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**Fixed Radio Systems;
Multipoint Equipment and Antennas;
Part 2: Harmonised Standard for access to radio spectrum**

Reference

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Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU 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.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in Table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

The present document covers characteristics and requirements for fixed multipoint radio equipment 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 2 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NOTE: Part 1 is no longer maintained and referenced in other parts of the series.

National transposition dates	
Date of adoption of this EN:	30 August 2021
Date of latest announcement of this EN (doa):	30 November 2021
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 May 2022
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Modal verbs terminology

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Introduction

The present document defines the essential characteristics for multipoint radio equipment and up to 43,5 GHz to comply with article 3.2 of Directive 2014/53/EU [i.1].

For the purpose of the present document, multipoint radio systems can be considered as radio systems which interconnect a number of fixed stations (usually more than two). The topology of the systems may be Point-to-MultiPoint (P-MP), or MultiPoint-to-MultiPoint (MP-MP), known as "Mesh".

Depending on the application, MultiPoint Systems can be seen either as "Fixed Wireless Access" (FWA) systems to grant multiple access to different services with a variety of bit rates, or as "infrastructure" or "backhaul" applications when different stations in a network will be connected to support, e.g. duplex mobile telephony.

Either as narrowband or wideband system MultiPoint technology facilitates access to public and private networks (PSTN, Internet, PDN, etc.) to connect residential and business subscribers in urban, suburban and rural areas.

Access and infrastructure applications can be supported simultaneously.

In order to (technically) cover different market and network requirements, with an appropriate balance of performance to cost and effective use of the radio spectrum, the present document, together with ETSI EN 302 326-3 [i.2], offers a number of radio equipment types and antennas alternatives (integral or dedicated antennas).

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 characteristics are not relevant for access to radio spectrum of MP fixed radio systems (see technical description in ETSI TR 101 506 [i.6]). For information, the most common types of antennas are standardized in Part 3 of this multi-part deliverable [i.2].

The applicability of this whole multi-part deliverable to MP equipment is governed by the definition of a number of equipment/system profiles that define the set of consistent requirements to which equipment would comply.

For compliance purposes, a specific type of equipment needs to be identified by an Equipment Classification (EqC) coherent set, as specified in annex C.

Based on this Equipment Classification, the appropriate clauses of the present document have to be applied.

The present document introduces new technical features compared to the previous version in terms of RX intermodulation requirements and ATPC functionality, mandatory for managing the different CS/RS link lengths where the system has to operate as intended. In addition, it covers equipment operating in the band 40,5 GHz to 43,5 GHz frequency band, previously separated and handled covered by ETSI EN 301 997-2 [i.27], under the regime of Directive 1999/5/EC [i.39].

For more background information on the antenna parameters, not relevant to article 3.2 of Directive 2014/53/EU [i.1], see ETSI EN 302 326-3 [i.2].

Following annexes are embedded in the present document:

- Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU [i.1]
- Annex B (normative): Test report in relation to flexible systems applications
- Annex C (normative): Equipment classification (EqC) and system capacity
- Annex D (informative): Transmitter Radio Frequency Spectrum mask background for ATPC and/or RTPC implementation
- Annex E (informative): Overview of technology features of multipoint systems
- Annex F (informative): Frequency bands
- Annex G (informative): Summary Table of EqC subject to conformance declaration
- Annex H (informative): System architecture
- Annex I (informative): Mixed-mode operation
- Annex J (informative): Antennas
- Annex K (informative): Typical reference model for BER, MGBR and EMO
- Annex L (informative): Test interpretation and measurement uncertainty
- Annex M (informative): Bibliography
- Annex N (informative): Change History

1 Scope

The present document specifies technical characteristics and methods of measurements applicable to radio equipment used in MultiPoint (MP) Digital Fixed Radio Systems (DFRS) (see note 2) designed for use in the following sub-ranges (see note 3):

- 30 MHz to 1 GHz.
- 1 GHz to 3 GHz.
- 3 GHz to 11 GHz.
- 24,25 GHz to 29,5 GHz.
- 31,0 GHz to 33,4 GHz.
- 40,5 GHz to 43,5 GHz.

NOTE 1: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.1] is given in Annex A.

The present document is applicable to multipoint radio system equipment using any arbitrary access method. It applies to all equipment composing the MP systems, i.e. to Central Station (CS), Terminal Station (TS) and Repeater Station (RS).

Time Division Duplex (TDD) or Frequency Division Duplex (FDD or H-FDD) can be used on an equivalent basis.

Systems implementing an actual FH-CDMA access method with hopping period exceeding 400 ms are not considered within the scope of the present document.

NOTE 2: 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.14], are also considered in the scope of the present document.

NOTE 3: For more information on the applicable frequency bands, refer to Annex F.

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.

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

- [1] CEPT/ERC/REC 74-01 (2019): "Unwanted emissions in the spurious domain".
- [2] ETSI EN 301 390 (V1.3.1) (08-2013): "Fixed Radio Systems; Point-to-point and Multipoint Systems; Unwanted emissions in the spurious domain and receiver immunity limits at equipment/antenna port of Digital Fixed Radio Systems".
- [3] ETSI EN 301 126-2-1 (V1.1.1) (12-2000): "Fixed Radio Systems; Conformance testing; Part 2-1: Point-to-Multipoint equipment; Definitions and general requirements".

- [4] ETSI EN 301 126-2-2 (V1.1.1) (11-2000): "Fixed Radio Systems; Conformance testing; Part 2-2: Point-to-Multipoint equipment; Test procedures for FDMA systems".
- [5] ETSI EN 301 126-2-3 (V1.2.1) (11-2004): "Fixed Radio Systems; Conformance testing; Part 2-3: Point-to-Multipoint equipment; Test procedures for TDMA systems".
- [6] ETSI EN 301 126-2-4 (V1.1.1) (11-2000): "Fixed Radio Systems; Conformance testing; Part 2-4: Point-to-Multipoint equipment; Test procedures for FH-CDMA systems".
- [7] ETSI EN 301 126-2-5 (V1.1.1) (11-2000): "Fixed Radio Systems; Conformance testing; Part 2-5: Point-to-Multipoint equipment; Test procedures for DS-CDMA systems".
- [8] ETSI EN 301 126-2-6 (V1.1.1) (02-2002): "Fixed Radio Systems; Conformance testing; Part 2-6: Point-to-Multipoint equipment; Test procedures for Multi Carrier Time Division Multiple Access (MC-TDMA) systems".
- [9] ETSI EN 300 019-1-3 (V2.4.1) (04-2014): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations".
- [10] ETSI EN 300 019-1-4 (V2.2.1) (04-2014): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weatherprotected locations".

2.2 Informative references

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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 EN 302 326-3: "Fixed Radio Systems; Multipoint Equipment and Antennas; Part 3: Multipoint Antennas".
- [i.3] ITU Radio Regulations (2016).
- [i.4] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.5] ETSI EG 203 336 (V1.2.1): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".
- [i.6] ETSI TR 101 506 (V2.2.1): "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.7] Recommendation ITU-R SM.1539-1: "Variation of the boundary between the out-of-band and spurious domains required for the application of Recommendations ITU-R SM.1541 and ITU-R SM.329".
- [i.8] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

- [i.9] ETSI TR 102 215: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Recommended approach, and possible limits for measurement uncertainty for the measurement of radiated electromagnetic fields above 1 GHz".
- [i.10] ETSI TR 103 103 (V1.1.1): "Fixed Radio Systems; Point-to-point systems; ATPC, RTPC, Adaptive Modulation (mixed-mode) and Bandwidth Adaptive functionalities; Technical background and impact on deployment, link design and coordination".
- [i.11] ERC Report 25: "The European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz".
- [i.12] ETSI TR 101 274: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Point-to-multipoint DRRS in the access network: Overview of different access techniques".
- [i.13] Recommendation ITU-R F.746: "Radio-frequency arrangements for fixed service systems".
- [i.14] Recommendation ITU-R F.1399: "Vocabulary of terms for wireless access".
- [i.15] CEPT/ECC/DEC(05)01: "The use of the band 27.5-29.5 GHz by the Fixed Service and uncoordinated Earth stations of the Fixed-Satellite Service (Earth-to-space)".
- [i.16] CEPT/ERC/REC(01)02: "Preferred channel arrangement for digital fixed service systems operating in the frequency band 31.8 - 33.4 GHz".
- [i.17] CEPT/ECC/REC(04)05: "Guidelines for accommodation and assignment of multipoint Fixed Wireless Systems in frequency bands 3.4-3.6 GHz and 3.6-3.8 GHz".
- [i.18] CEPT/ECC/REC(11)01: "Guidelines for assignment of frequency blocks for fixed wireless systems in the bands 24.5-26.5 GHz, 27.5-29.5 GHz AND 31.8-33.4 GHz".
- [i.19] CEPT/ERC/REC 12-05: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.0 - 10.68 GHz".
- [i.20] CEPT/ERC/REC 12-08: "Harmonized radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3 600 MHz to 4 200 MHz".
- [i.21] CEPT/ERC/REC T/R 13-02: "Preferred channel arrangements for the fixed services in the range 22.0 - 29.5 GHz".
- [i.22] CEPT/ERC/REC 14-03: "Harmonized radio frequency channel arrangements for low and medium capacity systems in the band 3 400 MHz to 3 600 MHz".
- [i.23] CEPT/ECC/REC(02)02: "Channel arrangements for digital fixed service systems (point-to-point and point-to-multipoint) operating in the frequency band 31 - 31.3 GHz".
- [i.24] ETSI EG 202 306: "Transmission and Multiplexing (TM); Access networks for residential customers".
- [i.25] ETSI ETS 300 019 (all parts): "Equipment engineering; Environmental conditions and environmental tests for telecommunications equipment".
- [i.26] ETSI EN 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- [i.27] 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".
- [i.28] ETSI EN 301 126-3-2 (V1.2.1) (12-2003): "Fixed Radio Systems; Conformance testing; Part 3-2: Point-to-Multipoint antennas - Definitions, general requirements and test procedures".
- [i.29] Recommendation ITU-R P.525-4: "Calculation of free-space attenuation".

- [i.30] CEPT/ECC/REC(01)04: "Recommended guidelines for the accommodation and assignment of multimedia wireless systems (MWS) and point-to-point (P-P) fixed wireless systems in the frequency band 40.5 - 43.5 GHz".
- [i.31] Decision 2007/344/EC: "Commission Decision of 16 May 2007 on harmonised availability of information regarding spectrum use within the Community".
- [i.32] Directive (EU) 2015/1535 of the European Parliament and of the Council of 9 September 2015 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services.
- [i.33] Commission Implementing Decision (EU) 2019/784 of 14 May 2019 on the harmonisation of the 24,25-27,5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union.
- [i.34] Decision 2008/411/EC: "Commission Decision of 21 May 2008 on the harmonisation of the 3 400 - 3 800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community".
- [i.35] ECO Frequency Information System (EFIS).
- NOTE: Available at [ECO Frequency Information System \(cept.org\)](http://www.cept.org).
- [i.36] ECO Report 04: "Fixed Service in Europe Implementation Status".
- [i.37] Technical Regulation Information System (TRIS).
- NOTE: Available at <https://ec.europa.eu/growth/tools-databases/tris/en>.
- [i.38] ISO/IEC 7498-1: "Information technology -- Open Systems Interconnection -- Basic Reference Model: The Basic Model".
- [i.39] 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).

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

active antenna: antenna including one or more active electronic components that interact with the Radio Frequency (RF) signal as e.g. amplifier or diode

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

assigned band: frequency block or the aggregation of all RF channels assigned to a MP system

NOTE: The assigned band may consist also of several non-contiguous RF channels (see Figure 1).

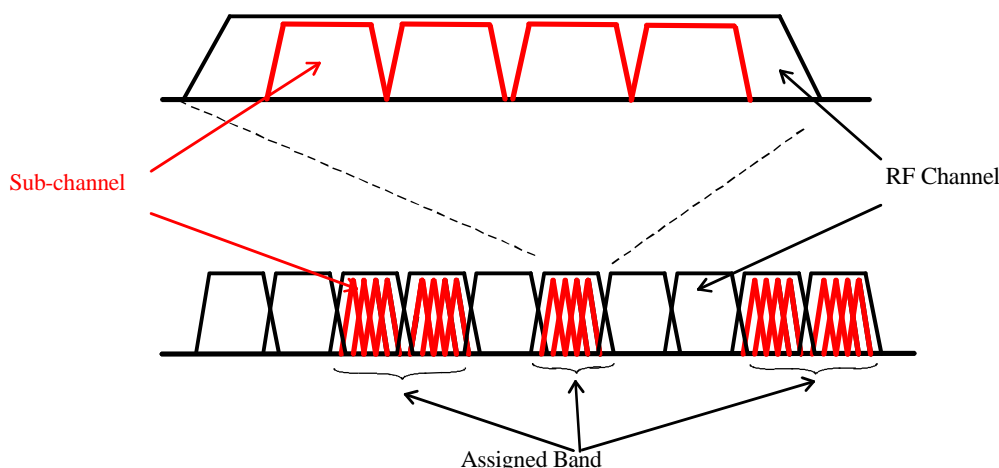


Figure 1: Relationship between "sub-channel", "RF channel" and "assigned band"

Automatic Transmit Power Control (ATPC): function implemented to offer a dynamic power control that delivers maximum power only during deep fading; in this way for most of the time the interference is reduced and the transmitter operates in a higher linearity mode

NOTE: When this function is used, the transmit power is dynamically changed with respect the propagation conditions. In principle, when ATPC is implemented, three different level of power may be identified:

- maximum available power (delivered only in conditions of deep fading);
- maximum nominal power (useable on a permanent basis when ATPC is disabled); it should be noted that this power is "nominal for the equipment" and is not to be confused with the "nominal link level" possibly set by the frequency co-ordinating body in the licensing conditions. The latter is achieved through passive RF attenuators or use of the RTPC type 1 function;
- minimum power (delivered in unfaded conditions).

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

Channel Separation (ChS): separation between the centre frequencies of neighbouring RF channels according Recommendation ITU-R F.746 [1.13] and used for adjacent channel interference requirements

NOTE 1: In some access methodologies the whole channel given to the system is subdivided in sub-channels for use by subsets of terminal stations; however also in this case the channel separation is still intended in the same way as the above definition (minimum continuous segment of bandwidth made available to the system, generally identified by the ChS occupancy of the CS).

NOTE 2: In this whole multi-part deliverable Channel Separation (ChS) is a free variable the value(s) of which the manufacturer declares. Limiting values of some other parameters which are requirements of the present document are expressed as functions of ChS. In general, MP licenses are given within a block of frequencies exclusively assigned to an operator; within that block, the licensing conditions provided by the responsible national administration may leave free use of any ChS or may place restrictions on which ChS values are permitted.

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)

downlink: direction of traffic flow from Central Station towards a Terminal Station (TS)

DS-CDMA maximum system loading: maximum number of 64 kbit/s signals or equivalent which can be transmitted and received by a single CS within a specified RF-bandwidth, fulfilling given performance and availability objectives in respect to fading conditions

Equipment Classification (EqC): multi-field classification which indicates the principal characteristics of a particular equipment within the scope of the present document and indicates which alternative consistent sets of requirements are applicable to that equipment

FDMA signal: signal comprising all permitted carriers in a channel at full system load

FH-CDMA Frequency Hopping (FH): spread spectrum technique whereby individual radio links are continually switched from one sub-channel to another

NOTE: Such links are not constrained to a single RF channel.

FH-CDMA hopping sequence: the activation sequence of sub-channels which a particular link follows

FH-CDMA slow frequency hopping: FH technique where the hopping period is larger than the symbol period

Frequency Hopping (FH): See **FH-CDMA Frequency Hopping (FH)**.

Full Load Condition (FLC): traffic conditions, as declared by manufacturer according the specific technology design (see notes 1 and 2), related to the maximum TX and RX spectrum utilization

NOTE 1: In some cases, Full Load Conditions may be different for TX and RX performances evaluation, as well as for CS, TS and RS equipment.

NOTE 2: For DS-CDMA access method see also definition of *DS-CDMA maximum system loading*.

gain (of an antenna): 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

gross bit rate: transmission bit rate over the air. In case of a transmitter working in burst mode, the gross bit rate is the instantaneous maximum transmission bit rate during the burst

NOTE: The gross bit rate has a unique relationship to the symbol rate through the implemented modulation format. In the case of OFDMA this relationship is unique when all OFDMA sub-carriers are in use. Gross bit rate for TDMA/OFDMA systems is the aggregate bit rate of all OFDMA sub-carriers transmitting simultaneously (e.g. for a TDMA/OFDMA system, in any single TDMA burst any single OFDMA TS may be dynamically assigned a subset of the OFDMA-sub-channels. Multiple TS are allowed to transmit at the same time on disjoint sets of OFDM-sub-carriers, so the MGBR is defined when all available OFDM-sub-carriers are in use at the same time).

hopping sequence: See **FH-CDMA hopping sequence**.

integral (or integrated) antenna: antenna which is declared as part of the radio equipment by the manufacturer

NOTE: Even when equipment with integral antenna is concerned, it may still be possible to separate the antenna from the equipment using a special tool. In such cases the assessment of the radio equipment against requirements of the present document and of the antenna against requirements of ETSI EN 302 326-3 [i.2] could be done separately by the actual manufacturer(s).

Maximum System Loading (MSL): (only defined for DS-CDMA systems), see **DS-CDMA maximum system loading**.

mixed-mode system: system having the capability for stations (CS or TS or RS) to operate on different modulation orders and/or switch dynamically between different modulation orders

NOTE: This capability may be used to improve deployment and capacity capabilities or to adaptively adjust for varying channel impairments, or to improve spectral efficiency by dynamically allocating transmission capacity. The switching between modulation orders may occur as frequently as appropriate to the system (e.g. on a per-burst or per-timeslot or per-carrier basis).

multi-carrier system: system where more than one modulated sub-carrier is radiated from the same transmitter

NOTE 1: A system that uses several transmitters sharing a single passive antenna is not considered as a multi-carrier system. Systems using FDM/OFDM modulation formats are also not considered multi-carrier unless more than one separate FDM/OFDM signal set is transmitted from the same transmitter.

NOTE 2: FDMA systems are intrinsically multicarrier, because any single sub-carrier may be easily discriminated at RF level (unlike OFDM modulations) and activated according to the traffic requirements. However, for the purpose of the present document, a FDMA system are also considered as a whole (fully loaded) single signal set (comprised of multiple carriers), unless more than one FDMA signal set is transmitted from the same transmitter.

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

NOTE: See Recommendation ITU-R F.1399 [i.14].

nominal output power: maximum output power of the Central Station (CS), Terminal Station (TS) or Repeater Station (RS) referred to point C' of Figure 2 under the Full Load Condition declared by the manufacturer

NOTE: See informative Annex D.

OFDM-sub-carrier: physical sub-division of the channel as determined by the manufacturer for OFDM and OFDMA systems

NOTE: The complete set of discrete sub-carriers is distributed throughout the assigned channel. With OFDM (and OFDMA), individual symbols are represented by all (or some) of the sub-carriers operating in concert rather than by individual sub-carriers.

Orthogonal Frequency Division Multiplexing (OFDM): transmission method where the transmitted signal is composed of multiple narrow band OFDM-sub-carriers, all modulated in parallel

Orthogonal Frequency Division Multiple Access (OFDMA): variant of OFDM where only a subset of the OFDM-sub-carriers are used by any single transmitter, allowing multiple transmitters to transmit at the same time on disjoint sets of OFDM-sub-carriers

NOTE: When used in conjunction with TDMA this applies burst by burst.

preset-mode (multi-format) system: system that can be statically configured or preset to operate on a permanent basis with one among several possible modulation orders

NOTE: Signals transmitted from any station use the single modulation order which has been preset. The pre-setting could be fixed, or if the licence permits, may be changed from time to time according to the operator's needs.

Radio Frequency channel (RF channel): partition of a radio frequency band which may be assigned by the authorities in accordance with CEPT, Recommendation ITU-Rs or national authorities regulations on channel arrangement

radome (of an antenna): cover of material which is nominally transparent to electromagnetic radiation and is intended to protect the antenna from the effects of its physical environment

reference signals: used for the transmission of framing, training and supervisory signals and do not carry user payload

NOTE: These signals may use a lower modulation order than that used for the transmission of user payload. The reference signals may, for example, have a short time duration (such as TDMA training bursts), occupy a small proportion of the available bandwidth (such as pilot signals) or, in principle, occupy a small proportion of the available power (such as might be the case in a CDMA system).

Remote Transmit Power Control (RTPC): facility whereby the transmitter output power can be controlled remotely

Remote Transmit Power Control type 1 (RTPC-1): RTPC which is used for the purpose of interference balancing

NOTE: However it does not control exclusively the output power of CSs.

Remote Transmit Power Control type 2 (RTPC-2): RTPC which is used for the purpose of intra-system power balancing of TSs close to the CS or for the shortest hops in Mesh architectures

Repeater Station (RS): radio station providing an intermediate 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.

single-mode system: system designed to operate with a single modulation order only

slow frequency hopping: See **FH-CDMA Slow frequency hopping**.

sub-channel: integer sub-division of one RF channel(s) as determined by the equipment manufacturer for subsets of terminal stations

NOTE: For OFDMA systems it is intended as the logical channel for transmission or control purposes, comprising a set of physical OFDM sub-carriers. The specific sub-carriers associated with a particular sub-channel are usually dynamically distributed throughout the whole channel bandwidth. The minimum number of sub-carriers that may comprise a sub-channel is dependent on the system design.

Symbol Frequency (SF): frequency of transmission of discrete symbols, each carrying one or more bits of information according to the modulation order of the system

system loading: total payload data rate on a single RF channel

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

uplink: direction of traffic flow from Terminal Station (TS) to Central Station (CS)

3.2 Symbols

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

ChS _{min}	Minimum practical channel separation for the given radio frequency arrangement
dB	deciBel
dBm	deciBel relative to 1 mW
f ₀	Actual carrier centre frequency
GHz	GigaHertz
Hz	Hertz
kbit/s	kilobit per second
kHz	kiloHertz
log ₁₀	logarithm to the base 10
MHz	MegaHertz
mW	milliWatt
ppm	parts per million
µS	microSecond

3.3 Abbreviations

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

ARQ	Automatic Repeat reQuest
ATM	Asynchronous Transfer Mode
ATPC	Automatic Transmit Power Control
BER	Bit Error Ratio
BS	Base Station
BW	BandWidth
CDMA	Code Division Multiple Access
CEPT	Conférence Européenne des administrations des Postes et des Télécommunications (European Conference of Postal and Telecommunications administrations)
CH	CHannel
ChS	Channel Separation
CS	Central Station
CW	Continuous Wave
DC	Direct Current
DFRS	Digital Fixed Radio Systems
DLC	Data Link Control
DM	OFDM (Orthogonal Frequency Division Multiplexing)
DQ	DQPSK (Differential Quadrature Phase Shift Keying)
DQPSK	Differential Quadrature Phase Shift Keying
DS-CDMA	Direct Sequence - Code Division Multiple Access
EC	European Community
ECC	Electronic Communication Committee of the CEPT

ECO	European Communication Office
EFIS	ECO Frequency Information System
EFTA	European Free Trade Association
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
EMO	Equivalent Modulation Order
EqC	Equipment Classification
EqC-ChS	EqC-Channel Separation
EqC-EMO	EqC-Equivalent Modulation Order
EqC-FR	EqC-Frequency Range
EqC-PET	EqC-Primary Equipment Type
EqC-SET	EqC-Secondary Equipment Type
EqC-STN	EqC-STatioN type
ERC	European Radiocommunications Committee of the CEPT, presently become ECC
EU	European Union
FDD	Frequency Division Duplex
FDM	Frequency Division Multiplexing
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FH-CDMA	Frequency Hopping - Code Division Multiple Access
FLC	Full Load Condition
FR	Frequency Range
FS	Fixed Service
FSK	Frequency Shift Keying
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
GBR	Gross Bit Rate
GM	GMSK (Gaussian Minimum Shift Keying)
GMSK	Gaussian Minimum Shift Keying
HC	High-Compatibility
H-FDD	Half duplex - Frequency Division Duplex
IF	Intermediate Frequency
IFbw	spectrum analyser (Intermediate Frequency) resolution bandwidth
IP	Internet Protocol
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
ITU-R	International Telecommunication Union - Radiocommunications standardization sector
LC	Low Compatibility
MA	OFDMA (Orthogonal Frequency Division Multiple Access)
MAC	Multiple Access Control
MGBR	Minimum Gross Bit Rate
MIB	Management Information Base
MO	Modulation Order
MP	MultiPoint
MP-MP	MultiPoint-to-MultiPoint
MSL	Maximum System Loading
MU	Measurement Uncertainty
NFD	Net Filter Discrimination
NNI	Network - Network Interface
NWA	Nomadic Wireless Access
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OR	Orthogonal coding
OSI	Open Systems Interconnection
PDN	Public Data Network
PET	Primary Equipment Type
P-MP	Point-to-MultiPoint
PR	Pseudo-Random coding
PSK	Phase-Shift Keying
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
QP	QPSK (Quadrature Phase Shift Keying)

QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RFC	Remote Frequency Control
RIS	Radio Interface Specifications
RPE	Radiation Performance Envelope
RS	Repeater Station
RSL	Receiver Signal Level
RTPC	Remote Transmit Power Control
RTPC-1	Type 1 RTPC
RTPC-2	Type 2 RTPC
RX	Receiver
S/I	Signal to Interference ratio
SET	Secondary Equipment Type
SF	Symbol Frequency
SNI	Service Node Interface
SNMP	Simple Network Management Protocol
ST	Station Type
STN	STation type
TBER	receiver BER Threshold
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TDMA/OFDMA	Time Division Multiple Access used in combination with Orthogonal Frequency Division Multiple Access
TE	Terminal Equipment
TRIS	Technical Regulation Information System
TS	Terminal Station
TX	Transmitter
UNI	User Network Interface

4 Framework for requirements

4.1 Generality

4.1.0 The "Manufacturer's declaration" concept

Fixed radio systems in the scope of the present document, besides being implemented in a wide range of frequency bands, are also designed for covering specific applications among a wide range of possible operational options.

Therefore, provided that the technical requirements are tailored for those specific operational options, the manufacturer should univocally identify (in his declaration) those covered by its equipment design, based on a selected Equipment Classification (EqC), in order to apply the relevant requirements.

In addition, some design parameters should be univocally known because indirectly correlated to the assessment method of other ones.

Therefore in the present document, whenever the words "(manufacturer's) declaration" or "declared (by the manufacturer)" are used, they are not related to any:

- Specific requirement, not elsewhere quantitatively indicated in the present document or in a normative reference.
- Performance criteria and/or tests, not elsewhere quantitatively indicated in the present document or in a normative reference.

Declarations, when required, are related only to:

- Operational options selected (e.g. available reference-modes and Full Load Conditions, FLC) for the equipment design among the many required in the EU/EEA market.

- Nominal values (e.g. Nominal TX power and ATPC/RTPC ranges and, when needed, antenna gain), when not regulated by any EC/ECC regulation (in such case, the regulatory limit is given in the present document and the declaration may possibly be needed only if not violating that limit).

4.1.1 Applicability of requirements

4.1.1.1 Generality

Guidance and description of the transmitter and receiver parameters relevant to "essential requirements" under article 3.2 of Directive 2014/53/EU [i.1] is given in ETSI EG 203 336 [i.5]; further justifications, specific for fixed radio systems, can be found in ETSI TR 101 506 [i.6].

In the following clauses, limits are required to be met at specific reference points of the system block diagram. Reference points and the system block diagram are set out in Figure 2.

All requirements are specified in clause 5 and are set considering that the equipment is a single transceiver with a common antenna port (basic 1+0 configuration). For more complex implementations (e.g. 1+1 protection either in frequency or hot-standby configuration) the additional losses in the branching network (e.g. additional circulators or power splitters/couplers) shall also be taken into account.

In the case of wide radio-frequency bands covering units and multirate/multiformat equipment, these specifications shall be met at any frequency and at any rate and/or format.

The traffic carried will be subject to certain minimum bit rate requirements as defined in clause C.3.

Unless otherwise stated, the requirements are intended for Fully Loaded Conditions (FLC) of the systems (according to the maximum loading provided by the equipment as declared by the manufacturer).

4.1.1.2 The Equipment Classification (EqC)

The requirements in the present document are strictly dependent on the adoption of specific definitions of a set of EqC that shall be declared by the manufacturer according to the terms in clause 3.1 and to Annex C provisions (summarized in clause C.4).

Equipment not fitting any of the set of EqC provided by Annex C, are not in the scope of the present document.

The Radio Frequency (RF) system block diagram is described in Annex H, showing the connection between two stations (Tx-Rx), together with the reference points to be used for the evaluation of parameters.

The present document considers many distinct types of equipment, and several ways in which they might be interconnected to form a network.

NOTE 1: For information, also several different antenna types can complement the equipment according its intended use; informative annex J gives background on some common antenna types.

However, in the present document, certain combinations of attributes are considered, which are called "profiles".

Profiles are defined for:

- Equipment profiles (normative, see clause C.4.1).
- Antenna profiles (informative, see clause J.2).
- System profiles (informative, see clause A.2 in ETSI EN 302 326-3 [i.2]).

Equipment requirements and relevant profiles are specified in Annex C.

NOTE 2: Information on antenna and system profiles are reported in ETSI EN 302 326-3 [i.2]; Some basic information can be found in the informative Annex J of present document.

Testing methods and conditions for assessing all requirements are specified in clause 6, where each clause number directly refers to a corresponding clause number in clause 5 (e.g. clause 6.3.6.2 refers to the ATPC test according the ATPC requirement in clause 5.3.6.2).

4.1.2 Asymmetric MP implementations

In general, P-MP systems will use corresponding multiplexing methods and multiple access methods in both CS-transmit and CS-receive directions, but no requirement prevents dissimilar methods being applied in the alternate directions. Likewise, different radio characteristics (such as different modulation methods, different modulation orders) may be employed in the alternate directions, potentially resulting in asymmetrical capacities and performance. Furthermore, some systems may be designed to operate with different channel separations in up- and down-link directions.

NOTE: Implementations, such as in some FDMA systems, where some TS may use a subset of the channels assigned to the CS are not regarded as asymmetric MP implementations from the point of view of the channel separation.

In all asymmetric cases, the provisions of the present document shall apply independently to the transmit and receive directions of a given equipment and a separate EqC shall be declared for each direction.

4.2 RF reference architecture

4.2.1 Reference block diagram

The RF system block diagram in Figure 2 shows the diagram of the RF transmitter part and the RF receiver part of the two stations.

The "Payload Processing" block contains the mapping functionalities required to convert the baseband interface data format to the raw data stream sent to the modulator or received by the demodulator. It can also convert the packet data protocols into the raw data stream.

The points shown are reference points only.

Where no payload processing function is present, the following pairs of points may coincide:

- X'_n and Z'.
- X_n and Z.

Where no branching network is present, the following pairs of points may coincide:

- B' and C'.
- B and C.

Where neither branching network nor feeder network is present, the following pairs of points may coincide:

- B' and D'.
- B and D.

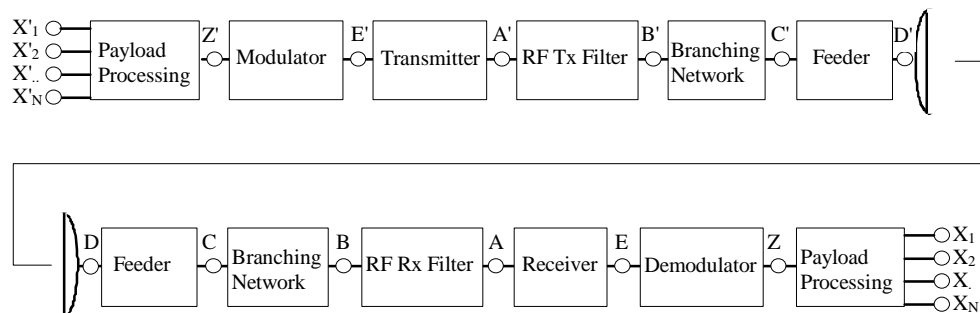


Figure 2: RF system block diagram

NOTE: The system represented by Figure 2 may be physically split between indoor and outdoor units. Their interconnection, commonly made by cable(s), is not represented by the interfaces shown in the diagram. Those units are seen as part of the whole system.

4.2.2 Measure reference points and system loading

All parameters are referred to reference point C' (Tx side) and C (Rx side), Figures H.1 and H.2 in informative Annex H show the generic Point-to-Point connection between multipoint stations.

The parameters shall be met under any system load conditions. Tests shall be made under the appropriate Full Load Conditions (as declared by the manufacturer according the definition given in clause 3.1) and with appropriate input signals presented at point Z' of the RF system block diagram, Figure 2.

When a MP systems utilizes an "*active antenna*" (i.e. antenna containing electronic components such as diodes), either as *integral* or *dedicated* antenna, the limits shall be respected with the equipment operating as in field (i.e. only radiated emission test shall be carried out).

5 Technical requirements specifications

5.1 General requirements

Clauses 5.3 and 5.4 describe general TX and RX requirements applicable to Multipoint equipment to be performed within the environmental profile described in clause 5.2.

5.2 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use, but as a minimum, shall be that specified in the test conditions contained in the present document. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

NOTE: Within the present document, the generic term of environmental profile is deemed to include any variation of the "external" conditions (e.g. climatic and external primary/secondary power supply sources feeding the equipment to be assessed) that might affect the system parameters relevant to the "essential requirements" of article 3.2 of Directive 2014/53/EU [i.1].

5.3 Transmitter requirements

5.3.1 General requirements

The specified transmitter characteristics shall be met with the appropriate base band signals applied at one of the reference points X' of Figure 2, as specified in text.

5.3.2 Transmitter output power

5.3.2.1 General

The transmitter output power is the value measured by a power meter or spectrum analyser, when the transmitter output is connected to a dummy load, or the equivalent level, derived from the radiated power, for equipment with *integral antenna*.

In case of burst transmission (e.g. TS for TDMA applications) the output power is intended as the mean power during the burst duration.

5.3.2.2 Transmitter maximum power and EIRP

At a worldwide level article 21 of the ITU Radio Regulations [i.3] defines sharing criteria with space services for a station in the fixed or mobile service. Specifically for fixed services the transmitter maximum power and EIRP are limited, as described below:

- Article 21.3 states that the Equivalent Isotropically Radiated Power (EIRP) shall not exceed +55 dBW (see note 1).
- Article 21.5 states that the power delivered by a transmitter to the antenna shall not exceed:
 - +13 dBW in frequency bands between 1 GHz and 10 GHz (see note 1).
 - +10 dBW in frequency bands above 10 GHz (see note 1).

NOTE 1: In different articles and footnotes of the ITU Radio Regulations [i.3] lower limits for specific bands or portions thereof may apply. Sometimes specific antenna elevation angles are requested. National restrictions may be present for the same purpose. These are generally managed by the licensing conditions.

In some frequency bands, or parts of frequency bands, EC or ECC Recommendation may define lower limits in terms of output power and/or EIRP (or output power and/or EIRP density and, in some cases, minimum antenna gain), in order to improve the compatibility with other radio services sharing these frequency bands with the FS. In those cases such limits are reported in the relevant frequency dependent annexes.

The above limits are considered values never to be exceeded, including , if applicable, ATPC/RTPC operational range.

NOTE 2: It is to be noted that an EIRP level requirement, when present, is directly addressed for assessment of equipment with integral antenna or dedicated antenna only; however, also equipment placed on the market without antennas are expected to refer to such limitations (e.g. defining the maximum associated antenna gain).

The test methods and conditions of transmitter maximum and EIRP are specified in clause 6.3.2.2.

5.3.2.3 Transmitter output power environmental variation

The *maximum nominal power* of the transmitter (see definition in clause 3.1) shall be declared by the manufacturer within the limitations given in clause 5.3.2.2.

The manufacturer shall also provide the procedure (e.g. through RTPC setting) for applying further limitations possibly given in the national licensing conditions.

In the case of EqC-PET = M, with N similar sub-carriers, the nominal output power for each sub-carrier would be 1/N of the total nominal output power emitted within the CS referred to point C'. In the case of N dissimilar sub-carriers, the relative power of each sub-carrier would depend upon the actual Symbol Frequencies (SF) and differ by a factor $10 \log (SF_1/SF_2)$. Therefore, under operational conditions, the output power of some sub-carriers may be greater than 1/N of the nominal output power.

For mixed-mode and preset-mode systems, the nominal power shall be declared for each EqC-EMO offered.

Within the environmental profile declared by the manufacturer for the intended limits of usage of the equipment, the variation of the nominal transmitter power of the carrier, or of each sub-carrier, when appropriate, shall remain within the limits given in Table 1.

Table 1: Power variation when operating within the declared environmental conditions

Frequency Range	Power variation
Below 11,00 GHz	±2 dB
24,25 GHz to 43,50 GHz	±3 dB

Environmental parameters to be considered shall be selected according the provisions specified in clause 6.2.

The test methods and conditions of Transmitter output power environmental variation are specified in clause 6.3.2.2.

5.3.3 Transmitter Radio Frequency tolerance

Frequency tolerance is defined in article 1.151 of the ITU Radio Regulations [i.3] as "The maximum permissible departure by the centre frequency of the frequency band occupied by an emission from the assigned frequency".

When operating in the environmental profile declared by the manufacturer, the maximum permitted Transmitter Radio Frequency tolerance shall not exceed the limits shown in Table 2.

Table 2: Maximum Transmitter Radio Frequency tolerance

Frequency Range (EqC-FR)	Frequency tolerance
All cases below 11 GHz	± 20 ppm
All cases equal to or above 24 GHz	± 15 ppm

The test methods and conditions of Transmitter Radio Frequency tolerance are specified in clause 6.3.3.

5.3.4 Transmitter Radio Frequency spectrum mask and emissions

5.3.4.1 Transmitter Radio Frequency spectrum mask

The Transmitter Radio Frequency spectrum density mask is commonly defined as a limit, applicable within ± 250 % of the relevant ChS, which is not to be exceeded in any condition, including the Full Load Conditions, as declared by the manufacturer, with the maximum number of sub-carriers for the declared equipment type.

The transmitter Radio Frequency spectrum mask to which the equipment shall conform depends on the EqC identified by the manufacturer, as follows:

- Primary Equipment Type (EqC-PET), which shall be one of the following: T, D, H, O, M or F;
- Equivalent Modulation Order (EqC-EMO);
- Secondary Equipment Type (EqC-SET);
- Frequency Range (EqC-FR).

The relevant ChS is that defined by the actual channel separation(s) to which the system is designed (e.g. that defined by the CS in any P-MP system).

The equipment shall comply to the mask, with the output power setting at the nominal output power declared by the manufacturer.

In the case where the down-link (from CS to TS or RS and RS to TS) ChS is identical in size to the up-link (TS or RS to CS and TS to RS), i.e. a symmetric FDD assignment, the transmit output power density spectrum mask of the TS or RS shall comply with the mask defined for a CS for the same EqC-EMO and with homogeneous EqC PET.

In the case where the TS or RS radiates a subset of carriers required for CS full loading conditions (e.g. in a system identified with EqC-PET = M, F or O), the TS or RS, when radiating their maximum number of sub-carriers and with any permitted placement of sub-carriers within the channel, shall comply with the same mask as that defined for the CS. In this case, the appropriate declared TX Full Load Condition (see definition) will be used for the test.

For mixed-mode and preset-mode systems, the manufacturer shall declare which combination of EqC-EMOs the equipment generates during its dynamic operation. The output power of the different EqC-EMOs shall be set equal to the nominal transmitted output power declared by the manufacturer for each EqC-EMO. Each EqC-EMO shall be compliant with the relevant mask.

When ATPC and/or RTPC are implemented see also clause 5.3.6.

Spectrum analyser settings are to be used according to Table 11.

The transmitter Radio Frequency spectrum masks are defined by a number of corner points in the mask, between which the mask is linearly interpolated. The number of points varies according to the EqC-PET and EqC-EMO.

The frequency of each corner point is expressed in terms of F/ChS ratio, where F is the frequency offset from the carrier centre frequency (f_0) and ChS is the relevant Channel Separation (EqC-ChS); both terms in the same dimensional unit.

The 0 dB level shown on the transmitter Radio Frequency spectrum masks is the maximum of the modulated spectrum density excluding any residual of unmodulated carrier resulting from not ideal modulation process (see note).

A pseudo-randomized test sequence is applied at the appropriate base band input, implying that the spectrum itself is composed by a very large, but finished, number of lines. The mean value of the trace should be used to set the 0 dB reference, since the trace is affected by a noise-like uncertainty.

NOTE: For information, this is intended to avoid uncertainty due to the unmodulated spectral line that, due to non infinite isolation of the modulation circuits, might become visible at the carrier (or sub-carriers) centre frequency; its relative level, with respect to the 0 dB reference, is not relevant for the test itself.

The mask is related to the actual carrier centre frequency (f_0).

Figure 3 shows the general form of a transmitter Radio Frequency spectrum mask having N corner points.

Table 3 defines the values of the points corresponding to the spectrum mask that the equipment shall fulfill according to the EqC-PET and EqC-EMO classifications.

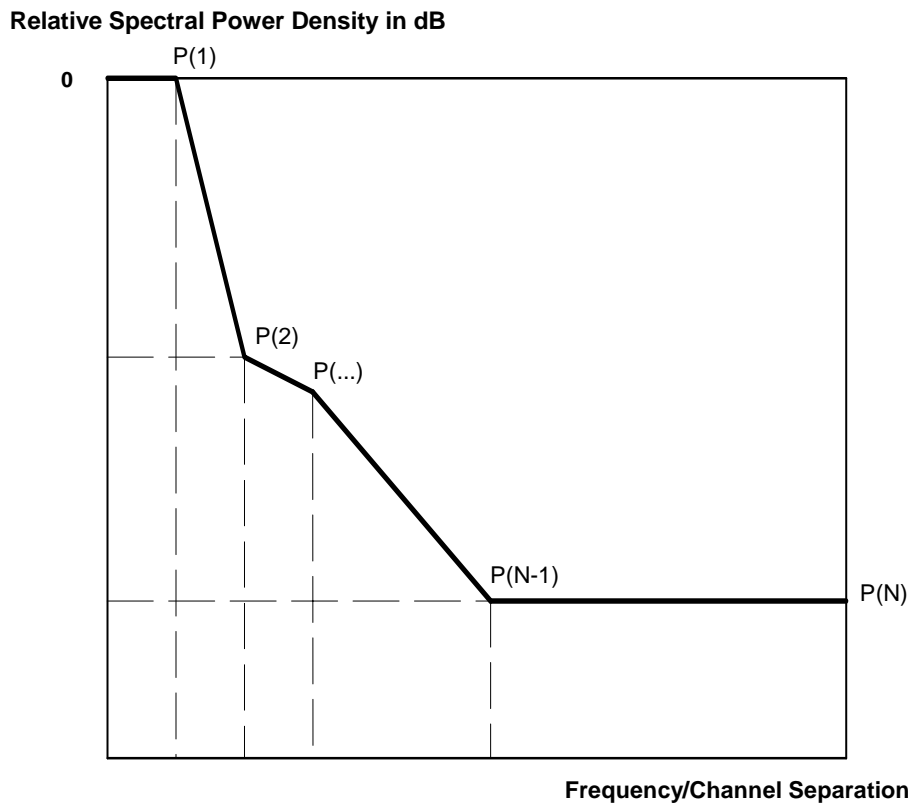


Figure 3: Transmitter Radio Frequency spectrum mask - Generalized Form

Table 3: Transmitter Radio Frequency Spectrum mask Reference corner Points

EqC-PET = T								
F/ChS ⇒	0	0,43	0,5	0,5	0,8	1,06	2	2,5
EqC-EMO ↓								
2:								
- For EqC-SET other than HC	0 dB	0 dB		-	-25 dB	-25 dB	-45 dB	-45 dB
- For EqC-SET = HC	0 dB	0 dB	-	-	-27 dB	-27 dB	-45 dB	-45 dB
4	0 dB	0 dB	-	-	-32 dB	-37 dB	-45 dB	-45 dB
6	0 dB	-	0 dB	-13 dB	-34 dB	-42 dB	-45 dB	-45 dB
EqC-PET = C or H								
F/ChS ⇒	0	0,5	0,8	1,0	1,5	2,5		
EqC-EMO ↓								
Not applicable	0 dB	0 dB	-25 dB	-25 dB	-45 dB	-45 dB		
EqC-PET = O								
F/ChS ⇒	0	0,5	0,5	0,71	1,06	2	2,5	
EqC-EMO ↓								
2	0 dB	0 dB	-8 dB	-25 dB	-27 dB	-50 dB	-50 dB	
4	0 dB	0 dB	-8 dB	-27 dB	-32 dB	-50 dB	-50 dB	
6	0 dB	0 dB	-8 dB	-32 dB	-38 dB	-50 dB	-50 dB	
EqC-PET = M								
F/ChS ⇒	0	0,5	0,5	0,54	0,64	1	2	2,5
EqC-EMO ↓								
2	0 dB	0 dB	-8 dB	-18 dB	-23 dB	-23 dB	-45 dB	-45 dB
4	0 dB	0 dB	-10 dB	-23 dB	-32 dB	-37 dB	-45 dB	-45 dB
6	0 dB	0 dB	-13 dB	-26 dB	-37 dB	-42 dB	-45 dB	-45 dB
EqC-PET = F								
F/ChS ⇒	0	0,5	0,5	0,6	0,85	1,5	2,5	
EqC-EMO ↓								
2	0 dB	0 dB	-23 dB	-25 dB	-25 dB	-45 dB	-45 dB	
3	0 dB	0 dB	-27 dB	-29 dB	-29 dB	-45 dB	-45 dB	
4 or 6	0 dB	0 dB	-31 dB	-33 dB	-33 dB	-45 dB	-45 dB	

With regard to Table 3, the following particular cases shall be taken into account:

- EqC-EMO = 1 option (not present in Table 3) may also be provided by mixed-mode systems only, among other more efficient EMOs; in such case the transmitter Radio Frequency spectrum mask requirement is equal to that of the EqC-EMO = 2 case.
- For systems where EqC-PET = M, the 0 dB level is relative to the maximum of the modulated spectrum of the sub-carrier with the lowest spectral density, disregarding residual unmodulated carriers which may be present due to modulation imperfections. When applying the spectrum mask, the spectral density of all sub-carriers shall be within 0 dB to +2 dB of the reference level as shown in the generic example in Figure 4.
- When a MP systems utilizes an *active antenna*, either *integral* or *dedicated* to the system, the limits shall be respected with the antenna connected as in field (i.e. only radiated emission test shall be carried out). See antenna definitions (*active*, *integral* and *dedicated*) in clause 3.1.

In Figure 4 example, if the power of the first carrier is K in dBm then the power of the second carrier in dBm is $(K + 10 \log 3 + 2)$ because it occupies 3 times the spectrum with respect of the first carrier and its power density is 2 dB higher. Consequently, the power of the third carrier in dBm is $(K + 10 \log 4)$ since the carrier occupies 4 times the spectrum of the first with equal power density.

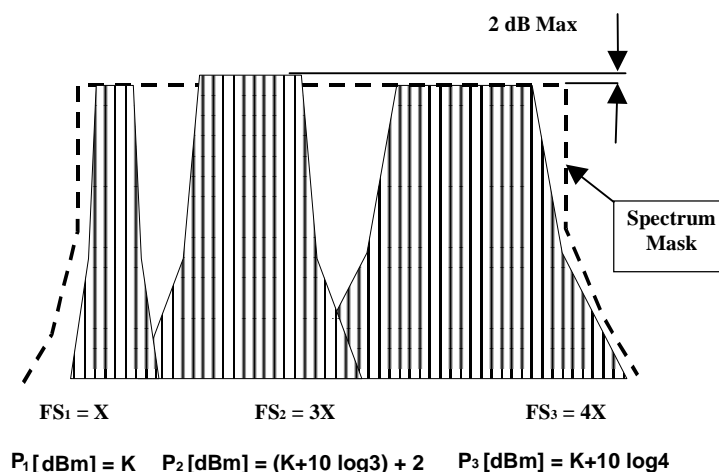


Figure 4: Example of equipment with EqC-PET = M, with three sub-carriers, each with a different Symbol Frequency (SF)

The test methods and conditions of transmitter Radio Frequency spectrum mask are specified in clause 6.3.4.1.

5.3.4.2 Transmitter discrete CW components exceeding the transmitter Radio Frequency spectrum mask limits

For systems operating above 1 GHz only, in the case where some CW components, other than the unmodulated residual of the carrier, exceed the transmitter Radio Frequency spectrum mask, specific limit is defined.

These spectral lines shall not:

- exceed the mask by a factor more than $\{10 \log (\text{ChS}_{\min}/\text{IFbw}) - 10\}$ dB (see clause 6.3);
- be spaced from each other in frequency by less than ChS_{\min} .

Where:

ChS_{\min} is the minimum practical channel separation for the given radio-frequency channel arrangement (see note):

- $\text{ChS}_{\min} = 25$ kHz for the operating frequency range from 30 MHz to 2 GHz;
- $\text{ChS}_{\min} = 500$ kHz for the operating frequency range from 2 GHz to 4 GHz;
- $\text{ChS}_{\min} = 1\,500$ kHz for the operating frequency range from 4 GHz to 11 GHz;
- $\text{ChS}_{\min} = 1\,750$ kHz for the operating frequency range from 24,25 GHz to 43,5 GHz.

IFbw is the recommended resolution bandwidth, expressed in kHz as given in Table 11.

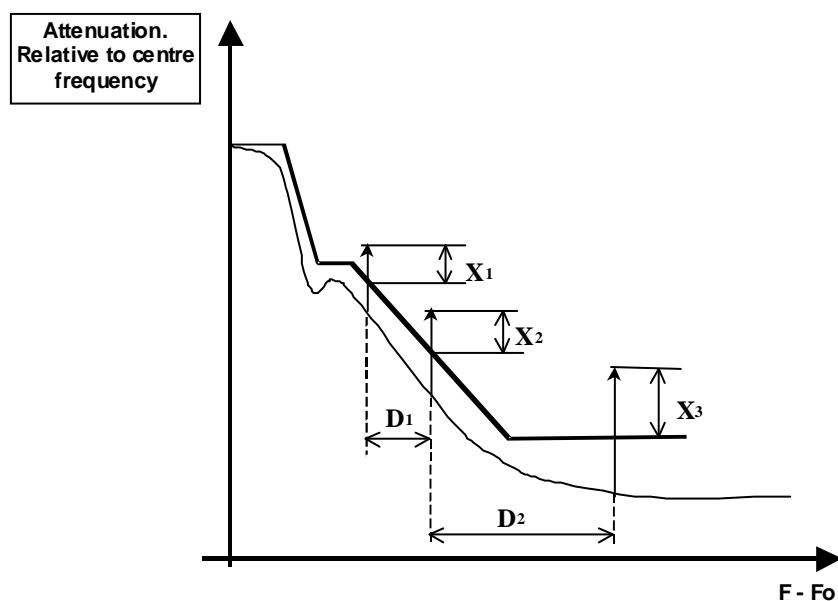
NOTE: Minimum ChS values are defined by the relevant CEPT/ECC (or CEPT/ERC) recommendations for the mentioned bands.

The following particular cases shall be taken into account:

In the case where the calculation above results in a negative value, only the Transmitter Radio Frequency spectrum mask applies:

- For mixed-mode and preset-mode systems, the specification for discrete spectral lines shall meet the specification independently for each EqC-EMO offered.
- When a MP system utilizes an *active antenna*, either *integral* or *dedicated* to the system, the limits shall be respected with the antenna connected as in field (i.e. only radiated emission test shall be carried out). See antenna definitions (*active*, *integral* and *dedicated*) in clause 3.1.

Figure 5 shows a typical example of this requirement.



$$X_1, X_2, X_3 \text{ [dB]} \leq 10\log(\text{CSmin}/\text{IF}_{\text{bw}}) - 10$$

$$D_1, D_2 \geq \text{CSmin}$$

Figure 5: CW lines exceeding the transmitter Radio Frequency spectrum mask (typical example)

The test methods and conditions of Transmitter discrete CW components exceeding the transmitter Radio Frequency spectrum mask limits are specified in clause 6.3.4.2.

5.3.5 Transmitter unwanted emissions in the spurious domain

It is necessary to limit transmitter unwanted emissions in the *spurious domain* from transmitters in order to keep under control the interference into other systems.

For Fixed Service (FS) systems, transmitter unwanted emissions in the spurious domain are defined by CEPT/ERC/REC 74-01 [1].

Limits are given in CEPT/ERC/REC 74-01 [1].

The *spurious domain* range is also established by CEPT/ERC/REC 74-01 [1], based on Recommendation ITU-R SM.1539-1 [i.7].

The equipment shall comply with the requirements under any ATPC and RTPC operating condition if needed.

For mixed-mode and preset-mode systems, each EqC-EMO offered shall independently meet the transmitter unwanted emissions in the spurious domain limits.

When a MP systems utilizes an *active antenna*, either *integral* or *dedicated* to the system, the limits shall be respected with the antenna connected as in field (i.e. only radiated emission test shall be carried out). See antenna definitions (*active*, *integral* and *dedicated*) in clause 3.1.

The test methods and conditions of Transmitter unwanted emissions in the spurious domain are specified in clause 6.3.5.

5.3.6 Transmitter power control (ATPC and RTPC)

5.3.6.1 General

ATPC and RTPC are common features in MP equipment. Both functionalities, allowing a reduction of transmitted power, are implemented in the transmitting chain (e.g. at IF level, RF level or both levels). Mixed configuration is possible, e.g.:

- ATPC is implemented only.
- RTPC is implemented only.
- ATPC + RTPC are both independently implemented by means of separate technical solutions functions.
- ATPC + RTPC are implemented acting on the same hardware block, with separate command functions (either hardware or software), but the combination of the two functionalities is limited by a maximum available power reduction, so that the value of each functionality is complementary to the value selected for the other.

NOTE: Information on implementation and use of ATPC and RTPC can be found in Annex D.

For mixed-mode and preset-mode systems, each EqC-EMO implemented in the equipment shall independently meet the specification for ATPC and RTPC.

5.3.6.2 Automatic Transmitter Power Control (ATPC)

The ATPC range shall be declared by the manufacturer.

An equipment, operating as intended shall, be designed with an ATPC range suitable to accommodate the range of link lengths between CS and TS (or equivalent when RS links are concerned) taking into account of the ATPC range and the possible amount of RTPC-2 range (see clause 5.3.6.3). The range of operational distance also to be declared by manufacturers, (see notes 1 and 2).

NOTE 1: The maximum foreseeable RSL in the corresponding receiver dynamic range, is based on the minimum link distance between the stations concerned (CS, RS and TS), as declared by manufacturer. It is calculated, on the basis of equipment parameters (i.e. maximum EIRP and RX antenna gain, also as declared by the manufacturer), using the corresponding free space propagation loss given in equation (4) of Recommendation ITU-R P.525-4 [i.29]. The note and the example in clause 5.4.3.4 (Receiver Dynamic range) provide the detailed description and example on the calculation to determine the maximum receiver level.

NOTE 2: It is assumed that the operational distance is indicated in the user's instruction, as well as the procedure of the RTPC-2 range setting.

The equipment shall comply with the requirements of transmitter Radio Frequency spectrum masks of Table 3 with ATPC operating in the range between maximum available power and maximum nominal power and within the whole attenuation range of RTPC-1 function, (if applicable). Attenuation of RTPC-2 function (if applicable) set to 0 dB.

NOTE 3: RTPC-1 and RTPC-2 are introduced in clause 5.3.6.3 and described in Annex D.

The test methods and conditions of Automatic Transmitter Power Control (ATPC) are specified in clause 6.3.6.2.

5.3.6.3 Remote Transmitter Power Control (RTPC)

According to Annex D, RTPC is employed for two distinct purposes:

- RTPC-1 which is for inter-operator interference balancing.
- RTPC-2 which is for intra-system power balancing of TSs close to the CS or for the shortest hops in Mesh architectures.

In case RTPC is implemented, the manufacturer shall specify in its declaration the RTPC-1 and/or RTPC-2 functionality together with the RTPC range and related accuracy.

NOTE: Any RTPC range subdivision is expected to be reflected in the user's instruction or data sheet.

The equipment shall comply with the requirements of transmitter Radio Frequency spectrum masks of Table 3 with ATPC operating in the range between maximum available power and maximum nominal power and within the RTPC-1 range (if applicable).

The test methods and conditions of Remote Transmitter Power Control (RTPC) are specified in clause 6.3.6.3.

5.3.7 Transmitter Remote Frequency Control (RFC)

RFC is commonly an optional (not mandatory) feature. When not implemented, there is no requirement.

Equipment with RFC will be subject to manufacturer's declaration of RFC ranges and related procedure description in the user's instructions for changing the frequency.

Any RFC setting procedure, for any EqC-EMO implemented in the equipment, shall not produce emissions outside the requirements of the appropriate previous and final centre frequencies' spectrum masks of Table 3.

The test methods and conditions of Automatic Remote Frequency Control (RFC) are specified in clause 6.3.7.

5.3.8 Transmitter Dynamic Change of Modulation Order

For mixed-mode systems, the dynamic transient behaviour of the transmitter, when a change from any EqC-EMO to any other occurs, shall meet the specification for the transmitter Radio Frequency spectrum mask (see clause 5.3.4.1) of the lowest applicable EqC-EMO and its associated CW spectral lines limit (see clause 5.3.4.2). Additionally, such transients shall not cause the specifications for spurious emissions to be exceeded.

The test methods and conditions of Transmitter dynamic change of modulation order are specified in clause 6.3.8.

5.4 Receiver requirements

5.4.1 General

The specified receiver characteristics shall be met at the appropriate base band output at the reference points X of Figure 2.

The receiver under test shall receive a test data signal, simulating traffic of all loads and with all representative services for generating the Full Load Conditions (FLC, see definition) as declared by manufacturer.

5.4.2 Receiver unwanted emissions in the spurious domain

The equipment shall comply with the limits given in CEPT/ERC/REC 74-01 [1].

The test methods and conditions of Receiver unwanted emissions in the spurious domain are specified in clause 6.4.2.

5.4.3 BER as a function of Receiver input Signal Level (RSL)

5.4.3.1 General

A Bit Error Ratio (BER) less than 10^{-6} shall be measured when the Receiver Signal Level (RSL) at the receiver input (reference point C of Figure 2 or the equivalent point for systems with integral antennas) is at a specified minimum level.

The definition of this requirement is dependent on the EqC system type as indicated in the following clauses.

For mixed-mode and preset-mode systems, the specification for minimum RSL shall be met independently for each EqC-EMO implemented in the equipment.

5.4.3.2 Single signal performance

The receiver Bit Error Ratio (BER) shall be $\leq 10^{-6}$ when the RSL is equal to the values of the Received Signal Level (RSL) threshold (T_{BER}) as given in Table 4, either as a number expressed in dBm, or as a function:

$$T_{BER}(A, B) = (A + 10 \log_{10}(B)) \text{ dBm}$$

where A is a constant and B is either GBR, the gross bit rate in Mbit/s or ChS, the channel separation in MHz, according to the specific requirement in Table 4.

Table 4: Limiting values of RSL to yield BER \leq than 10^{-6}

Primary Equipment Type (EqC-PET)	Frequency Range (EqC-FR)	Equivalent Modulation Order (EqC-EMO) (see note 1)	Secondary Equipment Type (EqC-SET)	RSL for BER $\leq 10^{-6}$ (dBm, Mbit/s) ($T_{BER}(A,B)$)	Note
D	Any	Not applicable	Any	-101	4
F	< 1 GHz	2	Any	$T_{BER}(-89, \text{GBR})$	
		3	Any	$T_{BER}(-86, \text{GBR})$	
		4	Any	$T_{BER}(-82, \text{GBR})$	
	1 GHz to 11 GHz	2	FA	$T_{BER}(-100,5, \text{GBR})$	
		3	FA	$T_{BER}(-99,5, \text{GBR})$	
		4	FA	$T_{BER}(-94,5, \text{GBR})$	
		2	FB	$T_{BER}(-89, \text{GBR})$	
		3	FB	$T_{BER}(-86, \text{GBR})$	
		4	FB	$T_{BER}(-82, \text{GBR})$	
	26 GHz, 28 GHz, 32 GHz and 42 GHz	2	Any	$T_{BER}(-95,5, \text{GBR})$	
		3	Any	$T_{BER}(-94,5, \text{GBR})$	
		4	Any	$T_{BER}(-89,5, \text{GBR})$	
26 GHz, 28 GHz and 42 GHz	6	Any	$T_{BER}(-83,5, \text{GBR})$		
H	< 11 GHz	Not applicable	Any	$T_{BER}(-87, \text{GBR})$	1
M	26 GHz, 28 GHz and 32 GHz	2	Any	$T_{BER}(-88, \text{GBR})$	3
		4	Any	$T_{BER}(-83, \text{GBR})$	3
		6	Any	$T_{BER}(-78,8, \text{GBR})$	3
T	< 1 GHz	2	QP	$T_{BER}(-89, \text{GBR})$	
			GM	$T_{BER}(-83, \text{GBR})$	
			DQ	$T_{BER}(-86, \text{GBR})$	
	1 GHz to 3 GHz	2	2 Mbits	-88	
			4 Mbits	-85	
			4	8 Mbits	-79
	3 GHz to 11 GHz	2	LC	$T_{BER}(-81, \text{GBR})$	
			HC	$T_{BER}(-92,5, \text{ChS})$	
			≥ 2 Mbits	$T_{BER}(-88,5, \text{ChS})$	
		4	< 2 Mbits (not LC or HC)	$T_{BER}(-89, \text{GBR})$	
			≥ 4 Mbits	$T_{BER}(-80,5, \text{ChS})$	
			< 4 Mbits	$T_{BER}(-81, \text{GBR})$	
	6	Any	$T_{BER}(-74,5, \text{ChS})$		
	26 GHz, 28 GHz and 32 GHz	2	HC	$T_{BER}(-91, \text{GBR})$	
			Not HC	$T_{BER}(-85, \text{GBR})$	
		4	Any	$T_{BER}(-79, \text{GBR})$	
	6	Any	$T_{BER}(-76, \text{GBR})$		
	42 GHz	2	HC	$T_{BER}(-89, \text{GBR})$	
Not HC			$T_{BER}(-83, \text{GBR})$		
4		Any	$T_{BER}(-77, \text{GBR})$		
6		Any	$T_{BER}(-74, \text{GBR})$		

Primary Equipment Type (EqC-PET)	Frequency Range (EqC-FR)	Equivalent Modulation Order (EqC-EMO) (see note 1)	Secondary Equipment Type (EqC-SET)	RSL for BER $\leq 10^{-6}$ (dBm, Mbit/s) ($T_{BER}(A,B)$)	Note
O	≤ 11 GHz	2	Any	$T_{BER}(-88,5, \text{ChS})$	2
		4	Any	$T_{BER}(-80,5, \text{ChS})$	2
		6	Any	$T_{BER}(-74,5, \text{ChS})$	2
NOTE 1: Mixed-mode systems may also provide EqC-EMO = 1 option, among other more efficient EMOs; for this case the requirement shall be 3 dB tighter than that for EqC-EMO = 2 case.					
NOTE 2: In the case of EqC PET = O / EqC SET = MA (true TDMA/OFDMA) systems, the above figures apply when all OFDMA sub-channels are in use and the above equations shall be modified as follows: <ul style="list-style-type: none"> ▪ the values for RSL in the table are increased by 1 dB; ▪ the effective bandwidth, ChS_{EFF} is substituted for ChS, (where $\text{ChS}_{\text{EFF}} = \text{ChS} \times n/m$; ▪ "m" specifies the total number of available OFDMA sub-channels and "n" specifies the number of active OFDMA sub-channels, received from one or more transmitters). 					
NOTE 3: The T_{BER} level is intended to be that of each sub-carrier. The effect of differential attenuation of the sub-carriers, due to rain intensity within the sector and/or ATPC shall be taken into account. Therefore the above requirements shall be met with the adjacent sub-carrier transmitter(s) operating at the maximum declared power level and the adjacent sub-carrier(s) RSL set to the higher differential power with respect to the sub-carrier under actual measurement, permitted by the system implementation, as declared by the manufacturer.					
NOTE 4: For EqC PET = D systems, these figures represent the situation for a single 64 kbit/s channel. The performance under maximum loaded conditions is specified in clause 5.4.3.3.					

The test methods and conditions of BER as a function of Receiver input Signal Level (RSL) for the single signal performance are specified in clause 6.4.3.2.

5.4.3.3 Performance with maximum system loading (EqC-PET = D only)

For PET = D equipment, the manufacturer shall declare a DS-CDMA Maximum System Loading (MSL) (see definition in clause 3.1). For equipment where the traffic capacity cannot be expressed in multiples of 64 kbit/s, the approximated value corresponding to the lower integer number of 64 kbit/s closest to the effective traffic should be used for the declaration.

EqC-PET = D may use orthogonal (EqC-SET = OR) or pseudo random (EqC-SET = PR) code sequences. For both, the BER for a single traffic channel will increase as the number of simultaneous traffic channels increases.

NOTE: SET = OR systems is less affected because of physical implementation; SET = PR systems is more quickly affected because all traffic channels interfere with each other. Thus the capacity of a SET = PR system will be less than that of a SET = OR system in a single cell environment but, when deployed in a frequency reuse environment, may provide similar network capacity.

The RSL levels at which the BER shall be lower than 10^{-6} depends on the channel separation (EqC-ChS), whether the coding is orthogonal or pseudo random (EqC-SET = OR or PR) and the declared MSL. The formulae for determining the limiting RSL level are shown in Table 5.

Table 5: Formulas for determining RSL for which BER is required to be lower than 10^{-6} for EqC-PET = D at various MSL values, channel separations and EqC-SET variants

Generalized EqC-ChS	EqC-SET	RSL value (dB) (see notes 1 and 2)
	OR	integer $(101,66 - 0,1895 \times q - 0,0606 \times q^2)$
PR	integer $(102,45 - 2,3211 \times q)$	
NOTE 1: $q = \text{MSL} / \text{EqC-ChS}$.		
NOTE 2: integer (x) means largest integer not exceeding x .		

The test methods and conditions of BER as a function of Receiver input Signal Level (RSL) for the maximum system loading are specified in clause 6.4.3.3.

5.4.3.4 Receiver Dynamic range

According ETSI EG 203 336 [i.5], the receiver dynamic range is defined as the range of the wanted input signal level over which a receiver functions at a specified performance level. The lower end of this range is normally the sensitivity of the receiver. The upper end of a receiver's dynamic range determines how strong a received signal can be before producing degradation due to overloading.

For the purpose of the present document, the receiver dynamic range is defined as the range of RSL from the RSL for $BER \leq 10^{-6}$ given in clauses 5.4.3.2 and 5.4.3.3, as appropriate, and the maximum foreseen RSL (see note), within which the system shall operate as intended.

Due to the need to maintain a stable RX power, independent from the different distances between the terminals and the central stations, the adoption of ATPC (see clause 5.3.6.2) is mandatory, with enough range to operate the system as intended up to the maximum foreseen RSL (see notes 1 and 2 in clause 5.3.6.2).

NOTE: For information, the RSL at the receiver reference point C (see Figure 2) is calculated from the following formula:

$$P_{RX} = P_{TX} + G_{TX} - L_{bf} + G_{RX} \quad (1)$$

Where L_{bf} is the free-space basic transmission loss defined in equation (4) of Recommendation ITU-R F.525-4 [i.29]

$$L_{bf}[\text{dB}] = 32,4 + 20\log(d)[\text{km}] + 20\log(f)[\text{MHz}] \quad (2)$$

Substituting (2) in (1), using the frequency (f) in GHz and the other system parameters of the systems under consideration, the maximum RSL, in clear sky condition, that the receiver withstands, operating as intended, by the receiver is determined by the following general equation:

$$P_{RXmax} = P_{TXmax} - TPC_{max} + G_{TX} - (92,4 + 20\log(d_{min})[\text{km}] + 20\log(f)[\text{GHz}]) + G_{RX} \quad (3)$$

Where:

- P_{TXmax} is the maximum TX level delivered at the highest modulation format by the corresponding transmitter station.
- TPC_{max} is the maximum combination of ATPC plus RTPC-2 ranges available for the highest modulation format on the corresponding transmitter station.
- G_{TX} and G_{RX} are the antenna gain of the corresponding transmitter and receiver stations; in case TS or RS can use different directional antenna sizes, the minimum of their gains is used.
- d_{min} is the minimum operating distance between TX and RX stations indicated by the manufacturer.
- P_{RXmax} is the maximum RX level, upper limit of dynamic range of the highest modulation format.

EXAMPLE: for a TS receiver with the following parameters:
 $f = 10,5$ GHz; $G_{TX} = 15$ dBi; $G_{RX} = 30$ dBi; $d_{min} = 50$ m; $P_{TXmax} + 30$ dBm; $ATPC_{max} 25$ dB and no RTPC-2
 $P_{RXmax} = 30 - 25 + 15 - (92,4 - 26 + 20,42) + 30 = -36,82$ dBm.

As such, the implementation of the ATPC function at TS, RS and CS keeps the receiver input signal level at a level where it is impossible to overload the receiver by wanted high signal. Thus, the dynamic range is related also to the ATPC functionality.

The maximum RSL test methods and conditions are specified in clause 6.4.3.4.

5.4.4 Receiver selectivity

5.4.4.0 Introduction

In general, the selectivity is the ability of the receiver to reduce the impact of interfering signals outside the wanted signal bandwidth. In the present document it is specified in terms of receiver sensitivity degradation in presence of:

- Signals with same spectral characteristics of the one received by the equipment under test (e.g. generated by an interfering CS using the same EqC-EMO and CH BW of TS equipment under test and vice versa when CS or RS are concerned), at level adjusted for a predefined C/I ratio in the adjacent channels.
- Generic unmodulated (CW interference) signal anywhere in a large portion of the spurious domain (blocking and spurious response requirement).

5.4.4.1 Receiver co-channel interference sensitivity

Receiver co-channel sensitivity is the ability of the receiver to receive a wanted signal in the presence of an uncorrelated unwanted signal, in the same RF channel of the equipment under test, operating with same set of EqC parameters.

The channel bandwidth and the adjacent channel frequency separation are considered to be that defined by the actual ChS used by the system (e.g. that defined by the CS in any P-MP system).

For mixed-mode systems (for applicable EqC-PET providing a number of EqC-EMO), the requirements shall be fulfilled for each EqC-EMO, using an interferer with identical EqC-EMO, setting the relative levels in accordance with Table 6.

For preset-mode systems (for applicable EqC-PET providing a number of EqC-EMO), each EqC-EMO mode shall fulfill the interference sensitivity requirements independently (as a separate single-mode system).

In the case of a TS operating on a selectable portion of such ChS (e.g. some TS in EqC-PET F or M, such as FDMA and MC-TDMA applications), the requirement shall be met for whichever portion of that channel the TS uses (e.g. for each operating sub-carrier). The requirement shall be met with an interfering signal, at maximum loading, occupying any portion of ChS, up to its whole; the S/I provided by Table 6 or the interference levels provided by Table 7, are intended to be evaluated in the portion of the channel that the TS is occupying.

The requirement for co-channel interference rejection, is the increase of the RSL threshold for $BER \leq 10^{-6}$ (as defined in clause 5.4.3.2) that shall not exceed 1 dB or 3 dB respectively, in the presence of two predefined levels of interference.

For equipment with EqC-PET = F, T, O, or M, when a wanted signal, with RSL enhanced by 1 dB and 3 dB with respect to the appropriate $BER \leq 10^{-6}$ entry in the BER/RSL threshold Table 4, is combined with an uncorrelated identically modulated unwanted signal with the RSL level as defined (as S/I ratio) by the appropriate 1 dB or 3 dB entries in Table 6, the BER with the wanted signals shall not exceed 10^{-6} . Where there is no entry for 3 dB degradation, no requirement exists.

For equipment with EqC-PET = H, for a system with all sub-channels in the RF channel occupied, each at a level exceeding, by 1 dB or 3 dB, the level specified in Table 4 for $BER \leq 10^{-6}$, the application of an additional uncorrelated co-channel interferer, at the levels indicated in Table 7, shall not cause the BER to exceed 10^{-6} . It is assumed the applied uncorrelated co-channel interferer carries the identical modulation of the equipment under test.

For equipment with EqC-PET = D and N signals (corresponding to MSL loading conditions) applied to the receiver each at a level greater than 1 dB or 3 dB compared to the relevant level derived from the formulas specified in Table 5, the addition of a uncorrelated co channel interferer with the same modulation at the relevant level in Table 7 shall not cause the BER to exceed 10^{-6} .

**Table 6: Receiver co-channel interference sensitivity limits for BER $\leq 10^{-6}$
for equipment with Primary Equipment Type F, T, O or M**

Primary Equipment Type (EqC-PET)	Frequency Range (EqC-FR)	Modulation Order (EqC-EMO) (see note 2)	Secondary Equipment Types (EqC-SET)	Signal to Interference level (S/I) (dB)	
				For 1 dB	For 3 dB
				Threshold Degradation	
F	< 1 GHz	2	Any	24	20
		3	Any	27	23
		4	Any	30	26
	1 GHz to 11 GHz	2	FA	17,5	13,5
		3	FA	19,5	15,5
		4	FA	26,5	22,5
	1 GHz to 3 GHz	2	FB	24	20
		3	FB	27	23
		4	FB	30	26
	3 GHz to 11 GHz	2	FB	22,5	18,5
		3	FB	24,5	20,5
		4	FB	31,5	27,5
	26 GHz, 28 GHz, 32 GHz and 42 GHz	2	Any	17,5	13,5
		3	Any	19,5	15,5
4		Any	26,5	22,5	
26 GHz and 28 GHz and 42 GHz	6	Any	38	34	
T, M	< 1 GHz	2	QP	19	13
		2	GM	14	12
		2	DQ	14	12
	1 GHz to 3 GHz	Any	Any	23	-
		2	HC	19	16
		2	Any excluding HC	23	-
	3 GHz to 11 GHz	4	Any	30	-
		6	Any	37	-
		2	HC	19	16
	26 GHz, 28 GHz and 42 GHz	2	Any excluding HC	23	19
		4	Any	30	26,5
6		Any	36	32,5	
O	≤ 11 GHz	2	Any	23	-
		4	Any	30	-
		6	Any	37	-

NOTE 1: For multi-carrier equipment, these limits shall be met for each sub-carrier.
NOTE 2: Mixed-mode systems may also provide EqC-EMO = 1 option, among other more efficient EMOs; for this case the requirement shall be 3 dB tighter than that for EqC-EMO = 2 case.

Table 7: Receiver co-channel interference sensitivity limits for BER $\leq 10^{-6}$ for equipment with Primary Equipment Type D or H

Nominal Access Method (EqC-PET)	Frequency Range (EqC-FR)	Channel Separation (MHz) (EqC-ChS)	Minimum RSL of unwanted signal (dBm)	
			For 1 dB	For 3 dB
			RSL degradation	
D	< 1 GHz	3,5	-112	-106
		5	-110	-104
		7	-109	-103
		10	-107	-101
		14	-106	-100
	1 GHz to 3 GHz	3,5	-112	-106
		7	-109	-103
		10,5	-108	-102
		14	-106	-100
	3 GHz to 11 GHz	3,5	-112	-106
		5	-110	-104
		7	-109	-103
		10	-107	-101
		14	-106	-100
	26 GHz and 28 GHz	3,5	-112	-106
		7	-109	-103
14		-106	-100	
28		-103	-97	
56		-100	-94	
H	≤ 11 GHz	1	-117	-111
		2	-114	-108
		3,5	-112	-106
		7	-109	-103
		14	-106	-100

NOTE: For Channel Separations (EqC-ChS) not included in the present table the S/I levels should be determined by linear interpolation (rounded down to the lower tenth of dB) between the two nearest values of EqC-ChS tabulated.

The test methods and conditions of Receiver co-channel interference sensitivity are specified in clause 6.4.4.1.

5.4.4.2 Receiver first adjacent channel interference sensitivity

Receiver first adjacent channel sensitivity is defined as the ability of the receiver to receive a wanted signal in the presence of an uncorrelated unwanted signal with a centre frequency selected to be at one channel separation (either below or above) from the equipment under test, operating with same set of EqC parameters and spectral characteristics.

The spectral characteristics of interfering signal should be the same of the system under test, channel separation is given in the specific (e.g. the ChS defined by the CS in any P-MP system).

For mixed-mode systems (for applicable EqC-PET providing a number of EqC-EMO), the applicable parameters shall be those of each EqC-EMO of the wanted signal (i.e. that of the receiving equipment for any of the EqC-EMO provided by the equipment as specified in Table 6), to be met with the same mixed-mode interfering signal operating with the same EqC-EMO.

For preset-mode systems (for applicable EqC-PET providing a number of EqC-EMO), each EqC-EMO mode shall meet the interference sensitivity requirements independently (as a separate single-mode system).

In the case of a TS operating on a selectable portion of such ChS (e.g. some TS in EqC–PET F or M, such as FDMA and MC-TDMA applications), the requirement shall be met for whichever portion of that channel the TS uses (e.g. for each operating sub-carrier). The requirement shall be met with an interfering signal occupying, at its relative FLC loading conditions, any portion of ChS, up to its whole; the S/I provided by Table 6 or the interference levels provided by Table 7, are intended to be evaluated in the portion of the channel that the TS is occupying. In such cases, for assessment purpose, unless the manufacturer will declare different worst case of victim/interfering signal configuration, the worst case is assumed to be that with victim and interferer occupying equal portions of channels closest to each other.

The requirement for the adjacent channel interference rejection, is that the degradation of the RSL threshold for $BER \leq 10^{-6}$ (as defined in clause 5.4.3.2) shall not exceed 1 dB or 3 dB respectively, in the presence of two predefined levels of interference.

The limits of maximum Carrier to Interference ratio (C/I) in case of first adjacent channel interference shall be as specified in Table 8 and Table 9 giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits.

Table 8: Limits of adjacent channel interference sensitivity for $BER \leq 10^{-6}$ for equipment with Primary Equipment Types F, T, O or M

Primary Equipment Type (EqC-PET)	Frequency Range (EqC-FR)	Modulation Order (EqC-EMO) (see note 2)	Sub-type (EqC-ST)	Signal to Interference level (S/I) (dB)	
				For 1 dB	For 3 dB
				Threshold Degradation	
F (see note 1)	< 1 GHz	2	Any	0	-4
		3	Any	0	-4
		4	Any	0	-4
	1 GHz to 11 GHz	2	FA	-15,5	-19,5
		3	FA	-13,5	-17,5
		4	FA	-6,5	-10,5
	1 GHz to 3 GHz	2	FB	-3	-7
		3	FB	-3	-7
		4	FB	-3	-7
	3 GHz to 11 GHz	2	FB	-10,5	-14,5
		3	FB	-8,5	-12,5
		4	FB	-1,5	-5,5
26 GHz, 28 GHz, 32 GHz and 42 GHz	2	Any	-15,5	-19,5	
	3	Any	-13,5	-17,5	
	4	Any	-6,5	-10,5	
26 GHz, 28 GHz and 42 GHz	6	Any	0	-4	
	2	Any	0	-4	
M (see note 3)	26 GHz, 28 GHz, 32 GHz and 42 GHz	4	Any	0	-4
		6	Any	0	-4
		2	Any	0	-4
T	< 1 GHz	2	QP	11	9
		2	GM	11	9
		2	DQ	11	9
	1 GHz to 3 GHz	Any	Any	0	Note 2
		2	HC	-10	-13
	3 GHz to 11 GHz	2, 4, 6	Not HC	0	-
		2	HC	-10	-13
	26 GHz, 28 GHz and 42 GHz	2	Not HC	0	-4
		4	Any	0	-4
	26 GHz, 28 GHz, 32 GHz and 42 GHz	6	Any	0	-4
Any		Any	0	-	
O	≤ 11 GHz	Any	Any	0	-
NOTE 1: The unwanted signal deviates by one ChS channel size.					
NOTE 2: Mixed-mode systems may also provide the EqC-EMO = 1 option, among other more efficient EMOs; for this case the requirement shall be 3 dB tighter than that for EqC-EMO = 2.					
NOTE 3: For multi-carrier equipment the limits shall be met for each sub-carrier.					

**Table 9: Limits of adjacent channel interference sensitivity for BER $\leq 10^{-6}$
for equipment with Primary Equipment Type D or H**

Nominal Access Method (EqC-PET)	Frequency Range (EqC-FR)	Channel Separation (MHz) (EqC-ChS) (see note)	Minimum RSL of unwanted signal (dBm)	
			For RSL degradation of	
			1 dB	3 dB
D	< 1 GHz	3,5	-96	-90
		5	-94	-88
		7	-93	-87
		10	-91	-85
		14	-90	-84
	1 GHz to 3 GHz	15	-89	-83
		3,5	-96	-90
		7	-93	-87
		10,5	-92	-88
	3 GHz to 11 GHz	14	-90	-84
		3,5	-96	-90
		5	-94	-88
		7	-93	-87
		10	-91	-85
	26 GHz and 28 GHz	10,5	-92	-88
		15	-89	-83
		3,5	-96	-90
		7	-93	-87
		14	-90	-84
		28	-87	-81
H	≤ 11 GHz	56	-84	-78
		112	-81	-75
		1	-101	-95
		2	-98	-92
		3,5	-96	-90
		7	-93	-87
		14	-90	-84

NOTE: For Channel Separations (EqC-ChS) not included in the present table the S/I levels should be determined by linear interpolation between the two closest values of EqC-ChS tabulated (rounded to the lower tenth of dB).

The test methods and conditions of Receiver adjacent-channel interference sensitivity are specified in clause 6.4.4.2.

5.4.4.3 Receiver blocking (CW spurious interference sensitivity)

This test is designed to identify specific frequencies at which the receiver may have a spurious response; e.g. image frequency, harmonics of the receive filter, etc.

The immunity of the receiver(s) to CW spurious interference is defined in ETSI EN 301 390 [2], clause 7.

For all EqC-PET, excluding D, receivers operating at the RSL specified in Table 4 for BER $\leq 10^{-6}$ threshold, interfered by a CW interferer, at a level of +30 dB related to the wanted signal and at any frequency up to the relevant upper and lower frequency limit derived from the table set out in clause 7.1 of ETSI EN 301 390 [2], but excluding frequencies either side of the wanted frequency by up to 500 % of the ChS, shall not result in a BER higher than 10^{-5} .

For PET = D equipment, the same requirement applies but with the appropriate reference RSL according to the relevant MSL loading conditions of the relevant EqC-SET and ChS derived from the formulas in Table 5.

The test methods and conditions of Receiver blocking are specified in clause 6.4.4.3.

5.4.4.4 Receiver radio-frequency intermodulation and Receiver second adjacent channel interference sensitivity

5.4.4.4.1 Requirement background

The receiver radio-frequency intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal, without exceeding a given degradation due to the presence of at least two unwanted signals, at frequencies F1 and F2, with a specific frequency relationship to the wanted signal frequency.

Second adjacent channel interference sensitivity is defined as the ability of the receiver to receive a wanted signal in the presence of an uncorrelated unwanted signal with a centre frequency which is two channels away (either below or above) from the equipment under test, operating with same set of EqC parameters.

Devices operating at the first and second channels adjacent to the operating channel of the equipment under test, with same bandwidth, will be chosen as interfering sources, to generate an intermodulation product exactly in the frequency band of the receiver under test. Adjacent channels are required to be selected within the tunable range of the equipment under test.

Such interference arrangement would produce a combined degradation derived from:

- First adjacent channel interference (which separate requirement is given in clause 5.4.4.2 and used as reference).
- Second adjacent channel interference.
- Intermodulation effects from first and second adjacent channels interference.

Therefore, a requirement in terms of overall degradation with respect to the first contribution will be effective as limit for the combination of the other two contributions.

5.4.4.4.2 Requirement limit

The requirement for radio-frequency intermodulation is that the increase of the RSL threshold for $BER \leq 10^{-6}$, as specified (for 1 dB degradation) in clause 5.4.4.2 for the case of the first adjacent channel interferer, does not exceed a total of 1,1 dB in presence of an additional second adjacent channel interfering signal (see note).

NOTE: This correspond to a combined effect of the two components of about 9 dB less than the effect of the first adjacent channel alone.

For mixed-mode systems (for applicable EqC–PET providing a number of EqC–EMO), the applicable requirements of each EqC-EMO of the wanted signal (i.e. the ones related to the receiving equipment for any of the EqC-EMO provided by the equipment as specified in Table 6), shall be met with the same mixed-mode interfering signal operating on the equivalent EqC-EMO.

For preset-mode systems, each mode shall meet the radio-frequency intermodulation requirements independently (as a separate single-mode system).

The channel bandwidth of the adjacent channels is the same used by the system under test (e.g. that defined by the CS in any P-MP system).

However, in the case of a TS operating on a selectable portion of such ChS (e.g. some TS in EqC–PET F or M, such as FDMA and MC-TDMA applications), the requirement shall be met for whichever portion of that channel the TS uses (e.g. for each operating sub-carrier). The requirement shall be met with the wanted and unwanted 1st adjacent in the same conditions for adjacent channel interference in clause 5.4.4.2 and the second interferer, at the same level of the first, occupying the whole channel.

The test methods and conditions of Receiver radio-frequency intermodulation and receiver second adjacent channel interference sensitivity are specified in clause 6.4.4.4.

6 Testing for conformance with technical requirements

6.1 General

Conditions for assessing all requirements and examples of testing methods are specified in this clause.

In the following clauses, limits are required to be met at specific reference points of the system block diagram identified in clause 4.2.1 (see note 1). Reference points and the system block diagram are set out in Figure 2.

NOTE 1: For information, the present document is directly applicable to fixed radio equipment without integral antennas, where a physical antenna connector is available and tests are made in conducted mode. Systems with integral antennas (not even detachable in factory), allow tests execution only in radiated mode.

In the case of wide radio-frequency bands covering units and multirate/multiformat equipment, these specifications shall be met at any frequency, at any rate/format. However the tests, required for generating an assessment test report and/or declaration of conformity, to fulfill any conformity assessment procedure with respect to the Directive 2014/53/EU [i.1], shall be carried-out in accordance with the principles set out in Annex B.

Unless otherwise stated, all requirements are intended for systems in the specific FLC conditions (see definition in clause 3.1) as declared by the manufacturer.

For defining the coherent set of essential test suites for conformity assessment, a number of declared EqC codes and other parameters are needed as declaration from the manufacturer according clause 4.1.1.2 (see note 2).

NOTE 2: Standing the considerable number of possibilities under the scope of the present document summarized in Table C.1 it is recommended to consider the production of a summary table, such as Table G.1 proposed in Informative Annex G, to be attached as header of the test documentation for the correct identification of the equipment/system profile by any interested third party.

For information on test interpretation and measurement uncertainty see Annex L.

6.2 Environmental conditions for testing

6.2.1 Generality

Tests defined in the present document shall be carried out at representative points within the boundary limits of the operational environmental profile defined by its intended use, which, as a minimum, shall be that specified in the test conditions contained in the present document.

The equipment, or the equipment-antenna assembly (in the case of systems with integral antenna, see note 3), shall comply with all the technical requirements of the present document at all times when operating within the limits of the operational environmental profile (see notes 1 and 2), including those limits of any primary/secondary power supply external to the equipment under assessment.

NOTE 1: The limits of the environmental climatic conditions, which are part of the environmental profile, may be determined by the environmental class for the intended use of the equipment according to the guidance given in clause 4.4 of ETSI EN 301 126-2-1 [3] (see note 5).

NOTE 2: The system under assessment, generically represented by the block diagram in Figure 2, may be physically split between indoor and outdoor units. Their interconnection, commonly made by cable(s), is not represented by the interfaces shown in the block diagram in Figure 2. Those units are considered as part of the whole system. The test should be carried out with separate environmental conditions for each part as defined in ETSI EN 301 126-2-1 [3], clause 4.3.

For all environmental profiles all required test, shall be carried out according the same principles and procedures (e.g. for temperature variation cycle and speed), for reference and extreme conditions (see note 4), set out in clause 4.4 of ETSI EN 301 126-2-1 [3] for climatic conditions and in Table 1 of ETSI EN 301 126-2-1 [3] (see notes 3 and 5) and clause 5.2 and note 1 in Table 10 of the present document for power supply conditions.

NOTE 3: For information; when integral DFRS antennas are used, and, even if not relevant for assessment under article 3.2 of the Directive 2014/53/EU [i.1], their directional phenomena, may be tested (e.g. according ETSI EN 302 326-3 [i.2]) at reference environmental conditions of the test field according to clause 4.1 of ETSI EN 301 126-3-2 [i.28]. It is intended that an integral equipment-antenna assembly which employs a radome meets the requirements of the present document with the radome in place.

NOTE 4: The requirement to test at reference or extreme conditions is set out in clauses 6.3 and 6.4 of the present document according to the principles set out in ETSI EN 301 126-2-1 [3].

NOTE 5: Clause 4.4 of ETSI EN 301 126-2-1 [3] contains non-specific (undated) references to other ETSI standards of the original ETSI ETS 300 019 series [i.25]; however, it is underlined that the clause 2 (References) of ETSI EN 301 126-2-1 [3] also stated that: "*A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number*". Therefore, for applying those guidelines, it is intended that they should refer to the relevant Part of ETSI EN 300 019 series [i.26] in force at the date of the equipment assessment according to the present document.

For testing equipment for compliance with technical requirements, ETSI EN 301 126-2-1 [3], ETSI EN 301 126-2-2 [4], ETSI EN 301 126-2-3 [5], ETSI EN 301 126-2-4 [6], ETSI EN 301 126-2-5 [7] and ETSI EN 301 126-2-6 [8] shall apply.

6.2.2 Minimum profile for indoor use

Class 3.2 (Partly temperature-controlled locations) of ETSI EN 300 019-1-3 [9], clause 4.2 shall apply.

6.2.3 Minimum profile for outdoor use

Class 4.1 (Non-weatherprotected locations) of ETSI EN 300 019-1-4 [10], clause 4.1 shall apply.

6.3 Transmitter requirements

6.3.1 General

6.3.1.1 Summary table for transmitter test conditions

Table 10: Transmitter test suites, clauses and conditions

Clause	Parameter	ETSI EN 301 126-2-x reference for the test methods	Climatic conditions (note 1)		Channels to be tested (note 2) B = Bottom M = Middle T = Top	Other specific conditions
			Ref	Extreme		
6.3.2	Transmitter output power					
6.3.2.2	Transmitter maximum power and EIRP	Table 12	X	X	BMT	
6.3.2.3	Transmitter output power environmental variation	Table 12	X	X	BMT	
6.3.3	Transmitter Radio Frequency tolerance	Table 13	X	X	BMT	
6.3.4	Transmitter Radio Frequency spectrum mask and emissions					

Clause	Parameter	ETSI EN 301 126-2-x reference for the test methods	Climatic conditions (note 1)		Channels to be tested (note 2) B = Bottom M = Middle T = Top	Other specific conditions
			Ref	Extreme		
6.3.4.1	Transmitter Radio Frequency spectrum mask	Table 13	X	X	BMT	
6.3.4.2	Transmitter discrete CW components exceeding the transmitter Radio Frequency spectrum masks limits	Table 15	X	X	BMT	
6.3.8	Transmitter dynamic Change of Modulation Order	Table 13	X	X	BMT	Required for mixed-mode systems only according clause 6.3.8 of the present document
6.3.5	Transmitter unwanted emissions in spurious domain	Table 16	X		BMT	The tests shall be carried-out with ATPC, if any, set to maximum available power and RTPC-1, if any, set at minimum attenuation. Actual test shall be limited to the practical frequency range set out by Table 1 of ERC/REC 74-01 [1]
6.3.6	Transmitter power control					
6.3.6.2	Automatic Transmitter Power Control (ATPC)	Table 13	X		M	
6.3.6.3	Remote Transmitter Power Control (RTPC)	Table 18	X		BMT	Shall be carried-out at three operating conditions (lowest, medium, and highest delivered power) of the RTPC power range and with ATPC (if any) set to maximum nominal power
6.3.7	Transmitter Remote Frequency Control (RFC)	Table 19	X		BMT	Tests shall be carried for RFC setting procedure for three frequencies (i.e. frequencies frequency settings from lower to centre, centre to higher and back to the lower frequency within the covered range). The test shall be carried-out at reference climatic conditions
NOTE 1: This refers to climatic conditions only; for other environmental and power supply conditions, please refer to ETSI EN 301 126-2-1 [3], which provides, for testing parameters and combined variations also of the power supply source, see Table 1 of ETSI EN 301 126-2-1 [3]; however, when DC regulators from the secondary sources (i.e. from conventional external battery supply) are integral part of the radio equipment, test can be done at nominal input voltage level.						
NOTE 2: Annex B provides more detailed information on channels to be tested, depending on the type of equipment.						

6.3.1.2 Spectrum analyser settings

Spectrum analyser settings to be used for spectral power density measurements are shown in Table 11.

Table 11: Spectrum analyser settings for RF transmitter Radio Frequency spectrum mask measurement

Channel Separation (CS) (MHz) (see note 2)	$0,003 < CS \leq 0,03$	$0,03 < CS \leq 0,3$	$0,3 < CS \leq 0,9$	$0,9 < CS \leq 12$	$12 < CS \leq 36$	$36 < CS \leq 150$	$CS > 150$
Centre frequency	fo (see note 1)						
Sweep width (MHz)	$\geq 5 \times CS$						$\geq 5 \times CS$ (for $CS < 500$) $\geq 3 \times CS + 1\,000$ (for $CS \geq 500$)
Scan time	Auto						
IF bandwidth (kHz)	1	3	10	30	100	300	2 000
Video bandwidth (kHz)	0,003	0,01	0,03	0,1	0,3	0,3	3
NOTE 1: It should be noted that, due to separate limits for spectral density and CW lines, IF resolution bandwidth is not essential for showing conformance. However, it should still be selected as the most appropriate for the system under test.							
NOTE 2: The settings proposed in this table are suitable when continuous emissions are concerned. When burst emissions are considered, the IF resolution and video bandwidths should be matched to the time characteristics (burst and frame durations) of the signal. The measurement of burst emission should also be carried out using the maximum-hold or gating functionality. General guidance information: in order to capture the burst with an adequate raise-time, the IFbw should be selected as $IFbw \cong k/Bd$ (where Bd is the burst duration and 'k' is a factor depending on the spectrum analyser, typically between 2 and 3), while the video filtering should be kept equal to IFbw. This approach might be adopted when burst duration is sensibly lower than the frame duration. In case Bd approaches the frame duration, the emissions tend to become continuous. For more complex access methodology, the IF and video bandwidths might be optimized taking into account all the time durations of the signal burst (e.g. mixed OFDMA/TDMA systems also in respect to the OFDMA symbols duration might be considered).							
NOTE 3: For FH-CDMA systems, the spectrum analyser setting is to be synchronized with the hopping sequence where practical.							

6.3.2 Transmitter output power

6.3.2.1 General

For mixed-mode and preset-mode systems, the nominal power shall be declared for each EqC-EMO offered.

6.3.2.2 Transmitter maximum power and EIRP

Test methods for the transmitter maximum power are referred to in Table 12.

Test shall be executed for the EqC-EMO associated to the highest nominal power.

Table 12: Test methods for the transmitter maximum power

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.1
T or O	ETSI EN 301 126-2-3 [5]	4.2.1
H	ETSI EN 301 126-2-4 [6]	4.2.1
D	ETSI EN 301 126-2-5 [7]	4.2.1
M	ETSI EN 301 126-2-6 [8]	4.2.1

The test is generally combined with that for the Output power environmental variation in clause 6.3.2.3.

NOTE: It is to be noted that EIRP level requirement, when present, is directly addressed for assessment of equipment with *integral antenna* or *dedicated antenna* only; however, also equipment placed on the market without antennas are expected to refer to such limitations (e.g. defining the maximum associated antenna gain).

6.3.2.3 Transmitter output power environmental variation

Test methods for the output power variation on the declared nominal level shall be as for maximum power in clause 6.3.2.2.

6.3.3 Transmitter Radio Frequency tolerance

Transmitter Radio Frequency tolerance shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 13: Test methods for the Transmitter Radio frequency tolerance

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.5
T or O	ETSI EN 301 126-2-3 [5]	4.2.5
H	ETSI EN 301 126-2-4 [6]	4.2.5
D	ETSI EN 301 126-2-5 [7]	4.2.5
M	ETSI EN 301 126-2-6 [8]	4.2.5

6.3.4 Transmitter Radio Frequency spectrum mask and emissions

6.3.4.1 Transmitter Radio Frequency spectrum mask

For mixed-mode and preset-mode systems, each EqC-EMO shall be compliant with the relevant mask.

EXAMPLE: A system offering 4 QAM, 16 QAM and 64 QAM which is compliant with the transmit mask requirement specification separately for each of the three EqC-EMOs.

Spectrum masks for single carrier systems (EqC-PET T, O, H and D) shall be measured in accordance with the following provisions of conformance standards according to the Primary Equipment Type.

Table 14: Test methods for the transmitter Radio Frequency Spectrum masks

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.6
T or O	ETSI EN 301 126-2-3 [5]	4.2.6
H	ETSI EN 301 126-2-4 [6]	4.2.6
D	ETSI EN 301 126-2-5 [7]	4.2.6
M	ETSI EN 301 126-2-6 [8]	4.2.6

The following test conditions should be applied when measuring the power spectrum density for systems where EqC-PET = M:

- the total output power level should be according to clause 5.3.2.3;
- all sub-carriers are modulated according to the Full Loading Conditions (FLC) (referred to Z' in Figure 2) declared by the manufacturer according definition in clause 3.1. The input signal shall be in accordance to the respective interfaces.

The following test conditions should be applied when measuring the power spectrum density for EqC-PET = F:

- The number (N) of carriers transmitted over one CS transceiver should correspond to the Full Loading Conditions (FLC) of the measured CS. The number N shall be declared by the manufacturer.

- The nominal output power for each carrier shall be $1/N$ of the total nominal output power of the equipment referred to point C' of the RF reference diagram, Figure 2.
- For systems operating in bands below 3 GHz, the capacity of the equipment shall be equally distributed among the N single carriers.
- For systems operating in bands above 3 GHz, all carriers are modulated according to the input bit rate declared by the manufacturer.

6.3.4.2 Transmitter Discrete CW components exceeding the transmitter Radio Frequency spectrum mask limit

Discrete (CW) spectral lines shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 15: Test methods for the Transmitter Discrete CW components exceeding the transmitter Radio Frequency spectrum mask limits

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.8
T or O	ETSI EN 301 126-2-3 [5]	4.2.8
H	ETSI EN 301 126-2-4 [6]	4.2.8
D	ETSI EN 301 126-2-5 [7]	4.2.8
M	ETSI EN 301 126-2-6 [8]	4.2.8

6.3.5 Transmitter unwanted emissions in the spurious domain

Transmitter unwanted emissions in the spurious domain shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 16: Test methods for the transmitter unwanted emissions in the spurious domain

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.9
T or O	ETSI EN 301 126-2-3 [5]	4.2.9
H	ETSI EN 301 126-2-4 [6]	4.2.9
D	ETSI EN 301 126-2-5 [7]	4.2.9
M	ETSI EN 301 126-2-6 [8]	4.2.9

The tests shall be carried out to produce the test report and/or declaration of conformity required (Directive 2014/53/EU [i.1]) with ATPC if applicable, set to maximum available power. The RTPC, if applicable, shall be set to give maximum available power.

Test shall be executed for the EqC-EMO associated to the highest nominal power.

The actual test shall be limited to the practical frequency ranges foreseen by Table 1 of CEPT/ERC/REC 74-01 [1].

The tests shall be carried out at reference climatic conditions according to ETSI EN 301 126-2-1 [3], clause 4.2, Table 1.

6.3.6 Transmitter power control (ATPC and RTPC)

6.3.6.1 General

NOTE: Void clause to preserve consistency of clause numbering between clauses 5 and 6.

6.3.6.2 Automatic Transmitter Power Control (ATPC)

Equipment with ATPC will be subject to the manufacturer's declaration of ATPC ranges.

ATPC shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 17: Test methods for the ATPC function requirements

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.3
T or O	ETSI EN 301 126-2-3 [5]	4.2.3
H	ETSI EN 301 126-2-4 [6]	4.2.3
D	ETSI EN 301 126-2-5 [7]	4.2.3
M	ETSI EN 301 126-2-6 [8]	4.2.3

Testing shall be carried out with transmitter power level corresponding to:

- ATPC set manually to a fixed value (as convenient for test purpose) for receiver requirements.
- ATPC set at maximum available power for transmitter requirements.

For the relevant power level definitions of ATPC operation see definition in clause 3.1, as well as for additional clarification on ATPC and RTPC requirements, see Annex D of the present document.

The test shall be carried out at reference climatic conditions according to ETSI EN 301 126-2-1 [3], clause 4.2, Table 1.

6.3.6.3 Remote Transmitter Power Control (RTPC)

RTPC shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 18: Test methods for the RTPC function requirements

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.4
T or O	ETSI EN 301 126-2-3 [5]	4.2.4
H	ETSI EN 301 126-2-4 [6]	4.2.4
D	ETSI EN 301 126-2-5 [7]	4.2.4
M	ETSI EN 301 126-2-6 [8]	4.2.4

Conformity assessment procedure with respect to the Directive 2014/53/EU [i.1], shall be conducted at reference and extreme climatic conditions with:

- RTPC-1 set manually to the maximum, middle and to the minimum values.
- RTPC-2 set at a maximum provided output power.
- ATPC set manually to maximum nominal power,

6.3.7 Transmitter Remote Frequency Control (RFC)

Applying the RFC setting procedure for those three frequencies (i.e. frequencies settings from lower end to centre frequency, centre frequency to higher end and back to the lower frequency in the covered range) the equipment shall not produce emissions outside the transmitter Radio Frequency spectrum masks for either of the previous or final centre radio frequency.

The test shall be carried out at reference climatic conditions according to ETSI EN 301 126-2-1 [3], clause 4.2, Table 1.

RFC shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 19: Test methods for the transmitter RFC function requirements

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.2.7
T or O	ETSI EN 301 126-2-3 [5]	4.2.7
H	ETSI EN 301 126-2-4 [6]	4.2.7
D	ETSI EN 301 126-2-5 [7]	4.2.7
M	ETSI EN 301 126-2-6 [8]	4.2.7

6.3.8 Transmitter dynamic Change of Modulation Order

The test applies for mixed-mode systems only.

It shall be carried out for transient behaviour with the spectrum analyser set to "max hold" mode.

The equipment shall be configured to operate with continuous modulation, switching at the maximum switching speed permitted by the system (e.g. within the same frame for a TDMA system), with equal duty cycle for all modulation orders, and with all training bursts or reference signals active as in normal operation.

The 0 dB reference mask shall be the maximum spectral density within the ChS, as specified in clause 5.3.4.1, with spectrum analyser trace in the "max-hold" condition.

6.4 Receiver requirements

6.4.1 General

Measurements shall be made under full load conditions (FLC as declared by the manufacturer according to definition in clause 3.1) and with appropriate input signals present at point C (or B when convenient) of the RF system block diagram, Figure 2.

Table 20: Receiver test suites clauses and conditions

Clause	Parameter (note 2)	ETSI EN 301 126-2-x reference and clause for test methods	Climatic conditions (note 1)		Channels to be tested (note 3) B = Bottom M = Middle T = Top	Other specific conditions (note 2)
			Ref	Extreme		
6.4.2	Receiver unwanted emissions in the spurious domain	Table 21	X		BMT	Actual test shall be limited to the frequency range specified by Table 1 of CEPT/ERC/REC 74-01 [1]
6.4.3	BER as a function of Receiver input Signal Level (RSL)					
6.4.3.2	Single signal performance	Table 22	X	X	BMT at Nominal M at Extreme	
6.4.3.3	Performance at maximum system loading (EqCPET = D only)	ETSI EN 301 126-2-5 [7], clauses 4.3.5.2.2 (TS→CS) or 4.3.5.2.4 (CS→TS)	X	X	BMT at Nominal M at Extreme	For systems with EqC-PET = D only
6.4.3.4	Receiver Dynamic range	See ATPC test in Table 10 and BER vs RSL in clauses 6.4.3.2 or 6.4.3.3 of the present document	X		M	
6.4.4	Receiver selectivity					
6.4.4.1	Receiver co-channel interference sensitivity	Table 23	X		M	
6.4.4.2	Receiver first adjacent channel interference sensitivity	Table 24	X		M	To be produced for the lower or for the upper frequency adjacent channel, arbitrarily selected by manufacturer
6.4.4.3	Receiver blocking (CW spurious interference sensitivity)	Table 25	X		M	Actual test shall be limited to the practical frequency range specified by clause 7.1 of ETSI EN 301 390 [2]
6.4.4.4	Receiver radio-frequency intermodulation and Receiver second adjacent channel interference sensitivity	Table 24	X		M	To be produced for the lower or for the upper frequency first and second adjacent channels, as selected for adjacent channel interference

NOTE 1: This refers to climatic conditions only; for other environmental and power supply conditions, please refer to ETSI EN 301 126-2-1 [3].

NOTE 2: All receiver test suite clauses are performed at nominal voltage only.

NOTE 3: Annex B provides more detailed information on channels to be tested, depending on the type of equipment.

6.4.2 Receiver unwanted emissions in the spurious domain

Receiver unwanted emissions in the spurious domain shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 21: Test methods for the receiver unwanted emissions in the spurious domain

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.3.2
T or O	ETSI EN 301 126-2-3 [5]	4.3.2
H	ETSI EN 301 126-2-4 [6]	4.3.2
D	ETSI EN 301 126-2-5 [7]	4.3.4
M	ETSI EN 301 126-2-6 [8]	4.3.2

The tests shall be carried out to produce the test report and/or declaration of conformity required (Directive 2014/53/EU [i.1] with ATPC if applicable), set to maximum available power. The RTPC, if applicable, shall be set at minimum attenuation. The actual test shall be limited to the frequency ranges foreseen by clause A.1 of ETSI EN 301 390 [2].

The tests shall be carried out at reference climatic conditions according to ETSI EN 301 126-2-1 [3], clause 4.2, Table 1.

6.4.3 BER as a function of Receiver input Signal Level (RSL)

6.4.3.1 General

NOTE: Void clause to preserve consistency of clause numbering between clauses 5 and 6.

6.4.3.2 Single signal performance

Minimum RSL under single signal conditions shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 22: Test methods for the minimum RSL

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.4.2
T or O	ETSI EN 301 126-2-3 [5]	4.4.2
H	ETSI EN 301 126-2-4 [6]	4.4.2
D	ETSI EN 301 126-2-5 [7]	4.3.5.2.1 and 4.3.5.2.3
M	ETSI EN 301 126-2-6 [8]	4.4.2

6.4.3.3 Performance at maximum system loading (EqC-PET = D only)

BER as a function of RSL for equipment with EqC- PET = D shall be measured in accordance with the provisions of ETSI EN 301 126-2-5 [7], clauses 4.3.5.2.2 or 4.3.5.2.4 for the appropriate station type.

6.4.3.4 Receiver dynamic range

According to the technical requirements specification (with RSL set according clause 5.4.3.4), the procedure for maximum foreseen RSL for the receiver dynamic range test is equivalent to that of BER vs RSL in clauses 6.4.3.2 or 6.4.3.3, as appropriate.

6.4.4 Receiver selectivity

6.4.4.1 Receiver co-channel interference sensitivity

For *fixed mode* or *preset-mode* systems, the co-channel interference specification shall be tested for all wanted modulation orders with interfering signals of the same modulation only.

For mixed-mode systems, the receiver co-channel interference sensitivity specification shall be met for all combinations of EqC-EMOs for the wanted and interfering signals.

Receiver co-channel interference sensitivity shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 23: Test methods for the receiver co-channel interference sensitivity

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.4.4.1
T or O	ETSI EN 301 126-2-3 [5]	4.4.4.1
H	ETSI EN 301 126-2-4 [6]	4.4.4.1
D	ETSI EN 301 126-2-5 [7]	4.3.6.1
M	ETSI EN 301 126-2-6 [8]	4.4.4.1

6.4.4.2 Receiver first adjacent channel interference sensitivity

For mixed-mode systems, the receiver first adjacent channel interference sensitivity requirement shall be met for all combinations of EqC-EMOs for the wanted and interfering signals. Each combination of EqC-EMOs shall fulfill the wanted EqC-EMO requirement. For test report purposes, the test shall be performed for all wanted EqC-EMO, but only with the lowest EqC-EMO modulation order interferer.

Receiver first adjacent channel interference sensitivity shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 24: Test methods for the receiver first adjacent channel interference sensitivity

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.4.4.2
T or O	ETSI EN 301 126-2-3 [5]	4.4.4.2
H	ETSI EN 301 126-2-4 [6]	4.4.4.2
D	ETSI EN 301 126-2-5 [7]	4.3.6.2
M	ETSI EN 301 126-2-6 [8]	4.4.4.2

NOTE: The adjacent channel interference test may be combined with the receiver radio-frequency intermodulation test (see clause 6.4.4.4).

6.4.4.3 Receiver blocking (CW spurious interference sensitivity)

CW spurious interference sensitivity shall be measured in accordance with the following provisions of conformance standards for the Primary Equipment Type.

Table 25: Test methods for the receiver blocking (CW spurious interference sensitivity)

Primary Equipment Type (EqC-PET)	Conformance testing standard	Conformance testing standard Clause number(s)
F	ETSI EN 301 126-2-2 [4]	4.4.4.3
T or O	ETSI EN 301 126-2-3 [5]	4.4.4.3
H	ETSI EN 301 126-2-4 [6]	4.4.4.3
D	ETSI EN 301 126-2-5 [7]	4.3.6.3
M	ETSI EN 301 126-2-6 [8]	4.4.4.3

The test shall be limited to the frequency ranges specified in clause 7.1 of ETSI EN 301 390 [2] and shall be carried-out at reference climatic conditions.

6.4.4.4 Receiver radio-frequency intermodulation and receiver second adjacent channel interference sensitivity

The test procedure is the same for that of adjacent channel interference (see clause 6.4.4.2) with the addition of a second, uncorrelated, interfering signal placed on the second adjacent channel at the same level and characteristics of the first adjacent channel.

NOTE: Receiver radio-frequency intermodulation test may be combined with the adjacent channel interference test (see clause 6.4.4.2).

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU 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.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in Table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 302 326-2					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Transmitter maximum power and EIRP	3.2	5.3.2.2	U	
2	Transmitter output power environmental variation	3.2	5.3.2.3	U	
3	Transmitter Radio Frequency tolerance	3.2	5.3.3	U	
4	Transmitter Radio Frequency spectrum mask	3.2	5.3.4.1	U	
5	Transmitter discrete (CW) components exceeding the transmitter Radio Frequency spectrum mask limits	3.2	5.3.4.2	U	
6	Transmitter unwanted emissions in the spurious domain	3.2	5.3.5	U	
7	Automatic Transmitter Power Control (ATPC)	3.2	5.3.6.2	C	Only applies if ATPC is implemented
8	Remote Transmitter Power Control (RTPC)	3.2	5.3.6.3	C	Only applies if RTPC is implemented
9	Transmitter Remote Frequency Control (RFC)	3.2	5.3.7	C	Only applies if RFC is implemented
10	Transmitter Dynamic Change of Modulation Order	3.2	5.3.8	U	
11	Receiver unwanted emissions in the spurious domain	3.2	5.4.2	U	
12	BER as a function of Receiver input Signal Level (RSL)	3.2	5.4.3	U	
13	Receiver Dynamic range	3.2	5.4.3.4	U	
14	Receiver co-channel interference sensitivity	3.2	5.4.4.1	U	
15	Receiver first adjacent channel interference sensitivity	3.2	5.4.4.2	U	
16	Receiver Blocking (CW spurious interference sensitivity)	3.2	5.4.4.3	U	
17	Receiver radio-frequency intermodulation and Receiver second adjacent channel interference sensitivity	3.2	5.4.4.4	U	

Key to columns:**Requirement:**

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturers' claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement is or is not be applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (normative): Test report in relation to flexible systems applications

B.1 Wide radio-frequency band covering units specification and tests

Even if radio frequency front-ends for DFRS are commonly designed for covering all or part(s) of the possible operating channels within a specific radio frequency channel arrangement, equipment can provide single radio frequency channel operation (e.g. when the RF duplex- filters are tuned to a specific channel) or offer a wider operating frequency range (e.g. wide-band RF duplexer and frequency agility by the RFC function). Figures B.1 and B.2 show how real operating channels of radio equipment may be mapped onto existing channel arrangements or parts thereof.

The equipment shall comply with all the requirements of the present document at any possible operating frequency.

The tests shall be carried -out in the following way to produce the test report and/or declaration of conformity (Directive 2014/53/EU [i.1]):

- 1) In the case where the equipment is intended for single channel operation the test report shall be produced for one radio frequency channel arbitrarily chosen by the manufacturer (see Figure B.1).
- 2) In the case where the equipment is intended for covering an operating frequency range the test report shall be produced for the lowest, intermediate and highest possible radio frequency channel within that operating frequency range (see Figure B.2).

Where applicable the following additional provisions shall also apply to the production of the test report:

- In the case where the equipment covers a radio frequency channel arrangement with more than one operating frequency range, the test report shall be produced for one of the operating frequency ranges arbitrarily chosen by the manufacturer, using the above procedures for equipment intended for single channel operation or for covering an operating frequency range (see Figures B.1 and B.2).
- In the case where the equipment is designed to cover, with the same requirements under the same ETSI standard, a number of fully or partially overlapping recommended and/or national radio frequency channel arrangements, similarly established across contiguous radio frequency bands allocated to Fixed Service, the test report shall be produced for one radio frequency channel arrangement arbitrarily chosen by the manufacturer, using the above procedures for equipment intended for single channel operation or for covering an operating frequency range (see Figures B.1 and B.2).

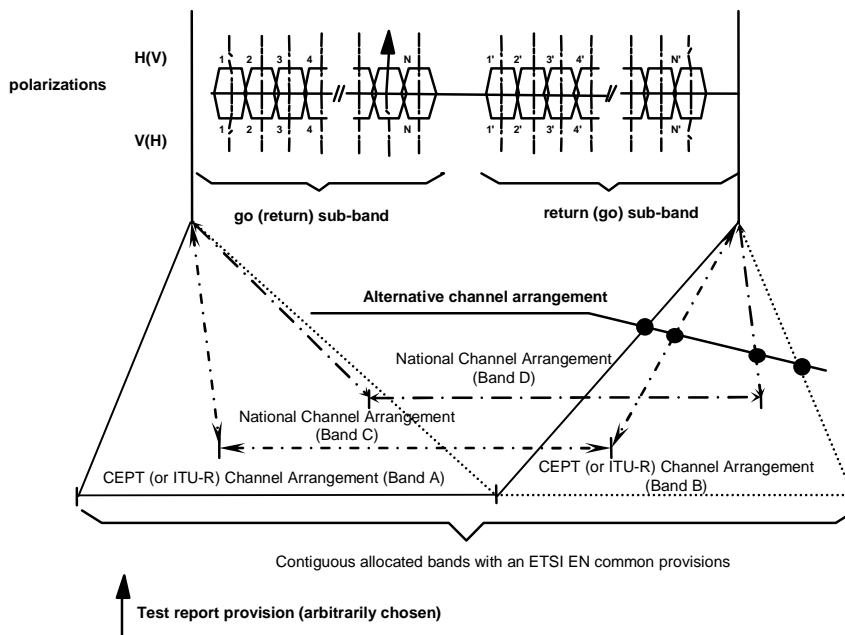


Figure B.1: Test report frequency requirement for equipment intended for single channel operation

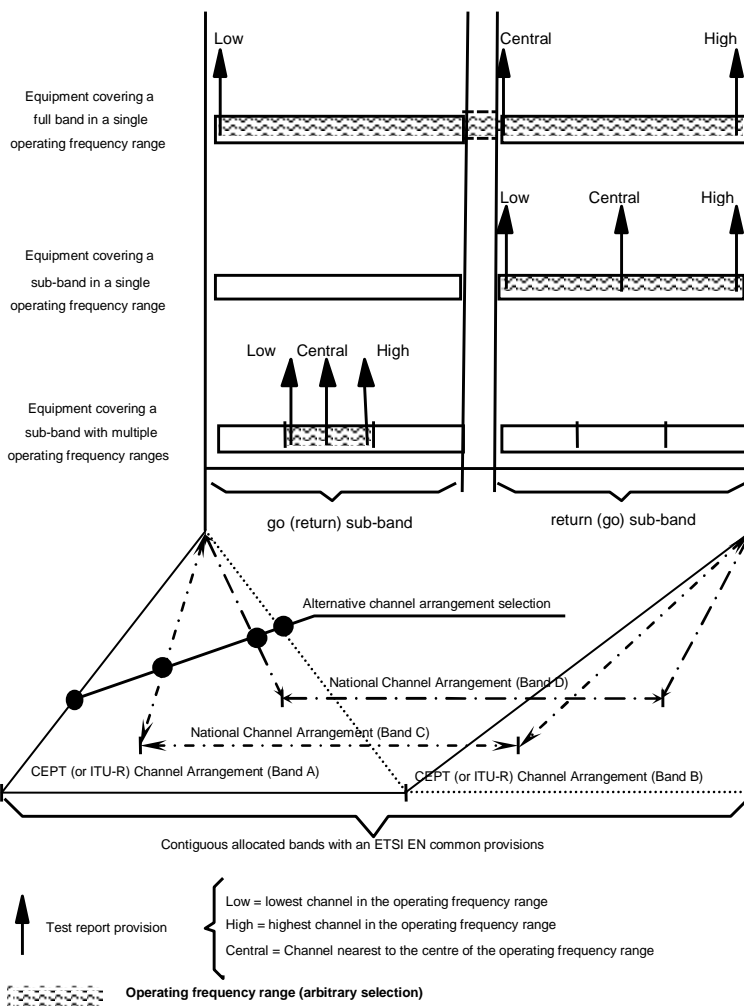


Figure B.2: Test report frequency requirements for equipment intended for covering an operating frequency range

NOTE 1: The go (return) channels in Figures B.1 and B.2 are often referred to as down-link (up-link) or as outbound (inbound) channels when used in multipoint systems.

NOTE 2: The above example of a frequency arrangement showing go and return channels is related to point-to-multipoint systems applying Frequency Division Duplex (FDD). Multipoint systems applying Time Division Duplex (TDD) transmit and receive at the same frequency channel in time sequence thus only one frequency channel, either a go or a return channel, is sufficient.

B.2 Multirate/Multiformat covering equipment specification and tests

DFRS equipment can cover a number of different payload-rates and, for preset-mode or mixed-mode systems, also different modulation formats and different error correction codes through software settings.

In such cases the equipment shall comply with all the requirements of the present document at any intended payload, modulation format and error correction code operation.

When more than one bit-rate is concerned, the required tests to be carried out as follows:

- transmitting phenomena (see clause 5.3) at any intended bit rate and modulation format (EqC-EMO) operation (see note);
- receiving phenomena (see clause 5.4) and control and monitoring functions, if present, shall be tested only at the lowest and the highest bit rate for any modulation format to produce the test report and/or declaration of conformity required (Directive 2014/53/EU [i.1]).

NOTE: Applicable when discrete number of bit rates is offered; cases where bit rate could be preset within a range with larger resolution, five bit rates (spread in the range offered as uniformly as possible) are only required to be tested for each Modulation format.

For preset-mode or mixed-mode systems, specific provisions are stated in specific parts of the present document; in addition, when different error correction codes are provided for the same bit rate and modulation format, the above provisions for different bit-rates and modulation formats still apply, but any test should be made with the selected worst cases error correction code, defined by the manufacturer as follows:

- the expected worst case (e.g. with the higher redundant error correction code) for transmitting phenomena tests (see clause 5.3) or, if equivalent, to one case only (e.g. when the symbol rate is kept constant);
- the expected worst case (e.g. with the less redundant error correction code) for the minimum RSL (see clause 5.4.3) and the receiver co-channel interference sensitivity (see clause 5.4.4.1);
- the expected mixed worst case (e.g. with the higher redundant error correction code on the interfering signal and the less redundant error correction code for the wanted signal) for receiver adjacent-channel interference (see clause 5.4.4.2).

Annex C (normative): Equipment classification (EqC) and system capacity

C.1 General

The present document allows several alternative technological approaches to multipoint systems and offers alternative sets of parameters with which equipment shall comply in order to be compliant with the present document.

The type of an equipment whose compliance with the present document is being considered is identified by a manufacturer's assertion that it is of a type precisely identified by an Equipment Classification (EqC).

Some examples of the characteristics which differ according to EqC are:

- The minimum system capacity.
- The transmitter Radio Frequency spectrum mask.
- BER as a function of Receiver input Signal Level (RSL).
- Receiver co-channel and adjacent channel interference sensitivity.

The Equipment Classification (EqC) comprises the following fields:

- Primary Equipment Type (EqC-PET).
- Secondary Equipment Type (EqC-SET).
- Equivalent Modulation Order (EqC-EMO).
- Channel Separation (EqC-ChS).
- Frequency Range (EqC-FR).
- Station Type (EqC-ST).

NOTE: Only certain combinations of values of these fields of EqC define Equipment Profiles covered.

C.2 EqC description

C.2.1 Void

Void.

C.2.2 Primary Equipment Type (EqC-PET)

Primary Equipment Type (PET) may only assume one of the following values:

- T, O, D, H, M, F.

There is no restriction on access method (see note). It is only required that if an equipment is claimed to be of a particular PET, then it shall conform to *all* requirements applicable to that PET.

NOTE: Historically, these PET values have been related access methods defined by the scope of former standards based on most common methods. Modern Access methods may be more complex combination of methods. Nevertheless, for information, without prejudice on the most appropriate selection to be made by manufacturer, those methods were based on: TDMA (T), TDMA/OFDMA (O), DS-CDMA (D); FH-CDMA (H), MC-TDMA (M) and FDMA (F).

C.2.3 Secondary Equipment Type (EqC-SET)

For certain of the above EqC- PET values, further variants are within the scope of the present document. The variants are distinguished by a Secondary Equipment Type (EqC-SET) which may only assume one of the following values as shown in Table C.1.

Table C.1: Relevant values of Secondary Equipment Type (SET)

Primary Equipment Types	Permitted Secondary Equipment Type (see note 1)
T	HC, LC, QP, GM, DQ, Null (see note 2)
F	FA, FB
D	OR, PR
O	DM, MA
H	Null
M	Null
NOTE 1: The purpose of these SET codes is to provide manufacturers an unambiguous means, in conjunction with the other fields of EqC, to identify a unique profile and to identify a consistent set of requirements which the equipment shall meet. They no longer have meaning beyond that.	
NOTE 2: SET types QP, GM and DQ are permitted only for systems operating below 1 GHz (Eq-FR < 1GHz).	

Each value of SET only relates to one specific PET. The valid combinations are only those defined in the present document.

NOTE: Historically, these SET values were defined by the scope of former standards based on most common technologies at that time. Modern Access methods may be more complex design. For information, without prejudice on the most appropriate selection to be made by manufacturer, those were based on: High-Compatibility (HC), Low Compatibility (LC) QPSK (QP), GMSK (GM); DQPSK (DQ), Orthogonal coding (OR), Pseudo-random Coding (PR), OFDM (DM), OFDMA (MA), FA and FB were related to different set of characteristics of Eq-PET = F systems.

C.2.4 Equivalent Modulation Order (EqC-EMO)

Equivalent Modulation Order (EMO), which is more fully discussed in informative Annex E, is related to the modulation and coding scheme applied in the equipment and to spectral efficiency. Within the scope of the present document, the EMO class may only assume one of the values recognized for the declared PET-SET combination.

NOTE 1: The actual EMO, calculated according to Annex K, may not fall within the set of values for the declared PET-SET combination and may not, indeed, be an integer value. Under these circumstances, the declared EMO should be chosen by the manufacturer from the defined set of values (typically, but not necessarily, the closest integer value), such that the equipment complies with all requirements for that declared EMO.

The higher values of Equivalent Modulation Order typically correspond to higher orders of modulation although no specific modulation or coding scheme is implied. Any Modulation Order represents an indication of the combined effect of the chosen combination of modulation method and coding scheme.

Limiting values of phenomena, which depend upon manufacturer asserted values of EMO, for some PET-SET combinations include capacity, minimum RSL, transmitter Radio Frequency spectrum masks, receiver co-channel and adjacent channel sensitivity.

NOTE 2: Historically, Equivalent Modulation Order was directly related to the order of modulation by the expression $\log_2(\text{number of discrete states which may be assigned to each symbol})$. Thus 2-state modulation would be EMO 1, 4-state modulation would be EMO 2, and 256-state modulation would be EMO 8.

When a mixed- mode equipment is designed to operate with variable EMO values the manufacturer shall indicate that it can operate at different EMO and shall list all the different values of EMO that apply. For example, a manufacturer of mixed-mode equipment might indicate EMO = Variable 2, 4, 6 meaning that the equipment may operate with EMO = 2, EMO = 4 or EMO = 6 according to conditions. The implications and requirements for mixed-mode equipment appear in Annex I.

Where a different EMO applies in each direction, the declared EMO shall indicate this by giving the EMO type for the downstream and the EMO type for the upstream. For example, a system conforming to EMO 2 in the downstream direction may have EMO 4 in the upstream direction. Where the EMO type differs for upstream and downstream, the system shall meet all requirements for the declared EMO for each direction independently.

C.2.5 Channel Separation (EqC-ChS)

A RF channel is a partition of a radio frequency band which may be assigned by the authorities in accordance with CEPT, Recommendation ITU-Rs or national authorities' regulations on channel arrangement.

The Channel Separation (EqC-ChS) is a field of EqC, which, in conjunction with the other fields of EqC, identifies which consistent sets of parameters are relevant to the equipment. EqC-ChS is stated by the manufacturer as being the separation in MHz between the centre frequencies of neighbouring RF channels relevant to the equipment.

EXAMPLE 1: EqC-ChS = 1,75 MHz.

In cases where the channel separation may vary depending on the mode of operation of the equipment, the manufacturer may either indicate the discrete set of values of channel separation available, or the narrowest and widest channel separation which apply.

EXAMPLE 2: EqC-ChS = 3,5 MHz; 7 MHz; 14 MHz or EqC-ChS = 1 MHz to 4 MHz.

In cases where the RF channel is not implicitly defined by the equipment, e.g. as it is often the case for EqC-PET = H systems, where the channel separation is less than the sub-channel bandwidth, the manufacturer shall indicate a value of EqC-ChS which, in conjunction with the other fields of EqC, defines a consistent set of parameters for compliance purposes.

C.2.6 Frequency Range (EqC-FR)

For multipoint equipment, the following radio frequency ranges are addressed.

For an equipment claiming compliance with the present document, the manufacturer shall indicate its range or the specific operational range. This may be done either by identifying which range below applies or by indicating the actual upper and lower frequencies the equipment is intended to operate:

- 30 MHz to 1 GHz.
- 1 GHz to 3 GHz.
- 3 GHz to 11 GHz.
- 24,25 GHz to 29,5 GHz.
- 31,0 GHz to 33,4 GHz.
- 40,5 GHz to 43,5 GHz

EXAMPLE: EqC-FR = 2,45 GHz to 2,95 GHz, which indicates the equipment's operational frequency range within the basic range 1 GHz to 3 GHz.

C.2.7 Station Type (EqC-STN)

Three different station types, TS, CS, RS, are covered by the present document.

The manufacturer shall indicate whether the equipment falls within the category: Terminal Station (TS), Central Station (CS) or Repeater Station (RS).

Example of a manufacturer indication of station type: EqC-STN = TS.

C.3 System capacity

C.3.1 General

The system capacity is the traffic capacity of the system per radio channel.

The efficient use of spectrum implies a minimum value of system capacity for applicability of the present document. Therefore equipment supporting at least the minimum capacity is defined in this annex.

For historical reasons, this capacity has been expressed differently for different Primary Equipment Types (EqC-PET) and in different Frequency Ranges (EqC-FR). In the interests of maintaining continuity with the previous standards, the current version of the present document retains this diversity of definition. It may be expected that future versions of the present document will express the system capacity in a more uniform manner.

C.3.2 Capacity of equipment with EqC-PET = T, O or M

For EqC-PET = T, O systems operating below 1 GHz, the system capacity shall be declared by the manufacturer (see note 1).

NOTE 1: Rationale for the need of declaration is the absence of recommended channel arrangements and the very small bandwidth available in this frequency range. Therefore, the trade-off between real traffic capacity and other functionalities needed for the multiple access functionality is case-by-case dependent and cannot be generalized.

For EqC-PET = T, M or O (with EqC-SET = DM) systems operating at 1 GHz or above, the minimum gross bit rate (MGBR) per Hz of channel width expressed as bits per second per Hz shall be equal or exceed:
 $0,5 \times \text{EqC-EMO bit/s/Hz}$.

For equipment with EqC-PET = O, EqC-SET = MA systems, the manufacturer shall declare the actual system traffic carrying capacity and the gross bit rate (MGBR) for the full load conditions (FLC) of the system (see note 2).

NOTE 2: Rationale for the need of declaration is that an EqC-PET = O, EqC-SET = MA system, in any single burst, any single TS may be dynamically assigned a subset of the OFDMA-sub-channels. Multiple TS are allowed to transmit at the same time on disjoint sets of OFDM-sub-carriers, so the MGBR is defined when all available OFDM-sub-carriers are in use.

C.3.3 Capacity of equipment with EqC-PET = F

For EqC-PET = F systems operating below 1 GHz, the system capacity shall be declared by the manufacturer (see note 1 in clause C.3.2).

For EqC-PET = F equipment operating at or above 1 GHz, the payload capacity for given channel widths shall be equal or exceed the values given in Table C.2 in units of 64 kbit/s.

Table C.2: Minimum payload capacity of EqC-PET = F equipment operating at 1 GHz or above

Channel separation (MHz) EqC-ChS	1	1,75	2	3,5	7	14	28	30	56	112
EqC-EMO Equivalent Modulation Order	Minimum capacity / 64 kbits									
2	12	21	24	42	84	256	512	544	1 024	2 048
3	18	31	36	62	160	320	640	704	1 280	2 430
4	24	42	48	84	256	512	1 024	1 088	2 048	4 096
6	-	-	-	192	384	768	1 536	-	2 430	4 860

With regard to Table C.2, the following shall also be taken into account:

- The use of smaller RF-channel separation within pre-defined RF channels may be permitted as long as the spectrum mask for the pre-defined RF channel will not be exceeded.
- For convenience, the minimum payload capacity is defined in units of 64 kbit/s. Any payload capacity is considered valid provided the above limits are met or exceeded, and the traffic need not be segmented in units of 64 kbit/s. E.g. instead of 256×64 kbit/s an overall capacity higher than 16,384 Mbit/s can be transmitted.
- For EqC-ChS values other than those indicated in Table C.2 (e.g. achieved by subdivision of the channel separation in Table C.2 or by other national/proprietary means) the minimum capacity shall be scaled accordingly and rounded down to the nearest 64 kbit/s multiple.

C.3.4 Capacity of equipment with EqC-PET = D

For EqC-PET = D systems, the minimum system capacity is defined as the number of 64 kbit/s channels which may be supported for any given channel separation. Capacities of equivalent total bit rates are permitted.

The system capacity shall meet or exceed the following requirements:

- for EqC-SET = OR, $N \geq \text{EqC-ChS} \times 40 / 7$;
- for EqC-SET = PR, $N \geq \text{EqC-ChS} \times 16 / 7$;

where N is the number of 64 kbit/s channels.

This equates to a minimum system loading of:

- 0,366 bps/Hz for EqC-SET = OR systems; and
- 0,146 bps/Hz for EqC-SET = PR systems.

EXAMPLE: Equipment with EqC-SET = OR and EqC-ChS = 10 MHz supports, at least:
 $10 \times 40 / 7 = 57,1428$, corresponding to at least 57 data channels of 64 kbit/s each.

For EqC-PET = H systems operating below 1 GHz, the system capacity shall be declared by the manufacturer (see note 1 in clause C.3.2).

For EqC-PET = H systems operating at or above 1 GHz, the manufacturer shall declare the maximum number of simultaneous duplex 64 kbit/s channels or the bit rates which the equipment is designed to carry for each channel separation supported.

Such declared capacity shall not be less than either 8×64 kbit/s channels or 500 kbit/s for each 1 MHz of channel separation. Non exhaustive examples of the required capacity appear in Table C.3.

Table C.3: Minimum capacity of EqC-PET = H equipment for some typical channel separations

Channel separation (MHz) EqC-ChS	1,0	2,0	3,5	7,0	14,0
Minimum number of 64 kbit/s channels	8	16	28	56	112
Equivalent Bit Rate (Mbit/s)	0,5	1,0	1,75	3,5	7,0

NOTE: Any other equivalent transmission capacity may be transported, e.g. instead of 112×64 kbit/s a capacity of 56×128 kbit/s can be transmitted, or any combination of capacity higher than 7 168 kbit/s.

C.4 Classification of equipment

C.4.1 Equipment profiles in the scope of present document

The applicability of the present document is limited to alternative consistent sets of recommendations and requirements.

Each identified equipment profile requires an Equipment Classification (EqC) and key characteristics.

The profiles (or any specific equipment) within the scope of this whole multi-part deliverable may be classified as discussed in clause C.2 in terms of the various fields of EqC.

Table C.4 shows the complete list of equipment profiles within the scope of the present document in terms of the permitted values (or ranges of values) of the various fields of EqC. The manufacturer shall indicate, e.g. in the Technical documentation, the profile that the specific equipment shall comply with, by defining the values of those fields of EqC shown in Table C.4. The equipment shall then comply with *all* requirements in the present document relevant to that EqC profile.

In the case of asymmetric MP implementations (see clause 4.1.2), the manufacturer shall identify separately the profiles of the equipment in the two alternate directions in terms of the various EqC fields.

For each direction, the requirements specified in present document shall apply.

Table C.4: Equipment Profiles within the scope of the present document defined by their Equipment Classification

EqC-FR Frequency Range (Basic ranges) (note 5)	EqC-PET Primary Equipment Type (note 1)	EqC-EMO Equivalent Modulation Order (note 2)	EqC-SET Secondary Equipment Type (note 3)	EqC-ChS Channel Separation (MHz) (Basic Ranges) (note 4)
< 1 GHz	T	2	QP, DQ, or GM	No restriction
	O	2, 4, 6	DM or MA	No restriction
	F (note 6)	2, 3, 4	Null	No restriction
	D	Not applicable	OR or PR	3,5 to 20
	H	Not applicable	Null	1 to 14
1 GHz to 3 GHz	T	1,2	Null	1,75 to 4
	O	2, 4, 6	DM or MA	1,75 to 14
	F (note 6)	2,3,4	Null	1 to 14
	D	Not applicable	OR or PR	3,5 to 14
	H	Not applicable	Null	1 to 14
3 GHz to 11 GHz	T	2	Null	0,025 to 30
			HC	1,75 to 30
		4	Null	0,025 to 30
			6	Null
	O	2, 4	DM or MA	0,025 to 30
		6	DM or MA	1,75 to 30
	F (note 6)	2, 3, 4	Null	1 to 30
	D	Not applicable	OR or PR	1 to 30
	H	Not applicable	Null	1 to 30
	24,25 GHz to 29,5 GHz	T	2	Null or HC
4,6			Null	3,5 to 112
M		2, 4, 6	Null	3,5 to 112
F (note 6)		2, 3, 4, 6	Null	3,5 to 112
D		Not applicable	OR or PR	3,5 to 112
31,0 GHz to 33,4 GHz	T	2, 4, 6	Null	3,5 to 56
	M	2, 4, 6	Null	3,5 to 56
	F (note 6)	2, 3, 4	Null	3,5 to 56
40,5 GHz to 43,5 GHz	T	2, 4, 6	Null	3,5 to 56
	M	2, 4, 6	Null	3,5 to 56
	F (note 6)	2, 3, 4	Null	3,5 to 56
<p>NOTE 1: Although EqC-PET historically has a relationship with a specific multiple access method (see note in clause C.2.2), any access method, or combination of access methods, may be used provided that the entire set of requirements relevant to article 3.2 of the Directive 2014/53/EU [i.1] in the present document are met for the stated EqC-PET value.</p> <p>NOTE 2: In the EqC-EMO column, the reference made to the modulation order is only indicative, and any equivalent modulation scheme is permitted provided that the whole set of requirements relevant to article 3.2 of the Directive 2014/53/EU [i.1] in the present document are met for the manufacturer's stated EqC-EMO value. For mixed-mode systems EqC-EMO = 1 might also be provided, among other more efficient EMO, within the same channel separations.</p> <p>NOTE 3: For certain primary equipment types (EqC-PET) it has historically been necessary to sub-divide the equipment's according to further characteristics which have different consistent sets of requirements (see note in clause C.2.3). Although no longer tied to specific characteristics, this subdivision is reflected in Secondary Equipment Type (EqC-SET) classifications which are represented by various two-letter codes.</p> <p>NOTE 4: The EqC-ChS column indicates range of ChS values for which the present document is applicable. Several parameters in the present document are given for discrete values of ChS only. For intermediate ChS values, methods are given for deriving the required characteristics by interpolation between the two nearest adjacent discrete ChS values provided.</p> <p>NOTE 5: The EqC-FR column represents the basic frequency range for which the present document is applicable. For assessment purpose the specific frequency band of the equipment operation should be defined (e.g. EqC-FR = 3,5 GHz or EqC - FR = 3,4 - 3,6 GHz) according to clause C.2.6 of the present document.</p> <p>NOTE 6: It is here reminded that systems of EqC-PET = H, implementing an actual FH-CDMA access method with hopping period exceeding 400 ms, are not within the scope (see clause 1) of the present document.</p>				

For defining the coherent set of test suites for conformity assessment, a number of declared EqC codes and other parameters are to be declared from the manufacturer. Standing the considerable number of possibilities under the scope of the present document, summarized in Table C.4 (see note), it is recommended to consider the production of a summary table, such as Table G.1 proposed in the informative Annex G, to be attached as header of the technical documentation file and/or test documentation for aid the correct identification of the equipment/system profile by any interested third party.

NOTE: For information; for systems with integral antennas, antenna profiles are shown in Table J.1 in Annex J.

Annex D (informative): Transmitter Radio Frequency Spectrum mask background for ATPC and/or RTPC implementation

D.0 Introduction

In most applications, ATPC and RTPC are realized by a single function software programmable, therefore the manufacturer that should declare how the available range of attenuation should be subdivided (and possibly limited) in order to meet the requirements described below.

Further information can be found in ETSI TR 103 103 [i.10].

D.1 ATPC impact

Amongst other requirements, set out in the present document as "non-essential" to fulfill article 3.2 of the Directive 2014/53/EU [i.1], Figure D.1 clarifies the ATPC related requirements that are considered "essential".

It is assumed that the equipment would comply with the requirements of spectrum masks in clause 5.3.4 with ATPC operating in the range between "maximum nominal power" and "maximum available power" (see note below) including the attenuation introduced by the RTPC function (type 1, if any).

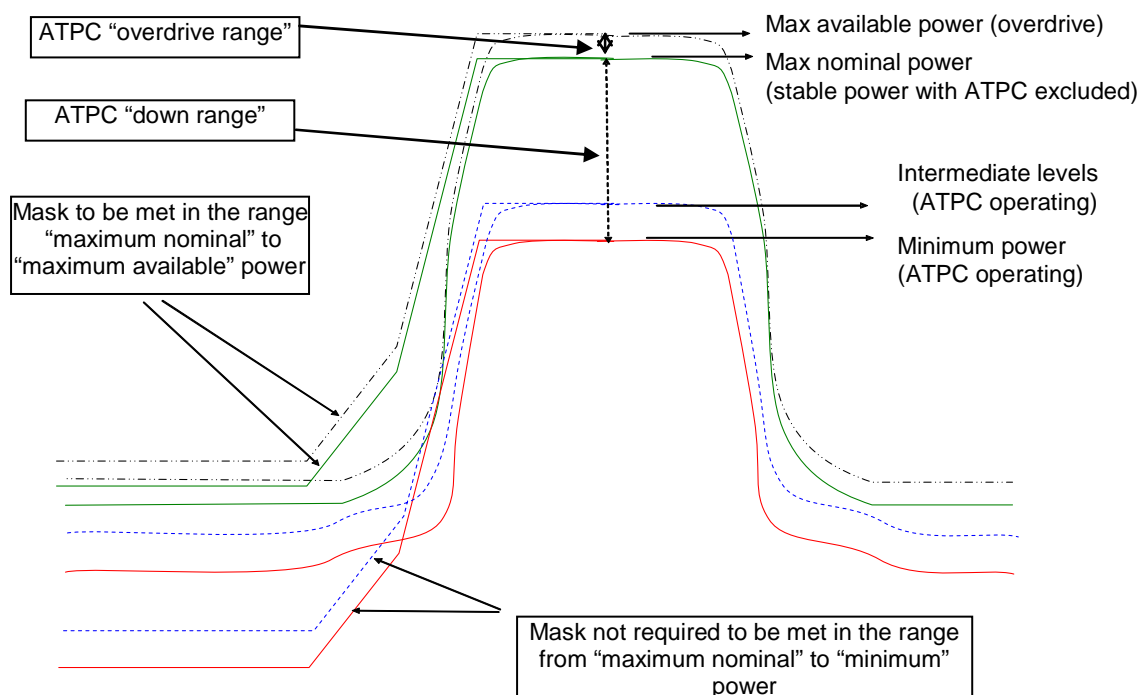


Figure D.1: Relationship between the transmitter Radio Frequency spectrum mask requirement and the ATPC operation

NOTE: The Rationale for the requirement is that while the mask is a "relative attenuation", the actual interference potential is given by the absolute power spill-over into adjacent channels. Therefore the NFD should be guaranteed when transmitters operate at maximum nominal power.

D.2 RTPC Impact

It should be considered that, when RTPC is used as an alternative to conventional RF attenuators (used in the past for a similar purpose) for setting the maximum power established in the network to reduce inter-system interference into other links/cells, e.g. for other operators, the NFD needs to be maintained. Therefore the mask is expected to be met throughout the operating range offered.

As a consequence, the range of RTPC is limited accordingly.

Different functionalities can be described for Point-to-Point systems (in other relevant ENs) and Multipoint systems (in the present document), as follows:

- a) Point-to-Point: RTPC is used only for inter/link interference and link-budget balancing.

Thus the compliance to the mask applies to all RTPC range.

- b) Multipoint: RTPC might be used for two different purposes:
 - b1) RTPC type1 for interference balancing among different operators, i.e.in particular but not limited to master stations. In this application it is similar to Point-to-Point RTPC, and the same concept applies (mask is expected to be met).
 - b2) RTPC type 2 for intra-system power balancing of TSs close to the CS or for the shortest hops in Mesh architectures. In this case the masks do not need to be met because it is an intra system issue (Any interference balancing with other cells of the same operator is done by taking account of the power levels associated with the most distant TSs).

In conclusion, in MP systems, the manufacturer specifies the RTPC feature in the manufacturer's declaration as two different ranges, type 1 and type 2. The mask is expected to be met in the corresponding range of type 1 only.

For all equipment classifications, it is appropriate, but not mandatory, for the manufacturer to indicate the range of transmit power covered by ATPC and RTPC.

Annex E (informative): Overview of technology features of multipoint systems

E.1 General

The following independent technological aspects of Multipoint systems are covered in this annex:

- Network Topology (see clause E.2).
- Multiplexing methods (examples are given in clause E.3).
- Multiple access methods (examples are given in clause E.4).
- Duplex methods (examples are given in clause E.5).
- Modulation methods (examples are given in clause E.6).
- Error correcting methods (examples are given in clause E.7).

E.2 Network topology

The present document mainly deals with the performance of multipoint equipment. However, in practice, a multiplicity of pieces of equipment will work together to provide a communication network. The present document considers just two alternative topologies:

- Point-to-Multipoint.
- Multipoint-to-Multipoint (also known as Mesh).

A **Point-to-Multipoint network topology** provides a communication route (on a single radio channel for each sector) from one central point to a number of terminals where users are located. Each user location is either served directly from the central location or via one or more radio repeaters. In general, each user location communicates with the central location by a single pathway.

A **Multipoint-to-Multipoint (or mesh) network topology** provides communication pathways (sharing a limited number of radio channels) between various system nodes where each node has a communication pathway with a few of its near neighbours. One (or a few) of the nodes might be associated with a core network interface, and many will be at user terminal locations. The communication pathway between the core network and the user will comprise a number of node-to-node hops. In general there will be multiple alternative routes from the user terminal to a core network.

These topologies are discussed in more detail in informative Annex H.

E.3 Multiplexing methods

A variety of different multiplex methods is used in Point-to-MultiPoint (P-MP) systems to multiplex the signals from a Central Station (CS) to a number of Terminal Stations (TSs) to allow the radio medium to be shared effectively between the various traffic paths typically under the control of the central station.

Examples of **multiplexing methods** are:

- TDM: Time Division Multiplexing.
- FDM: Frequency Division Multiplexing.
- CDM: Code Division Multiplexing.
- OFDM: Orthogonal Frequency Division Multiplexing (see note).

NOTE: OFDM has some attributes of a modulation technique as well as of a multiplexing method.

E.4 Multiple access methods

In order to grant multiple access from a number of TSs to one CS, a variety of multiple access methods can be used. With the adequate method, the traffic requirements of the TSs can be adapted to the available radio capacity of the CS.

According to the article 3.2 of Directive 2014/53/EU [i.1], it is not required to define a specific multiplexing or multiple access technique.

However, it may be noted that a number of consistent system profiles are required to assess equipment of different technical characteristics. These profiles replace the technology dependent classification in earlier standards, but do not now imply any particular implementation. In general, the Equipment Classification Primary Equipment Type (EqC-PET) replaces the earlier concept of differentiation by the access method.

Examples of **multiple access methods** are:

- TDMA: Time Division Multiple Access either using a single carrier or multiple carriers; the latter usually identified as Multi Carrier-Time Division Multiple Access (MC-TDMA), whose requirements are generally different from the single carrier applications.
- FDMA: Frequency Division Multiple Access.
- DS-CDMA: Direct-Sequence Code Division Multiple Access.
- FH-CDMA: Frequency Hopping-Code Division Multiple Access.
- OFDMA: Orthogonal Frequency Division Multiple Access.

It should be noted that the above list of access methods is historically derived from those defined in the earlier set of multipoint standards. It is not exhaustive and in this respect the present document is, as far as possible, independent of the access method. In particular modern digital access technology allows the use of more than one basic access layer (e.g. TDMA/OFDMA).

A description of some of the different basic access methods and a generic comparison among them is provided in ETSI TR 101 274 [i.12]. In general, the multiplex method is analogous to the access method. For example, a system using FDMA as the multiple access method from the TSs to CS typically uses Frequency Division Multiplexing (FDM) as the multiplexing method from the CS to the TSs.

It should be noted that, in general, these different access methods have different values of parameters applicable due to the variation in technical characteristics.

E.5 Duplex methods

Two different **duplex methods** are used to separate the two directions of signal in a bi-directional link:

- TDD: Time Division Duplex.
- FDD: Frequency Division Duplex.

NOTE 1: In FDD operation, two operational modes are possible:
- Full duplex, when both directions transmit simultaneously.
- Half duplex, H-FDD, when the two directions operate at variable times.

NOTE 2: It should be considered that National Regulatory Authorities may restrict applicable duplex methods and FDD frequency separation by Radio Interface Specifications (RIS).

E.6 Modulation methods

E.6.1 Modulation techniques

In order to transmit digital data across the radio frequency path, one or more parameters of the radio frequency signal is/are modulated, by frequency, phase or amplitude. For the commonly used modulation technique, Quadrature Amplitude Modulation (QAM), the two orthogonal carriers are independently amplitude modulated, with the number of discrete amplitude steps permitted for each phase determining the number of possible different states each symbol may assume. In order to limit the bandwidth of the modulated signal, either the modulating signals or the modulated carriers are filtered (e.g. using square root raised cosine shaping of the carrier/sub-carrier). Within a multipoint system different modulation methods may be applied in different situations, at different times and in alternate directions: up-link and down-link.

Examples of **modulation techniques** which may be used in multipoint radio systems are:

FSK: Frequency Shift Keying.

PSK: Phase Shift Keying.

QPSK: Quadrature Phase Shift Keying.

QAM: Quadrature Amplitude Modulation.

OFDM: Orthogonal Frequency Division Multiplexing.

NOTE: OFDM has some attributes of a multiplexing method as well as of a modulation technique.

E.6.2 Equivalent Modulation Order (EMO)

The modulation order "n" of a modulator and demodulator is determined by the number of discrete states which may be assigned to each symbol.

The modulation order is defined as $n = \log_2(N)$, where N is the number of permitted states per symbol. All other factors being equal, modulation at higher orders is capable of carrying a higher bit rate in the equivalent radio frequency channel when compared with modulation at lower orders, but it can tolerate less interference for the same bit error rate.

However, with the advent of techniques such as forward error correction, the instantaneous bit rate of information transmitted over the air is no longer solely determined by the modulation order. The same applies for BER of a system with FEC, where the modulation order itself does not specify the performance.

Annex C addresses Equipment Classification (EqC) and defines a new key element in the system profile, Equivalent Modulation Order (EqC-EMO). The manufacturer indicates a value of EqC-EMO, (not necessarily corresponding to the physical modulation order, see note) which together with other aspects of EqC, determines the requirements of the standard applicable to that specific equipment.

NOTE: For reference only, modulation techniques described in clause E.6.1 may "physically" fit to:

- FSK may correspond to EqC-EMO = n, but only implementations with $n = 1, 2$ and very often 3 were historically used due to quick error performance degradation with n.
- PSK corresponds to EqC-EMO = 1.
- QPSK corresponds to EqC-EMO = 2.
- QAM and OFDM may correspond to EqC-EMO = n, where n is, in principle, unlimited; however, in the present document $n \leq 6$ is used, even if higher n values are also practical and might be considered in future.

Informative Annex K discusses practical implementation issues concerning the relationship between transmitted bits per second, symbol rate and error correction aspects and considers the reference points at which the Minimum Gross Bit Rate (MGBR) and BER may be defined.

Within a multipoint system different modulation orders may be applied in different situations, at different times and in alternate directions, up-link and down-link. It should be noted that in P-MP systems CS may use different modulation order (generally higher) than that used in TSs.

E.7 Error correction

The error performance of the system may be improved by the use of **Forward Error Correction (FEC)** or **Automatic Request for retransmission (ARQ)**. One of the main differences between these two techniques stems from their different implementation aspects within the 7 layer basic Reference Model of the Open Systems Interconnection (OSI) described in ISO/IEC 7498-1 [i.38].

Forward error correction may use an inner code (e.g. convolutional coding), an outer code (e.g. Reed Solomon), a concatenation of an inner and outer code, or an integrated inner and outer code (e.g. Turbo code). In general, FEC incurs a constant delay to the data transported and a constant overhead to the available bit rate, although a system may adapt the level of FEC according to varying conditions.

ARQ detects the reception of data which are in error and requests retransmission of the faulty data. In general, the delay to the data transmitted may vary, as may the overhead to the available bit rate, although bit error ratios approaching zero may be obtained for a wider range of conditions.

A multipoint system may use both FEC, ARQ, or neither of them.

E.8 Other relevant system characteristics

For equipment assessment covered by the present document neither the duplex method used nor the duplex frequency separation in the case of FDD are considered relevant. However, such information needs to be known by third parties conducting tests to demonstrate compliance.

Equipment within the scope of the present document may be combined with other equipment in a system to form any multipoint architecture, typically either Point-to-MultiPoint (P-MP) or MultiPoint-to-MultiPoint (MP-MP), also referred to as Mesh. Such architectures are illustrated in Annex H.

In general, P-MP systems will use corresponding multiplexing methods and multiple access methods in both CS-transmit and CS-receive directions. Dissimilar methods can be applied in the alternate directions. Likewise, different radio characteristics (e.g. different modulation methods, different modulation orders) may be employed in the alternate directions, potentially resulting in asymmetrical capacities and performance.

Furthermore, some systems may be designed to operate with different channel separations in up- and down-link directions.

NOTE: The asymmetry of channel separations is not intended to cover the case (e.g. in FDMA systems) where some TSs use a subset of the channels assigned to the CS.

Annex F (informative): Frequency bands

F.1 Frequency ranges

The present document is applicable to multipoint radio systems operating in bands allocated to Fixed Service and assigned by national regulations to MP applications, within the following frequency ranges:

- 30 MHz to 1 GHz.
- 1 GHz to 3 GHz.
- 3 GHz to 11 GHz.
- 24,25 GHz to 29,5 GHz.
- 31,0 GHz to 33,4 GHz.
- 40,5 GHz to 43,5 GHz.

The specific frequency bands currently in use for Fixed Wireless Access are subject to national regulations, which, according to the Commission Decision 2007/344/EC [i.31], Directive 2014/53 EU [i.1] and Directive (EU) 2015/1535 [i.32], have to be notified and stored in EU data bases such as the "ECO Frequency Information System (EFIS)" [i.35] and "Technical Regulation Information System (TRIS)" [i.37]. Thus those databases provide reliable information on Radio Interface Specifications (RIS) and national frequency plans.

CEPT reports, like ERC Report 25 [i.11] and ECO Report 04 [i.36], summarize information on channel arrangements and block assignments with future objectives linked to CEPT recommendations.

It should be noted that some EC Decisions might have an effect on the technical licensing conditions that national administrations have to adopt for authorizing mobile and fixed access system in some of those bands. Decision 2008/411/EC [i.34] (as amended) would be relevant for the FWA licenses in band 3,4 to 3,8 GHz, while Commission Implementing Decision (EU) 2019/784 [i.33] provides guidance to administrations wishing to maintain FS (including FWA) licensing in presence of new 5G application authorization.

Table F.1 summarizes the actual bands more likely used for FS multipoint applications and relevant CEPT recommendations for the channel/block arrangements.

Table F.1: Frequency bands identified by CEPT for Multipoint Access or Infrastructure applications (see note 1)

Band (GHz)	Frequency limits (MHz)	Basic Channel separations (MHz) (EqC-ChS) (note 2)	Relevant CEPT Recommendations on channel/block arrangements and assignment	Notes
3,5	3 410 to 3 600	1,75; 3,5; 7; 14	CEPT/ERC/REC 14-03 [i.22]	
3,5	3 410 to 3 600	N × 0,25 5; 10; 15 (20/40/60 × 0,25)	CEPT/ERC/REC 14-03 [i.22]	3
3,5 and 3,7	3 410 to 3 800	Blocks	CEPT/ECC/REC(04)05 [i.17]	
3,7	3 600 to 3 800	1,75; 3,5; 7; 14	CEPT/ERC/REC 12-08 [i.20]	
3,7	3 600 to 3 800	N × 0,25 5; 10; 15 (20/40/60 × 0,25)	CEPT/ERC/REC 12-08 [i.20]	3
10,5	10 150 to 10 300 paired with 10 500 to 10 650	3,5; 7; 14; 28; 56	CEPT/ERC/REC 12-05 [i.19]	
10,5	10 150 to 10 300 paired with 10 500 to 10 650	N × 0,5 5; 10; 15 (10/20/30 × 0,5)	CEPT/ERC/REC 12-05 [i.19]	3
26	24 500 to 26 500	3,5; 7; 14; 28; 56; 112	CEPT/ERC/REC T/R 13-02 Annex 2 [i.21]	
26	24 500 to 26 500	Blocks	CEPT/ECC/REC(11)01 [i.18]	
28	27 500 to 29 500	3,5; 7; 14; 28; 56; 112; 224;	CEPT/ERC/REC T/R 13-02 Annex C [i.21]	4
28	27 500 to 29 500	Blocks	CEPT/ECC/REC (11)01 [i.18]	4
31	31 000 to 31 300	3,5; 7; 14; 28	CEPT/ECC/REC(02)02 [i.23]	
32	31 800 to 33 400	3,5; 7; 14; 28; 56; 112; 224;	CEPT/ERC/REC(01)02 [i.16] CEPT/ECC	
32	31 800 to 33 400	Blocks	CEPT/ECC/REC(11)01 [i.18]	
42	40 500 to 43 500	7; 14; 28; 56; 112; 224; Blocks	CEPT/ECC/REC(01)04 [i.30]	

NOTE 1: The above bands are those specifically identified by CEPT for FWA or multipoint infrastructures for fixed or mobile networks. However, in some cases, mixed P-P and Multipoint systems may be deployed.

NOTE 2: Basic channel separations are those recommended in the relevant Recommendations and might be related to the size of licensed frequency slots. It is currently assumed that multi-carrier systems may use any number and bandwidth size of sub-carriers within a specific RF channel. The above bands are those where CEPT Recommendations consider possible deployment for FWA or multipoint infrastructures for fixed or mobile networks. However, in some cases, mixed P-P and Multipoint systems may be deployed.

NOTE 3: Basic ChS defined only for EqC-PET = D in order to define adjacent channel performances and system capacity.

NOTE 4: This band is allocated for shared use with FSS. CEPT has designated its segmentation to ease its use by FS and FSS in CEPT/ECC/DEC(05)01 [i.15].

F.2 Frequency ranges CEPT applications

Based on the frequency band availability background given in clause F.1, a schematic picture of the frequency bands covered in the present document is shown in Figure F.1, also showing the relationship of the bands specified for antenna ranges in ETSI EN 302 326-3 [i.2], the bands specified for equipment and the bands for possible use of FWA.

The actual frequency band of operation of a particular equipment is one of the components of the Equipment Classification (EqC-FR) of the particular equipment which determines the frequency range, of which the requirements in the present document apply to that equipment. Annex C defines Equipment Classification (EqC).

Antenna Range (MHz)	Not in scope of ETSI EN 302 326-3 [i.2]						
Equipment Range (MHz)	30 ÷ 1 000						
CEPT FS allocation (MHz)		146 - 174	335,4 - 380	420 - 430	440 - 470	(See note)	
FWA and Multipoint bands identified in CEPT	none						
Antenna Range (MHz) ETSI EN 302 326-3 [i.2]							
Equipment Range (MHz)	1 000 ÷ 3 000						
CEPT FS allocation (MHz)	1 350 - 1 400	1 427 - 1 452	1 492 - 1 530	1 700 - 1 800	1 805 - 1 880	2 025 - 2 110	2 200 - 2 690
FWA and Multipoint bands identified in CEPT	none						
Antenna Range (MHz) ETSI EN 302 326-3 [i.2]	3 000 ÷ 11 000						
Equipment Range (MHz)	3 000 ÷ 11 000						
CEPT FS allocation (MHz)	3 410 - 3 600	3 600 - 4 200		4 400 - 5 000	5 850 - 8 500	10 150 - 10 300	10 500 - 10 650
FWA and Multipoint bands identified in CEPT	3 410 - 3 600	3 600 - 3 800				10 150 - 10 300	10 500 - 10 650
Antenna Range (GHz) ETSI EN 302 326-3 [i.2]	24,25 ÷ 43,5						
Equipment Range (GHz)	24,25 ÷ 33,4					Not in scope of the present document	40,5 - 43,5
CEPT FS allocation (GHz)	24,25 - 29,5		31,0 - 31,3	31,8 - 33,4		37,0 - 40,5	40,5 - 43,5
FWA and Multipoint bands identified in CEPT (GHz)	24,5 - 26,5	27,5 - 29,5	31,0 - 31,3	31,8 - 33,4			40,5 - 43,5
NOTE:	Bands (with the exclusion of few small slots inside) for which note EU 7 of ERC Report 25 [i.11] applies EU 7: "This band can also be used by low capacity fixed links in rural areas on a national basis. These links need to be co-ordinated with mobile service and require full protection". The actual national availability of such bands should be verified through the EFIS tool [i.35].						

Figure F.1: Relationships between the frequency ranges of application of the present document, CEPT FS primary allocations and bands where multipoint applications are specifically indicated (Not to scale)

Annex G (informative): Summary Table of EqC subject to conformance declaration

G.1 The right to copy

Notwithstanding the provisions of the copyright clause related to the text of the present document, ETSI grants that users of the present document may freely reproduce the Table G.1 pro forma in this annex so that it can be used for its intended purposes and may further publish the completed Table G.1.

A considerable number of EqC (defined in Annex D) and other parameters need manufacturer's declaration for the selection of coherent requirements according to the scope of the present document summarized in Table C.4. The manufacturer is invited (even if not considered mandatory) to fill in the following Table G.1 with those relevant parameters. The completed table can be used as general header of the technical documentation and the collection of assessment tests under the obligation of the Directive 2014/53/EU [i.1]. It would also enable third parties (e.g. test houses or Regulatory authorities) to quickly identify the actual equipment/system profiles.

**Table G.1: Summary of EqC codes and other relevant parameters
for equipment/system identification**

Equipment commercial designation (note 1):				
Station type (EqC = STN) (note 2):				
Actual operational frequency range (GHz) (note 3):				
Integral antenna (if applicable)		Antenna type (note 4):		
		Antenna polarization (note 5):		
		Antenna class (note 5):		
EqC-FR Frequency Range (Basic or operational range) (note 2)	EqC-PET Primary Equipment Type (note 2)	EqC-SET Secondary Equipment Type (note 2)	EqC-EMO Equivalent Modulation Order (note 2)	EqC-ChS Channel Separation (MHz) (note 2)
.....	Multirate <input type="checkbox"/> Multiformat <input type="checkbox"/> Mixed-mode <input type="checkbox"/> (note 6)	
		
		
		
NOTE 1: This is the formal system name reported on the Declaration of Conformity in accordance with the Directive 2014 /53/EU [i.1], article 3.2 through the present document.				
NOTE 2: For definitions, Annex D should be referred. Some EqC likely require single entry, however, for further information, if it is the case, new rows should be added for additional entries required.				
NOTE 3: Includes the actual frequency range(s) of the system covered by the Declaration of Conformity according to Directive 2014/53/EU [i.1], article 3.2.				
NOTE 4: The classification given in clause 1.3.3 of ETSI EN 302 326-3 [i.2] (e.g. directional, sectored-single beam, sectored multibeam, omnidirectional). CS antennas for sector angles less than 15° should be labelled as "sectored 2α < 15°". Symmetric or asymmetric elevation RPE should also be mentioned.				
NOTE 5: As for antenna type, for due information, it may be indicated according the polarization possibility given in clause 1.3.3 of ETSI EN 302 326-3 [i.2] (e.g. linear, circular) including single or dual polarization and actual V and/or H or tilted axes information.				
NOTE 6: Multirate and/or multiformat systems (see Annex B) or mixed mode systems should tick the appropriate box(es) and list the offered combinations of EMO and ChS for each capacity (bit rate) offered.				

Annex H (informative): System architecture

H.1 General architecture

Multipoint fixed wireless systems are characterized by systems architectures in which a number of stations are interconnected by radio to deliver services from one or more core network connection points to connections to terminal equipment.

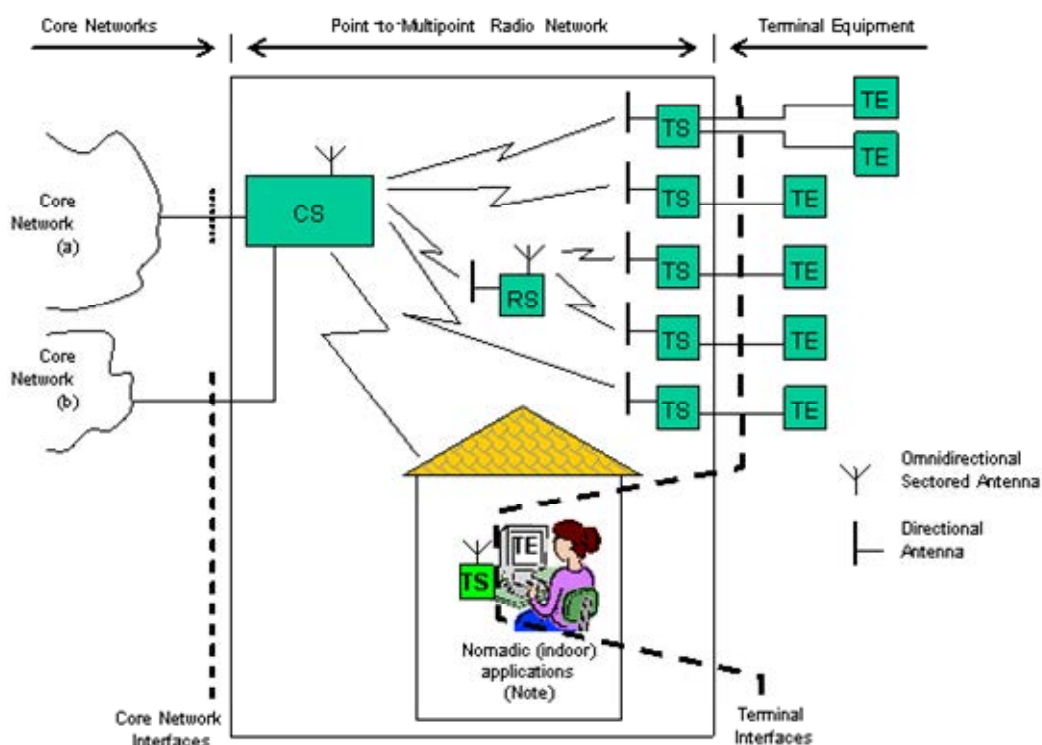
Architectures currently covered by the present document are:

- Point-to-MultiPoint (P-MP).
- Mesh or MultiPoint-to-MultiPoint (MP-MP).

The next two clauses describe these architectures and Figures H.1 and H.2 show representative examples of such systems.

H.2 Point-to-MultiPoint (P-MP) architectures

In a Point-to-MultiPoint system, a Central Station communicates with Terminal Stations, occasionally via Repeater Stations, and exceptionally via further cascaded Repeater Stations. In the example of Figure H.1, the Central Station uses a sectored or omni directional antenna in a Point-to-Multipoint configuration, serving three Terminal Stations directly and two via a Repeater Station.



NOTE: Omnidirectional indoor TS antennas limited to Nomadic Wireless Access (NWA) applications in bands 3,4 GHz to 3,8 GHz.

Figure H.1: Representative example of a Point-to-MultiPoint radio network

In the given example:

- **CS** is a Central Station, which interfaces to the core network.
- **TE** is Terminal Equipment (under user ownership and responsibility, not in the scope of present document).
- **TS** is a Terminal Station connected to one or more Terminal Equipment units.
- **RS** is a Repeater Station which provides a radio repeater outstation function.

Any specific equipment in a Point-to-MultiPoint system can be classified as a CS, a TS or a RS. The station type (EqC-STN) for a particular equipment is identified by the Equipment Identification Code, which also determines which parts of the standard apply to that specific equipment. Annex C addresses EqC.

The Central Station provides, in addition to its function as an interface to the core network, a control function in the system (e.g. to allocate radio system capacity on a demand basis). The CS may be distributed between locations interconnected by digital transmission wired links (for example: an indoor part, containing the digital data processing and other access managing functions, collocated with a central exchange and an outdoor part (or parts), containing the radio frequency TX and RX front-ends, located where convenient for radio coverage).

In a Point-to-MultiPoint system, the Repeater Station simply acts as a relay for a signal received from a Central Station to the Terminal Stations or further Repeater Stations. In the opposite direction the Repeater station transfers the signal received from the Terminal Stations and possible Repeater Stations back to the Central Station.

In this mode of operation the Repeater Station can serve one or more terminals, covering areas shielded by physical obstacles. The Repeater Stations typically utilize a directional antenna facing the Central Station or "upstream" Repeater Station and a directional, sectored or omni directional antenna facing the Terminal Stations or "downstream" Repeater Station(s).

A Terminal Station communicates with either a single Central Station or a single Repeater Station.

Terminal Stations normally use a directional antenna to communicate with Repeaters or Central Stations. Only in the band 3,4 GHz to 3,8 GHz, Terminal Stations with typically indoor omnidirectional antennas for NWA applications (e.g. desk antenna or lap-top RLAN-like antennas) are used.

When a multipoint radio system is deployed in the access telephony network, it may be appropriate to connect the CS to a local exchange, in which case the Core Network Interface (see Figure H.1) between the CS and the local exchange forms the Service Node Interface (SNI), as described, i.e. in ETSI EG 202 306 [i.24]. Alternatively, where the CS incorporates local exchange functionality (e.g. the CS may incorporate an ATM switch interfacing into an ATM network), it may be appropriate to connect the CS directly to a trunk or international exchange, in which case the interface between the CS and the exchange forms the NNI (Network Node Interface). In either case, the Terminal Interface (see Figure H.1) between the RS or TS and the Terminal Equipment forms the User Network Interface (UNI), as described in ETSI EG 202 306 [i.24]. Similar options apply when the radio system provides access functionality for IP services.

When broadcast or private networks are concerned, different interfaces are also possible. For private networks, customer interfaces can also be used to connect to the Terminal Equipment.

In the case where the multipoint radio system provides backhaul facilities for a different service, (e.g. for mobile base stations interconnections), the multipoint system will usually provide a "bit pipe" between remote nodes (equivalent to Terminal Equipment on the diagram) and core network nodes.

It should also be noted that Central Stations may not be co-located with core network nodes and the connection between the two may be supplied by point-to-point radio links, optical fibre links, or other means.

In some networks, subscriber to subscriber connections may also be provided by multipoint radio systems, instead of using external core network. In this case, connections between Central Stations can be carried out by point-to-point radio links, optical fibre links, or by other means.

H.3 Mesh (or MP-MP) architectures

In Mesh architectures different stations are connected as an adaptable network, using individual station to station links. In this case, the network may be designed to provide multiple paths to each individual station. In Figure H.2, seven Repeater Stations operate as a Mesh network communicating via directional antennas and interfacing to Terminal Equipment and Core Networks.

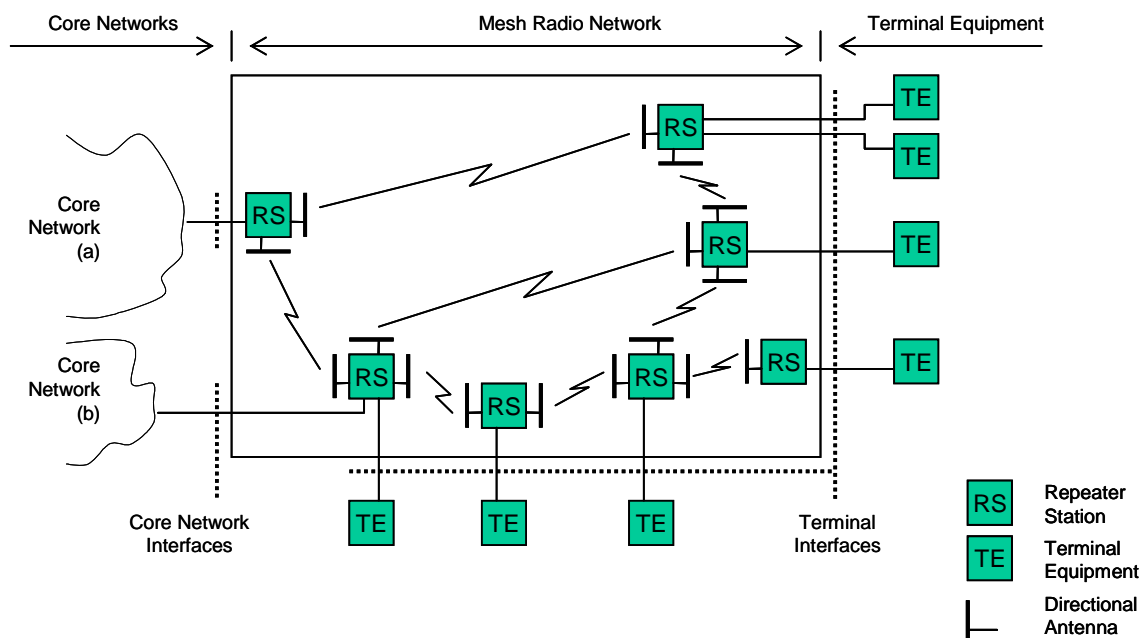


Figure H.2: Representative example of a Mesh radio network using directional antennas

In the given example:

- **TE** is **Terminal Equipment** (under user ownership and responsibility, not in the scope of present document).
- **RS** is a **Repeater Station** which provides a radio repeater outstation function and usually interfaces to one or more Terminal Equipment units and/or one or more Core Networks. All stations in a Mesh system within the scope of the present document are RSs. Such stations use directional antennas only.

Any specific equipment in a Mesh system that is within the scope of the present document is intended to be a RS. The Station Type (EqC-STN) for a particular equipment is one of the key components the Equipment Classification of that equipment which determines which parts of the standard apply to that equipment. Annex C addresses the EqC types.

In addition to the radio repeating functionality, the Repeater Station in Mesh networks may additionally terminate or re-route local traffic. Therefore, an RS in a mesh network, acts as a node in the network and transmits traffic by selecting the optimum link to reach its required destination (based on quality information gathered from the overall network); additionally, it routes the source and/or terminating traffic directly to the Terminal Equipment and/or Core Network, as appropriate.

Annex I (informative): Mixed-mode operation

I.1 Introduction

This annex is intended to offer guidance on the application of spectrum density masks and receiver interference immunity in the context of mixed-mode systems.

I.2 General description of mixed-mode systems

Systems applying mixed-mode technology use different modulation orders according to the actual network needs.

The different modulation order can be selected by a simple pre-setting, defining which modulation order is to be used by a particular CS or TS. Systems offering this functionality are referred as "preset-mode systems".

Once a modulation order has been selected, the spectrum mask and other requirements considered in clause 5.3.4 apply. Preset-mode (or "multi-format") systems also have the capability to change the modulation order through remote controls according to the operator and customer needs.

The term "mixed-mode systems" is appropriate when the modulation order can be changed dynamically, for example:

- A TDMA CS might use different modulation orders on a slot-by-slot base according to the TS addressed by that slot. An FDMA CS might use different modulation orders on a carrier-by-carrier basis. The modulation order might also be changed to adapt to varying propagation channel impairments, or for a change in service profile.
- The corresponding TS would use one modulation order until the network situation changes due to either propagation channel impairments, or a change in service profile (e.g. a different service profile can be achieved by using a more robust modulation or a higher spectral efficiency).

I.3 Background for transmitter and receiver requirements operating in mixed-mode

I.3.1 Requirements summary

The sole requirement for a transmitter Radio Frequency spectrum mask and receive interference performance should be to ensure that inter-system frequency planning can be performed with the predefined acceptable level of interference between systems deployed in adjacent geographical areas or in adjacent frequency blocks in the same geographical area (e.g. considered to be the frequency ranges assigned to different operators).

The intra-system receiver co-channel and adjacent channel sensitivity performance of a system deployed by an operator within its assigned block can be achieved by system itself.

I.3.2 Transmitter Radio Frequency spectrum masks for mixed-mode systems

The manufacturer should declare the modulation orders (in terms of declared EMOs) that the equipment is designed to comply with the appropriate mask of the specific EMO given in the present document. The planning assumptions are normally based on the least stringent mask permitted by the licence.

All relevant requirements apply for the assessment of essential requirements under article 3.2 of the Directive 2014/53/EU [i.1]. It is assumed that, when operational, the system should meet the mask of the lowest licensed EMO, in terms of power density in dBm/MHz. To optimize service, the system is able to adjust the power of the more complex modulation formats even if exceeding their own mask, provided that the least stringent absolute power density mask is always met in all static and transient conditions, including any training bursts or reference signals. It should be noted that a possible overlapping of EMO masks would occur if the same peak power is used for all EMOs, due to the first roll-off point P(1) of the EMO = 6 mask lying outside the envelope of the EMO = 2 and EMO = 4 masks. However, the less stringent masks do not need to be further relaxed because the overlapping condition is very unlikely to occur in deployed mixed-mode systems, for the following reasons:

- 1) There is a significant power drop with higher modulation orders (due to power amplifier back off) that automatically "solves" the overlapping problem, as shown in Figure I.1.
- 2) For frequency coordination purposes, a mixed-mode system will not be worse than a single-mode system employing the lowest licensed EMO.

An example is shown in Figure I.1, where the output powers of the actual higher modulation orders are increased (in any case within the limits given in clause 5.3.2) slightly to optimize service, but are always maintained at a sufficient margin below the absolute EMO = 2 (e.g. 4 QAM) power so that all portions of their spectrum masks remain below the lowest EMO = 2 transmitter Radio Frequency spectrum mask.

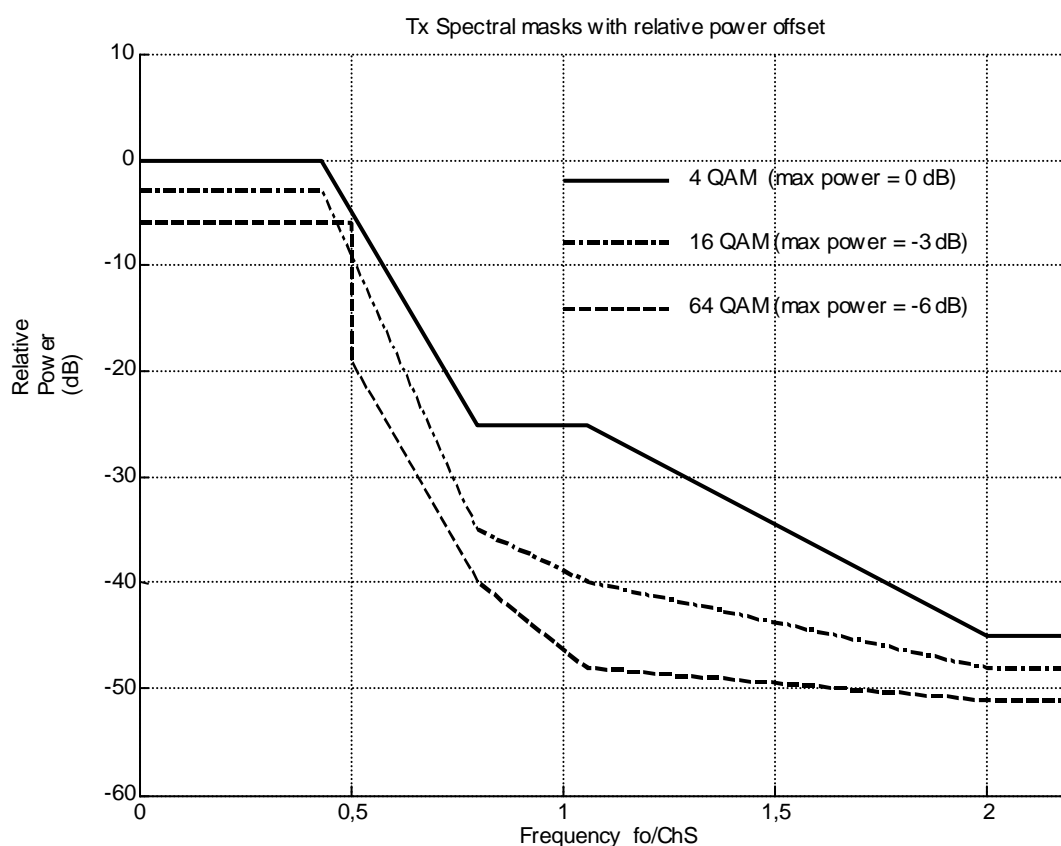


Figure I.1: Transmitter Radio Frequency spectrum masks of 16 QAM and 64 QAM with powers adjusted to remain below the 4 QAM mask

1.3.3 Receiver adjacent channel interference sensitivity

In order to achieve satisfactory spectrum utilization within the frequency range (block) assigned to the operator, particularly where the capacity of a cell is increased by the use of more than one channel per sector, mixed-mode systems should be required to operate in adjacent channels over the same physical link in precisely the same way that single-mode systems are required to operate. As a consequence, that a mixed-mode system should be required, for each actual modulation order used, to meet the related EMO adjacent channel performance specification, with all combinations of interfering actual modulation order (including training bursts).

For example, in a mixed-mode TDMA system offering QAM states of 4, 16 and 64 (EMO = 2, 4, and 6 respectively), a time slot which is operating at 64 QAM should meet the adjacent channel performance specification for 64 QAM with an adjacent channel interfering signal of 4 QAM, 16 QAM or 64 QAM. Similarly, a timeslot which is operating at 4 QAM should meet the adjacent performance specification for 4 QAM with an adjacent channel interfering signal of 4 QAM, 16 QAM or 64 QAM.

1.3.4 Receiver co-channel interference sensitivity

Receiver co-channel interference can occur where the interfering and victim systems are geographically separated or operating on different sectors. In both cases it is extremely unlikely (and spectrally inefficient) that the TDMA frames of the two systems would be synchronized and that the timeslots within each system's frames would operate on identical modulation orders. It therefore follows that the receiver co-channel interference sensitivity specification for each victim modulation order offered should be met with an interfering signal of any modulation order offered (including training bursts), in the same way as for the adjacent channel performance. However, unlike the adjacent channel case, the receiver co-channel interference sensitivity performance would not generally depend on the interfering transmitter modulation.

Annex J (informative): Antennas

J.1 Antenna generality

Various types of antennas for Multipoint system antennas are available, e.g. directional, sectorial, multi-sectorial, omni-directional (including fixed or adaptive beam). ETSI EN 302 326-3 [i.2] gives non exhaustive information on their use for BS, RS and TS.

Provided that MP systems operate within spectrum blocks for exclusive use of one operator only, the antenna gain and directional characteristics are not assumed relevant to essential requirement under article 3.2 of the Directive 2014/53/EU [i.1].

For information only, some "passive" antenna characteristics for the bands in the scope of the present document are reported in ETSI EN 302 326-3 [i.2]. However, those characteristics are not exhaustive in reflecting all possible types on the market (e.g. adaptive antennas are not included); nevertheless, they can be use as reference whenever specific characteristics are not known.

J.2 Antenna profiles

According to their characteristics, multipoint systems use different types of antennas. Table J.1 provides an overview of multipoint antenna types described in ETSI EN 302 326-3 [i.2].

Annex B of ETSI EN 302 326-3 [i.2] discusses also the Antenna Profiles for multipoint systems.

Table J.1: Antenna Types

Frequency Range	Types	Polarization	Notes
1 GHz to 3 GHz	Directional Sectored single beam Omni directional	Linear	The sectored and omni directional antennas may have a symmetric or asymmetric radiation pattern in the elevation plane.
3 GHz to 11 GHz	Directional Sectored single beam Sectored multibeam (up to 5,9 GHz only) Omni directional	Linear	The sectored single and omni directional 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 Omni directional	Circular	The sectored and omni directional 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 43,5 GHz	Directional Sectored single beam Omni directional	Linear	The omni directional antennas may have a symmetric or asymmetric radiation pattern in the elevation plane.

The present document is applicable to multipoint antennas using either linear (single or dual) polarization or 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 the interference considerations in network planning. A number of antenna options are defined in ETSI EN 302 326-3 [i.2] to allow a trade-off between necessary RPE directivity and station/installation constraints.

Annex K (informative): Typical reference model for BER, MGBR and EMO

K.1 General

Directive 2014/53/EU [i.1] requires the adoption of proper techniques to use the spectrum effectively. A large number of factors contribute to the spectral efficiency of a deployed system, but two key parameters have historically been recognized and specified for digital systems: Minimum Gross Bit Rate (MGBR) and modulation order. Historically, FDMA systems have specified the payload data rate in terms of number of 64 Kbit/s channels, while systems employing other access methods have defined the MGBR as the instantaneous bit rate applied to the modulator when user data are carried.

Due to the addition of functionality not present in previous systems, such as Forward Error Correction (FEC) and payload processing, the definitions of Minimum Gross Bit Rate (MGBR) and Modulation Order (MO) have become potential sources of misunderstanding, when compared to elder systems.

It should be noted that the data rate currently specified for Point-to-Point systems is reduced by overhead used for error correction. Without a new commonly harmonized definition of data rate, Point-to-Point systems appear less spectrally efficient than Multipoint systems for the given reason.

For all systems currently within the scope of the present document, the rate at which symbols, understood as distinct states of the analogue signal output from the modulator, are transmitted is a constant and is referred to as the symbol rate.

For the purpose of the present document, a new parameter is defined, Equivalent Modulation Order (EMO) representing the ratio of the bit rate (during a transmission burst, if applicable) at the chosen reference point to the symbol rate. In systems without FEC, the EMO is equivalent to the modulation order. This definition of EMO is independent of duplex method (e.g. FDD or TDD).

This annex describes a typical reference architecture of the multipoint radio equipment which may be used by a manufacturer to define the reference point where the which measurement of Bit Error Ratio (BER) can be made, and Minimum Gross Bit Rate (MGBR) and Equivalent Modulation Order (EMO) are declared. The EMO declaration should be limited to one of the values in the appropriate equipment profile. It should be noted that for certain types of systems this architecture may vary, in which case this annex may be of limited applicability.

The reference architecture described in Figure K.1 should be considered as an expansion of the blocks between and including the payload processing and modulation (demodulation for the receive direction) blocks in the system reference architecture shown in Figure 2. The reference points X'_N and E' correspond to the equivalent points in the system reference architecture shown in Figure 2. The reference point Z' in the system reference architecture is not directly related to any reference point in the architecture described in this annex. The reference points P to T within the architecture described in this annex are specific to this annex and do not directly correspond to the reference points in the system reference architecture shown in Figure 2.

The reference architecture for the transmit direction is shown in Figure K.1. The architecture for the receive direction is a mirror image of the transmit direction, although it should be noted that certain functions, such as ARQ, require interaction between the transmit and receive data streams.

The reference points in this architecture are conceptual and may not relate to an accessible physical interface in the equipment.

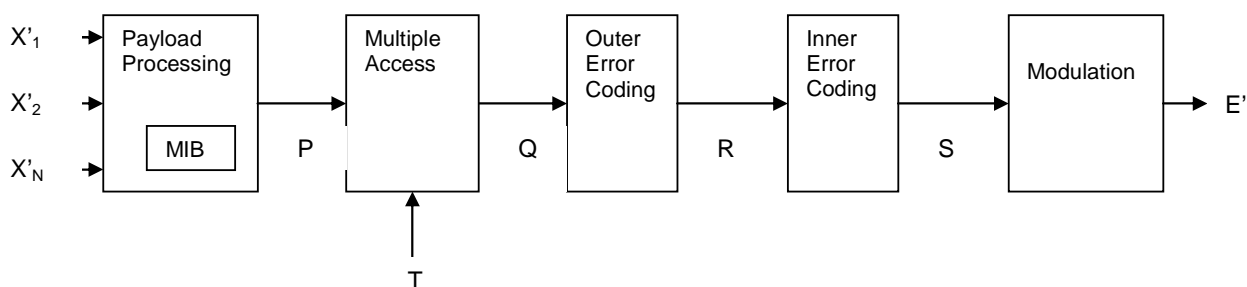


Figure K.1: Reference architecture - transmit direction

K.2 Interface X'_1 to X'_N

The reference points are the points of connection between the radio equipment and the terminal or network equipment from which user data are submitted to the radio equipment for transmission.

It should be noted that the raw data rates at points X'_1 to X'_N may not have a direct relationship to the data rate over the air. As an example, interfaces such as 100baseT may be present at these reference points although the data rate of the radio system may only be in the order of a few Mbit/s.

K.3 Payload processing block

The payload processing block provides a range of functions to extract, switch and process user data presented at interfaces X'_1 to X'_N , so that they can be transmitted over the radio link as output at reference point P.

Some management protocols, such as Simple Network Management Protocol (SNMP) operate using data which are encoded as packets in the same or similar way as the user data and are transmitted in the same data stream as the user data. These protocols typically control and monitor the hardware parameters of the equipment via a data array called the Management Information Block (MIB). Given the similarity, in this case, of the transmission of network management data to the transmission of user data, it is appropriate to include such functions in the payload processing block.

Some systems provide Automatic Repeat reQuest (ARQ) error correction within the Data Link Control (DLC) function such that packets of data which are lost or received in error are caused to be retransmitted by the radio equipment. Since the proportion of the available data rate used by the protocol overhead of such systems is both variable and also low, it is appropriate to include ARQ within the payload processing block.

By this function, the error rate of user data is reduced to a very low value, at the expense of overhead and delay. Should this function be included when measuring the BER, it is important to account for the consequent loss of user capacity in evaluating the bit rate of the system, noting that the overhead will vary with the error rate of the channel. It should also be noted that the BER may be so low to be hardly measurable and that the delay may be both variable and indeterminate.

Where the payload processing includes a Multiple Access Control (MAC) layer, it is important to distinguish between this protocol layer, which is applicable to the user data interfaces, and the multiple access function described further on which is applicable to the appropriate routing between radio stations in the multipoint system. Under certain circumstances these two functions may be combined. It is then necessary to evaluate the effect of this function on the available bit rate of the system to convey user data between radio stations.

K.4 Multiple access block

The multiple access block accepts data from the payload processing block at reference point P.

At the CS, the function of the multiple access block is to split of data addressed to the different TSs and to present these data to the error correcting and modulation functions so that they will be received by the appropriate TS. There may be multiple instances of the error correcting and modulation functions.

At the TS, the function of the multiple access block is to transmit the data destined for the CS in a way to be independent from and not interfering with data from other TSs. There are several means by which this may be accomplished, such as placing data in separate timeslots or placing data in separate carriers.

In the specific case of DS-CDMA systems, the modulation process is preceded by the convolution of the output data for each channel with a code at a higher bit rate (the chip rate). As a consequence, the function of multiple access might be preceded by the outer error coding (see clause K.5) and following the inner error coding (see clause K.6).

Where the data are separated in the time domain, the multiple access block may generate timing signals to the modulator(s) to define, for example, the start of frames.

For Time Division Duplex (TDD), it may be appropriate to include the duplex control functions within the multiple access control block. Thus the selection of the reference point Q or R for the declared MGBR and EMO and the measurement of BER is not affected by the use of TDD, as opposed to FDD.

In the process of encoding and timing data in the multiple access block, network management may be introduced as data inserted at reference point T, shown in the Figure K.1. This information may be implemented in various forms, e.g. additional timeslots or additional carriers.

In certain systems packets of data from TSs may collide and are then retransmitted either if collisions are detected or the packets of data are not received. This function can be regarded as a multiple access technique, although the overhead of this multiple access function is not constant but rising with increasing traffic.

The data required to be transmitted, including additional data for access control and management, are passed to the outer error correcting block at reference point Q.

K.5 Outer error correcting block

Many systems provide two levels of Forward Error Correction (FEC) and it is usual to designate these as an outer (furthest from the modulator) and inner (nearest the modulator) code.

The outer error correction is not linked to the modulation process and could, in principle, operate on any bitstream. Such error correcting schemes typically operate by framing the data and then introducing a number of additional bits which may detect errors and, typically, correct a smaller number of such errors. Error correcting schemes of this type introduce a small overhead to the data stream but only correct errors at an error rate which introduces a small number of bit errors per frame. An example of such an error correcting scheme is Reed-Solomon coding.

The data required to be transmitted, including additional data introduced by the outer coding, are passed to the inner error correcting block at reference point R of Figure K.1.

K.6 Inner error correcting block

The inner error correction is linked to the modulation process. Typically, the error correction coding involves limiting the number of valid states that may be transmitted in each symbol, depending on the state of the preceding symbol. The separation between the permitted states of two successive symbols is thus larger than it would have been had any state been permitted for each symbol. Thus, the demodulation process will operate correctly in the presence of a larger noise compared to standard the case.

The inner error correcting block passes information to the modulator block at reference point S. Typically, for each symbol to be transmitted, the inner error correcting block provides a binary code which determines the state to be transmitted in the following symbol.

In the receive direction, the demodulator transfers to the inner error correcting block a decoded binary value representing the state of the received symbol (hard decoding). It may also pass a binary representation of the value of the received symbol (example the amplitude of the in-phase and quadrature elements of the received symbol) at a higher resolution (soft decoding) which permits more intelligent decision making by the inner decoder.

In the case of an inner error correction code placing a limit on the states which are permitted to be output via the modulator, it is appropriate to define the EMO according to the number of permitted states per symbol, rather than the total number of states the modulator may transmit.

Thus, for a QAM system without FEC with modulator transmitting any of 16 states, the EMO would be $\log_2(16) = 4$. In a QAM system using FEC which only permits 8 out of the 16 available states per symbol, the EMO would be $\log_2(8) = 3$.

K.7 Modulator

The modulator takes a digital representation of each symbol to be transmitted and uses this value to alter the parameters of an analogue signal (e.g. amplitude or phase) on a per symbol basis. The transition of these analogue parameters from one state to another is normally controlled by either filtering the baseband digital signals or filtering the output of the modulation process such that the output of the modulator is band limited.

The output of the modulator is presented at reference point E' to the following processes of translating the signal to the desired frequency and amplifying it to the desired level and impedance to match the feeder and antenna.

K.8 Choice of reference point for BER, MGBR and EMO

The declared MGBR and EMO should be chosen in accordance with the capacity of the system and any coding gain from the error correction balanced with a corresponding loss in MGBR. The reference point for BER and MGBR should be identical.

It should be such that the BER can be measured. The measurement can be performed by intercepting data directly at the reference point, by measuring the BER at the user interfaces with all error correction between the user interface and the reference point disabled, or any other method agreed with the test house (e.g. the use of internal diagnostic facilities).

In the typical reference architecture above, it would be appropriate to select either the reference point Q or R where BER is measured and MGBR and EMO are declared. This method removes any dependence on the nature of the payload processing and access control. In either case, the coding gain from the FEC is balanced against the consequent loss in MGBR enabling fair comparisons with other systems.

Where a FEC is used which combines the characteristics of inner and outer coding (e.g. Turbo coding), it would be appropriate to select reference point Q and reference point R would not exist.

Where the system comprises multiple instances of the error correction and modulation functions, the MGBR should be defined as the sum of MGBRs across all modulators.

K.9 Examples

K.9.1 16 QAM TDMA system with 3/4 rate convolutional coding

For a 16 QAM TDMA system with $3/4$ rate convolutional coding (e.g. Bidimensional 16TCM), the inner coding block is present, but not the outer coding block. Reference point Q does not exist and the multiple access block is connected directly to the inner coding block at reference point R.

For reference point R, the EMO would be $3/4 \times \log_2(16) = 3$.

K.9.2 16 QAM TDMA system with 1/2 rate convolutional coding and 204/188 Reed Solomon coding

For a 16 QAM TDMA system with 1/2 rate convolutional coding and 204/188 Reed Solomon coding, both coding blocks are present.

For reference point Q, the unconstrained EMO would be $188/204 \times 1/2 \times \log_2(16) = 1.843$. However, with the EMO constrained to be one of the permitted values in the profile, the declared EMO might be 1 or 2. For either declaration, both the bit rate per Hz and the BER specifications are both assumed to be met for the declared EMO.

K.9.3 16 QAM TDMA system with 1/2 rate turbo coding

Turbo coding can exceed the performance of concatenated (inner and outer) coding and, given a long enough block length, can approach the Shannon limit. It is therefore convenient to view turbo coding as equivalent to the combination of the inner and outer coding blocks, which are merged into one coding block with reference point R no longer applicable.

For the selection of reference point Q, the EMO would be $1/2 \times \log_2(16) = 2$.

K.9.4 16 QAM FDMA system with 1/2 rate convolutional coding

In a 16 QAM FDMA system with 1/2 rate convolutional coding, the multiple access block would be connected at point R to N multiple instances of the outer coding and modulator blocks, where N is the number of FDMA sub-channels.

In this case, for reference point R, the EMO would be $1/2 \times \log_2(16) = 2$ and the bit rate would be the sum of the bit rates at the multiple interface points R between the multiple access block and the N inner coding blocks.

Annex L (informative): Test interpretation and measurement uncertainty

Interpretation of the results recorded in a test report (of the measurements described in the present document) would be as follows:

- For the purposes of test, the limits in the present document are based on the "shared risk" of measurement uncertainty, e.g. if a measurement meets the requirements of the standard, even if it is within the calculated measurement uncertainties, it would be deemed compliant with the measurement parameter.
- If it fails to meet the requirements of a standard, even within measurement uncertainty, it is deemed to be not compliant with the measurement parameter.

Measurement uncertainty calculations should be based on the latest available ETSI guidelines (e.g. ETSI TR 100 028 [i.8] and, when radiated measurements are concerned, ETSI TR 102 215 [i.9]).

In conclusion:

- the measured value related to the corresponding limit is used to decide whether an equipment meets the requirements of the present document; Figure L.1 graphically shows this concept;
- the value of the measurement uncertainty for the measurement of each parameter is included in the test report.

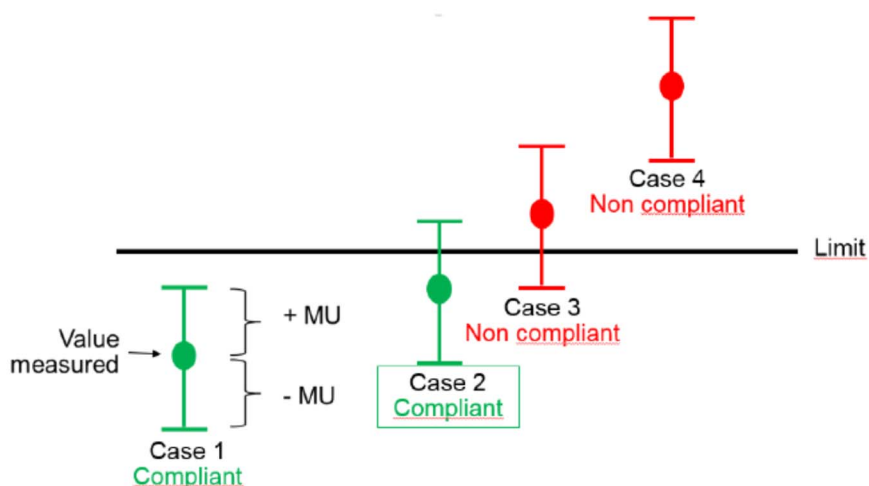


Figure L.1: Measurement Uncertainty (MU) and compliance to the limit

Annex M (informative): Bibliography

- 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".
- Recommendation ITU-R SM.329: "Unwanted emissions in the spurious domain".
- CEPT/ECC/REC(01)05: "List of parameters of digital point-to-point fixed radio links used for national planning".
- Recommendation ITU-R F.1249-1 (2000): "Maximum equivalent isotropically radiated power of transmitting stations in the fixed service operating in the frequency band 25.25 - 27.5 GHz shared with the inter-satellite service".

Annex N (informative): Change History

Version	Information about changes
V1.1.1	First publication as HS under Directive 1999/5/EC
V1.1.2	Editorial revision
V1.2.2	Introduction of new applications in 3,4-3,8 GHz band, including indoor TggS
V2.1.1	Full revision under Directive 2014/53/EU: <ul style="list-style-type: none">- Added new requirements for RX intermodulation and RX dynamic range- Added requirements for equipment in band 40,5 GHz to 43,5 GHz- Incorporation of relevant informative text from ETSI EN 302 326-1 (Part 1 no longer supported)- Overall editorial and technical updating of old text

History

Document history		
V1.1.1	December 2005	Publication
V1.1.2	March 2006	Publication
V1.2.2	June 2007	Publication
V2.1.0	August 2020	EN Approval Procedure AP 20201119: 2020-08-21 to 2020-11-19
V2.1.1	June 2021	Vote V 20210829: 2021-06-30 to 2021-08-30
V2.1.1	September 2021	Publication