and Antennas, as identified below:

Part 1: "Overview and Requirements for Digital Multipoint Radio Systems";

Part 2: "Harmonized EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment";

Part 3: "Harmonized EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Multipoint Radio Antennas".

EN 302 326-2 [7] and the present document are Harmonized ENs and essential requirements are those requirements which are essential under Article 3.2 of the R&TTE Directive [1].

In the above, "equipment" includes equipment with integral antennas, and "antennas" include requirements for antennas whether they are integral or non-integral.

The present document with EN 302 326-2 [7] will replace and supersede the harmonized EN 301 753 (see bibliography) for all Multipoint equipment and antennas under its scope.

The date of cessation of presumption of conformity to R&TTE Directive [1] with reference to EN 301 753 (see bibliography, latest version published) is proposed to be two years after the date of publication in the OJ EC of the present document.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	24 months after doa

0 Introduction

0.1 General

For the general background, rationale and structure of this multi-part deliverable see also the clause "Introduction" in EN 302 326-1 [6].

0.2 Applicability to the R&TTE directive

The present document is part of a set of standards designed to fit in a modular structure to cover all radio and telecommunications terminal equipment under the R&TTE Directive [1]. Each standard is a module in the structure. The modular structure is shown in figure 1.

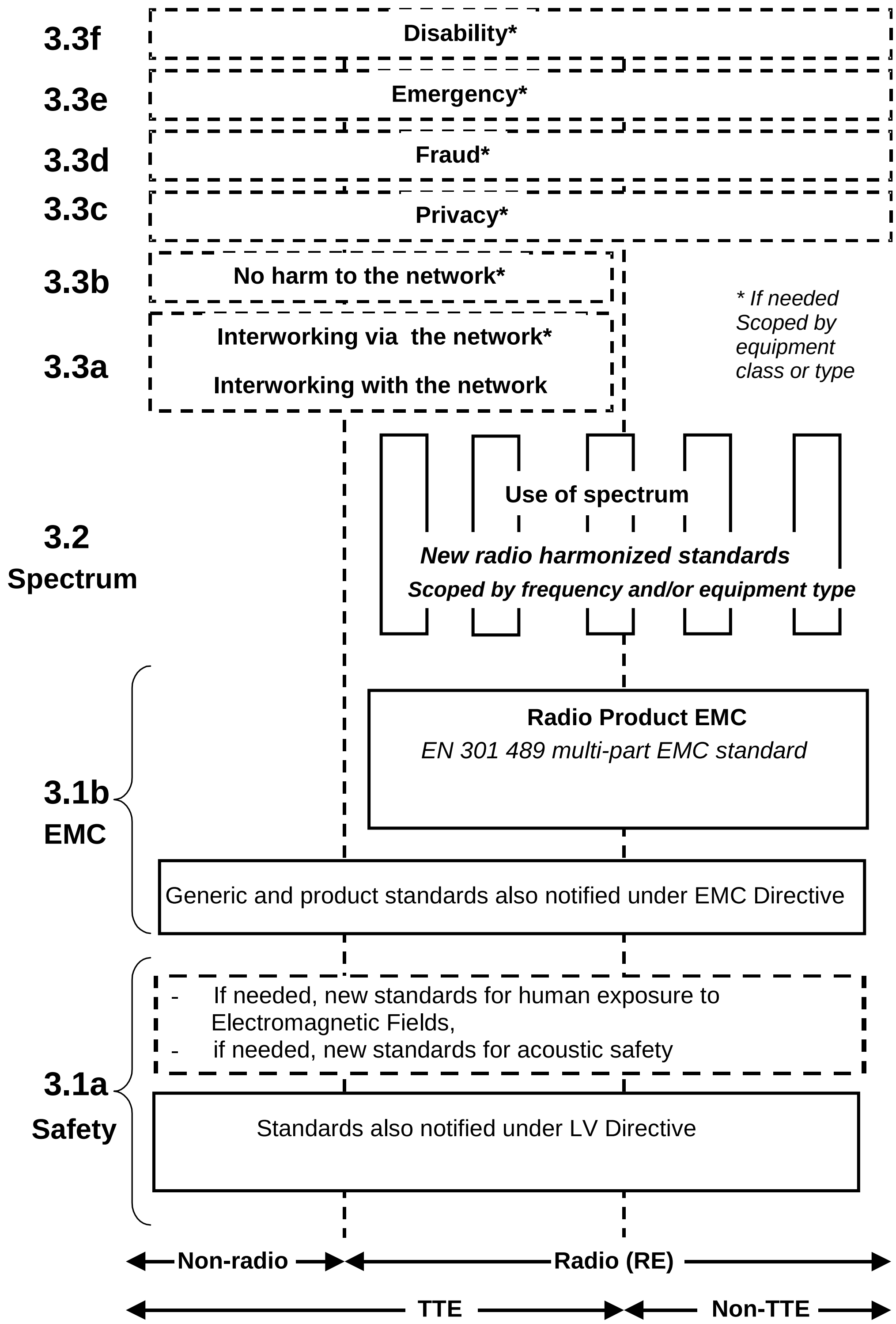

Figure 1: Modular structure for the various standards used under the R&TTE Directive [1]

The left hand edge of figure 1 shows the different clauses of Article 3 of the R&TTE Directive [1].

For Article 3.3 various horizontal boxes are shown. Dotted lines indicate that at the time of publication of the present document essential requirements in these areas have to be adopted by the Commission. If such essential requirements are adopted, and as far and as long as they are applicable, they will justify individual standards whose scope is likely to be specified by function or interface type.

The vertical boxes show the standards under Article 3.2 for the use of the radio spectrum by radio equipment. The scopes of these standards are specified either by frequency (normally in the case where frequency bands are harmonized) or by radio equipment type.

For Article 3.1b the diagram shows EN 301 489 (see bibliography), the multi-part product EMC standard for radio used under the EMC Directive 89/336/EEC (see bibliography).

NOTE: For Fixed Radio Systems EN, EN 301 489-1 and EN 301 489-4 (see bibliography) are relevant.

For Article 3.1a the diagram shows the existing safety standards currently used under the LV Directive 73/23/EEC (see bibliography) and new standards covering human exposure to electromagnetic fields. New standards covering acoustic safety may also be required.

The bottom of the figure shows the relationship of the standards to radio equipment and telecommunications terminal equipment. A particular equipment may be radio equipment, telecommunications terminal equipment or both. A radio spectrum standard will apply if it is radio equipment. An Article 3.3 standard will apply as well only if the relevant essential requirement under the R&TTE Directive [1] is adopted by the Commission and if the equipment in question is covered by the scope of the corresponding standard. Thus, depending on the nature of the equipment, the essential requirements under the R&TTE Directive [1] may be covered in a set of standards.

The modularity principle has been taken because:

- it minimizes the number of standards needed. Because equipment may, in fact, have multiple interfaces and functions it is not practicable to produce a single standard for each possible combination of functions that may occur in an equipment;
- it provides scope for standards to be added:
  - under Article 3.2 when new frequency bands are agreed; or
  - under Article 3.3 should the Commission take the necessary decisions

  without requiring alteration of standards that are already published;
- it clarifies, simplifies and promotes the usage of Harmonized Standards as the relevant means of conformity assessment.

1 Scope

1.1 General

The present document is intended to cover the provisions of the R&TTE Directive [1] regarding Article 3.2, which states that "….. radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference".

The present document is applicable to the essential requirements of antennas (including equipment with integral antennas) used in fixed multipoint radio systems

The present document together with EN 302 326-2 [7], is intended to replace and supersede, after a suitable transition period, the harmonized EN 301 753 (see bibliography). for all multipoint equipment and antennas under its scope.

The present document and EN 302 326-2 [7] introduce rationalization among systems conforming to previous EN 301 753 (see bibliography) referencing a number of ENs which, being developed at different times, may have specified slightly different antenna parameters. Nevertheless, care has been taken so that such variations will not affect any frequency planning assumption for already deployed networks. Therefore, unless specifically mentioned, these new requirements, whenever different from those single ENs, are considered completely "equivalent". Therefore mixed use of antennas conforming to this multi-part deliverable and to those previous ones will not change, in practice, any frequency planning rule in any network.

Therefore, from a strictly technical point of view, in most cases it is expected that equipment already conforming to the previous versions of Harmonized EN 301 753 (see bibliography), would not need re-assessment of essential requirements according to this multi-part deliverable. The legal implications of the declaration of conformity and equipment labelling are, however, outside the scope of this multi-part deliverable. Cases, where additional conformance assessment is required, will be specifically mentioned in EN 302 326-2 [7] and the present document.

A formal change in the requirements, introduced by the present document, is that the antenna manufacturer shall declare the nominal gain and tolerance of the antenna against which the conformity assessment is done.

In addition to the present document, other ENs specify technical requirements in respect of essential requirements under other parts of Article 3 of the R&TTE Directive [1] and which will apply to antennas within the scope of the present document.

NOTE: A list of such ENs is included on the web site: http://www.newapproach.org.

In order to (technically) cover different market and network requirements, with an appropriate balance of performance to cost and effective and appropriate use of the radio spectrum, the present document, together with EN 302 326-2 [7], offers a number of system types and antennas alternatives, for selection by administrations, operators and manufacturers dependent on the desired use of the radio spectrum and network/market requirements; those options include:

- channel separation alternatives (as provided by the relevant CEPT Recommendation);
- spectral efficiency class alternatives (different modulation formats provided in radio equipment standards);
- antenna sectorization alternatives and directivity classes for CS;
- antenna directivity class alternatives for TS and/or RS;
- antenna basic polarization (linear or circular).

For Digital Fixed Radio Systems (DFRS), antennas are considered "relevant components" of "radio equipment" according the definition in Article 2(c) of the R&TTE Directive [1]. In particular, it has to be noted that TCAM, while recognizing the "essentiality" of antenna directional requirements for some applications, including the Fixed Service, has deliberated that there should be no obligation for separate declaration of conformity for stand alone antennas and that the conformity to the relevant essential requirements should be the responsibility of the final system integrator.

However, it has also been recognized that the assessment of Article 3.2 requirements on the radio-sites is technically impractical. Therefore, it should not be forbidden to a supplier of DFRS antennas, who decides, under his responsibility, to declare compliance to the relevant harmonized standard (or part thereof, in this case), to affix the CE label to a stand-alone Fixed Radio antenna product, fulfilling all other obligations foreseen by the R&TTE Directive [1] and in particular, providing information for the user on the intended use of the apparatus. The final system integrator might benefit from such a declaration of conformity for any final radio-site assessment obligations.

In the case where the antenna manufacturer does not wish to fulfil all the applicable obligations of the R&TTE Directive [1] it is recommended to keep the specific radio test suite (relevant to the antenna essential requirements) and offer them on request to the radio system vendor or to the final system integrator in order to fulfil his obligation to the R&TTE Directive [1].

More information and background on the R&TTE Directive [1] possible applicability and requirements for stand alone DFRS antennas is found in EG 201 399 (see bibliography) and in TR 101 506 (see bibliography).

Technical specifications relevant to the R&TTE Directive [1] are summarized in annex A. For Fixed Systems, antennas are considered "relevant components" of "radio equipment" according the definition in Article 2(c) of the R&TTE Directive [1].

1.2 Frequency ranges

The present document is applicable to antennas (whether integral or non-integral) used in multipoint radio systems operating in bands allocated to Fixed Service and assigned by national regulations to MP applications within the following frequency ranges:

- 1,00 GHz to 3,00 GHz;
- 3,00 GHz to 5,90 GHz;
- 5,90 GHz to 8,50 GHz;
- 8,50 GHz to 11,00 GHz;
- 24,25 GHz to 30 GHz;
- 30,00 GHz to 40,50 GHz.

NOTE 1: Attention is drawn to the fact that the specific operating bands are subject of CEPT or national licensing rules. Currently applicable Fixed Service bands and channel plans are described in EN 302 326-1 [6], although the applicability of these Fixed Service bands is at the discretion of the national administrations.

NOTE 2: Antenna characteristics are not specified at frequencies below 1,00 GHz and therefore the present document and Harmonized EN 302 326-2 [7] can not be used for Declaration of conformity, according Article 3.2 of the R&TTE Directive [1] for non integral antennas or for equipment with integral antennas below this limit. In this case, additional test suites for relevant antenna directional phenomena shall be produced in accordance with a Notified Body.

NOTE 3: MWS antenna systems in the band 40,5 GHz to 43,5 GHz are not within the scope of this multi-part deliverable. For these systems see EN 301 997-2 (see bibliography).

1.3 Profiles

1.3.1 General

This multi-part deliverable allows many distinct types of equipment, several different antenna types and several ways in which they might be interconnected to form a network. However, the applicability of this multi-part deliverable is limited to certain combinations of attributes and these combinations of attributes are called "profiles". The following clauses address:

- Equipment profiles.
- Antenna profiles.

- System profiles.

1.3.2 Equipment profiles

The present document allows alternative consistent sets of recommendations and requirements, each for identified equipment profiles, which are defined in terms of their Equipment Classification (EqC), which classify equipments in terms of key characteristics. The profiles (or indeed any specific equipment) within the scope of this multi-part deliverable may be classified as discussed in normative annex A of EN 302 326-1 [6]. Clause 6.1 of EN 302 326-1 [6] defines the permitted equipment profiles in terms of the various fields of EqC.

1.3.3 Antenna profiles

According to their characteristics, multipoint systems use different types of antennas. Table 1 outlines the multipoint antenna types described in the present document.

Table 1: Antenna Types

Frequency Range	Types	Polarization	Notes
1 GHz to 3 GHz	Directional Sectored single beam Omnidirectional	Linear	The sectored and omnidirectional antennas may have a symmetric or asymmetric radiation pattern in the elevation plane.
3 GHz to 11 GHz	Directional Sectored single beam Sectored multi beam (up to 5,9 GHz only) Omnidirectional	Linear	The sectored single and omnidirectional antennas may have a symmetric or asymmetric radiation pattern in the elevation plane. The sectored multi beam antennas have a symmetric radiation pattern only.
1 GHz to 11 GHz	Directional Sectored single beam Omnidirectional	Circular	The sectored and omnidirectional antennas may have a symmetric or asymmetric radiation pattern in the elevation plane.
24,25 GHz to 30 GHz	Directional Sectored single beam	Linear	
30 GHz to 40,5 GHz	Directional Sectored single beam Omnidirectional	Linear	The omnidirectional antennas may have a symmetric or asymmetric radiation pattern in the elevation plane.

The present document is applicable to multipoint radio system antennas of both linear (single or dual) polarization and circular (single or dual) polarization. Linear polarization antennas may support either or both of two mutually perpendicular planes of polarization. These planes are frequently, though not always, horizontal and vertical. Circular polarization antennas may support either right hand or left hand polarization or, for dual polarization, both.

The RPE directional characteristics and polarization characteristics (co-polar and cross-polar and for either linear or circular polarized antennas) impact on the interference to be considered in network planning. A number of antenna options are defined in this multi-part deliverable to allow a trade-off between highly demanding RPE directivity and the cost/size/weight of the antennas. The antenna choice should take into account present and future networks requirements and constraints.

Annex B discusses Antenna Profiles for multipoint systems.

1.3.4 System profiles

This multi-part deliverable applies only to Multipoint systems using the following antenna type to station type combinations according to whether the network topology is P-MP or MP-MP (Mesh). Table 2 indicates which system profiles are within the scope of this multi-part deliverable.

Table 2: System Profiles within the scope of this multi-part deliverable: Antenna types - Station types combinations

Network topology	Station types	Antenna types Omnidirectional	Sectored	Directional
P-MP	Central Station (CS)	Yes	Yes (See note)	No (See note)
	Repeater Station (RS)			
	Facing CS	No	No	Yes
	Facing TS or further RS	Yes	Yes	Yes
	Terminal Station (TS)	No	No	Yes
MP-MP	Repeater Station (RS)	No	No	Yes
NOTE: Sectored antennas with beamwidth < 15° shall conform to the specification otherwise applicable to a directional antenna.				

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] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

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

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

[4] ETSI EN 302 217-4-1: "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-1: System-dependent requirements for antennas".

[5] ETSI EN 302 217-4-2: "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-2: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for antennas".

[6] ETSI EN 302 326-1: "Fixed Radio Systems; Multipoint Equipment and Antennas; Part 1: Overview and Requirements for Digital Multipoint Radio Systems".

[7] ETSI EN 302 326-2: "Fixed Radio Systems; Multipoint Equipment and Antennas; Part 2: Harmonized EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment".

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

azimuth plane: reference plane (see note) from which Radiation Pattern Envelopes are referenced

NOTE: This plane is nominally horizontal (see also *tilt*). The azimuth plane is generally mechanically identified by reference to the technical description for actual antennas for testing and deployment purposes.Sectorial and omnidirectional antennas might have intrinsic down-tilt of few degrees. In such cases, it would be more theoretically appropriate reference to a "conical" surface rather than a plane. However, tilt is generally compensated for by the test set antenna mounting (i.e. by tilting up the antenna test set mounting by an equivalent quantity) and the assessment is done by rotating the antenna rather then the receiving instrument. The test is thus performed in such a way that the measurements may be considered equivalent to those made in a true azimuth plane.

Central Station (CS): base station which communicates with Terminal Stations and in some cases Repeater Stations

co-polar: used to define parameters (such as gain or radiation pattern) applicable to radiated signals in the wanted plane of polarization (for linear polarization) or wanted direction of rotation (for circular polarization)

NOTE: The wanted plane or direction of rotation may be defined when the parameter is being measured by the plane or direction of rotation of the reference antenna.

co-polar pattern: diagram representing the co-polar radiation pattern of an antenna under test

NOTE: It is scaled in dBi or, as used in the present document, in dB relative to the measured antenna gain.

cross-polar: used to define parameters (such as gain or radiation pattern) applicable to radiated signals in the unwanted plane of polarization (for linear polarization) or unwanted direction of rotation (for circular polarization)

NOTE: The unwanted plane of polarization of a linear polarized antenna is defined as the plane which lies at right angles to the wanted plane. The unwanted direction of rotation of a circular polarized antenna is defined as that which is opposite to the wanted direction.

cross-polar pattern: diagram representing the cross-polar radiation pattern of an antenna under test

NOTE: It is scaled in dBi or, as used in the present document, in dB relative to the measured **co-polar** antenna gain.

electrical tilt: See "tilt".

elevation plane: reference plane, orthogonal to the azimuth plane, from which Radiation Pattern Envelopes are referenced

NOTE: This plane is nominally vertical. For directional, single beam sectored and multi-beam sectored antennas, the elevation plane is that which contains the zero degree reference direction (within each beam in multi-beam). For omnidirectional antennas, the elevation plane is not constrained in azimuth direction and is specific only to a given measurement.

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

gain ripple: for omnidirectional antennas, the maximum gain variance in the azimuth plane around the actual gain of the antenna under test

Figure 2 shows the relationship between the X dB gain ripple, measured minimum and maximum gains in the azimuth plane, and the declared nominal gain and tolerance of an omnidirectional antenna.

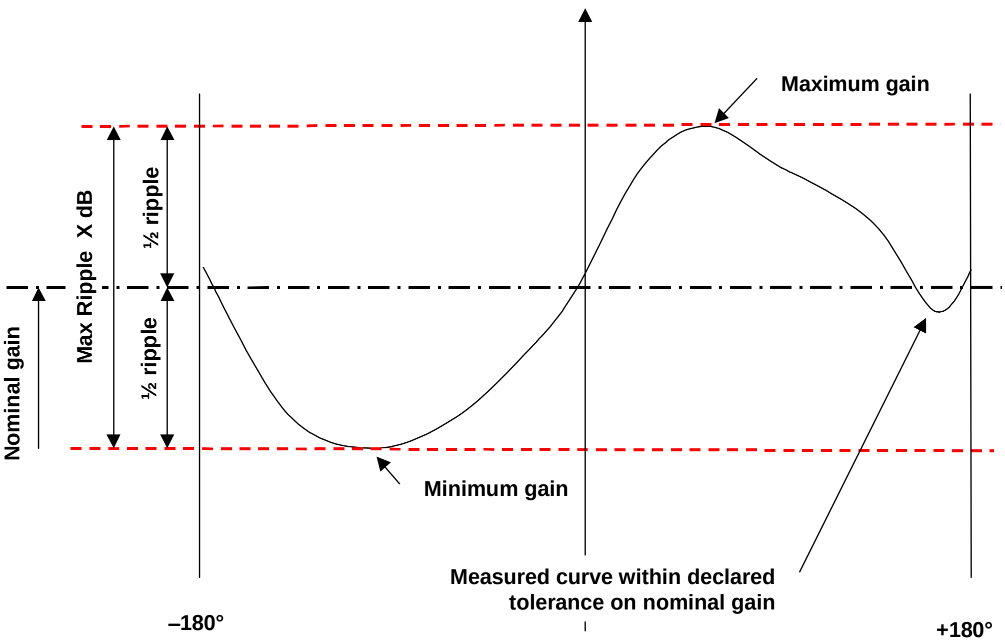

Figure 2: Gain ripple for an omnidirectional antenna

gain tolerance: tolerance on the nominal gain, as declared by the supplier according to the principles shown in figures 2 and 3.

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

left hand (anticlockwise) polarized wave: elliptically - or circularly - polarized wave, in which the electric field vector, observed in any fixed plane, normal to the direction of propagation, rotates in time in a left-hand or anticlockwise direction

maximum gain: the highest gain (in any direction) of the antenna under test

mechanical tilt: See "tilt".

nominal gain: gain declared by the supplier to which gain assessment is to be referenced

- **For directional antennas** it is referenced to the maximum gain.
- **For sectorial antennas**, the supplier shall make a declaration of the gain for the antenna, together with maximum tolerance that shall include the minimum gain within the declared sector. The gain of the antenna, as measured, shall not, therefore, exceed the declared gain at the declared upper tolerance limit, nor shall it be lower than the nominal gain at the declared lower tolerance limit; see figure 3.
- **For omnidirectional antennas** it refers to the mean value of the gain ripple as shown in figure 2.

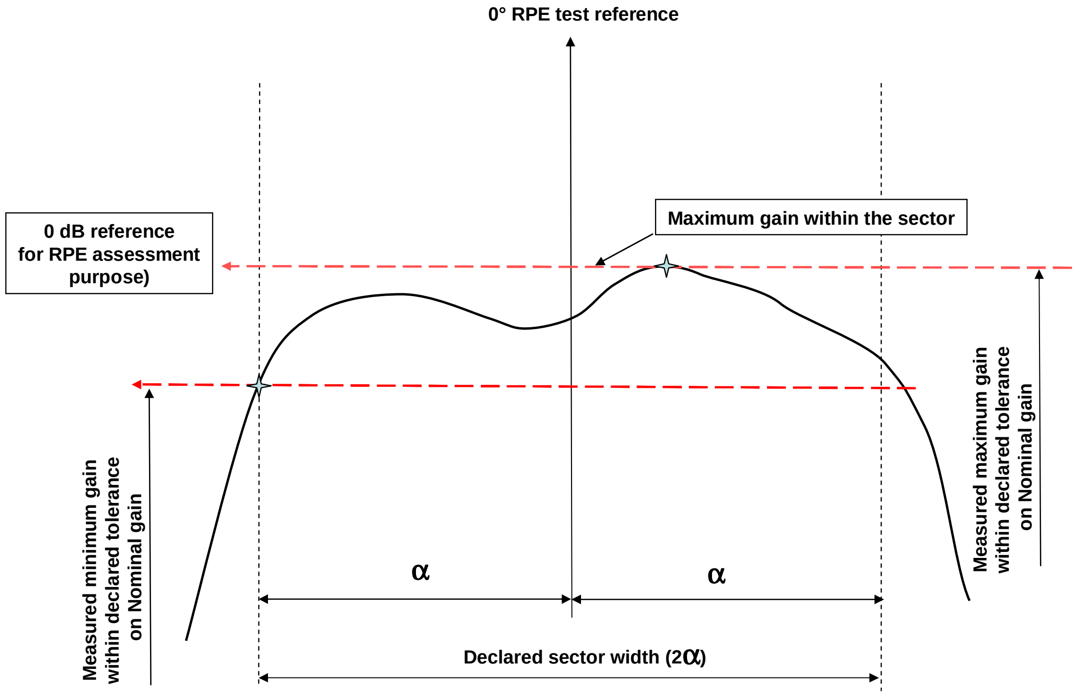

Figure 3: Gain ripple for a sectored antenna

radiation pattern: diagram describing the power flux density in a given plane and at a constant distance from the antenna as a function of the angle from the zero degree reference direction

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

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

reference beam direction (ε°): direction, defined as ε° in EN 302 326-3, defined by the manufacturer with reference to the mechanical characteristics of the antenna which is used as reference for every beam RPE (applicable only to multi-beam antennas)

Repeater Station (RS): radio station providing the connection via the air to the Central Station(s), the Terminal Stations and other Repeater Stations

NOTE: The Repeater Station may also provide the interfaces to the subscriber equipment if applicable.

right hand (clockwise) polarized wave: circularly (or, more generally, elliptically) polarized wave, in which the electric field vector, observed in any fixed plane, normal to the direction of propagation, rotates in time in a right-hand or clockwise direction

sector angle: the angle of coverage in azimuth of a sectored antenna, defined as 2α° in EN 302 326-3 shall be declared by the manufacturer

NOTE: The sector angle may depend on the characteristics of the system to which the antenna will be connected and this may therefore result in the need for a different definition of the sector angle. Therefore no specific rule is given for such declaration although in general it is assumed that the sector angle may be close to the half-power (3 dB) beam-width.

Terminal Station (TS): remote (out) station, which communicates with a Central Station or Repeater Station

tilt: fixed angular shift of the direction of maximum gain of the antenna in the elevation plane by either electrical or mechanical means

electrical tilt: angular shift in elevation of the direction of maximum gain of the antenna by a specific electrical design of the antenna

mechanical tilt: angular shift in elevation of the direction of maximum gain of the antenna by a change to the physical mounting of the antenna

Zero dB gain reference (azimuth and elevation):

For directional (DN) antennas:

The maximum gain of the antenna. It is equal to the gain in the direction of the boresight (a term not used in EN 302 326-3).

For sectored single beam antennas (SS):

The maximum gain of the antenna within the declared sector (as in figure 3).

For sectored multi-beam antennas (MS):

The maximum gain of the antenna within each beam (as in figure 3). It should therefore be noted that the multiple beams may have different zero dB gain references.

For omnidirectional antennas (OD):

The maximum gain of the antenna in the elevation plane in which the radiation pattern is being measured. It is not defined for azimuth plane.

NOTE: It should be noted that except for directional antennas, the zero dB gain reference does not necessarily equal the gain in the direction of the zero degree reference.

Zero degree (0°) reference direction: direction used as the reference direction for the RPEs. It is generally mechanically identified by reference to the technical description for actual antennas for testing and deployment purposes and must be declared by the manufacturer.

For directional (DN) antennas:

The direction of maximum gain in both axes of the antenna. It is equivalent to the boresight (a term not used in EN 302 326-3).

For sectored single beam antennas (SS):

The direction which in azimuth is the centre of the declared sector angle and in elevation is, in principle, the direction of maximum gain, which, ideally, coincides with the azimuth plane (see note).

For sectored multi-beam antennas (MS):

In the azimuth plane, the zero degree reference direction is the common reference direction for the RPEs of all beams and is declared by the manufacturer. In the elevation plane, it is the direction of maximum gain of each beam (see note). It should therefore be noted that the multiple beams may have different zero degree reference directions.

For omnidirectional antennas (OD):

The zero degree reference direction for an omnidirectional antenna is, in principle, not defined in the azimuth plane (i.e. only a 0° reference for actual test report should be identified according figure 2); In the elevation plane in which the radiation pattern is being measured, it is the direction of maximum gain (see note).

NOTE: In practical tests, in particular for sector and omnidirectional antennas, the elevation RPE might have slight variation within a relatively large elevation angle and might lead to uncertainty in finding the maximum gain for the RPE assessment. In such cases the direction of the azimuth plane (including tilts, if any) should be used as 0° reference in elevation even if actual slightly higher gain might be experienced in a slight different direction. See also the note to "azimuth plane" definition.

3.2 Symbols

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

abs( )	Absolute value of the number
dB	Decibel
dBi	Decibels relative to an isotropic source
f_0	Nominal centre frequency of declared antenna operating range
GHz	GigaHertz
α	Alpha (= half of the sector angle)
θ	Theta (= angle from zero degree reference direction)
ε	Epsilon (= beam reference direction)

3.3 Abbreviations

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

CS	Central Station
DFRS	Digital Fixed Radio System
DN	Directional (used of an antenna)
EIRP	Equivalent Isotropic Radiated Power
EqC	Equipment Classification
LHCP	Left Hand Circular Polarization
MP	MultiPoint
MP-MP	MultiPoint-to-MultiPoint
MS	Multi-beam Sectorial (used of an antenna)
OD	OmniDirectional (used of an antenna)
pfd	power flux density
P-MP	Point-to-MultiPoint
RHCP	Right Hand Circular Polarization
RPE	Radiation Pattern Envelope
RS	Repeater Station
SS	Single beam Sectorial (used of an antenna)
TS	Terminal Station

4 Technical requirements specifications

4.1 Classification of antennas

For each antenna type and frequency range, a number of different antenna classes are defined. The class of antenna selected will depend on operational requirements (and the published Interface Requirements of the relevant administration).

For each combination of antenna type and frequency range, several classes of antenna may be designated.

Directional antennas are designated as DN1, DN2 … DNn which are classified by increasingly demanding RPE according to the ranges defined in annex B.

Single beam sectored antennas are designated SS1, SS2 … SSn according to their increasingly demanding RPEs.

Multi-beam sectored antennas are designated MS1, MS2 … MSn according to their increasingly demanding RPEs.

Only one class of omnidirectional antenna is currently specified. Should it occur that more than one class of omnidirectional antenna is designated, the designations OD1, OD2 … ODn may be used.

In few cases, when more than one standardized antenna parameters are close enough for being considered belonging to the same class, further alphabetical suffix (a, b, etc.) is used. For more information on antenna classes see annex B.

4.2 Phenomena description

4.2.1 General

Two phenomena are identified as applicable to the essential requirements of antennas used in fixed multipoint radio systems:

- Radiation pattern envelope (RPE).
- Gain.

The RPE consists of different co-polar and cross polar envelopes.

For sectored (single beam or multi beam) and omnidirectional antenna types the RPE is specified in different azimuth and elevation patterns. Different azimuth and elevation patterns are also specified in the case of linearly polarized directional antennas in the frequency range.

It should be noted that the method of specifying these phenomena is different for different antenna types due to inherent differences of antennas of different types. The phenomena are therefore separately specified for each antenna type.

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

For the purpose of the present document, an antenna is specific to a Type, Class, Polarization Type, the frequency range of operation. An antenna, which employs a radome, shall meet the requirements of the present document with the radome in place.

The following clauses specify the two essential phenomena for each antenna type, class and frequency range.

4.2.2 Radiation pattern envelope (RPE)

A zero degree reference direction shall be defined for each antenna and declared by the manufacturer. The radiation characteristics in the present document are all referred to this zero degree reference direction.

Elevation RPEs are defined at the zero degree azimuth direction. In the remaining directions slight variation may be expected (within 3 dB), however no specific tests are required.

The radiation pattern envelope is the envelope which the gain of the antenna must not exceed, relative to its declared value, as a function of angle from the zero degree reference direction. The RPE is specified separately (for both co-polar and cross-polar values) for azimuth (the nominally horizontal plane) and elevation (the nominally vertical plane).

For the majority of antennas of type "Directional", the elevation and azimuth RPEs are identical and are thus specified in this way. For antennas of type "Omnidirectional", where the antenna performance is nominally uniform in the azimuth plane, the azimuth RPE is expressed as gain ripple in this plane.

Linearly polarized antennas radiate an electromagnetic wave which is nominally plane polarized. Radiation emitted which is in the wanted plane of polarization is referred to as co-polar. Radiation emitted in the unwanted plane of polarization (orthogonal to the wanted plane) is referred to as cross-polar.

Circularly polarized antennas radiate an electromagnetic wave which is nominally circularly polarized such that the plane of polarization rotates in either a right hand or left hand direction. Radiation emitted for which the plane of polarization rotates in the wanted direction is referred to as co-polar. Radiation emitted for which the plane of polarization rotates in the opposite direction to that wanted is referred to as cross-polar.

The RPE is specified separately for co-polar and cross-polar radiation.

NOTE 1: In some cases, typically where co-polar RPE is the more demanding, the cross polar RPE may be less stringent than the co-polar in the azimuth region around 180°. This is justified, for the Operators may take into account polarization decoupling in adjacent cell/sector planning. However, when inter-operator planning (e.g. for pfd boundary evaluation) is concerned, in general, unless polarization decoupling is also specifically taken into account, the "worst case envelope" of the co-polar and cross polar RPE should be considered.

For single beam sectored and omnidirectional antennas, two types of antenna elevation RPE are defined:

- one for antennas designed to exhibit symmetric RPEs about the zero degree reference direction; and
- one for antennas designed for asymmetric RPEs about the zero degree reference direction.

For single beam sectored and multibeam sectored antennas, the elevation RPE applies only to the elevation plane at the azimuth zero degree reference of each beam.

For omnidirectional antennas, the elevation RPE applies at any azimuth angle.

Single beam sectored, multibeam sectored and omnidirectional antennas may have an electrical tilt. The scope of the present document includes antennas with electrical tilt in the range of 0° to -10°, where a positive tilt is in the upward direction and a negative tilt is in the downward direction. Further mechanical tilt of up to ±10° may be suitable for deployment of single beam sectored and multibeam sectored antennas in some situations (see note).

NOTE 2: All RPEs are here defined referenced to a "nominal" azimuth plane that corresponds to the horizontal plane only when the antenna has no tilt. When tilt is present, the effect of the tilt will be compensated for in the test process as described in the definition so that the tests will be conducted as if for an antenna with no tilt.

The antenna technical description shall provide information on the nominal electrical tilt of the antenna to be used for test report purposes.

The RPEs for the frequency range 1 GHz to 11 GHz apply to both linearly and circularly polarized antennas, except for sectored multibeam antennas, for which only linearly polarized antennas are within the scope of the present document.

The RPEs for the frequency range 30 GHz to 40,5 GHz apply only to linearly polarized antennas.

The applicability of each set of parameters to linear or circular polarization is indicated.

The parameters for a single linear polarized antenna shall apply equally to the wanted plane of polarization of an antenna of either plane. The parameters for a dual linear polarized antenna shall apply equally to both planes of the antenna.

The parameters for a single circular polarized antenna shall apply equally to antennas using Left Hand Circular Polarization (LHCP) and antennas using Right Hand Circular Polarization (RHCP). The parameters for a dual circular polarized antenna shall apply equally to both LHCP and RHCP.

4.2.3 Antenna Gain

The actual antenna gain is the reference for evaluating the EIRP, which is the basic parameter that must be taken into account in order to control interference on the network.

The supplier shall make a declaration of the gain for the antenna, together with maximum tolerance of the gain of the antenna. The gain of the antenna, as measured, shall not, therefore, exceed the declared gain at the declared upper tolerance limit, nor shall it be lower than the nominal gain at the declared lower tolerance limit.

The nominal gain of the antenna, its tolerance and their relationship to the RPE are defined in clause 3.1 according to the type of antenna to which they refer.

The minimum gain of the antenna shall also meet the requirements of clause 4.5.

4.3 Environmental specifications and test

The technical requirements of the present document apply under the environmental profile for operation of the antenna or the equipment-antenna assembly, with its radome (if applicable) in place, which shall be declared by the supplier.

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.

4.4 Radiation Pattern Envelope (RPE) requirements

4.4.1 Directional antennas (DN): co- and cross- polar RPEs

4.4.1.1 Classes defined in the present document

Where several directional antenna classes are specified in a frequency band, these are designated DN1, DN2, etc. The rationale for this classification is given in annex B, together with a table showing the correspondence between these classes and those of antennas previously falling within the scope of EN 301 753 (see bibliography).

The Radiation Pattern Envelope (RPE) is defined as a gain which may not be exceeded as a function of the angle from the zero degree reference of the antenna. This gain is expressed as a gain relative to the **maximum, actual** gain (0 dB reference defined in clause 3.1) at the measured frequency.

The RPEs for both co-polar and cross polar gain are specified in the tables below. There is a separate table for each range of frequencies and, within each table, two separate columns are given for each class of antenna, one for the co-polar RPE and one for the cross polar RPE. The co-polar column is headed "Co" and the cross polar column is headed "X". The RPE defined by each column is the envelope obtained by joining each of the points for which there is an entry in the column, the point being defined by the relative gain in the column and the angle from the zero degree reference given at the left of the table for that point. The number of points in each column is variable, depending on the number of turning points in the graph of the RPE. Unless otherwise stated, the RPE applies to both elevation and azimuth.

Figure 4 is an example of the co-polar and cross polar RPEs for a class of antenna with six defined points in the co-polar REP and four defined points in the cross polar RPE.

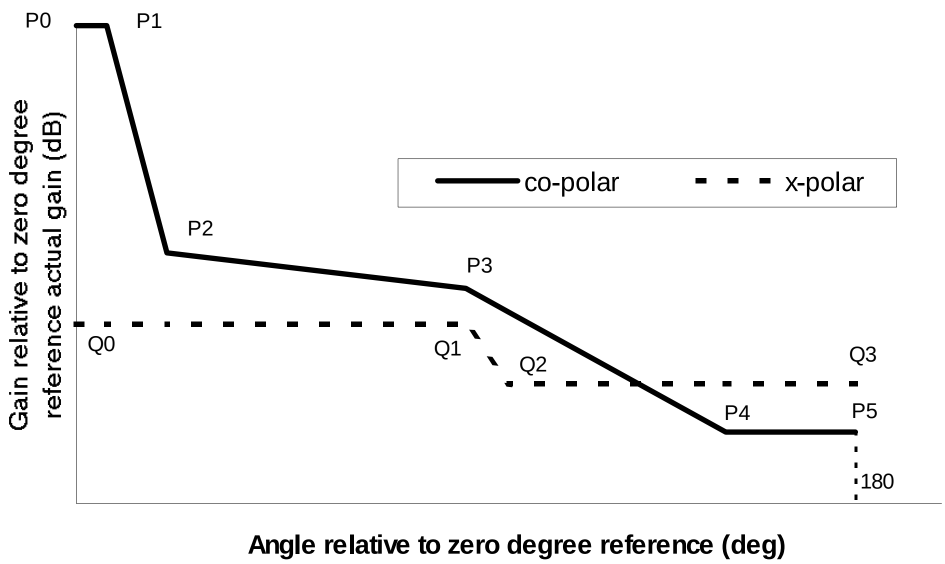

Figure 4: Normalized RPE for DN Azimuth and Elevation

The actual number and values of corner points for the standardized antennas are to be derived from the following tables.

Table 3: Directional antennas (linear polarization) from 1,0 GHz to 3,0 GHz, types DN1 to DN4

θ (º)	Gain relative to maximum actual gain at the measurement frequency															
	DN1 (void)				DN2				DN3				DN4			
	Azimuth		Elevation		Azimuth		Elevation		Azimuth		Elevation		Azimuth		Elevation	
	Co	X	Co	X	Co	X	Co	X (see note)	Co	X	Co	X (see note)	Co	X	Co	X (see note)
0					0	-13	0	-13	0	-15	0	-15	0	-14	0	14
0																
10									0		0					
20													0		0	
30					0	-13	0		-8		-8					
40													-10	-14		
45											-8					
60					-5	-18	-5								-10	
90									-15	-15			-10			
90										-20					-10	
100														-29		
110					-14	-20	-14									
120													-26		-26	
150									-20		-20					
180					-16	-20	-16		-20	-20	-20		-26	-29	-26	

NOTE: There is no compliance or test report requirements for cross-polar elevation RPE; however it is intended that at 0° reference the value should be the same of cross-polar azimuth at the same 0° reference, while in other directions it should, in principle, be not worse than elevation co-polar RPE.

Table 4: Directional antennas (circular polarization) from 1,0 GHz to 3,0 GHz, types DN1 to DN4

Θ (º)	Gain relative to maximum actual gain at the measurement frequency															
	DN1 (void)				DN2				DN3				DN4			
	Azimuth		Elevation		Azimuth		Elevation		Azimuth		Elevation		Azimuth		Elevation	
	Co	X	Co	X	Co	X	Co	X	Co	X	Co	X	Co	X	Co	X
0					0	-13	0	-15	0	-14	0	-13	0	-15	0	-14
10							0						0			
20									0						0	
30					0	-13	-8				0	-13	-8			
40									-10	-14					-10	-14
60					-5	-18					-5	-18				
90							-15	-15	-10				-15	-15	-10	
90								-20						-20		
100										-29						-29
110					-14	-20					-14	-20				
120									-26						-26	
150							-20						-20			
180					-16	-20	-20	-20	-26	-29	-16	-20	-20	-20	-26	-29

Table 5: Directional antennas (either polarization type) from 3,0 GHz to 5,9 GHz, types DN1 to DN5

θ (º)	Gain relative to maximum actual gain at the measurement frequency									
	DN1		DN2		DN3		DN4		DN5	
	Co	X	Co	X	Co	X	Co	X	Co	X
0	0	-15	0	-15	0	-19	0	-20	0	-20
10					0				0	
12			0				0			
20					-12					
30			-10				-17		-17	
70					-14					
90	0		-15	-15		-19	-17	-20	-17	-20
90	-10									
150			-20	-20	-29	-20	-30	-25	-30	-30
180	-10	-15	-20	-20	-29	-20	-30	-25	-30	-30

Table 6: Directional antennas (either polarization type) from 5,9 GHz to 8,5 GHz, types DN1 to DN5

θ (º)	Gain relative to maximum actual gain at the measurement frequency									
	DN1 (void)		DN2		DN3		DN4		DN5 (void)	
	Co	X	Co	X	Co	X	Co	X	Co	X
0			0	-17	0	-25	0	-25		
8							0			
9			0		0					
20							-20			
22			-12		-18					
90			-17	-17	-21	-25	-22	-25		
100						-30				
150			-25	-25	-33		-35	-35		
180			-25	-25	-33	-30	-35	-35		

Table 7: Directional antennas (either polarization type) from 8,5 GHz to 11,0 GHz, types DN1 to DN5

θ (º)	Gain relative to maximum actual gain at the measurement frequency											
	DN 1		DN2 (void)		DN3A		DN3b		DN4 (void)		DN5 (note)	
	Co	X	Co	X	Co	X	Co	X	Co	X	Co	X
0	0	-12			0	-20	0	-28			0	-30
5											0	
6							0					
7					0							
10	0											
15					-13		-13				-20	
30	-10											
90	-15	-12			-20	-20	-24	-28			-30	-30
100								-33				
130		-17			-30	-30					-40	-40
150	-20						-36					
180	-20	-17			-30	-30	-36	-33			-40	-40
NOTE: DN5 is only defined for linear polarization.												

Table 8: Directional antennas (linear polarization) from 24,25 GHz to 30 GHz, types DN1 to DN5

θ (º)	Gain relative to maximum actual gain at the measurement frequency											
	DN 1 (void)		DN2 (void)		DN3A		DN3b		DN4		DN5 (void)	
	Co	X	Co	X	Co	X	Co	X	Co	X	Co	X
0					0	-27	0	-30	0	-30		
2					0		0	-30				
2								-20				
2,5									0			
5						-27		-20				
8					-17		-17					
10						-30		-30	-17	-30		
20									-22	-45		
30					-22		-22					
90					-30	-30	-30	-30	-40			
100					-35	-35	-35	-35				
180					-37	-37	-40	-40	-40	-45		

Table 9: Directional antennas (linear polarization) from 30 GHz to 40,5 GHz, types DN1 to DN5

θ (º)	Gain relative to maximum actual gain at the measurement frequency									
	DN1 (void)		DN2		DN3		DN4		DN5 (void)	
	Co	X	Co	X	Co	X	Co	X	Co	X
0			0	-30	0	-27	0	-30		
2					0					
2,5							0			
5			0	-30		-27				
5				-20						
8					-17					
10						-30	-17	-30		
12,5				-20						
15			-17							
20							-22	-45		
25				-30						
30			-22		-22					
90			-25		-30	-30	-40			
100			-30	-30	-35	-35				
180			-35	-35	-40	-40	-40	-45		

4.4.1.2 Directional antennas conforming to EN 302 217

If a directional antenna, used for multipoint application, conforms to EN 302 217-4-1 [4] or EN 302 217-4-2 [5] in place of conformity with the present document, then the antenna RPE shall conform to:

- that specified for any antenna class in EN 302 217-4-2 [5];
- that specified for class 1 antennas referenced in annex A of EN 302 217-4-1 [4].

4.4.2 Sectored single beam antennas (SS)

4.4.2.1 Radiation Pattern Envelope (RPE), azimuth: co- and cross- polar

For single beam sectored antennas the co-polar and cross polar RPEs in tables 10 to 14 shall apply. The RPEs are constructed from the points in the table in the same way as the RPEs for directional antennas.

The sector width, defined here as 2α (see also clause 3.1) and otherwise referred to as sector angle, must be declared by the supplier. The gain values are all relative to the actual maximum gain in the declared sector width (0 dB reference).

f_0 is defined as the centre frequency in GHz of the declared frequency range of operation of the antenna.

It should be noted that the positions of some of the points on the RPEs are calculated values from α and f_0. In these cases, the positions of the points are given as mathematical expressions in the table entries. Actual values derived from all expressions are rounded to the nearest integer value. The azimuth patterns defined by such expressions apply for all combinations of frequency and sector angle within the ranges addressed by the relevant table.

Where more than one class of antenna is specified in a frequency range, these classes are designated SS1, SS2, SS3, etc. according to their increasingly demanding RPE requirements.

The rationale for this classification is given in annex B of this, together with a table showing the correspondence between these classes and those previously used.

The range of sector widths for which each antenna class is applicable is shown at the head of each table.

Sectored antennas with beamwidth < 15° shall conform to the specification otherwise applicable to a directional antenna.

Table 10: Azimuth RPEs for linear polarized single beam sector antennas 1 GHz to 3 GHz (Applicable to sector widths (2α) of 15º to 180º)

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)	
	Co-Polar	**Cross Polar**
0	0	-20
α + 5	0	
α + (57,5 - 5f_0)		-20
α + (105 - 7f_0)	-0,7f_0 - 16	
α + (87,5 - 5f_0)		-1,4f_0 - 20
184,4 - 4,4f_0	-1,4f_0 - 20	
180	-1,4f_0 - 20	-1,4f_0 - 20

Table 11: Azimuth RPEs for circularly polarized single beam sector antennas 1 GHz to 3 GHz (Applicable to sector widths (2α) of 15º to 180º)

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)	
	Co-Polar	**Cross Polar**
0	0	-10
α + 5	0	
α + (57,5 - 5f_0)		-10
α + (105 - 7f_0)	-0,7f_0 - 16	
α + (87,5 - 5f_0)		-15
184,4 - 4,4f_0	-1,4f_0 - 20	
180	-1,4f_0 - 20	- 20

Table 12: Azimuth RPEs for linear polarized single beam sector antennas 3 GHz to 11 GHz (Applicable to sector widths (2α) of 15º to 180º)

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)					
	SS1		**SS2**		**SS3**	
	Co	**X**	**Co**	**X**	**Co**	**X**
0	0	-12	0	-20	0	-0,7 f_0 -17,5
α + 5	0	-15	0			
α + (20 - 1,4 f_0)					0	-0,7 f_0 -17,5
α + (57,5 - 5 f_0)				-20		
α + (75 - 4,3 f_0)					-23	-1,4 f_0 -20
α + (105 - 7 f_0)			-20			
α + (87,5 - 5 f_0)				-25		
195 - 7 f_0			-20			
165 - 4,3 f_0					-23	
186 - 4,4 f_0			-25			
150					-1,4 f_0 -20	
160	-20	-20				
180	-20	-20	-25	-25	-1,4 f_0 -20	-1,4 f_0 -20

Table 13: Azimuth RPEs for circularly polarized single beam sector antennas 3 GHz to 11 GHz (Applicable to sector widths (2α) of 15º to 180º)

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)					
	SS1		SS2		SS3	
	Co	X	Co	X	Co	X
0	0	-10	0	-10	0	-12
α + 5	0	-10	0			
α + (20 - 1,4 f_0)					0	-12
α + (57,5 - 5 f_0)				-10		
α + (75 - 4,3 f_0)					-23	-20
α + (105 - 7 f_0)			-20			
α + (87,5 - 5 f_0)				-15		
195 - 7 f_0			-20			
165 - 4,3 f_0					-23	
186 - 4,4 f_0			-25			
150					-30	
160	-20	-20				
180	-20	-20	-25	-25	-30	-30

Table 14: Azimuth RPEs for linear polarized single beam sector antennas 24 GHz to 40,5 GHz (Applicable to sector widths (2α) of 15º to 130º for antenna class SS1 and of 15º to 180º for all other antenna classes)

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)									
	SS1		SS2a		SS2b		SS3		SS4	
	Co	X	Co	X	Co	X	Co	X	Co	X
0	0	-20	0	-20	0	-25	0	-25	0	-25
α		-20		-20				-25		-25
α + 5	0		0		0	-25	0		0	
α + 15		-25							-20	-30
α + 30							-20	-30		
2α			-20	-25	-20	-30				
2α + 5	-10									
105								-30		-30
110							-23		-23	
135	-12									
140							-35	-35	-35	-35
155	-15									
180	-25	-25	-30	-30	-30	-30	-35	-35	-35	-35

4.4.2.2 Radiation Pattern Envelope (RPE), elevation

4.4.2.2.1 Symmetric elevation RPEs: co- and cross- polar

For symmetric single beam sectored antennas, the co-polar RPE in the elevation plane shall conform to the RPEs given in table 15.

The angle θ° is relative to the 0 degree reference as defined in clause 3.1.

Since the co-polar RPE is symmetrical, the table applies equally to positive and negative values of θ.

Table 15: Symmetric elevation RPEs for single beam sector antennas

±θ (°)	Gain relative to maximum actual gain at the measurement frequency (dB)			
	1 GHz to 3 GHz	3 GHz to 11 GHz	24 GHz to 30 GHz	30 GHz to 40,5 GHz
0	0	0	0	0
6			0	0
10		0		-10
12	0			
12	-3			
14	-5			
15			-15	
20	-5			
25		-15		
60	-13			
60	-18			
90	-18	-19	-25	-20
From 90 to 180	See notes 1 and 2			

NOTE 1: The co-polar limit for elevation in table 15 shall be linearly interpolated beyond the 90° point in table 15 out to the point defined at 180° by the co-polar column in the appropriate azimuth RPE table (from tables 10 to 14) for the frequency range and class of antenna.

NOTE 2: The cross polar limit shall be linearly interpolated between the 0° and the 180° points taken from the cross polar column in the appropriate azimuth RPE table (from tables 10 to 14) for the frequency range and class of antenna.

4.4.2.2.2 Asymmetric elevation RPEs: co- and cross- polar

In frequency bands from 1 to 11 GHz, between the angles of -30° (down) and +90° (up), the single beam sectored antenna shall meet the co-polar and cross polar limits in table 16.

Table 16: Asymmetric elevation RPEs for single beam sector antennas for bands within the range 1 GHz to 11 GHz

Angle (°)	Co-Polar (dB)	Cross-Polar (dB)
-180 to -30	Note 1	Note 2
-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
90 to 180	Note 3	Note 4

NOTE 1: For angles more negative than -30° (down), the co-polar limit shall be linearly interpolated between the co-polar -30° -3 dB point in table 16 out to the point defined at 180° by the co-polar column in the appropriate azimuth RPE table (from tables 10 to 14) for the frequency range and class of antenna.

NOTE 2: For angles more negative than -30° (down), the cross polar limit shall be linearly interpolated between the cross polar -30° -3 dB point in table 16 out to the point defined at 180° by the cross polar column in the appropriate azimuth RPE table (from tables 10 to 14) for the frequency range and class of antenna.

NOTE 3: For angles more positive than +90° (up), the co-polar limit shall be linearly interpolated between the co-polar +90° -8 dB point in table 16 out to the point defined at 180° by the co-polar column in the appropriate azimuth RPE table (from tables 10 to 14) for the frequency range and class of antenna.

NOTE 4: For angles more positive than +90° (up), the cross polar limit shall be linearly interpolated between the cross polar +90° -8 dB point in table 16 out to the point defined at 180° by the cross polar column in the appropriate azimuth RPE table (from tables 10 to 14) for the frequency range and class of antenna.

4.4.3 Sectored multi-beam antennas (MS)

4.4.3.1 General

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 in the same time while using different frequencies. Each beam may be used as the central station 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 sectored multi-beam antennas in which the aggregate of all beams covers up to 180° in the frequency range 3 GHz to 5,9 GHz.

Sectored multi-beam antennas use only linear polarization. The parameters apply equally to linearly polarized antennas of either plane.

The co-polar and cross-polar radiation pattern envelopes for sectored multi-beam antennas are specified in the tables below.

4.4.3.2 Radiation Pattern Envelope (RPE), azimuth: co- and cross- polar

Where more than one class of antenna is specified in a frequency range, these classes are designated MS1, MS2 etc. in order of increasing stringency.

It should be noted that the positions of some of the points on the RPEs are calculated values from α, ε and f_0. In these cases, the positions of the points are given as mathematical expressions in the table entries. All expressions are rounded to the nearest integer value.

The sector angle, the beamwidth (defined as 2α) and the reference beam direction (ε) shall be declared by the supplier for each beam. The azimuth patterns defined below in figure 5 and tables 17 and 18 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.

NOTE: MS1 antennas are defined only for abs(ε + 3 × α) ≤ 90°.
MS2 antennas are defined only for abs(ε + 6 × α) ≤ 60°.

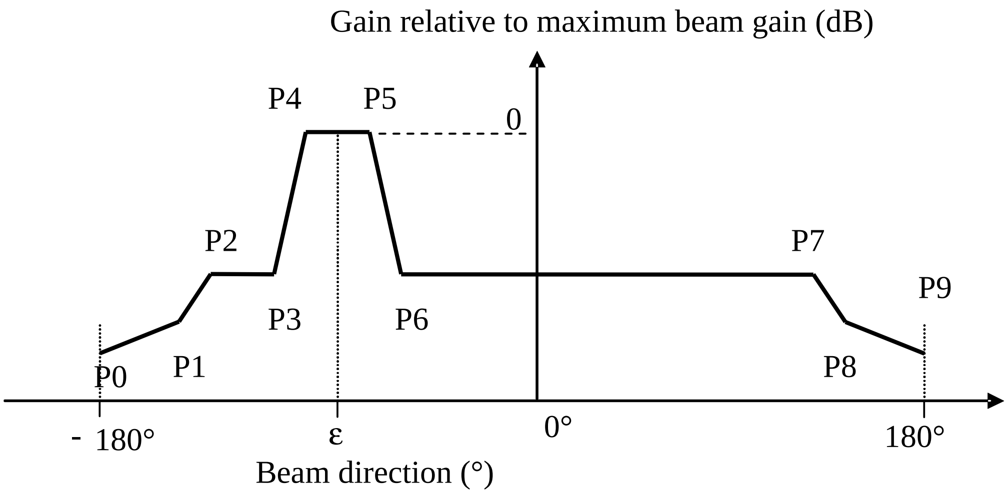

Figure 5: Azimuth RPEs for linear polarized multi beam sector antennas 3 GHz to 5,9 GHz (defined for each beam)

Table 17: Co-polar, azimuth RPEs for linear polarized multi beam sector antennas 3 GHz to 5,9 GHz

θ (º)	Gain relative to maximum gain in the considered reference beam sector/angle (dB)	
	MS1	**MS2**
	Co Polar	**Co Polar**
-180	-25	-35
-120	-20	
-135		-35
-90	-15	
-60		-20
ε - 6 × α		-20
ε - 5 × α		-17
ε - 3,3 × α		-17
ε - 3 × α	-15	
ε - 1,6 × α		0
ε - 1,5 × α	0	
ε		
ε + 1,5 × α	0	
ε + 1,6 × α		0
ε + 3 × α	-15	
ε + 3,3 × α		-17
ε + 5 × α		-17
ε + 6 × α		-20
60		-20
90	-15	
120	-20	-35
135		
180	-25	-35

Table 18: Cross-polar, azimuth RPEs for linear polarized multi beam sector antennas 3 GHz to 5,9 GHz

θ (º)	Gain relative to maximum gain in the considered reference beam sector/angle (dB)	
	MS1	MS2
	Cross Polar	Cross Polar
ε – 180	-20	-20
ε – abs(α + 75 - 4,3 f_0)		-20
ε – abs(α + 57,5 - 5 f_0)	-20	
ε – abs(α + 57,5 - 5 f_0)	-15	
ε – abs(α + 20 - 1,4 f_0)		-15
ε	-15	-15
ε + abs(α + 20 - 1,4 f_0)		-15
ε + abs(α + 57,5 - 5 f_0)	-15	
ε + abs(α + 57,5 - 5 f_0)	-20	
ε + abs(α + 75 - 4,3 f_0)		-20
ε + 180	-20	-20

4.4.3.3 Radiation Pattern Envelope (RPE), elevation: co- and cross- polar

For multi beam sectored antennas only symmetric RPEs are defined. The co-polar and cross-polar RPEs in the elevation plane shall conform, for all beams, with the RPEs given in table 19.

Since the co-polar RPE is symmetrical, the table applies equally to positive and negative values of θ.

Table 19: Elevation RPEs for multi beam sector antennas

±θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)			
	MS1		MS2	
	Co-polar	Cross-polar	Co-polar	Cross-polar
0	0	-15	0	-15
10	0		0	
25	-15		-15	
90	-19		-19	
180	note	-20	note	-20
NOTE: The co-polar limit, for each beam, shall be linearly interpolated beyond 90° to the azimuth co-polar RPE value at (ε° + 180°) derived from table 17 for each MS 1 and MS 2 classes.				

4.4.4 Omnidirectional antennas (OD)

4.4.4.1 General

No omnidirectional antennas are currently within the scope of the present document for the frequency range 24 GHz to 30 GHz.

4.4.4.2 Radiation Pattern Envelope (RPE), azimuth

For omnidirectional antennas, the co-polar radiation pattern in the azimuth plane is defined by the maximum gain ripple, which is defined in clause 3.1.

For both linear and circular polarization, the gain ripple shall not exceed 3 dB.

For omnidirectional antennas, the cross-polar radiation pattern in the azimuth plane is defined by the cross-polar gain relative to the measured gain at all azimuth angles.

The cross-polar radiation pattern in the azimuth plane shall not exceed -20 dB for linear polarization antennas and -12 dB for circular polarization antennas.

4.4.4.3 Radiation Pattern Envelope (RPE), elevation

4.4.4.3.1 Symmetric elevation RPEs: co- and cross- polar

For omnidirectional symmetric elevation antennas the RPEs in table 20 shall apply. The RPEs are constructed from the points in the table in the same way as the RPEs for directional antennas.

Since the elevation pattern is symmetrical, the table applies equally to positive and negative values of θ.

Table 20: Elevation RPEs for symmetric elevation omnidirectional antennas

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)					
	1 GHz to 3 GHz		3 GHz to 11 GHz		30 GHz to 40,5 GHz	
	Co-polar	Cross-polar	Co-polar	Cross-polar	Co-polar	Cross-polar
0	0	XP (note 1)	0	XP (note 1)	0	-20
4	0	XP (note 1)		XP (note 1)		
4	0	0		0		
8					0	
10			0	0		
12	0	0				
12	-3	-3				
14	-5	-5				
20	-5	-5				
25			-15	-15		
30					-10	
60	-13	-13				
60	-18	-18				
90 (note 2)	-18	-18	-19	-19	-20	-20

NOTE 1: XP has the value -20 for linear polarization antennas and -12 for circular polarization antennas.

NOTE 2: For antennas with electrical (down) tilt, the +90º limit shall be extended up to $(90^\circ + |tilt^\circ|)$ and the -90° limited to $(-90^\circ + |tilt^\circ|)$ in order to cover the actual vertical direction.

4.4.4.3.2 Asymmetric elevation RPEs: co- and cross- polar

Omnidirectional antennas with an asymmetric elevation RPE and electrical tilt are included in the scope of the present document.

For omnidirectional asymmetric elevation antennas the co-polar RPEs in table 21 shall apply. The RPEs are constructed from the points in the table in the same way as the RPEs for directional antennas.

Table 21: Elevation RPEs for asymmetric elevation omnidirectional antennas

θ (º)	Gain relative to maximum actual gain at the measurement frequency (dB)			
	1 GHz to 11 GHz		30 GHz to 40,5 GHz	
	Co-polar	Cross-polar	Co-polar	Cross-polar
-90	-3	-3	-20	-20
-30				
-20			-20	
-5	-3			
-4	0	-3		
-4	0	XP (note 1)		
0			0	-20
4	0	XP (note 1)		
4	0	0		
8			0	
10	-10	-10		
30			-10	
45	-10	-10		
45	-8	-8		
90 (note 2)	-8	-8	-20	-20

NOTE 1: XP has the value -20 for linear polarization antennas and -12 for circular polarization antennas.

NOTE 2: For antennas with electrical (down) tilt, the +90º limit shall be extended up to $(90^\circ + |tilt^\circ|)$ and the -90° limited to $(-90^\circ + |tilt^\circ|)$ in order to cover the actual vertical direction.

4.5 Antenna gain requirements

4.5.1 General

This parameter is relevant to essential requirements under Article 3.2 of the R&TTE Directive [1].

It should be noted, however, that regulators might set a minimum gain requirement in the interface notification under Article 4.1.

For the purpose of the present document, an antenna is specific to a Type, Class, the frequency range 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.

The gain of the antenna is specified as the maximum gain of the antenna with reference to an isotropic radiator and is expressed in dBi. For some antenna types the gain is specified as a function of one or more declared design parameters (see definitions in clause 3.1).

The supplier shall declare the nominal gain and related tolerances according to the relevant definition and the minimum values set in following clauses; the actual antenna gain shall be in accordance to those declared values.

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

The gain parameters apply for linearly polarized and circularly polarized antennas. The applicability of each set of parameters to linear or circular polarization is indicated for each set of parameters.

The parameters for linear polarized antennas apply equally to both horizontal and vertical linearly polarized antennas.

The parameters for circularly polarized antennas apply equally to antennas using either RHCP or LHCP.

4.5.2 Directional antennas

Where several directional antenna classes are specified in a frequency band, these are designated DN1, DN2, etc.

The minimum declared gain of the directional antenna, expressed relative to an isotropic radiator, shall be as detailed in table 22.

Table 22: Minimum antenna gain for each frequency range and antenna class

Frequency band	Antenna class	Polarization type	Minimum declared gain (dBi)	Notes
1 GHz to 3 GHz	DN1 and DN2 DN3	Linear	8,0 14,0	
3 GHz to 11 GHz	All classes	Linear	ROUND (0,85 f_0 + 5)	ROUND ( ) means rounded up to the closest integer. f_0 is the nominal centre frequency
1 GHz to 11 GHz	All classes	Circular	ROUND (0,85 f_0 + 5)	As above
24,25 GHz to 30 GHz	All classes	Linear	22	
30 GHz to 40,5 GHz	All classes	Linear	24	

4.5.3 Sectored single beam antennas

The single beam sectored antenna declared gain shall exceed the values defined in figure 6 as a function of sector angle, 2α, in the range 15° to 180° and for all frequency ranges from 1 GHz to 11 GHz and from 24,25 GHz to 40,5 GHz.

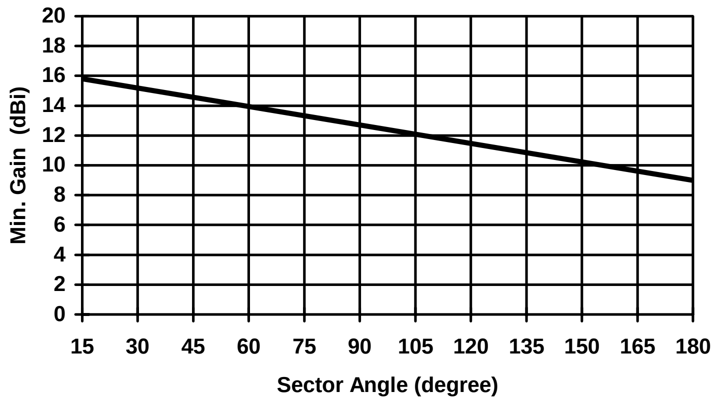

Figure 6: CS Sector Antenna Minimum Declared Nominal Gain Limits

4.5.4 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 in the same time while using different frequencies. Each beam may be used as the central station 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 sectored multi-beam antennas in which the aggregate of all beams covers up to 180° in the frequency range 3 GHz to 11 GHz.

Sectored multi-beam antennas use only linear polarization. The parameters apply equally to both horizontal and vertical linearly polarized antennas.

The declared nominal gain, for each beam of a multiple beam sectored antenna, shall exceed 11,5 dB for any beamwidth in the range 10° to 90°.

4.5.5 Omnidirectional antennas

The minimum declared nominal gain for omnidirectional antennas is specified in table 23.

Note that no omnidirectional antennas have been identified for the frequency range 24,25 GHz to 30 GHz.

The minimum declared gains for the frequency range 1 GHz to 11 GHz apply to both linearly and circularly polarized antennas.

The minimum declared gain for the frequency range 30 GHz to 40,5 GHz applies only to linearly polarized antennas.

Table 23: Minimum declared nominal gain for omnidirectional antennas

Frequency Range (GHz)	Minimum declared gain (dBi)
1 to 3	5
3 to 11	8
30 to 40,5	8

5 Testing for conformance with technical requirements

5.1 Void

This clause is left void.

5.2 Wide radio-frequency band covering antennas specification and test

Commonly, multipoint antennas cover an operating frequency range declared by the supplier. The antenna parameters shall comply with all the requirements of the present document within the declared operating frequency range.

The tests shall be carried out at the lowest, middle and highest frequency of the relevant frequency range to produce the test report and/or declaration of conformity required (R&TTE Directive [1]).

5.3 Environmental conditions for Testing

The technical requirements of the present document apply under the environmental profile for operation of the antenna or the equipment-antenna assembly, with its radome (if applicable) in place, which shall be declared by the supplier.

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 antennas for compliance with technical requirements, EN 301 126-3-2 [3] shall apply.

Any test, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure specification by the R&TTE Directive [1] for stand-alone DFRS or integral antennas (directional phenomena of EN 302 326-2 [7]), shall be carried-out at reference environmental conditions at the test field according to clause 4.1 of EN 301 126-3-1 [2].

The test report shall be produced according to the procedure specified by article 10 of the Directive 1999/5/EC [1].

5.4 Radiation Pattern Envelope (RPE)

The elevation RPE is measured at the 0 deg reference which must be declared by the manufacturer.

In the remaining directions slight variation may be expected (within 3 dB), however no specific tests are required.

5.5 Antenna gain

The antenna gain shall be measured in accordance with the definitions in clause 3.1 consistent with the declaration of the supplier.

Annex A (normative): The EN Requirements Table (EN-RT)

The EN Requirements Table (EN-RT) serves a number of purposes, as follows:

- it provides a tabular summary of all the requirements;
- it shows the status of each EN-R, whether it is essential to implement in all circumstances (Mandatory), or whether the requirement is dependent on the supplier having chosen to support a particular optional service or functionality (Optional). In particular it enables the EN-Rs associated with a particular optional service or functionality to be grouped and identified;
- when completed in respect of a particular equipment it provides a means to undertake the static assessment of conformity with the EN.

Table A.1: EN Requirements Table (EN-RT)

EN Reference		EN 302 326-3 Annex A			
No.	**Clause**	**EN-R (note)**	**Status**	**Note**	**Supplier Comment for declaration**
1	4.4	Radiation Pattern Envelope (RPE)	M		
2	4.5	Antenna Gain	M		
NOTE: These EN-Rs are justified under Article 3.2 of the R&TTE Directive.					

Key to columns:

No Table entry number;

Reference Clause reference number of conformance requirement within the present document;

EN-R Title of conformance requirement within the present document;

Status Status of the entry as follows:

M Mandatory, shall be implemented under all circumstances;
O Optional, may be provided, but if provided shall be implemented in accordance with the requirements;
O.n this status is used for mutually exclusive or selectable options among a set. The integer "n" shall refer to a unique group of options within the EN-RT. A footnote to the EN-RT shall explicitly state what the requirement is for each numbered group. For example, "It is mandatory to support at least one of these options", or, "It is mandatory to support exactly one of these options".

Comments To be completed as required.

Annex B (informative): Antenna profiles

B.1 General

According their characteristics, Multipoint systems use different types of antennas: Directional, Sectorial and Omnidirectional.

Their RPE directional characteristics (co-polar and cross-polar and for either linear or circular polarized antennas) impact on the interference to be considered in network planning. A number of options (classes) are defined in this multi-part deliverable as trade-off between highly demanding RPE directivity and the cost/size/weight of the antennas. Their choice should take into account compatible with the constraints of present and future networks requirements and cost constraints.

The classes used in the present document supersede the classes used in previous standards (which were arbitrary in their sequence) and the relationship between the new classes and those previously used is defined in the tables in the following clauses.

B.2 Directional antennas

The five directional antenna classes (classes DN1 to DN5) have been redefined in line with the principle that the antennas with more demanding maximum combined co-polar and cross-polar RPEs have higher class numbers and antennas with closely related RPEs are assigned to sub classes.

The subdivision of classes has been done setting practical RPE range steps differentiating the classes in order to accommodate, as much as possible, in logical and consistent order, across all frequency band, the various RPE of antenna previously in the scope of EN 301 753 (see bibliography). Whenever more than one RPE fall within the same step of RPE range, they have been distinguished with alphabetical suffix (a, b, etc.) within the same class, still according an increasing demand of their actual RPE. In order of maintaining the above consistencies also for possible future introduction of other RPE, some classes in some frequency ranges are actually kept void of parameters.

The correspondence with the classes used in previous standards is given in table B.1.

Table B.1: Correspondence between previous directional antenna classes and new classes

Range	Previous EN TS Classes	Revised DN Classes (DNx)
1 GHz to 3 GHz (EN 301 525)	TS 1, TS 2, TS 3	Class 1, 2 and 3
3 GHz to 5,9 GHz (EN 302 085)	TS 1, TS 2, TS 3	Class 1, 2 and 3
	TS 4	Class 5
	TS 5	Class 4
5,9 GHz to 8,5 GHz (EN 302 085)	TS 1	Class 2
	TS 2	Class 4
	TS 3	Class 3
	Void	Classes 1 and 5 (void)
8,5 GHz to 11 GHz (EN 302 085)	TS 1	Class 3A
	TS 2	Class 5
	TS 3	Class 3B
	TS 4	Class 1
	Void	Classes 2 and 4 (void)
24 GHz to 30 GHz (EN 301 215-2)	TS 1	Class 3B
	TS 2	Class 4
	TS 3	Class 3A
	Void	Classes 1, 2 and 5 (void)
30 GHz to 40,5 GHz (EN 301 215-3)	TS 1	Class 2
	TS 2	Class 3
	TS 3	Class 4
	Void	Class 1 and 5 (void)
NOTE: All ENs mentioned in this table are referenced in Bibliography.		

B.3 Sectorial and omnidirectional antennas

The antenna classes defined for single beam sectorial antennas in the frequency range 1 GHz to 11 GHz remain unchanged apart from the previous classes CS1 to CS3 that are defined in the present document as SS1 to SS3, respectively.

The antenna classes defined for single beam sectorial antennas in the frequency range 24,25 GHz to 40,5 GHz have been redefined in line with the principle that the antennas with more demanding RPEs have higher class numbers and antennas with closely related RPEs are assigned to sub classes. Table B.2 shows the correspondence between the antenna classes used in previous standards and those used in the present document.

The classes for multi beam sectorial antennas remain unchanged in that the previous class CSMB1 is defined in the present document as MS1 and the previous class CSMB2 is defined in the present document as MS2.

There are no omnidirectional antenna classes within the current scope of the present document.

Table B.2: Correspondence between previous single beam antenna classes and new classes in the frequency range 24,0 GHz to 40,5 GHz

Range	Previous EN CS Classes	Revised SS Classes (SSx)
24,25 GHz to 30,0 GHz (EN 301 215-2)	CS 1	SS 1
	CS 2	SS 4
	CS 3	SS 2a
30,0 GHz to 40,5 GHz (EN 301 215-4)	CS 1	SS 1
	CS 2	SS 2a
	CS 3	SS 2b
	CS 4	SS 3
NOTE: All ENs mentioned in this table are referenced in Bibliography.		

Annex C (informative): The EN title in the official languages

Language	EN title
Czech	
Danish	
Dutch	
English	Fixed Radio Systems; Multipoint equipment and antennas; Part 3: Harmonized EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Multipoint Radio Antennas
Estonian	
Finnish	
French	
German	Fester Funkdienst; Geräte und Antennen für Mehrpunkt Systeme; Teil 3: Harmonisierte Europäische Norm bezüglich der grundlegenden Anforderungen des Artikels 3.2 der R&TTE Direktive für Mehrpunkt Richtfunk Antennen
Greek	
Hungarian	Állandóhelyû rádiórendszerek; Többpont berendezések és antennák; 3. rész: Többpont rádióantennáknak az R&TTE-irányelv 3.2 cikkelyének lényegi követelményeit tartalmazó, harmonizált európai szabványa
Icelandic	
Italian	Sistemi radio per il Servizio Fisso; Caratteristiche e requisiti per apparati multi-punto e relative antenne; Parte 3: Norma armonizzata riguardante i requisiti essenziali per l'articolo 3.2 della Direttiva R&TTE delle antenne
Latvian	
Lithuanian	
Maltese	
Polish	
Portuguese	
Slovak	
Slovenian	
Spanish	
Swedish	

Annex D (informative): Bibliography

Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).

Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).

ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matter (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".

ETSI EN 301 215-1: "Fixed Radio Systems; Point to Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 1: General aspects".

ETSI EN 301 215-2: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 2: 24 GHz to 30 GHz".

ETSI EN 301 215-4: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 4: 30 GHz to 40,5 GHz".

ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

ETSI EN 301 489-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services".

ETSI EN 301 525: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for Point-to-Multipoint fixed radio systems in the 1 GHz to 3 GHz band".

ETSI EN 301 753: "Fixed Radio Systems; Multipoint equipment and antennas; Generic harmonized standard for multipoint digital fixed radio systems and antennas covering the essential requirements under article 3.2 of the Directive 1999/5/EC".

ETSI EN 301 997-2: "Transmission and Multiplexing (TM); Multipoint equipment; Radio equipment for use in Multimedia Wireless Systems (MWS) in the frequency band 40,5 GHz to 43,5 GHz; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive".

ETSI EN 302 078: "Fixed Radio Systems; Multipoint antennas; Circularly polarized antennas for multipoint fixed radio systems in the 1 GHz to 11 GHz band".

ETSI EN 302 085: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 3 GHz to 11 GHz band".

ETSI TR 101 506: "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements under the Article 3.2 of 99/05/EC Directive to Fixed Radio Systems".

ETSI EN 301 215-3: "Fixed Radio Systems; Point to Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 3: Multipoint Multimedia Wireless System in 40,5 GHz to 43,5 GHz".

History

Document history		
V1.1.1	March 2005	Public Enquiry PE 20050701: 2005-03-02 to 2005-07-01