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Fixed Radio Systems; Multipoint Equipment and Antennas; Part 3: Multipoint Antennas

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Foreword

This final draft European Standard (EN) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM), and is now submitted for the Vote phase of the ETSI standards EN Approval Procedure.

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: "Harmonised Standard for access to radio spectrum";

Part 3: "Multipoint Antennas".

NOTE: Part 1 is no longer maintained and referenced in other parts of the series.

The present document includes requirements for antennas whether they are *integral* or *non-integral* (i.e. *dedicated* or *stand-alone* antennas).

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):	6 months after doa

Modal verbs terminology

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

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

Introduction

For the general background, rationale and structure of the present document see also the clause "Introduction" in ETSI EN 302 326-2 [i.4].

1 Scope

1.1 General

The present document is applicable to antennas (*stand-alone*, *dedicated* or *integral* antennas according to the definitions of terms in clause 3.1) used in Multipoint (MP) Digital Fixed Radio Systems (DFRS) (see note 1) intended for use in the frequency bands identified in ETSI EN 302 326-2 [i.4].

NOTE 1: Applications intended for offering in the bands 3,4 GHz to 3,8 GHz the option of Nomadic Wireless Access (NWA), according to the NWA definition in Recommendation ITU-R F.1399 [i.3], are also considered in the scope of the present document.

For Multipoint Fixed Radio Systems, antenna characteristics are not considered relevant to essential requirements under article 3.2 of Directive 2014/53/EU [i.1] (see note 2). Antenna characteristics in the present document are considered applicable whenever they are considered appropriate for the associated multipoint radio system.

NOTE 2: Rationale can be found in ETSI TR 101 506 [i.2].

1.2 Antenna types and operating frequency

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 has to be considered in network planning. A number of antenna options are defined in the present document.

Table 1 outlines the multipoint antenna types and their operating frequencies described in the present document.

NOTE: Antenna characteristics are not standardized at frequencies below 1 GHz.

Table 1: Antenna Types

Frequency Range (see note)	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 5,9 GHz, 5,9 GHz to 8,5 GHz and 8,5 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 and 40,5 GHZ to 43,5 GHz	Directional Sectored single beam Omnidirectional	Linear	The omnidirectional antennas may have a symmetric or asymmetric radiation pattern in the *elevation plane*.
NOTE: 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 ETSI EN 302 326-2 [i.4], although the applicability of these Fixed Service bands is at the discretion of the national administrations. Therefore, the present document applies only to those bands which are allocated to the Fixed Service and/or assigned by national regulations to MP applications on the date on which the EN was published.			

1.3 Profiles

The present document and associated ETSI EN 302 326-2 [i.4] for equipment and systems 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 is limited to certain combinations of attributes and these combinations of attributes are called "profiles":

- Equipment profiles.
- Antenna profiles.
- System profiles.

Annex A discusses Equipment, Antennas and System Profiles for multipoint systems in the scope of this multi-part deliverable.

2 References

2.1 Normative references

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

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

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

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

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

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

[3] Void.

[4] Void.

2.2 Informative references

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

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

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

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

[i.2] ETSI TR 101 506 (V2.1.1): "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements covering article 3.2 of Directive 2014/53/EU to Fixed Radio Systems".

[i.3] Recommendation ITU-R F.1399: "Vocabulary of terms for wireless access".

[i.4] ETSI EN 302 326-2 (V2.1.1): "Fixed Radio Systems; Multipoint Equipment and Antennas; Part 2: Harmonised Standard for access to radio spectrum".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms (see note) apply:

NOTE: For the correct understanding and application of the requirements in the present document, the definitions below are identified, when relevant, with the use of *italic characters* (e.g. *azimuth plane*).

antenna: part of the transmitting or receiving system 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 than 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.

dedicated antenna: antenna specifically designed for being attached to the radio equipment (i.e. with special mechanical fixing to the antenna port of the specific radio supplied), but can be separated from the equipment (typically for transport purpose) by using normal tools

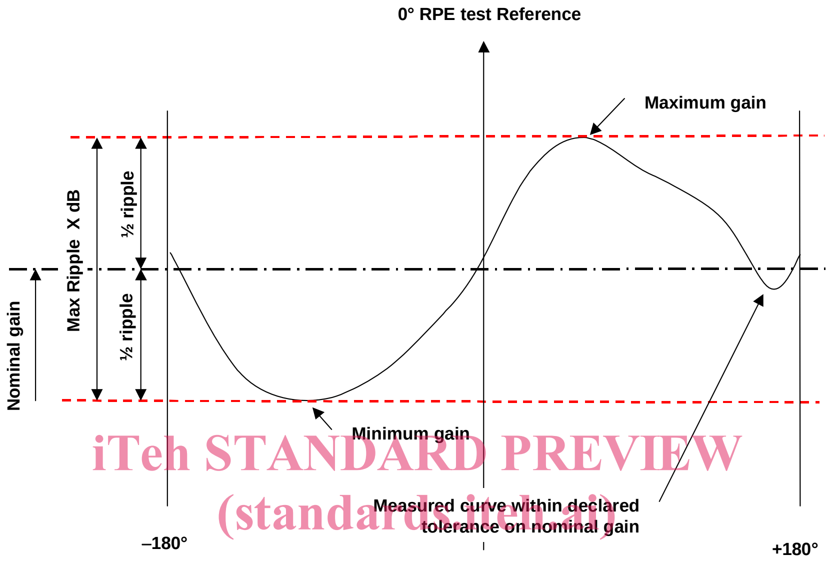
electrical tilt: angular shift in elevation of the direction of *maximum gain* of the antenna by a specific electrical design of the antenna

elevation plane: reference plane, orthogonal to the *azimuth plane*, to 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 centred to the azimuth *zero degree (0°) reference direction* (within each beam in multi-beam). For omnidirectional antennas, the *elevation plane* is not limited in the *azimuth plane* 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) maximum variance of the gain in the *azimuth plane* around the actual gain of the antenna under test



NOTE: Figure 1 shows the relationship between the X dB gain ripple, measured minimum and *maximum gain*s in the *azimuth plane*, and the declared *nominal gain* and *gain tolerance* of an omnidirectional antenna.

Figure 1: Gain ripple for an omnidirectional antenna

gain tolerance: tolerance of the *nominal gain*, as declared by the supplier according to the principles shown in figures 1 and 2

integral (integrated) antenna: antenna which is declared as part of the radio equipment by the manufacturer; it is not physically separable from the equipment

isotropic radiator: hypothetical, lossless antenna with homogenous 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: highest gain (in any direction) of the antenna under test

mechanical tilt: angular shift in the *elevation plane* in the direction of *maximum gain* of the antenna when modifying the physical mounting of the antenna

Nomadic Wireless Access (NWA): "Wireless access" application in which the location of the "end-user termination" may be in different places but is stationary while in use

NOTE: See Recommendation ITU-R F.1399 [i.3].

nominal gain: gain declared by the supplier as a basis for the gain assessment:

- **For directional antennas:** it is related to the *maximum gain* through the *gain tolerance*.
- **For sectorial antennas:** the supplier should make a declaration of the gain for the antenna, together with maximum *gain tolerance* that should include the minimum gain within the declared sector. The gain of the antenna, as measured, should not, therefore, exceed the declared gain at the declared upper *gain tolerance* limit, nor should it be lower than the nominal gain at the declared lower *gain tolerance* limit (see figure 2).
- **For omnidirectional antennas:** it refers to the mean value of the gain ripple as shown in figure 1.

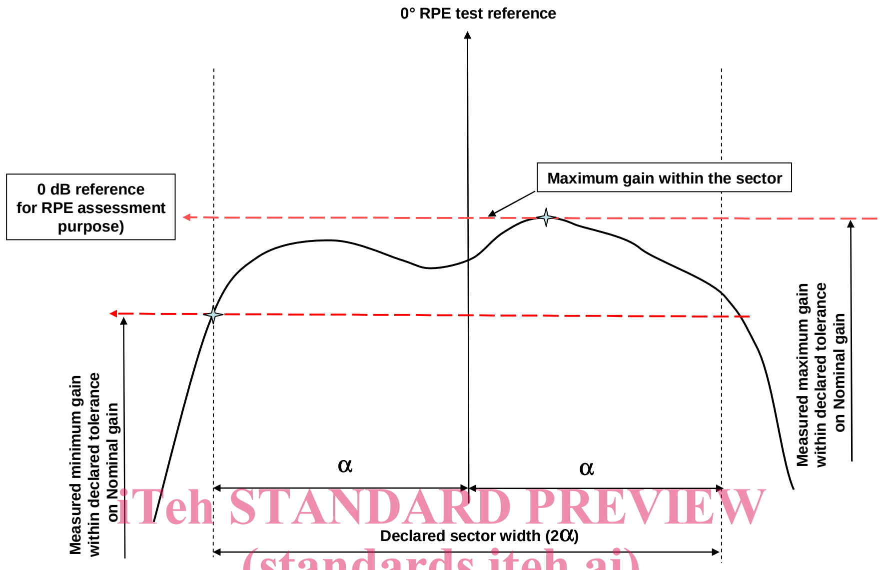


Figure 2: Gain ripple for a sectored antenna

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 (0°) reference direction*

Radiation Pattern Envelope (RPE): envelope of the radiation pattern

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°, defined by the manufacturer in relation to the mechanical characteristics of the antenna and used as reference for every beam RPE (applicable only to multi-beam antennas)

Repeater Station (RS): radio station providing the connection by 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: angle of coverage in *azimuth plane* of a sectored antenna, defined as 2α° in the present document as 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.

stand-alone antenna: antenna designed independently from the fixed radio equipment, by the same or a different manufacturer and connected to the radio equipment in the field by standard cables and waveguides

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

Zero dB gain reference (*azimuth* and *elevation planes*):

- **For directional (DN) antennas:** corresponds to the *maximum gain* of the antenna. It is equal to the gain in the direction of the boresight (a term not used in the present document).
- **For sectored single beam antennas (SS):** corresponds to the *maximum gain* of the antenna within the declared sector (as in figure 2).
- **For sectored multi-beam antennas (MS):** corresponds to the *maximum gain* of the antenna within each beam (as in figure 2). It should therefore be noted that the multiple beams may have different zero dB gain references.
- **For omnidirectional antennas (OD):** corresponds to 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 correspond to the gain in the *zero degree(0°) reference direction*.

Zero degree (0°) reference direction: direction used as the reference direction for the RPEs

NOTE 1: It is generally identified by the reference to the technical description for actual antennas for testing and deployment purposes and is declared by the manufacturer. It has a different geometrical relationship with the actual antenna type considered as follows:

- **For directional (DN) antennas:** corresponds to the direction of *maximum gain* in both axes of the antenna. It is equivalent to the boresight direction (term not used in the present document).
- **For sectored single beam antennas (SS):** the direction which, in the *azimuth plane*, is the centre of the declared *sector angle* and, in the *elevation plane*, corresponds to the direction of the *maximum gain*, nominally coincident to the *azimuth plane* intersection. (see figure 2 and note 2).
- **For sectored multi-beam antennas (MS):** corresponds, in the *azimuth plane*, to the *zero degree reference direction*; it 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 2). It should therefore be noted that the multiple beams may have different *zero degree reference directions*.
- **For CS omnidirectional antennas (OD):** the *zero degree reference direction* for this omnidirectional antenna type 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 2).
- **For NWA TS omnidirectional antennas (ODT):** *the zero degree reference direction* for this omnidirectional antenna type is, in principle, not defined in any plane (i.e. only a 0° reference for actual test report should be identified, for each plane, according figure 2).

NOTE 2: In practical tests, in particular for sector and CS 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 *zero (0°) degree reference direction* in *elevation plane* even if actual slightly higher gain might be experienced in a slightly 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
α	Alpha (= half of the sector angle)
dB	deciBel
dBi	deciBels relative to an isotropic source