Draft ETSI EN 302 217-2 V3.3.0 (2021-06)


# Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2: Digital systems operating in frequency bands from 1 GHz to 86 GHz; Harmonised Standard for access to radio spectrum

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REN/ATTM-0450

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# Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.61] 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 is part 2 of a multi-part deliverable covering Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas. Full details of the entire series can be found in ETSI EN 302 217-1 [5].

| **Proposed national transposition dates** | |
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| Date of latest announcement of this EN (doa): | 3 months after ETSI publication |
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Major changes with respect to previously published versions are summarized in annex U.

# Modal verbs terminology

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

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

# Introduction

The ETSI EN 302 217 series has been produced in order to rationalize a large number of previous ETSI ENs dealing with equipment and antennas for Point-to-Point (P-P) Fixed Service applications. For more details, see foreword in ETSI EN 302 217-1 [5].

In the present document the "*italic"* font is used for "terms" defined in clause 3.1 of ETSI EN 302 217-1 [5].

# 1 Scope

The present document specifies technical characteristics and methods of measurements for Point-to-point (P-P) Digital Fixed Radio Systems (DFRS) operating in frequency bands allocated to Fixed Service (FS) from 1 GHz to 86 GHz, corresponding to the appropriate frequency bands from 1,4 GHz to 86 GHz as described in annex B to annex J.

Systems in the scope of the present document are generally intended to operate in full Frequency Division Duplex (FDD) and cover also unidirectional applications. Time Division Duplex (TDD) applications, when possibly applicable in a specific band, are explicitly mentioned as appropriate in annex B through annex J.

Systems may be composed by equipment without antennas (see informative annex Q for background) or equipment including *integral* or *dedicated antenna*, both cases are in the scope of the present document.

The present document covers requirements to demonstrate that radio equipment both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference

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

# 2 References

## 2.1 Normative references

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

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

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

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

[1] ETSI EN 301 126-1 (V1.1.2) (09-1999): "Fixed Radio Systems; Conformance testing; Part 1: Point-to-point equipment - Definitions, general requirements and test procedures".

[2] ETSI EN 301 126-3-1 (V1.1.2) (12-2002): "Fixed Radio Systems; Conformance testing; Part 3-1: Point-to-Point antennas; Definitions, general requirements and test procedures".

[3] CEPT/ERC/REC 74-01 (May 2019): "Unwanted emissions in the spurious domain".

[4] 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".

[5] ETSI EN 302 217-1 (V3.3.0): "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 1: Overview, common characteristics and requirements not related to access to radio spectrum".

NOTE: This revised version of ETSI EN 302 217-1 is included in the same EN AP together with the present document.

[6] ETSI EN 302 217-4 (V2.1.1) (05-2017): "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4: Antennas".

[7] Recommendation ITU-T O.151 (10-1992)/Corrigendum 1 (05-2002): "Error performance measuring equipment operating at the primary rate and above".

[8] Recommendation ITU-T O.181 (05-2002): "Equipment to assess error performance on STM-N interfaces".

[9] Recommendation ITU-T O.191 (02-2000): "Equipment to measure the cell transfer performance of ATM connections".

[10] IEEE 802.3™-2018: "IEEE Standard for Ethernet".

[11] ITU Radio Regulations (2020).

[12] ITU-R Resolution 750 (REV.WRC-19): "Compatibility between the Earth exploration-satellite service (passive) and relevant active services".

[13] 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".

[14] 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

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

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

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

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

[i.2] ETSI EG 203 336 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); 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.3] CEPT/ERC/REC (01)02 (2019): "Preferred channel arrangement for digital fixed service systems operating in the frequency band 31.8 - 33.4 GHz".

[i.4] CEPT/ERC/REC 12-02 (2007): "Harmonized radio frequency channel arrangements for analogue and digital terrestrial fixed systems operating in the band 12.75 GHz to 13.25 GHz".

[i.5] CEPT/ERC/REC 12-03 (2019): "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 17.7 GHz to 19.7 GHz".

[i.6] CEPT/ERC/REC 12-05 (2007): "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.0 - 10.68 GHz".

[i.7] CEPT/ERC/REC 12-06 (2019): "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.7 GHz to 11.7 GHz".

[i.8] CEPT/ERC/REC 12-07 (1996): "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 14.5 - 14.62 GHz paired with 15.23 - 15.35 GHz".

[i.9] CEPT/ERC/REC 12-08 (1998): "Harmonized radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3600 MHz to 4200 MHz".

[i.10] CEPT/ERC/REC 12-11 (2015): "Radio frequency channel arrangement for fixed service systems operating in the bands 48.5-50.2 GHz and 50.9-52.6 GHz".

[i.11] CEPT/ERC/REC 12-12 (2015): "Radio frequency channel arrangement for fixed service systems operating in the band 55.78-57.0 GHz".

[i.12] CEPT/ERC/REC 14-01 (2014): "Radio-frequency channel arrangements for high capacity analogue and digital radio-relay systems operating in the band 5925 MHz - 6425 MHz".

[i.13] CEPT/ERC/REC 14-02 (2014): "Radio-frequency channel arrangements for medium and high capacity analogue or high capacity digital radio-relay systems operating in the band 6425 MHz - 7125 MHz".

[i.14] CEPT/ERC/REC 14-03 (1997): "Harmonized radio frequency channel arrangements for low and medium capacity systems in the band 3400 MHz to 3600 MHz".

[i.15] CEPT/ERC/REC T/R 12-01 (2019): "Preferred channel arrangements for fixed service systems operating in the band 37-39.5 GHz".

[i.16] CEPT/ERC/REC T/R 13-01 (2010): "Preferred channel arrangements for fixed services systems operating in the frequency range 1-2.3 GHz".

[i.17] CEPT/ERC/REC T/R 13-02 (2010): "Preferred channel arrangements for fixed services systems in the frequency range 22.0 - 29.5 GHz".

[i.18] CEPT ECC/REC (01)04 (2014): "Recommended guidelines for the accommodation and assignment of Fixed Multimedia Wireless Systems (MWS) and Point-to-point (P-P) Fixed Wireless Systems in the frequency band 40.5-43.5 GHz".

[i.19] ECC Report 198: "Adaptive modulation and ATPC operations in fixed point-to-point systems - Guideline on coordination procedures".

[i.20] CEPT ECC/REC (02)02 (2010): "Channel arrangement for digital fixed service systems (point-to-point and point-to-multipoint) operating in the frequency band 31 - 31.3 GHz".

[i.21] CEPT ECC/REC (02)06 (2015): "Preferred channel arrangements for digital fixed service systems operating in the frequency range 7125-8500 MHz".

[i.22] CEPT ECC/REC (05)02 (2009): "Use of the 64 - 66 GHz frequency band for Fixed Service".

[i.23] CEPT ECC/REC(05)07 (2013): "Radio frequency channel arrangements for fixed service systems operating in the bands 71-76 GHz and 81-86 GHz".

[i.24] CEPT ECC/REC(09)01 (2009): "Use of the 57 - 64 GHz frequency band for point-to-point Fixed Wireless Systems".

[i.25] CEPT ECC/REC(14)06 (2015): "Implementation of Fixed Service Point-to-Point narrow channels (3.5 MHz, 1.75 MHz, 0.5 MHz, 0.25 MHz, 0.025 MHz) in the guard bands and centre gaps of the lower 6 GHz (5925 to 6425 MHz) and upper 6 GHz (6425 to 7125 MHz) bands".

[i.26] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[i.27] ETSI TR 101 506 (V2.1.1): "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements covering article 3.2 of Directive 2014/53/EU to Fixed Radio Systems".

[i.28] ETSI TR 101 854: "Fixed Radio Systems; Point-to-point equipment; Derivation of receiver interference parameters useful for planning fixed service point-to-point systems operating different equipment classes and/or capacities".

[i.29] 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.30] ETSI TR 102 243-1: "Fixed Radio Systems; Representative values for transmitter power and antenna gain to support inter- and intra-compatibility and sharing analysis; Part 1: Digital point-to-point systems".

[i.31] ETSI TR 102 565: "Fixed Radio Systems (FRS); Point-to-point systems; Requirements and bit rates of PtP Fixed Radio Systems with packet data interfaces, effects of flexible system parameters, use of mixed interfaces and implications on IP/ATM networks".

[i.32] ETSI TR 103 103: "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.33] Recommendation ITU-R F.382-8: "Radio-frequency channel arrangements for fixed wireless systems operating in the 2 and 4 GHz bands".

[i.34] Recommendation ITU-R F.383-9: "Radio-frequency channel arrangements for high capacity fixed wireless systems operating in the lower 6 GHz (5 925 to 6 425 MHz) band".

[i.35] Recommendation ITU-R F.384-11: "Radio-frequency channel arrangements for medium and high capacity digital fixed wireless systems operating in the 6 425-7 125 MHz band".

[i.36] Recommendation ITU-R F.385-10: "Radio-frequency channel arrangements for fixed wireless systems operating in the 7 110-7 900 MHz band".

[i.37] Recommendation ITU-R F.386-9: "Radio-frequency channel arrangements for fixed wireless systems operating in the 8 GHz (7 725 to 8 500 MHz) band".

[i.38] Recommendation ITU-R F.387-12: "Radio-frequency channel arrangements for fixed wireless systems operating in the 10.7-11.7 GHz band".

[i.39] Recommendation ITU-R F.497-7: "Radio-frequency channel arrangements for fixed wireless systems operating in the 13 GHz (12.75-13.25 GHz) frequency band".

[i.40] Recommendation ITU-R F.595-10: "Radio-frequency channel arrangements for fixed wireless systems operating in the 17.7-19.7 GHz band".

[i.41] Recommendation ITU-R F.635-7: "Radio-frequency channel arrangements based on a homogeneous pattern for fixed wireless systems operating in the 4 GHz band".

[i.42] Recommendation ITU-R F.636-4: "Radio-frequency channel arrangements for fixed wireless systems operating in the 14.4-15.35 GHz band".

[i.43] Recommendation ITU-R F.637-4: "Radio-frequency channel arrangements for fixed wireless systems operating in the 21.2-23.6 GHz band".

[i.44] Recommendation ITU-R F.746-10: "Radio-frequency arrangements for fixed service systems".

[i.45] Recommendation ITU-R F.747-1: "Radio-frequency channel arrangements for fixed wireless systems operating in the 10-10.68 GHz band".

[i.46] Recommendation ITU-R F.748-4: "Radio-frequency arrangements for systems of the fixed service operating in the 25, 26 and 28 GHz bands".

[i.47] Recommendation ITU-R F.749-3: "Radio-frequency arrangements for systems of the fixed service operating in sub-bands in the 36-40.5 GHz band".

[i.48] Recommendation ITU-R F.1098-1: "Radio-frequency channel arrangements for fixed wireless systems in the 1 900 - 2 300 MHz band".

[i.49] Recommendation ITU-R F.1099-5: "Radio-frequency channel arrangements for high and medium capacity digital fixed wireless systems in the upper 4 GHz (4 400-5 000 MHz) band".

[i.50] Void.

[i.51] Recommendation ITU-R F.1191-3: "Necessary and occupied bandwidths and unwanted emissions of digital fixed service systems".

[i.52] Recommendation ITU-R F.1242-0: "Radio-frequency channel arrangements for digital radio systems operating in the range 1 350 MHz to 1 530 MHz".

[i.53] Recommendation ITU-R F.1243-0: "Radio-frequency channel arrangements for digital radio systems operating in the range 2 290-2 670 MHz".

[i.54] Recommendation ITU-R F.1496-1: "Radio-frequency channel arrangements for fixed wireless systems operating in the band 51.4-52.6 GHz".

[i.55] Recommendation ITU-R F.1497-2: "Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz".

[i.56] Recommendation ITU-R F.1520-3: "Radio-frequency arrangements for systems in the fixed service operating in the band 31.8-33.4 GHz".

[i.57] Recommendation ITU-R F.2005-0: "Radio-frequency channel and block arrangements for fixed wireless systems operating in the 42 GHz (40.5 to 43.5 GHz) band".

[i.58] Recommendation ITU-R F.2006-0: "Radio-frequency channel and block arrangements for fixed wireless systems operating in the 71-76 and 81-86 GHz bands".

[i.59] Recommendation ITU-R SM.329-12: "Unwanted emissions in the spurious domain".

[i.60] 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.61] 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.

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 302 217-1 [5] apply.

## 3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 302 217-1 [5] apply.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 302 217-1 [5] apply.

# 4 Technical requirements specifications

## 4.0 Generality

### 4.0.1 The "Manufacturer declarations" 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 (declaration) those covered by its equipment design in order to apply the relevant requirements.

In addition, some parameters, even if not related to the assessment of article 3.2 of Directive 2014/53/EU [i.1], should nevertheless be univocally known because indirectly correlated to the assessment method of other ones.

Therefore in the present document, whenever the words "(manufacturer) declaration" or "declared (by 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 are related only to:

- Operational options selected (e.g. available reference-modes) for the equipment design among the many required in the worldwide market.
- Nominal values (e.g. Nominal TX power and ATPC/RTPC ranges), 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).
- Performance better than the minimum requirement specified in the present document (e.g. better RX sensitivity).

### 4.0.2 Basic understanding of all requirements

For the correct understanding and application of the requirements in the present document, the definitions summarized in ETSI EN 302 217-1 [5] are also relevant; those definitions are generally hereby identified with the use of *italic characters* (e.g. *mixed-mode*).The present document summarizes all requirements applicable to Digital P-P systems operating in frequency bands from 1 GHz to 86 GHz. Consequent to a large variance of the practical links deployed in the field as regulated by the link licensing conditions, based on the usual link-by-link planning according to common national and international planning rules, the equipment, in each band may present a wide option of operational characteristics for following such link-by-link licensing conditions.

Therefore, it shall be understood that each requirement in the normative part and normative annexes of the present document shall be fulfilled in whichever operative conditions permitted within the range specified by the manufacturer. The fact that each requirement is accompanied by some "test conditions" for a common minimum test reports (referred in annex V (h) of Directive 2014/53/EU [i.1], assumed to be reasonably severe, shall not be intended as a potential safeguard whenever a different non-compliant condition is still found within the operational range specified by the manufacturer.

For example, in the case of wide radio-frequency bands tuneable units and *multirate* equipment, specifications shall be met at any frequency, at any rate/format; the latter, for *mixed-mode* and/or *bandwidth-adaptive* systems, is intended as any rate/format defined by the manufacturer as *reference-mode* (see note).

Also, when *channels-aggregation* equipment is concerned, it is considered that all TX and RX requirements in the present document shall be met by each *aggregated channel* when all *aggregated channels* emissions are turned on and operating according to normal operating conditions specified by the manufacturer.

When *multi-carrier* systems (see definition in ETSI EN 302-217-1 [5]) are concerned, the requirements related to TX output power and to Receiver Signal Level (RSL) are intended to be applied to the total power integrated for all sub-carriers (see example).

EXAMPLE: In case of two equal sub-carriers, the RSL of each sub-carrier is intended to be 3 dB less than the total RSL power specified in the present document.

NOTE: The terms *channels-aggregation, aggregated channel, multirate, mixed-mode, bandwidth-adaptive* and *reference-mode* are defined in ETSI EN 302 217-1 [5]. It is generally intended that the chosen *reference-modes* are those more suitable for the link planning purpose. See more information on ECC Report 198 [i.19].

## 4.1 Framework for categorization of system

### 4.1.1 Introduction and equipment flexibility

Guidance and description of the phenomena relevant to "essential requirements" under article 3.2 of Directive 2014/53/EU [i.1] are given in ETSI EG 203 336 [i.2]; specific applications and descriptions for DFRS are given in ETSI TR 101 506 [i.27] and in ETSI TR 103 103 [i.32].

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 1 of ETSI EN 302 217-1 [5].

Only the declared operational *reference-modes* are subject of assessment according to the present document. Modes not declared operational as *reference-mode* can be used only as additional modes in dynamic *mixed-mode* operation in accordance with the relevant requirement in clause 4.2.6.

Whenever signal power is referred (e.g. when Pout or EIRP or C/I ratios are concerned), it is intended as mean power for FDD systems and as the mean power during the signal burst for TDD systems.

When *channels-aggregation* equipment is concerned, it is considered that:

1) The manufacturer shall declare the equipment operating conditions in terms of:

    a) the mutual range of frequency on which each *aggregated channel* emission can be preset for proper operation within the limits of the present document;

    b) the mutual limitations in terms of different receive power ratio (see note 1);

    c) for *channels-aggregation/multi-port* only the mutual limitations also in terms of different transmit power ratio (e.g. for ATPC, RTPC separate operation, see note 2). RX and TX power ratio declarations may differ for each *reference-mode* provided.
    The above RX and TX power ratios are intended when *aggregated channels* are independently transmitted.

2) For assessment purpose according to the present document, all characteristics and options (including channel size, *mixed-mode* and/or *bandwidth-adaptive* operation), are assumed the same for each *aggregated-channel*; however, in their field deployment, they can be differently configured according to the need. This does not imply violation of the general principle expressed in point 1.
However, this may not be applicable when *dual-band* implementation is considered (i.e. the *aggregated-channels* operate in non-contiguous or non-overlapping bands, also with different operational configurations as declared by the manufacturer); in this case, according to provision in clause O.1 for assessment of wide band covering equipment, a complete separate assessment of each band (i.e. for one *aggregated-channel* at a time) is required with the second channel (that not under test) turned on in the more demanding operational condition as declared by the manufacturer.

NOTE 1: For information only: the RX power ratio may be needed for managing TX power differences of the *aggregated channels* and/or expected differential nominal level and/or fade margins on channels transmitted either over the same link or over different link directions; see application examples in annex C of ETSI EN 302 217-1 [5]. RX power ratio may be function of the aggregated channels frequency separation.

NOTE 2: For information only: the TX power ratio may be needed for different applications, in particular for *multi-port* equipment, e.g. where different nominal levels in different links direction are possibly needed or, in case of *multiple-channels-port*, when differential RSL with fading on one of the two channels can lead to TX power ratio (e.g. due to ATPC intervention). This may also imply, in practice, mutual limitation on the ATPC/RTPC available range.

Testing methods and conditions for assessing all requirements are specified in clause 5, where each clause directly refers to a corresponding clause within this clause 4 (e.g. clause 5.2.2.1.1 refers to the ATPC test according to the requirement in clause 4.2.2.1.1).

The assessment of radio equipment and antenna may be made separately; this is also valid for integral antennas, whenever practical and technically justified (i.e. when special tools are made available by the manufacturer and their appropriateness validated), for avoiding the need of radiated tests on the equipment.

### 4.1.2 Operating frequency bands and channel arrangements

The radio systems in the scope of the present document operate in one of the frequency bands listed in tables "X".2 (where "X" = B, C, D, E, F, G, H, I, J represents the relevant annex); "*channel-aggregation*" (see definition in ETSI EN 302 217-1 [5]) systems may be designed with "*aggregated-channels*" also in different bands among those listed in the above mentioned tables.

Individual radio equipment may also operate on different segments of those bands.

The above mentioned tables "X".2 provide also the relevant ECC and/or Recommendations ITU-R defining the channel arrangements and the channel separations of different bands; whenever a different national band arrangement is used in one Union member state, those provisions apply as well.

The above ECC and/or Recommendations ITU-R provide arrangements for the whole band; however, the actual frequency range(s) available for fixed links applications may vary on national basis (e.g. in the 57 GHz to 66 GHz range, where a number of applications other than FS are accommodated).

### 4.1.3 Spectral efficiency classes

As the maximum transmission rate in a given bandwidth depends on system spectral efficiency, different equipment classes are here defined in table 0. They are based on typical modulation formats and limited by a "minimum Radio Interface Capacity density" (Mbit/s/MHz) identified in clause 4.1.7. *Radio Interface Capacity* (RIC) is defined in ETSI EN 302 217-1 [5].

The classes reported in table 0 are for system identification only and will not imply any constraint to the actual modulation format, provided that all the requirements of the selected class are met.

**Table 0: Spectral efficiency classes**

| Reference modulation index | Spectral efficiency class | Description |
|---|---|---|
| 1 | 1 | Equipment with spectral efficiency based on typical 2-states modulation scheme (e.g. 2FSK, 2PSK) |
| 2 | 2 | Equipment with spectral efficiency based on typical 4-states modulation scheme (e.g. 4FSK, 4QAM) |
| 3 | 3 | Equipment with spectral efficiency based on typical 8-states modulation scheme (e.g. 8PSK) |
| 4 | 4L | Equipment with spectral efficiency based on typical 16-states modulation scheme (e.g. 16QAM, 16APSK) |
| 5 | 4H | Equipment with spectral efficiency based on typical 32-states modulation scheme (e.g. 32QAM, 32APSK) |
| 6 | 5L | Equipment with spectral efficiency based on typical 64-states modulation scheme (e.g. 64QAM) |
| 7 | 5H | Equipment with spectral efficiency based on typical 128-states modulation scheme (e.g. 128QAM) |
| 8 | 6L | Equipment with spectral efficiency based on typical 256-states modulation scheme (e.g. 256QAM) |
| 9 | 6H | Equipment with spectral efficiency based on typical 512-states modulation scheme (e.g. 512QAM) |
| 10 | 7 | Equipment with spectral efficiency based on typical 1 024-states modulation scheme (e.g. 1024QAM) |
| 11 | 8 | Equipment with spectral efficiency based on typical 2 048-states modulation scheme (e.g. 2048QAM) |

All classes up to class 4H, for any CS, and classes 5L, 5H, 6L, 6H, 7 and 8, for CS < 27,5 MHz, are intended suitable for adjacent channel co-polar (ACCP) operation and, in principle, whenever appropriate, also expandable to Co-Channel Dual Polarization (CCDP). Classes 5L, 5H, 6L, 6H, 7 and 8, only for CS ≥ 27,5 MHz, are further subdivided in two sub-classes:

- subClass A: classes 5LA, 5HA, 6LA, 6HA, 7A and 8A can operate, on the same link, only in cross-polar adjacent channel (ACAP) operation only (see figure 1).

- subClass B: classes 5LB, 5HB, 6LB, 6HB, 7B and 8B can operate, on the same link, in ACCP operation and, in principle, whenever appropriate, also expandable to CCDP (see figure 1).

## 4.1.4 System alternatives

In order to (technically) cover different market and network requirements, with an appropriate balance of performance to cost and effective and appropriate use of the radio spectrum, the present document, together with ETSI EN 302 217-4 [6], offers a number of system types and antennas alternatives, for selection by administrations, operators and manufacturers dependent on the desired use of the radio spectrum and network/market requirements; those options include:

- adjacent channel separation alternatives (as provided by the relevant CEPT or Recommendation ITU-R) (see note 1);
- spectral efficiency class alternatives (different modulation formats provided in radio equipment standards) as defined in clause 4.1.3; actual equipment may operate within one spectral efficiency class only (Single-mode) or within multiple classes, either with static pre-selection of the class (Preset-mode) or with dynamic variation of capacity according to the propagation conditions (Mixed-mode, including bandwidth-adaptive) (see note 2);
- antenna directivity class alternatives (for different network requirements).

NOTE 1: This is intended as the "external" channel separation between emissions from different equipment working on certain channel arrangement; when *"channels-aggregation"* equipment are concerned, a further "internal" *aggregate* channels separation between the generated emissions will be identified, where needed in the present document.

NOTE 2: *Single- mode*, *preset-mode*, *mixed-mode*, *bandwidth-adaptive* and *channels-aggregation* systems are defined in clause 3.1 of ETSI EN 302 217-1 [5]; additional information on *Mixed-mode* systems can be found in clause D.5 of ETSI EN 302 217-1 [5] and in ETSI TR 103 103 [i.32].

## 4.1.5 Channel arrangements and utilization

Requirements for different bands are described in the individual annexes from B through J based on minimum Channel Separation (CS) in a single path application for a given spectral efficiency class in FDD technology. TDD specific requirements are stated as appropriate.

The possible channel arrangements may be:

- Adjacent Channel Alternate-Polarized (ACAP);
- Adjacent Channel Co-Polarized (ACCP);
- Co-Channel Dual-Polarization (CCDP).

For their illustration refer to figure 1.

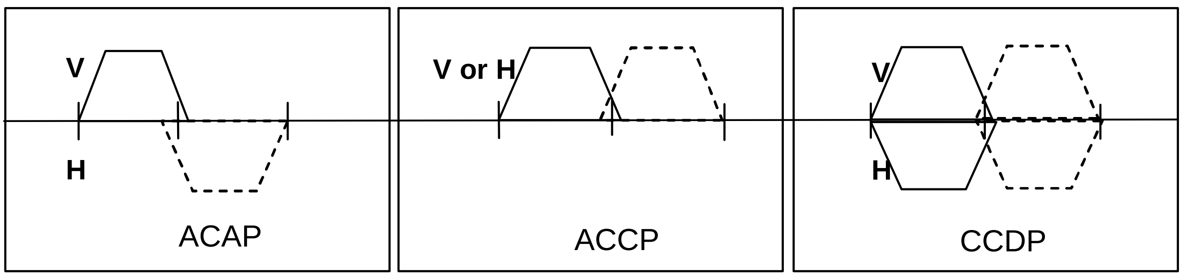



**Figure 1: Examples of adjacent channel arrangements on the same route**

### 4.1.6 Specific requirements for frequency bands

The present document is intended to cover fixed radio equipment with antennas. *Integral* or *dedicated* antennas are considered for which all the technical requirements included in the present document apply and guidelines are given when *stand-alone antenna* are possibly used. Various antenna types definitions are found in ETSI EN 302 217-1 [5]; for more background information on the equipment and antenna parameters here identified as relevant to article 3.2 of Directive 2014/53/EU [i.1], see ETSI EG 203 336 [i.2] and ETSI TR 101 506 [i.27].

For simplicity, the point-to-point systems refer to a number of technical requirements, common to all bands, which are described in the main body of the present document, while frequency dependent requirements are split into separate annexes, with respect to ranges of frequency bands and channel separations, into the following families which may include a range of corresponding payload rates for covering various applications requested by the market:

- Annex B: Frequency bands from 1,4 GHz to 2,6 GHz:
    - Systems with channel separations ranging from 0,025 MHz to 14 MHz for indicative payloads capacity detailed in summary table B.2.
- Annex C: Frequency bands from 3,5 GHz to 11 GHz (channel separation up to 30 MHz, 56/60 MHz and, for 11 GHz band only, 112 MHz):
    - Systems with channel separations ranging from 1,75 MHz to 30 MHz and 56/60 MHz for minimum RIC payload rates detailed in summary table C.2.
- Annex D: Frequency bands from 4 GHz to 11 GHz (channel separation 40 MHz and 80 MHz):
    - Systems with channel separations 40 MHz and 80 MHz for minimum RIC payload rates detailed in summary table D.2.
- Annex E: Frequency bands 13 GHz, 15 GHz and 18 GHz:
    - Systems with channel separations ranging from 1,75 MHz to 55/56 MHz (or, for 18 GHz band only, up to 220 MHz) for minimum RIC payload rates detailed in summary table E.2.
- Annex F: Frequency bands from 23 GHz to 42 GHz:
    - Systems with channel separations ranging from 3,5 MHz to 220 MHz for minimum RIC payload rates detailed in summary table F.2.
- Annex G: Frequency bands from 50 GHz to 55 GHz:
    - Systems with channel separations ranging from 3,5 MHz to 56 MHz for minimum RIC payload rates detailed in summary table G.2.
- Annex H: Frequency bands from 57 GHz to 66 GHz:
    - Systems with channel separations N × 50 MHz granularity up to 2 000 MHz. for minimum RIC payload rates detailed in summary table H.2.
- Annex I: Frequency band from 64 GHz to 66 GHz:
    - Systems with channel separations N × 50 MHz or N × 30 MHz up to about 2 000 MHz for minimum RIC payload rates detailed in summary table I.2.
- Annex J: Frequency bands from 71 GHz to 76 GHz and 81 GHz to 86 GHz:
    - Systems with channel separation ranging from 62,5 MHz to 2 000 MHz for minimum RIC payload rates detailed in summary table J.2.
- Annexes K, L and M are left void for providing room for future considered bands

In those annexes further subdivision is made, as appropriate (see note), according to frequency bands, capacities and/or channel separation (informative summary of them is reported in table 2 and table 3 of ETSI EN 302 217-1 [5]).

NOTE: For information only:
The channel separation provided in the relevant annexes form B through J are chosen from relevant CEPT recommendations, see tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the relevant annex).
Where a CS is missing, either because the present document is not yet aligned to the CEPT one or because the CS is used only in some national radio frequency channel arrangement, it is still possible, from the present document, to derive equivalent requirements from the closest CS in the same band and spectrum efficiency class as follows:
Assuming, as described above, $CS_n$ is the CS "not included" in the present document and $CS_k$ is the closest "known" CS size available in the present document, then:
# spectrum masks: frequency corners multiplied by $CS_n$ / $CS_k$
# minimum RIC: multiplied by $CS_n$ / $CS_k$
# RSL thresholds: increased by 10 log ($CS_n$ / $CS_k$)
# Co-channel behaviour: same of that for $CS_k$
# 1st and 2nd adjacent channel behaviour: same of that for $CS_k$.
However, such data are not directly useable for self-declaration of conformance, based on the present document, under Directive 2014/53/EU [i.1], but only when conformance is required through Notified Bodies).

### 4.1.7 Minimum RIC density for spectral efficiency class selection

**Table 1: Minimum RIC density for the spectral efficiency classes**

| Reference modulation index | Spectral efficiency class | Minimum RIC density (Mbit/s/MHz) (see notes 1 and 2) |
|---|---|---|
| 1 | 1 | 0,57 |
| 2 | 2 | 1,14 |
| 3 | 3 | 1,7 |
| 4 | 4L | 2,28 |
| 5 | 4H | 3,5 |
| 6 | 5L | 4,2 |
| 7 | 5H | 4,9 |
| 8 | 6L | 5,6 |
| 9 | 6H | 6,3 |
| 10 | 7 | 7 |
| 11 | 8 | 7,7 |
| NOTE 1: When defining the minimum RIC for actual channel separations, for simplicity, it is rounded to the suitably closer Mbit/s integer. Tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the relevant annex) give the actual minimum requirement for all CS considered. | | |
| NOTE 2: Minimum RIC figures for some systems operating on some channel separation, with RIC density lower than the minimum requirement in table 1, are defined, when appropriate, in tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the relevant annex). | | |

The minimum RIC density figures in table 1 are not applicable to systems in annex B operating on Channel Separation (CS) 2 MHz and lower than 1,75 MHz; annex B gives alternative channel capacities.

The minimum RIC density figures in table 1 are valid only for systems operating on the the following Channel Separation (CS) :

- For bands below 57 GHz: equal to or about multiples of 1,75 MHz and taking into account that, for channel separations "about" 14 MHz (i.e. from 13,75 MHz to 15,0 MHz), "about" 28 MHz (i.e. from 27,5 MHz to 30 MHz), "about" 56 MHz (i.e. from 55 MHz to 60 MHz), "about" 112 MHz (i.e. 110 MHz or 112 MHz) and "about" 224 MHz (i.e. 220 MHz or 224 MHz), the RIC density of actual systems is evaluated only over the "nominal" 14 MHz, 28 MHz, 56 MHz, 112 MHz and 224 MHz channel width. In some bands also applies to 20 MHz, 40 MHz and 80 MHz.

- For bands above 57 GHz: equal to or multiple of basic CS, depending on the bands, of 30 MHz, 50 MHz or 250 MHz, the latter including 1/2 or 1/4 submultiples.

NOTE 1: For "*channels-aggregation"* equipment minimum RIC is defined for each *aggregated-channel* used.

RIC density is to be used for defining the minimum overall RIC transported over certain CS size and for each spectral efficiency class. Overall RIC should be calculated as:

$$\text{Minimum RIC} = \text{minimum RIC density} \times \text{nominal CS}$$

NOTE 2: Minimum RIC is used as "gauge" for verifying that the system loading produced by the test instrument in clause 4.2.0 is appropriate for the system under assessment.

In the present document the minimum RIC density defined above is intended as one direction in FDD systems, while in TDD systems is intended as the sum of both directions adjusted as to account for the TDD switching intervals which are allowed to consume up to 5 % of the time.

It should be considered that, for each efficiency class and CS, the minimum Radio Interface Capacity (i.e. minimum RIC in all tables associated to BER and C/I in the annexes from B through J) shall be met whichever is (are) the data traffic network interface(s); information on how this can be met for most common standardized network interfaces can be found in informative annex R.

### 4.1.8 System identification and traffic loading

Equipment in the scope of the present document shall refer to a coherent set of transmitter and receiver requirements uniquely defined on the basis of the following identifying parameters:

1) Operating frequency band.

2) Operating radio frequency channel separation.

3) Spectral efficiency class, defined in clause 4.1.3, to which the minimum RIC density, required in clause 4.1.7, is associated.

4) Actual declared maximum total RIC transmitted over the channel with the selected spectral efficiency class evaluated in accordance with clause 4.1.7. This will be used for presetting the payload signal generators referred in clause 4.2.0.

When *mixed-mode* and/or *bandwidth-adaptive* systems are concerned, the identification shall be related only to the declared *reference-modes*. These can be an arbitrary subset of the classes provided in clause 4.1.3 and, for *bandwidth-adaptive* systems, selected only among those related to the maximum operating bandwidth. Only *reference-modes* shall be considered and are subject to the minimum RIC density limitation of table 1 (see note 1). All other higher or lower complexity or lower bandwidth modes, eventually generated during the dynamic operation of the system, are not subject to that minimum RIC density limitation (see example).

EXAMPLE: A *mixed-mode* system operating with class 4L *reference-mode* (2,28 Mbit/s/MHz minimum RIC) can dynamically operate up to class 7 with a RIC density (e.g. 2,28 Mbit/s × 10/4/MHz = 5,7 Mbit/s/MHz) lower than the minimum RIC (7 Mbit/s/MHz) defined for spectral efficiency class 7. Also, for enhanced availability reasons, the system can drop the modulation format, and/or increase the error correction code redundancy, and/or reduce the operating bandwidth without any constraint in terms of related minimum RIC.

NOTE 1: For information only. It is also recognized that the higher modes (e.g. classes 7 and 8 and, in some cases, also 6H or lower classes) are hardly suitable as *reference-mode* because their very limited fade margin might not be enough to guarantee the required performance and availability objectives in typical links. Therefore they are likely to be used only during dynamic operation with a lower class *reference-mode*. Nevertheless, their systems characteristics are also reported for specifically designed equipment or for reference in administrative licensing procedures.
Moreover, classes even higher than 8 (e.g. 4096 QAM and above) are today possible during dynamic operation; however, even more for the the same reason mentioned above, they are not specifically mentioned in the present document.

All the requirements are intended to be met loading the system with the maximum possible RIC (see point 4 above in the present clause), which shall be evaluated by the manufacturer according to the definition in ETSI EN 302 217-1 [5] (see note 2). It shall be equal to or higher than the minimum RIC defined for the chosen system profile selected from tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the relevant annex). However, when the system is carrying only PDH or SDH hierarchical traffic, the minimum declared total RIC capacity shall follow the specific conversion shown in table N.1a to table N.1h in annex N.

NOTE 2: More guidance on the practical system RIC evaluation can be found in ETSI TR 102 565 [i.31].

When SDH hierarchical capacity higher than STM-1 rate transmission is concerned according to system cases in clause O.3.2, the requirements are intended, for applicable systems with fully loaded STM-4 or 4 × STM-1 or 2 × STM-1 (according to the maximum loading required for the equipment) capacities at the base band interface. Similar loading principles apply also for higher Ethernet Base-T interfaces transmitted over multiple radio systems.

NOTE 3: For information only: there might be additional equipment characteristics, not considered relevant to article 3.2 of Directive 2014/53/EU [i.1]. Nevertheless they are considered important for proper behaviour of the system itself or for deployment conditions where local antenna sharing between equipment of different manufacturers is required; these additional characteristics, when identified, may be found in ETSI EN 302 217-1 [5].

### 4.1.9 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: The generic term of environmental profile means 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].

## 4.2 Transmitter requirements

### 4.2.0 General: system loading

The specified transmitter characteristics shall be met with the appropriate base band signals applied at one of the reference points X' of figure 1 of ETSI EN 302 217-1 [5].

Table 2 gives the appropriate base band signals.

**Table 2: Test signal and type of base band interface**

| Type of base band signal interface at X/X' | Test signal to be applied according to |
|---|---|
| PDH | PRBS Recommendation ITU-T O.151 [7] |
| SDH | Recommendation ITU-T O.181 [8] |
| ATM | Recommendation ITU-T O.191 [9] |
| Ethernet interface (packet data) (see note 1) | IEEE 802.3™ [10] (see note 2) |
| Other than the above (see note 1) | Relevant standards which the interface refers to (see note 3) |
| NOTE 1: As a general approach, all system characteristics and spectral efficiency classes are defined only in terms of "minimum RIC". However, when the BER requirements are considered, they can be directly tested when conventional PDH or SDH interfaces are provided; Ethernet test instruments also often offer an option for calculating the equivalent BER; while, whenever equipment offers different standardized base-band interfaces, annex N gives the criteria for defining an equivalent frame error rate (FER) for conformance purpose.<br>NOTE 2: The relevant clauses in IEEE 802.3™ [10] are those relevant to the appropriate 10BASE-T (clause 14), 100BASE-T (clause 21), 1000BASE-T (clause 34) or 10GBASE-T (clause 55).<br>NOTE 3: When standard interfaces are provided they shall comply with ITU-T standards or other standardized interface indicated by the manufacturer. However, in some applications of these radio relay systems, interface parts may be integrated with other systems and therefore standard interfaces (X, X' reference points) are not available under these circumstances. In the latter case the radio system assessment shall be made including those other equipment for properly supplying all loading conditions foreseen. | |

## 4.2.1 Transmitter power and power environmental variation

### 4.2.1.1 Transmitter maximum power and EIRP

At a worldwide level article 21 of the ITU Radio Regulations [11] 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.

Art. 21.3 states that the equivalent isotropically radiated power (e.i.r.p.) shall not exceed +55 dBW (see note).

Art. 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).
- +10 dBW in frequency bands above 10 GHz (see note).

NOTE: In different articles and footnotes of the ITU Radio Regulations [11] lower limits for specific bands or portions thereof may apply. Sometimes dedicated 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 from B through J.

The above limits are considered maximum values, never to be exceeded, including ATPC/RTPC influence, when they are implemented in the equipment.

### 4.2.1.2 Transmitter combined nominal output power and EIRP limits

When conventional link-by-link planning is foreseen on the basis of the actual antenna used in each station, the maximum EIRP or transmitter maximum power will be defined in the link license.

However, in bands where link by link planning is not used or is not the unique method of licensing FS links, a joint limitation of TX *nominal output power* and *nominal EIRP* and, consequently, also *nominal antenna gain*, is provided in the present document. These limitations are retained essential for improving, in average, the efficient band usage also in absence of full coordination (see note).

These limits are additional to those eventually given in clause 4.2.1.1, which shall never to be exceeded.

NOTE: Definition of *nominal output power*, *nominal EIRP* and *nominal antenna gain* are given in clause 3.1 of ETSI EN 302 217-1 [5].

It is to be noted that EIRP level requirement is directly addressed for assessment of equipment with *integral antenna* or *dedicated antenna* only; however, also equipment placed on the market without antennas should refer to such limitations (e.g. defining the maximum associated antenna gain; see clause 4.4.2).

Specific limitations, in bands where they are appropriate, are reported in the relevant frequency dependent annexes from B through J.

#### 4.2.1.3 Transmitter output power environmental variation

The *maximum nominal output power* of the transmitter shall be declared by the manufacturer within the limitations given in clause 4.2.1.1.

The manufacturer shall also provide the procedure (e.g. through RTPC setting) for applying the combined power and EIRP limits given, when required, in clause 4.2.1.2.

Within the environmental profile declared by the manufacturer for the intended limits of usage of the equipment, the variation of the nominal transmitter power shall remain within the following limits:

- Equipment operating in bands below 3 GHz: +2/-1 dB
- Equipment operating in bands from 3 GHz to 30 GHz: ±2 dB
- Equipment operating in bands higher than 30 GHz: ±3 dB

The test methods and conditions of transmitter power environmental variation are specified in clause 5.2.1.3.

## 4.2.2 Transmitter power and frequency control

### 4.2.2.1 Transmitter Power and Frequency Control (ATPC, RTPC and RFC)

#### 4.2.2.1.0 General background

*Automatic Transmit Power Control* (ATPC), *Remote Transmit Power Control* (RTPC) and *Remote Frequency Control* (RFC) are common, independent and not mandatory features. When not implemented, there is no requirement.

Information on their implementation and use can be found in clause D.5.1 of ETSI EN 302 217-1 [5].

#### 4.2.2.1.1 Automatic Transmit Power Control (ATPC)

When ATPC is implemented,equipment with ATPC will be subject to a manufacturer's declaration of ATPC ranges (see note) and related setting accuracy. The manufacturer shall also declare if the equipment is designed with ATPC as a fixed permanent feature.

The equipment shall comply with the requirements of spectrum masks in clause 4.2.3 with ATPC operating in the range between *maximum nominal power* and *maximum available power* (see note) including the attenuation introduced by RTPC function (if any).

NOTE: For the relevant power level definitions of ATPC operation see clause 3.1 of ETSI EN 302 217-1 [5] while general background for ATPC operation and for additional clarification on ATPC and RTPC impact on requirements see clause D.5 of ETSI EN 302 217-1 [5] and ETSI TR 103 103 [i.32].

The test methods and conditions of ATPC are specified in clause 5.2.2.1.1.

#### 4.2.2.1.2 Remote Transmit Power Control (RTPC)

When RTPC is implemented, equipment with RTPC will be subject to a manufacturer's declaration with respect to RTPC ranges and related setting accuracy.

The equipment shall comply with the requirements of spectrum masks in clause 4.2.3 throughout the RTPC range.

NOTE: For additional clarification on ATPC and RTPC impact on requirements see clause D.5 of ETSI EN 302 217-1 [5] and ETSI TR 103 103 [i.32].

The test methods and conditions of RTPC are specified in clause 5.2.2.1.2.

#### 4.2.2.1.3 Transmitter Remote Frequency Control (RFC)

When RFC is implemented, equipment with RFC will be subject to a manufacturer's declaration of RFC ranges and related change frequency procedure.

RFC setting procedure (i.e. the hardware/software mechanisms that permit to move the operating frequency of both TX and RX from initial status to final status) shall not produce emissions outside of the previous and the final centre frequency spectrum masks required in clause 4.2.3.

The test methods and conditions of transmitter RFC are specified in clause 5.2.2.1.3.

## 4.2.3 Transmitter Radio Frequency (RF) spectrum mask

### 4.2.3.1 Limits background

The transmitter Radio Frequency spectrum masks limits are necessary for a number of intra-system and inter-system regulatory and performance requirements.

The 0 dB level shown on the spectrum masks relates to the spectral power density at the carrier centre frequency (see note 1), disregarding the level of the possible residual of the unmodulated carrier (see note 2). The actual carrier frequency is identified with the f0 corner point (see note 3); spectrum masks are shown in frequencies relative to f0; the spectrum mask is assumed to be symmetrical with respect to the centre frequency f0.

When "*multi-carrier*" systems are concerned (see definition in ETSI EN 302 217-1 [5]) the 0 dB level is relative to the maximum of the modulated spectrum of the sub-carrier with the lowest spectral density, disregarding the level of the possible residual of the carriers (see note 2). When applying the spectrum mask, the spectral density of all sub-carriers shall be within 0 dB to $+K_1$ dB of the reference level as shown in the generic example in figure 2.

NOTE 1: For information only: It should be noted that practical test spectrums are obtained with test signal loading that are only "pseudo-randomized"; this implies that the spectrum itself is composed by a very large, but finished, number of lines. The effect on the analyser is that the trace is affected by a noise-like undetermination; therefore, the 0 dB reference, is here intended to be at the mean value of the trace nearby the centre frequency and, similarly, is intended the mask compliance.
It should be further noted that the $K_1$ dB, in-band allowance, is intended to provide room for the unavoidable gain variance of TX front-end; that is why $K_1$ dB increases with the channel bandwidth (i.e. 1 dB for CS $\leq$ 15 MHz, 2 dB for 15 MHz $<$ CS $\leq$ 112 MHz and 3 dB for CS $>$ 112 MHz).

NOTE 2: For information only: 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, variable with the reference bandwidth, is not relevant for the test itself. When the presence of such residual carrier is doubtful, it can be easily verified by reducing the analyser resolution bandwidth by a factor or 10; the power of unmodulated carrier residue, if any, remains constant, while the whole spectrum is reduced by 10 dB.

NOTE 3: For information only: the actual carrier frequency f0 may differ from the nominal centre frequency of the assigned channel due to the frequency tolerance provided in clause 4.2.7.

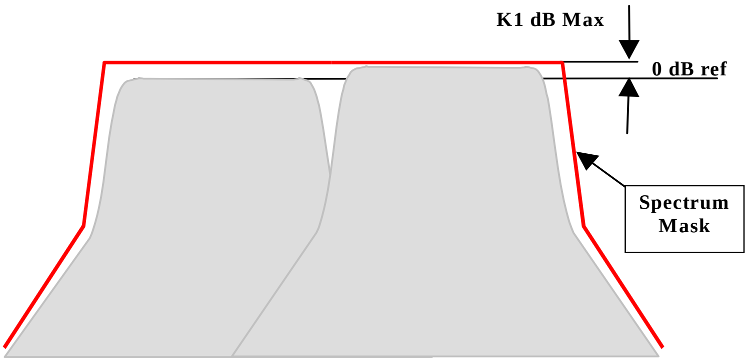


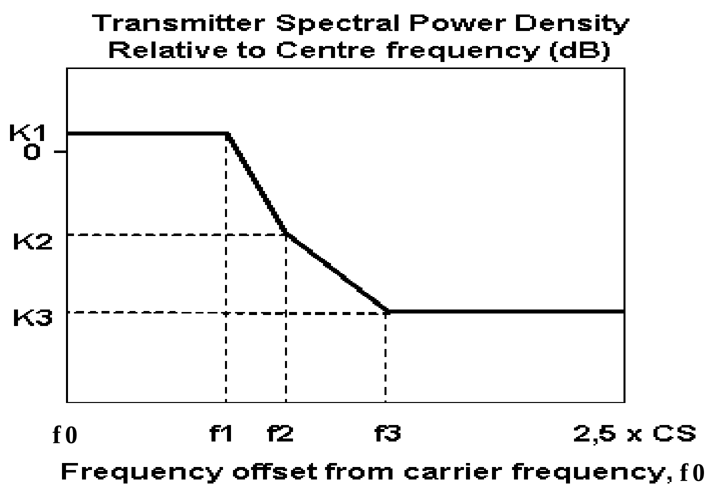

**Figure 2: Example of 0 dB reference setting for *multi-carrier* equipment**

When *channels-aggregation* systems are concerned (see definition in ETSI EN 302 217-1 [5]), each *aggregated channel* emission shall respect, in any condition, its own channel specific spectrum mask (see clause 4.2.3.2 for details).

Radio frequency spectrum mask limits have been reduced to a set of curves and a set of discreet points (i.e. fx MHz/Kx dB) identifying the frequency offset from f0 and the related attenuation; each curve is divided into a number of segments; each spectrum mask is then represented by values located at discrete points on the relevant graph; the number of discreet points is dependent on the number of segments on the actual mask.

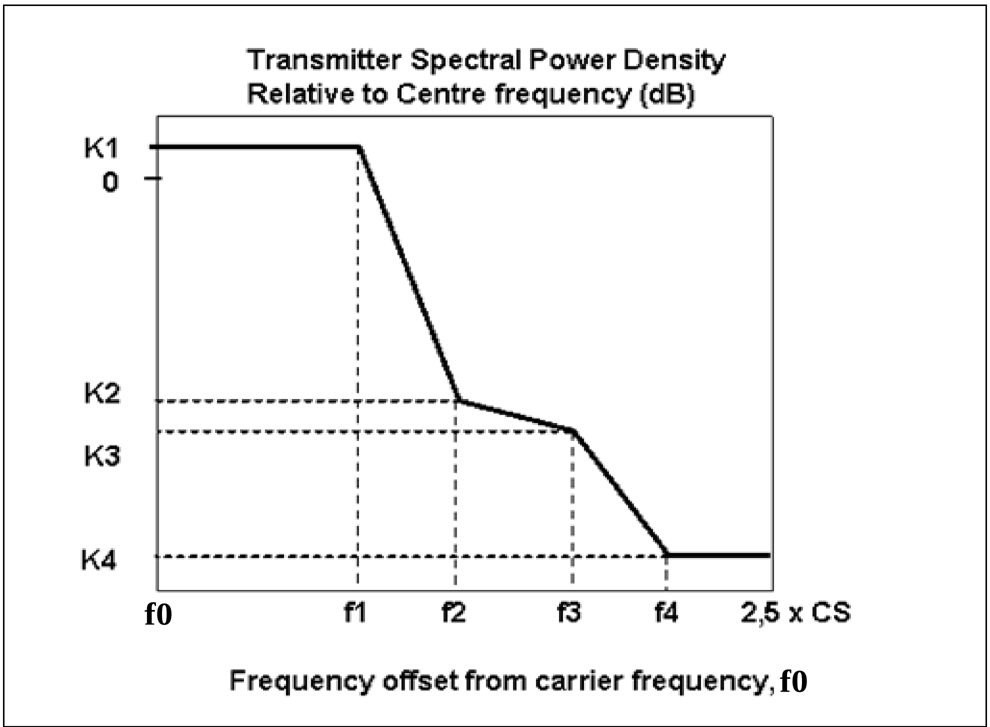
It is also assumed that the value associated with the final discreet point on the graph extends to a point equal to 2,5 times the channel separation (i.e. 2,5 × CS) or, for emissions bandwidth > 500 MHz, to a reduced extension according to Recommendation ITU-R SM.1539-1 [i.60] (i.e. 1,5 × CS + 500 MHz) on each side of the centre frequency.

Figure 3 to figure 6 give the typical curves and their respective spectrum mask tabular representation. For all spectrum masks, the upper limit for frequencies is 2,5 × CS where CS is the channel separation.



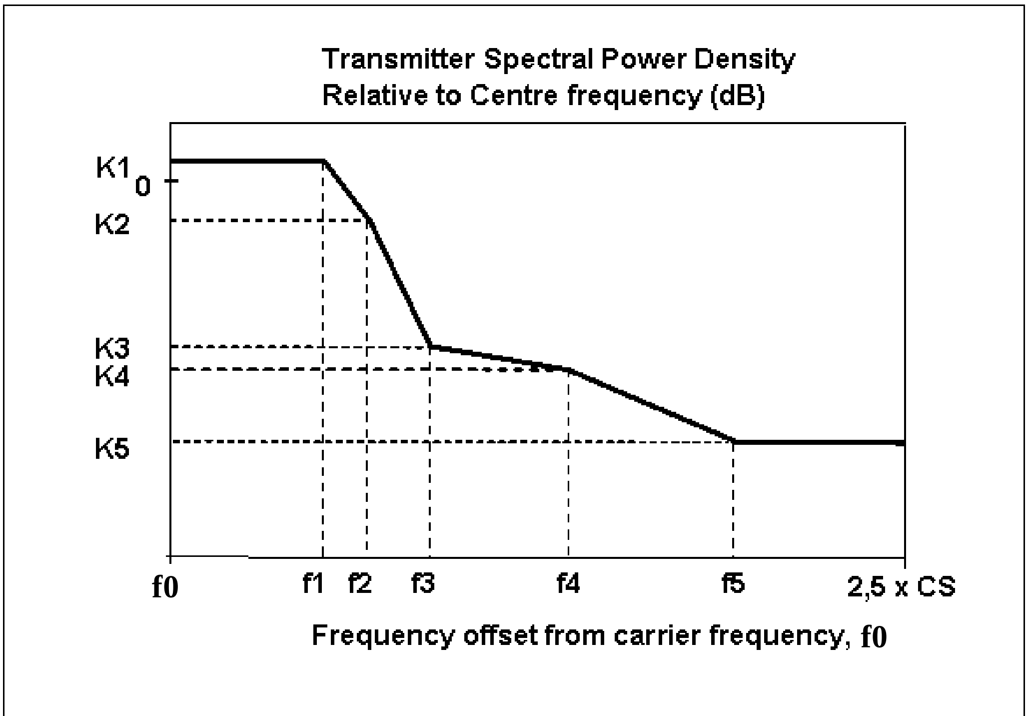

| Number of segments | K1 in dB f1 in MHz | K2 in dB f2 in MHz | K3 in dB f3 in MHz |
|---|---|---|---|
| 4 | K1/f1 | K2/f2 | K3/f3 |

**Figure 3: Four segment spectrum mask**



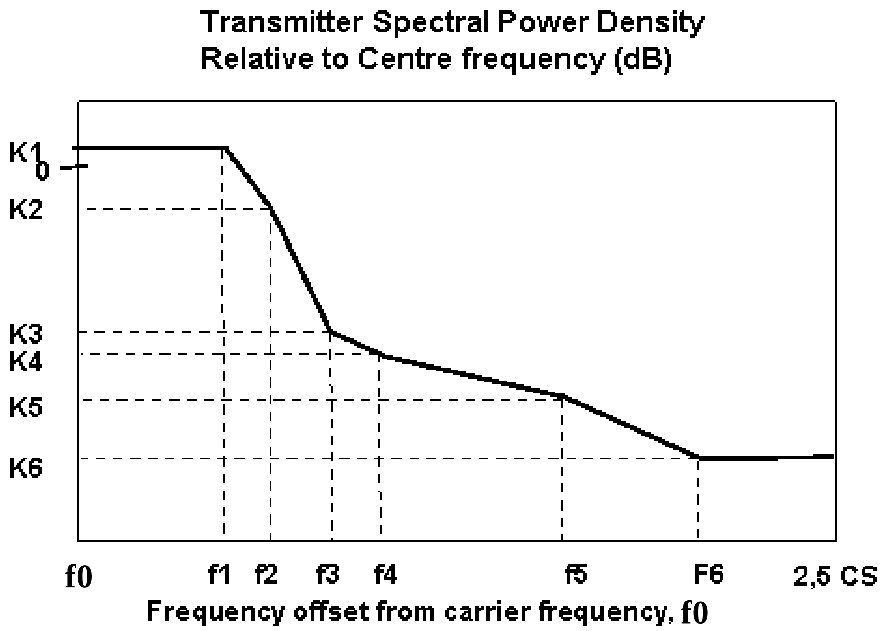

| Number of segments | K1 in dB f1 in MHz | K2 in dB f2 in MHz | K3 in dB f3 in MHz | K4 in dB f4 in MHz |
|---|---|---|---|---|
| **5** | K1/f1 | K2/f2 | K3/f3 | K4/f4 |

**Figure 4: Five segment spectrum mask**




| Number of segments | K1 in dB f1 in MHz | K2 in dB f2 in MHz | K3 in dB f3 in MHz | K4 in dB f4 in MHz | K5 in dB f5 in MHz |
|---|---|---|---|---|---|
| **6** | K1/f1 | K2/f2 | K3/f3 | K4/f4 | K5/f5 |

**Figure 5: Six segment spectrum mask**




| Number of segments | K1 in dB f1 in MHz | K2 in dB f2 in MHz | K3 in dB f3 in MHz | K4 in dB f4 in MHz | K5 in dB f5 in MHz | K6 in dB f6 in MHz |
|---|---|---|---|---|---|---|
| 7 | K1/f1 | K2/f2 | K3/f3 | K4/f4 | K5/f5 | K6/f6 |

**Figure 6: Seven segment spectrum mask**

### 4.2.3.2 Limits

The spectral emission shall comply with spectral power density of the masks provided in table 3a through table 3m for CS size equal to 1,75 MHz and equal to or higher than 3,5 MHz. Exceptionally, for CS = 20 MHz, available only for U6 band and spectrum efficiency class 4L, the relevant spectrum mask is reported in annex C.

In the frequency bands reported in annex B, CS size 2 MHz and lower than 1,75 MHz are provided in the relevant ITU-R and ECC recommended channel arrangements. Specific masks for those CSs are defined in annex B.

For *preset-mode* systems, the manufacturer shall declare which spectral efficiency classes the equipment offers, within each CS. For each spectral efficiency class the equipment shall be compliant with the relevant mask. The output power of the different classes shall be the nominal transmitted output power declared by the manufacturer for each class.

For *mixed-mode* systems, the manufacturer shall declare which *Reference Modes* can be supported by the equipment, within each CS (see example). For each *Reference Mode* the equipment shall demonstrate the capability of being compliant with the RF spectrum mask associated with the corresponding system parameters and spectral efficiency class (see note 1). Compliance with the RF spectrum mask can be jointly verified with the "dynamic change of modulation" requirement in clause 4.2.6.

The manufacturer shall also indicate all other modes, not used as *Reference Modes,* that may be activated during dynamic operation (see example). They are not subject to any requirement besides being also enabled for the "dynamic change of modulation" requirement in clause 4.2.6.

EXAMPLE: More than one *Reference Mode* is declared; e.g. for a CS = 28 MHz three *Reference Mode* are declared: Class 2 (e.g. 4QAM, 32 Mbit/s min RIC), Class 4L (e.g. 16QAM, 64 Mbit/s min RIC) and Class 5HB (e.g. 128QAM, 137 Mbit/s min RIC). In this case three relevant set of tests for spectrum mask (and all other relevant parameters) should be provided. When the dynamic operation is enabled, the other declared modulation formats, other than the three related to the *Reference Modes*, but included in the test for the "dynamic change of modulation" requirement in clause 4.2.6, can be operated. They are intermediate to the three Reference Modes (e.g. 8PSK, 32QAM and 64QAM), higher (e.g. 256QAM, 1024QAM or any higher modes, see also note 2 in clause 4.1.8) or lower (e.g. PSK) or even in reduced bandwidths (when *bandwidth adaptive* operation is also concerned and the band-reduction included in the declaration).

NOTE 1: For information only, for *mixed-mode* systems, these requirements have to be considered for the access to radio spectrum. It is assumed that, when operational, the system should be subject to different considerations, related to the unique actual *Reference Mode* used for co-ordination purpose; see clause D.5 of ETSI EN 302 217-1 [5]. See additional information in ECC Report 198 [i.19].

Only for equipment in the bands above 57 GHz, *mixed-mode* operation may include also *bandwidth-adaptive* operations (see definition in ETSI EN 302 217-1 [5]). In this case, the spectrum mask for compliance shall be the one relevant to the maximum CS used by the equipment during dynamic operation, declared by the manufacturer; consequently, the "reduced bandwidth" mode of operation cannot be used as *Reference Mode*.

For *channels-aggregation* systems, each *aggregated channel* emission shall be compliant to its relevant channel RF spectrum mask when the second channel operates according to the manufacturer's instructions. Clause O.4.1 describes the general assessment test cases and clause O.4.2 the specific definition of joint envelope mask for the two channels emitted from any "*multiple-channels-port*" case.

Figure 7 shows the "up to scale" set of spectral power density masks for spectral efficiency classes 1, 2, 3, 4L, 4H, 5L, 5H, 6L, 6H, 7, 8, valid for all frequency bands up to 57 GHz.

Figure 8 shows the "up to scale" set of spectral power density masks for spectral efficiency classes 1, 2, 3, 4L, 4H, 5L, 5H and 6L, valid for frequency bands above 57 GHz.

NOTE 2: Each mask has corner points with constant attenuation while offset frequencies vary with CS.

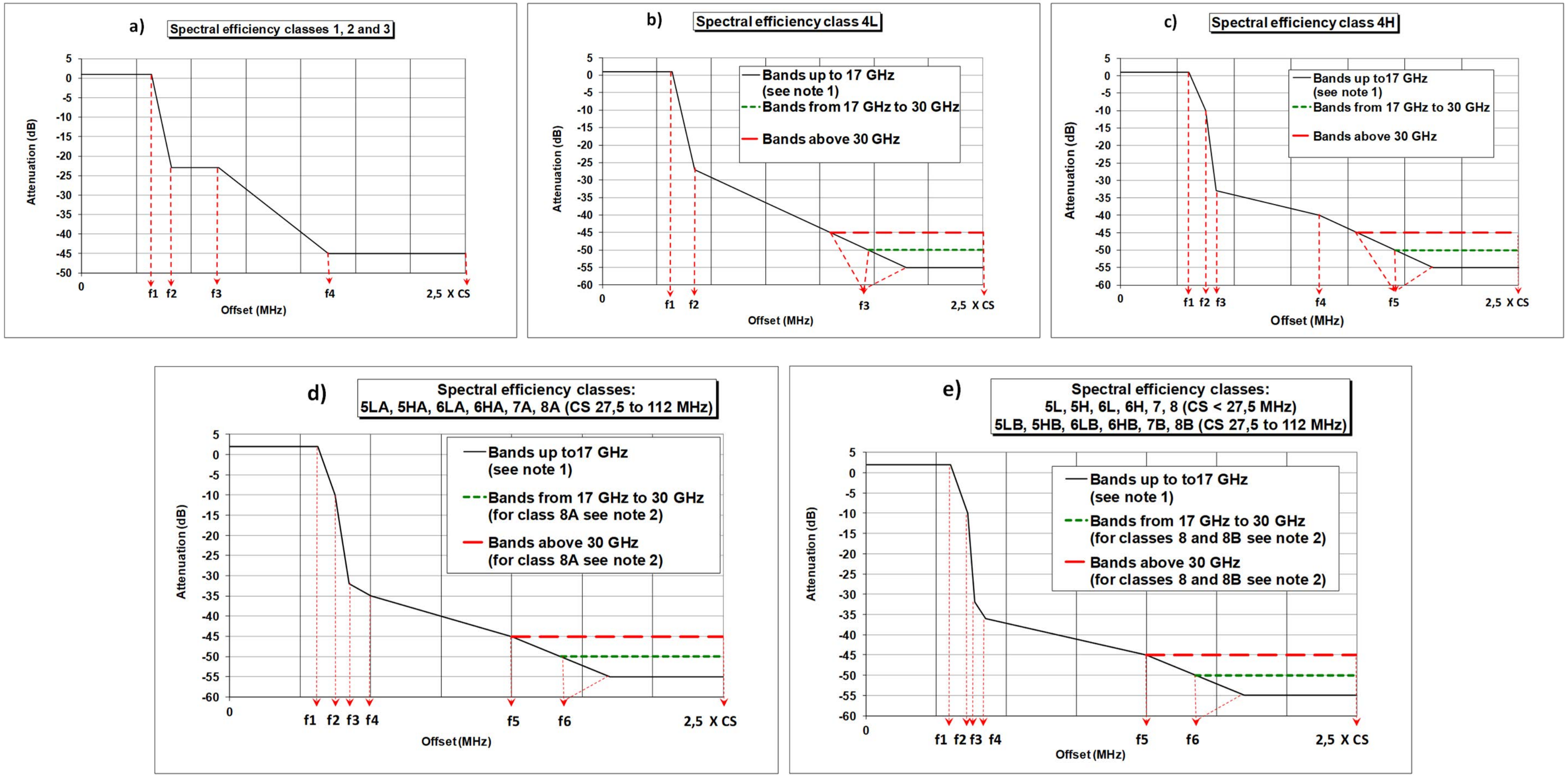
Table 3a through table 3h give all the corner points, graphically shown in figure 7, for the foreseen channel separations, spectral efficiency classes and minimum RIC capacity for all frequency bands up to 57 GHz.

Table 3i through table 3m give all the corner points, graphically shown in figure 8, for the foreseen channel separations, spectral efficiency classes and minimum RIC capacity for frequency bands above 57 GHz.

In principle, these masks are valid for each combination of equipment class, nominal capacity CS and frequency band; however, not all combinations are actually possible and fully defined in the present document. Depending on the channel arrangement and the expected usage, only a subset of combinations is fully defined in each band (see note 3); these subsets are summarized in tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the annex number) in the relevant annexes from B through J.

NOTE 3: In particular:

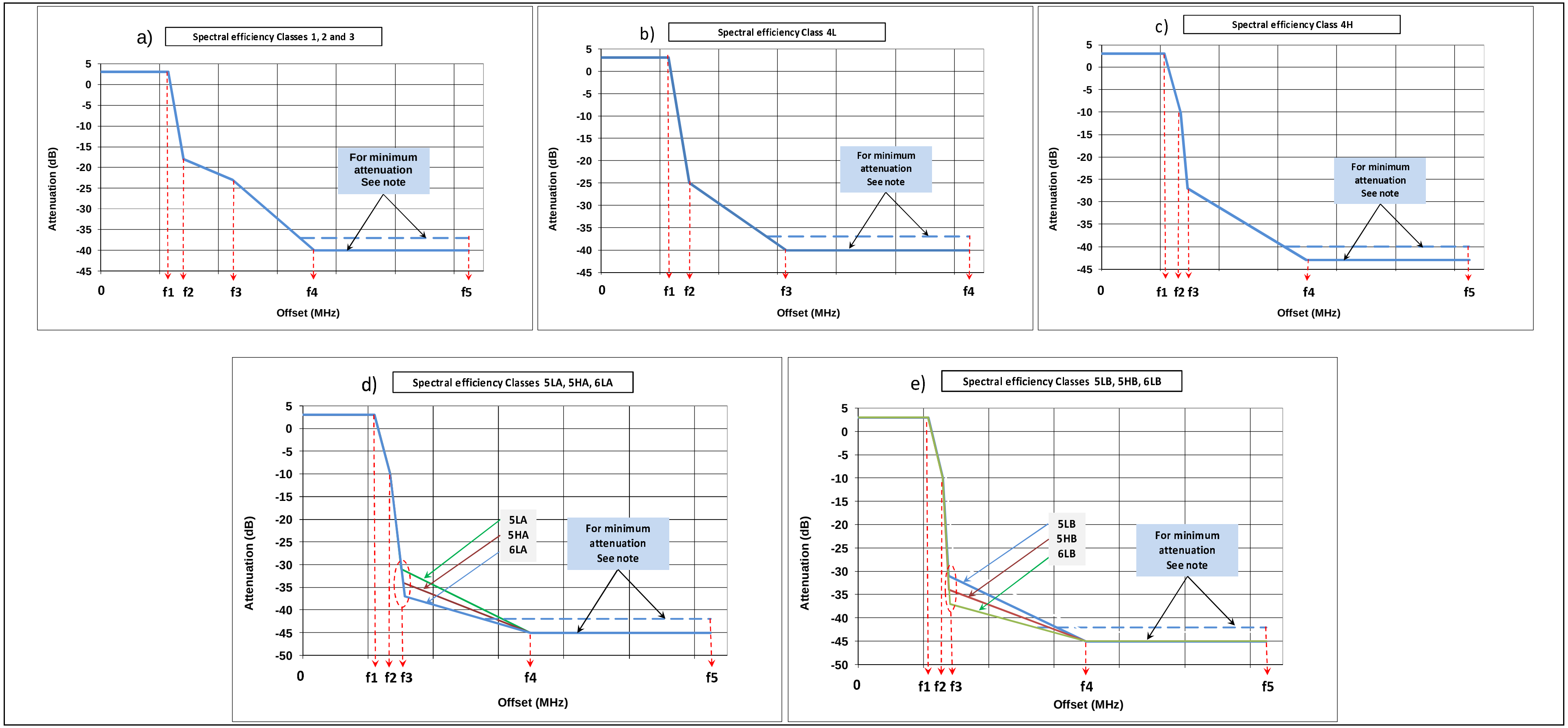
- some class 1 systems are defined only for bands from 1,4 GHz to 2,5 GHz and for 50 GHz and above;
- systems for CS = 1,75 MHz are defined only for classes up to 4L and bands up to 18 GHz;
- systems for CS = 3,5 MHz are not defined for classes higher than 4L and in 42 GHz band;
- classes 6H, 7 and 8 systems are defined only for CS ≥ 13,75 MHz;
- systems for CS = 40 MHz or 80 MHz are defined only for classes 5L and higher;
- subdivision of systems into sub-classes A (ACAP) and B (ACCP) are defined only for class 5L and higher classes and for CS ≥ 27,5 MHz.




NOTE 1: For bands from 3 GHz to 17 GHz, see also note (1) in table 3a through table 3f and in table 3h.

NOTE 2: For classes 8, 8A and 8B the limit for bands within the range 17 GHz to 30 GHz is valid also above 30 GHz; see note (2) and note (3) in table 3d through table 3f and note (1) and note (2) in table 3g.

**Figure 7: Transmitter Radio Frequency spectrum masks (frequency bands in the range below 57 GHz)**




NOTE: The noise floor attenuation depends on the CS; see table 3k, table 3l and table 3m for details.

**Figure 8: Transmitter Radio Frequency spectrum masks (frequency bands above 57 GHz)**

**Table 3a: Transmitter Radio Frequency spectrum masks: Corner points for CS = 1,75 MHz**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 1 | 1 | 1 | Figure 7a) | 1 | 0,85 | -23 | 1,05 | -23 | 1,7 | -45 | 3 | | | | |
| 2 | 2 | 2 | | | | | | | | | | | | | |
| 3 | 3 | 3 | | | | | | | | | | | | | |
| 4 | 4L | 4 | Figure 7b) | 1 | 0,8 | -28 | 1,1 | -55(1)<br>-50(2)<br>-45(3) | 3,5(1)<br>3,1(2)<br>2,6(3) | | | | | | |

(1) For systems in frequency bands within the range from 3 GHz to 17 GHz. In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].
For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.
(2) For systems in frequency bands within the range from 17 GHz to 30 GHz.
(3) For systems in frequency bands in the range above 30 GHz.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 4 | 4L | 4 | Figure 7b) | K3/f3 = -60 dB/4 MHz |

**Table 3b: Transmitter Radio Frequency spectrum masks: Corner points for CS = 3,5 MHz**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 1 | 1 | 2 | Figure 7a) | 1 | 1,7 | -23 | 2,1 | -23 | 3,4 | -45 | 6 | | | | |
| 2 | 2 | 4 | | | | | | | | | | | | | |
| 3 | 3 | 6 | | | | | | | | | | | | | |
| 4 | 4L | 8 | Figure 7b) | 1 | 1,6 | -28 | 2,2 | -55(1)<br>-50(2)<br>-45(3) | 7(1)<br>6,2(2)<br>5,2(3) | | | | | | |

(1) For systems in frequency bands within the range from 3 GHz to 17 GHz. In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].
For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.
(2) For systems in frequency bands within the range from 17 GHz to 30 GHz.
(3) For systems in frequency bands in the range above 30 GHz.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 4 | 4L | 8 | Figure 7b) | K3/f3 = -60 dB/8 MHz |

**Table 3c: Transmitter Radio Frequency spectrum masks: Corner points for CS = 7 MHz**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 1 | 1 | 4 | Figure 7a) | 1 | 3,4 | -23 | 4,2 | -23 | 6,8 | -45 | 12 | | | | |
| 2 | 2 | 8 | | | | | | | | | | | | | |
| 3 | 3 | 12 | | | | | | | | | | | | | |
| 4 | 4L | 16 | Figure 7b) | 1 | 3,2 | -28 | 4,4 | -55(1)<br>-50(2)<br>-45(3) | 14(1)<br>12,4(2)<br>10,4(3) | | | | | | |
| 5 | 4H | 24 | Figure 7c) | 1 | 3 | -10 | 3,75 | -33 | 4,2 | -40 | 8,75 | -55(1)<br>-50(2)<br>-45(3) | 13,75(1)<br>12,075(2)<br>10,425(3) | | |
| 6 | 5L | 29 (ACCP) | Figure 7e) | 1 | 3 | -10 | 3,625 | -32 | 3,875 | -36 | 4,25 | -45 | 10 | -55(1)<br>-50(2)<br>-45(3)(4) | 13,5(1)<br>11,75(2)<br>10(3)(4) |
| 7 | 5H | 34 (ACCP) | | | | | | | | | | | | | |
| 8 | 6L | 39 (ACCP) | | | | | | | | | | | | | |

(1) For systems in frequency bands within the range from 3 GHz to 17 GHz. In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].
For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.

(2) For systems in frequency bands within the range from 17 GHz to 30 GHz.

(3) For systems in frequency bands in the range above 30 GHz.

(4) For systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 4 | 4L | 16 | Figure 7b) | K3/f3 = -60 dB/16 MHz |
| 5 | 4H | 24 | Figure 7c) | K5/f5 = -60 dB/15,425 MHz |
| 6, 7, 8 | 5L, 5H, 6L | 29, 34, and 39 (all ACCP) | Figure 7e) | K6/f6 = -60 dB/15,25 MHz |

**Table 3d: Transmitter Radio Frequency spectrum masks: Corner points for CS = 13,75 MHz ≤ CS ≤ 15 MHz (Nominal 14 MHz)**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 1 | 1 | 8 | Figure 7a) | 1 | 6,8 | -23 | 8,4 | -23 | 13,6 | -45 | 24 | | | | |
| 2 | 2 | 16 | | | | | | | | | | | | | |
| 3 | 3 | 24 | | | | | | | | | | | | | |
| 4 | 4L | 32 | Figure 7b) | 1 | 6,4 | -28 | 8,8 | -55(1)<br>-50(2)<br>-45(3) | 28(1)<br>24,8(2)<br>20,8(3) | | | | | | |
| 5 | 4H | 49 | Figure 7c) | 1 | 6 | -10 | 7,5 | -33 | 8,4 | -40 | 17,5 | -55(1)<br>-50(2)<br>-45(3) | 27,5(1)<br>24,15(2)<br>20,85(3) | | |
| 6 | 5L | 58 (ACCP) | Figure 7e) | 1 | 6 | -10 | 7,25 | -32 | 7,75 | -36 | 8,5 | -45 | 20 | -55(1)<br>-50(2)<br>-45(3)(4) | 27(1)<br>23,5(2)<br>20(3)(4) |
| 7 | 5H | 68 (ACCP) | | | | | | | | | | | | | |
| 8 | 6L | 78 (ACCP) | | | | | | | | | | | | | |
| 9 | 6H | 88 (ACCP) | | | | | | | | | | | | | |
| 10 | 7 | 98 (ACCP) | | | | | | | | | | | | | |
| 11 | 8 | 107 (ACCP) | | | | | | | | | | | | | |

(1) For systems in frequency bands within the range from 3 GHz to 17 GHz. In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].
For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.

(2) For systems in frequency bands within the range from 17 GHz to 30 GHz and for class 8B from 17 GHz to 57 GHz.

(3) For systems of all classes up to 7 (included) in frequency bands in the range above 30 GHz.

(4) For all classes, excluding class 8, systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 4 | 4L | 32 | Figure 7b) | K3/f3 = -60 dB/32 MHz |
| 5 | 4H | 49 | Figure 7c) | K5/f5 = -60 dB/30,85 MHz |
| 6, 7, 8, 9, 10, 11 | 5L 5H, 6L, 6H, 7, 8 | 58, 68, 78, 88, 98 and 107 (all ACCP) | Figure 7e) | K6/f6 = -60 dB/30,5 MHz |

**Table 3e: Transmitter Radio Frequency spectrum masks:**
**Corner points for CS = 27,5 MHz ≤ CS ≤ 30 MHz (Nominal 28 MHz)**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 1 | 1 | 16 | Figure 7a) | 2 | 12,8 | -23 | 16,4 | -23 | 25 | -45 | 45 | | | | |
| 2 | 2 | 32 | | | | | | | | | | | | | |
| 3 | 3 | 48 | | | | | | | | | | | | | |
| 4 | 4L | 64 | Figure 7b) | 2 | 12,8 | -27 | 17 | -55(1)<br>-50(2)<br>-45(3) | 56(1)<br>49(2)<br>42(3) | | | | | | |
| 5 | 4H | 98 | Figure 7c) | 2 | 12 | -10 | 15 | -33 | 16,8 | -40 | 35 | -55(1)<br>-50(2)<br>-45(3) | 55(1)<br>48,3(2)<br>41,7(3) | | |
| 6 | 5LA | 117 (ACAP) | Figure 7d) | 2 | 12,5 | -10 | 15 | -32 | 17 | -35 | 20 | -45 | 40 | -55(1)<br>-50(2)<br>-45(3)(4) | 54(1)<br>47(2)<br>40(3)(4) |
| 7 | 5HA | 137 (ACAP) | | | | | | | | | | | | | |
| 8 | 6LA | 156 (ACAP) | | | | | | | | | | | | | |
| 9 | 6HA | 176 (ACAP) | | | | | | | | | | | | | |
| 10 | 7A | 196 (ACAP) | | | | | | | | | | | | | |
| 11 | 8A | 215 (ACAP) | | | | | | | | | | | | | |
| 6 | 5LB | 117 (ACCP) | Figure 7e) | 2 | 12 | -10 | 14,5 | -32 | 15,5 | -36 | 17 | -45 | 40 | | |
| 7 | 5HB | 137 (ACCP) | | | | | | | | | | | | | |
| 8 | 6LB | 156 (ACCP) | | | | | | | | | | | | | |
| 9 | 6HB | 176 (ACCP) | | | | | | | | | | | | | |
| 10 | 7B | 196 (ACCP) | | | | | | | | | | | | | |
| 11 | 8B | 215 (ACCP) | | | | | | | | | | | | | |

(1) For systems in frequency bands within the range from 3 GHz to 17 GHz. In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].
For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.

(2) For systems in frequency bands within the range from 17 GHz to 30 GHz and for classes 8A and 8B from 17 GHz to 57 GHz.

(3) For systems of all classes up to 7A and 7B (included)in frequency bands in the range above 30 GHz.

(4) For all classes, excluding classes 8A and 8B, systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 4 | 4L | 64 | Figure 7b) | K3/f3 = -60 dB/63 MHz |
| 5 | 4H | 98 | Figure 7c) | K5/f5 = -60 dB/61,7 MHz |
| 6, 7, 8, 9, 10, 11 | 5LA, 5HA, 6LA, 6HA, 7A, 8A | 117, 137, 156, 176, 196, 215 (all ACAP) | Figure 7d) | K6/f6 = -60 dB/61 MHz |
| 6, 7, 8, 9, 10, 11 | 5LB, 5HB, 6LB 6HB, 7B, 8B | 117, 137, 156, 176, 196, 215 (all ACCP) | Figure 7e) | K6/f6 = -60 dB/61 MHz |

**Table 3f: Transmitter Radio Frequency spectrum masks: Corner points for CS = 55 MHz ≤ CS ≤ 60 MHz (Nominal 56 MHz)**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 1 | 1 | 32 | Figure 7a) | 2 | 25,6 | -23 | 32,8 | -23 | 50 | -45 | 90 | | | | |
| 2 | 2 | 64 | | | | | | | | | | | | | |
| 3 | 3 | 96 | | | | | | | | | | | | | |
| 4 | 4L | 128 | Figure 7b) | 2 | 25,6 | -27 | 34 | -55(1)<br>-50(2)<br>-45(3) | 112(1)<br>98(2)<br>84(3) | | | | | | |
| 5 | 4H | 196 | Figure 7c) | 2 | 24 | -10 | 30 | -33 | 33,6 | -40 | 70 | -55(1)<br>-50(2)<br>-45(3) | 110(1)<br>96,6(2)<br>83,4(3) | | |
| 6 | 5LA | 235 (ACAP) | Figure 7d) | 2 | 25 | -10 | 30 | -32 | 34 | -35 | 40 | -45 | 80 | -55(1)<br>-50(2)<br>-45(3)(4) | 108(1)<br>94(2)<br>80(3)(4) |
| 7 | 5HA | 274 (ACAP) | | | | | | | | | | | | | |
| 8 | 6LA | 313 (ACAP) | | | | | | | | | | | | | |
| 9 | 6HA | 352 (ACAP) | | | | | | | | | | | | | |
| 10 | 7A | 392 (ACAP) | | | | | | | | | | | | | |
| 11 | 8A | 431 (ACAP) | | | | | | | | | | | | | |
| 6 | 5LB | 235 (ACCP) | Figure 7e) | 2 | 24 | -10 | 29 | -32 | 31 | -36 | 34 | -45 | 80 | | |
| 7 | 5HB | 274 (ACCP) | | | | | | | | | | | | | |
| 8 | 6LB | 313 (ACCP) | | | | | | | | | | | | | |
| 9 | 6HB | 352 (ACCP) | | | | | | | | | | | | | |
| 10 | 7B | 392 (ACCP) | | | | | | | | | | | | | |
| 11 | 8B | 431 (ACCP) | | | | | | | | | | | | | |

(1) For systems in frequency bands within the range from 3 GHz to 17 GHz. In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].
For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.

(2) For systems in frequency bands within the range from 17 GHz to 30 GHz and for classes 8A and 8B from 17 GHz to 57 GHz.

(3) For systems of all classes up to 7A and 7B (included) in frequency bands in the range above 30 GHz.

(4) For all classes, excluding classes 8A and 8B, systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.

| Spectral efficiency class | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 4 | 4L | 128 | Figure 7b) | K3/f3 = -60 dB/126,0 MHz |
| 5 | 4H | 196 | Figure 7c) | K5/f5 = -60 dB/123,4 MHz |
| 6, 7, 8, 9, 10, 11 | 5LA, 5HA, 6LA, 6HA, 7A, 8A | 235, 274, 313, 352, 392 431 (all ACAP) | Figure 7d) | K6/f6 = -60 dB/122 MHz |
| 6, 7, 8, 9, 10, 11 | 5LB, 5HB, 6LB, 6HB, 7B, 8B | 235, 274, 313, 352, 392 431 (all ACCP) | Figure 7e) | K6/f6 = -60 dB/122 MHz |

**Table 3g: Transmitter Radio Frequency spectrum masks: Corner points for CS = 110 MHz to 112 MHz (Nominal 112 MHz) (for bands 11 GHz and from 18 GHz up to 42 GHz)**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| | | | Figure 7a) | 2 | 51,2 | -23 | 65,6 | -23 | 100 | -45 | 180 | | | | |
| 2 | 2 | 128 | | | | | | | | | | | | | |
| 3 | 3 | 191 | | | | | | | | | | | | | |
| 4 | 4L | 256 | Figure 7b) | 2 | 51,2 | -27 | 68 | -55 (4)<br>-50 (1)<br>-45 (2) | 224 (4)<br>196 (1)<br>168 (2) | | | | | | |
| 5 | 4H | 392 | Figure 7c) | 2 | 48 | -10 | 60 | -33 | 67,2 | -40 | 140 | -55 (4)<br>-50 (1)<br>-45 (2) | 220 (4)<br>193,2 (1)<br>166,8 (2) | | |
| 6 | 5LA | 470 (ACAP) | Figure 7d) | 2 | 50 | -10 | 60 | -32 | 68 | -35 | 80 | -45 | 160 | -55 (4)<br>-50 (1)<br>-45 (2)(3) | 216 (4)<br>188 (1)<br>160 (2)(3) |
| 7 | 5HA | 548 (ACAP) | | | | | | | | | | | | | |
| 8 | 6LA | 627 (ACAP) | | | | | | | | | | | | | |
| 9 | 6HA | 705 (ACAP) | | | | | | | | | | | | | |
| 10 | 7A | 784 (ACAP) | | | | | | | | | | | | | |
| 11 | 8A | 862 (ACAP) | | | | | | | | | | | | | |
| 6 | 5LB | 470 (ACCP) | Figure 7e) | 2 | 48 | -10 | 58 | -32 | 62 | -36 | 68 | -45 | 160 | | |
| 7 | 5HB | 584 (ACCP) | | | | | | | | | | | | | |
| 8 | 6LB | 627 (ACCP) | | | | | | | | | | | | | |
| 9 | 6HB | 705 (ACCP) | | | | | | | | | | | | | |
| 10 | 7B | 784 (ACCP) | | | | | | | | | | | | | |
| 11 | 8B | 862 (ACCP) | | | | | | | | | | | | | |

(1) For systems in frequency bands within the range from 17 GHz to 30 GHz and for classes 8A and 8B from 17 GHz to 57 GHz.
(2) For systems of all classes up to 7A and 7B (included) in frequency bands in the range above 30 GHz.
(3) For all classes, excluding classes 8A and 8B, systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.
(4) For 11 GHz band only.

**Table 3h: Transmitter Radio Frequency spectrum masks: Corner points for CS = 40 MHz**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 6 | 5LA | 168 (ACAP) | Figure 7d) | 2 | 18 | -10 | 21,5 | -32 | 24,5 | -35 | 29 | -45 | 57 | -55(1) | 77(1) |
| 7 | 5HA | 196 (ACAP) | | | | | | | | | | | | | |
| 8 | 6LA | 224 (ACAP) | | | | | | | | | | | | | |
| 9 | 6HA | 252 (ACAP) | | | | | | | | | | | | | |
| 10 | 7A | 280 (ACAP) | | | | | | | | | | | | | |
| 11 | 8A | 308 (ACAP) | | | | | | | | | | | | | |
| 6 | 5LB | 168 (ACCP) | Figure 7e) | 2 | 17,2 | -10 | 20,8 | -32 | 22,2 | -36 | 24,5 | -45 | 57 | | |
| 7 | 5HB | 196 (ACCP) | | | | | | | | | | | | | |
| 8 | 6LB | 224 (ACCP) | | | | | | | | | | | | | |
| 9 | 6HB | 252 (ACCP) | | | | | | | | | | | | | |
| 10 | 7B | 280 (ACCP) | | | | | | | | | | | | | |
| 11 | 8B | 308 (ACCP) | | | | | | | | | | | | | |

(1) In addition, for frequency bands in the range below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.

NOTE: Frequency bands with 40 MHz CS are generally intended for high capacity connections. Classes lower than 5L are not considered in the present document.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 6, 7, 8, 9, 10, 11 | 5LA, 5HA, 6LA, 6HA, 7A, 8A | 168, 196, 224, 252, 280, 308 (ACAP) | Figure 7d) | K6/f6 = -60 dB/87 MHz |
| 6, 7, 8, 9, 10, 11 | 5LB, 5HB, 6LB, 6HB, 7B, 8B | 168, 196, 224, 252, 280, 308 (ACCP) | Figure 7e) | K6/f6 = -60 dB/87 MHz |

**Table 3i: Transmitter Radio Frequency spectrum masks: Corner points for CS = 62,5 MHz**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | |
| 1 | 1 | 35 | Figure 8a) | 2 | 28,7 | -18 | 35 | -23 | 56 | -40 | 90,7 | -40 | 156,3 |
| 2 | 2 | 71 | | | | | | | | | | | |
| 3 | 3 | 106 | | | | | | | | | | | |
| 4 | 4L | 142 | Figure 8b) | 2 | 28,7 | -25 | 37,3 | -40 (2) | 78,5 | -40 | 156,3 | | |
| 5 | 4H | 219 | Figure 8c) | 2 | 27,5 | -10 | 33,5 | -28 | 37,3 | -43 | 87 | -43 | 156,3 |
| 6 | 5LA | 262 | Figure 8d) | 2 | 27,5 | -10 | 33,5 | -31 | 37,7 | -45 | 87 | -45 | 156,3 |
| 7 | 5HA | 306 | | | | | | -34 | 38,5 | -45 | | -45 | |
| 8 | 6LA | 350 | | | | | | -37 | 39,1 | -45 | | -45 | |
| 6 | 5LB | 262 | Figure 8e) | 2 | 26,8 | -10 | 32,4 | -31 | 34,5 | -45 | 87 | -45 | 156,3 |
| 7 | 5HB | 306 | | | | | | -34 | 34,8 | -45 | | -45 | |
| 8 | 6LB | 350 | | | | | | -37 | 35 | -45 | | -45 | |

**Table 3j: Transmitter Radio Frequency spectrum masks: Corner points for CS = 125 MHz**

| Spectral efficiency Reference Index | Spectral efficiency Class | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 71 | Figure 8a) | 3 | 57,3 | -18 | 70 | -23 | 112 | -40 | 181,3 | -40 | 312,5 |
| 2 | 2 | 142 | | | | | | | | | | | |
| 3 | 3 | 212 | | | | | | | | | | | |
| 4 | 4L | 284 | Figure 8b) | 3 | 57,3 | -25 | 74,5 | -40 (2) | 157 | -40 | 312,5 | | |
| 5 | 4H | 438 | Figure 8c) | 3 | 55 | -10 | 67 | -28 | 74,5 | -43 | 174 | -43 | 312,5 |
| 6 | 5LA | 438 | Figure 8d) | 3 | 55 | -10 | 67 | -31 | 75,8 | -45 | 174 | -45 | 312,5 |
| 7 | 5HA | 612 | | | | | | -34 | 77 | -45 | | -45 | |
| 8 | 6LA | 700 | | | | | | -37 | 78,2 | -45 | | -45 | |
| 6 | 5LB | 438 | Figure 8e) | 3 | 53,5 | -10 | 64,8 | -31 | 69 | -45 | 174 | -45 | 312,5 |
| 7 | 5HB | 612 | | | | | | -34 | 69,5 | -45 | | -45 | |
| 8 | 6LB | 700 | | | | | | -37 | 70 | -45 | | -45 | |

**Table 3k: Transmitter Radio Frequency spectrum masks: Corner points for CS = N × 250 MHz (see note 1)**

| Spectral efficiency Reference Index | Spectral efficiency Class | Min. RIC rate (Mbit/s) | Mask reference shape | K1(dB) | f1(MHz) | K2(dB) | f2(MHz) | K3(dB) | f3 (MHz) | K4(dB) | f4(MHz) | K5(dB) | f5(MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | N × 142 | Figure 8a) | 3 | N × 114,5 | -18 | N × 140 | -23 | N × 224 | -40 (2) | N × 362,5 | -40 (2) | (1) |
| 2 | 2 | N × 285 (7) | | | | | | | | | | | |
| 3 | 3 | N × 425 (7) | | | | | | | | | | | |
| 4 | 4L | N × 570 (7) | Figure 8b) | 3 | N × 114,5 | -25 | N × 149 | -40 (2) | N × 314 | -40 (2) | (1) | | |
| 5 | 4H | N x 875 | Figure 8c) | 3 | N × 110 | -10 | N × 134 | -28 | N × 149 | -43 (3) | N × 348 | -43 (3) | (1) |
| 6 | 5LA | N x 1 050 (7) | Figure 8d) | 3 | N ×110 | -10 | N × 134 | -31 | N × 151 | -45 (4) | N × 348 | -45 (4) | (1) |
| 7 | 5HA | N x 1 225 | | | | | | -34 | N × 154 | -45 (5) | | -45 (5) | |
| 8 | 6LA | N x 1 400 | | | | | | -37 | N × 156 | -45 (6) | | -45 (6) | |
| 6 | 5LB | N x 1 050 (7) | Figure 8e) | 3 | N × 107 | -10 | N × 129,5 | -31 | N × 138 | -45 (4) | N × 348 | -45 (4) | (1) |
| 7 | 5HB | N x 1 225 | | | | | | -34 | N × 139 | -45 (5) | | -45 (5) | |
| 8 | 6LB | N x 1 400 | | | | | | -37 | N × 140 | -45 (6) | | -45 (6) | |

(1) For CS ≤ 500 MHz this value is CS × 2,5.
For CS > 500 MHz, this value is variable with CS (MHz) according to the formula CS × 1,5 + 500.
(2) Attenuation less than -40 + 10log(N) is not required.
(3) Attenuation less than -43 + 10log(N) is not required.
(4) For N ≥ 2, attenuation less, in dB, than -46 + 10log(N) is not required.
(5) For N ≥ 3, attenuation less, in dB, than -49 + 10log(N) is not required.
(6) For N ≥ 6, attenuation less, in dB, than -52 + 10log(N) is not required.
(7) For class 2 (N = 4), class 3 (N = 5), class 4 (N = 2 and N = 4), classes 5LA and 5LB (N = 1, 2, 3) a minimum RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid. See table J.2 in annex J for details.
NOTE 1: N can vary from 1 to 8. See table J.2 in annex J for details.
NOTE 2: The 10log(N) value is intended truncated to the first decimal place.

**Table 3l: Transmitter Radio Frequency spectrum masks: Corner points for CS = N × 50 MHz Frequency range 57 GHz to 66 GHz (see note 1)**

| Spectral efficiency Reference Index | Spectral efficiency Class | Min. RIC rate (Mbit/s) | Mask reference shape | K1(dB) | f1(MHz) | K2(dB) | f2(MHz) | K3(dB) | f3 (MHz) | K4(dB) | f4(MHz) | K5(dB) | f5(MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | N × 28,5 (7) | Figure 8a) | 3 | N × 22,9 | -18 | N × 28 | -23 | N × 44,8 | -40 (2) | N × 72,5 | -40 (2) | (1) |
| 2 | 2 | N × 57 | | | | | | | | | | | |
| 3 | 3 | N × 85 | | | | | | | | | | | |
| 4 | 4L | N × 114 | Figure 8b) | 3 | N × 22,9 | -25 | N × 29,8 | -40 (2) | N × 62,8 | -40 (2) | (1) | | |
| 5 | 4H | N x 175 | Figure 8c) | 3 | N × 22 | -10 | N × 26,8 | -28 | N × 29,8 | -43 (3) | N × 69,6 | -43 (3) | (1) |
| 6 | 5LA | N x 210 | Figure 8d) | 3 | N × 22 | -10 | N × 26,8 | -31 | N × 30,2 | -45 (4) | N × 69,6 | -45 (4) | (1) |
| 7 | 5HA | N x 245 | | | | | | -34 | N × 30,8 | -45 (5) | | -45 (5) | |
| 8 | 6LA | N x 280 | | | | | | -37 | N × 31,2 | -45 (6) | | -45 (6) | |
| 6 | 5LB | N x 210 | Figure 8e) | 3 | N × 21,4 | -10 | N × 25,9 | -31 | N × 27,6 | -45 (4) | N × 69,6 | -45 (4) | (1) |
| 7 | 5HB | N x 245 | | | | | | -34 | N × 27,8 | -45 (5) | | -45 (5) | |
| 8 | 6LB | N x 280 | | | | | | -37 | N × 28 | -45 (6) | | -45 (6) | |

(1) For CS ≤ 500 MHz this value is CS × 2,5.
For CS > 500 MHz, this value is variable with CS (MHz) according to the formula CS × 1,5 + 500.
(2) Attenuation less, in dB, than -40 + 10log(N/5) is not required.
(3) Attenuation less, in dB, than -43 + 10log(N/5) is not required.
(4) For N ≥ 10, attenuation less, in dB, than -46 + 10log(N/5) is not required.
(5) For N ≥ 15, attenuation less, in dB than -49 + 10log(N/5) is not required.
(6) For N ≥ 30, attenuation less, in dB, than -52 + 10log(N/5) is not required.
(7) For N > 4 rounded down to the lower Mbit/s integer.
NOTE 1: N can vary from 1 to 40; however, equipment characteristics are not presented for all cases. See table H.2 in annex H for details.
NOTE 2: The 10log(N/5) value is intended truncated to the first decimal place.

**Table 3m: Transmitter Radio Frequency spectrum masks: Corner points for CS = N × 30 MHz Frequency range 64 GHz to 66 GHz (see note 1)**

| Spectral efficiency Reference Index | Spectral efficiency Class | Min. RIC rate (Mbit/s) | Mask reference shape | K1(dB) | f1(MHz) | K2(dB) | f2(MHz) | K3(dB) | f3 (MHz) | K4(dB) | f4(MHz) | K5(dB) | f5(MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | N × 17 | Figure 8a) | 3 | N × 13,8 | -18 | N × 16,8 | -23 | N × 26,9 | -40 (2) | N × 43,5 | -40 (2) | (1) |
| 2 | 2 | N × 34 | | | | | | | | | | | |
| 3 | 3 | N × 51 | | | | | | | | | | | |
| 4 | 4L | N × 68 | Figure 8b) | 3 | N × 13,8 | -25 | N × 17,9 | -40 (2) | N × 37,7 | -40 (2) | (1) | | |
| 5 | 4H | N x 105 | Figure 8c) | 3 | N × 13,2 | -10 | N × 16,1 | -28 | N × 17,9 | -43 (3) | N × 41,8 | -43 (3) | (1) |
| 6 | 5LA | N x 126 | Figure 8d) | 3 | N × 13,2 | -10 | N × 16,1 | -31 | N × 18,1 | -45 (4) | N × 41,8 | -45 (4) | (1) |
| 7 | 5HA | N x 147 | | | | | | -34 | N × 18,5 | -45 (5) | | -45 (5) | |
| 8 | 6LA | N x 168 | | | | | | -37 | N × 18,7 | -45 (6) | | -45 (6) | |
| 6 | 5LB | N x 126 | Figure 8e) | 3 | N × 12,7 | -10 | N × 15,6 | -31 | N × 16,6 | -45 (4) | N × 41,8 | -45 (4) | (1) |
| 7 | 5HB | N x 147 | | | | | | -34 | N × 16,7 | -45 (5) | | -45 (5) | |
| 8 | 6LB | N x 168 | | | | | | -37 | N × 16,8 | -45 (6) | | -45 (6) | |

(1) For CS ≤ 500 MHz this value is CS × 2,5.
For CS > 500 MHz, this value is variable with CS (MHz) according to the formula CS × 1,5 + 500.
(2) Attenuation less than -40 + 10log(N/8) is not required.
(3) Attenuation less than -43 + 10log(N/8) is not required.
(4) For N ≥ 17, attenuation less, in dB, than -46 + 10log(N/8) is not required.
(5) For N ≥ 25, attenuation less, in dB, than -49 + 10log(N/8) is not required.
(6) For N ≥ 50, attenuation less, in dB, than -52 + 10log(N/8) is not required.
NOTE 1: N can vary from 1 to 33 for FDD systems and from 1 to 66 for TDD systems; however, equipment characteristics are not presented for all cases. See table I.2 in annex I for details.
NOTE 2: The 10log(N/8) value is intended truncated to the first decimal place.

**Table 3n: Transmitter Radio Frequency spectrum masks: Corner points for CS = 80 MHz**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 6 | 5LA | 336 (ACAP) | Figure 7(d) | 2 | 36 | -10 | 43 | -32 | 49 | -35 | 58 | -45 | 114 | -55 (1) | 154 (1) |
| 7 | 5HA | 392 (ACAP) | | | | | | | | | | | | | |
| 8 | 6LA | 448 (ACAP) | | | | | | | | | | | | | |
| 9 | 6HA | 504 (ACAP) | | | | | | | | | | | | | |
| 10 | 7A | 560 (ACAP) | | | | | | | | | | | | | |
| 11 | 8A | 616 (ACAP) | | | | | | | | | | | | | |
| 6 | 5LB | 336 (ACCP) | Figure 7(e) | 2 | 34,4 | -10 | 41,6 | -32 | 44,4 | -36 | 49 | -45 | 114 | | |
| 7 | 5HB | 392 (ACCP) | | | | | | | | | | | | | |
| 8 | 6LB | 448 (ACCP) | | | | | | | | | | | | | |
| 9 | 6HB | 504 (ACCP) | | | | | | | | | | | | | |
| 10 | 7B | 560 (ACCP) | | | | | | | | | | | | | |
| 11 | 8B | 616 (ACCP) | | | | | | | | | | | | | |

(1) In addition, for frequency bands in the range below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products.

NOTE: Frequency bands with 40 MHz and 80 MHz CS are generally intended for high capacity connections. Classes lower than 5L are not considered in the present document.

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | Frequency corner variation for the -60 dB floor option |
|---|---|---|---|---|
| Reference Index | Class | | | |
| 6, 7, 8, 9, 10, 11 | 5LA, 5HA, 6LA, 6HA, 7A, 8A | 336, 392, 448, 504, 560, 616 (ACAP) | Figure 7(d) | K6/f6 = -60 dB/174 MHz |
| 6, 7, 8, 9, 10, 11 | 5LB, 5HB, 6LB, 6HB, 7B, 8B | 336, 392, 448, 504, 560, 616 (ACCP) | Figure 7(e) | K6/f6 = -60 dB/174 MHz |

**Table 3o: Transmitter Radio Frequency spectrum masks: Corner points for CS = 220 MHz to 224 MHz (Nominal 224 MHz) (for bands from 18 GHz up to 42 GHz)**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) | K6 (dB) | f6 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | | | | | | | | | | | | |
| 2 | 2 | 256 | Figure 7a) | 3 | 102,4 | -23 | 131,2 | -23 | 200 | -45 | 360 | | | | |
| 3 | 3 | 382 | | | | | | | | | | | | | |
| 4 | 4L | 255126 | Figure 7b) | 3 | 102,4 | -27 | 136 | -50[1] -45[2] | 392[1] 336[2] | | | | | | |
| 5 | 4H | 784 | Figure 7c) | 3 | 96 | -10 | 120 | -33 | 134,4 | -40 | 280 | -50[1] -45[2] | 386,4[1] 333,6[2] | | |
| 6 | 5LA | 940 (ACAP) | Figure 7d) | 3 | 100 | -10 | 120 | -32 | 136 | -35 | 160 | -45 | 320 | -50[1] -45[2][3] | 376[1] 320[2][3] |
| 7 | 5HA | 1096 (ACAP) | | | | | | | | | | | | | |
| 8 | 6LA | 1254 (ACAP) | | | | | | | | | | | | | |
| 9 | 6HA | 1410 (ACAP) | | | | | | | | | | | | | |
| 10 | 7A | 1568 (ACAP) | | | | | | | | | | | | | |
| 11 | 8A | 1724 (ACAP) | | | | | | | | | | | | | |
| 6 | 5LB | 940 (ACCP) | Figure 7e) | 3 | 96 | -10 | 116 | -32 | 124 | -36 | 136 | -45 | 320 | | |
| 7 | 5HB | 1096 (ACCP) | | | | | | | | | | | | | |
| 8 | 6LB | 1254 (ACCP) | | | | | | | | | | | | | |
| 9 | 6HB | 1410 (ACCP) | | | | | | | | | | | | | |
| 10 | 7B | 1568 (ACCP) | | | | | | | | | | | | | |
| 11 | 8B | 1724 (ACCP) | | | | | | | | | | | | | |

(1) For systems in frequency bands within the range from 17 GHz to 30 GHz and for classes 8A and 8B from 17 GHz to 57 GHz.
(2) For systems of all classes up to 7A and 7B (included) in frequency bands in the range above 30 GHz.
(3) For all classes, excluding classes 8A and 8B, systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.

## 4.2.4 Transmitter discrete CW components exceeding the transmitter Radio Frequency spectrum mask limit

### 4.2.4.1 Transmitter discrete CW components at the symbol rate

In case discrete CW components at the symbol rate exceed the spectrum mask, the power level (at reference point C' or at point B' if C' of figure 1 of ETSI EN 302 217-1 [5] is not available) of spectral lines at a distance from the carrier (or from each *aggregated channel* carrier for *channels-aggregation* equipment, or each sub-carrier in *multi-carrier* equipment) centre frequency equal to the symbol rate shall be below the mean power level of the carrier by more than:

- 23 dB for classes 1, 2;
- 29 dB for class 3;
- 37 dB for classes 4L, 4H, 5LA, 5HA, 6LA, 6HA, 7A, 8A;
- 43 dB for classes 5L, 5LB, 5H, 5HB;
- 49 dB for classes 6L, 6LB, 6H, 6HB;
- 55 dB for classes 7, 7B, 8, 8B.

When *channels-aggregation* equipment is concerned see also clause O.4.

### 4.2.4.2 Transmitter other discrete CW components exceeding the transmitter Radio Frequency spectrum mask limit

In case CW components, other than the residual of the unmodulated carrier (sub-carriers) or those at the symbol rate, exceed the spectrum mask given in the relevant annexes from B through J, an additional allowance is given as follows.

Let CSmin (MHz) be a parameter, dependent on the frequency band and the system under consideration defined in table 4 and the result of the formula:

$$(10\log\frac{CS\min}{IFbandwidth} - 10)\ (\mathrm{dB}) \qquad (1)$$

be calculated, where IF bandwidth (IFbw) is the recommended resolution bandwidth set out in table 7.

If the result is ≤ 0 dB, no additional allowance is then permitted.

If the result is > 0 dB the power aggregation of the lines falling, outside the operating CS, within any CSmin width where the spectrum mask is defined shall not exceed the ratio in dB calculated by the following formula:

$$10\log\sum_{i=1}^{i=n}10^{\frac{x_i}{10}} \le 10\log\frac{CS\min}{IFbandwidth} - 10 \qquad (2)$$

Where $X_i$ is the mask excess (in dB) of the $i^{th}$ of *n* lines, falling in the CSmin width (see examples 1 and 2 and figure 9).

EXAMPLE 1: Using equations (1) and (2) above, figure 9 example applied to the 10,7 GHz to 11,7 GHz band (CSmin = 10 MHz; IFbw = 30 kHz) shows that the same effect can be obtained by:
a) one single line, e.g. in leftmost CSmin slot, exceeding the mask by up to 15,2 dB;
b) two lines (n = 2), e.g. in next CSmin slot, exceeding the mask e.g. up to $X_1$ = 14 dB and $X_2$ = 9 dB, respectively;
c) three lines (n = 3), e.g. in rightmost CSmin width, exceeding the mask e.g. up to $X_1$ = 12 dB, $X_2$ = 11 dB and $X_3$ = 7 dB, respectively.

EXAMPLE 2: Using equations (1) and (2) above, figure 9 example applied to the 71 GHz to 86 GHz band (CSmin = 250 MHz; IFbw = 2 MHz) shows that the same effect can be obtained by:
a) one single line, e.g. in leftmost CSmin slot, exceeding the mask by up to 11 dB;
b) two lines (n = 2), e.g. in next CSmin slot, exceeding the mask e.g. up to $X_1$ = 9 dB and $X_2$ = 6,5 dB, respectively;
c) three lines (n = 3), e.g. in rightmost CSmin width, exceeding the mask e.g. up to $X_1$ = 9 dB, $X_2$ = 4,7 dB and $X_3$ = 2 dB, respectively.

**Table 4: CSmin values for relevant bands**

| Frequency band/Channel separation | CSmin (MHz) |
|---|---|
| 1,4 GHz/All channel separations | 0,025 |
| 2,4 GHz/All channel separations | 0,5 |
| 3,4 GHz to 3,8 GHz/Channel separations ≤ 14 MHz | 0,5 |
| 3,6 GHz to 4,2 GHz/Channel separations > 14 MHz | 10 |
| U4 GHz/All channel separations | 10 |
| L6 GHz/All channel separations | 14,825 |
| U6 GHz/All channel separations | 10 |
| 7 GHz and 8 GHz/All channel separations | 7 |
| 10 GHz/All channel separations | 1,5 |
| 11 GHz/All channel separations | 10 |
| 13 GHz, 15 GHz and 18 GHz/All channel separations | 1,75 |
| 23 GHz to 55 GHz (42 GHz excluded)/All channel separations | 3,5 |
| 42 GHz/All channel separations | 7 |
| 57 GHz to 64 GHz | 50 |
| 64 GHz to 66 GHz | 30 |
| 71 GHz to 86 GHz/62,5 MHz or 125 MHz | 62,5 |
| 71 GHz to 86 GHz/channel separations higher than 125 MHz | 250 |

Figure 9 shows a typical example of this requirement.

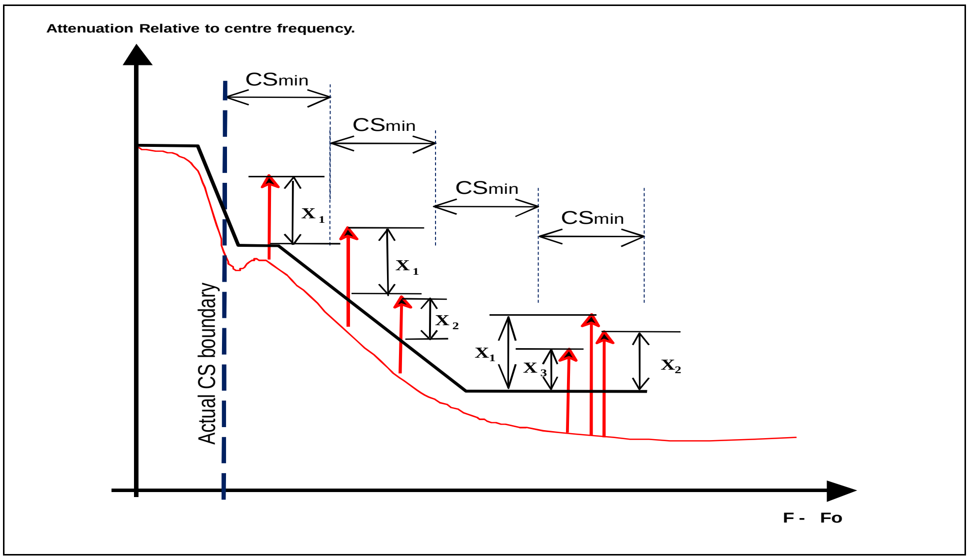



**Figure 9: CW lines exceeding the spectrum mask (typical example)**

When *channels-aggregation* equipment is concerned see also clause O.4.

### 4.2.5 Transmitter unwanted emissions in the *spurious domain*

It is necessary to define limits for unwanted emissions in the *spurious domain* from transmitters in order to limit interference into other systems operating wholly externally to the system under consideration.

The limits are set out in CEPT/ERC/REC 74-01 [3] (see note 1).

The *spurious domain* range is also established by CEPT/ERC/REC 74-01 [3] based on Recommendation ITU-R SM.1539-1 [i.60] (see note 2).

The equipment shall comply with the requirements of CEPT/ERC/REC 74-01 [3] for any setting of ATPC and RTPC (if any).

NOTE 1: CEPT/ERC/REC 74-01 [3] based on Recommendation ITU-R SM.329-12 [i.59] and Recommendation ITU-R F.1191-3 [i.51] gives the definitions applicable to fixed service equipment.

NOTE 2: For information only: according to Recommendation ITU-R SM.1539-1 [i.60] and Appendix 3 of the ITU Radio Regulations [11], the boundary where the *spurious domains* begins, is considered to be offset from the nominal centre frequency of the emission by ±250 % of the relevant Channel Separation (CS), as far as they do not exceed 500 MHz. Beyond this value the boundary is evaluated as: ±(500 MHz + 1,5 × CS). When a CS is not defined (e.g. bandwidth size is left free), the actual occupied bandwidth (i.e. the 99 % of power of the emission) is used.

When *channel-aggregation* equipment are concerned (see note 3), each *aggregated-channel* emission shall be compliant to the unwanted emissions in the spurious domain limit when the other *aggregated-channels* are operating within the manufacturer prescription. Clause O.4.1 describes the general assessment test cases and clause O.4.2 the definition of possible specific joint envelope limits for the two channels emitted from *multiple-channels port* equipment case.

NOTE 3: For information only: it should be taken into account that CEPT/ERC/REC 74-01 [3], for *multi-channel ports* of *channels-aggregation* systems below 21,2 GHz, does not provide, for CS lower than 28 MHz, any further limit adaptation through resolution bandwidth steps lower than 100 KHz. Since the use of *channels-aggregation* system is intended, in general, to provide high capacity, through the aggregation of wide channels (e.g. 28/56/112/224 MHz), this restriction is not considered major drawback for such types of equipment.

The limits are applicable at reference point C' or at point B' (see figure 1 of ETSI EN 302 217-1 [5]) if C' is not available.

### 4.2.6 Transmitter dynamic Change of Modulation Order

For *mixed-mode* systems (including *bandwidth adaptive* operation, if any), the transient behaviour of the transmitter, when a transition from any dynamically activated modulation format (and/or any *bandwidth adaptive* operation), to any other occurs, shall meet the specification of the declared *Reference mode* (i.e. reference spectral efficiency class and, when *bandwidth adaptive* system are concerned, widest operating bandwidth) applicable for each relevant CS for:

- the spectral power density mask (see clause 4.2.3.2) with the flat in-band level (i.e. the "K1" mask values) raised to +3 dB for all systems;
- its associated CW spectral lines allowance (see clause 4.2.4).

In this case, the 0 dB reference of the spectral power density mask, shall be kept fixed as the one obtained with the *Reference mode* in static conditions, except for the case of *bandwidth adaptive* modulation in which the 0 dB reference level can be exceeded by a factor of 10log(BWmax/BWmin), but not more than 6 dB (i.e. 4 times band reduction). The corresponding combined spectrum mask is shown in the example of figure 10 for the most common case of both 1/2 and 1/4 bandwidth reductions activated (see notes 1 and 2).

NOTE 1: Provided that, for maximizing the instantaneous traffic capacity, band reduction is generally activated when the lower modulation format is reached on the nominal CS bandwidth, the portion of the reduced bandwidth masks exceeding the top limit of the *reference mode* mask in figure 10 remain those of the class 2 (equal to class 1).

NOTE 2: Obviously, when different reduction ratio is used, the reduced bandwidth mask in the example of figure 10 should be derived through appropriate frequency scaling.

The manufacturer shall declare, for each CS, the possible *Reference mode(s)* (among which to select the one used for link licensing procedures), which the system is capable to fulfil. For each *Reference mode*, the manufacturer shall define the corresponding equipment settings (e.g. the output power) for meeting the requirements (e.g. spectrum mask) of that *Reference mode*. See also clause D.5 of ETSI EN 302 217-1 [5].

When *channels-aggregation* equipment is concerned, the dynamic change of modulation of the aggregated channels shall be activated according to the normal operating conditions (e.g. synchronous or non-synchronous transitions) specified by the manufacturer.

Such dynamic transitions shall also not cause the specifications for unwanted emissions in the spurious domain (see clause 4.2.5) to be exceeded.

The test methods and conditions of transmitter dynamic change of modulation order are specified in clause 5.2.6.

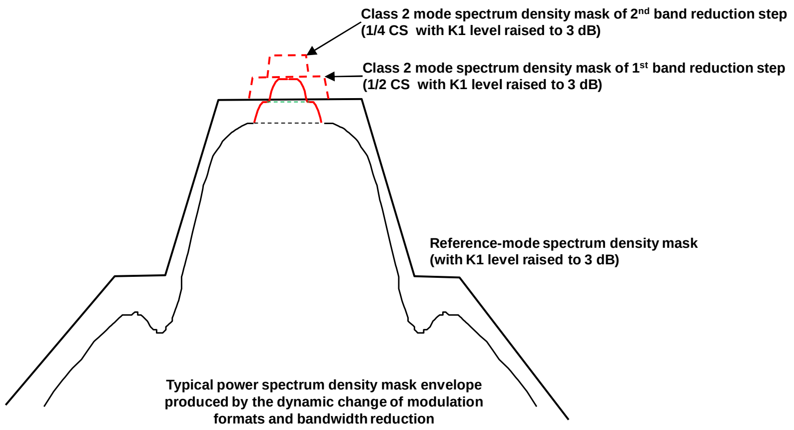



**Figure 10: Combined mask for dynamic change of modulation and bandwidth reduction (example case for 1/2 and 1/4 bandwidth ratios)**

### 4.2.7 Transmitter Frequency tolerance

Frequency tolerance is defined in article 1.151 of the ITU Radio Regulations [11] 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 allowable RF frequency tolerance shall not exceed, by any reason, the following limits (see note):

| | | |
|---|---|---|
| Equipment operating in bands below 3 GHz: | - for CS ≥ 1 MHz: | ±15 ppm |
| | - for CS < 1 MHz: | 0,02 × CS but not less than ±2 ppm |
| Equipment operating in the bands above 57 GHz: | ±50 ppm or 0,02 × CS (MHz), whichever is more stringent | |
| All other cases: | ±15 ppm | |

NOTE: For information only: From the limits expressed in part per million (ppm) e.g. in Hz/MHz or kHz/GHz, the actual limits, in absolute terms, are derived as:
limit (ppm) × operating frequency; e.g. for 11 GHz case, 15 (kHz/GHz) × 11 (GHz) = 165 kHz.

The test methods and conditions of transmitter frequency tolerance are specified in clause 5.2.7.

### 4.2.8 Transmitter emission limitations outside the allocated band

In some frequency bands, for limiting the unwanted emissions possibly exceeding the allocated band boundaries, additional limitations are required. When necessary, they are given in the relevant annexes from B through J.

The test methods and conditions of transmitter frequency tolerance are specified in clause 5.2.8.

## 4.3 Receiver requirements

### 4.3.0 General: System loading

All measurements, when applicable, shall be carried out with the transmitters loaded with test signals defined in clause 4.2.0.

Equipment may provide BB traffic interfaces either single (e.g. 1 × 100base-T) or multiple (e.g. 10 × 10base-T); BER and C/I performance tests will be carried only on one interface. However, when systems are configured as *multi-channels* (including similar use of *channels-aggregation* equipment) clause O.3 describes the necessary variation of the assessment methodology.

### 4.3.1 Receiver unwanted emissions in the *spurious domain*

It is necessary to define limits for unwanted emissions in the *spurious domain* from receivers in order to limit interference into other systems operating wholly externally to the system under consideration.

The limits are set out in CEPT/ERC/REC 74-01 [3] (see note).

No exclusion band around operating frequency (i.e. that inside the spurious domain boundaries described in note 2 to clause 4.2.5 for TX limits) is considered.

Those limits are applicable at reference point C or at point B (see figure 1 of ETSI EN 302 217-1 [5]) if C is not available.

For *channel aggregation* systems the same principles defined in clause 4.2.5 and clause O.4 apply.

NOTE: CEPT/ERC/REC 74-01 [3] based on Recommendation ITU-R SM.329-12 [i.59] and Recommendation ITU-R F.1191-3 [i.51] gives the applicable definitions.

The test methods and conditions of receiver unwanted emissions in the *spurious domain* are specified in clause 5.3.1.

## 4.3.2 BER as a function of receiver input signal level RSL

All parameters are referred to reference point C (for systems with a simple duplexer) or B (for systems with a multi-channel branching system). Losses in RF couplers (possibly used for protected systems) are not taken into account in the limits specified below.

When packet data transmission is considered, the BER values shall be transformed into FER values according to the rules given in annex N, clause N.3.

The manufacturer shall declare the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in the tables of the relevant annex(es) B through J. These declared values shall be used as reference for any C/I tests elsewhere specified in the present document.

Equipment working at the above relevant declared RSL thresholds shall produce a BER equal to or less than the corresponding values (i.e. $10^{-6}$ and $10^{-8}$ for systems with minimum RIC ≤ 100 Mbit/s, or $10^{-6}$ and $10^{-10}$ for systems with minimum RIC > 100 Mbit/s).

When multiple payload interfaces are also provided (at reference points X', X), the BER shall be evaluated on the worst case interface.

When *channels-aggregation* equipment are concerned, the limits are intended as:

a) when independent baseband signal interconnections according to clause O.3.1 are provided, see prescriptions in table O.1;

b) when common baseband signal interconnections according to clause O.3.2 are provided, see prescriptions in table O.2;

c) for *multiple-channels-port(s)* only, in the event that a "passive" device splitting the two received signals into separate receiver chains is integrated in the equipment, the RSL thresholds specified in annex B to annex J will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

When equipment can be configured according either to conditions a) or b) above, the a) conditions shall be the one used for conformance assessment.

NOTE 1: For information only: For *mixed-mode* systems, these requirements apply only for the assessment in respect to the access to radio spectrum. It is assumed that, when operational in the field, the switchover among different modes (or different bandwidth for *bandwidth adaptive* systems in 71 GHz to 86 GHz) will happen at suitable RSL thresholds defined by the manufacturer or the operator. See clause D.5 of ETSI EN 302 217-1 [5].

NOTE 2: For information only: when planning very short links, where propagation would require fade margins limited to few dB for fulfilling the availability and the SES error performance objectives, a minimum link budget should nevertheless be defined for fulfilling also the "Background Block Error Ratio" (BBER) error performance objective. The required RSL for reaching the RBER (established in ETSI EN 302 217-1 [5]) should be considered.

The test methods and conditions are specified in clause 5.3.2.

## 4.3.3 Receiver selectivity

### 4.3.3.1 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 like signals of predefined C/I ratio in the adjacent channels and to generic unmodulated (CW interference) signal anywhere in a large portion of the spurious domain (blocking and spurious response requirement).

Co-channel interference sensitivity is also used as reference for deriving the selectivity; annex P details the methodology on how to translate C/I requirements into selectivity-like figures.

### 4.3.3.2 Receiver co-channel, first and second adjacent channel interference sensitivity

#### 4.3.3.2.1 Requirements basic

In clauses 4.3.3.2.1 through 4.3.3.2.3 all requirements and their definitions are intended with wanted and unwanted signals of same equipment type, operating on identical or corresponding adjacent centre frequencies according to the relevant ECC recommendations, on same CS size and preset for same nominal emissions (in terms of actual modulation formats, RIC and, unless specifically defined, output power level).

The co-channel interference is considered to be that given by a like signal completely uncorrelated with the one under test. There are different requirements for "internal" interference given by the transmitters in systems implementing frequency reuse (see note); however, the latter requirements are not considered relevant for European Harmonised Standards and are set out in ETSI EN 302 217-1 [5].

NOTE: E.g. implementing Cross-polar Interference Canceller (XPIC) in CCDP operation or Multiple Input-Multiple Output (MIMO) technique.

The first and second adjacent channel interference is that given by a like signal completely uncorrelated to the one under test displaced by one CS size from its nominal centre frequency, in its appropriate band, as detailed in the relevant annexes from B through J. The requirement is intended to be separately met by both upper and lower CS interference cases.

All Carrier to Interference ratio (C/I) settings are applied to reference point C (for systems for single channel applications) or B (for systems with multi-channel branching system).

When *channels-aggregation* equipment is concerned, the limits are intended as:

a) when independent baseband signal interconnections according to clause O.3.1 are provided, see prescriptions in table O.1;

b) when common baseband signal interconnections according to clause O.3.2 are provided, see prescriptions in table O.2.

When equipment can be configured according either to conditions a) or b) above, the a) conditions shall be the one used for conformance assessment.

#### 4.3.3.2.2 Limits for co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as specified in the relevant tables of annex B to annex J, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits (see note 1) as declared by the manufacturer for a BER $\leq 10^{-6}$ according to clause 4.3.2.

The format of such tables is given in table 5.

NOTE 1: For information only: for the purpose of frequency co-ordination, intermediate co-channel or adjacent channel sensitivity values may be found in clause D.6 of annex D of ETSI EN 302 217-1 [5].

NOTE 2: For some equipment in annex B only 1 dB degradation is required. In those cases a requirement for second adjacent channel interference is also given.

For adjacent channel interference, the requirement shall be met independently on upper and lower adjacent interference.

The test methods and conditions are specified in clause 5.3.3.2.2.

**Table 5: Co-channel and first adjacent channel interference sensitivity table format**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| Reference Index | Class | | | Co-channel Interference | | adjacent channel interference | |
| | | | | 1 dB | 3 dB | 1 dB | 3 dB |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| NOTE: Actual values for this template are found in the specific frequency band annexes from B through J. | | | | | | | |

#### 4.3.3.2.3 Limits for second adjacent channel interference sensitivity

For equipment in bands covered by annex B, the limits are reported in that annex.

For equipment operating in other bands, the value of Carrier to Interference ratio (C/I) in case of second adjacent channel interference shall be declared by the manufacturer. This value shall be equal or greater (see note 1, note 2 and note 3) than the level of C/I for first adjacent channel for the same 1 dB degradation of BER ≤ $10^{-6}$ required in clause 4.3.3.2.2.

When manufacturer declaration implies a greater C/I ratio (see note 1 and note 3), formal assessment shall be carried out with procedure similar to that for first adjacent channel interference sensitivity.

NOTE 1: In this contest the term "greater" means giving higher immunity to interference than that to the first channel, independently from the positive/negative sign of the actual C/I.

NOTE 2: For information only: the minimum level of C/I ratio (i.e. equal to the first adjacent C/I ratio requirement) is obtained as a consequence of compliance to first adjacent channel interference in clause 4.3.3.2.2 and to the more demanding CW spurious interference sensitivity in clause 4.3.3.3. Therefore, compliance is guaranteed and specific assessment procedure of this functionality is not necessary.

NOTE 3: For information only: it is intended that the declared C/I value is within a range coherent with spectrum mask requirement in the present document. Clause P.2.2 gives the appropriate technical background.

The test methods and conditions are specified in clause 5.3.3.2.3.

### 4.3.3.3 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 test is not intended to imply a relaxed specification at all out of band frequencies elsewhere specified in ETSI EN 302 217 series (e.g. image(s) rejection specified in ETSI EN 302 217-1 [5]).

For a receiver operating at 1 dB above the RSL threshold for a BER ≤ $10^{-6}$ as declared by the manufacturer in clause 4.3.2, the introduction of a CW interferer at a level specified by clause 7.1 of ETSI EN 301 390 [4], but not exceeding the maximum input level (RSL) limit for BER = $10^{-6}$ defined in clause 7.4.1 of ETSI EN 302 217-1 [5], with respect to the wanted signal and at any frequency up to the relevant upper and lower frequency limits derived from the table set out in clause 7.1 of ETSI EN 301 390 [4], but excluding frequencies either side of the channel(s) under test by up to 250 % of the relevant CS (or ( ±(500 MHz + 1,5 × CS) for CS > 500 MHz)),, shall not result in a BER greater than $10^{-6}$.

In case of *multi-carrier* systems, the wanted signal level corresponds to the total power integrated for all sub-carriers and, when multiple payload interfaces are also provided (at reference points X', X), the BER shall be evaluated on the worst case interface.

When *channels-aggregation* equipment is concerned, the limits are intended as:

a) when independent baseband signal interconnections according to clause O.3.1 are provided, see prescriptions in table O.1;

b) when common baseband signal interconnections according to clause O.3.2 are provided, see prescriptions in table O.2.

When equipment can be configured according either to conditions a) or b) above, the a) conditions shall be the one used for conformance assessment.

The test methods and conditions are specified in clause 5.3.3.3.

# 4.4 Antenna Characteristics

## 4.4.1 Integral antennas or dedicated antennas

### 4.4.1.1 Introduction

This clause applies to all equipment specified in annex B to annex J where either an *integral antenna* or a *dedicated antenna* is provided. Antenna characteristics are specified, for the relevant frequency band and antenna class, in ETSI EN 302 217-4 [6].

RPE, *nominal gain* and XPD of antennas are essential parameters for both transmitter and receiver side as antenna performance is deemed equally essential to both transmit and receive direction.

### 4.4.1.2 Radiation Pattern Envelope (Off-axis EIRP density)

Co-polar and cross-polar Radiation Pattern Envelope (RPE) shall be considered for access to radio spectrum; limits that shall apply are:

- For bands in the range 1 GHz to 3 GHz: any class in clause 4.4.2 of ETSI EN 302 217-4 [6] (see note).
- For bands above 3 GHz: only class 2 or higher classes in clause 4.4.3 to clause 4.4.9 of ETSI EN 302 217-4 [6] (see note).

For bands in the range from 57 GHz to 66 GHz, *cross-polar* RPE is not mandatory requirement for assessment according to the present document, even if the antenna is actually dual polarized. Values specified in clause 4.2.9 of ETSI EN 302 217-4 [6] should be considered for reference purposes.

NOTE: It is assumed that the equipment manufacturer identifies which class the antenna meets.

The test methods and conditions are specified in clause 5.4.1.2.

### 4.4.1.3 Antenna gain

The antenna gain is considered essential parameter under article 3.2 of Directive 2014/53/EU [i.1] (see note).

NOTE: For information only: the *antenna gain* concurs to build up the EIRP given, for each link, in the licensing conditions and derived from the planning procedure for the required link availability.

Minimum gain requirements for specific bands are also referred in the relevant annexes from B through J of the present document.

The test methods and conditions are specified in clause 5.4.1.3.

### 4.4.1.4 Antenna Cross-Polar Discrimination (XPD)

The antenna *Cross-Polar* Discrimination (XPD) is considered essential parameter under article 3.2 of Directive 2014/53/EU [i.1]; minimum required limits are those of XPD class 1 defined in clause 4.5 of ETSI EN 302 217-4 [6].

For bands in the range from 57 GHz to 66 GHz, XPD is not mandatory requirement for assessment according to the present document, even if the antenna is actually dual polarized. Values specified in clause 4.5 of ETSI EN 302 217-4 [6] for that range should be considered for reference purposes only.

The test methods and conditions are specified in clause 5.4.1.4.

### 4.4.2 Guidelines for *stand-alone* antennas

When equipment is placed on the market without an antenna, and the user therefore sources a *stand-alone antenna* from the marketplace, the equipment manufacturer should consider the guidelines in the informative annex Q.

# 5 Testing for compliance with technical requirements

## 5.1 Environmental and other conditions for testing

### 5.1.1 Environmental conditions

#### 5.1.1.1 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 in clause 5.1.1.2 or 5.1.1.3 as appropriate.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions where specified in the present document to give confidence of compliance for the affected technical requirements.

Conformity assessment procedure shall be carried out:

a) For radio equipment, with respect to the same principles and procedures (e.g. for temperature variation cycle and speed), for reference and extreme conditions, set out in ETSI EN 300 019-1-3 [13] and/or ETSI EN 300 019-1-4 [14] and clause 5.2.0 (table 6) and clause 5.3.0 (table 7) of the present document for climatic conditions and for power supply conditions.

The requirement to test at reference or extreme conditions is set out in clause 5. 2.0 (table 6) and clause 5.3.0 (table 7) of the present document.

The requirement to test at reference or extreme conditions is set out in clause 5.2 and clause 5.3 of the present document.

b) For DFRS antennas (clause 4.4 and clause 5.4 of the present document), at reference environmental conditions of the test field according to clause 4.1 of ETSI EN 301 126-3-1 [2].

#### 5.1.1.2 Minimum profile for equipment indoor use

Class 3.2 (Partly temperature-controlled locations) of ETSI EN 300 019-1-3 [13] clause 4.2 shall apply.

#### 5.1.1.3 Minimum profile for equipment outdoor use

Class 4.1 (Non-weatherprotected locations) of ETSI EN 300 019-1-4 [14] clause 4.1 shall apply.

### 5.1.2 Other basic conditions

The manufacturer shall identify the chosen system profile, selected from tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the relevant annex).

The system shall be loaded with a continuous data stream at the declared RIC rate (user's interfaces shall be loaded accordingly) and no loss of data shall be experienced (see note).

NOTE: As further guidance, ETSI TR 102 565 [i.31] states that the accumulated data rate of all interfaces at X/X' reference point(s) should not be the limiting bottleneck, but the capacity of the radio link. In case that the portion between X/X' and Z/Z' is able to provide control mechanisms for the data stream at X/X', these mechanisms should be configured such that the radio link capacity determines the accepted data rate at X/X'. Figure 1 of ETSI EN 302 217-1 [5] defines X/X' and Z/Z' reference interfaces on the generic system block diagram; further guidance can be found in figure 2 of ETSI TR 102 565 [i.31].

When *channels-aggregation* equipment is concerned, all *aggregated channels* shall be loaded and, when not elsewhere specified, transmitting/receiving the intended capacity.

Systems can, in principle, be fully loaded only in the direction under test; however, when bidirectional systems are assessed, the TX co-located to the RX under test, shall at least transmit its modulated carrier at maximum possible power suitably terminated at the antenna port (reference points C' defined in figure 1 of ETSI EN 302 217-1 [5]); however, it may be muted when RX unwanted emissions are tested.

When equipment operate with intermittent emissions (i.e. time periods when no net user capacity is transmitted, either for internal system purpose or real transmitter shut down) care should be taken that the tests are not affected by those system shut down periods.

In case of equipment with *integral* or *dedicated antennas,* the tests for radio equipment and antennas may be made separately, whenever appropriate (see clause 4.1.1).

Information on test interpretation and measurement uncertainty is given in informative annex S.

# 5.2 Test methods for the transmitter

## 5.2.0 General test summary

The tests, carried out to generate the test report in order to fulfil any conformity assessment procedure with respect to Directive 2014/53/EU [i.1], shall be carried out at climatic conditions referred to in table 6 and, when applicable for equipment with integral or dedicated antenna, in table 9.

Table 6 indicates the different clauses applicable, for a given parameter, to the requirement, the test clause in the present document and the corresponding test method in the base test document ETSI EN 301 126-1 [1].

**Table 6: Transmitter parameters, test clauses and conditions**

| Clause (see note 2) | Parameter (see note 2) | ETSI EN 301 126-1 [1] reference clause for the test methods | Climatic conditions (see note 1) | | Channels to be tested (see note 4) | Other specific conditions |
|---|---|---|---|---|---|---|
| | | | Ref | Extreme | B = Bottom<br>M = Middle<br>T = Top | |
| **5.2.1.1** | **Transmitter maximum power and EIRP** | - 5.2.1 (transmitter power)<br>- 6.3 of ETSI EN 301 126-3-1 [2] (EIRP) | X | X | BMT | See note 3 |
| **5.2.1.2** | **Transmitter combined nominal output power and EIRP limits** | - 5.2.1 (transmitter power)<br>- 6.3 of ETSI EN 301 126-3-1 [2] (EIRP) | X | | BMT | |
| **5.2.1.3** | **Transmitter output power environmental variation** | 5.2.1 | X | X | BMT | See note 3 |

| Clause (see note 2) | Parameter (see note 2) | ETSI EN 301 126-1 [1] reference clause for the test methods | Climatic conditions (see note 1) | | Channels to be tested (see note 4) | Other specific conditions |
|---|---|---|---|---|---|---|
| | | | Ref | Extreme | B = Bottom M = Middle T = Top | |
| **5.2.2** | **Transmitter power and frequency control** | | | | | |
| **5.2.2.1.1** | **Automatic Transmitter Power Control (ATPC)** | 5.2.3 and 5.2.6 | X | | M | |
| **5.2.2.1.2** | **Remote Transmitter Power Control (RTPC)** | 5.2.4 and 5.2.6 | 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 |
| **5.2.2.1.3** | **Transmitter Remote Frequency Control (RFC)** | 5.2.7 and 5.2.6 | X | | BMT | Tests shall be carried for RFC setting procedure for three frequencies (i.e. frequency settings from lower to centre, centre to higher and back to the lower frequency within the covered range) |
| **5.2.3** | **Transmitter RF Spectrum Mask** | 5.2.6 | X | X | BMT | See note 3 |
| **5.2.4** | **Transmitter discrete CW components exceeding the Transmitter RF spectrum masks limits** | 5.2.8 | X | X | BMT | See note 3 |
| **5.2.5** | **Transmitter unwanted emissions in the spurious domain** | 5.2.9 | X | | BMT | The tests shall be carried out with ATPC, if any, set to maximum available power and RTPC, if any, set at minimum attenuation.<br>Actual test shall be limited to the practical frequency range set out in table 1 of CEPT/ERC/REC 74-01 [3] |
| **5.2.6** | **Transmitter dynamic Change of Modulation Order** | - | X | X | BMT | See note 3<br>Required for *mixed-mode* systems only (including *bandwidth adaptive* systems), according to clause 5.2.6 of the present document<br>Test at extremes of temperature limited to spectrum mask and CW components assessment |
| **5.2.7** | **Transmitter Radio Frequency tolerance** | 5.2.5 | X | X | BMT | See note 3 |
| **5.2.8** | **Transmitter emission limitations outside the allocated band** | 5.2.9 | X | | B and/or T | B and/or T depending on which adjacent band is subject to the requirement. |

| Clause (see note 2) | Parameter (see note 2) | ETSI EN 301 126-1 [1] reference clause for the test methods | Climatic conditions (see note 1) | | Channels to be tested (see note 4) | Other specific conditions |
|---|---|---|---|---|---|---|
| | | | Ref | Extreme | B = Bottom<br>M = Middle<br>T = Top | |

NOTE 1: This refers to climatic conditions only; for other environmental and power supply conditions, please refer to ETSI EN 301 126-1 [1], which provides, for testing some parameters, combined variations also of the power supply source, see table 1 of ETSI EN 301 126-1 [1]; however, when DC regulators from the secondary sources (i.e. from conventional external battery supply) are integral to the radio equipment, test can be done at nominal input voltage level.
NOTE 2: For equipment with integral antennas, the transmitter test clauses include the antenna parameters, test clauses and conditions contained in table 9, clause 5.4.
NOTE 3: This clause requires, besides extremes of temperature, testing also at extremes of voltage (see note 1).
NOTE 4: Annex O provides more detailed information on channels to be tested, depending on the type of equipment and on possible reduction of amount of tests for preset/mixed-mode systems.

## 5.2.1 Transmitter power and power environmental variation

### 5.2.1.1 Transmitter maximum power and EIRP

Test methods for the transmitter power and transmitter power environmental variation may be in accordance with clause 5.2.1 of ETSI EN 301 126-1 [1]; other test methods can be adopted provided that technical evidence of their effectiveness is provided.

For continuous signals (FDD) the mean power shall be measured. For burst type signals (TDD) the mean power during the signal burst shall be measured.

For equipment with integral antenna, the clause that provides the test methods for the EIRP and/or EIRP density mask is derived from the measurement in clause 6.3 of ETSI EN 301 126-3-1 [2].

The test is generally combined with that for the Output power environmental variation in clause 5.2.1.3.

### 5.2.1.2 Transmitter combined nominal output power and EIRP limits

When required in the relevant frequency band annexes from B through J, the mutual limitations of maximum TX output power and EIRP as function of antenna gain, are not subject of dedicated tests, but verified through the equipment documentation (e.g. user instruction).

### 5.2.1.3 Transmitter output power environmental variation

Test methods for the transmitter power environmental variation shall be in accordance with clause 5.2.1 of ETSI EN 301 126-1 [1].

## 5.2.2 Transmitter power and frequency control

### 5.2.2.1 Transmitter Power and Frequency Control (ATPC, RTPC and RFC)

#### 5.2.2.1.1 Automatic Transmit Power Control (ATPC)

The correct operation of the ATPC function (according to the manufacturer's declaration) shall be tested according to the test method described in clause 5.2.3 of ETSI EN 301 126-1 [1]. The test shall be carried out at reference climatic conditions.

Other TX and RX Testing shall be carried out with transmitter power level corresponding to:

- ATPC set manually to a fixed value for receiver requirements.

- ATPC set at maximum available power for transmitter requirements.
- When ATPC is used as permanent feature for enhancing the maximum EIRP/Pout limits provided in the relevant annexes H, I and J, EIRP and Pout requirements will be tested with ATPC set to both maximum unfaded and full power levels as indicated by the manufacturer (see note).

NOTE: For information only: these power levels are intended as the specific value of "*minimum power*" and "*maximum available power*", respectively, selected by the manufacturer among a possible wider flexibility range of the equipment. It is reminded that, in this case, the user should not be able to autonomously increase those levels.

#### 5.2.2.1.2 Remote Transmit Power Control (RTPC)

The tests, carried out to generate the test report and/or declaration of conformity, required in order to fulfil any Conformity assessment procedure with respect to Directive 2014/53/EU [i.1], 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.

Even if all the procedures set out in clause 5.2.6 of ETSI EN 301 126-1 [1] are followed, the actual tests, at the lower RTPC power levels, may fall outside of the available sensitivity of test instruments currently available on the market. In this event the manufacturer shall produce an attachment to the test report containing:

- calculated evidence that the noise floor of the actual test bed is higher than the mask requirement;
- calculated evidence that the actual noise floor, generated by the transmitter with respect to the noise figure and implemented amplification/attenuation chain, is lower than the mask requirement.

Tests for other transmit and receive requirements shall be made with RTPC set at highest delivered power.

#### 5.2.2.1.3 Transmitter Remote Frequency Control (RFC)

Test methods for the *remote frequency control* shall be in accordance with clause 5.2.7 of ETSI EN 301 126-1 [1].

### 5.2.3 Transmitter Radio Frequency spectrum mask

Test methods for the RF spectrum masks may be in accordance with clause 5.2.6 of ETSI EN 301 126-1 [1]; other test methods can be adopted provided that technical evidence of their effectiveness is provided.

The required values may be evaluated by adding a measured filter characteristic to the spectrum measured at reference point A' of figure 1 of ETSI EN 302 217-1 [5]. Due to the limitations of some spectrum analysers, difficulties may be experienced when testing high frequency, high capacity/wideband systems. In this event, the following options are to be considered: measurement using a high performance spectrum analyser; use of a notch filter for improving the dynamic range; two step measurement techniques (e.g. separate tests of spectrum density at power amplifier output and of RF filter(s) subsequent attenuation).

Table 7 shows the recommended spectrum analyser settings.

**Table 7: Spectrum analyser settings for Transmitter Radio Frequency power spectrum measurement**

| **Channel separation (CS) (MHz) (see note 2)** | **0,003 < CS ≤ 0,03** | **0,03 < CS ≤ 0,3** | **0,3 < CS ≤ 0,9** | **0,9 < CS ≤ 12** | **12 < CS ≤ 36** | **36 < CS ≤ 150** | **CS > 150** |
|---|---|---|---|---|---|---|---|
| **Centre frequency** | fo (see note 1) | | | | | | |
| **Sweep width (MHz)** | ≥ 5 × CS | | | | | | ≥ 5 × CS (for CS < 500)<br>≥ 3 × CS + 1 000<br>(for CS ≥ 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: f0 represents the actual carrier frequency.<br>NOTE 2: For *channels-aggregation* equipment is the CS of each *aggregated channel*. | | | | | | | |

## 5.2.4 Transmitter discrete CW components exceeding the transmitter Radio Frequency spectrum mask limit

Test methods for the discrete CW lines exceeding the spectrum mask may be in accordance with clause 5.2.8 of ETSI EN 301 126-1 [1]; other test methods can be adopted provided that technical evidence of their effectiveness is provided.

## 5.2.5 Transmitter unwanted emissions in the spurious domain

Test methods for unwanted emissions in the spurious domain maybe in accordance with clause 5.2.9 of ETSI EN 301 126-1 [1]; other test methods can be adopted provided that technical evidence of their effectiveness is provided.

The test shall be limited to the practical frequency ranges specified in table 1 of CEPT/ERC/REC 74-01 [3]. The test shall be carried out at reference climatic conditions.

## 5.2.6 Transmitter dynamic Change of Modulation Order

For *mixed-mode* systems only (and *bandwidth adaptive* systems in 71 GHz to 86 GHz); this test shall be carried out for transient behaviour with the spectrum analyser in "max hold" mode. The equipment shall be configured to operate with continuous sequence of modulation modes (and/or bandwidth, if applicable) switching at the maximum switching speed permitted by the system (see note), the duty cycle for all modulation orders should be kept as equal as possible; each modulation format shall automatically change its maximum rated power for not exceeding the *Reference mode* emission limitations.

NOTE: The change of modulation format (and/or bandwidth, if applicable) could be produced through suitable stimulation of the transmitter or of the corresponding receiver (return link needed).

In this case, the 0 dB reference of the spectral power density mask shall be kept fixed as the one obtained with the *Reference mode* in static conditions. The spectrum mask shall be modified taking into account also the possible in-band additional allowance described in clause 4.2.6 (k1 = +3 dB) as well as, if applicable, the combination of bandwidth reduction allowance as shown in figure 10.

The maximum spectral density in the "max-hold" condition, disregarding, if any, residual of the carrier (see note in clause 4.2.3.1), shall not exceed, the spectral power density mask described above.

## 5.2.7 Transmitter Radio Frequency tolerance

Test methods for the radio frequency tolerance may be in accordance with clause 5.2.5 of ETSI EN 301 126-1 [1]; other test methods can be adopted provided that technical evidence of their effectiveness is provided.

### 5.2.8 Transmitter emission limitations outside the allocated band

The test method is the same for the unwanted emissions in the spurious domain given in clause 5.2.5 adapted to the required resolution bandwidth and the frequency range of the requirement in clause 4.2.8.

## 5.3 Test methods for the receiver

### 5.3.0 General test summary

The tests, carried out to generate the test report in order to fulfil any conformity assessment procedure with respect to Directive 2014/53/EU [i.1], shall be carried out at reference and extreme climatic conditions according to the provisions for each test summarized in table 8; these tests will be carried out at nominal power supply conditions only. For each parameter table 8 gives the applicable clauses for the requirement, for the test clause in the present document, for the corresponding clause in ETSI EN 301 126-1 [1] and comments on climatic and other specific conditions.

Receiving phenomena tests are considered without the option of space diversity. However, in the case of diversity applications, they do apply separately to any receiver.

For receiving phenomena, the tests, required to generate the test report and/or declaration of conformity in order to fulfil any conformity assessment procedure with respect to Directive 2014/53/EU [i.1], shall be carried out with ATPC, if any, set either to automatic operation or to maximum nominal power operation and RTPC, if any, set to an arbitrary value chosen by the manufacturer. The manufacturer will select the appropriate condition according to the actual implementation on the equipment.

**Table 8: Receiver parameters, test clauses and conditions**

| Clause (see note 2) | Parameter (see note 2) | ETSI EN 301 126-1 [1] reference clause for test methods | Climatic conditions (see note 1) | | Channels to be tested (see note 4) | Other specific conditions |
|---|---|---|---|---|---|---|
| | | | Ref | Extreme | B = Bottom<br>M = Middle<br>T = Top | (see note 3) |
| 5.3.1 | Receiver unwanted emissions in the spurious domain | 5.3.2 | X | | BMT | Actual test shall be limited to the practical frequency range specified in table 1 of CEPT/ERC/REC 74-01 [3] |
| 5.3.2 | BER as a function of receiver input signal level (RSL) | 5.3.3.1 | X | X | BMT at Nominal<br>M at Extreme | |
| 5.3.3.2 | Receiver co-channel, first and second adjacent channel interference sensitivity | 5.3.3.2 (co-channel) | X | | M | |
| | | 5.3.3.3 (first adjacent channel) | X | | M | To be produced for the lower or for the upper frequency of first adjacent channel, arbitrarily selected by manufacturer |
| | | 5.3.3.3 (first adjacent channel applicable also to second adjacent) | X | | M | To be produced for the lower or for the upper frequency of second adjacent channel, arbitrarily selected by manufacturer (see note 5) |
| 5.3.3.3 | Receiver Blocking (CW spurious interference sensitivity | 5.3.3.4 | X | | M | Actual test shall be limited to the practical frequency range specified by clause 7.1 of ETSI EN 301 390 [4] |

NOTE 1: This refers to climatic conditions only; for other environmental and power supply conditions, please refer to ETSI EN 301 126-1 [1].
NOTE 2: For receiving equipment with integral antennas, the essential receiver test suite clauses include the antenna parameters, test clauses and conditions contained in table 9, clause 5.4.
NOTE 3: All receiver test suite clauses are performed at nominal voltage only.
NOTE 4: Annex O provides more detailed information on channels to be tested, depending on the type of equipment and on possible reduction of amount of tests for *preset/mixed-mode* systems.
NOTE 5: Test conditionally required; see clause 5.3.3.2.2.

## 5.3.1 Receiver unwanted emissions in the spurious domain

The test shall be limited to the practical frequency ranges specified by CEPT/ERC/REC 74-01 [3]. The test shall be carried out at reference climatic conditions.

Test methods may be in accordance with clause 5.3.2 of ETSI EN 301 126-1 [1]; other test methods can be adopted provided that technical evidence of their effectiveness is provided.

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

Test methods of the BER as a function of receiver input signal level RSL shall be in accordance with clause 5.3.3.1 of ETSI EN 301 126-1 [1].

Compliance to the present document shall be obtained by:

- sequentially setting the RSL thresholds required in clause 4.3.2;
- verifying that the corresponding BER is less or equal to the specified value (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$).

In the case of a multi-interface, *multi-channel* and *channels-aggregation* system, clause O.3 shall apply.

## 5.3.3 Receiver selectivity

### 5.3.3.1 Void

NOTE: Void clause to preserve consistency of clause numbering between clauses 4 and 5.

### 5.3.3.2 Receiver co-channel, first and second adjacent channel interference sensitivity

#### 5.3.3.2.1 Void

NOTE: Void clause to preserve consistency of clause numbering between clauses 4 and 5.

#### 5.3.3.2.2 Receiver co-channel and first adjacent channel

Test methods for co-channel interference sensitivity shall be in accordance with method 2 of clause 5.3.3.2 of ETSI EN 301 126-1 [1].

Test methods for first adjacent channel interference sensitivity shall be in accordance with method 2 of clause 5.3.3.3 of ETSI EN 301 126-1 [1].

Compliance to the present document shall be obtained by:

- sequentially setting the RSL at 1 dB or 3 dB higher than the thresholds required, as manufacturer declaration according to clause 4.3.2, for BER $10^{-6}$;
- apply the corresponding C/I required in clause 4.3.3.2;
- verifying that the BER is less than or equal to $10^{-6}$.

In the case of a *multi-interface*, *multi-channel* and *channels-aggregation* system, clause O.3 shall apply.

The tests shall be carried out at reference climatic conditions. The test will be produced for the lower or for the upper frequency adjacent channel, arbitrarily selected by the manufacturer.

#### 5.3.3.2.3 Receiver second adjacent channel

Where the value for C/I is declared to be the same as the first adjacent channel value as in clause 4.3.3.2.3, no further assessment is required. When more demanding C/I level is declared the test shall be in accordance with method for first adjacent channel in clause 5.3.3.2.1 above, but applied to the second adjacent channel spacing.

In the case of a *multi-interface*, *multi-channel* and *channels-aggregation* system, clause O.3 shall apply.

### 5.3.3.3 Receiver Blocking (CW spurious interference sensitivity)

Test methods for CW spurious interference shall be in accordance with clause 5.3.3.4 of ETSI EN 301 126-1 [1]. The test shall be limited to the practical frequency ranges specified in clause 7.1 of ETSI EN 301 390 [4]. The test shall be carried out at reference climatic conditions.

In the case of a multi-interface, *multi-channel* and *channels-aggregation* system, clause O.3 shall apply.

# 5.4 Antenna test methods

## 5.4.1 Integral antennas or dedicated antenna

### 5.4.1.1 Summary

The tests, carried out to generate the test report in order to fulfil any conformity assessment procedure with respect to Directive 2014/53/EU [i.1], shall be carried out at reference climatic conditions according to the provisions for each test summarized in table 9; these tests will be carried out at nominal power supply conditions only. For each parameter table 9 gives the applicable clauses for the requirement, for the test clause in the present document, for the corresponding clause in ETSI EN 301 126-3-1 [2] and comments on climatic and other specific conditions.

The tests for antennas may made separately from the radio equipment, whenever appropriate (see clause 4.1.1).

**Table 9: Transmitter/receiver antenna parameters, test clauses and conditions**

| Clause | Parameter | ETSI EN 301 126-3-1 [2] reference clause for test methods | Climatic conditions (see note 1) | | Frequency to be tested (see note 2) | Other specific conditions |
|---|---|---|---|---|---|---|
| | | | Reference | Extreme | B = Bottom T = Top | |
| 5.4 | Antenna directional requirements | | | | | |
| 5.4.1.2 | Radiation Pattern Envelope (RPE) (Off-axis EIRP density) | 6.1 | X | | BT | |
| 5.4.1.3 | Antenna gain | 6.3 | X | | BT | |
| 5.4.1.4 | Antenna Cross-Polar Discrimination (XPD) | 6.2 | X | | BT | |
| NOTE 1: This refers to climatic conditions only; for other environmental conditions, please refer to ETSI EN 301 126-3-1 [2].<br>NOTE 2: For more detailed information on frequency to be tested for wideband antennas, see ETSI EN 302 217-4 [6]. | | | | | | |

### 5.4.1.2 Radiation Pattern Envelope (Off-axis EIRP density)

Test methods for the Radiation Pattern Envelope (RPE) shall be in accordance with clause 6.1 of ETSI EN 301 126-3-1 [2].

### 5.4.1.3 Antenna gain

Test methods for the antenna gain shall be in accordance with clause 6.3 of ETSI EN 301 126-3-1 [2].

### 5.4.1.4 Antenna Cross-Polar Discrimination (XPD)

Test methods for the Antenna Cross-Polar Discrimination shall be in accordance with clause 6.2 of ETSI EN 301 126-3-1 [2].

## 5.4.2 Information on *stand-alone* antennas tests

When equipment is placed on the market without an antenna, and the user therefore sources a *stand-alone antenna* from the marketplace, the equipment manufacturer should consider the guidelines in the informative annex Q, as well as the test methods in clause 5.4.1.

# 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.61] 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 302 217-2 | | | | | |
|---|---|---|---|---|---|
| **Requirement** | | | | **Requirement Conditionality** | |
| **No** | **Description** | **Essential requirements of Directive** | **Clause(s) of the present document** | **U/C** | **Condition** |
| **Transmitting requirements** | | | | | |
| 1 | Transmitter maximum power and EIRP | 3.2 | 4.2.1.1 | U | |
| 2 | Transmitter combined nominal output power and EIRP limits | 3.2 | 4.2.1.2 | C | Required when specific limitations are reported in the frequency dependent annexes from B through J and only applies to systems with integral or dedicated antennas |
| 3 | Transmitter output power environmental variation | 3.2 | 4.2.1.3 | U | |
| 4 | Automatic Transmit Power Control (ATPC) | 3.2 | 4.2.2.1.1 | C | Only applies if ATPC is provided |
| 5 | Remote Transmit Power Control (RTPC) | 3.2 | 4.2.2.1.2 | C | Only applies if RTPC is provided |
| 6 | Transmitter Remote Frequency Control (RFC) | 3.2 | 4.2.2.1.3 | C | Only applies if RFC is provided |
| 7 | Transmitter Radio Frequency spectrum mask | 3.2 | 4.2.3 | U | |
| 8 | Transmitter discrete CW components exceeding the transmitter Radio Frequency spectrum mask limit | 3.2 | 4.2.4 | U | |
| 9 | Transmitter unwanted emissions in the spurious domain | 3.2 | 4.2.5 | U | |
| 10 | Transmitter dynamic Change of Modulation Order | 3.2 | 4.2.6 | C | Applies only to *mixed-mode* equipment |
| 11 | Transmitter Frequency tolerance | 3.2 | 4.2.7 | U | |
| 12 | Transmitter emission limitations outside the allocated band | 3.2 | 4.2.8 | C | In specifically identified frequency bands |

| Harmonised Standard ETSI EN 302 217-2 | | | | | |
|---|---|---|---|---|---|
| **Requirement** | | | | **Requirement Conditionality** | |
| **No** | **Description** | **Essential requirements of Directive** | **Clause(s) of the present document** | **U/C** | **Condition** |
| **Receiver requirements** | | | | | |
| 13 | Receiver unwanted emissions in the spurious domain | 3.2 | 4.3.1 | U | |
| 14 | BER as a function of receiver input signal level (RSL) | 3.2 | 4.3.2 | U | |
| 15 | Receiver co-channel interference sensitivity | 3.2 | 4.3.3.2.2 | U | |
| 16 | Receiver first adjacent channel interference sensitivity | 3.2 | 4.3.3.2.2 | U | |
| 17 | Receiver second adjacent channel interference sensitivity | 3.2 | 4.3.3.2.3 | U | |
| 18 | Receiver Blocking (CW Spurious interference sensitivity) | 3.2 | 4.3.3.3 | U | |
| **Antenna requirements** | | | | | |
| 19 | Off-axis EIRP density - Radiation Pattern Envelope (RPE) | 3.2 | 4.4.1.2 | C | Only applies to systems with *integral* and/or *dedicated antennas* |
| 20 | Antenna gain | 3.2 | 4.4.1.3 | C | Only applies to systems with *integral* and/or *dedicated antennas* |
| 21 | Antenna Cross-Polar Discrimination | 3.2 | 4.4.1.4 | C | Only applies to systems with *integral* and/or *dedicated antennas* |

**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 manufacturer's claimed functionality of the equipment (C).

**Condition** Explains the conditions when the requirement is or is not 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): Frequency bands from 1,4 GHz to 2,6 GHz

# B.1 Introduction

This annex contains requirements for a variety of equipment that, depending on the channel arrangements adopted by the local administrations (according to clause B.2.1 and table B.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according to clause B.2.2 and table B.2).

In this annex only FDD equipment are considered.

# B.2 General characteristics

## B.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table B.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or ECC recommendations set around the rough boundary of present ITU-R or ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table B.1: Frequency characteristics information**

| Band (GHz) | Frequency range (MHz) | Channel separation (MHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|---|
| | | | CEPT/ERC Recommendation | ITU-R Recommendation |
| 1,4 | 1 350 to 1 375 paired with 1 492 to 1 517 | 0,025 to 3,5 | T/R 13-01 annex A [i.16] | F.1242-0 [i.52] |
| 1,4 | 1 375 to 1 400 paired with 1 427 to 1 452 | 0,025 to 3,5 | T/R 13-01 annex B [i.16] | F.1242-0 [i.52] |
| 2,1 | 2 025 to 2 110 paired with 2 200 to 2 290 | 1,75 to 14 | T/R 13-01 annex C [i.16] | F.1098-1 [i.48] |
| 2,6 | 2 520 to 2 593 paired with 2 597 to 2 670 | 1,75 to 14 | See note | F.1243-0 [i.53] |
| 2,4 | 2 300 to 2 500 | 1 and 2 | - | F.746-10 annex 1 [i.44] |
| NOTE: This band was also considered, with the same arrangement of Recommendation ITU-R F.1243-0 [i.53], in annex D of CEPT/ERC/REC T/R 13-01 [i.16] but it was removed from the 2010 revision. | | | | |

# B.2.2 Transmission capacities

Digital systems covered by this annex are intended to be used for point-to-point connections in local and regional networks.

Only relatively low capacity systems are considered in these bands; therefore, in table B.2 the minimum RIC have been specified only for the channel separations which are multiples of 1,75 MHz and for spectral efficiency classes 2 and above. For spectral efficiency class 1 and other channel sizes (see note) only indicative channel capacity, in terms of gross bit rate, is mentioned for guidance:

- Systems in bands 1,4 GHz and 2,4 GHz — Typical base band data rates are between 9,6 kbit/s and 4 × 2 Mbit/s.
- Systems in bands 2,1 GHz and 2,6 GHz — Typical base band data rates are N × 2 Mbit/s (N = 1, 2, 4, 8, 16), 2 × 8 Mbit/s and 34 Mbit/s.

The indicative channel capacities (gross bit rate), shown in table B.2 for the three classes of equipment, are based on the maximum gross bit rate for the minimum modulation level in each class. It is possible to improve on the gross bit rate by using higher modulation schemes within each class. The use of higher modulation levels within each class is permitted so long as the limits of the relevant spectral power density mask are not exceeded.

NOTE: For information only: these systems are used for telemetry/telecontrols; therefore, the design would follow different criteria than that for the telecommunication data transmission based on at least the primary rate of 2 048 kbit/s (2 Mbit/s).

**Table B.2: Indicative channel capacities (*gross bit rate*) and minimum RIC, for ACCP operation**

| Frequency band (GHz) | Channel separation | Spectral efficiency Class 1 equipment (reference index 1) | | Spectral efficiency Class 2 equipment (reference index 2) | | Spectral efficiency Class 4L equipment (reference index 4) | |
|---|---|---|---|---|---|---|---|
| | | Indicative capacity | Min RIC | Indicative capacity | Min RIC | Indicative capacity | Min RIC |
| 1,4 | 25 kHz | 20 kbit/s | - | 32 kbit/s | - | 64 kbit/s | - |
| 1,4 | 75 kHz | 60 kbit/s | - | 95 kbit/s | - | 190 kbit/s | - |
| 1,4 | 250 kHz | 200 kbit/s | - | 325 kbit/s | - | 650 kbit/s | - |
| 1,4 | 500 kHz | 400 kbit/s | - | 650 kbit/s | - | 1 300 kbit/s | - |
| 1,4 and 2,4 | 1 MHz | 800 kbit/s | - | 1 300 kbit/s | - | 2 600 kbit/s | 2 Mbit/s |
| 2,1 and 2,6 | 1,75 MHz | 1 400 kbit/s | 1 Mbit/s | 2 275 kbit/s | 2 Mbit/s | 4 550 kbit/s | 4 Mbit/s |
| 1,4 and 2,4 | 2 MHz | 1 600 kbit/s | - | 2 600 kbit/s | - | 5 200 kbit/s | - |
| 1,4; 2,1 and 2,6 | 3,5 MHz | 2 800 kbit/s | 2 Mbit/s | 4 500 kbit/s | 4 Mbit/s | 9 100 kbit/s | 8 Mbit/s |
| 2,1 and 2,6 | 7 MHz | Not applicable | | 9 000 kbit/s | 8 Mbit/s | 18 200 kbit/s | 16 Mbit/s |
| 2,1 and 2,6 | 14 MHz | Not applicable | | 18 000 kbit/s | 16 Mbit/s | 38 000 kbit/s | 32 Mbit/s |

# B.3 Transmitter

## B.3.1 General requirements

**Table B.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause 4.2.1.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 (for CS 1,75 MHz or multiple thereof) or in clause B.3.2 (for other CS) |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |

## B.3.2 Transmitter Radio Frequency spectrum masks options

The masks in clause 4.2.3.2 are valid only for those specific combinations of CS, nominal capacity and spectral efficiency class that are also included among those foreseen in table B.2.

In addition, with reference to the relevant generic mask shape specified in figure 4, table B.4 shows the offset frequency from f0 and attenuation of corner points of spectrum masks for CS = 2 MHz and CS < 1,75 MHz, which shall be used for compliance.

**Table B.4: Limits of transmitter spectral power density for CS = 2 MHz and CS < 1,75 MHz**

| Spectral efficiency | | Frequency band (GHz) | Channel separation (MHz) | K1 (dB) | f1 (kHz) | K2 (dB) | f2 (kHz) | K3 (dB) | f3 (kHz) | K4 (dB) | f4 (kHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference index | Class | | | | | | | | | | |
| 1 and 2 | 1 and 2 | 1,4 | 0,025 | +3 | 12 | -25 | 18 | -25 | 25 | -45 | 40 |
| | | | 0,075 | | 36 | | 54 | | 75 | | 120 |
| | | | 0,250 | | 110 | | 170 | | 230 | | 400 |
| | | | 0,500 | | 210 | | 325 | | 450 | | 800 |
| | | 1,4 and 2,4 | 1 | | 420 | | 650 | | 900 | | 1 600 |
| | | | 2 | | 840 | | 1 300 | | 1 800 | | 3 200 |
| 4 | 4L | 1,4 | 0,025 | +1 | 12 | -32 | 18 | -32 | 25 | -55 | 40 |
| | | | 0,075 | | 36 | | 54 | | 75 | | 120 |
| | | | 0,250 | | 110 | | 170 | | 230 | | 400 |
| | | | 0,500 | | 210 | | 325 | | 450 | | 800 |
| | | 1,4 and 2,4 | 1 | | 420 | | 650 | | 900 | | 1 600 |
| | | | 2 | | 840 | | 1 300 | | 1 800 | | 3 200 |
| NOTE: For mask reference shape see figure 4. | | | | | | | | | | | |

# B.4 Receiver

## B.4.1 General requirements

**Table B.5: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table B.6 |
| **Receiver co-channel, first and second adjacent channels interference sensitivity** | Tables B.7a and B.7b |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## B.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for BER $\leq 10^{-6}$ and, when required, also for BER $\leq 10^{-8}$, which shall not be worse than the corresponding RSL upper bound values indicated in table B.6. The above declared Receiver Signal Levels (RSL) shall produce a BER $\leq 10^{-6}$ and, when required, a BER $\leq 10^{-8}$.

**Table B.6: BER as a function of receiver input signal level RSL (upper bound of declared limit)**

| Spectral efficiency | | Frequency band (GHz) | Co-polar channel separation | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) |
|---|---|---|---|---|---|
| Reference index | Class | | | | |
| 1 | 1 (see note 1) | 1,4 | 25 kHz | -105 | - |
| | | 1,4 | 75 kHz | -100 | - |
| | | 1,4 | 250 kHz | -94 | - |
| | | 1,4 | 500 kHz | -92 | - |
| | | 1,4 and 2,4 | 1 MHz | -89 | - |
| | | 2,1 and 2,6 | 1,75 MHz | -87 | -85,5 |
| | | 1,4 and 2,4 | 2 MHz | -86 | -84,5 |
| | | 1,4; 2,1 and 2,6 | 3,5 MHz | -83 | -81,5 |
| 2 | 2 | 1,4 | 25 kHz | -108 | - |
| | | 1,4 | 75 kHz | -103 | - |
| | | 1,4 | 250 kHz | -97 | - |
| | | 1,4 | 500 kHz | -95 | - |
| | | 1,4 and 2,4 | 1 MHz | -92 | - |
| | | 2,1 and 2,6 | 1,75 MHz | -94 | -92,5 |
| | | 1,4 and 2,4 | 2 MHz | -93 | -91,5 |
| | | 1,4; 2,1 and 2,6 | 3,5 MHz | -91 | -89,5 |
| | | 2,1 and 2,6 | 7 MHz | -88 | -86,5 |
| | | 2,1 and 2,6 | 14 MHz | -85 | -83,5 |
| 4 | 4L | 1,4 | 25 kHz | -101 | - |
| | | 1,4 | 75 kHz | -97 | - |
| | | 1,4 | 250 kHz | -91 | - |
| | | 1,4 | 500 kHz | -89 | - |
| | | 1,4 and 2,4 | 1 MHz | -86 | - |
| | | 2,1 and 2,6 | 1,75 MHz | -87 | -85,5 |
| | | 1,4 and 2,4 | 2 MHz | -86 | -84,5 |
| | | 1,4; 2,1 and 2,6 | 3,5 MHz | -84 | -82,5 |
| | | 2,1 and 2,6 | 7 MHz | -81 | -79,5 |
| | | 2,1 and 2,6 | 14 MHz | -78 | -76,5 |
| NOTE 1: Class 1 equipment performances are based on simpler receiver/demodulator implementation and modulation formats (e.g. FSK); this justifies their limits worse than those of class 2 equipment. NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler). | | | | | |

# B.4.3 Receiver co-channel, first and second adjacent channels interference sensitivity

The limits of Carrier to Interference ratio (C/I), in case of co-channel, first and second adjacent channel interference, shall be as set out in table B.7a, giving maximum C/I values for 1 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER $\leq 10^{-6}$ in clause B.4.2, or in table B.7b, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits, as above declared, for BER $\leq 10^{-6}$ according clause B.4.2.

**Table B.7a: Co-channel and adjacent channels interference sensitivity (CS = 0,025 MHz to 1 MHz and 2 MHz)**

| Spectral efficiency | | Channel separation (MHz) | C/I (dB) for BER ≤ $10^{-6}$ RSL degradation of 1 dB | | |
|---|---|---|---|---|---|
| Reference index | Class | | Co-channel interference C/I (dB) | First adjacent channel interference C/I (dB) | Second adjacent channel interference C/I (dB) |
| 1 | 1 | 0,025 to 1 and 2 | 23 | 0 | -25 |
| 2 | 2 | 0,025 to 1 and 2 | 23 | 0 | -25 |
| 4 | 4L | 0,025 to 1 and 2 | 30 | 0 | -25 |

**Table B.7b: Co-channel and adjacent channels interference sensitivity (CS = 1,75 MHz multiples)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) (see note 1) | Channel separation (MHz) (see note 1) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| | | | | Co-channel interference | | First adjacent (note 2) channel interference | |
| Reference index | Class | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 1 | 1 | 1; 2; 4; 8 | 1,75; 3,5; 7; 14 | 23 | 19 | 0 | -4 |
| 2 | 2 | 2; 4; 8; 16 | 1,75; 3,5; 7; 14 | 23 | 19 | 0 | -4 |
| 4 | 4L | 4; 8; 16; 32 | 1,75; 3,5; 7; 14 | 30 | 26,5 | 0 | -4 |

NOTE 1: Minimum RIC and Channel separation series of values in each row are intended one to one coupled in their orders.

NOTE 2: For the second adjacent channel interference see clause 4.3.3.2.3.

# Annex C (normative): Frequency bands from 3,5 GHz to 11 GHz (channel separation up to 30 MHz, 56/60 MHz and 112 MHz)

# C.1 Introduction

This annex contains requirements for a variety of equipment that, depending on the channel arrangements adopted by the local administrations (according to clause C.2.1 and table C.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according to clause C.2.2 and table C.2).

In this annex only FDD equipment are considered.

# C.2 General characteristics

## C.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table C.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table C.1: Frequency characteristics information**

| Band (GHz) | Frequency range (GHz) | Channel separation (MHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|---|
| | | | CEPT/ECC (CEPT/ERC) Recommendation | ITU-R Recommendation |
| 3,5 | 3,410 to 3,600 | 1,75 to 14 | 14-03 [i.14] | - |
| 4 | 3,600 to 3,800 | 1,75 to 14 | 12-08 annex B part 2 [i.9] | - |
| | 3,600 to 4,200 | 30 | 12-08 annex A part 2 [i.9] | F.635-7 [i.41] |
| | 3,600 to 4,200 | 60 (see note) | - | - |
| | 3,800 to 4,200 | 29 | 12-08 annex B part 1 [i.9] | F.382-8 [i.33] |
| | 3,800 to 4,200 | 58 (see note) | - | - |
| U4 | 4,400 to 5,000 | 28 and 56 | - | F.1099-5 annex 3 [i.49] |
| | | 60 | - | F.1099-5 annex 1 [i.49] |
| L6 | 5,925 to 6,425 | 29,65 and 59,3 | 14-01 [i.12] | F.383-9 [i.34] |
| | | 28 | - | F.383-9 annex 2 [i.34] |
| | Guard and central gap | 1,75 and 3,5 | (14)06 [i.25] | - |
| U6 | Guard and central gap | 1,75 and 3,5 | (14)06 [i.25] | - |
| | 6,425 to 7,100 | 20 | (14)02 [i.13] | F.384-11 [i.35] |
| | 6,425 to 7,100 | 30 and 60 | (14)02 [i.13] | F.384-11 [i.35] |
| | | 3,5, 7, 14 | (14)02 annex 1 [i.13] | F.384-11 annex 2 [i.35] |

| Band (GHz) | Frequency range (GHz) | Channel separation (MHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|---|
| | | | CEPT/ECC (CEPT/ERC) Recommendation | ITU-R Recommendation |
| 7 | 7,125 to 7,425 | 7 to 28 and 56 | - | F.385-10 [i.36] |
| | 7,425 to 7,725 | | - | F.385-10 [i.36] |
| | 7,250 to 7,550 | | - | F.385-10 [i.36] |
| | 7,550 to 7,850 | | - | F.385-10 [i.36] |
| | 7,110 to 7,750 | 28 and 56 | - | F.385-10 annex 3 [i.36] |
| | 7,425 to 7,900 | 7 to 28 and 56 | (02)06 annex 2.2 and annex 3 [i.21] | F.385-10 annex 4 [i.36] |
| | 7,250 to 7,550 | 3,5 to 28 and 56 | - | F.385-10 annex 5 [i.36] |
| | 7,125 to 7,425 | 1,75 to 28 and 56 | (02)06 annexes 1.1, 2.1 and annex 3 [i.21] | F.385-10 annex 1 [i.36] |
| | 7,425 to 7,725 | | (02)06 annex 1.1 and annex 3 [i.21] | F.385-10 annex 1 [i.36] |
| 8 | 7,725 to 8,275 | 7, 14, 28 and 56 | (02)06 annex 1.2.1 and annex 3 [i.21] | F.386-9 annex 2 [i.37] |
| | | 29,65 and 59,3 | (02)06 annex 1.2.2 and annex 3 [i.21] | F.386-9 annex 6 [i.37] |
| | 7,725 to 8,275 | 30 and 60 | - | F.386-9 annex 1 [i.37] |
| | 8,025 to 8,500 | 7 to 28 and 56 | - | F.386-9 annex 5 [i.37] |
| | 8,275 to 8,500 | 7 to 28 and 56 | (02)06 annex 1.3 and annex 3 [i.21] | F.386-9 annex 2 [i.37] |
| | 7,900 to 8,400 | 7 to 28 and 56 | - | F.386-9 annex 3 [i.37] |
| | 7,900 to 8,500 | 1,75 to 28 and 56 | (02)06 annex 2.3 and annex 3 [i.21] | - |
| 10,5 | 10,000 to 10,680 | 3,5 to 28 | - | F.747-1 annex 4 [i.45] |
| | 10,500 to 10,680 | 7 | - | F.747-1 annex 1 [i.45] |
| | 10,150 to 10,3 paired with 10,5 to 10,650 | 3,5 to 28 and 56 | 12-05 [i.6] | F.747-1 annex 3 [i.45] |
| 11 | 10,700 to 11,700 | 7, 14, 28, 56 and 112 | 12-06 [i.7] | F.387-12 annex 4 [i.38] |
| NOTE: In bands from 3,6 GHz to 4,2 GHz, systems with 58/60 MHz CS do not rely on any Recommended CEPT or ITU-R radio frequency channel arrangements providing channel separation up to 56 MHz to 60 MHz; however, in bands that provide 28 MHz to 30 MHz CS, it is assumed that aggregation of two half sized channels might be permitted on national basis. Also in higher bands CEPT and ITU-R Recommendations provide 56 MHz to 60 MHz CS only in terms of aggregation of about 2 x 28 MHz to 30 MHz CS, subject to their availability and possible national license restrictions. | | | | |

## C.2.2 Transmission capacities

**Table C.2: Minimum RIC transmission capacity and system classes for various channel separation**

| Channel arrangement→ | | | Co-polar (ACCP) | | | | | | | | Cross-polar (ACAP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel separation (MHz) → | | | 1,75 | 3,5 | 7 | 14 to 15 | 20 | 28 to 30 | 56 to 60 | 112 | 28 to 30 | 56 to 60 | 112 |
| Min. payload RIC rate Mbit/s (note 1) | Spectral efficiency↓ | | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ |
| | Reference Index | Class | | | | | | | | | | | |
| | 2 | 2 | 2 | 4 | 8 | 16 | - | 32 | 64 | 128 | - | - | - |
| | 3 | 3 | 3 | 6 | 12 | 24 | - | 48 | 96 | 192 | - | - | - |
| | 4 | 4L | 4 | 8 | 16 | 32 | 45 | 64 | 128 | 256 | - | - | - |
| | 5 | 4H | - | - | 24 | 49 | - | 98 | 196 | 392 | - | - | - |
| | 6 | 5L | - | - | 29 | 58 | - | - | - | - | - | - | - |
| | | 5LB, 5LA | - | - | - | - | - | 117 | 235 | 470 | 117 | 235 | 470 |
| | 7 | 5H | - | - | 34 | 68 | - | - | - | - | - | - | - |
| | | 5HB, 5HA | - | - | - | - | - | 137 | 274 (note 2) | 548 | 137 | 274 (note 2) | 548 |
| | 8 | 6L | - | - | 39 | 78 | - | - | - | - | - | - | - |
| | | 6LB, 6LA | - | - | - | - | - | 156 | 313 | 626 | 156 | 313 | 626 |
| | 9 | 6H | - | - | - | 88 | - | - | - | - | - | - | - |
| | | 6HB, 6HA | - | - | - | - | - | 176 | 352 | 704 | 176 | 352 | 704 |
| | 10 | 7 | - | - | - | 98 | - | - | - | - | - | - | - |
| | | 7B, 7A | - | - | - | - | - | 196 | 392 | 784 | 196 | 392 | 784 |
| | 11 | 8 | - | - | - | 107 | - | - | - | - | - | - | - |
| | | 8B, 8A | - | - | - | - | - | 215 | 431 | 862 | 215 | 431 | 862 |

NOTE 1: For equipment assessment with different base band interfaces, see annex N.

NOTE 2: Equipment requirements are set only on the basis of the RIC rate on one polarization. However, 4 × STM-1 or STM-4 capacity can be possible by doubling 2 × STM-1 equipment either in CCDP operation or through operation of two 2 × STM-1 systems (or one *channels-aggregation* equipment) in two 55/56 MHz channels, which, due to spectrum availability, may also not be adjacent. For the assessment of such cases, refer to clause O.3. Similar considerations apply as well for Ethernet capacity, e.g. when 1000Base-T or N × 100Base-T capacity are concerned.

# C.3 Transmitter

## C.3.1 General requirements

**Table C.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause 4.2.1.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause C.3.2 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |

## C.3.2 Transmitter Radio Frequency spectrum masks

The masks in clause 4.2.3.2 are valid only for those specific combinations of CS, nominal capacity and spectral efficiency class that are also included among those foreseen in table C.2.

For equipment with CS = 20 MHz and spectral efficiency class 4L the mask corner points in table C.4 apply with reference to mask shape in figure 5 in clause 4.2.3.1.

**Table C.4: Alternative and special limits of spectral power density**

| Spectral efficiency class | Nominal bit rate (Mbit/s) | Channel separation (MHz) | Mask reference shape | K1 (dB) | f1 (MHz) | K2 (dB) | f2 (MHz) | K3 (dB) | f3 (MHz) | K4 (dB) | f4 (MHz) | K5 (dB) | f5 (MHz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4L** | STM-0 | 20 | Figure 5 | +1 | 7,5 | -10 | 9,5 | -33 | 12,5 | -40 | 15 | -55 (note) | 30 (note) |
| NOTE: In addition, for frequency bands below 10 GHz, a second equipment option with spectrum masks floor extended at -60 dB is also here below provided; this frequency corner of the mask shall be derived by linear interpolation from the values in the table. For clarity these values, affecting this corner point, are reported below in this table. Rationale for that is that cases of very congested nodal areas are not infrequent. Regulatory bodies, for the links converging in those nodal points, on a case by case basis, might limit the licensing only to equipment that fulfils the more stringent figure of -60 dB. Administrations, requiring for those special cases also the more tightening option, will mention it in the Interface Notification foreseen in Directive 2014/53/EU [i.1].<br>For fulfilling one or both requirements, equipment manufacturer may choose to produce and assess different products. | | | | | | | | | | | | | |
| **Spectral efficiency class** | **Nominal Bit rate (Mbit/s)** | **Channel separation (MHz)** | **K1/f1 to K4/f4 (dB/MHz)** | | | | | | | | | **K5 (dB)** | **f5 (MHz)** |
| **4L** | STM-0 | 20 | n.c. | | | | | | | | | -60 | 35 |
| n.c.: No change with respect to table B.4. | | | | | | | | | | | | | |

# C.4 Receiver

## C.4.1 General requirements

**Table C.5: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table C.6 |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table C.7 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## C.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in the table C.6. The above declared Receiver Signal Levels (RSL) shall produce a BER $\leq 10^{-6}$ and either $\leq 10^{-8}$ or $\leq 10^{-10}$.

NOTE: For information only:RSL values (in terms of noise figure and S/N for BER=$10^{-6}$), evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.28] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table C.6: BER as a function of receiver input signal level RSL (upper bound of declared limit)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Co-polar channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) (see note 2) | RSL for BER ≤ $10^{-8}$ (dBm) (see note 2) | RSL for BER ≤ $10^{-10}$ (dBm) (see note 2) |
|---|---|---|---|---|---|---|
| Reference index | Class | | | | | |
| 2 | 2 | 2 | 1,75 | -93 | -91,5 | - |
| | | 4 | 3,5 | -90 | -88,5 | |
| | | 8 | 7 | -87 | -85,5 | |
| | | 16 | 14 to 15 | -84 | -82,5 | |
| | | 32 | 28 to 30 | -81 | -79,5 | |
| | | 64 | 56 to 60 | -78 | -76,5 | |
| | | 128 | 112 | -75 | - | -72 |
| 3 | 3 | 3 | 1,75 | -88 | -86,5 | - |
| | | 6 | 3,5 | -85 | -83,5 | |
| | | 12 | 7 | -82 | -80,5 | |
| | | 24 | 14 to 15 | -79 | -77,5 | |
| | | 48 | 28 to 30 | -76 | -74,5 | |
| | | 96 | 56 to 60 | -73 | -71,5 | |
| | | 192 | 112 | -70 | - | -67 |
| 4 | 4L | 4 | 1,75 | -86 | -84,5 | - |
| | | 8 | 3,5 | -83 | -81,5 | |
| | | 16 | 7 | -80 | -78,5 | |
| | | 32 | 14 to 15 | -77 | -75,5 | |
| | | 45 | 20 | -76 | -74,5 | |
| | | 64 | 28 to 30 | -74 | -72,5 | |
| | | 128 | 56 to 60 | -71 | - | -68 |
| | | 256 | 112 | -68 | - | -65 |
| 5 | 4H | 24 | 7 | -77 | -75,5 | - |
| | | 49 | 14 to 15 | -74 | -72,5 | - |
| | | 98 | 28 to 30 | -71 | -69,5 | - |
| | | 196 | 56 to 60 | -68 | - | -65 |
| | | 392 | 112 | -65 | - | -62 |
| 6 | 5L | 29 | 7 | -74 | -72,5 | - |
| | | 58 | 14 to 15 | -71 | -69,5 | - |
| | 5LA/5LB (note 1) | 117 | 28 to 30 (ACAP/ACCP) | -68 | - | -65 |
| | | 235 | 56 to 60 (ACAP/ACCP) | -65 | - | -62 |
| | | 470 | 112 | -62 | - | -59 |
| 7 | 5H | 34 | 7 | -72,5 | -71 | - |
| | | 68 | 14 to 15 | -69,5 | -68 | - |
| | 5HA/5HB (note 1) | 137 | 28 to 30 (ACAP/ACCP) | -67 | - | -64 |
| | | 274 | 56 to 60 (ACAP/ACCP) | -64 | - | -61 |
| | | 548 | 112 (ACAP/ACCP) | -61 | - | -58 |
| 8 | 6L | 39 | 7 | -68 | -66,5 | - |
| | | 78 | 14 to 15 | -65 | -63,5 | - |
| | 6LA/6LB (note 1) | 156 | 28 to 30 (ACAP/ACCP) | -63 | - | -60 |
| | | 313 | 56 to 60 (ACAP/ACCP) | -60 | - | -57 |
| | | 626 | 112 (ACAP/ACCP) | -57 | - | -54 |
| 9 | 6H | 88 | 14 to 15 | -61 | -59,5 | |
| | 6HA/6HB (note 1) | 176 | 28 to 30 (ACAP/ACCP) | -58,5 | - | -55,5 |
| | | 352 | 56 to 60 (ACAP/ACCP) | -56 | - | -53 |
| | | 704 | 112 (ACAP/ACCP) | -53 | - | -50 |
| 10 | 7 | 98 | 14 to 15 | -57,5 | -56 | - |
| | 7A/7B (note 1) | 196 | 28 to 30 (ACAP/ACCP) | -55 | - | -52 |

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Co-polar channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) (see note 2) | RSL for BER ≤ $10^{-8}$ (dBm) (see note 2) | RSL for BER ≤ $10^{-10}$ (dBm) (see note 2) |
|---|---|---|---|---|---|---|
| Reference index | Class | | | | | |
| | | 392 | 56 to 60 (ACAP/ACCP) | -52,5 | - | -49,5 |
| | | 784 | 112 (ACAP/ACCP) | -49,5 | - | --46,5 |
| 11 | 8 | 107 | 14 to 15 | -54,5 | - | -51,5 |
| | 8A/8B (note 1) | 215 | 28 to 30 (ACAP/ACCP) | -51,5 | - | -48,5 |
| | | 431 | 56 to 60 (ACAP/ACCP) | -49 | - | -46 |
| | | 862 | 112 (ACAP/ACCP) | -46 | - | -43 |

NOTE 1: For CS 28 MHz to 30 MHz or 56 MHz to 60 MHz or 112 MHz, systems of classes 5LB, 5HB, 6LB, 6HB, 7B and 8B, the limits are required when the connection to the same antenna port of even and odd channels, spaced about 30 MHz or about 60 MHz or 112 MHz, respectively, apart on the same polarization, is made with the use of an external 3 dB hybrid coupler placed at reference point C. When alternatively, for the above purpose, narrow-band branching filters solution are used, the above BER performance thresholds can be increased by 1,5 dB.

NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

## C.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as set out in table C.7, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause C.4.2.

**Table C.7: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) (see note) | Channel separation (MHz) (see note) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 2 | 2 | 2; 4; 8; 16; 32; 64; 128 | 1,75; 3,5; 7; 14 to 15; 28 to 30; 56 to 60; 112 | 23 | 19 | 0 | -4 |
| 3 | 3 | 3; 6; 12; 24; 48; 96; 192 | 1,75; 3,5; 7; 14 to 15; 28 to 30; 56 to 60; 112 | 27 | 23 | -1 | -5 |
| 4 | 4L | 4; 8; 16; 32; 64; 128; 256 | 1,75; 3,5; 7; 14 to 15; 28 to 30; 56 to 60; 112 | 30 | 26,5 | -3 | -7 |
| | | 45 | 20 | 30 | 26,5 | -8 | -12 |
| 5 | 4H | 24; 49; 98; 196; 392 | 7; 14 to 15; 28 to 30; 56 to 60; 112 | 33 | 29 | -5 | -9 |
| 6 | 5L | 29; 58 | 7; 14 to 15 | 34 | 30 | -3 | -7 |
| | 5LB | 117; 235; 470 | 28 to 30; 56 to 60; 112 (ACCP) | | | | |
| | 5LA | 117; 235; 470 | 28 to 30; 56 to 60; 112 (ACAP) | 34 | 30 | 4 | 1 |
| 7 | 5H | 32; 64 | 7; 14 to 15 | 37 | 33 | -2 | -6 |
| | 5HB | 137; 274; 548 | 28 to 30; 56 to 60; 112 (ACCP) | 35 | 32 | -5 | -8 |
| | 5HA | 137; 274; 548 | 28 to 30; 56 to 60; 112 (ACAP) | 37 | 33 | 3 | -1 |
| 8 | 6L | 39 | 7 | 40 | 36 | 0 | -4 |
| | | 78 | 14 to 15 | | | | |
| | 6LB | 156; 313; 626 | 28 to 30; 56 to 60; 112 (ACCP) | 40 | 36 | 0 | -4 |
| | 6LA | 156; 313; 626 | 28 to 30; 56 to 60; 112 (ACAP) | 40 | 36 | 10 | 7 |
| 9 | 6H | 88 | 14 to 15 | 43 | 39 | 0 | -4 |
| | 6HB | 176; 352; 704 | 28 to 30; 56 to 60; 112 (ACCP) | | | | |
| | 6HA | 176; 352; 704 | 28 to 30; 56 to 60; 112 (ACAP) | 43 | 39 | 10 | 6 |

| Spectral efficiency | | Minimum RIC rate (Mbit/s) (see note) | Channel separation (MHz) (see note) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 10 | 7 | 98 | 14 to 15 | 46 | 42 | 0 | -4 |
| | 7B | 196; 392; 784 | 28 to 30; 56 to 60; 112 (ACCP) | | | | |
| | 7A | 196; 392; 784 | 28 to 30; 56 to 60; 112 (ACAP) | 46 | 42 | 13 | 9 |
| 11 | 8 | 107 | 14 to 15 | 50 | 46 | 0 | -4 |
| | 8B | 215; 431; 862 | 28 to 30; 56 to 60; 112 (ACCP) | | | | |
| | 8A | 215; 431; 862 | 28 to 30; 56 to 60; 112 (ACAP) | 50 | 46 | 17 | 13 |
| NOTE: Minimum RIC and Channel separation series of values in each row are intended one to one coupled in their orders. | | | | | | | |

# Annex D (normative): Frequency bands from 4 GHz to 11 GHz (channel separation 40 MHz and 80 MHz)

# D.1 Introduction

This annex contains requirements for equipment that, depending on the 40 MHz and 80 MHz channel arrangements adopted by the local administrations (according to clause D.2.1 and table D.1), can offer different transmission capacities using the necessary spectral efficiency class (according to clause D.2.2 and table D.2).

In this annex only FDD equipment are considered.

NOTE: For information only:
The use in CEPT countries of 40/80 MHz CS in the bands subject of this annex is generally limited to "high capacity" links. For this reason system with efficiency classes lower than 5L are not provided in the present document. Nevertheless, if lower classes are desired for some special cases, informative reference characteristics (not directly useable for self-declaration of conformance, based on the present document, under Directive 2014/53/EU [i.1], but only when conformance is required through Notified Bodies) may be derived from the corresponding classes and bands within 28 MHz CS in annex C as follows:

- # Spectrum masks: frequency corners multiplied by 40/28 or by 80/28
- # Minimum RIC: multiplied by 40/28 or by 80/28
- # RSL thresholds: increased by 10 log (40/28) or by 10 log (80/28)
- # Co-channel interference sensitivity: same of that at 28 MHz
- # First and second adjacent channel interference sensitivity: same of that at 28 MHz

# D.2 General characteristics

## D.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table D.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC Recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table D.1: Frequency characteristics information**

| Band (GHz) | Frequency range (GHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|
| | | CEPT/ERC Recommendation | ITU-R Recommendation |
| 4 | 3,600 to 4,200 | 12-08 annex A part 1 [i.9] | F.635-7 [i.41] |
| U4 | 4,400 to 5,000 | - | F.1099-5 annex 1 and annex 2 [i.49] |
| U6 | 6,425 to 7,110 | 14-02 [i.13] | F.384-11 [i.35] |
| 8 | 7,725 to 8,275 | - | F.386-9 annex 4 [i.37] |
| 11 | 10,7 to 11,7 | 12-06 [i.7] | F.387-12 [i.38] |
| NOTE: 80 MHz arrangements are present only for U6 and 11 GHz bands. | | | |

# D.2.2 Transmission capacities

**Table D.2: Minimum RIC transmission capacity and system classes for various channel separation**

| | | Channel arrangement → | Co-polar (ACCP) | Cross-polar (ACAP) | Co-polar (ACCP) | Cross-polar (ACAP) |
|---|---|---|---|---|---|---|
| | | Channel separation→ | 40 MHz | 40 MHz | 80 MHz | 80 MHz |
| Min. payload RIC rate Mbit/s (note 1) | Spectral efficiency ↓ | | ⇩ | ⇩ | ⇩ | ⇩ |
| | Reference index | Class | | | | |
| | 6 | 5LB | STM-1 or 137 | - | 2×STM-1 or 274 | - |
| | | 5LB | 168 | - | 336 | - |
| | | 5LA | - | 168 | - | 336 |
| | 7 | 5HB/28 (note 2) | STM-1 or 137 | - | 2×STM-1 or 274 | - |
| | | 5HB | 196 | - | 392 | - |
| | | 5HA | - | 196 | - | 392 |
| | 8 | 6LA | - | 224 | - | 448 |
| | | 6LB | 224 | - | 448 | - |
| | 9 | 6HA (note 3) | - | 252 | - | 504 |
| | | 6HB (note 3) | 252 | - | 504 | - |
| | 10 | 7A (note 3) | - | 280 | - | 560 |
| | | 7B (note 3) | 280 | - | 560 | - |
| | 11 | 8A | - | 308 | - | 616 |
| | | 8B | 308 | - | 616 | - |

NOTE 1: For equipment assessment with different base band interfaces see annex N.
NOTE 2: This case provides system parameters, intended for ACCP or CCDP operation with a minimum RIC that does not fulfil the minimum RIC density established in clause 4.1.7. This is intended for commonality in order to cover also the 40/80 MHz channel arrangements with STM-1/2×STM1 systems used in the more popular arrangements based on CS multiple of 28 MHz.
NOTE 3: Equipment requirements are set only on the basis of the RIC rate on one polarization per 40 MHz channel. However, 4 × STM-1 or STM-4 capacity can be possible by doubling 2 × STM-1 equipment either in CCDP operation or through operation of two 2 × STM-1 systems (or one *channels-aggregation* equipment) in one 80 MHz channels or two 40 MHz channels, which, due to spectrum availability, may also not be adjacent. For the assessment of such cases, refer to clause O.3. Similar considerations apply as well for Ethernet capacity, e.g. when 1 000BaseT or N × 100BaseT capacity are concerned.

# D.3 Transmitter

## D.3.1 General requirements

**Table D.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause 4.2.1.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause D.3.2 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |

## D.3.2 Transmitter Radio Frequency spectrum masks

The masks in clause 4.2.3.2 are valid only for those specific combinations of CS, nominal capacity and spectral efficiency class that are also included among those foreseen in table D.2. Class 5HB/28 systems shall refer to the corresponding 28 MHz mask.

# D.4 Receiver

## D.4.1 General requirements

**Table D.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table D.5 |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table D.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## D.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in table D.5. The declared Receiver Signal levels shall produce a BER of either $\leq 10^{-6}$ or $\leq 10^{-10}$.

NOTE: For information only: RSL values (in terms of noise figure and S/N for BER=$10^{-6}$), evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.28] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table D.5: BER as a function of receiver input signal level RSL (upper bound)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | Frequency band(s) (GHz) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
|---|---|---|---|---|---|---|
| Reference index | Class | | | | | |
| 6 | 5LB | STM-1 or 137 | 40 ACCP | 4, U4, U6, 8 | -69 | -66 |
| | | | | 11 | -68 | -65 |
| | 5LA/5LB | 168 | | 4, U4, U6, 8 | -68 | -65 |
| | | | | 11 | -67 | -64 |
| 7 | 5HA/5HB | 196 | 40 ACCP | 4, U4, U6, 8 | -63,5 | -60,5 |
| | | | | 11 | -63,5 | -60,5 |
| | 5HB/28 | STM-1 or 137 | 40 ACCP | 4, U4, U6, 8 | -65 | -62 |
| | | | | 11 | -64 | -61 |
| 8 | 6LA/6LB | 224 | 40 ACAP/ACCP | 4, U4, U6, 8, 11 | -60,5 | -57,5 |
| 9 | 6HA/6HB | 252 | 40 ACAP/ACCP | 4, U4, U6, 8, 11 | -57,5 | -54,5 |
| 10 | 7A/7B | 280 | 40 ACAP/ACCP | 4, U4, U6, 8, 11 | -54 | -51 |
| 11 | 8A/8B | 308 | 40 ACAP/ACCP | 4, U4, U6, 8, 11 | -50,5 | -47,5 |
| 6 | 5LB | 2×STM-1 or 274 | 80 ACCP | U6 | -66 | -63 |
| | | | | 11 | -65 | -62 |
| | 5LA/5LB | 336 | | U6 | -65 | -62 |
| | | | | 11 | -64 | -61 |
| 7 | 5HA/5HB | 392 | 80 ACCP | U6 | -60,5 | -57,5 |
| | | | | 11 | -60,5 | -57,5 |
| | 5HB/28 | 2×STM-1 or 274 | 80 ACCP | U6 | -62 | -59 |
| | | | | 11 | -61 | -58 |
| 8 | 6LA/6LB | 448 | 80 ACAP/ACCP | U6, 11 | -57,5 | -54,5 |
| 9 | 6HA/6HB | 504 | 80 ACAP/ACCP | U6, 11 | -54,5 | -51,5 |
| 10 | 7A/7B | 560 | 80 ACAP/ACCP | U6, 11 | -51 | -48 |
| 11 | 8A/8B | 616 | 80 ACAP/ACCP | U6, 11 | -47,5 | -44,5 |

NOTE 1: These limits are required when the connection to the same antenna port of even and odd channels, spaced 40 MHz or 80 MHz apart on the same polarization, is made with the use of an external 3 dB hybrid coupler placed at reference point C. When alternatively, for the above purpose, narrow-band branching filters solutions are used, the above BER performance thresholds can be increased by 1,5 dB.

NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

# D.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table D.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER $\leq 10^{-6}$ in clause D.4.2.

**Table D.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 6 | 5LA | 168/336 | 40/80 (ACAP) | 33 | 29 | 3 | 0 |
| | 5LB | STM-1 or 137/ 2×STM-1 or 274 | 40/80 (ACCP) | 33 | 29 | -4 | -8 |
| | | 168/336 | | 33 | 29 | -3 | -7 |
| 7 | 5HA | 196/392 | 40/80 (ACCP) | 37 | 33 | 7 | 4 |
| | 5HB/28 | STM-1 or 137/ 2×STM-1 or 274 | 40/80 (ACCP) | 37 | 33 | -4 | -8 |
| | 5HB | 196/392 | 40/80 (ACCP) | 37 | 33 | -3 | -7 |
| 8 | 6LA | 224/448 | 40/80 (ACAP) | 40 | 36 | 10 | 7 |
| | 6LB | 224/448 | 40/80 (ACCP) | 40 | 36 | 0 | -4 |
| 9 | 6HA | 252/504 | 40/80 (ACAP) | 43 | 39 | 10 | 7 |
| | 6HB | 252/504 | 40/80 (ACCP) | 43 | 39 | 0 | -4 |
| 10 | 7A | 280/560 | 40/80 (ACAP) | 46 | 42 | 13 | 9 |
| | 7B | 280/560 | 40/80 (ACCP) | 46 | 42 | 0 | -4 |
| 11 | 8A | 308/616 | 40/80 (ACAP) | 50 | 46 | 17 | 13 |
| | 8B | 308/616 | 40/80 (ACCP) | 50 | 46 | 0 | -4 |

# Annex E (normative): Frequency bands 13 GHz, 15 GHz and 18 GHz

# E.1 Introduction

This annex contains requirements for a variety of equipment that, depending on the channel arrangements adopted by the local administrations (according to clause E.2.1 and table E.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according to clause E.2.2 and table E.2).

In this annex only FDD equipment are considered.

# E.2 General characteristics

## E.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table E.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems, see annex O.

**Table E.1: Frequency characteristics information**

<table>
<tr><th rowspan="2">Band<br>(GHz)</th><th rowspan="2">Frequency range<br>(GHz)</th><th rowspan="2">Channel separation<br>(MHz)</th><th colspan="2">Recommendations for radio frequency channel arrangements</th></tr>
<tr><th>CEPT/ERC<br>Recommendation</th><th>ITU-R<br>Recommendation</th></tr>
<tr><td>13</td><td>12,75 to 13,25</td><td>1,75 to 28</td><td>12-02 [i.4]</td><td>F.497-7 [i.39]</td></tr>
<tr><td>13</td><td>12,75 to 13,25</td><td>56 (note 3)</td><td>12-02 [i.4]</td><td>F.497-7 [i.39]</td></tr>
<tr><td rowspan="2">15</td><td>14,5 to14,62 paired with 15,23 to15,35</td><td rowspan="2">1,75 to 56</td><td>12-07 [i.8]</td><td rowspan="2">F.636-4 [i.42]</td></tr>
<tr><td>14,5 to 15,35</td><td>-</td></tr>
<tr><td>18</td><td>17,7 to 19,7</td><td>13,75 to 220<br>or<br>1,75 to 14 (note 2)</td><td>12-03 [i.5]<br>(note 1)</td><td>F.595-10 [i.40]<br>(note 1)</td></tr>
<tr><td colspan="5">NOTE 1: CEPT/ERC/REC 12-03 [i.5] allows for low-capacity channel arrangements on a national basis. Recommendation ITU-R F.595-10 [i.40] details various channel arrangements including low-capacity channel arrangements.<br>NOTE 2: As recommended CEPT channel separation lower than 13,75 MHz are not available in the 18 GHz frequency band at the date of the present document, the equipment requirements set for system in 18 GHz band for CS 1,75 MHz to 14 MHz are considered for the use in national frequency plans based on 1,75/3,5/7/14 MHz basic pattern.<br>NOTE 3: In the 13 GHz band the CEPT and Recommendations ITU-R provide the 56 MHz CS only in terms of aggregation of 2 × 28 MHz CS, subject to their availability and possible national license restrictions.</td></tr>
</table>

## E.2.2 Transmission capacities

**Table E.2: Minimum RIC transmission capacity and system classes for various channel separation**

| Channel arrangement → | | | Co-polar (ACCP) | | | | | | | | Cross-polar (ACAP) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel separation (MHz) → | | | 1,75 | 3,5 | 7 | 13,75/14 | 27,5/28 | 55/56 | 110 (18 GHz) | 220 (18 GHz) | 27,5 /28 | 55/56 | 110 (18 GHz) | 220 (18 GHz) |
| Min. payload RIC rate Mbit/s (note 1) | Spectral Efficiency ↓ Reference index | Class | | | | | | | | | | | | |
| | 2 | 2 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | - | - | - | - | - |
| | 3 | 3 | 3 | 6 | 12 | 24 | 48 | 96 | 191 | - | - | - | - | - |
| | 4 | 4L | 4 | 8 | 16 | 32 | 64 | 128 | 256 | - | - | - | - | - |
| | 5 | 4H | - | 12 | 24 | 49 | 98 | 196 | 392 | - | - | - | - | - |
| | 6 | 5L | - | - | 29 | 58 | - | - | - | - | - | - | - | - |
| | | 5LB, 5LA | - | - | - | - | 117 | 235 | 470 | 940 | 117 | 235 | 470 | 940 |
| | 7 | 5H | - | 17 | 34 | 68 | - | - | - | - | - | - | - | - |
| | | 5HB, 5HA | - | - | - | - | 137 (note 2) | 274 (note 2) | 548 | 1 096 | 137 (note 2) | 274 (note 2) | 548 | 1 096 |
| | 8 | 6L | - | - | 39 | 78 | - | - | - | - | - | - | - | - |
| | | 6LB, 6LA | - | - | - | - | 156 (note 2) | 313 (note 2) | 627 | 1 254 | 156 (note 2) | 314 (note 2) | 627 | 1 254 |
| | 9 | 6H | - | - | - | 88 | - | - | - | - | - | - | - | - |
| | | 6HB, 6HA | - | - | - | - | 176 | 352 | 705 | 1 410 | 176 | 352 | 705 | 1 410 |
| | 10 | 7 | - | - | - | 98 | - | - | - | - | - | - | - | - |
| | | 7B, 7A | - | - | - | - | 196 | 392 | 784 | 1 568 | 196 | 392 | 784 | 1 568 |
| | 11 | 8 | - | - | - | 107 | - | - | - | - | - | - | - | - |
| | | 8B, 8A | - | - | - | - | 215 | 431 | 862 | 1 724 | 215 | 431 | 862 | 1 724 |

NOTE 1: For equipment assessment with different base band interfaces see annex N.

NOTE 2: Equipment requirements are set only on the basis of the RIC rate on one polarization. However, 4 × STM-1 or STM-4 capacity can be possible by doubling 2 × STM-1 equipment either in CCDP operation or through operation of two 2 × STM-1 systems (or one *channels-aggregation* equipment) in two separate 55/56 MHz channels, which, due to spectrum availability, may also not be adjacent. For the assessment of such cases, refer to clause O.3. Similar considerations apply as well for Ethernet capacity, e.g. when 1000Base-T or N × 100Base-T capacity are concerned.

# E.3 Transmitter

## E.3.1 General requirements

**Table E.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause 4.2.1.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause E.3.2 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |

## E.3.2 Transmitter Radio Frequency spectrum masks

The masks in clause 4.2.3.2 are valid only for those specific combinations of CS, nominal capacity and spectral efficiency class that are also included among those foreseen in table E.2.

# E.4 Receiver

## E.4.1 General requirements

**Table E.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table E.5a (equipment operating in 13 GHz and 15 GHz bands)<br>Table E.5b (equipment operating in 18 GHz band) |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table E.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## E.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in table E.5a and table E.5b. The declared Receiver Signal levels shall produce a BER of $10^{-6}$ or either $\leq 10^{-8}$ or $\leq 10^{-10}$.

NOTE: For information only: RSL values (in terms of noise figure and S/N for BER=$10^{-6}$), evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.28] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table E.5a: BER as a function of receiver input signal level RSL (upper bound of declared limit) for 13 GHz and 15 GHz bands**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
|---|---|---|---|---|---|---|
| Reference index | Class | | | | | |
| 2 | 2 | 2 | 1,75 | -93 | -91,5 | - |
| | | 4 | 3,5 | -90 | -88,5 | - |
| | | 8 | 7 | -87 | -85,5 | - |
| | | 16 | 14 | -84 | -82,5 | - |
| | | 32 | 28 | -81 | -79,5 | - |
| | | 64 | 56 | -78 | -76,5 | - |
| 3 | 3 | 3 | 1,75 | -88 | -86,5 | - |
| | | 6 | 3,5 | -85 | -83,5 | - |
| | | 12 | 7 | -82 | -80,5 | - |
| | | 24 | 14 | -79 | -77,5 | - |
| | | 48 | 28 | -76 | -74,5 | - |
| | | 96 | 56 | -73 | -71,5 | - |
| 4 | 4L | 4 | 1,75 | -86 | -84,5 | - |
| | | 8 | 3,5 | -83 | -81,5 | - |
| | | 16 | 7 | -80 | -78,5 | - |
| | | 32 | 14 | -77 | -75,5 | - |
| | | 64 | 28 | -74 | -72,5 | - |
| | | 128 | 56 | -71 | - | -68 |

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
|---|---|---|---|---|---|---|
| Reference index | Class | | | | | |
| 5 | 4H | 24 | 7 | -77 | -75,5 | - |
| | | 49 | 14 | -74 | -72,5 | - |
| | | 98 | 28 | -71 | -69,5 | - |
| | | 196 | 56 | -68 | - | -65 |
| 6 | 5L | 29 | 7 | -74 | -72,5 | - |
| | | 58 | 14 | -71 | -69,5 | - |
| | 5LA/5LB | 117 | 28 (ACAP/ACCP) | -68 | - | -65 |
| | | 235 | 56 (ACAP/ACCP) | -65 | - | -62 |
| 7 | 5H | 34 | 7 | -71,5 | -70 | - |
| | | 68 | 14 | -68,5 | -67 | - |
| | 5HA/5HB | 137 | 28 (ACAP/ACCP) | -65,5 | - | -62,5 |
| | | 274 | 56 (ACAP/ACCP) | -62 | - | -59 |
| 8 | 6L | 39 | 7 | -67,5 | -66 | - |
| | | 78 | 14 | -64,5 | -63 | - |
| | 6LA/6LB | 156 | 28 (ACAP/ACCP) | -62 | - | -59 |
| | | 313 | 56 (ACAP/ACCP) | -59 | - | -56 |
| 9 | 6H | 88 | 14 | -61 | -59,5 | - |
| | 6HA/6HB | 176 | 28 (ACAP/ACCP) | -58,5 | - | -55,5 |
| | | 352 | 56 (ACAP/ACCP) | -56 | - | -53 |
| 10 | 7 | 98 | 14 | -57,5 | -56 | - |
| | 7A/7B | 196 | 28 (ACAP/ACCP) | -55 | - | -52 |
| | | 392 | 56 (ACAP/ACCP) | -52,5 | - | -49,5 |
| 11 | 8 | 107 | 14 | -54,5 | - | -51,5 |
| | 8A/8B | 215 | 28 (ACAP/ACCP) | -51,5 | - | -48,5 |
| | | 431 | 56 (ACAP/ACCP) | -49 | - | -46 |

NOTE: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

**Table E.5b: BER as a function of receiver input signal level RSL (upper bound of declared limit) for 18 GHz bands**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
|---|---|---|---|---|---|---|
| Reference index | Class | | | | | |
| 2 | 2 | 2 | 1,75 | -92 | -90,5 | - |
| | | 4 | 3,5 | -89 | -87,5 | - |
| | | 8 | 7 | -86 | -84,5 | - |
| | | 16 | 14/13,75 | -83 | -81,5 | - |
| | | 32 | 27,5 | -80 | -78,5 | - |
| | | 64 | 55 | -77 | -75,5 | - |
| | | 128 | 110 | -74 | - | -71 |
| | | 265 | 220 | -71 | - | -68 |
| 3 | 3 | 3 | 1,75 | -87 | -85,5 | - |
| | | 6 | 3,5 | -84 | -82,5 | - |
| | | 12 | 7 | -81 | -79,5 | - |
| | | 24 | 14/13,75 | -78 | -76,5 | - |
| | | 48 | 27,5 | -75 | -73,5 | - |
| | | 96 | 55 | -72 | -70,5 | - |
| | | 191 | 110 | -69 | - | -66 |
| | | 382 | 220 | -66 | - | -63 |
| 4 | 4L | 4 | 1,75 | -85 | -83,5 | - |
| | | 8 | 3,5 | -82 | -80,5 | - |
| | | 16 | 7 | -79 | -77,5 | - |
| | | 32 | 14/13,75 | -76 | -74,5 | - |
| | | 64 | 27,5 | -73 | -71,5 | - |
| | | 128 | 55 | -70 | - | -67 |
| | | 256 | 110 | -67 | - | -64 |
| | | 512 | 220 | -64 | - | -61 |

| **Spectral efficiency** | | **Minimum RIC rate (Mbit/s)** | **Channel separation (MHz)** | **RSL for BER ≤ $10^{-6}$ (dBm)** | **RSL for BER ≤ $10^{-8}$ (dBm)** | **RSL for BER ≤ $10^{-10}$ (dBm)** |
|---|---|---|---|---|---|---|
| **Reference index** | **Class** | | | | | |
| 5 | 4H | 12 | 3,5 | -79 | -77,5 | - |
| | | 24 | 7 | -76 | -74,5 | - |
| | | 49 | 14/13,75 | -73 | -71,5 | - |
| | | 98 | 27,5 | -70 | -68,5 | - |
| | | 196 | 55 | -67 | - | -64 |
| | | 392 | 110 | -64 | - | -61 |
| | | 784 | 220 | -61 | - | -58 |
| 6 | 5L | 29 | 7 | -73 | -71,5 | - |
| | | 58 | 14/13,75 | -70 | -68,5 | - |
| | 5LA/5LB (note 1) | 117 | 27,5 | -67 | - | -64 |
| | | 235 | 55 | -64 | - | -61 |
| | | 470 | 110 | -61 | - | -58 |
| | | 940 | 220 | -58 | - | -55 |
| 7 | 5H | 17 | 3,5 | -73 | -71,5 | - |
| | | 34 | 7 | -70 | -68,5 | - |
| | | 68 | 13,75 | -67 | -65,5 | - |
| | 5HA/5HB (note 1) | 137 | 27,5 (ACAP/ACCP) | -64 | - | -61 |
| | | 274 | 55 (ACAP/ACCP) | -61 | - | -58 |
| | | 548 | 110 (ACAP/ACCP) | -58 | - | -55 |
| | | 1 096 | 220 (ACAP/ACCP) | -55 | - | -52 |
| 8 | 6L | 39 | 7 | -66 | -64,5 | - |
| | | 78 | 13,75/14 | -63,5 | -62 | - |
| | 6LA/6LB (note 1) | 156 | 27,5 (ACAP/ACCP) | -61 | - | -58 |
| | | 313 | 55 (ACAP/ACCP) | -58 | - | -55 |
| | | 627 | 110 (ACAP/ACCP) | -55 | - | -52 |
| | | 1 254 | 220 (ACAP/ACCP) | -52 | | -49 |
| 9 | 6H | 88 | 13,75/14 | -60 | -58,5 | - |
| | 6HA/6HB (note 1) | 176 | 27,5 (ACAP/ACCP) | -57,5 | - | -54,5 |
| | | 352 | 55 (ACAP/ACCP) | -55 | - | -52 |
| | | 705 | 110 (ACAP/ACCP) | -52 | - | -49 |
| | | 1 410 | 220 (ACAP/ACCP) | -49 | - | -46 |
| 10 | 7 | 98 | 13,75/14 | -56,5 | -55 | - |
| | 7A/7B (note 1) | 196 | 27,5 (ACAP/ACCP) | -54 | - | -51 |
| | | 392 | 55 (ACAP/ACCP) | -51,5 | - | -48,5 |
| | | 784 | 110 (ACAP/ACCP) | -49 | - | -46 |
| | | 1 568 | 220 (ACAP/ACCP) | -46 | - | -43 |
| 11 | 8 | 107 | 13,75/14 | -53,5 | - | -50,5 |
| | 8A/8B (note 1) | 215 | 27,5 (ACAP/ACCP) | -50,5 | - | -47,5 |
| | | 431 | 55 (ACAP/ACCP) | -48 | - | -45 |
| | | 862 | 110 (ACAP/ACCP) | -45,5 | - | -42,5 |
| | | 1 724 | 220 (ACAP/ACCP) | -42,5 | - | -39,5 |

NOTE 1: For CS 27,5 MHz or 55 MHz or 110 MHz, systems of classes 5HB, 6LB and 7B, the limits are required when the connection to the same antenna port of even and odd channels, spaced 27,5 MHz or 55 MHz, or 110 MHz, respectively, apart on the same polarization, is made with the use of an external 3 dB hybrid coupler placed at reference point C. When alternatively, for the above purpose, narrow-band branching filters solution are used, the above BER performance thresholds can be increased by 1,5 dB.

NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

# E.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table E.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause E.4.2.

**Table E.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) (see note) | Channel separation (MHz) (see note) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| Reference index | Class | | | Co-channel interference | | First adjacent channel interference | |
| | | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 2 | 2 | 2; 4; 8; 16; 32; 64 | 1,75; 3,5; 7; 14; 28; 56 | 23 | 19 | 0 | -4 |
| | | 16; 32; 64; 128; 256 | 13,75; 27,5; 55; 110; 220 | 23 | 19 | 1 | -3 |
| 3 | 3 | 3; 6; 12; 24; 48 | 1,75; 3,5; 7; 14; 28; 56 | 27 | 24,5 | -1 | -5 |
| | | 24; 48; 96; 191 | 13,75; 27,5; 55; 110; 220 | 27 | 24,5 | -0 | -4 |
| 4 | 4L | 4; 8; 16; 32; 64 | 1,75; 3,5; 7; 14; 28 | 30 | 26,5 | -1 | -5 |
| | | 32; 64 | 13,75; 27,5 | 30 | 26,5 | 0 | -4 |
| | | 128; 256 | 55/56; 110; 220 | 29 | 25 | -5 | -9 |
| 5 | 4H | 12 | 3,5 | 30 | 26 | -4 | -8 |
| | | 24; 49; 98; 196 | 7; 14; 28; 56 | 30 | 26,5 | -6 | -9,5 |
| | | 49; 98; 196; 392 | 13,75; 27,5; 55; 110; 220 | 30 | 26,5 | -2 | -5,5 |
| 6 | 5L | 29; 58 | 7; 13,75/14 | 34 | 30 | -3 | -7 |
| | 5LB | 117; 235; 470 | 27,5/28; 55/56; 110; 220 (ACCP) | 34 | 30 | -3 | -7 |
| | 5LA | 117; 235; 470 | 27,5/28; 55/56; 110; 220 (ACAP) | 34 | 30 | 4 | 1 |
| 7 | 5H | 17 | 3,5 | 37 | 33 | 0 | -4 |
| | | 34; 68 | 7; 13,75/14 | 37 | 33 | -3,5 | -7,5 |
| | 5HB | 137 | 28 | 35 | 32 | -5 | -8 |
| | | | 27,5 | 37 | 33 | -3 | -7 |
| | | | | | | | |
| | | 274; 548; 1 096 | 55/56; 110; 220 | 37 | 33 | -3,5 | -7,5 |
| | 5HA | 137; 274; 548; 1 096 | 27,5/28; 55/56; 110; 220 (ACAP) | 37 | 33 | 3 | -1 |
| 8 | 6L | 39; 78 | 7; 13,75/14 | 40 | 36 | 0 | -4 |
| | 6LB | 156; 313; 627; 1 254 | 27,5/28; 55/56; 110; 220 (ACCP) | 40 | 36 | 0 | -4 |
| | 6LA | 156; 313; 627; 1 254 | 27,5/28; 55/56; 110; 220 (ACAP) | 40 | 36 | 10 | 7 |
| 9 | 6H | 88 | 13,75/14 | 43 | 39 | 0 | -4 |
| | 6HB | 176; 352; 705; 1 410 | 27,5/28; 55/56; 110; 220 (ACCP) | | | | |
| | 6HA | 176; 352; 705; 1 410 | 27,5/28; 55/56; 110; 220 (ACAP) | 43 | 39 | 10 | 6 |
| 10 | 7 | 98 | 13,75/14 | 46 | 42 | 0 | -4 |
| | 7B | 196; 392; 784; 1 568 | 27,5/28; 55/56; 110; 220 (ACCP) | 46 | 42 | 0 | -4 |
| | 7A | 196; 392; 784 | 27,5/28; 55/56; 110; 220 (ACAP) | 46 | 42 | 13 | 9 |
| 11 | 8 | 107 | 13,75/14 | 50 | 46 | 0 | -4 |
| | 8B | 215; 431; 862; 1 724 | 27,5/28; 55/56; 110; 220 (ACCP) | | | | |
| | 8A | 215; 431; 862; 1 724 | 27,5/28; 55/56; 110; 220 (ACAP) | 50 | 46 | 17 | 13 |

NOTE: Minimum RIC and Channel separation series of values in each row are intended one to one coupled in their orders.

# Annex F (normative): Frequency bands from 23 GHz to 42 GHz

# F.1 Introduction

This annex contains requirements for a variety of equipment that, depending on the channel arrangements adopted by the local administrations (according to clause F.2.1 and table F.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according to clause F.2.2 and table F.2).

In this annex only FDD equipment is considered except for the 31 GHz (31,0 GHz to 31,3 GHz) band where both FDD and TDD are considered.

# F.2 General characteristics

## F.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table F.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table F.1: Frequency characteristics information**

| **Band (GHz)** | **Frequency range (GHz)** | **Channel separation (MHz)** | **Recommendations for radio frequency channel arrangements** | |
|---|---|---|---|---|
| | | | **CEPT/ECC (CEPT/ERC) Recommendation** | **ITU-R Recommendation** |
| 23 | 22,0 to 23,6 | 3,5 to 224 | T/R 13-02 annex 1 [i.17] | F.637-4 [i.43] |
| 26 | 24,5 to 26,5 | 3,5 to 112 | T/R 13-02 annex 2 [i.17] | F.748-4 [i.46] |
| 28 | 27,5 to 29,5 | 3,5 to 224 | T/R 13-02 annex 3 [i.17] | F.748-4 [i.46] |
| 31 | 31,0 to 31,3 | 3,5 to 28/56 (see note) | (02)02 [i.20] | F.746-10 annex 6 [i.44] |
| 32 | 31,8 to 33,4 | 3,5 to 224 | (01)02 [i.3] | F.1520-3 [i.56] |
| 38 | 37,0 to 39,5 | 3,5 to 224 | T/R 12-01 [i.15] | F.749-3 [i.47] |
| 42 | 40,5 to 43,5 | 7 to 224 | (01)04 [i.18] | F.2005-0 [i.57] |
| NOTE: In 31 GHz band, no recommended CEPT or ITU-R radio frequency channel arrangements providing for channel separation of 56 MHz; however, it is assumed that aggregation of two half sized channels might be permitted on national basis. | | | | |

## F.2.2 Transmission capacities

**Table F.2: Minimum RIC transmission capacity and system classes for various channel separation**

| | | | **Channel arrangement →** | **Co-polar (ACCP)** | | | | | | | **Cross-polar (ACAP)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Channel separation (MHz) →** | **3,5** | **7** | **14** | **28** | **56** | **112 (*)** | **224 (*)** | **28** | **56** | **112 (*)** | **224 (*)** |
| **Minimum payload RIC rate Mbit/s (note 1)** | **Spectral efficiency ↓** | | **Frequency band (GHz) ↓** | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ |
| | **Reference index** | **Class** | | | | | | | | | | | | |
| | 2 | 2 | 23 to 38 | 4 | 8 | 16 | 32 | 64 | 128 | 256 | - | - | - | - |
| | | | 42 | - | 8 | 16 | 32 | 64 | 128 | 256 | - | - | - | - |
| | 3 | 3 | 23 to 38 | 6 | 12 | 24 | 48 | 96 | 191 | 382 | - | - | - | - |
| | | | 42 | - | 12 | 24 | 48 | 96 | 191 | 382 | - | - | - | - |
| | 4 | 4L | 23 to 38 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | - | - | - | - |
| | | | 42 | - | 16 | 32 | 64 | 128 | 256 | 512 | - | - | - | - |
| | 5 | 4H | 23 to 42 | - | 24 | 49 | 98 | 196 | 392 | 784 | - | - | - | - |
| | 6 | 5L | 23 to 42 | - | 29 | 58 | - | - | - | - | - | - | - | - |
| | | 5LB, 5LA | 23 to 42 | - | - | - | 117 | 235 | 470 | 940 | 117 | 235 | 470 | 940 |
| | 7 | 5H | 23 to 42 | - | 34 | 68 | - | - | - | - | - | - | - | - |
| | | 5HB, 5HA | 23 to 42 | - | - | - | 137 (note 2) | 274 (note 2) | 548 | 1 096 | 137 (note 2) | 274 (note 2) | 548 | 1 096 |
| | 8 | 6L | 23 to 42 | - | 39 | 78 | - | - | - | - | - | - | - | - |
| | | 6LB, 6LA | 23 to 42 | - | - | - | 156 | 313 | 627 | 1 254 | 156 | 313 | 627 | 1 254 |
| | 9 | 6H | 23 to 42 | - | - | 88 | - | - | - | - | - | - | - | - |
| | | 6HB, 6HA | 23 to 42 | - | - | - | 176 | 352 | 705 | 1 410 | 176 | 352 | 705 | 1 410 |
| | 10 | 7 | 23 to 42 | - | - | 98 | - | - | - | - | - | - | - | - |
| | | 7B, 7A | 23 to 42 | - | - | - | 196 | 392 | 784 | 1 568 | 196 | 392 | 784 | 1 568 |
| | 11 | 8 | 23 to 42 | - | - | 107 | - | - | - | | - | - | - | |
| | | 8B, 8A | 23 to 42 | - | - | - | 215 | 431 | 862 | 1 724 | 215 | 431 | 862 | 1 724 |

NOTE 1: For equipment assessment with different base band interfaces see annex N.

NOTE 2: Equipment requirements are set only on the basis of the RIC rate on one polarization. However, 4 × STM-1 or STM-4 capacity can be possible by doubling 2 × STM-1 equipment either in CCDP operation, or through operation of two 2 × STM-1 systems (or one *channels-aggregation* equipment) in two separate 56 MHz channels, which, due to spectrum availability, may also not be adjacent. For the assessment of such cases, refer to clause O.3. Similar considerations apply as well for Ethernet capacity, e.g. when 1000Base-T or N × 100Base-T capacity are concerned.

(*) 112 MHz not provided in 31 GHz band; 224 MHz not provided in 26 GHz and 31 GHz bands.

# F.3 Transmitter

## F.3.1 General requirements

**Table F.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause 4.2.1.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause F.3.2 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |

## F.3.2 Transmitter Radio Frequency spectrum masks

The masks in clause 4.2.3.2 are valid only for those specific combinations of CS, nominal capacity and spectral efficiency class that are also included among those foreseen in table F.2.

# F.4 Receiver

## F.4.1 General requirements

**Table F.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table F.5a and table F.5b |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table F.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## F.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in the table F.5a and table F.5b. The above declared Receiver Signal levels shall produce a BER $\leq 10^{-6}$ and either $\leq 10^{-6}$ or $\leq 10^{-8}$ as required.

NOTE: For information only: RSL values (in terms of noise figure and S/N for BER=$10^{-6}$), evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.28] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table F.5a: BER performance thresholds for 23 GHz to 42 GHz bands (systems for minimum RIC < 100 Mbit/s) (upper bound of declared limit)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Band → | 23 GHz band | | 26 GHz and 28 GHz bands | | 31 GHz and 32 GHz band | | 38 GHz band | | 42 GHz band | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference index | Class | | Channel separation (MHz) ↓ | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-8}$ (dBm) |
| 2 | 2 | 4 | 3,5 | -89 | -87,5 | -88 | -86,5 | -88 | -86,5 | -87 | -85,5 | | |
| | | 8 | 7 | -86 | -84,5 | -85 | -83,5 | -85 | -83,5 | -84 | -82,5 | -84 | -82,5 |
| | | 16 | 14 | -83 | -81,5 | -82 | -80,5 | -82 | -80,5 | -81 | -79,5 | -81 | -79,5 |
| | | 32 | 28 | -80 | -78,5 | -79 | -77,5 | -79 | -77,5 | -78 | -76,5 | -78 | -76,5 |
| | | 64 | 56 | -77 | -75,5 | -76 | -74,5 | -76 | -74,5 | -75 | -73,5 | -75 | -73,5 |
| 3 | 3 | 6 | 3,5 | -84 | -82,5 | -83 | -81,5 | -83 | -81,5 | -82 | -80,5 | | |
| | | 12 | 7 | -81 | -79,5 | -80 | -78,5 | -80 | -78,5 | -79 | -77,5 | -79 | -77,5 |
| | | 24 | 14 | -78 | -76,5 | -77 | -75,5 | -77 | -75,5 | -76 | -74,5 | -76 | -74,5 |
| | | 48 | 28 | -75 | -73,5 | -74 | -72,5 | -74 | -72,5 | -73 | -71,5 | -73 | -71,5 |
| | | 96 | 56 | -72 | -70,5 | -71 | -69,5 | -71 | -69,5 | -70 | -68,5 | -70 | -68,5 |
| 4 | 4L | 8 | 3,5 | -82 | -80,5 | -81 | -79,5 | -81 | -79,5 | -80 | -78,5 | | |
| | | 16 | 7 | -79 | -77,5 | -78 | -76,5 | -78 | -76,5 | -77 | -75,5 | -77 | -75,5 |
| | | 32 | 14 | -76 | -74,5 | -75 | -73,5 | -75 | -73,5 | -74 | -72,5 | -74 | -72,5 |
| | | 64 | 28 | -73 | -71,5 | -72 | -70,5 | -72 | -70,5 | -71 | -69,5 | -71 | -69,5 |
| 5 | 4H | 24 | 7 | -76 | -74,5 | -75 | -73,5 | -75 | -73,5 | -74 | -72,5 | -74 | -72,5 |
| | | 49 | 14 | -73 | -71,5 | -72 | -70,5 | -72 | -70,5 | -71 | -69,5 | -71 | -69,5 |
| | | 98 | 28 | -70 | -68,5 | -69 | -67,5 | -69 | -67,5 | -68 | -66,5 | -68 | -66,5 |
| 6 | 5L | 29 | 7 | -73 | -71,5 | -72 | -70,5 | -71,5 | -70 | -70,5 | -69 | -70,5 | -69 |
| | | 58 | 14 | -70 | -68,5 | -69 | -67,5 | -69 | -67,5 | -68 | -66,5 | -68 | -66,5 |
| 7 | 5H | 34 | 7 | -70 | -68,5 | -69 | -67,5 | -68 | -66,5 | -67 | -65,5 | -67 | -65,5 |
| | | 68 | 14 | -67 | -65,5 | -66 | -64,5 | -66 | -64,5 | -65 | -63,5 | -64,5 | -63 |
| 8 | 6L | 39 | 7 | -66 | -64,5 | -65 | -63,5 | -64,5 | -63 | -63,5 | -62 | -63,5 | -62 |
| | | 78 | 14 | -63,5 | -62 | -62,5 | -61 | -62 | -60,5 | -61 | -59,5 | -61 | -59,5 |
| 9 | 6H | 88 | 14 | -60 | -58,5 | -59 | -57,5 | -59 | -57,5 | -57,5 | -56 | -57,5 | -56 |
| 10 | 7 | 98 | 14 | -56,5 | -55 | -55,5 | -54 | -55,5 | -54 | -54,5 | -53 | -54,5 | -53 |

NOTE: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

**Table F.5b: BER performance thresholds for 23 GHz to 42 GHz bands (systems for minimum RIC ≥ 100 Mbit/s) (upper bound of declared limit)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Band → | 23 GHz band | | 26 GHz (note 1) and 28 GHz bands | | 31 GHz (note 1) and 32 GHz band | | 38 GHz band | | 42 GHz band | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference index | Class | | Channel separation (MHz) ↓ | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
| 2 | 2 | 128 | 112 | -74 | -71 | -73 | -70 | -73 | -70 | -72 | -69 | -72 | -69 |
| 3 | 3 | 191 | 112 | -69 | -66 | -68 | -65 | -68 | -65 | -67 | -64 | -67 | -64 |
| | | 382 | 224 | -66 | -63 | -65 | -62 | -65 | -62 | -64 | -61 | -64 | -61 |
| 4 | 4L | 128 | 56 | -70 | -67 | -69 | -66 | -69 | -66 | -68 | -65 | -68 | -65 |
| | | 256 | 112 | -67 | -64 | -66 | -63 | -66 | -63 | -65 | -62 | -65 | -62 |
| | | 512 | 224 | -64 | -61 | -63 | -60 | -63 | -60 | -62 | -59 | -62 | -59 |
| 5 | 4H | 196 | 56 | -67 | -64 | -66 | -63 | -66 | -63 | -65 | -62 | -65 | -62 |
| | | 392 | 112 | -64 | -61 | -63 | -60 | -63 | -60 | -62 | -59 | -62 | -59 |
| | | 784 | 224 | -61 | -58 | -60 | -57 | -60 | -57 | -59 | -56 | -59 | -56 |
| 6 | 5LA/5LB | 117 | 28 | -67 | -64 | -66 | -63 | -66 | -63 | -65 | -62 | -65 | -62 |
| | | 235 | 56 | -64 | -61 | -63 | -60 | -63 | -60 | -62 | -59 | -62 | -59 |
| | | 470 | 112 | -61 | -58 | -60 | -57 | -60 | -57 | -59 | -56 | -59 | -56 |
| | | 940 | 224 | -58 | -55 | -57 | -54 | -57 | -54 | -56 | -53 | -56 | -53 |
| 7 | 5HA/5HB | 137 | 28 | -64 | -61 | -63 | -60 | -63 | -60 | -62 | -59 | -62 | -59 |
| | | 274 | 56 | -61 | -58 | -60 | -57 | -60 | -57 | -59 | -56 | -59 | -56 |
| | | 548 | 112 | -58 | -55 | -57 | -54 | -57 | -54 | -56 | -53 | -56 | -53 |
| | | 1 096 | 224 | -55 | -52 | -54 | -51 | -54 | -51 | -53 | -50 | -53 | -50 |
| 8 | 6LA/6LB | 156 | 28 | -61 | -58 | -60 | -57 | -59,5 | -56,5 | -58,5 | -55,5 | -58,5 | -55,5 |
| | | 313 | 56 | -58 | -55 | -57 | -54 | -57 | -54 | -56 | -53 | -56 | -53 |
| | | 627 | 112 | -55 | -52 | -54 | -51 | -54 | -51 | -53 | -50 | -53 | -50 |
| | | 1 254 | 224 | -52 | -49 | -51 | -48 | -51 | -48 | -50 | -47 | -50 | -47 |
| 9 | 6HA/6HB | 176 | 28 | -57,5 | -54,5 | -56,5 | -53,5 | -56 | -53 | -55 | -52 | -55 | -52 |
| | | 352 | 56 | -55 | -52 | -54 | -51 | -53,5 | -50,5 | -52,5 | -49,5 | -52,5 | -49,5 |
| | | 705 | 112 | -52 | -49 | -51 | -48 | -51 | -48 | -50 | -47 | -50 | -47 |
| | | 1 410 | 224 | -49 | -46 | -48 | -45 | -48 | -45 | -47 | -44 | -47 | -44 |
| 10 | 7A/7B | 196 | 28 | -54 | -51 | -53 | -50 | -52,5 | -49,5 | -51,5 | -48,5 | -51,5 | -48,5 |
| | | 392 | 56 | -51,5 | -48,5 | -50,5 | -47,5 | -50 | -47 | -49 | -46 | -49 | -46 |
| | | 784 | 112 | -49 | -46 | -48 | -45 | -47,5 | -44,5 | -46,5 | -43,5 | -46,5 | -43,5 |
| | | 1 568 | 224 | -46 | -43 | -45 | -42 | -44,5 | -41,5 | -43,5 | -40,5 | -43,5 | -40,5 |
| 11 | 8A/8B | 107 | 14 | -53,5 | -50,5 | -52,5 | -49,5 | -52,5 | -49,5 | -51,5 | -48,5 | -51,5 | -48,5 |
| | | 215 | 28 | -50,5 | -47,5 | -49,5 | -46,6 | -49,5 | -46,5 | -48,5 | -45,5 | -48,5 | -45,5 |
| | | 431 | 56 | -48 | -45 | -47 | -44 | -46,5 | -43,5 | -46 | -43 | -46 | -43 |
| | | 862 | 112 | -45,5 | -42,5 | -44,5 | -41,5 | -44 | -41 | -43 | -40 | -43 | -40 |
| | | 1 724 | 224 | -42,5 | -39,5 | -41,5 | -38,5 | -41 | -38 | -40 | -37 | -40 | -37 |

NOTE 1: 112 MHz not provided in 31 GHz band; 224 MHz not provided in 26 GHz and 31 GHz bands.

NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

## F.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table F.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause F.4.2.

**Table F.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Frequency band (GHz) | Minimum RIC rate (Mbit/s) (see note 1) | Channel separation (MHz) (see notes 1 and 2) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 2 | 2 | All except 42 | 4 | 3,5 | 23 | 19 | 0 | -4 |
| | | All | 8; 16; 32; 64; 128; 256 | 7; 14; 28; 56; 112; 224 | | | | |
| 3 | 3 | All except 42 | 6 | 3,5 | 23 | 19 | -1 | -5 |
| | | All | 12; 24; 48; 96; 191; 382 | 7; 14; 28; 56; 112; 224 | | | | |
| 4 | 4L | All except 42 | 8 | 3,5 | 30 | 26 | -1 | -5 |
| | | All | 16; 32; 64; 128; 256; 512 | 7; 14; 28; 56; 112; 224 | | | | |
| 5 | 4H | All | 24; 49; 98; 196; 392; 984 | 7; 14; 28; 56; 112; 224 | 30 | 26 | -6 | -9,5 |
| 6 | 5L | All | 29; 58 | 7; 14 | 34 | 30 | -3 | -7 |
| | 5LB | All | 117; 235; 470; 940 | 28; 56; 112; 224 (ACCP) | 34 | 30 | -3 | -7 |
| | 5LA | All | 117; 235; 470; 940 | 28; 56; 112; 224 (ACAP) | 34 | 30 | 4 | 1 |
| 7 | 5H | All | 34; 68 | 7; 14 | 37 | 33 | -3 | -7 |
| | 5HB | All | 137 | 28 (ACCP) | | | | |
| | | | 274; 548; 1096 | 56; 112; 224 (ACCP) | 37 | 33 | -3,5 | -7,5 |
| | 5HA | All | 137; 274; 548; 1096 | 28; 56; 112; 224 (ACAP) | 37 | 33 | +3 | -1 |
| 8 | 6L | All | 39; 78 | 7; 14 | 40 | 36 | 0 | -4 |
| | 6LB | All | 156; 313; 627; 1254 | 28; 56; 112; 224 (ACCP) | | | | |
| | 6LA | All | 156; 313; 627;1254 | 28; 56; 112; 224 (ACAP) | 40 | 36 | 10 | 7 |
| 9 | 6H | All | 88 | 14 | 43 | 39 | 0 | -4 |
| | 6HB | All | 176; 352; 705; 1410 | 28; 56; 112; 224 (ACCP) | | | | |
| | 6HA | All | 176; 352; 705;1410 | 28; 56; 112; 224 (ACAP) | 43 | 39 | 10 | 6 |
| 10 | 7 | All | 98 | 14 | 46 | 42 | 0 | -4 |
| | 7B | All | 196; 392; 784; 1568 | 28; 56; 112; 224 (ACCP) | | | | |
| | 7A | All | 196; 392; 784; 1568 | 28; 56; 112; 224 (ACAP) | 46 | 42 | 13 | 9 |
| 11 | 8 | All | 107 | 14 | 50 | 46 | 0 | -4 |
| | 8B | All | 215; 431; 862; 1724 | 28; 56; 112; 224 (ACCP) | | | | |
| | 8A | All | 215; 431; 862; 1724 | 28; 56; 112; 224 (ACAP) | 50 | 46 | 17 | 13 |
| NOTE 1: Minimum RIC and Channel separation series of values in each row are intended one to one coupled in their orders. | | | | | | | | |
| NOTE 2: 112 MHz not provided in 31 GHz band; 224 MHz not provided in 26 GHz and 31 GHz bands. | | | | | | | | |

# Annex G (normative):<br>Frequency bands from 50 GHz to 55 GHz

# G.1 Introduction

This annex contains requirements for a variety of equipment that, depending on the channel arrangements adopted by the local administrations (according to clause G.2.1 and table G.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according to clause G.2.2 and table G.2).

In this annex only FDD equipment is considered except for the 55 GHz (55,78 GHz to 57,0 GHz) band where both FDD and TDD are considered.

# G.2 General characteristics

## G.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table G.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table G.1: Frequency characteristics information**

| Band (GHz) | Frequency range (GHz) | Channel separation (MHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|---|
| | | | CEPT/ERC Recommendation | ITU-R Recommendation |
| 50 | 48,5 to 50,2 | 3,5 to 28 (see note 1) | 12-11 annex 2 [i.10] | - |
| 52 | 51,4 to 52,6 | 3,5 to 56 (see note 1) | 12-11 annex 1 [i.10] | F.1496-1 [i.54] |
| 50 to 52 | 48,5 to 50,2 paired with 50,9 to 52,6 | 14 to 56 (see note 1) | 12-11 annex C [i.10] | – |
| 55 | 55,78 to 57,0 | 3,5 to 56 (see note 2) | 12-12 [i.11] | F.1497-2 [i.55] |
| NOTE 1: 2015 revision of CEPT/ERC/REC 12-11 [i.10] has extended the maximum channel size to 112 MHz in 50 GHz and 52 GHz bands and up to 224 MHz in the paired 50 GHz to 52 GHz band. However, the present document has not yet considered channel sizes higher than those mentioned in the table. NOTE 2: 2015 revision of CEPT/ERC/REC 12-12 [i.11] has extended the maximum channel size to 112 MHz. However, the present document has not yet considered channel sizes higher than those mentioned in the table. | | | | |

## G.2.2 Transmission capacities

**Table G.2: Minimum RIC transmission capacity and system classes for various channel separation**

| Channel arrangement → | | | | Co-polar (ACCP) | | | | | | Cross-polar (ACAP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel separation (MHz) → | | | | **3,5** | **7** | **14** | **28** | **56** | **112** | **28** | **56** | **112** |
| | Spectral efficiency ↓ | | Frequency band (GHz) ↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ |
| | Reference index | Class | | | | | | | | | | |
| Minimum payload RIC rate Mbit/s (note) | 1 | 1 | 50 | 2 | - | - | - | - | | - | - | - |
| | | | 52; 55 | 2 | 4 | 8 | 16 | 32 | | - | - | - |
| | 2 | 2 | 50 | 4 | 8 | 16 | 32 | - | - | - | - | - |
| | | | 52; 55 | 4 | 8 | 16 | 32 | 64 | - | - | - | - |
| | 3 | 3 | 50 | 6 | 12 | 24 | 48 | - | - | - | - | - |
| | | | 52; 55 | 6 | 12 | 24 | 48 | 96 | - | - | - | - |
| | 4 | 4L | 50 | 8 | 16 | 32 | 64 | - | - | - | - | - |
| | | | 52; 55 | 8 | 16 | 32 | 64 | 128 | - | - | - | - |
| NOTE: For equipment assessment with different base band interfaces see annex N. | | | | | | | | | | | | |

# G.3 Transmitter

## G.3.1 General requirements

**Table G.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause 4.2.1.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause G.3.2 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |

## G.3.2 Transmitter Radio Frequency spectrum masks

The masks in clause 4.2.3.2 are valid only for those specific combinations of CS, nominal capacity and spectral efficiency class that are also included among those foreseen in table G.2.

# G.4 Receiver

## G.4.1 General requirements

**Table G.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table G. 5 |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table G.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## G.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in table G.5. The above declared Receiver Signal levels shall produce a BER $\leq 10^{-6}$ and either $\leq 10^{-6}$ or $\leq 10^{-10}$ as required.

NOTE: For information only: RSL values (in terms of noise figure and S/N for BER=$10^{-6}$), evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.28] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table G.5: BER performance thresholds for 50 GHz to 55 GHz (upper bound of declared limit)**

| Spectral efficiency | | Minimum | Band → | 50 GHz 50 and 52 GHz Paired | | | 52 GHz and 55 GHz | | |
|---|---|---|---|---|---|---|---|---|---|
| **Reference index** | **Class** | **RIC rate (Mbit/s)** | **Channel separation (MHz) ↓** | **RSL for BER ≤ $10^{-6}$ (dBm)** | **RSL for BER ≤ $10^{-8}$ (dBm)** | **RSL for BER ≤ $10^{-10}$ (dBm)** | **RSL for BER ≤ $10^{-6}$ (dBm)** | **RSL for BER ≤ $10^{-8}$ (dBm)** | **RSL for BER ≤ $10^{-10}$ (dBm)** |
| 1 | 1 | 2 | 3,5 | -89 | -87,5 | - | -88 | -86,5 | - |
| | | 4 | 7 | - | - | - | -85 | -83,5 | - |
| | | 8 | 14 | - | - | - | -82 | -80,5 | - |
| | | 16 | 28 | - | - | - | -79 | -77,5 | - |
| | | 32 | 56 | - | - | - | -76 | -74,5 | - |
| 2 | 2 | 4 | 3,5 | -86 | -84,5 | - | -85 | -83,5 | - |
| | | 8 | 7 | -83 | -81,5 | - | -82 | -80,5 | - |
| | | 16 | 14 | -80 | -78,5 | - | -79 | -77,5 | - |
| | | 32 | 28 | -77 | -75,5 | - | -76 | -74,5 | - |
| | | 64 | 56 | -74 | -72,5 | - | -73 | -71,5 | - |
| 3 | 3 | 6 | 3,5 | -80,5 | -79 | - | -79,5 | -78 | - |
| | | 12 | 7 | -77,5 | -76 | - | -76,5 | -75 | |
| | | 24 | 14 | -74,5 | -73 | - | -73,5 | -72 | |
| | | 48 | 28 | -71,5 | -70 | - | -70,5 | -69 | |
| | | 96 | 56 | -68,5 | -67 | - | -67,5 | -66 | |
| 4 | 4L | 8 | 3,5 | -78,5 | -77 | - | -77,5 | -76 | - |
| | | 16 | 7 | -75,5 | -74 | - | -74,5 | -73 | - |
| | | 32 | 14 | -73 | -71,5 | - | -72 | -70,5 | - |
| | | 64 | 28 | -70 | -68,5 | - | -69 | -67,5 | - |
| | | 128 | 56 | -67 | | -64 | -66 | - | -63 |

NOTE: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

# G.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table G.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause G.4.2.

**Table G.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Frequency band (GHz) | Minimum RIC rate (Mbit/s) (see note) | Channel separation (MHz) (see note) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 1 | 1 | All | 2; 4; 8; 16; 32 | 3,5; 7; 14; 28; 56 | 23 | 19 | 0 | -4 |
| 2 | 2 | All | 4; 8; 16; 32; 64 | 3,5; 7; 14; 28; 56 | 23 | 19 | 0 | -4 |
| 3 | 3 | All | 6, 12; 24; 48; 96 | 3,5; 7; 14; 28; 56 | 23 | 19 | -1 | -5 |
| 4 | 4L | All | 8; 16; 32; 64; 128 | 3,5; 7; 14; 28; 56 | 30 | 26 | -1 | -5 |
| NOTE: Minimum RIC and Channel separation series of values in each row are intended one to one coupled in their orders. | | | | | | | | |

# Annex H (normative): Frequency band 57 GHz to 66 GHz

## H.1 Introduction

Both FDD and TDD applications are covered in this annex.

The frequency arrangement in the whole frequency range covered in this annex is derived from the CEPT ECC/REC(09)01 [i.24] (for the band 57 GHz to 64 GHz) and CEPT ECC/REC(05)02 [i.22] (for the band 64 GHz to 66 GHz) when the latter is used in conjunction to the first with same 50 MHz slots.

According those recommendations, administrations may choose either to allow assignments in this band without a specific channel arrangement, or establish an arrangement based on simplified frequency slots arrangement.

This annex refers to systems based on CS = n × 50 MHz, with $1 \leq n \leq 40$; systems not designed according that CS granularity should refer to the closest CS closest to their *occupied bandwidth*.

NOTE: For information only: Equipment operating only in the frequency band 64 GHz to 66 GHz, less stringent emission requirements referred in annex I may also apply on national basis.

The upper (64,0 GHz to 66,0 GHz) portions of this band are included within the High Density Fixed Service (HDFS) bands referred in the ITU Radio Regulations [11].

## H.2 General characteristics

### H.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table H.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table H.1: Frequency characteristics information**

| Band (GHz) | Frequency range (GHz) | Channel separation (MHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|---|
| | | | CEPT/ECC Recommendation | ITU-R Recommendation |
| 57 to 64 | 57 to 64 | 50 to 2 000 (see note) | (09)01 [i.24] | Annex 2 of F.1497-2 [i.55] |
| 64 to 66 | 64 to 66 | 50 to 2 000 (see note) | (05)02 [i.22] | Annex 3.2 of F.1497-2 [i.55] |
| NOTE: In steps of n × 50 MHz; systems not designed according specific channel arrangement shall declare the *occupied bandwidth* and should refer to the closest n × 50 MHz channel separation. | | | | |

## H.2.2 Transmission capacities

Table H.2 gives the minimum RIC as function of spectral efficiency class and CS; specific values are given for the minimum and maximum CS foreseen for each class, while, for intermediate N × 50 MHz CS, only parametric formula is given; values of (RIC) in brackets are intermediate CS reference only.

**Table H.2: Minimum RIC transmission capacity and system classes for various channel separation**

| Channel separation (MHz) → | | | 50 | N × 50 (N < 40) | 500 (N = 10) | 750 (N = 15) | 1 250 (N = 25) | 2 000 (N = 40) |
|---|---|---|---|---|---|---|---|---|
| Minimum payload RIC rate Mbit/s (note 1) | Spectral efficiency ↓ | | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ |
| | Reference index | Class | | | | | | |
| | 1 | 1 | 28,5 | 28,5 × N (note 2) | (285) | (427) | (712) | 1 140 |
| | 2 | 2 | 57 | 57 × N | (570) | (855) | (1 425) | 2 280 |
| | 3 | 3 | 85 | 85 × N | (850) | (1 275) | (2 125) | 3 400 |
| | 4 | 4L | 114 | 114 × N (note 3) | (1 140) | (1 710) | 2 850 | - |
| | 5 | 4H | 175 | 175 × N (note 4) | (1 750) | 2 625 | - | - |
| | 6 | 5LA/5LB | 210 | 210 × N (note 4) | (2 100) | 3 150 | - | - |
| | 7 | 5HA/5HB | 245 | 245 × N (note 5) | 2 450 | - | - | - |
| | 8 | 6LA/6LB | 280 | 280 × N (note 5) | 2 800 | - | - | - |

NOTE 1: For equipment assessment with different base band interfaces see annex N.
NOTE 2: For N > 4 rounded down to the lower Mbit/s integer.
NOTE 3: N < 25.
NOTE 4: N < 15.
NOTE 5: N < 10.

# H.3 Transmitter

## H.3.1 General requirements

Table H.3 summarizes the TX requirements.

**Table H.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause H.3.2.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause H.3.2.2.1 or clause H.3.2.2.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause H.3.3 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |
| **Transmitter emission limitations outside the allocated band** | Clause H.3.4 |

# H.3.2 Transmitter power and EIRP

## H.3.2.1 Transmitter maximum power and EIRP

The following transmitter output power, antenna gain and EIRP limits are set by ECC/REC(09)01 [i.24] for the 57 GHz to 64 GHz band:

- Maximum EIRP: +55 dBm.
- Minimum antenna gain: +30 dBi.
- Maximum transmitter output power: +10 dBm.

ECC/REC(05)02 [i.22] does not fix any limit for the band 64 GHz to 66 GHz; therefore, only the generic limits for terrestrial stations set in the article 21 of ITU Radio Regulations [11] apply.

Equipment that can operate in the whole range 57 GHz to 66 GHz should select, for the range 64 GHz to 66 GHz only, either to apply for commonality the same limitation given in clause H.3.2.2 or the less restrictive one given in clause I.3.2 of annex I.

## H.3.2.2 Transmitter Combined nominal output power and EIRP limits

### H.3.2.2.0 Generality

In addition to the limits given in clause H.3.2.1, which shall never to be exceeded, in order of safeguarding a fair and efficient use of the spectrum, maximum *nominal output power* (Pout) and *nominal EIRP* emissions (referred in clause 4.2.1.2) of equipment in the scope of the present document, and operating in the range 57 GHz to 64 GHz, shall be limited as in following clauses H.3.2.2.1 and H.3.2.2.2 as function of the *nominal antenna gain* ($G_{ant}$).

### H.3.2.2.1 Equipment without ATPC as permanent feature

These are equipment that, even if ATPC is implemented, it can be freely enabled, disabled and/or preset by the user.

- **Equipment with *integral antennas* or *dedicated antennas***

1a) EIRP (dBm) $\leq +55$ for $G_{ant} \geq 45$ dBi.

$\leq +10 + G_{ant}$ (dBi) for 45 dBi $> G_{ant} \geq 38$ dBi.

$\leq -28 + 2 \times G_{ant}$ (dBi) for 38 dBi $> G_{ant} \geq 30$ dBi.

2a) EIRP density (dBm/MHz) $\leq -10$ dBm/MHz + $G_{ant}$ (dBi).

3a) Minimum $G_{ant}$ (dBi) $\geq 30$.

The above limitations automatically imply (see figure H.1) also a limit to the maximum Pout:

4a) Pout (dBm) $\leq G_{ant} - 28$ for 30 dBi $\leq G_{ant} <$ 38 dBi
$\leq +10$ for 38 dBi $\leq G_{ant} <$ 45 dBi
$\leq 55 - G_{ant}$ for $G_{ant} \geq 45$ dBi.

- **Equipment offering external antenna connectors (see note)**

For equipment offering only an external antenna connectors (i.e. fitted for the use of a *stand alone antenna*) the above limitation should be translated in terms of maximum output power and range of antenna gain that the manufacturer should state (see note) for the use with the equipment for not exceeding the above EIRP limitations, i.e.:

1b) Pout $\leq +10$ dBm.

2b) Pout density ≤ -10 dBm/MHz.

3b) Minimum $G_{ant}$ (dBi) ≥ Pout (dBm) + 30; or
≥ 30 (dBi) (whichever is the greater).

4b) Maximum $G_{ant}$ (dBi) ≤ 55 - Pout (dBm)

NOTE: For information only: it is assumed that the above information on antenna gain range, not specifically relevant to article 3.2 of Directive 2014/53/EU [i.1], is supplied in the user instructions as specified in article 10.8 of Directive 2014/53/EU [i.1] (see also informative annex Q).

The above limitations are visually represented in figure H.1 and figure H.2.

#### H.3.2.2.2 Equipment implementing ATPC as permanent feature

With the term "permanent feature" it shall be intended that ATPC cannot be disabled by the user or, whenever it is possible, the maximum output power delivered, in any conditions, cannot be set to a value exceeding clause H.3.2.2 provisions 1a, 2a, 3a and 4a (or 1b, 2b, 3b and 4b as appropriate). More information on the use of ATPC may be found in ETSI TR 103 103 [i.32].

Equipment implementing ATPC as a permanent feature, linearly activated by the drop of RSL in the corresponding far end receiver, should respect the following limitations:

- **Equipment with *integral antennas* or *dedicated antennas***

  EIRP and Pout in full power ATPC regime:

  $1a_{ATPC}$) EIRP (dBm) ≤ +10 + $G_{ant}$ (dBi); or
  ≤ +55 (whichever is the lower).

  $2a_{ATPC}$) EIRP density (dBm/MHz) ≤ -10 dBm/MHz + $G_{ant}$ (dBi).

  $3a_{ATPC}$) Minimum $G_{ant}$ (dBi) ≥ 30.

  The above limitations automatically imply (see figure H.1) also a limit to the maximum Pout in full power ATPC regime:

  $4a_{ATPC}$) Pout (dBm) ≤ +10 for 30 dBi ≤ $G_{ant}$ < 45 dBi
  ≤ 55 - $G_{ant}$ for $G_{ant}$ ≥ 45 dBi.

  $5a_{ATPC}$) Minimum ATPC attenuation (dB) ≥ actual Pout (max delivered in
  full power ATPC regime) - max Pout (from formula 4a, clause H.3.2.2.1).

- **Equipment offering external antenna connectors (see note)**

  For equipment offering external antenna connectors the above limitation should be translated in terms of range of antenna gain that the manufacturer shall state for the use with the equipment (see note in clause I.3.2.1) for not exceeding the above EIRP limitations, i.e.:

  $1b_{ATPC}$) Pout (dBm) ≤ +10 (in any conditions) (see note).

  $2b_{ATPC}$) Pout density ≤ -10 dBm/MHz.

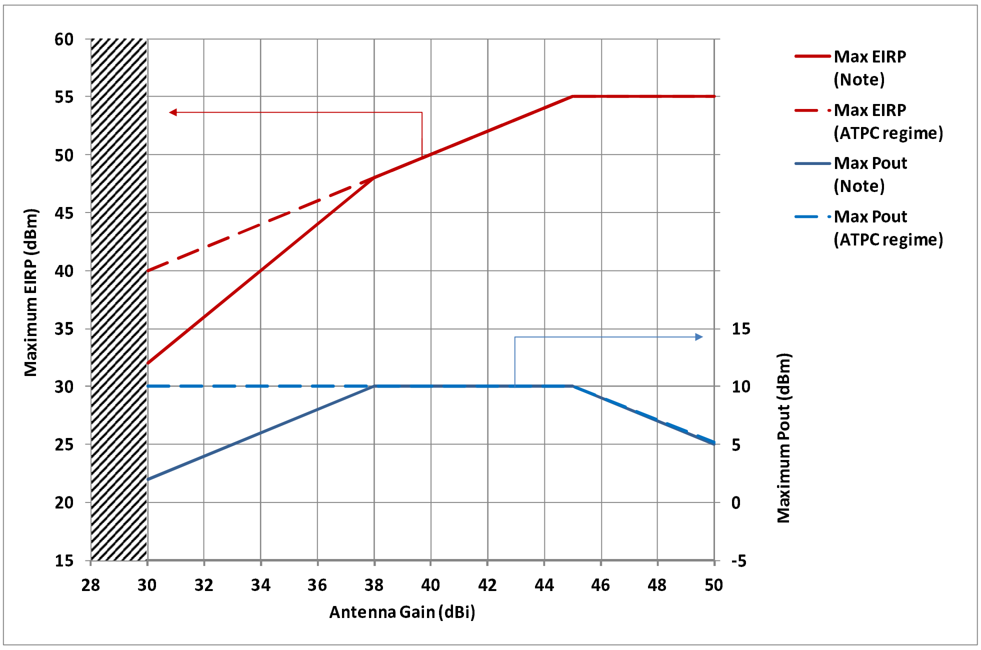
  $3b_{ATPC}$) Minimum $G_{ant}$ (dBi) ≥ Pout (dBm) + 30; or
  ≥ 30 (dBi) (whichever is the greater)
  where Pout is intended as the maximum delivered by ATPC regime in unfaded condition.

  $4b_{ATPC}$) Maximum $G_{ant}$ (dBi) ≤ 55 - Pout (dBm)
  where Pout is intended as the maximum delivered in full power ATPC regime.

  $5b_{ATPC}$) Minimum ATPC attenuation (dB) ≥ actual Pout (max delivered in
  full power ATPC regime) - max Pout (from formula 4a, clause H.3.2.2.1).

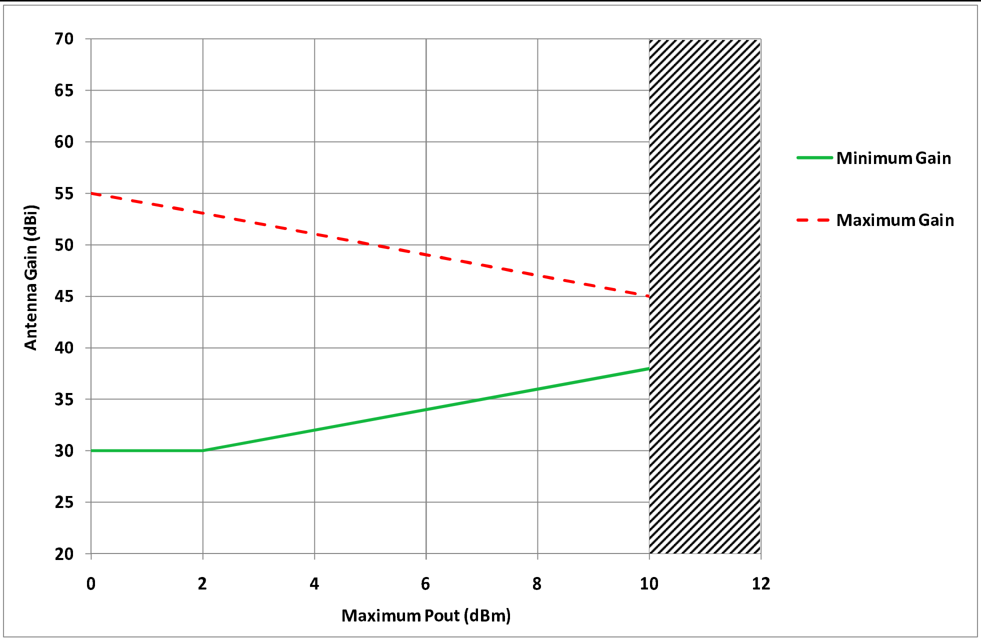
NOTE: For information only: it should be considered that the Pout limits are generic maximum, but, when coupled with actual antenna within minimum/maximum $G_{ant}$ range described in formulas $3b_{ATPC}$ and $4b_{ATPC}$, this implies that are also satisfied the limitations expressed in formula 4a (clause H.3.2.2.1) for the Pout in unfaded conditions and in formula $4a_{ATPC}$ (present clause) for the Pout in ATPC regime.

The above limitations are also visually represented in figure H.1 and figure H.2 (dashed lines).




NOTE: For equipment with permanent ATPC feature, these are intended the maximum Pout and EIRP delivered by the ATPC regime in unfaded conditions.

**Figure H.1: Graphical relationship among EIRP limitation, antenna gain and output power**




NOTE: For equipment with permanent ATPC feature, the minimum gain is intended evaluated with the maximum Pout delivered by the ATPC regime in unfaded condition, while the maximum gain is intended evaluated with the maximum Pout in full power ATPC regime (see example).

EXAMPLE: A system with permanent ATPC operating between +0 dBm (ATPC regime in unfaded condition) and +10 dBm (full power ATPC regime) may be connected to any antenna with 30 ≤ $G_{ant}$ (dBi) ≤ 45.

**Figure H.2: Graphical relationship between actual output power and possible range of antenna gain for matching the EIRP limits (applicable to equipment with external antenna connector)**

## H.3.3 Transmitter Radio Frequency spectrum masks

The appropriate mask described in clause 4.2.3.2 for N × 50 MHz case shall apply.

## H.3.4 Transmitter emissions limitations outside the 57 GHz to 66 GHz range

Besides respecting the relevant spectrum mask in clause H.3.3, the *occupied bandwidth* (see definitions in ETSI EN 302 217-1 [5]) shall remain within the specified band 57 GHz to 66 GHz.

However, out-of-band emissions (i.e. those within the spectrum masks frequency range required in clause H.3.3) of systems operating close to the 57 GHz to 66 GHz band edges, may still fall outside the band edges (see note 1). Consequently, the EIRP spectral density, within the spectrum density mask frequency boundaries, eventually falling outside of the 57 GHz to 66 GHz band edges shall be further limited (see note 2) to a maximum of:

- +10 dBm/MHz.

NOTE 1: The ECC channel arrangements in the range 64 GHz to 66 GHz are based only on continuous raster of elementary frequency slots and do not provide variable guard bands consistent with the actual CS used, as typically done for bands below 57 GHz; hence the need for this safeguard for the larger CS.

NOTE 2: Besides equipment with integral antenna, where conventional direct radiated EIRP test are required, for other cases where separate antenna may be autonomously provided by the end user, it is assumed that the above limitation implies as foreseen in Directive 2014/53/EU [i.1] the inclusion in the user instructions of specific indication on the intended use for meeting the requirement (e.g. minimum distance of the carrier center frequency from the band edges and/or associated maximum EIRP).

This shall not be intended as a relaxation of either the emission mask foreseen in clause H.3.3 or of the emissions in the spurious domain of clause 4.2.5.

# H.4 Receiver

## H.4.1 General requirements

Table H.4 summarizes the RX requirements.

**Table H.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table H.5 |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table H.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## H.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in table H.5. The above declared Receiver Signal levels shall produce a BER ≤ $10^{-6}$ or ≤ $10^{-10}$.

NOTE: RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table H.5: BER as a function of receiver input signal level RSL (upper bound of declared limit)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) (see note 2) | RSL for BER ≤ $10^{-10}$ (dBm) (see note 2) |
|---|---|---|---|---|---|
| Reference index | Class | | | | |
| 1 | 1 | 28,5 | 50 | -73 | -71 |
| | | 28,5 × N (N < 40) (see note 1) | N × 50 (N < 40) | -73 + 10logN | -71 + 10logN |
| | | 1 140 | 2 000 (N = 40) | -57 | -55 |
| 2 | 2 | 57 | 50 | -71 | -69 |
| | | 57 × N (N < 40) | N × 50 (N < 40) | -71 + 10logN | -69 + 10logN |
| | | 1 140 | 2 000 (N = 40) | -55 | -53 |
| 3 | 3 | 85 | 50 | -68 | -66 |
| | | 85 × N (N < 40) | N × 50 (N < 40) | -68 + 10logN | -66 + 10logN |
| | | 1 140 | 2 000 (N = 40) | -52 | -50 |
| 4 | 4L | 114 | 50 | -65,5 | -61,5 |
| | | 114 × N (N < 25) | N × 50 (N < 25) | -65,5 + 10logN | -61,5 + 10logN |
| | | 2 850 | 1 250 (N = 25) | -51,5 | -47,5 |
| 5 | 4H | 175 | 50 | -62 | -58 |
| | | 175 × N (N < 15) | N × 50 (N < 15) | -62 + 10logN | -58 + 10logN |
| | | 2 625 | 750 (N = 15) | -50 | -46 |
| 6 | 5LA/5LB | 210 | 50 | -58,5 | -54,5 |
| | | 210 × N (N < 15) | N × 50 (N < 15) | -58,5 + 10logN | -54,5 + 10logN |
| | | 3 150 | 750 (N = 15) | -46,5 | -42,5 |
| 7 | 5HA/5HB | 245 | 50 | -55 | -51 |
| | | 245 × N (N < 10) | N × 50 (N < 10) | -55 + 10logN | -51 + 10logN |
| | | 2 450 | 500 (N = 10) | -45 | -41 |
| 8 | 6LA/6LB | 280 | 50 | -51 | -47 |
| | | 280 × N (N < 10) | N × 50 (N < 10) | -51 + 10logN | -47 + 10logN |
| | | 2 800 | 500 (N = 10) | -41 | -37 |

NOTE 1: For N > 4 rounded down to the lower Mbit/s integer.
NOTE 2: Value of 10logN rounded to the closest 1/2 dB granularity.
NOTE 3: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

### H.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table H.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause H.4.2.

**Table H.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Channel separation (MHz) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 1 | 1 | 28,5 × N (1 ≤ N ≤ 40) (see note) | N × 50 (1 ≤ N ≤ 40) | 23 | 19 | 0 | -4 |
| 2 | 2 | 57 × N (1 ≤ N ≤ 40) | | | | | |
| 3 | 3 | 85 × N (1 ≤ N ≤ 40) | N × 50 (1 ≤ N ≤ 40) | 25 | 21 | 0 | -4 |
| 4 | 4L | 114 × N (1 ≤ N ≤ 25) | N × 50 (1 ≤ N ≤ 25) | 27 | 23 | 0 | -4 |
| 5 | 4H | 175 × N (1 ≤ N ≤ 15) | N × 50 (1 ≤ N ≤ 15) | 30 | 26 | -2 | -6 |
| 6 | 5LB | 210 × N (1 ≤ N ≤ 15) | N × 50 (ACCP) (1 ≤ N ≤ 15) | 33,5 | 29,5 | -6 | -10 |
| | 5LA | 210 × N (1 ≤ N ≤ 15) | N × 50 (ACAP) (1 ≤ N ≤ 15) | 33,5 | 29,5 | +3 | -1 |
| 7 | 5HB | 245 × N (1 ≤ N ≤ 10) | N × 50 (ACCP) (1 ≤ N ≤ 10) | 37 | 33 | -3 | -7 |
| | 5HA | 245 × N (1 ≤ N ≤ 10) | N × 50 (ACAP) (1 ≤ N ≤ 10) | 37 | 33 | +6 | +2 |
| 8 | 6LB | 280 × N (1 ≤ N ≤ 10) | N × 50 (ACCP) (1 ≤ N ≤ 10) | 40,5 | 36,5 | 0 | -4 |
| | 6LA | 280 × N (1 ≤ N ≤ 10) | N × 50 (ACAP) (1 ≤ N ≤ 10) | 40,5 | 36,5 | +9 | +5 |
| NOTE: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid. | | | | | | | |

## H.5 Minimum antenna gain

According to the ECC/REC(09)01 [i.24] emission limitations (see clause H.3.2.1), equipment with *integral* antenna or *dedicated antenna* shall be associated to a directional antenna with a minimum gain of 30 dBi.

When equipment is supplied without antenna see also informative annex Q.

# Annex I (normative): Frequency band 64 GHz to 66 GHz

## I.1 Introduction

Both FDD and TDD applications are covered in this annex.

The frequency arrangement in the frequency range covered in this annex is derived from the CEPT ECC/REC (05)02 [i.22].

According to that recommendation administrations may choose either to allow assignments in this band without a specific channel arrangement, or establish an arrangement based on simplified frequency slots arrangement (see note 1).

This annex refers to systems based on:

- CS = n × 50 MHz, with $1 \leq n \leq 38$ for TDD systems or $1 \leq n \leq 19$ for FDD systems;
- CS = n × 30 MHz, with $1 \leq n \leq 66$ for TDD systems or $1 \leq n \leq 33$ for FDD systems.

Systems not designed according to the above CS granularity should refer to the CS closest to their *occupied bandwidth*.

NOTE 1: Administrations might require specific measures to avoid interference (e.g. listen-before talk).

NOTE 2: In the frequency band 64 GHz to 66 GHz equipment characteristics referred in annex H may also apply. The manufacturer should select the more appropriate according to the actual system and application foreseen.

This band is included within the High Density Fixed Service (HDFS) bands referred in the ITU Radio Regulations [11].

## I.2 General characteristics

### I.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table I.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or CEPT/ECC recommendations set around the rough boundary of present ITU-R or CEPT/ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

**Table I.1: Frequency characteristics**

| Frequency range (GHz) | Channel separation (MHz) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|
| | | CEPT/ECC Recommendation | ITU-R Recommendation |
| 64 to 66 | FDD: 30 to 990 (see note 1)<br>TDD: 30 to 1 980 (see note 1) | Annex 3 of (05)02 [i.22] | Annex 3.2 of F.1497-2 [i.55] |
| 64 to 66 | FDD: 50 to 950 (see note 2)<br>TDD: 50 to 1 900 (see note 2) | Annex 3 of (05)02 [i.22] | Annex 3.2 of F.1497-2 [i.55] |
| NOTE 1: In steps of n × 30 MHz; systems not designed according specific channel arrangement shall declare the *occupied bandwidth* and should refer to the closest n × 30 MHz channel separation.<br>NOTE 2: In steps of n × 50 MHz. FDD also extensible up to 1 950 MHz when national regulations foresee go/return conjunction with lower band 57 GHz to 64 GHz. TDD extensible to 1 950 MHz when the national regulations foresee. | | | |

# I.2.2 Transmission capacities

## I.2.2.1 Channel arrangement based on N × 50 MHz

In this case table H.2 of annex H applies taking into consideration that cases with N > 38 (TDD) or N > 19 (FDD) are not applicable; however, FDD up to N = 39 are possible when the national administration foresee use of the band in conjunction (go/return) with the lower 57 GHz to 64 GHz range.

## I.2.2.2 Channel arrangement based on N × 30 MHz

Table I.2 gives the minimum RIC as function of spectral efficiency class and CS based on N × 30 MHz arrangement; specific values are given for the minimum and maximum CS foreseen for each class, while, for intermediate N × 30 MHz CS, only parametric formula is given; values of (RIC) in brackets are intermediate CS reference only.

**Table I.2: Minimum RIC transmission capacity and system classes for various channel separation based on N × 30 MHz arrangement**

| Channel separation (MHz) → | | | 30 | N ×30 (TDD: N < 66) (FDD: N < 33) | 480 (N = 16) | 750 (N = 25) | 990 (N = 33) | 1 230 (N = 41) | 1 980 (N = 66) |
|---|---|---|---|---|---|---|---|---|---|
| Minimum payload RIC rate (Mbit/s) (note 1) | Spectral efficiency ↓ | | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ | ↓ ↓ |
| | Reference index | Class | | | | | | | |
| | 1 | 1 | 17 | 17 × N | (272) | (425) | 561 | (697) | 1 122 |
| | 2 | 2 | 34 | 34 × N | (544) | (850) | 1 122 | (1 394) | 2 244 |
| | 3 | 3 | 51 | 51 × N | (816) | (1 275) | 1 683 | (2 091) | 3 366 |
| | 4 | 4L | 68 | 68 × N (note 2) | (1 088) | (1 700) | 2 244 | 2 788 | - |
| | 5 | 4H | 105 | 105 × N (note 3) | (1 680) | 2 625 | - | - | - |
| | 6 | 5LA/5LB | 126 | 126 × N (note 3) | (2 016) | 3 150 | - | - | - |
| | 7 | 5HA/5HB | 147 | 147 × N (note 4) | 2 352 | - | - | - | - |
| | 8 | 6LA/6LB | 168 | 168 × N (note 4) | 2 688 | - | - | - | - |
| NOTE 1: For equipment assessment with different base band interfaces see annex N.<br>NOTE 2: N < 41.<br>NOTE 3: N < 25.<br>NOTE 4: N < 16. | | | | | | | | | |

# I.3 Transmitter

## I.3.1 General requirements

Table I.3 summarizes the TX requirements.

**Table I.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 and I.3.2.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause I.3.2.2.1 or clause I.3.2.2.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause I.3.3 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |
| **Transmitter emission limitations outside the allocated band** | Clause I.3.4 |

## I.3.2 Transmitter power and EIRP limits

### I.3.2.1 Transmitter maximum power and EIRP

CEPT ECC/REC(05)02 [i.22] does not fix any limit for the band 64 GHz to 66 GHz; therefore, only the generic limits for terrestrial stations set in the article 21 of ITU Radio Regulations [11], reported in clause 4.2.1.1, apply.

NOTE: Further emission limitations, in terms of EIRP and/or Pout and/or antenna gain, might be present on a national basis.

### I.3.2.2 Transmitter Combined nominal output power and EIRP limits

#### I.3.2.2.0 Generality

In addition to the limits given in clause I.3.2.1, which shall never to be exceeded, in order of safeguarding a fair and efficient use of the spectrum, maximum *nominal output power* (Pout) and *nominal EIRP* emissions (referred in clause 4.2.1.2) of equipment in the scope of the present document shall be limited as in following clauses I.3.2.2.1 and I.3.2.2.2 as function of the *nominal antenna gain* ($G_{ant}$).

#### I.3.2.2.1 Equipment without ATPC as permanent feature

These are equipment that, even if ATPC is implemented, it can be freely enabled, disabled and/or preset by the user.

- **Equipment with *integral antenna* or *dedicated antennas***

  1a) EIRP limit (dBm) $\leq +85$ (see [11], article 21) for $G_{ant} \geq 50$ dBi.
  $\leq +85 - 2 \times (50 - G_{ant})$ for 50 dBi $> G_{ant} \geq 30$ dBi.

  2a) Minimum $G_{ant}$ (dBi) $\geq 30$.

  The above limitations automatically imply (see figure I.1) also a limit to the maximum Pout:

  3a) Pout (dBm) $\leq G_{ant} - 15$ for 30 dBi $\leq G_{ant} < 50$ dBi
  $\leq 85 - G_{ant}$ for $G_{ant} \geq 50$ dBi.

- **Equipment offering external antenna connectors (see note)**

  For equipment offering only an external antenna connectors (i.e. fitted for the use of a *stand alone antenna*) the above limitation should be translated in terms of range of antenna gain that the manufacturer should state for the use with the equipment (see note) for not exceeding the above EIRP limitations, i.e.:

  1b) Minimum $G_{ant}$ (dBi) ≥ Pout (dBm) + 15 or
  ≥ 30 (dBi) (whichever is the greater).

  2b) Maximum $G_{ant}$ (dBi) ≤ 85 - Pout (dBm).

  3b) Pout (dBm) ≤ +35

NOTE: For information only: it is assumed that the above information on antenna gain range, not specifically relevant to article 3.2 of Directive 2014/53/EU [i.1], is supplied in the user instructions as specified in article 10.8 of Directive 2014/53/EU [i.1] (see also informative annex Q).

The above limitations are visually represented in figure I.1 and figure I.2.

#### I.3.2.2.2 Equipment implementing ATPC as permanent feature

With the term "permanent feature" it shall be intended that ATPC cannot be disabled by the user or, whenever it is possible, the maximum output power delivered, in any conditions, cannot be set to a value exceeding clause I.3.2.2 provisions 1a, 2a and 3a (or 1b, 2b and 3b as appropriate). More information on the use of ATPC may be found in ETSI TR 103 103 [i.32].

Equipment implementing ATPC as a permanent feature, linearly activated by the drop of RSL in the corresponding far end receiver, should respect the following limitations:

- **Equipment with *integral antennas* or *dedicated antennas***

  EIRP and Pout in full power ATPC regime:

  $1a_{ATPC}$) EIRP (dBm) ≤ +35 + $G_{ant}$ (dBi); or
  ≤ +85 (whichever is the lower).

  $2a_{ATPC}$) $G_{ant}$ (dBi) ≥ 30.

  The above limitations automatically imply (see figure I.1) also a limit to the maximum Pout in full power ATPC regime:

  $3a_{ATPC}$) Pout (dBm) ≤ +35 for $30 \le G_{ant} < 50$ dBi
  ≤ 85 - $G_{ant}$ for $G_{ant} \ge 50$ dBi.

  $4a_{ATPC}$) Minimum ATPC attenuation (dB) ≥ actual Pout (max delivered in
  full power ATPC regime) - maximum Pout (from formula 3a, clause I.3.2.2).

- **Equipment offering external antenna connectors (see note)**

  For equipment offering external antenna connectors the above limitation should be translated in terms of range of antenna gain that the manufacturer shall state for the use with the equipment (see note in clause I.3.2.2.1) for not exceeding the above EIRP limitations, i.e.:

  $1b_{ATPC}$) Minimum $G_{ant}$ (dBi) ≥ Pout (dBm) + 15; or
  ≥ 30 (dBi) (whichever is the greater)
  where Pout is intended as the maximum delivered by ATPC regime in unfaded condition.

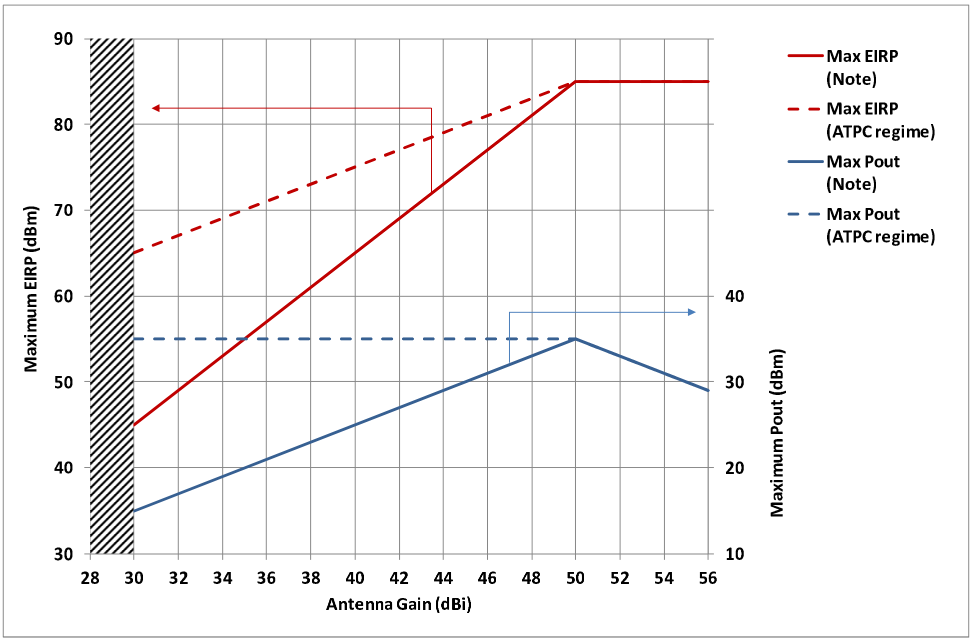
  $2b_{ATPC}$) Maximum $G_{ant}$ (dBi) ≤ 85 - Pout (dBm)
  where Pout is intended as the maximum delivered in full power ATPC regime.

  $3b_{ATPC}$) Pout (dBm) ≤ +35 (in any conditions) (see note).

  $4b_{ATPC}$) Minimum ATPC attenuation (dB) ≥ actual Pout (max delivered
  in full power ATPC regime) - maximum Pout (from formula 3a clause I.3.2.2).

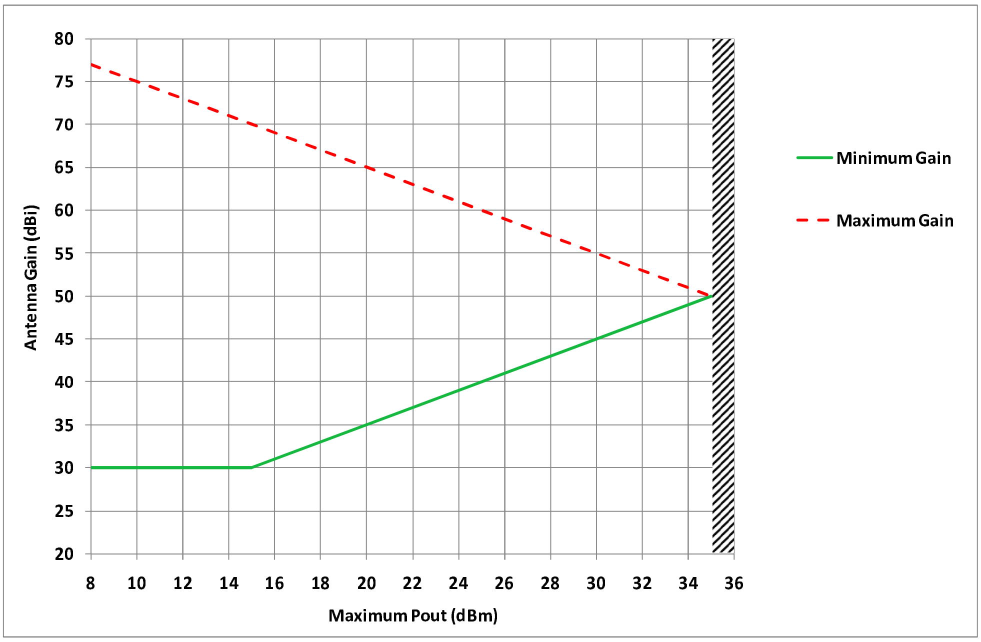
NOTE: For information only: should be considered that the Pout limits are generic maximum, but, when coupled with actual antenna within minimum/maximum $G_{ant}$ range described in formulas $1b_{ATPC}$ and $2b_{ATPC}$, this implies that the limitations expressed in formula 3a (clause I.3.2.2.1) for the Pout in unfaded conditions and in formula $3a_{ATPC}$ (present clause) for the Pout in ATPC regime are also satisfied.

The above limitations are also visually represented in figure I.1 and figure I.2 (dashed lines).




NOTE: For equipment with permanent ATPC feature, these are intended the maximum Pout and EIRP delivered by the ATPC regime in unfaded conditions.

**Figure I.1: Graphical relationship among EIRP limitation, antenna gain and output power**




NOTE: For equipment with permanent ATPC feature, the minimum gain is intended evaluated with the maximum Pout delivered by the ATPC regime in unfaded condition, while the maximum gain is intended evaluated with the maximum Pout in full power ATPC regime (see example).

EXAMPLE: A system with permanent ATPC operating between +20 dBm (ATPC regime in unfaded condition) and +30 dBm (full power ATPC regime) may be connected to any antenna with $35 \leq G_{ant}$ (dBi) $\leq 55$.

**Figure I.2: Graphical relationship between actual output power and possible range of antenna gain for matching the EIRP limits (applicable to equipment with external antenna connector)**

## I.3.3 Transmitter Radio Frequency spectrum mask

The appropriate masks described in clause 4.2.3 for N × 50 MHz or for N × 30 MHz cases shall apply.

## I.3.4 Transmitter emissions limitations outside the 64 GHz to 66 GHz range

Besides respecting the relevant spectrum mask in clause I.3.3, the occupied bandwidth (see definitions in ETSI EN 302 217-1 [5]) shall remain within the specified band 64 GHz to 66 GHz.

However, out-of-band emissions (i.e. those within the spectrum masks frequency range required in clause I.3.3) of systems operating close to the 64 GHz to 66 GHz band edges, may still fall outside the band edges (see note 1). Consequently, the EIRP spectral density, within the spectrum density mask frequency boundaries, eventually falling outside of the 64 GHz to 66 GHz band edges shall be further limited (see note 2) to a maximum of:

- +10 dBm/MHz.

NOTE 1: The ECC channel arrangements in the range 64 GHz to 66 GHz are based only on continuous raster of elementary frequency slots and do not provide variable guard bands consistent with the actual CS used, as typically done for bands below 57 GHz; hence the need for this safeguard for the larger CS.

NOTE 2: Besides equipment with integral antenna, where conventional direct radiated EIRP test are required, for other cases where separate antenna may be autonomously provided by the end user, it is assumed that the above limitation implies as foreseen in Directive 2014/53/EU [i.1] the inclusion in the user instructions of specific indication on the intended use for meeting the requirement (e.g. minimum distance of the carrier center frequency from the band edges and/or associated maximum EIRP).

This shall not be intended as a relaxation of either the emission mask foreseen in clause I.3.3 or of the emissions in the spurious domain of clause 4.2.5.

# I.4 Receiver

## I.4.1 General requirements

Table I.4 summarizes the RX requirements.

**Table I.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table I.5 |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table I.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## I.4.2 BER as a function of Receiver input Signal Level (RSL)

### I.4.2.1 Channel arrangement based on N × 50 MHz

In this case clause H.4.2 of annex H applies taking into consideration that cases with N > 38 (TDD) or N > 19 (FDD) are not applicable.

### I.4.2.2 Channel arrangement based on N × 30 MHz

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-8}$ or $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in table I.5. The above declared Receiver Signal levels shall produce a BER $\leq 10^{-6}$ or $\leq 10^{-10}$.

NOTE: RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table I.5: BER as a function of receiver input signal level RSL (upper bound of declared limit)**

| Spectral efficiency | | Minimum RIC rate (Mbit/s) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) (see note 1) | RSL for BER ≤ $10^{-10}$ (dBm) (see note 1) |
|---|---|---|---|---|---|
| Reference index | Class | | | | |
| 1 | 1 | 17 | 30 | -75,2 | -73,2 |
| | | 17 × N (TDD: N < 66) (FDD: N < 33) | N × 30 (TDD: N < 66) (FDD: N < 33) | -75,2 + 10logN | -73,2 + 10logN |
| | | 561 (FDD: N = 33) | 990 (FDD: N = 33) | -60 | -58 |
| | | 1 122 (TDD: N = 66) | 1 980 (TDD: N = 66) | -57 | -55 |
| 2 | 2 | 34 | 30 | -73,2 | -71,2 |
| | | 34× N (TDD: N < 66) (FDD: N < 33) | N × 30 (TDD: N < 66) (FDD: N < 33) | -73,2 + 10logN | -71,2 + 10logN |
| | | 1 122 (FDD: N = 33) | 990 (FDD: N = 33) | -58 | -56 |
| | | 2 244 (TDD: N = 66) | 1 980 (TDD: N = 66) | -55 | -53 |
| 3 | 3 | 51 | 30 | -70,2 | -68,2 |
| | | 51 × N (TDD: N < 66) (FDD: N < 33) | N × 30 (TDD: N < 66) (FDD: N < 33) | -70,2 + 10logN | -68,2 + 10logN |
| | | 1 683 (FDD: N = 33) | 990 (FDD: N = 33) | -55 | -53 |
| | | 3 366 (TDD: N = 66) | 1 980 (TDD: N = 66) | -52 | -50 |
| 4 | 4L | 68 | 30 | -67,7 | -63,7 |
| | | 68 × N (TDD: N < 41) (FDD: N < 33) | N × 30 (TDD: N < 41) (FDD: N < 33) | -67,7 + 10logN | -63,7 + 10logN |
| | | 2 244 (FDD: N = 33) | 990 (FDD: N = 33) | -52,5 | -48,5 |
| | | 2 788 (TDD: N = 41) | 1 980 (TDD: N = 41) | -51,5 | 50,5 |
| 5 | 4H | 105 | 30 | -64,2 | -60,2 |
| | | 105 × N (N < 25) | N × 30 (N < 25) | -64,2 + 10logN | -60,2 + 10logN |
| | | 2 625 (N = 25) | 750 (N = 25) | -50,2 | -46,2 |
| 6 | 5LA/5LB | 126 | 30 | -60,7 | -56,7 |
| | | 126 × N (N < 25) | N × 30 (N < 25) | -60,7+ 10logN | -56,7 + 10logN |
| | | 3 150 (N = 25) | 750 (N = 25) | -46,7 | -42,7 |
| 7 | 5HA/5HB | 147 | 30 | -57,2 | -53,2 |
| | | 147 × N (N < 16) | N × 30 (N < 16) | -57,2 + 10logN | -53,2 + 10logN |
| | | 2 352 (N = 16) | 480 (N = 16) | -45 | -41 |
| 8 | 6LA/6LB | 168 | 30 | -53,2 | -49,2 |
| | | 168 × N (N < 16) | N × 30 (N < 16) | -53,2 + 10logN | -49,2 + 10logN |
| | | 2 688 (N = 16) | 480 (N = 16) | -41 | -37 |

NOTE 1: Value of 10logN rounded to the closest 1/2 dB granularity.
NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

# I.4.3 Receiver co-channel and first adjacent channel interference sensitivity

## I.4.3.1 Channel arrangement based on N × 50 MHz

In this case clause H.4.3 of annex H applies taking into consideration that cases with N > 38 (TDD) or N > 19 (FDD) are not applicable.

### I.4.3.2 Channel arrangement based on N × 30 MHz

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table I.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause I.4.2.

**Table I.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Min. RIC rate (Mbit/s) | Channel separation (MHz) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| | | | | Co-channel interference | | First adjacent channel interference | |
| Reference index | Class | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 1 | 1 | 17 × N (TDD: 1 ≤ N ≤ 66) (FDD: 1 ≤ N ≤ 33) | N × 30 (TDD: 1 ≤ N ≤ 66) (FDD: 1 ≤ N ≤ 33) | 23 | 19 | 0 | -4 |
| 2 | 2 | 34 × N (TDD: 1 ≤ N ≤ 66) (FDD: 1 ≤ N ≤ 33) | | | | | |
| 3 | 3 | 51 × N (TDD: 1 ≤ N ≤ 66) (FDD: 1 ≤ N ≤ 33) | N × 30 (TDD: 1 ≤ N ≤ 66) (FDD: 1 ≤ N ≤ 33) | 25 | 21 | 0 | -4 |
| 4 | 4L | 68 × N (TDD: 1 ≤ N ≤ 41) (FDD: 1 ≤ N ≤ 33) | N × 30 (TDD: 1 ≤ N ≤ 41) (FDD: 1 ≤ N ≤ 33) | 27 | 23 | 0 | -4 |
| 5 | 4H | 105 × N (1 ≤ N ≤ 25) | N × 30 (1 ≤ N ≤ 25) | 30 | 26 | -2 | -6 |
| 6 | 5LB | 126 × N (1 ≤ N ≤ 25) | N × 30 (ACCP) (1 ≤ N ≤ 25) | 33,5 | 29,5 | -6 | -10 |
| | 5LA | 126 × N (1 ≤ N ≤ 25) | N × 30 (ACAP) (1 ≤ N ≤ 25) | 33,5 | 29,5 | +3 | -1 |
| 7 | 5HB | 147 × N (1 ≤ N ≤ 16) | N × 30 (ACCP) (1 ≤ N ≤ 16) | 37 | 33 | -3 | -7 |
| | 5HA | 147 × N (1 ≤ N ≤ 16) | N × 30 (ACAP) (1 ≤ N ≤ 16) | 37 | 33 | +6 | +2 |
| 8 | 6LB | 168 × N (1 ≤ N ≤ 16) | N × 30 (ACCP) (1 ≤ N ≤ 16) | 40,5 | 36,5 | 0 | -4 |
| | 6LA | 168 × N (1 ≤ N ≤ 16) | N × 30 (ACAP) (1 ≤ N ≤ 16) | 40,5 | 36,5 | +9 | +5 |

## I.5 Minimum antenna gain

Equipment with *integral* antenna or *dedicated antenna* shall be associated to a directional antenna with a minimum *nominal gain* (see definition in ETSI EN 302 217-1 [5]) of 30 dBi.

When equipment is supplied without antenna see also informative annex Q.

# Annex J (normative): Frequency bands from 71 GHz to 86 GHz

# J.1 Introduction

In this frequency band, CEPT ECC/REC(05)07 [i.23] recognizes that, due to the negligible Oxygen absorption attenuation, the conventional link-by-link planning may be profitably applied (typically for FDD only) improving the spectrum usage. However, a number of administrations apply simplified licensing procedures based on self-planning or simple station notification.

Both FDD and TDD applications are covered in this annex.

The frequency bands are from 71 GHz to 76 GHz and 81 GHz to 86 GHz, which, for FDD, are typically coupled as go-return bands, with 10 GHz duplex separation, as reported in CEPT ECC/REC(05)07 [i.23] and Recommendation ITU-R F.2006-0 [i.58].

However, those recommendations provide also the option of using the bands 71 GHz to 76 GHz and 81 GHz to 86 GHz as a separate single bands containing internal 2,5 GHz duplex separation.

According to that recommendation administrations may choose either to allow assignments in this band without a specific channel arrangement, or establish arrangements based on aggregation of basic frequency slots arrangement.

This annex refers to systems based on:

- CS = 62,5 MHz or 125 MHz;
- CS = n × 250 MHz, with $1 \leq n \leq 8$.

Systems not designed according the above CS granularity should refer to the CS closest to their *occupied bandwidth*.

The requirements in this annex cover a variety of equipment that, depending on the channel arrangements adopted by the local administrations (according to clause J.2.1 and table J.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according to clause J.2.2 and table J.2).

# J.2 General characteristics

## J.2.1 Frequency characteristics and channel arrangements

The present clause contains, for information only, published ITU-R and ECC (formerly CEPT/ERC) recommendations dealing with frequency channel arrangements pertinent to the frequency range considered in the present annex.

Table J.1 summarizes the references of those recommendations known at the date of publication of the present document.

The channel arrangement in itself is not relevant to article 3.2 of Directive 2014/53/EU [i.1] requirements; only the frequency band(s) and actual channel separation are relevant and are used for defining, in the next clauses, the set of parameters and test suites relevant to each system designed for that channel separation and that frequency band.

Other national or future ITU-R or ECC recommendations (see note) set around the rough boundary of present ITU-R or ECC recommendations are considered applicable to systems assessed against the present document, provided that they use the same channel separation.

For assessment of wide-band coverage systems see annex O.

NOTE: In some case block assignment may also be applied; in such case additional "licensing conditions" (e.g. block edges masks) might be required by local administrations.

**Table J.1: Frequency characteristics**

| Band (GHz) | Frequency range (GHz) | Channel separation (MHz) (see note 1) | Recommendations for radio frequency channel arrangements | |
|---|---|---|---|---|
| | | | CEPT/ECC Recommendation | ITU-R Recommendation |
| 70 | 71,0 to 76,0 | 62,5, 125<br>250 to 2 250 (9 × 250) | (05)07 [i.23] | F.2006-0 [i.58] |
| 80 | 81,0 to 86,0 | | | |
| 70<br>paired with<br>80 | 71,0 to 76,0<br>paired with<br>81,0 to 86,0 | 62,5, 125<br>250 to 4 500 (18 × 250) | | |
| 70 (upper part)<br>paired with<br>80 (upper part)<br>(see note 2) | 74,0 to 76,0<br>paired with<br>84,0 to 86,0 | 62,5, 125<br>250 to 1 750 (7 × 250) | | |
| 70 and 80 | 71,0 to 76,0<br>and<br>81,0 to 86,0 | Free (see note 3) | | |
| 70 and 80 | 71,0 to 76,0<br>and<br>81,0 to 86,0 | Block (see note 3) | | |

NOTE 1: The present document provides system parameters only up to 2 000 MHz.
NOTE 2: Typically used in countries where the lower part of the two bands are allocated to military applications.
NOTE 3: See the note in clause J.2.1.

## J.2.2 Transmission capacities

Table J.2 gives the minimum RIC as function of spectral efficiency class and CS 62,5 MHz, 125 MHz and wider CS based on N × 250 MHz arrangement.

**Table J.2: Minimum RIC transmission capacity and system classes for various channel separation**

| Channel separation (MHz) → | | | 62,5 | 125 | 250 | 500 | 750 | 1 000 | 1 250 | 1 500 | 1 750 | 2 000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum payload RIC rate Mbit/s (note 2) | Spectral efficiency ↓ | | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ | ↓↓ |
| | Reference index | Class | | | | | | | | | | |
| | 1 | 1 | 35 | 71 | 142 | 285 | 427 | 570 | 712 | 855 | 997 | 1 140 (note 1) |
| | 2 | 2 | 71 | 142 | 285 | 570 | 855 | 1 140 (note 1) | 1 425 | 1 710 | 1 995 | 2 280 (note 1) |
| | 3 | 3 | 106 | 212 | 425 | 850 | 1 275 | 1 700 | 2 125 (note 1) | 2 550 | 2 975 | 3 400 |
| | 4 | 4L | 142 | 285 | 570 | 1 140 (note 1) | 1 710 | 2 280 (note 1) | 2 850 | 3 420 | 3 990 | 4 560 |
| | 5 | 4H | 219 | 438 | 875 | 1 750 | 2 625 | 3 500 | 4 375 (note 1) | 5 250 (note 1) | 6 125 (note 1) | 7 000 |
| | 6 | 5LA/5LB | 262 | 525 | 1 050 (note 1) | 2 100 (note 1) | 3 150 (note 1) | 4200 (note 1) | 5 250 (note 1) | 6 300 (note 1) | 7 350 (note 1) | 8 400 (note 1) |
| | 7 | 5HA/5HB | 306 | 612 | 1 225 | 2 450 | 3 675 | 4 900 | 6 125 (note 1) | 7 350 (note 1) | 8 575 (note 1) | 9 800 |
| | 8 | 6LA/6LB | 350 | 700 | 1 400 | 2 800 | 4 200 (note 1) | 5 600 (note 1) | 7 000 | 8 400 (note 1) | 9 800 | 11 200 (note 1) |

NOTE 1: These required RIC values are calculated from the general rule in table 1 of clause 4.1.2; they may be rounded down to closest multiple of 1 Gbit/s rate. This for not imposing an additional 1000Base-T interface for covering a relatively small residual RIC capacity for reaching the calculated minimum RIC.
NOTE 2: For equipment assessment with different base band interfaces see annex N.

# J.3 Transmitter

## J.3.1 General requirements

Table J.3 summarizes the TX requirements.

**Table J.3: Transmitter requirements**

| Requirements | Limits |
|---|---|
| **Transmitter maximum power and EIRP** | Clause 4.2.1.1 and I.3.2.1 |
| **Transmitter combined nominal output power and EIRP limits** | Clause J.3.2.2.1 or clause J.3.2.2.2 |
| **Transmitter output power environmental variation** | Clause 4.2.1.3 |
| **Transmitter power and frequency control (RTPC/ATPC and RFC)** | Clause 4.2.2 |
| **Transmitter Radio Frequency spectrum mask** | Clause 4.2.3.2 and clause J.3.3 |
| **Transmitter discrete CW components exceeding the Transmitter Radio Frequency spectrum mask limit** | Clause 4.2.4 |
| **Transmitter unwanted emissions in the spurious domain** | Clause 4.2.5 |
| **Transmitter dynamic Change of Modulation Order** | Clause 4.2.6 |
| **Transmitter Radio Frequency tolerance** | Clause 4.2.7 |
| **Transmitter emission limitations outside the allocated band** | Clause J.3.4 |

## J.3.2 Transmitter power and EIRP limits

### J.3.2.1 Transmitter maximum power and EIRP

CEPT ECC/REC(05)07 [i.23] does not fix any limit for the bands 71 GHz to 76 GHz and 81 GHz to 86 GHz; therefore, only the generic limits for terrestrial stations set in the article 21 of ITU Radio Regulations [11], reported in clause 4.2.1.1, apply.

Further emission limitations, in terms of EIRP and/or Pout and/or antenna gain, might be present on a national basis.

### J.3.2.2 Transmitter Combined nominal output power and EIRP limits

#### J.3.2.2.0 Generality

In addition to the limits given in clause I.3.2.1, which shall never to be exceeded, in order of safeguarding a fair and efficient use of the spectrum, maximum *nominal output power* (Pout) and *nominal EIRP* emissions (referred in clause 4.2.1.2) of equipment in the scope of the present document shall be limited as in following clauses J.3.2.2.1 and J.3.2.2.2 as function of the *nominal antenna gain* ($G_{ant}$).

#### J.3.2.2.1 Equipment without ATPC as permanent feature

These are equipment that, even if ATPC is implemented, it can be freely enabled, disabled and/or preset by the user.

- **Equipment with integral antenna or *dedicated antennas***

  1a) EIRP limit (dBm) $\leq$ +85 (see [11] article 21) for $G_{ant} \geq 55$ dBi.
  $\leq +85 - (55 - G_{ant})$ for $55 \text{ dBi} > G_{ant} \geq 45$ dBi.
  $\leq +75 - 2 \times (45 - G_{ant})$ for $45 \text{ dBi} > G_{ant} \geq 30$ dBi.

  2a) Minimum $G_{ant}$ (dBi) $\geq 30$.

The above limitations automatically imply (see figure J.1) also a limit to the maximum Pout:

3a) Pout (dBm) $\leq G_{ant}$ - 15 for 30 dBi $\leq G_{ant}$ < 45 dBi.
$\leq$ +30 for 45 dBi $\leq G_{ant}$ < 55 dBi.
$\leq$ +85 - $G_{ant}$ for $G_{ant} \geq$ 55 dBi.

- **Equipment offering external antenna connectors (see note)**

For equipment offering only an external antenna connectors (i.e. fitted for the use of a *stand alone antenna*) the above limitations should be translated in terms of range of antenna gain that the manufacturer should state for the use with the equipment (see note) for not exceeding the above EIRP limitations, i.e.:

1b) Minimum $G_{ant}$ (dBi) $\geq$ Pout (dBm) + 15; or
$\geq$ 30 (whichever is the greater).

2b) Maximum $G_{ant}$ (dBi) $\leq$ 85 - Pout (dBm).

3b) Pout (dBm) $\leq$ +30

NOTE: For information only: it is assumed that the above information on antenna gain range, not specifically relevant to article 3.2 of Directive 2014/53/EU [i.1], is supplied in the user instructions as specified in article 10.8 of Directive 2014/53/EU [i.1] (see also informative annex Q).

The above limitations are visually represented in figure J.1 and figure J.2 (solid lines).

## J.3.2.2.2 Equipment implementing ATPC as permanent feature

With the term "permanent feature" it shall be intended that ATPC cannot be disabled by the user or, whenever it is possible, the maximum output power delivered, in any conditions, cannot be set to a value exceeding clause J.3.2.2 provisions 1a, 2a and 3a (or 1b, 2b and 3b as appropriate). More information on the use of ATPC may be found in ETSI TR 103 103 [i.32].

Equipment implementing ATPC as a permanent feature, linearly activated by the drop of RSL in the corresponding far end receiver, should respect the following limitations:

- **Equipment with integral antennas or *dedicated antennas***

EIRP and Pout in full power ATPC regime:

$1a_{ATPC}$) EIRP (dBm) $\leq$ +35+ $G_{ant}$ (dBi); or
$\leq$ +85 dBm (whichever is the lower).

$2a_{ATPC}$) Minimum $G_{ant}$ (dBi) $\geq$ 30.

The above limitations automatically imply (see figure J.1) also a limit to the maximum Pout in full power ATPC regime:

$3a_{ATPC}$) Pout (dBm) $\leq$ +35 for 30dBi $\leq G_{ant}$ < 50 dBi
$\leq$ +85 - $G_{ant}$ for $G_{ant} \geq$ 50 dBi.

$4a_{ATPC}$) Minimum ATPC attenuation (dB) $\geq$ actual Pout (max delivered in full power ATPC regime) - maximum Pout (from formula 3a, clause J.3.2.2).

- **Equipment offering external antenna connectors (see note)**

For equipment offering external antenna connectors the above limitation should be translated in terms of range of antenna gain that the manufacturer shall state for the use with the equipment (see note in clause J.3.2.2.1) for not exceeding the above EIRP limitations, i.e.:

$1b_{ATPC}$) Minimum $G_{ant}$ (dBi) $\geq$ Pout (dBm) + 15; or
$\geq$ 30 (dBi) (whichever is the greater)
where Pout is intended as the maximum delivered by ATPC regime in unfaded condition.

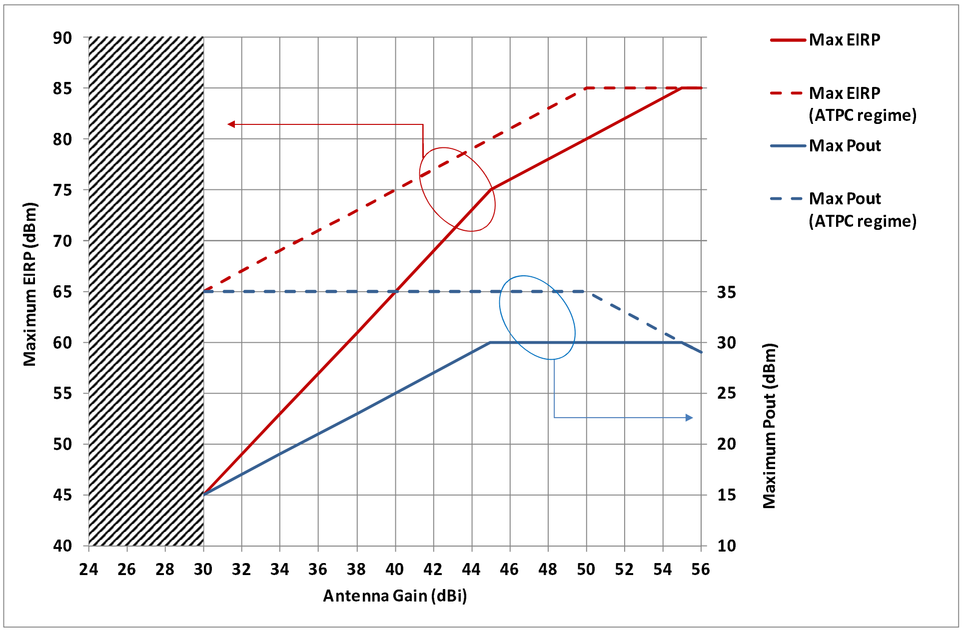
$2b_{ATPC}$) Maximum $G_{ant}$ (dBi) ≤ 85 - Pout (dBm)
where Pout is intended as the maximum delivered in full power ATPC regime.

$3b_{ATPC}$) Pout (dBm) ≤ +30 (ATPC regime in unfaded conditions) (see note)
≤ +35 (full power ATPC regime) (see note).

$4b_{ATPC}$) Minimum ATPC attenuation (dB) ≥ actual Pout (max delivered in full power ATPC regime) -
- maximum Pout (from formula 3a, clause J.3.2.2) (see note).

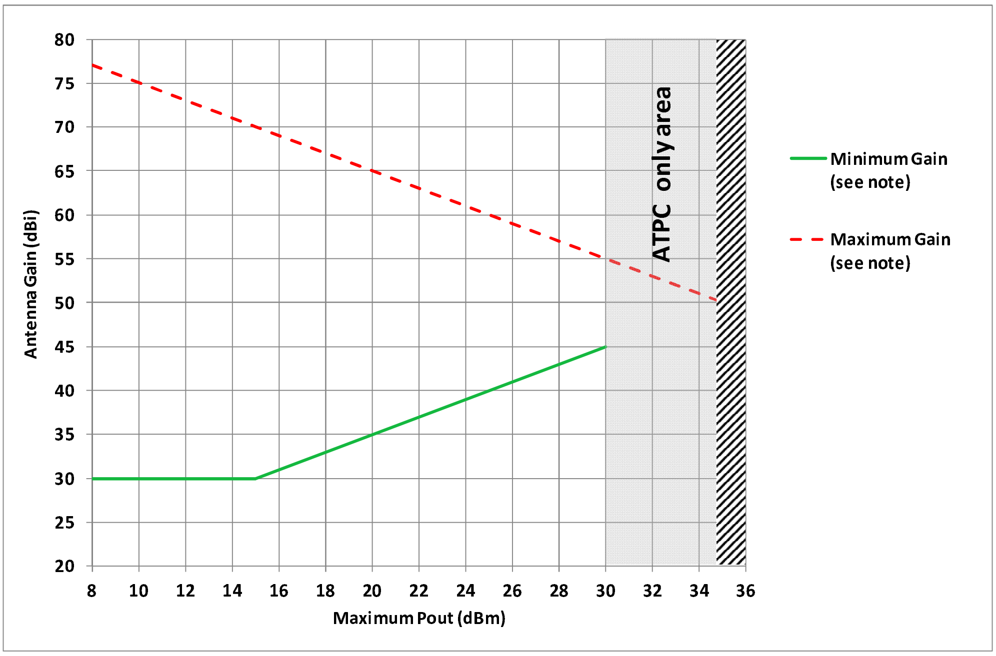
NOTE: For information only: should be considered that the Pout limits are generic maximum, but, when coupled with actual antenna within minimum/maximum $G_{ant}$ range described in formulas $1b_{ATPC}$ and $2b_{ATPC}$, this implies that the limitations expressed in formula 3a (clause I.3.2.2.1) for the Pout in unfaded conditions and in formula $3a_{ATPC}$ (present clause) for the Pout in ATPC regime are also satisfied. In particular, if the formula $4b_{ATPC}$ (present clause) cannot be satisfied with the minimum $G_{ant}$ (30 dBi) a suitably higher minimum $G_{ant}$ or a reduced full power in ATPC regime should be prescribed (see also note in clause J.3.2.2.1).

The above limitations are also visually represented in figure J.1 and figure J.2 (dashed lines).




NOTE: For equipment with permanent ATPC feature, these are intended the maximum Pout and EIRP delivered by the ATPC regime in unfaded conditions.

**Figure J.1: Graphical relationship among EIRP limitation, antenna gain and output power**




NOTE: For equipment with permanent ATPC feature, the minimum gain is intended evaluated with the maximum Pout delivered by the ATPC regime in unfaded condition, while the maximum gain is intended evaluated with the maximum Pout in full power ATPC regime (see example).

EXAMPLE: A system with permanent ATPC operating between +18 dBm (ATPC regime in unfaded condition) and +32 dBm (full power ATPC regime) may be connected to any antenna with 33 ≤ $G_{ant}$ (dBi) ≤ 53.

**Figure J.2: Graphical relationship between actual maximum output power and possible range of antenna gain for matching the EIRP limits (applicable to equipment with external antenna connector)**

## J.3.3 Transmitter Radio Frequency spectrum masks

The appropriate masks described in clause 4.2.3 for 62,5 MHz, 125 MHz or N × 250 MHz shall apply.

## J.3.4 Transmitter emissions limitations outside the 71 GHz to 76 GHz and 81 GHz to 86 GHz ranges

### J.3.4.1 General requirement

In addition, the occupied bandwidth shall remain within the specified bands 71 GHz to 76 GHz or 81 GHz to 86 GHz.

However, out-of-band emissions (i.e. those within the spectrum masks required in clause J.3.3) of systems operating close to the 71 GHz to 76 GHz band edges or 81 GHz to 86 GHz lower band edge, may still fall outside the band edges. Consequently, the output power spectral density, at antenna port, falling outside of the 71 GHz to 76 GHz band edges or below the lower band edge of 81 GHz to 86 GHz band shall be further limited to a maximum of:

- -55 dBW/MHz.

This shall not be intended as a relaxation of either the emission mask foreseen in clause J.3.3 or of the emissions in the spurious domain of clause 4.2.5.

### J.3.4.2 Requirement for emissions above 86 GHz band edge

The band 86 GHz to 92 GHz is allocated to Passive Services and, in particular to Earth Exploration Satellite Service; for their protection, as required by footnote 5.340 of ITU Radio Regulations [11], the unwanted emissions of fixed service systems shall respect, at the antenna port, the limit Provided in table 2 of ITU-R Resolution 750 [12], which formulas is graphically shown in figure J.3.

NOTE 1: See also CEPT ECC/REC(05)07 [i.23].

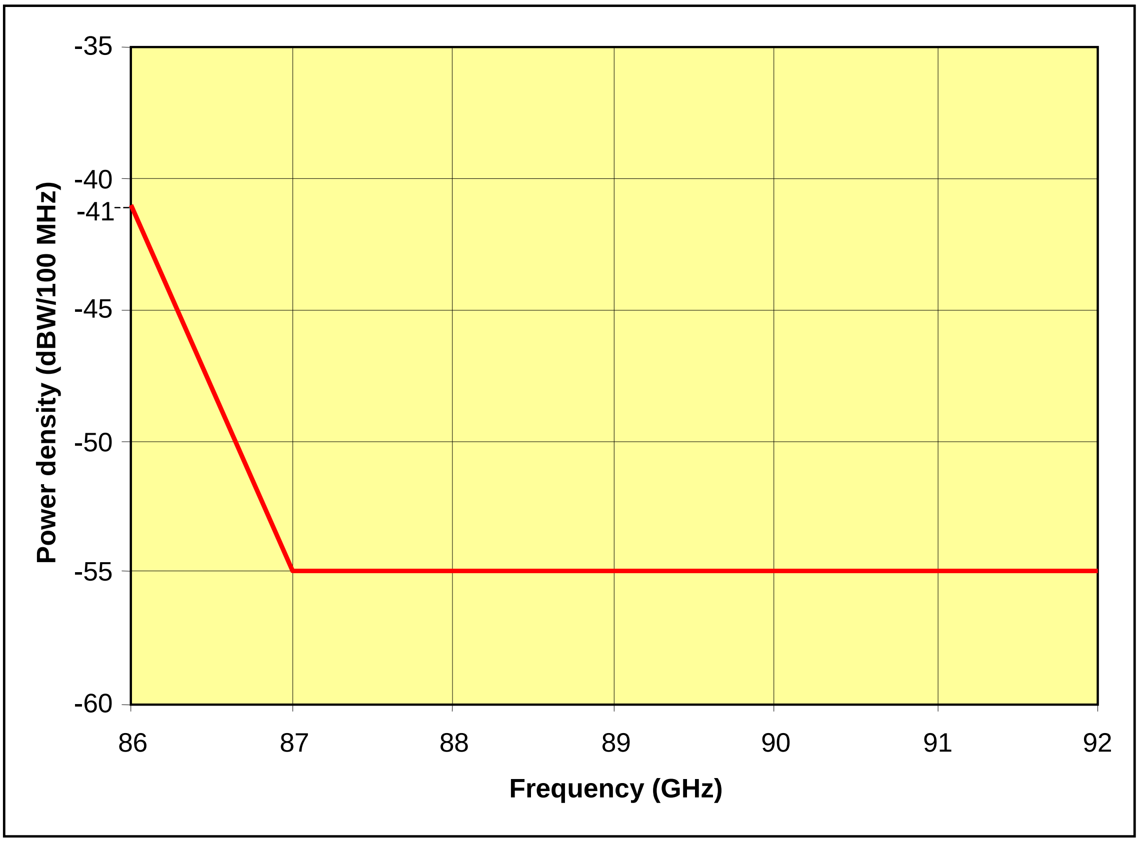



**Figure J.3: Unwanted emission power density at the antenna port**

It is intended (see CEPT ECC/REC(05)07 [i.23]) that, at the 86 GHz band edge, the first 100 MHz slot limit is centred at 86,05 GHz (see note 2).

NOTE 2: Rationale is that the requirement refers to a level in the adjacent band and it is specified with an integration (resolution) bandwidth of 100 MHz, as in the formulas in ITU-R Resolution 750 [12] the first 100 MHz testing slot should be fully within the adjacent band (i.e. centred at 50 MHz offset from the edge ).

### J.3.4.3 Conformance statement

The manufacturer shall indicate, for each system operation conditions (e.g. modulation format, bandwidth and output power) the minimum distances of the carrier centre frequency from the band edges in order to fulfil requirements in clause J.3.4.1 and clause J.3.4.2 (see note).

NOTE: It is assumed that the above information, not specifically relevant to the equipment assessment under article 3.2 of Directive 2014/53/EU [i.1], is supplied in the user instruction as foreseen in Directive 2014/53/EU [i.1].

# J.4 Receiver

## J.4.1 General requirements

Table J.4 summarizes the RX requirements.

**Table J.4: Receiver requirements**

| Requirements | Limits |
|---|---|
| **Receiver unwanted emissions in the spurious domain** | Clause 4.3.1 |
| **BER as a function of receiver input signal level (RSL)** | Table J.5 |
| **Receiver co-channel and first adjacent channel interference sensitivity** | Table J.6 |
| **Receiver second adjacent channel interference sensitivity** | Clause 4.3.3.2.3 |
| **Receiver Blocking (CW spurious interference sensitivity)** | Clause 4.3.3.3 |

## J.4.2 BER as a function of Receiver input Signal Level (RSL)

The manufacturer shall declare, according to clause 4.3.2, the RSL threshold(s) (dBm) for the relevant BER values (i.e. $10^{-6}$ and $10^{-10}$), which shall not be worse than the corresponding RSL upper bound values indicated in the table J.5. The above declared Receiver Signal levels shall produce a BER of either $\leq 10^{-6}$ or $\leq 10^{-10}$ as required.

NOTE: RSL values (in terms of noise figure and S/N for BER=$10^{-6}$), evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.28] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [5].

**Table J.5: BER as a function of receiver input signal level RSL (upper bound of declared limit)**

| Spectral efficiency | | Min. RIC rate (Mbit/s) (note 1) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
|---|---|---|---|---|---|
| Reference index | Class | | | | |
| 1 | 1 | 35 | 62,5 | -72 | -70 |
| | | 71 | 125 | -69 | -67 |
| | | 142 | 250 | -66 | -64 |
| | | 285 | 500 | -63 | -61 |
| | | 427 | 750 | -61 | -59 |
| | | 570 | 1 000 | -60 | -58 |
| | | 712 | 1 250 | -59 | -57 |
| | | 855 | 1 500 | -58 | -56 |
| | | 997 | 1 750 | -57,5 | -55,5 |
| | | 1 140 | 2 000 | -57 | -55 |
| 2 | 2 | 71 | 62,5 | -70 | -68 |
| | | 142 | 125 | -67 | -65 |
| | | 285 | 250 | -64 | -62 |
| | | 570 | 500 | -61 | -59 |
| | | 855 | 750 | -59 | -57 |
| | | 1 140 | 1 000 | -58 | -56 |
| | | 1 425 | 1 250 | -57 | -55 |
| | | 1 710 | 1 500 | -56 | -54 |
| | | 1 995 | 1 750 | -55,5 | -53,5 |
| | | 2 280 | 2 000 | -55 | -53 |
| 3 | 3 | 106 | 62,5 | -67 | -65 |
| | | 212 | 125 | -64 | -62 |
| | | 425 | 250 | -61 | -59 |
| | | 850 | 500 | -58 | -56 |
| | | 1 275 | 750 | -56 | -54 |
| | | 1 700 | 1 000 | -55 | -53 |
| | | 2 125 | 1 250 | -54 | -52 |
| | | 2 550 | 1 500 | -53 | -51 |
| | | 2 975 | 1 750 | -52,5 | -50,5 |
| | | 3 400 | 2 000 | -52 | -50 |

| Spectral efficiency | | Min. RIC rate (Mbit/s) (note 1) | Channel separation (MHz) | RSL for BER ≤ $10^{-6}$ (dBm) | RSL for BER ≤ $10^{-10}$ (dBm) |
|---|---|---|---|---|---|
| Reference index | Class | | | | |
| 4 | 4L | 142 | 62,5 | -64,5 | -60,5 |
| | | 285 | 125 | -61,5 | -57,5 |
| | | 570 | 250 | -58,5 | -54,5 |
| | | 1 140 | 500 | -55,5 | -51,5 |
| | | 1 710 | 750 | -53,5 | -49,5 |
| | | 2 280 | 1 000 | -52,5 | -48,5 |
| | | 2 850 | 1 250 | -51,5 | -47,5 |
| | | 3 420 | 1 500 | -50,5 | -46,5 |
| | | 3 990 | 1 750 | -50 | -46 |
| | | 4 560 | 2 000 | -49,5 | -45,5 |
| 5 | 4H | 219 | 62,5 | -61 | -57 |
| | | 438 | 125 | -58 | -54 |
| | | 875 | 250 | -55 | -51 |
| | | 1 750 | 500 | -52 | -48 |
| | | 2 625 | 750 | -50 | -46 |
| | | 3 500 | 1 000 | -49 | -45 |
| | | 4 375 | 1 250 | -48 | -44 |
| | | 5 250 | 1 500 | -47 | -43 |
| | | 6 125 | 1 750 | -46,5 | -42,5 |
| | | 7 000 | 2000 | -46 | -42 |
| 6 | 5LA/5LB | 262 | 62,5 | -57,5 | -53,5 |
| | | 525 | 125 | -54,5 | -50,5 |
| | | 1 050 | 250 | -51,5 | -47,5 |
| | | 2 100 | 500 | -48,5 | -44,5 |
| | | 3 150 | 750 | -46,5 | -42,5 |
| | | 4 200 | 1 000 | -45,5 | -41,5 |
| | | 5 250 | 1 250 | -44,5 | -40,5 |
| | | 6 300 | 1 500 | -43,5 | -39,5 |
| | | 7 350 | 1 750 | -43 | -39 |
| | | 8 400 | 2 000 | -42,5 | -38,5 |
| 7 | 5HA/5HB | 306 | 62,5 | -54 | -50 |
| | | 612 | 125 | -51 | -47 |
| | | 1 225 | 250 | -48 | -44 |
| | | 2 450 | 500 | -45 | -41 |
| | | 3 675 | 750 | -43 | -39 |
| | | 4 900 | 1 000 | -42 | -38 |
| | | 6 125 | 1 250 | -41 | -37 |
| | | 7 350 | 1 500 | -40 | -36 |
| | | 8 575 | 1 750 | -39,5 | -35,5 |
| | | 9 800 | 2 000 | -39 | -35 |
| 8 | 6LA/6LB | 350 | 62,5 | -50 | -46 |
| | | 700 | 125 | -47 | -43 |
| | | 1 400 | 250 | -44 | -40 |
| | | 2 800 | 500 | -41 | -37 |
| | | 4 200 | 750 | -39 | -35 |
| | | 5 600 | 1 000 | -38 | -34 |
| | | 7 000 | 1 250 | -37 | -33 |
| | | 8 400 | 1 500 | -36 | -32 |
| | | 9 800 | 1 750 | -35,5 | -31,5 |
| | | 11 200 | 2 000 | -35 | -31 |

NOTE 1: See note 1 in table J.2 for possible RIC rounding down.

NOTE 2: For *multiple-channels-port* of *channels-aggregation* equipment, in the event that a "passive" device splitting received signals into separate receiver chains is integrated in the equipment, the RSL thresholds will be increased by the combining device loss (e.g. 3 dB for a hybrid coupler).

## J.4.3 Receiver co-channel and first adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and first adjacent channel interference shall be as in table J.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared, according to clause 4.3.2, for BER ≤ $10^{-6}$ in clause J.4.2.

**Table J.6: Co-channel and first adjacent channel interference sensitivity**

| Spectral efficiency | | Min. RIC rate (Mbit/s) (note) | Channel separation (MHz) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| Reference index | Class | | | Co-channel interference | | First adjacent channel interference | |
| | | | | 1 dB | 3 dB | 1 dB | 3 dB |
| 1 or 2 | 1 or 2 | 35 or 71 | 62,5 | 23 | 19 | 0 | -4 |
| | | 71 or 142 | 125 | | | | |
| | | 142 or 285 | 250 | | | | |
| | | 285 or 570 | 500 | | | | |
| | | 427 or 855 | 750 | | | | |
| | | 570 or 1 140 | 1 000 | | | | |
| | | 712 or 1 425 | 1 250 | | | | |
| | | 855 or 1 710 | 1 500 | | | | |
| | | 997 or 1 995 | 1 750 | | | | |
| | | 1 140 or 2 280 | 2 000 | | | | |
| 3 | 3 | 106 | 62,5 | 25 | 21 | 0 | -4 |
| | | 212 | 125 | | | | |
| | | 425 | 250 | | | | |
| | | 850 | 500 | | | | |
| | | 1 275 | 750 | | | | |
| | | 1 700 | 1 000 | | | | |
| | | 2 125 | 1 250 | | | | |
| | | 2 550 | 1 500 | | | | |
| | | 2 975 | 1 750 | | | | |
| | | 3 400 | 2 000 | | | | |
| 4 | 4L | 142 | 62,5 | 27 | 23 | 0 | -4 |
| | | 285 | 125 | | | | |
| | | 570 | 250 | | | | |
| | | 1 140 | 500 | | | | |
| | | 1 710 | 750 | | | | |
| | | 2 280 | 1 000 | | | | |
| | | 2 850 | 1 250 | | | | |
| | | 3 420 | 1 500 | | | | |
| | | 3 990 | 1 750 | | | | |
| | | 4 560 | 2 000 | | | | |
| 5 | 4H | 219 | 62,5 | 30 | 26 | -2 | -6 |
| | | 438 | 125 | | | | |
| | | 875 | 250 | | | | |
| | | 1 750 | 500 | | | | |
| | | 2 625 | 750 | | | | |
| | | 3 500 | 1 000 | | | | |
| | | 4 375 | 1 250 | | | | |
| | | 5 250 | 1 500 | | | | |
| | | 6 125 | 1 750 | | | | |
| | | 7 000 | 2 000 | | | | |

| Spectral efficiency | | Min. RIC rate (Mbit/s) (note) | Channel separation (MHz) | C/I for BER ≤ $10^{-6}$ RSL degradation of 1 dB or 3 dB | | | |
|---|---|---|---|---|---|---|---|
| **Reference index** | **Class** | | | **Co-channel interference** | | **First adjacent channel interference** | |
| | | | | **1 dB** | **3 dB** | **1 dB** | **3 dB** |
| 6 | 5LB | 262 | 62,5 (ACCP) | 33,5 | 29,5 | -6 | -10 |
| | | 525 | 125 (ACCP) | | | | |
| | | 1 050 | 250 (ACCP) | | | | |
| | | 2 100 | 500 (ACCP) | | | | |
| | | 3 150 | 750 (ACCP) | | | | |
| | | 4 200 | 1 000 (ACCP) | | | | |
| | | 5 250 | 1 250 (ACCP) | | | | |
| | | 6 300 | 1 500 (ACCP) | | | | |
| | | 7 350 | 1 750 (ACCP) | | | | |
| | | 8 400 | 2 000 (ACCP) | | | | |
| | 5LA | 262 | 62,5 (ACAP) | 33,5 | 29,5 | +3 | -1 |
| | | 525 | 125 (ACAP) | | | | |
| | | 1 050 | 250 (ACAP) | | | | |
| | | 2 100 | 500 (ACAP) | | | | |
| | | 3 150 | 750 (ACAP) | | | | |
| | | 4 200 | 1 000 (ACAP) | | | | |
| | | 5 250 | 1 250 (ACAP) | | | | |
| | | 6 300 | 1 500 (ACAP) | | | | |
| | | 7 350 | 1 750 (ACAP) | | | | |
| | | 8 400 | 2 000 (ACAP) | | | | |
| 7 | 5HB | 306 | 62,5 (ACCP) | 37 | 33 | -3 | -7 |
| | | 612 | 125 (ACCP) | | | | |
| | | 1 225 | 250 (ACCP) | | | | |
| | | 2 450 | 500 (ACCP) | | | | |
| | | 3 675 | 750 (ACCP) | | | | |
| | | 4 900 | 1 000 (ACCP) | | | | |
| | | 6 125 | 1 250 (ACCP) | | | | |
| | | 7 350 | 1 500 (ACCP) | | | | |
| | | 8 575 | 1 750 (ACCP) | | | | |
| | | 9 800 | 2 000 (ACCP) | | | | |
| | 5HA | 306 | 62,5 (ACAP) | 37 | 33 | +6 | +2 |
| | | 612 | 125 (ACAP) | | | | |
| | | 1 225 | 250 (ACAP) | | | | |
| | | 2 450 | 500 (ACAP) | | | | |
| | | 3 675 | 750 (ACAP) | | | | |
| | | 4 900 | 1 000 (ACAP) | | | | |
| | | 6 125 | 1 250 (ACAP) | | | | |
| | | 7 350 | 1 500 (ACAP) | | | | |
| | | 8 575 | 1 750 (ACAP) | | | | |
| | | 9 800 | 2 000 (ACAP) | | | | |
| 8 | 6LB | 350 | 62,5 (ACCP) | 40,5 | 36,5 | 0 | -4 |
| | | 700 | 125 (ACCP) | | | | |
| | | 1 400 | 250 (ACCP) | | | | |
| | | 2 800 | 500 (ACCP) | | | | |
| | | 4 200 | 750 (ACCP) | | | | |
| | | 5 600 | 1 000 (ACCP) | | | | |
| | | 7 000 | 1 250 (ACCP) | | | | |
| | | 8 400 | 1 500 (ACCP) | | | | |
| | | 9 800 | 1 750 (ACCP) | | | | |
| | | 11 200 | 2 000 (ACCP) | | | | |
| | 6LA | 350 | 62,5 (ACAP) | 40,5 | 36,5 | +9 | +5 |
| | | 700 | 125 (ACAP) | | | | |
| | | 1 400 | 250 (ACAP) | | | | |
| | | 2 800 | 500 (ACAP) | | | | |
| | | 4 200 | 750 (ACAP) | | | | |
| | | 5 600 | 1 000 (ACCP) | | | | |
| | | 7 000 | 1 250 (ACCP) | | | | |
| | | 8 400 | 1 500 (ACCP) | | | | |
| | | 9 800 | 1 750 (ACCP) | | | | |
| | | 11 200 | 2 000 (ACCP) | | | | |
| NOTE: See note 1 in table J.2 for possible RIC rounding down. | | | | | | | |

# J.5 Minimum antenna gain

Equipment with *integral* antenna or *dedicated antenna* shall be associated to a directional antenna with a minimum *nominal gain* (see definition in ETSI EN 302 217-1 [5]) of 30 dBi.

When equipment is supplied without antenna see also informative annex Q.

# Annex K:
Void

# Annex L:
# Void

# Annex M:
# Void

# Annex N (normative): Definition of equivalent data rates for packet data, PDH/SDH and other signals on the traffic interface

# N.1 Introduction

This annex provides the conditions under which the BER oriented specifications can be used for systems with traffic interface other than PDH/SDH.

# N.2 General characteristics

## N.2.1 Frequency characteristics and channel arrangements

The equipment shall operate on frequency bands and channels arrangements in accordance with the information provided, for the selected spectral efficiency class, in the main body and the relevant annexes from B through J.

## N.2.2 Transmission capacities

Table N.1a to table N.1h show the minimum Radio Interface Capacity (RIC) required for the assessment of radio systems in the scope of the present document. All spectral efficiency classes are listed even if for some cases the relevant system parameters are not presently provided in the present document. In some other cases, minimum equivalent PDH/SDH rates are not defined.

The minimum RIC values for each CS are derived from the minimum RIC density values given in table 1 of the main body of the present document rounded down to closer suitable values. The RIC density is defined as the RIC per unit bandwidth, Mbit/s/MHz.

The minimum RIC is valid when the system is not exclusively offering PDH or SDH interface combinations; table N.1a through table N.1h, valid for CS 1,75 MHz through 112 MHz, give also the minimum transmission capacity in terms of the number of equivalent 2,048 Mbit/s PDH streams that shall be transported either aggregated into higher PDH/SDH hierarchy or as separate streams, directly multiplexed into the proprietary radio frame. The shown hierarchic aggregated interfaces are just examples offering the minimum number of 2,048 Mbit/s PDH streams, other hierarchic combinations are also possible (e.g. 3 × STM-1 plus 1 × STM-0 in place of 10 × STM-0).

It should also be noted that regulating only the minimum RIC the actual system may fulfil requirements for more than one class, provided that they are capable of meeting all the requirements, e.g. the two different spectrum masks and receiver requirements. The manufacturer may choose which class to assess.

Table N.1a to table N.1h are presented for channel separations limited to those conventionally used in the past for PDH or SDH links; more recently opened bands (typically above 57 GHz), based on channel sizes multiple/sub-multiple of basic channels (e.g. N × 50 MHz or N × 250 MHz) are not reported because unlikely used for PDH or SDH transmission. However, even if no specific equivalence tables are here defined, PDH or SDH interface combinations are possible provided that the overall RIC fulfil the relevant minimum RIC requirement reported in table H.2, table I.2 and table J.2.

**Table N.1a: Minimum RIC and equivalent PDH/SDH capacity for CS = 1,75 MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| See note | 1 | 1 | - | - |
| 2 | 2 | 2 | 1 | 2,048 |
| 3 | 3 | 3 | 2 | 2 × 2,048 |
| 4 | 4 | 4L | 2 | 2 × 2,048 |
| See note | 5 up to 11 | 4H up to 8 | - | - |
| NOTE: These classes, for this CS, are not covered in the present document. | | | | |

**Table N.1b: Minimum RIC and equivalent PDH/SDH capacity for CS = 3,5 MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| 2 (note 1) | 1 | 1 | 1 | 2,048 |
| 4 | 2 | 2 | 2 | 2 × 2,048 |
| 6 | 3 | 3 | 3 | 3 × 2,048 |
| 8 | 4 | 4L | 4 | 8,448 |
| Note 2 | 5 up to 11 | 4H up to 8 | - | - |
| NOTE 1: This class is present only for 50 GHz band.<br>NOTE 2: These classes, for this CS, are not covered in the present document. | | | | |

**Table N.1c: Minimum RIC and equivalent PDH/SDH capacity (CS = 7 MHz)**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| 4 (note 1) | 1 | 1 | 2 | 2 × 2,048 |
| 8 | 2 | 2 | 4 | 8,448 |
| 12 | 3 | 3 | 6 | 6 × 2,048 |
| 16 | 4 | 4L | 8 | 2 × 8,448 |
| 24 | 5 | 4H | 12 | 3 × 8,448 |
| 29 | 6 | 5L | 14 | 14 × 2,048 |
| 34 | 7 | 5H | 16 | 34,368 |
| 39 | 8 | 6L | 21 | STM-0 |
| Note 2 | 9 to 11 | 6H to 8 | - | - |
| NOTE 1: This class is present only for 50 GHz and higher bands.<br>NOTE 2: These classes, for this CS, are not covered in the present document. | | | | |

**Table N.1d: Minimum RIC and equivalent PDH/SDH capacity for CS = ~14 (13,75 to 15) MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| 8 (see note) | 1 | 1 | 4 | 8,448 |
| 16 | 2 | 2 | 8 | 2 × 8,448 |
| 24 | 3 | 3 | 12 | 3 × 8,448 |
| 32 | 4 | 4L | 16 | 34,368 |
| 49 | 5 | 4H | 24 or 21 (if VC12 framed) | 6 × 8,448 or STM-0 |
| 58 | 6 | 5L | 28 | 7 × 8,448 |
| 68 | 7 | 5H | 32 | 2 x 34,368 |
| 78 | 8 | 6L | 40 | 10 × 8,448 |
| 88 | 9 | 6H | 48 or 42 (if VC12 framed) | 3 x 34,368 or 2 x STM-0 |
| 98 | 10 | 7 | 52 | 13 × 8,448 |
| 107 | 11 | 8 | 56 | 14 × 8,448 |
| NOTE: This class, for this CS, are not covered in the present document. | | | | |

**Table N.1e: Minimum RIC and equivalent PDH/SDH capacity for CS = ~28 (27,5 to 30) MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| 16 (see note) | 1 | 1 | 8 | 2 × 8,448 |
| 32 | 2 | 2 | 16 | 34,368 |
| 48 | 3 | 3 | 24 or 21 (if VC12 framed) | 6 × 8,448 or STM-0 |
| 64 | 4 | 4L | 32 | 2 × 34,368 |
| 98 | 5 | 4H | 48 or 42 (if VC12 framed) | 3 × 34,368 or 2 x STM-0 |
| 117 | 6 | 5L | 56 | 14 × 8,448 |
| 137 | 7 | 5H | 64 or 63 (if VC12 framed) | 4 × 34,368 or STM-1 |
| 156 | 8 | 6L | 80 | 14 × 8,448 |
| 176 | 9 | 6H | 96 or 84 (if VC12 framed) | 6 × 34,368 or 4 x STM-0 |
| 196 | 10 | 7 | 104 | 26 × 8,448 |
| 215 | 11 | 8 | 112 or 106 (if VC12 framed) | 7 × 34,368 or 5 x STM-0 |
| NOTE: This class, for this CS, are not covered in the present document. | | | | |

**Table N.1f: Minimum RIC and equivalent PDH/SDH capacity for CS = ~56 (55 to 60) MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| 32 (see note) | 1 | 1 | 16 | 34,368 |
| 64 | 2 | 2 | 32 | 2 × 34,368 |
| 96 | 3 | 3 | 48 or 42 (if VC12 framed) | 3 × 34,368 or 2 x STM-0 |
| 128 | 4 | 4L | 64 or 63 (if VC12 framed) | 4 × 34,368 or STM-1 |
| 196 | 5 | 4H | 96 or 84 (if VC12 framed) | 6 × 34,368 or 4 x STM-0 |
| 235 | 6 | 5L | 112 or 105 (if VC12 framed) | 7 × 34,368 or 5 x STM-0 |
| 274 | 7 | 5H | 144 or 126 (if VC12 framed) | 9 × 34,368 or 2 x STM-1 |
| 314 | 8 | 6L | 160 or 147 (if VC12 framed) | 10 × 34,368 or 7 x STM-0 |
| 352 | 9 | 6H | 192 or 168 (if VC12 framed) | 12 × 34,368 or 8 x STM-0 |
| 392 | 10 | 7 | 208 or 189 (if VC12 framed) | 13 × 34,368 or 3 x STM-1 |
| 431 | 11 | 8 | 224 or 210 (if VC12 framed) | 14 × 34,368 or 10 x STM-0 |
| NOTE: This class, for this CS, is present only for 50 GHz and higher bands. | | | | |

**Table N.1g: Minimum RIC and equivalent PDH/SDH capacity for CS = ~112 (110 to 112) MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| See note | 1 | 1 | - | - |
| 128 | 2 | 2 | 64 or 63 (if VC12 framed) | 4 × 34,368 or STM-1 |
| 191 | 3 | 3 | 96 or 84 (if VC12 framed) | 6 × 34,368 or 4 x STM-0 |
| 256 | 4 | 4L | 128 or 126 (if VC12 framed) | 8 × 34,368 or 2 x STM-1 |
| 392 | 5 | 4H | 192 or 168 (if VC12 framed) | 12 × 34,368 or 8 x STM-0 |
| 470 | 6 | 5L | 240 or 210 (if VC12 framed) | 15 × 34,368 or 10 x STM-0 |
| 548 | 7 | 5H | 288 or 252 (if VC12 framed) | 18 × 34,368 or 4 x STM-1 or STM-4 |
| 627 | 8 | 6L | 320 or 294 (if VC12 framed) | 20 × 34,368 or 14 x STM-0 |
| 705 | 9 | 6H | 368 or 336 (if VC12 framed) | 23 × 34,368 or 16 x STM-0 |
| 784 | 10 | 7 | 400 or 378 (if VC12 framed) | 25 × 34,368 or 6 x STM-1 |
| 862 | 11 | 8 | 432 or 420 (if VC12 framed) | 27 × 34,368 or 20 x STM-0 |
| NOTE: This class, for this CS, are not covered in the present document. | | | | |

**Table N.1h: Minimum RIC and equivalent PDH/SDH capacity for CS = ~224 (220 to 224) MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| See note | 1 | 1 | - | - |
| 128 | 2 | 2 | 64 or 63 (if VC12 framed) | 4 × 34,368 or STM-1 |
| 191 | 3 | 3 | 96 or 84 (if VC12 framed) | 6 × 34,368 or 4 x STM-0 |
| 256 | 4 | 4L | 128 or 126 (if VC12 framed) | 8 × 34,368 or 2 x STM-1 |
| 392 | 5 | 4H | 192 or 168 (if VC12 framed) | 12 × 34,368 or 8 x STM-0 |
| 470 | 6 | 5L | 240 or 210 (if VC12 framed) | 15 × 34,368 or 10 x STM-0 |
| 548 | 7 | 5H | 288 or 252 (if VC12 framed) | 18 × 34,368 or 4 x STM-1 or STM-4 |
| 627 | 8 | 6L | 320 or 294 (if VC12 framed) | 20 × 34,368 or 14 x STM-0 |
| 705 | 9 | 6H | 368 or 336 (if VC12 framed) | 23 × 34,368 or 16 x STM-0 |
| 784 | 10 | 7 | 400 or 378 (if VC12 framed) | 25 × 34,368 or 6 x STM-1 |
| 862 | 11 | 8 | 432 or 420 (if VC12 framed) | 27 × 34,368 or 20 x STM-0 |
| NOTE: This class, for this CS, are not covered in the present document. | | | | |

**Table N.1i: Minimum RIC and equivalent PDH/SDH capacity for CS = 40 MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| (note 1) | 1 to 5 | 1 to 4H | - | - |
| 137 | 6 | 5L | 80 or 63 (if VC12 framed) | 5 × 34,368 or STM-1 |
| 137 (note 2) | 7 | 5H/28 | 80 or 63 (if VC12 framed) | 5 × 34,368 STM-1 |
| 196 | 7 | 5H | 96 or 84 (if VC12 framed) | 6 × 34,368 or 4 × STM-0 |
| 224 | 8 | 6L | 112 or 105 (if VC12 framed) | 7 × 34,368 or 5 × STM-0 |
| 252 | 9 | 6H | 128 or 126 (if VC12 framed) | 8 × 34,368 or 2 × STM-1 (note 3) |
| 280 | 10 | 7 | 144 or 126 (if VC12 framed) | 9 × 34,368 or 2 × STM-1 (note 3) |
| 308 | 11 | 8 | 160 or 147 (if VC12 framed) | 10 × 34,368 or 7 × STM-0 |
| NOTE 1: These classes, for this CS, are not covered in the present document.<br>NOTE 2: This system does not respect the minimum RIC density for their classes; however, it is also considered in the present document for commonality of more widely used technology for bands based on CS multiple of 28 MHz.<br>NOTE 3: 4 × STM-1 or STM-4 are possible coupling two systems operating over 2 × 40 MHz channels or two ACCP systems in CCDP operation on different polarization of the same 40 MHz channel. | | | | |

**Table N.1j: Minimum RIC and equivalent PDH/SDH capacity for CS = 80 MHz**

| Minimum applicable RIC (Mbit/s) | Spectral efficiency | | Minimum Equivalent PDH/SDH rates (Mbit/s) | |
|---|---|---|---|---|
| | Reference index | Class | Equivalent number of 2,048 streams | Hierarchical (example) |
| Note 1 | 1 to 5 | 1 to 4H | - | - |
| 274 (note 2) | 6 | 5L | 160 or 126 (if VC12 framed) | 10 × 34,368 or 2 × STM-1 |
| 336 | 6 | 5L | 164 or 144 (if VC12 framed) | 9 × 34,368 or 2 × STM-1 |
| 274 (note 2) | 7 | 5H/28 | 160 or 126 (if VC12 framed) | 10 × 34,368 or 2 × STM-1 |
| 392 | 7 | 5H | 192 or 168 (if VC12 framed) | 12 × 34,368 or 8 × STM-0 |
| 448 | 8 | 6L | 224 or 210 (if VC12 framed) | 14 × 34,368 or 10 × STM-0 |
| 504 | 9 | 6H | 256 or 252 (if VC12 framed) | 16 × 34,368 or 4 × STM-1 |
| 560 | 10 | 7 | 288 or 252 (if VC12 framed) | 18 × 34,368 or 4 × STM-1 |
| 616 | 11 | 8 | 320 or 294 (if VC12 framed) | 20 × 34,368 or 14 × STM-0 |
| NOTE 1: These classes, for this CS, are not covered in the present document.<br>NOTE 2: This system does not respect the minimum RIC density for their classes; however, it is also considered in the present document for commonality of more widely used technology for bands based on CS multiple of 28 MHz. | | | | |

# N.3 System parameters

## N.3.0 Introduction

There are no essential requirements under Directive 2014/53/EU [i.1] specific to the radio systems Network Interface Capacity (NIC) represented by the sum of electrical or optical base-band interface (PDH/SDH, packet data or any other kind of interface) at the reference points X/X' shown in the generic block diagram of figure 1 of ETSI EN 302 217-1 [5].

All radio requirements shall be taken from a unique appropriate set of technical parameters defined on the basis of radio frequency band, channel separation, spectral efficiency class and their associated minimum RIC requirement.

When packet data interface are provided, the manufacturer shall declare the actual Radio Interface Capacity (RIC). In addition, the Network Interface Capacity (NIC) defined at X'/X reference point of figure 1 in ETSI EN 302 217-1 [5] shall be equal to or exceed the actual Radio Interface Capacity (RIC) to allow application of a specific set of technical parameters.

## N.3.1 Transmitter

Transmitter requirements and test procedures are independent from the type of data and base-band interfaces.

## N.3.2 Receiver

All requirements for the same channel separation for the same class of equipment are applicable provided that, when packed data interfaces are provided, BER tests may be substituted by the equivalent FER as defined in clause N.3.3.

## N.3.3 FER as a function of BER

In the event that no PDH/SDH interface is available at base band level (reference points X, X' of figure 1 of ETSI EN 302 217-1 [5]), and no other means (even proprietary ones) are possible for a true bit-to-bit error count at reference point X, this clause describes how to translate the BER requirements from the PDH/SDH specification to verify compliance of the radio system when such a combination of interfaces includes (as a minimum) an Ethernet interface.

The manufacturer shall describe how to load the system with the Radio Interface Capacity (RIC), possibly using multiple interfaces. The error rates specified in the PDH/SDH specification shall be met on all traffic loading the system. The traffic may contain combinations of PDH, SDH, packet data or other signals. For Ethernet interfaces, the BER requirements in the PDH/SDH standard shall be converted to FER requirements using table N.2 (based on 64 octet frames).

**Table N.2: Conversion between Bit Error Ratio (BER) and Frame Error Ratio (FER)**

| BER | FER |
|---|---|
| $10^{-6}$ | $5 \times 10^{-4}$ |
| $10^{-8}$ | $5 \times 10^{-6}$ |
| $10^{-10}$ | $5 \times 10^{-8}$ |
| $10^{-12}$ | $5 \times 10^{-10}$ |

Automatic Repeat reQuest (ARQ) algorithms may also be used as an error correction method.

NOTE 1: Additional information with respect to the derivation of the BER/FER relationship and testing examples may be found in annex D of ETSI EN 302 217-1 [5].

NOTE 2: In the event that an Ethernet interface is not offered, but other standardized interfaces are used, the manufacturer would produce an equivalent conversion table supported by technical evidence of its appropriateness.

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

## O.1 Wide radio-frequency band covering units

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 duplexer filters are tuned to a specific channel) or offer a wider operating frequency range (e.g. wide-band RF duplexer and frequency agility through the use of a RFC function. Ease of deployment and spare parts handling by operators with large networks is facilitated where more than one channel is assigned).

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

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any conformity assessment procedure with respect to Directive 2014/53/EU [i.1], shall be carried out in the following way:

1) In the case of equipment intended for single channel operation, within a given channel arrangement, the test report shall be produced for one radio frequency channel arbitrarily chosen by the manufacturer (see figure O.1).

2) In the case of equipment intended for covering operating frequency sub-ranges (i.e. a number of pre-selectable channels within a given channel arrangement, covered without changing any hardware e.g. duplex filters), it is considered enough that one frequency sub-range is subject of testing.
The test report shall be produced:

   - For transmitter parameters summarized in table 6, for the lowest (B, bottom), intermediate (M, median) and highest (T, top) possible radio frequency channel within that operating frequency range (see figure O.2).When *channels-aggregation* (*single-band*) equipment is concerned this applies to one *aggregated channel* only, alternatively tuned to the relevant B, M and T frequency within the equipment *tuning range*; if the equipment provides *multiple-channel-ports*, such channel shall be selected among the two transmitted from one of those ports. Other *aggregated channels* shall be tested only at intermediate (M) frequency tuning;.
   In any case, the channels not under test are set as described in the relevant clauses.

   - For receiver parameters summarized in table 8, only unwanted emissions in the spurious domain-external and BER as a function of RSL parameters, for the lowest (B, bottom), intermediate (M, median) and highest (T, top) possible radio frequency channel within that operating frequency range. When *channels-aggregation* (*single-band*) equipment is concerned this applies to one *aggregated channel* only, alternatively tuned to the relevant B, M and T frequency within the equipment *tuning range*; if the equipment provides *multiple-channel-ports*, such channel shall be selected among the two transmitted from one of those ports. Other *aggregated channels* shall be tested only at intermediate (M) frequency tuning.
   In any case, the channels not under test are set as described in the relevant clauses.
   Other receiver parameters have to be tested for the intermediate radio frequency channel (M) only.

3) It is not required that all the tests, required for the test report, are made on the same sample of equipment and at the same time; provided that the test report includes all of the tests required by the present document, each test may be made on different samples of the same equipment, at different channel frequencies or frequency ranges and at different times (see note).

NOTE: In principle, all tests are carried out on the same equipment during a single test session. However, it is permitted to have different test sessions and equipment under test to allow for unpredictable events (e.g. equipment or test instrument failure during the test session that is not immediately repairable), and for any additional tests required by a future revision of the present document. This allowance is not intended as a means to circumvent failed tests without corrective actions.

When applicable the following additional provisions apply to the production of a test report:

- In the case of equipment covering 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 figure O.1 and figure O.2).
- In the case of equipment 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 the 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 figure O.1 and figure O.2).

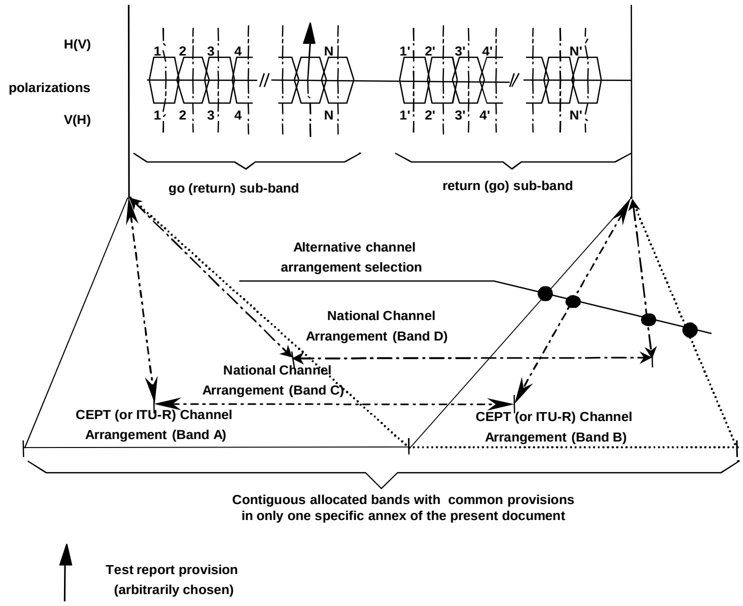



**Figure O.1: Test report frequency requirement for equipment intended for single channel operation**

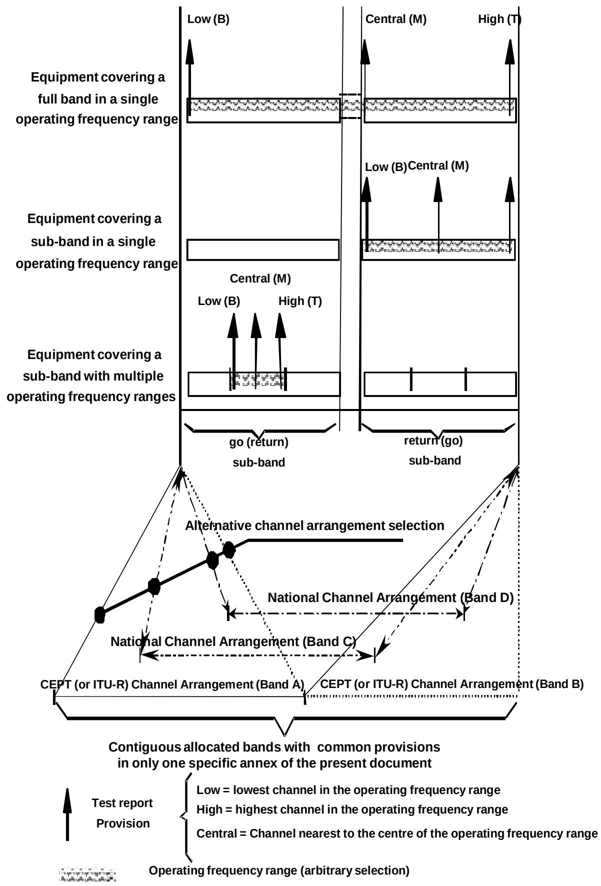



**Figure O.2: Test report frequency requirements for equipment intended for covering an operating frequency range**

# O.2 Multirate/multiformat and channel-aggregation equipment

## O.2.0 Introduction and general principles

DFRS equipment can be designed either for a unique payload and modulation format (*single-mode* systems, see note) or for covering a number of different payload rates ("*multirate"* systems, see note) or different modulation formats (i.e. different equipment classes) or different error correction codes transmitted, through software presetting or protocols, over a number of different channel separations.

In the latter case, within a certain CS, the payload and modulation presetting may offer static operation over different payload/modulation (*preset-mode* systems, see note) or dynamic operation changing payload/modulation (*mixed-mode* systems, see note) according to network requirements (e.g. propagation variations).

NOTE: As defined in ETSI EN 302 217-1 [5].

For *preset-mode* and *mixed-mode* systems the equipment shall comply with all the requirements of the present document at any possible combination of operating RIC, CS and efficiency classes declared (see note in clause O.2.1).

For *channels-aggregation* systems each *aggregated channel* shall comply with all the requirements of the present document (including those related to *preset-mode* and *mixed-mode* operation, if implemented) when all *aggregated channels* emissions are turned on and operating according to normal operating conditions within the declared operational ranges of mutual power and frequency differences (see clause 4.1.1).

## O.2.1 Generic required tests in the test report

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure with respect to Directive 2014/53/EU [i.1], shall be carried out, at each frequency channel prescribed in clause O.1, for:

- transmitter parameters summarized in table 6 at any possible CS and efficiency classes, each case should be loaded with the highest possible RIC;
- receiver parameters summarized in table 8 shall be tested only at the lowest and the highest CS for any efficiency class, each case loaded with the highest possible RIC.

*Mixed-mode* systems, besides specific Dynamic Change of Modulation Order test referred in clause 5.2.6, are to be tested, for each *Reference mode* offered only (see note), as they were *preset-mode* systems (i.e. dynamic operation in *mixed-mode* systems shall be disabled for all other tests).

NOTE: *Mixed-mode* systems might use a number of modes (e.g. BPSK/4/16/32/64/128/256/512/1024QAM) in dynamic operations but, for technical/operational convenience only few modes might be available as "*reference*" (e.g. only 4/16/128QAM are considered suitable for network performance and availability needs and/or may find suitable assessment characteristics in the present document); therefore, only the latter ones are relevant for static (*preset-mode* like) operation conformance test.

*Channels aggregation* systems, shall be tested as other single emission systems according to their mode of operation (i.e. *single-mode*, *mixed-mode* or *preset-mode*).The tests should be made on one of the *aggregated channels* with the others set in the operational condition identified in the clause 4.1.1 and clauses O.3 and O.4.

## O.2.2 Reduced set of required tests in the test report

### O.2.2.0 Introduction

*Preset-mode* and *mixed-mode* systems usually use constant, or scalable with CS, baseband processing (e.g. symbol rate, FEC typology/redundancy). This implies, de facto, that the results of many tests are also expected to have the same results scaled for CS and/or baseband processing.

Therefore, for their test report, *Preset-mode*, *mixed-mode* and *channels-aggregation* may benefit of a reduced set of required tests as described in clause O.2.2.1 and clause O.2.2.2.

### O.2.2.1 Reduced transmitter tests

Further reduction of *preset-mode* and *mixed-mode* test report complexity is permitted; transmitter parameters test report may be reduced as follows:

a) The lowest and highest efficiency class provided (*preset-mode* systems) or used as *reference-mode* (*mixed-mode* systems) should be tested, only for the lowest and the highest CS, at all three test frequency channels (B, M and T), if applicable.

b) The other modes provided (*preset-mode* systems) or used as *reference-mode* (*mixed-mode* systems), for the all CSs, only at the M frequency channel.
In addition, for these cases, the frequency range of the transmitter unwanted emission in the spurious domain test will be reduced to ±1 GHz or to the frequency band boundaries (whichever results larger) across the M test frequency.

In case one or more preset/reference modes may operate on a CS with more than one *symbol-rate* (e.g. for different error correction coding), the test shall be done with the highest *symbol-rate*.

Whenever *channels-aggregation* systems implement also *preset-mode* and *mixed-mode* as well as a multi-rate flexibility, the tests, still done according the above criteria in terms of CS and modes, shall be done with all *aggregated-channels* equally set (i.e. no mixed CS or different modes settings among the *aggregated-channels*), unless differently specified in the relevant clause.

Figure O.3 graphically shows the reduced set of tests.

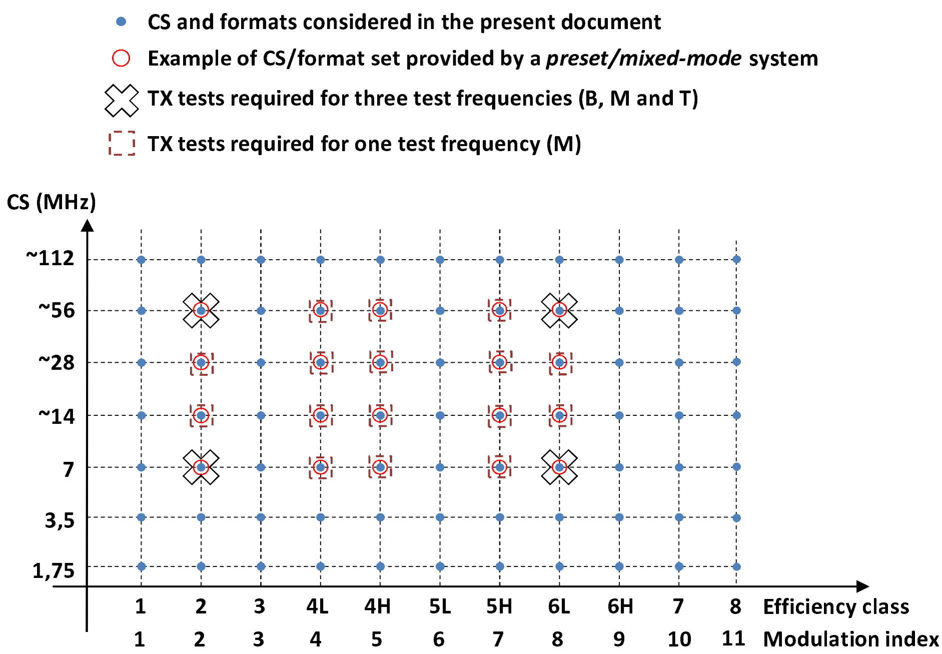



**Figure O.3: Example of *Preset/mixed-mode* systems reduced TX test report**

## O.2.2.2 Reduced receiver tests

As further permitted reduction of *preset-mode* and *mixed-mode* test report complexity, it is considered that receiver parameters can be tested, only for efficiency classes provided (*preset-mode* systems) or used as *reference-mode* (*mixed-mode* systems) as follows:

1) RX BER versus RSL (clause 4.3.2):

   1a) The lowest and highest efficiency class should be tested, only for the relevant lower and the higher CS, at all three test frequency channels (B, M and T).

2) RX unwanted emissions in the spurious domain (clause 4.3.1) further reduced only to test, at all three test frequency channels (B, M and T), for the lowest and the highest CS with the lowest efficiency class provided for those channels.

3) RX co/adjacent channel interference (clause 4.3.3.2) and Receiver Blocking (CW spurious interference sensitivity) (clause 4.3.3.3) further reduced to test:

   3a) At M test frequency channel, with the lowest and highest efficiency class only, for the lowest and the highest CS.

   3b) Receiver Blocking (CW spurious interference sensitivity) should be additionally tested also at M test frequency channel with the highest efficiency class only, for other intermediate CSs. In addition, for these cases, the frequency range of the test will be reduced to ±1 GHz or to the frequency band boundaries (whichever results larger) across the M test frequency.

In case one or more preset/reference modes may operate on a CS with more than one *symbol-rate* (e.g. for different error correction coding), the test shall be done with the highest *symbol-rate*.

Whenever *channels-aggregation* systems implement also *preset-mode* and *mixed-mode* as well as a *multi-rate* flexibility, the tests, still done according the above criteria in terms of CS and modes, shall be done with all *aggregated-channels* equally set (i.e. no mixed CS or different modes settings among the *aggregated-channels*), unless differently specified in the relevant clause.

Figure O.4 graphically shows the reduced set of tests.

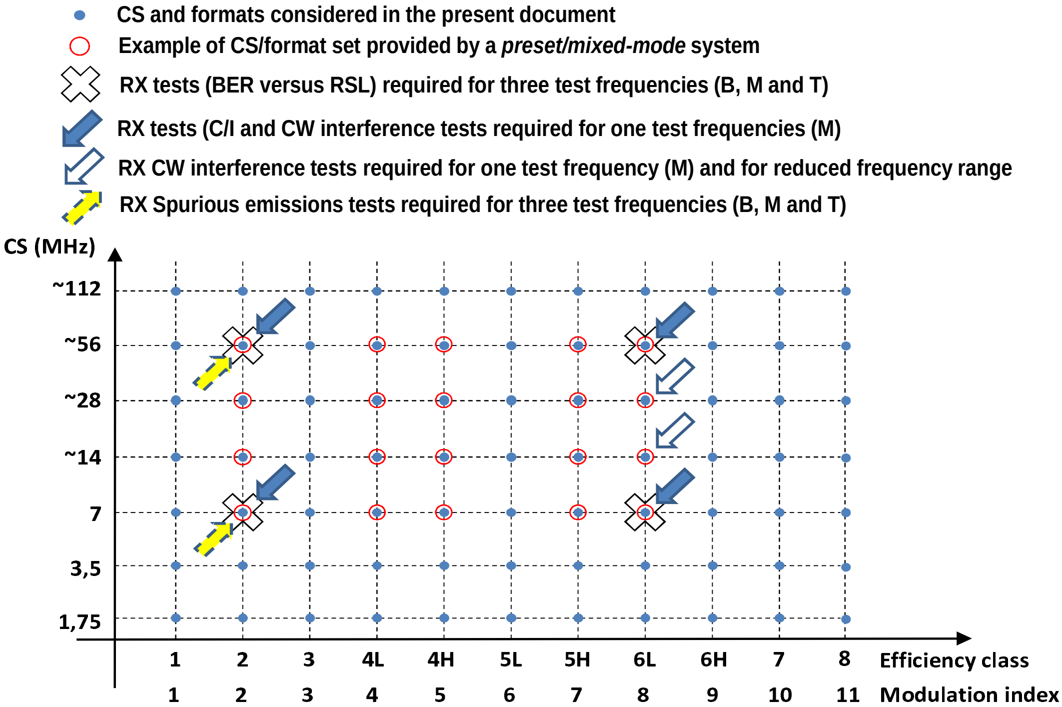



**Figure O.4: Example of *Preset/mixed-mode* systems reduced RX test report**

# O.2.3 Bandwidth adaptive test set requirements

When "*bandwidth adaptive*" operation is considered, the *reference modes* are defined as those relevant to the widest possible bandwidth and therefore tests for Directive 2014/53/EU [i.1] assessment should be performed according to clause O.1 and clause O.2. There may also be a number of preset operational modes with differing maximum bandwidth; these will be tested as independent CS modes, each with its own "*reference modes*" (see example).

EXAMPLE: A system may adjust its operational mode to not exceed a maximum licensed CS of 500 MHz, dynamically reducing to 250 MHz or even less (or a maximum licensed CS of 1 000 MHz, dynamically reducing to 250 MHz, and so on). These are seen as two different CS operational modes, 500 MHz and 1 000 MHz.

# O.3 Receiver BER and C/I measurement in *multi-channels* systems (including *channels-aggregation*) when common SDH or Ethernet single/multiple-interfaces payload is provided

## O.3.0 Introduction

Clause O.3 and its subclauses deal with systems that have both the following characteristics:

- high traffic capacity with common baseband SDH interfaces (e.g. STM-4 or several STM-1), or common baseband Ethernet interfaces (e.g. 1000Base-T or several 100Base-T);
- two or more combined (through the above common BB interface(s)) emissions, over two or more different (in frequency and/or polarization) channels on the same path or on paths originating from the same node, using either a "multi-channel" configuration of separate RF equipment or *aggregated channels* of a *channels-aggregation* equipment (see definitions in ETSI EN 302 217-1 [5])). Each channel carrying an equal fraction (see note) of the total payload.

In order to keep the requirements set out in the standard aligned with single channel single/multiple (e.g. N × 2 Mbit/s) interface(s), there is a need to modify the basic requirements definition according to the system type. BER and C/I performance measurements and test setup need to take into consideration the system type and configuration. The purpose of this annex is to provide guidance for the measurement of these systems.

NOTE: The "equal fraction" of payload condition is assumed for assessment purpose only; in normal field operation, the subdivision of payload on the various channels may dynamically vary (to the instantaneously operating mode) due to propagation or operative conditions.
In addition, without any impact on the guidelines of this annex, the emission on each channel could be composed by one single-carrier or by two or more sub-carriers (*"multi-carrier*" equipment, see definition in ETSI EN 302 217-1 [5]).

## O.3.1 Case 1: multi-interfaces for two (or more) channels systems where each interface payload is transmitted on one channel only

This case is also equivalent to generic single-channel equipment (or generic *channels-aggregation* equipment) operation (see note and example); therefore, the test procedure, in case of *multi-channels* systems, falls in the general case described in the main body of the present document.

When *channels-aggregation* equipment are also concerned, common tests sets configuration are described in table O.1.

NOTE: The difference may reside in a baseband unit common to all channels; which is irrelevant from the radio performance point of view when no traffic interface split its data over differentchannels.

EXAMPLE: This case fits with the examples of transmission of 2 × STM-1 (or 3 × 100BaseT) single channel and 4 × STM-1 (or 6 × 100BaseT) dual channels; each interface is transmitted only over one channel.

Test equipment will be connected to one of the interfaces (e.g. an STM-1 or 100BaseT interface as in the single-channel general case). The resulting BER shall comply with the requirements in the standard.

Since each interface (e.g. STM-1 or 100Base-T) signal is transmitted by one equipment on one single channel (or one of the *aggregated channels*), all measurements of performance are in general identical to other single interface, single channel (or one of the *aggregated channels*) operation.

**Table O.1: BER testing when single interface per channel is provided (Channels aggregation only)**

| Clause | Measurement | Test method (see note 1) | BER requirement |
|---|---|---|---|
| | | Separate simulated link added to each port with all *aggregated-channels* operating as intended according to manufacturer prescription. Mutual position and RSL as in following rows: | |
| 4.3.2 | BER vs. RSL | ***a) E*quipment offering only two or more *single-channels-ports:*** with *aggregated-channels* in other *port(s)* (not under test) operating as intended on the closest adjacent CS frequency(ies), with the more demanding declared operational differential RSL ratio with the channel under test (e.g. set through different RTPC levels), (see clause 4.1.1 and notes 2 and 3).<br>RSL reduced until limit is reached, maintaining the differential ratios with other channels.<br>***b)* Equipment offering mixture of *single-channel-port(s)* and *multiple-channels-port(s)*:**<br>***b1) test on single-channel-port(s)*:**<br>with other channels (not under test):<br>- those on other *single-channel-port(s)* set as in bullet a) above;<br>- those on other *multiple-channels-port(s)* loaded with the two supported channels equally spaced over their *tuning range* and with the more demanding declared operational differential RSL ratio with the channel under test (e.g. set through different RTPC levels), (see clause 4.1.1).<br>RSL reduced until limit is reached, maintaining the differential ratios with other channels.<br>***b2) test on multiple-channels-port(s)*:**<br>Other channels (not under test):<br>- the other channel of the same port of channel under test set with the more demanding declared operational differential RSL ratio with the channel under test (e.g. set through different RTPC levels), (see clause 4.1.1 and notes 2 and 3) and set at 2nd adjacent channel closer to that under test;<br>- those in ports other than that under test, set as in bullet *b1*) above.<br>RSL reduced until limit is reached, maintaining the differential ratios with other channels. | As specified |
| 4.3.3.2 | Receiver co-channel, first and second adjacent channel Interference sensitivity | Simulated links arrangement, relative channel frequencies and RSL ratios as for each type of system and ports as a), and b1) and b2) of row above (BER vs. RSL), a part from the b2) test on multiple-channels-port(s) position of the channel not under test that, when 2nd adjacent test is concerned, is set at the 3rd adjacent closer to channel under test (see note 4).<br>RSL reduced, maintaining the differential ratios with other channels, until the $10^{-6}$ RSL threshold plus the 1 dB or 3 dB degradation (i.e. as RSL increment), as specified in clause 4.3.3.2, is reached. The interferer C/I ratio (for the 1 dB or 3 dB degradation) is applied to the channel under test only. | As specified |

| Clause | Measurement | Test method (see note 1) | BER requirement |
|---|---|---|---|
| 4.3.3.3 | Receiver Blocking (CW spurious interference sensitivity) | ***a) E*****quipment offering only two or more *single-channels-ports:*** with *aggregated channels* in other *port(s)* (not under test) on the channel frequency(ies) with more demanding declared operational differential RSL ratio to that under test (e.g. set through different RTPC levels), (see clause 4.1.1).<br>***b)* Equipment offering mixture of *single-channel-port(s)* and *multiple-channels-port(s)*:**<br>***b1) test on single-channel-port(s)*:** with other channels (not under test):<br>- *single-channel-port(s)* set as in bullet a) above;<br>- other *multiple-channels-port(s)* loaded with all supported channels equally spaced over their tuning range and with the more demanding declared operational differential RSL ratio with the channel under test (e.g. set through different RTPC levels), (see clause 4.1.1).<br>***b2) test on multiple-channels-port(s):*** with other channels (not under test):<br>- those on other port(s), *single-channel* and *multiple-channels*, set as in bullet b1) above.<br>- the two on the same multiple-channels-port with the other *aggregated channel* (that not under test) operating, according manufacturer prescription, on the channel frequency with more demanding operational differential RSL ratio to that under test (e.g. set through different RTPC levels), (see clause 4.1.1);<br>RSL reduced, maintaining the differential ratios with other channels, until the $10^{-6}$ RSL threshold plus 1 dB degradation (i.e. RSL increment), as specified in clause 4.3.3.2, is reached for the channel under test.<br>The CW C/I interference ratio is applied to the port under test only through the specified frequency range (see note 6). | As specified |

NOTE 1: Test frequencies (B, M and T, as required by table 8) apply to one channel only (see clause O.1), unless when *channels-aggregation (dual-band)* operation is considered (separate band assessment is required). For dual-band operation, also the required channels placement are not applicable; in this case the closest possible frequency shall be used.

NOTE 2: In principle, all channels not under test might be set on the same channel unless specifically forbidden in the operating conditions declared by the manufacturer.

NOTE 3: (informative) 1st adjacent channel operation is foreseen with no degradation permitted because the separate simulated links do not generate actual interference for the two channels.

NOTE 4: For the *multiple-channel-ports*, depending on the relevant channel arrangement and on the channel size under test, the number of channels possibly covered by that multiple-channel-port, might be not enough for permitting the 3rd adjacent positions for the "M" test frequency (see note 1); in that case, the M test frequency is not possible and is substituted by the T test frequency. For the 32 GHz band (according to CEPT/ERC/REC T/R 13-02 [i.17]) with CS 224 MHz the number of contiguous channels is only 3; therefore, the second adjacent channel interference can be done only using the second channel (not under test) as interferer to that under test]. For the 23 GHz band (according ERC/REC(01)02 [i.3]) with CS 224 MHz the number of contiguous channels is only 2; therefore the 2nd adjacent channel test is not possible and relevant.

NOTE 5: In some cases, it is not possible to apply the 1 dB / 3 dB RSL increase only to the channel under test (e.g. in common simulated link, e.g. for *multiple-channels-port*, it is impossible to increase RSL power only on the channel under test). This is not relevant being all channels connected to a separate data port.

NOTE 6: The single CW interference applied on the port under test shall exclude frequencies either side of the channel under test by up to ± (250 % of CS).

# O.3.2 Case 2: single interface or multi-interfaces for two (or more) channels system where each payload interface is transmitted equally split on more than one channel

This case 2, alternative to case 1 in clause O.3.1, considers that the payload of each single network interface is transmitted over more than one channel (see example), so that the BER degradation of one channel only would fractionally affect the payload BER (see example and note).

However, when multiple-channel-port(s) are present, if the equipment can be alternatively configured, possibly also using external complementary payload processing equipment at reference points Z and Z' of figure 1 of ETSI EN 302 217-1 [5], for reproducing a single traffic interface on the channel under test, that configuration (case 1 in clause O.3.1) shall be used for the assessment tests.

EXAMPLE: This case fits with the example of transmission of STM-4 (or 1000BaseT) dual channels or fits with the examples of transmission of 4 × STM-1 (or 6 × 100BaseT) dual channels; each STM-1 or 100BaseT interface is transmitted, equally split (see note), over all channels.
It fits also typical BCA systems (in both *multi-channel* or *channels-aggregation* configuration) when they share common network interface(s).

NOTE: For Ethernet transmission, the equally split condition is for testing purpose only; it is assumed that when in operation, the split can be dynamically assigned according path conditions and/or traffic priority. This might not be applicable in BCA systems, where, due to different CS and/or reference modes in the different bands might require different fractional subdivision of the payload.

Test equipment will be connected to one interface only, e.g. in the example above the STM-4 or one STM-1 (or 1000BaseT or one 100BaseT) interface. The resulting BER shall comply with the requirements in the standard as described in table O.2, which reports a common assessment test sets.

If dynamic traffic split is implemented (e.g. when *mixed-mode* or *bandwidth adaptive* techniques are used over the same CS bandwidth for all channels), it should be blocked to a fixed equal split or to a suitable fixed fractional split (e.g. when BCA technique implies different CS and/or different *reference mode* for each channel).

**Table O.2: BER testing when single interface common to two or more channels is provided**

| Clause | Measurement | Test method (see note 1) | BER requirement |
|---|---|---|---|
| | | Separate simulated link added to each port with all *aggregated-channels* operating as intended according to manufacturer prescription. Mutual position and RSL as in following rows: | |
| 4.3.2 | BER vs. input RSL | ***Multi-channel equipment:*** All channels sharing the same interface Simultaneously (same RSL).<br>The attenuation is simultaneously increased until the RSL thresholds, as specified in clause 4.3.2, are reached (see note 2).<br>***Channels aggregation equipment*:**<br>***a)*** **Equipment offering only two or more *single-channels-ports:*** channels set as in equivalent row, bullet a), of table O.1 apart from RSL set equal for the channels sharing the same interface under test;<br>level reduced contemporaneously until limit is reached, maintaining the differential ratios with other channels not under test.<br>***b)*** **Equipment offering mixture of *single-channel-port(s)* and *multiple-channels-port(s)*:**<br>***b1) test on single-channel-port(s)*:** channels set as in equivalent row, bullet b1), of table O.1 apart from RSL set equal for the channels sharing the same interface under test. RSL reduced contemporaneously to all channels until limit is reached, maintaining the differential ratios with other channels not sharing the interface.<br>***b2) test on multiple-channels-port(s):*** channels set as in equivalent row, bullet b2), of table O.1 apart from RSL set equal among channels sharing the same interface under test and reduced contemporaneously until limit is reached, maintaining the differential ratios with other channels not sharing the interface (see note 4). | As specified |

| Clause | Measurement | Test method (see note 1) | BER requirement |
|---|---|---|---|
| 4.3.3.2 | Receiver co-channel, first and second adjacent channel Interference sensitivity | Simulated links arrangement, relative channel frequencies and RSL ratios as for each type of system and ports as for a), b1) and b2) of the present table in the row above (BER vs. RSL), a part from the b2) test of 2nd adjacent interference on *multiple-channels-port*(s), where the position of the channel not under test is set at the 4th adjacent closer to channel under test (see note 4).<br>RSL reduced, maintaining the differential ratios with other channels not sharing the same data interface, until the $10^{-6}$ RSL threshold plus 1 dB or 3 dB degradation (RSL increment), as specified in clause 4.3.3.2, is reached for all the channels sharing the same interface. The interferer C/I ratio (for the 1 dB or 3 dB degradation) (i.e. RSL increment) is applied to the channel under test only (see note 5). | As specified |
| 4.3.3.3 | Receiver Blocking (CW spurious interference sensitivity) | Simulated links arrangement, relative channel frequencies, RSL ratios and test configurations as in corresponding row of table O.1 forall cases a), b1) and b2), apart from RSL set equal for the channels sharing the same interface under test.<br>RSL reduced, maintaining the differential ratios with other channels not sharing the same data interface until the $10^{-6}$ RSL threshold plus 1 dB degradation (i.e. RSL increment), as specified in clause 4.3.3.3, is reached for the channels sharing the same interface (see note 6).<br>The CW C/I interference ratio is applied to the port under test only through the specified frequency range (see note 7). | As specified (see note 6) |

NOTE 1: Test frequencies (B, M and T, as required by table 8) apply to one channel only (see clause O.1), unless when *channels-aggregation (dual-band)* operation is considered (separate band assessment is required). For dual-band operation, also the required channels placement are not applicable; in this case the closest possible frequency shall be used.

NOTE 2: Relative frequencies and simulated link arrangement (common or separate) chosen by the manufacturer.

NOTE 3: (informative) 1st adjacent channel operation is foreseen with no degradation permitted because the separate simulated links do not generate actual interference for the two channels.

NOTE 4: For the *multiple-channel-ports*, depending on the relevant channel arrangement and on the channel size under test, the number of channels possibly covered by that *multiple-channel-port*, might be not enough for permitting the 4th adjacent positions for the "M" test frequency (see note 1); in that case, the M test frequency is substituted by the T test frequency. For the 32 GHz band (according ECC T/R 13-02 [i.17]) with CS 224 MHz the number of contiguous channels is only 3; therefore, the second adjacent channel interference can be done only using the second channel (not under test) turned-off (see also note 5). For the 23 GHz band (according ERC/REC(01)02 [i.3]) with CS 224 MHz the number of contiguous channels is only 2; therefore the 2nd adjacent channel test is not possible nor relevant.

NOTE 5: When testing the channel on a *single-channel-port*, only that channel is affected by the interference; therefore, the BER requirement shall be divided by the number "N" of the channels sharing the same data interface (i.e. BER $\leq 5 \times 10^{-7}$ for two-channels equipment, BER $\leq 3{,}3 \times 10^{-7}$ for three-channels equipment and so on).
However, due to the common simulated link for the two channels sharing the same *multiple-channel-port* under test, the interference would affect both channels, therefore:
1) When testing one channel of a *multiple-channel-ports*, the first and second adjacent channel interference test is done with the interfering signal placed in between the two channels (under test and not under test) of that port; two cases are possible:
- If not sharing the same data interface, the above rule for *single-channel-port* of dividing by N the BER requirement, applies as well.;
- If they are both sharing the same data interface (i.e. both are affected by the same interference and equally contribute to the BER test), the BER requirement shall be divided by "N/2" (i.e. BER $\leq 1 \times 10^{-6}$ for two-channels per data interface, BER $\leq 6.6 \times 10^{-7}$ for three-channels per data interface and so on).
2) When testing one channel of a *multiple-channel-ports*, the receiver blocking (CW interference test) is done through a single CW interference affecting both channel of that port; therefore the same adaptation of the BER limit described for the adjacent channel tests in 1) above applies, depending if the two channels of the port are sharing or not the same data interface.

NOTE 6: The CW interference is equally affecting all channel of the same port; therefore, when they are also sharing the same interface, no BER averaging is expected and the limit remain as specified unless the channels sharing the same interface are emitted from different ports; in such case, the BER limit should be mediated among the "n" number of channels on port under test (n ≤ 2) and the "m" sum number of channels on the other port(s):
- When method 1 of clause 4.3.3.3 is used $BER \leq (n \times 1 \times 10^{-6})/(n+m)$
When method 2 of clause 4.3.3.3 is used $BER \leq (n \times 1 \times 10^{-5})/(n+m)$.

NOTE 7: The single CW interference applied on the port under test shall exclude frequencies, by up to ± (250 % of CS), either side of the channel under test or, when multiple-channel port in concerned, also of the second channel if it shares the same interface.

# O.4 Transmitter test provisions for *channels-aggregation* equipment

## O.4.1 General requirement and test method

*Channels-aggregation* equipment needs additional consideration for ensuring that the two *aggregated channels* do not interfere with each other in the internal TX and RX signal paths in order to avoid a degradation of the single-channel performance.

The above principle shall be valid whenever the aggregated channels operate according to the manufacturer's instructions.

From assessment point of view spectrum mask and unwanted emission in the spurious domain tests shall be carried as described in table O.3.

**Table O.3: *Channels-aggregation* equipment: transmitter Radio Frequency Spectrum mask and transmitter unwanted emission in the spurious domain**

| Clause | Measurement | Test method | Compliance Requirement |
|---|---|---|---|
| 4.2.4 | Transmitter Radio Frequency Spectrum Mask | All channels on: adjacent tuning (see note 4):<br>• Channels transmitted through same *multiple-channels port*<br>• Channels transmitted through different *single-channel ports* | Combination of two spectral masks. See figure O.5 and clause O.4.2 (see notes 2, 5 and 6)<br>Normal mask for all channels (see note 3 and note 6) |
| 4.2.4 | Transmitter Radio Frequency Spectrum Mask | All channels on: farthest tuning (see note 4):<br>• Channels transmitted through same *multiple-channels port*<br>• Channels transmitted through different *single-channel ports* | Combination of two spectral masks. See figure O.6 (see notes 3, 5 and 6)<br>Normal mask for all channels (see note 3 and note 6) |
| 4.2.4 | Transmitter Radio Frequency Spectrum Mask | One channel on, second off and vice versa (2 tests):<br>• multiple-channel -ports only | Spectral mask according to clause 4.2.4.2.1 (conditional test see note 1) |
| 4.2.6 | Transmitter unwanted emission in the spurious domain | Both channels on: farthest tuning:<br>• Channels transmitted through same *multiple-channels port*<br>• Channels transmitted through different *single-channels ports* | Systems operating above 21,2 GHz: Combined limit: see figure O.7 (see notes 3 and 6)<br>Systems operating below 21,2 GHz: Limits provided by annex 1, section A.1.3 of CEPT/ERC/REC 74-01 [3]<br>Normal Limits for all channels (see note 3 and note 6) |
| 4.2.6 | Transmitter unwanted emission in the spurious domain | One channel is on, while other channel is off (2 tests):<br>• multiple-channels port | As specified (conditional test see note 1) |

NOTE 1: Additional tests, only for:
Transmitter Radio Frequency spectral masks in all cases of *multiple-channels port:*
- For equipment operating above 21,2 GHz, for transmitter unwanted emission in the spurious domain.
- For equipment operating below 21,2 GHz, for transmitter unwanted emissions in the spurious domain outside the ±150 % of the *tuning range* (see section A1.3 in annex A of ERC/REC74-01 [3]).

Test required only if needed for verifying the conditions of combined limit in clause O.4.2. One channel is tested for B, and/or M and/or T frequencies as needed.

NOTE 2: For *single*-band operation, one channel is tested for B, M and T frequencies, with other channel as convenient (i.e. uppermost for B test, lowermost for H test, indifferent for M test). For *dual-band* operation the same separately applies to the group of channels in each band.

NOTE 3: For *single*-band operation, one channel is tested for B, M and T frequencies, with other channel set at farthest possible frequency. For *dual-band* operation the same separately applies to the group of channels in each band.

NOTE 4: Test required for *single-band* equipment only; for *dual-band* equipment each band emissions and ports are considered a separately tetsed *channels-aggregation* system.

NOTE 5: Combined limits adaptation according to clause O.4 and figure O.7 and figure O.8 shall apply as well when relevant.

NOTE 6: When the manufacturer declaration of operational conditions does not permit the use of the channels belonging to different ports on different links in different directions (see clause 4.1.1), the limits, within the actual operating CS bandwidth of the channels not under test, may be exceeded provided that the overall power of unwanted emissions, integrated over that CS bandwidth, shall be attenuated by at least 50 dB with respect to the level of the total carrier emission on that channel (i.e. that not under test). This attenuation shall be respected within the whole declared range of RTPC. [Rationale is that the "over the air" decoupling of the ports on the same link, even with high XPD antennas, will already be quite less than 50 dB.

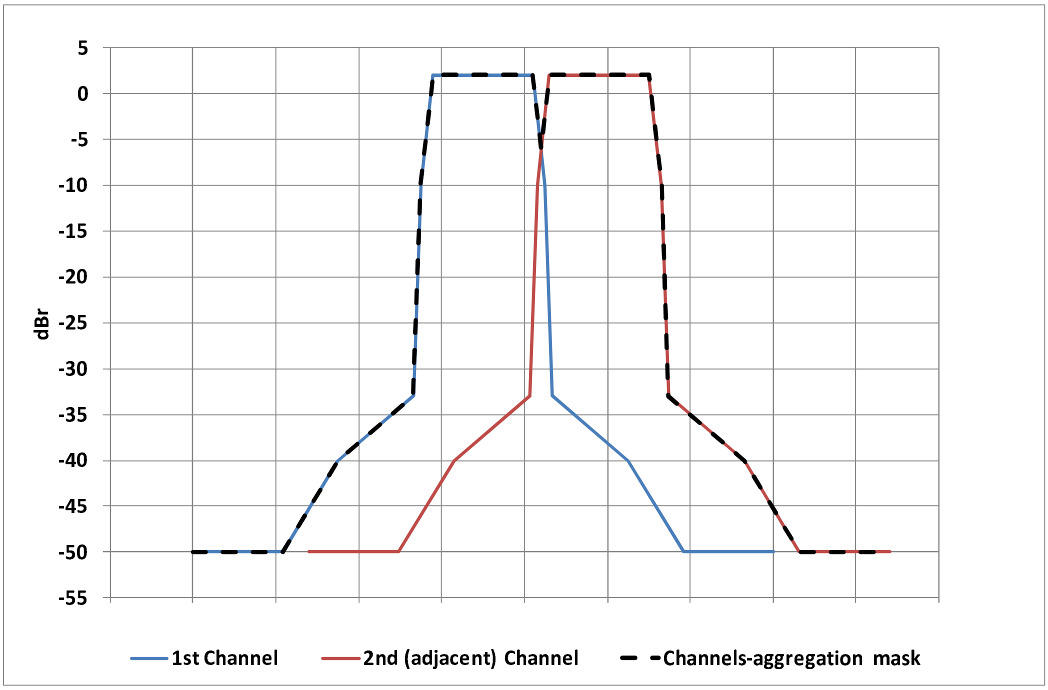
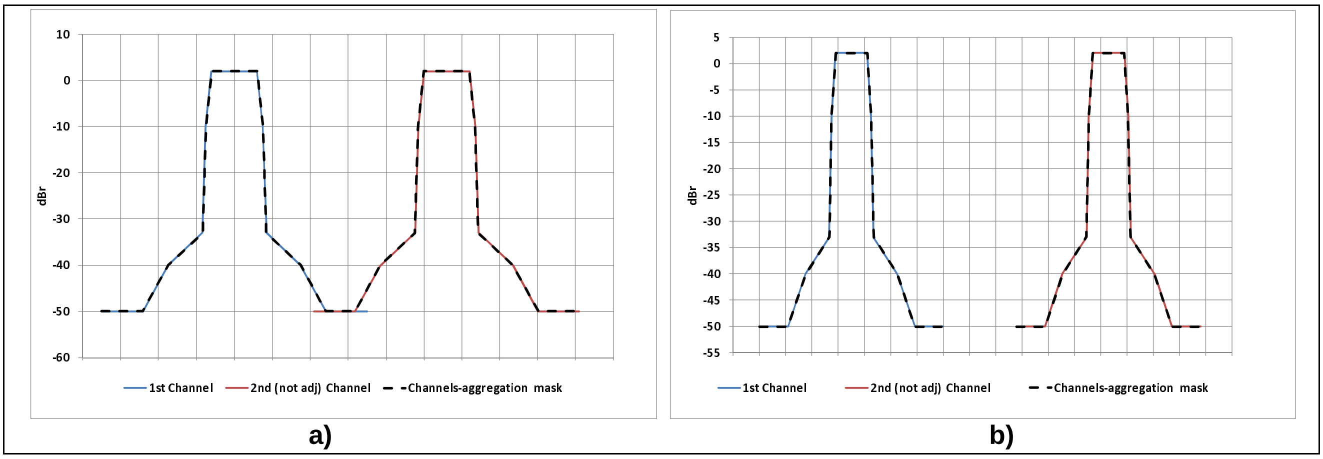



**Figure O.5: *Channels-aggregation* equipment: combined adjacent channels tuning transmitter Radio Frequency Spectrum mask (two adjacent *aggregated channels* through same *multiple-channels-port* example)**




NOTE: It should be highlighted that the blank space in the middle of the two emissions examples (i.e. spurious domain for both emissions in figure b) is present only when the spacing between the emissions is higher than 5 × CS. Therefore, in a number of cases, it will not be experienced and figure a) example (here 4 × CS case) applies.

**Figure O.6: *Channels-aggregation* equipment: combined farthest channels tuning transmitter Radio Frequency spectrum mask (*aggregated channels* through same *multiple-channels port* example)**

The examples shown in figure O.5 and O.6 assume that all channels have exactly the same output power; however, in practice, even if carried on at the same environmental conditions, some slight power difference might be experienced, in particular when farthest tuning is considered as in figure O.6. In such case each separate 0 dB reference shall be used when evaluating their envelope.

## O.4.2 Limits combination for *multiple-channelsport* case

For *channels-aggregation* systems, each *aggregate channel* emission shall be compliant when the other channel emissions is turned off or also turned on in any possible frequency and/or polarization within their permitted setting range.

When the *single-port* case equipment is concerned, the overall emission is the power combination of the two emissions, both separately fulfilling the required limit; therefore, in frequencies where either the spectrum masks or the spurious domains limits are possibly exceeded, the combined emission limit may be accordingly scaled as follows:

1) In frequency ranges where homogeneous limits apply for all *aggregated channels*; i.e. in all cases, in masks crossover central to frequency range (C) in figure O.7 and figure O.8a) or, only for equipment operating above 21,2 GHz (see note 1), in the spurious domain frequency ranges (A) of figure O.7, figure O.8a) and figure O.8b):

 1.1 When discrete CW spectral lines are concerned, the prescribed limit applies.

 1.2 When spread spectral densities are concerned, the limit may be adapted on the basis of the actual emissions levels of the individual *aggregated channel* emissions, when other channels are turned off, according to the following formula:

$$\text{Limit adaptation (+dB)} = \text{Max}\left[10\log\left(10^{\frac{M_1}{10}} + 10^{\frac{M_2}{10}}\right), 0\right] \quad (O.1)$$

 where M1 and M2are the margins (-dB) to the relevant limit that each aggregated channel emissions have separately shown when the second is turned off (see example 1).

NOTE 1: *Multiple-channels-ports* of *channels-aggregation* equipment operating below 21,2 GHz are subject to the specific provisions of section A1.3 of CEPT/ERC REC 74-01 [3] applicable to the overall aggregated set of channels.

EXAMPLE 1: With second channel turned off, at certain spurious domain frequency outside the tuning range of the multiple-channels-port under test, the emission on *aggregate channel* 1 had 1 dB margin ($M_1 = -1$) on the limit of -50 dBm/MHz, while the emission on *aggregate channel* 2 had 3 dB margin ($M_2 = -3$) on that limit. When both are turned on, at that spurious domain frequency, the limit is adapted increasing the limit by 1,12 dB (i.e. to -48,88 dBm/MHz).

2) In the frequency ranges where inhomogeneous limits apply (see note 2) for each *aggregated channel*; i.e. in frequency ranges (B) of figure O.7 and figure O.8, the spectrum mask for one aggregated channel overlaps the spurious domain for the other. In this case, the relative spectral emission density of the mask shall be first normalized into power density in dBm/MHz (rightmost axis in the example figure O.7 and figure O.8) for comparison to the unwanted emission in the spurious domain levels (see note 3). Then the following apply:

 2.1 When discrete CW spectral lines are concerned, the transmitter unwanted emission in the spurious domain of one channel can exceed the mask limit of the other and vice versa (see note 4).

 2.2 When spread spectral densities are concerned the combined margin of (see equation O.1) above still apply considering that M1 is the margin (-dB) of one channel to its own relevant limit (e.g. spectrum mask or spurious domain) while M2 is the inhomogeneous difference (case by case +dB or -dB, see note 3) between the first channel limit and the second channel emissions in that frequency (e.g. spectrum mask "limit" minus spurious domain "actual emission" or vice versa, see example 2 and example 3 and note 5).

NOTE 2: It should be considered that, *Multiple-channels-ports* of *channels-aggregation* equipment operating below 21,2 GHz, would not have inhomogeneous limits because ERC/REC74-01 [3] provides a comprehensive limit for all unwanted emissions in the spurious domain (i.e. including intermodulation effects among the channels) within the whole tuning range of the *multiple-channels-port*.

NOTE 3: For conventional QAM formats the normalization may be made translating the 0 dB reference of the spectrum mask into a power reference of [Pout - 10 × log (Symbol frequency)] dBm/MHz, with Pout in dBm and Symbol frequency in MHz.
Depending on the frequency band and system parameters, the spurious domain emission limit (-30 dBm/MHz) may result higher or lower than the power density of the spectrum mask limits (e.g. in the specific example of figure O.7 and figure O.8 the -30 dBm/MHz spurious domain limit is higher than the spectrum mask).

NOTE 4: The level of the CW spectral lines does not benefit of any limit adaptation because can be verified with very narrow resolution bandwidth not affected by additional spectral density power.

NOTE 5: It is intended that the limit adaptation of the spectrum mask could be further verified with a resolution bandwidth coherent with the spurious limit (e.g. of 1 MHz above 1 GHz as in the most common example 2 and example 3) independently from the actual value prescribed in table 7 for the system under consideration. Alternatively the spurious emission level should be normalized to the mask resolution bandwidth and similar calculation be done.

EXAMPLE 2: **With reference to figure O.7 lower frequency B range**:
**1) Possible limit adaptation of the transmitter Radio Frequency spectrum mask of blue channel:**
with second (e.g. red one at the higher frequency) channel turned off, at certain spectrum mask frequency within lower (B) range under test, the emission on first (i.e. the blue one at lower frequency) *aggregate channel* had 1 dB margin ($M_1$ = -1) on its mask limit of -50 dBr (level that, with the equipment parameters shown in figure O.7, have been verified to correspond to a power density, in absolute terms, of -41 dBm/MHz), while the transmitter unwanted emission in the spurious domain of second *aggregate channel* (i.e. the red one with other blue channel turned off) has a level (derived from the spurious domain emission test) of -38 dBm/MHz (i.e. exceeds 3 dB the mask limit normalized to power density in absolute terms, i.e. $M_2$ = 3). When both are turned on, at that mask frequency, the mask limit is adapted by increasing 4,45 dB.
**2) Possible limit adaptation of the spurious level of red channel:**
Following the same rationale, the transmitter unwanted emission in the spurious domain limit of the red channel, in correspondence of the -38 dBm/MHz spectral emission ($M_1$ = -8) could not be further adapted because the combination, through equation O.1 above, of the blue mask power of -42 dBm/MHz ($M_2$ = -12 with respect to the spurious limit of -30 dBm/MHz) results in a negative -6,54 dB value, and therefore, according to equation O.1, Combined Limits Adaptation will be 0 dB (total of: -30 dBm/MHz).

EXAMPLE 3: **With reference to figure O.7 upper frequency B range**:
**1) Possible limit adaptation of the transmitter Radio Frequency spectrum mask of red channel:**
with previous (e.g. the blue one at lower frequency) channel turned off, at certain spectrum mask frequency within upper (B) range under test, the emission of the blue *aggregate channel* had 2 dB margin ($M_1$ = -2) on its mask limit of -50 dBr (level that also corresponds, in absolute terms, to power density of -41 dBm/MHz), while the transmitter unwanted emission in the spurious domain of other *aggregate channel* (i.e. the blue one with red channel turned off) has a level (derived from the spurious domain emission test) of exactly -30 dBm/MHz (i.e. exceeds 11 dB the mask limit normalized to power density in absolute terms, i.e. $M_2$ = 11). When both are turned on, at that mask frequency, the mask limit is adapted by increasing 11,21 dB.
**2) Possible limit adaptation of the transmitter unwanted emission in the spurious domain level of blue channel:**
Following the same rationale, the spurious emission limit of the blue channel, in correspondence of the -30 dBm/MHz spectral line ($M_1$ = 0) could be further adapted because the combination, through equation O.1 above, of the red mask power of -43 dBm/MHz ($M_2$ = -13 with respect to the transmitter unwanted emission in the spurious domain limit of -30 dBm/MHz) results in a positive increase of 0,21 dB (i.e. limit adapted to -29,79 dBm/MHz).

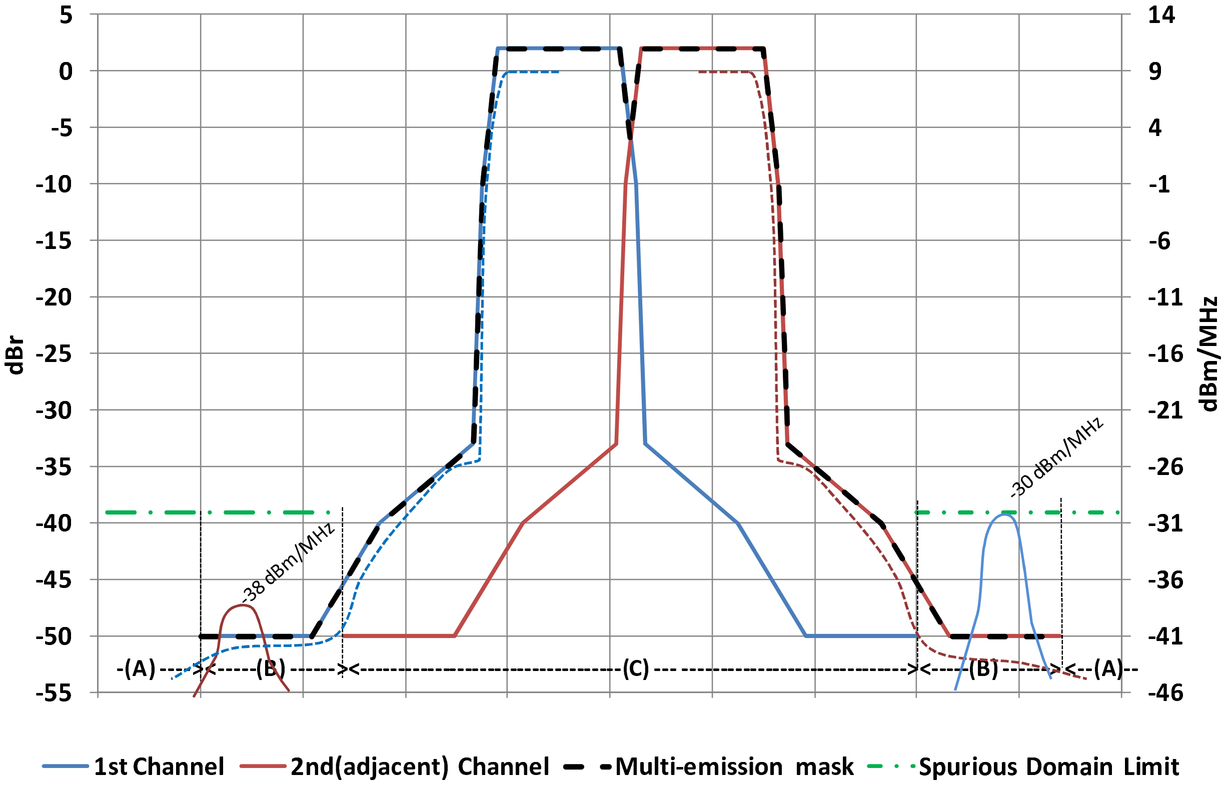
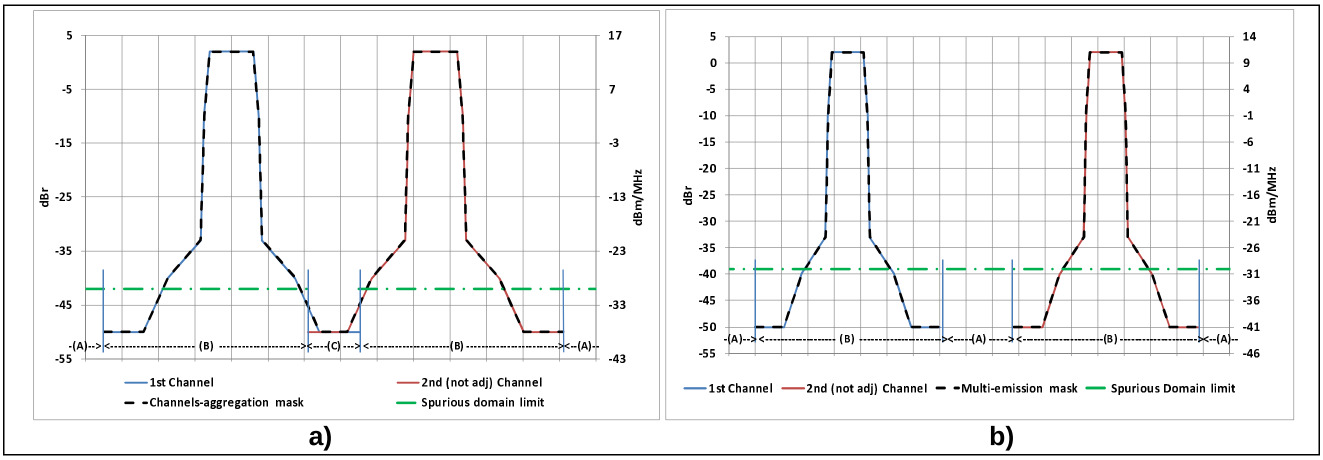



**Figure O.7: Example of combined limits in adjacent channels conditions (23 GHz to 28 GHz band; class 4H; Pout = +23 dBm; symbol frequency 25 MHz)**




NOTE: Example a) refers to the case up to 4 × CS emission spacing; example b) refers to cases with emission spacing > 5 × CS (or, for CS > 500 MHz, > 3 × CS + 1 000). In more than 5 × CS (or, for CS > 500 MHz, more than 3 × CS + 1 000) spacing case range (C) is not present .

**Figure O.8: Examples of combined limits in farthest channels conditions (23 GHz to 28 GHz band; class 4H; Pout = +23 dBm; symbol frequency 25 MHz)**

# Annex P (informative): Technical background for receiver selectivity and C/I interference sensitivity evaluation

# P.1 Receiver selectivity

## P.1.1 Introduction

In general the term selectivity indicates the transfer function in terms of gain (or attenuation) versus frequency of a given double bipole.

When the bipole comprises several complex and active functions the transfer function is a combination of many elementary parts; the presence of active functions also implies that the total transfer function depends also on the levels of the signals passing through (e.g. due to non-linear effects).

In digital microwave receivers the input and output signals are inhomogeneous (RF modulated signal input and digital data stream output); therefore, a plain gain/frequency transfer function cannot be practically defined or tested. In addition, the signal environment is generally "broadband"; therefore, single frequency selectivity values are not practically enough for devising wide band RX response to wide band interference (i.e. wide band integration is necessary).

Furthermore, the digital implementation of filters, typically employed for the final baseband channel shaping, implies that their predicted performance are experienced only in presence of like-modulated interfering signals. For interfering signals of different nature the response, while performances are still close, they cannot be assumed the same; therefore, the use of CW line becomes appropriate and convenient for interfering signals far from the wanted centre frequency where the analogue parts of filter chain (typically at RF and IF level) become more predominant. Here the CW line interference becomes quite representative for any kind of interfering signal, including broadband ones, e.g. for compatibility with service/systems allocated in adjacent bands.

For the above reasons, DFRS receiver selectivity is generally described and easily tested through BER threshold degradation in presence of interference at predefined frequency offset and C/I ratio. Comparing the C/I ratios at given BER threshold degradation to the co-channel C/I ratio producing the same degradation it is possible to estimate the overall (broadband) selectivity of the receiver to like signals at various distance from RX centre frequency.
This kind of Wide-Band SELectivity (WBSEL) response is comprehensive of all effects (linear and not linear) that define the overall response of the receiver to interference; therefore, it is intended as the real selectivity of the digital receiver.

The WBSEL mask can be easily evaluated through the assessments provided for:

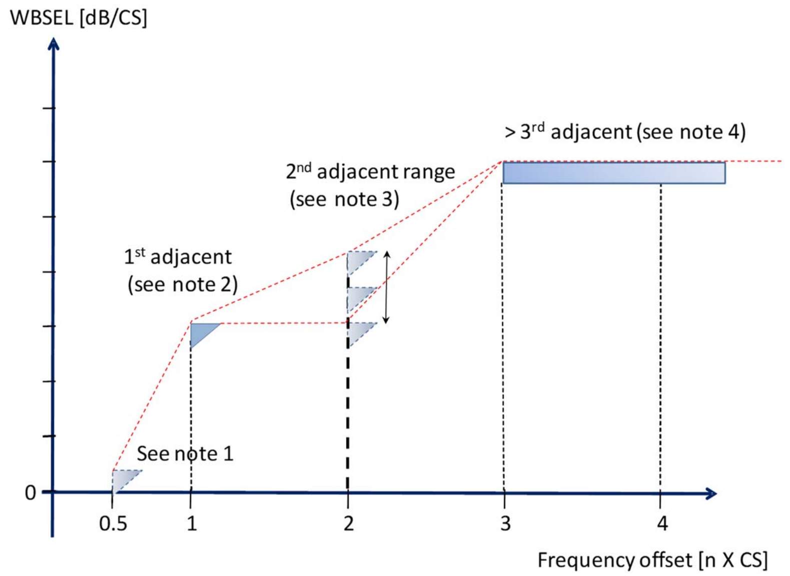
- receiver co-channel interference sensitivity C/I at 1 dB threshold degradation ($C/I_C$) required in clause 4.3.3.2.2;
- receiver first adjacent channel interference sensitivity C/I at 1 dB threshold degradation ($C/I_{1A}$) required in clause 4.3.3.2.2;
- receiver second adjacent channel interference sensitivity C/I at 1 dB threshold degradation ($C/I_{2A}$) required in clause 4.3.3.2.3;
- receiver Blocking (CW spurious interference sensitivity) C/I at 1 dB threshold degradation ($C/I_{CW}$); test required in clause 4.3.3.3 at any frequency over a wide frequency range (i.e. continuous sweep) starting from the *spurious domain* boundary.

It should be reminded that the first three requirements are "wideband" interference related, while the third is CW "single line" interference; therefore, the WBSEL, can be intended "guaranteed" from Directive 2014/53/EU [i.1] point of view only in the assessed frequencies and under their specific assessment provisions (i.e. like-modulated or CW C/I ratio); nevertheless, it can be usefully used for any sharing/compatibility study with service/system other than DFRS.

## P.1.2 Graphical representation of WBSEL

From the above background it is possible to derive the WBSEL in graphical form as shown in figure P.1.

The graph in figure P.1 is usually used as response to a "broadband" interference, i.e. with bandwidth comparable to that of the concerned DFRS; therefore, the point derived from CW line interference in clause 4.3.3.3 is considered applicable, in such broadband context, from the 3rd CS spacing on.




NOTE 1: It is commonly assumed that, at 0,5 × CS, 3 dB of WBSEL is obtained.

NOTE 2: $WBSEL_{1A}$ point evaluated as $C/I_C$ - $C/I_{1A}$ requirements in clause 4.3.3.2.2.

NOTE 3: $WBSEL_{2A}$ point evaluated as $C/I_C$ - $C/I_{2A}$; it depends on the level of compliance and manufacturer declaration in clause 4.3.3.2.3 (see background in clause P.2).

NOTE 4: $WBSEL_{CW}$ range evaluated as $C/I_C$ - $C/I_{CW}$; requirement in clause 4.3.3.3; value is valid from ±3rd CS (as centre frequency of the channel fully within the CW requirement range) and up to the frequency range where the CW test is defined by clause 7 of ETSI EN 301 390 [4]. It should also be understood that $WBSEL_{CW}$ value is applicable on real interference environment only if the interfering signal emission exhibits a corresponding reduction of its OOB and spurious emissions within the victim DFRS RX bandwidth.

**Figure P.1: Wide-Band integral SELectivity (WBSEL) graphical representation**

Table P.1 shows the WBSEL corner points evaluated for few example systems in the present document.

**Table P.1: Examples of WBSEL corner points (refer to figure P.3) calculated from C/I requirements**

| Reference Index | Class | Band (GHz) | CS (MHz) | $WBSEL_{1A}$ (dB) | $WBSEL_{2A}$ (dB) | $WBSEL_{CW}$ > 3A (dB) |
|---|---|---|---|---|---|---|
| **4** | **4L** | **13** | **< 56** | 31 | 31 to 50,9 | 60 |
| | | | **56, 112** | 34 | 34 to 50,9 | 59 |
| **8** | **6L/6LB** | **23 to 28** | **All** | 40 | 40 to 49,2 | 70 |
| **6** | **5LB** | **> 57** | **250, 500** | 33,5 | 33,5 to 44,3 | 63,5 |
| **4** | **4L** | **> 57** | **1 250** | 27 | 27 to 32,5 | 57 |

# P.2 C/I interference sensitivity

## P.2.1 Introduction

The interference sensitivity behaviour of a digital receiver mainly depends on four factors:

1) The modulation format and the error corrections algorithms; basically defining the co-channel C/I behaviour.

2) The spectrum mask of the interfering signal; basically defining the residual of the interfering signal falling within the victim receiver bandwidth. This would limit the best obtainable behaviour of the receiver in presence of such interference.

3) The ideal receiver filters chain transfer function; basically defining the capability of the receiver of reducing interference level at various frequency distance from the victim receiver centre frequency.

4) The level of C/I ratio at each intermediate stage of the receiver chain; basically related to the possible non-linear effects when the interference I is significantly larger than the wanted signal C.

On the basis of the above factors, the following background is relevant for each of the C/I interference sensitivity requirements in the present document:

a) Co-channel $C/I_{co}$ ratio is related to the S/N ratio (e.g. for BER = $10^{-6}$) typical for the actual modulation format. It can slightly differ due to the error correction employed, but is substantially a constant for each format (see note).

b) First adjacent channel $C/I_{1A}$ ratio mainly depends on the pulse "shaping" (roll-off) filters (typically obtained by baseband digital filters in TX and RX chains) that determine the 1$^{st}$ adjacent NFD. In minor extent, it also depends on 3$^{rd}$ order intermodulation effects of the interfering TX (generally controlled by TX Radio Frequency spectrum mask, see note). It should be noted that the TX "shaping" part is only marginally controlled by the transmitter Radio Frequency spectrum mask, which, being made by discrete segments, cannot closely describe a continuous shaping. First adjacent channel C/I ratio typical requirement in DFRS applications is generally limited to about 0 dB to -5 dB; this implies that in no stage of the RX chain non-linear effects (point 4 above) are expected.

   Receiver second adjacent channel $C/I_{2A}$ ratio mainly depends on two effects:

   - the residual of interfering TX mask falling within the RX filter chain (effect dominated by the baseband shaping filter, tighter one in RX chain); this is intended as the ideal best case C/I ratio (see clause P.2.2);

   - the actual C/I ratio, where usually I is higher than C; when becoming too negative, it would create non-linear effects in the first RF and IF receiver stages, which would impair the above ideal behaviour. This is due to the physical behaviour of any filter related to its "relative bandwidth" cannot be as effective as the baseband shaping filter in a frequency range still relatively close to the wanted signal.

c) For the receiver Blocking, the CW C/I ratio, used in the spurious domain frequency range, depends on both filtering and non-linear effects (point 3 and point 4 above); filter effects, when very far from centre frequency (depending on the operating frequency, the requirement is extended up to 10$^{th}$ harmonic) becomes unpredictable and only a "minimum" safeguard can be counted on. The CW C/I ratio is then more related to avoid non-linear effects from normally expected level of interference; it should not be forgotten that the normally expected level of interference depends also on the directional (dish) antennas used in DFRS applications giving considerable "geometrical angle selectivity" over a wide frequency range.

NOTE: The difference (Co-channel C/I - First adjacent C/I) in dB at same threshold degradation, may also be intended similar to the Net Filter Discrimination (NFD) on the first adjacent, more theoretically described in Recommendation ITU-R F.746-10 [i.44] and ETSI TR 101 854 [i.28].

## P.2.2 Ideal selectivity and best case C/I value for 2nd adjacent CS

As described in clause P.1.2 and clause P.2.1, the second adjacent channel $WBSEL_{2A}$ (and consequently the corresponding $C/I_{2A}$ requirement) may not exceed what is generated by the spectrum mask of the interfering like-modulated signal.

The ideal $WBSEL_{2A}$ can be calculated as $NFD_{2A}$ with the same NFD methodology theoretically described in Recommendation ITU-R F.746-10 [i.44] and ETSI TR 101 854 [i.28]. In practice, $NFD_{2A}$ is the ratio, in dB, of the integral of TX power density (blue envelope in figure P.2) and integral of residual interference power density (red envelope in figure P.2) after RX filtering (green curve in figure P.2).

The actual RX shaping filter, here simulated as nearly rectangular, depends on the actual symbol-rate and roll-off used and these are not subject of standardization; however, it can be demonstrated that approximating it with a rectangular (i.e. roll-off < 1 %) filter of CS width, will result in a conservative calculation (see note) with a variance with respect any possible real implementation of less than about 1 dB.

NOTE: For $NFD_{2A}$ evaluation the in band TX spectrum mask is limited to 0 dB because the X1 dB allowance provided in table 3a through table 3m does not, in average, count as actual power density for NFD evaluation. Moreover, the maximum RX attenuation is assumed to be only 10 dB higher than the TX mask floor attenuation.

Figure P.2 shows an example of ideal $NFD_{2A}$ evaluation.

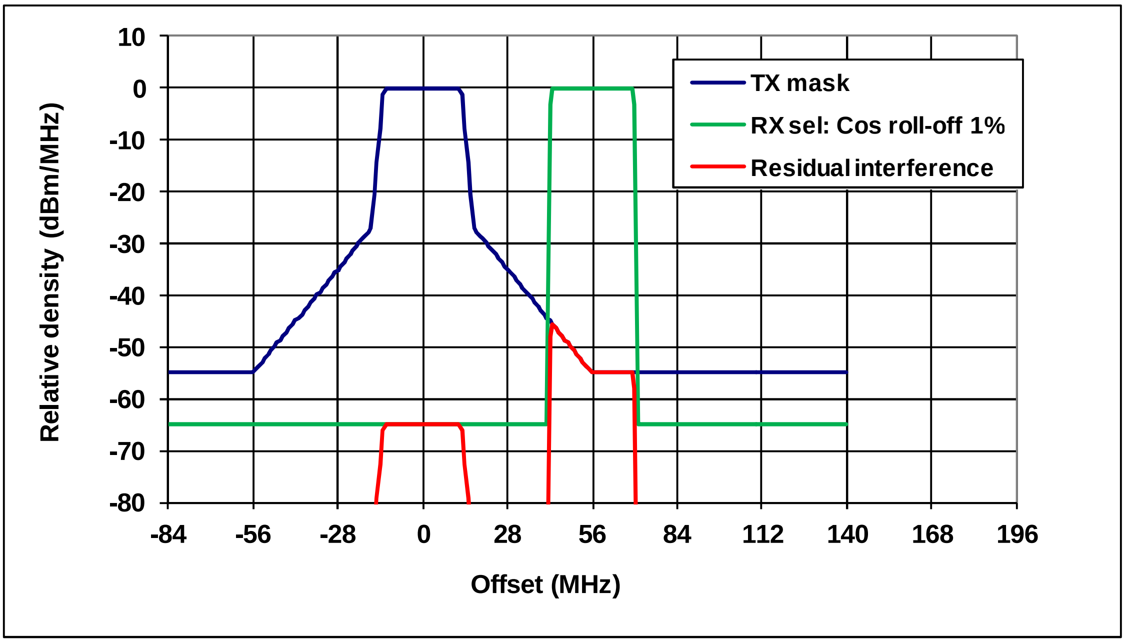



**Figure P.2: Example of $NFD_{2A}$ evaluation (CS 28 MHz, class 4, roll-off 1 % resulting in $NFD_{2A}$ = 50,91 dB)**

The corresponding best case (i.e. without allowance for non-linear effects) of $C/I_{2A}$ for 1 dB BER $10^{-6}$ threshold degradation is easily calculated as $C/I_{2A} = C/I_C - NFD_{2A}$.

Table P.2 summarizes the ideal $NFD_{2A}$ values calculated for all mask cases below 57 GHz in the present document; being all masks parametric the values does not depend on CS.

**Table P.2: $NFD_{2A}$ ideal values calculated for bands below 57 GHz**

| Spectral efficiency | | $NFD_{2A}$ (dB) Frequency bands (GHz) | | |
|---|---|---|---|---|
| Reference Index | Class | 3 to 17 | > 17 to 30 | > 30 to 57 |
| 1-2-3 | 1-2-3 | 44,3 | 44,3 | 44,3 |
| 4 | 4L | 50,9 | 48,7 | 44,4 |
| 5 | 4H | 51,2 | 48,8 | 44,4 |
| 6, 7, 8, 9,10, 11 | 5LA, 5HA, 6LA, 6HA, 7A, 8A | 51,9 | 49,1 | 44,4 |
| | 5L, 5LB, 5H, 5HB, 6L, 6LB, 6H, 6HB, 7, 7B, 8, 8B | 51,8 | 49 | 44,4 |

Table P.3 summarizes the ideal $NFD_{2A}$ values calculated for all mask cases above 57 GHz in the present document. In this case, the mask floor is variable with CS (but fixed for all bands).

Table P.4 and table P.5 show the conversion of ideal $NFD_{2A}$ into the possible best case $C/I_{2A}$.

**Table P.3: $NFD_{2A}$ ideal values calculated for bands above 57 GHz**

| Spectral efficiency | | $NFD_{2A}$ (dB) CS (MHz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | ≤ 250 | 251 to 500 | 501 to 750 | 751 to 1 000 | 1 001 to 1 250 | 1 251 to 1 500 | 1 501 to 1 750 | 1 751 to 2 000 |
| **1-2-3** | **1-2-3** | 39,5 | 36,5 | 34,7 | 33,5 | 32,5 | 31,7 | 31,0 | 30,5 |
| **4** | **4L** | 39,5 | 36,5 | 34,7 | 33,5 | 32,5 | 31,7 | 31 | 30,5 |
| **5** | **4H** | 42,4 | 39,4 | 37,7 | 36,5 | 35,5 | 34,7 | 34 | 33,5 |
| **6** | **5LA** | 44,4 | 42,4 | 40,7 | 39,5 | 38,5 | 37,7 | 37 | 36,4 |
| **7** | **5HA** | 44,4 | 44,4 | 43,7 | 42,5 | 41,5 | 40,7 | 40 | 39,4 |
| **8** | **6LA** | 44,4 | 44,4 | 44,5 | 44,5 | 44,5 | 43,7 | 43 | 42,4 |
| **6** | **5LB** | 44,3 | 42,3 | 40,5 | 39,3 | 38,3 | 37,5 | 36,9 | 36,3 |
| **7** | **5HB** | 44,3 | 44,3 | 43,5 | 42,3 | 41,3 | 40,5 | 39,9 | 39,3 |
| **8** | **6LB** | 44,3 | 44,3 | 44,3 | 44,3 | 44,3 | 43,5 | 42,9 | 42,3 |

**Table P.4: C/I$_{2A}$ best case values calculated for bands below 57 GHz**

| Current C/I$_{co}$ (1 dB deg) (reprinted values in dB from clause 4.3.2) | | | | | Calculated: C/I$_{2A}$ (1 dB deg) = (C/I$_{co}$ – NFD$_{2A}$) (NFD$_{2A}$ from table P.2) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reference | | Frequency bands (GHz) | | | Reference | | Frequency bands (GHz) | | |
| Index | Class | 3 to 17 | > 17 to 30 | > 30 to 55 | Index | Class | 3 to 17 | > 17 to 30 | > 30 to 55 |
| **1 and 2** | **1 and 2** | 23 | 23 | 23 | **1 and 2** | **1 and 2** | -21,3 | -21,3 | -21,3 |
| **3** | **3** | 27/23 | 27 | 23 | **3** | **3** | -17,3/-21,3 | -17,3 | -21,3 |
| **4** | **4L** | 30/29 | 30/29 | 30 | **4** | **4L** | -20,9/-21,9 | -18,7/-19,7 | -14,4 |
| **5** | **4H** | 33/30 | 30 | 30 | **5** | **4H** | -18,2/-21,2 | -18,8 | -14,4 |
| **6** | **5L/5LB** | 34/33 | 34 | 34 | **6** | **5L/5LB** | -17,8/-18,8 | -15 | -10,4 |
| **7** | **5H/5HB** | 37/35 | 37 | 37 | **7** | **5H/5HB** | -14,8/-16,8 | -12 | -7,4 |
| **8** | **6L/6LB** | 40 | 40 | 40 | **8** | **6L/6LB** | -11,8 | -9 | -4,4 |
| **9** | **6H/6HB** | 43 | 43 | 43 | **9** | **6H/6HB** | -8,8 | -6 | -1,4 |
| **10** | **7/7B** | 46 | 46 | 46 | **10** | **7/7B** | -5,8 | -3 | (1,6) (see note) |
| **11** | **8/8B** | 50 | 50 | 50 | **11** | **8/8B** | -1,8 | (0,8) (see note) | (5,6) (see note) |
| **6** | **5LA** | 34 | 34 | 34 | **6** | **5LA** | -17,9 | -15,1 | -10,4 |
| **7** | **5HA** | 37 | 37 | 37 | **7** | **5HA** | -14,9 | -12,1 | -7,4 |
| **8** | **6LA** | 40 | 40 | 40 | **8** | **6LA** | -11,9 | -9,1 | -4,4 |
| **9** | **6HA** | 43 | 43 | 43 | **9** | **6HA** | -8,9 | -6,1 | -1,4 |
| **10** | **7A** | 46 | 46 | 46 | **10** | **7A** | -5,9 | -3,1 | 1,6 |
| **11** | **8A** | 50 | 50 | 50 | **11** | **8A** | -1,9 | 0,9 | 5,6 |

NOTE: Positive values for sub-class "B" should not be taken into consideration; in all these cases the 1st adjacent channel requirement in clause 4.3.2 is fixed to 0 dB even if the relevant spectrum masks is not formally consistent. Therefore, 0 dB should be assumed also for the 2nd adjacent requirement.

**Table P.5: C/I$_{2A}$ best case values calculated for bands above 57 GHz**

| Current C/I$_{co}$ (1 dB deg) (reprinted values in dB from clause 4.3.2) | | | Calculated: C/I$_{2A}$ (1 dB deg) = (C/I$_{co}$ – NFD$_{2A}$) (NFD$_{2A}$ from table P.3) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Index | Class | dB | Reference Index | Class | CS (MHz) | | | | | | | |
| | | | | | ≤ 250 | 251 to 500 | 501 to 750 | 751 to 1 000 | 1 001 to 1 250 | 1 250 to 1 500 | 1 501 to 1 750 | 1 751 to 2 000 |
| **1 and 2** | 1 and 2 | 23,0 | **1 and 2** | **1 and 2** | -16,5 | -13,5 | -11,7 | -10,5 | -9,5 | -8,7 | -8,0 | -7,5 |
| **3** | 3 | 25,0 | **3** | **3** | -14,5 | -11,5 | -9,7 | -8,5 | -7,5 | -6,7 | -6,0 | -5,5 |
| **4** | 4L | 27,0 | **4** | **4L** | -12,5 | -9,5 | -7,7 | -6,5 | -5,5 | -4,70 | -4,00 | -3,50 |
| **5** | 4H | 30,0 | **5** | **4H** | -12,4 | -9,4 | -7,7 | -6,50 | -5,50 | -4,70 | -4,00 | -3,50 |
| **6** | 5LB | 33,5 | **6** | **5LB** | -10,8 | -8,8 | -7,0 | -5,80 | -4,80 | -4,00 | -3,40 | -2,80 |
| **7** | 5HB | 37,0 | **7** | **5HB** | -7,3 | -7,3 | -6,50 | -5,30 | -4,30 | -3,50 | -2,90 | -2,30 |
| **8** | 6LB | 40,5 | **8** | **6LB** | -3,8 | -3,8 | -3,80 | -3,80 | -3,80 | -3,00 | -2,40 | -1,80 |
| **6** | 5LA | 33,5 | **6** | **5LA** | -10,9 | -8,9 | -7,2 | -6,00 | -5,00 | -4,20 | -3,50 | -2,90 |
| **7** | 5HA | 37,0 | **7** | **5HA** | -7,4 | -7,4 | -6,70 | -5,50 | -4,50 | -3,70 | -3,00 | -2,40 |
| **8** | 6LA | 40,5 | **8** | **6LA** | -3,9 | -3,9 | -4,00 | -4,00 | -4,00 | -3,20 | -2,50 | -1,90 |

# Annex Q (informative): Guidelines for using *stand-alone antennas*

When equipment is placed on the market without an antenna, and the user therefore sources a *stand-alone antenna* from the Marketplace, it is considered important, that the radio equipment manufacturer informs the user of the antenna characteristics required to use the radio equipment in accordance with its intended use.

Consequently, it is assumed that the equipment manufacturer would provide sufficient guidance to ensure that the combination of equipment and *stand-alone antenna* continues to meet the requirements of Directive 2014/53/EU [i.1] during its intended use. Therefore, where the use of *stand-alone antenna* is possible, it is assumed that the user instruction contains the information that the equipment can operate as intended only if connected to antenna with characteristics conforming:

- for bands in the range 1 GHz to 3 GHz: RPE of any class according to clause 4.4.2 of ETSI EN 302 217-4 [6] and XPD class 1 according to clause 4.5.2 of ETSI EN 302 217-4 [6];
- for bands above 3 GHz: RPE of class 2 or higher classes according to clause 4.4.3 to clause 4.4.9 of ETSI EN 302 217-4 [6] and XPD class 1 according to clause 4.5.2 of ETSI EN 302 217-4 [6];
- to minimum gain according to the minimum value, if any required, in the relevant band annexes from B through J of the present document.

# Annex R (informative): Payload flexibility

For quick identification of the system, the capacities in tables X.2 (where X = B, C, D, E, F, G, H, I, J represents the relevant annex) are the minimum transmitted RIC required for conformance to the present document; they are based on the "minimum RIC density" defined in clause 4.1.4. Only some cases of systems in annex B, due to the smaller channel separation provided, are (exceptionally) labelled with typical *gross bit rate* rather than minimum RIC capacity rates.

However, equipment may offer a variety of base band interfaces, e.g. typical hierarchical rates PDH or SDH, ISDN, Ethernet as well as mixture of these or other standardized interfaces. Mapping/multiplexing of the various base-band interfaces into common frame(s) suitable for radio transmission may be done using standardized higher hierarchical frames or other proprietary methods. Basically, the sum of the payloads of all base band interfaces, that are transported through the system to the equivalent receiver interface, should be higher than the minimum RIC for the specific case considered.

NOTE: Information on applicable base-band interfaces can be found in ETSI EN 302 217-1 [5].

Table N.1a through table N.1h in annex N summarize the "minimum RIC" considered in the present document and, when only PDH or SDH interfaces are provided, give the equivalent capacity in terms of number of 2,048 Mbit/s streams provided as multiple or single multiplexed PDH or SDH interfaces. These minimum capacities will be associated to the relevant channel separation and spectral efficiency classes defined.

Regulatory provisions for frequency bands above 57 GHz are relatively more recent than for lower frequency bands and provide larger CS sizes; therefore, the specified minimum RIC density is likely composed by packed based traffic only. However, even if no specific equivalence tables are here defined, PDH or SDH interface combinations are possible provided that the overall RIC fulfil the relevant minimum RIC requirement reported in table G.2, table H.2 and table I.2.

Equipment may operate with one single RIC payload rate or with multiple RIC payload rates (*multirate systems*), either statically preset (possibly coupled also with *preset-mode* operation) or, when coupled with *mixed-mode* operation, dynamically changing according to the modulation format.

The requirements of the present document apply separately to each transmitter/receiver or single transmitters or receivers used for combining complex or simple (e.g. space diversity receivers or single transmitters and receivers used for unidirectional links) fixed radio systems. Systems carrying N × single channel capacity might actually be aggregated for carrying a higher capacity level signal (see example) in more than one radio frequency channel/polarization (e.g. in *multi-channel* configuration, including similar use of *channels-aggregation* equipment), provided that each equipment for each channel meets the channel requirements (see clause O.3 in annex O). When frequency reuse (e.g. dual polarization reuse or other frequency reuse techniques) is applied, the requirements apply independently to each transmitter/receiver and, in *channels-aggregation* case, to each *aggregated channel*; the different interference potential of frequency reuse will be dealt with in the frequency planning associated with the licensing process.

EXAMPLE: N × STM-1 (N = 1,2) capacity might be aggregated for carrying STM-4 signal in more than one radio frequency channel/polarization; also N × Ethernet capacity might be aggregated for carrying 1000base-T (or multiple 1000base-T) signal in more than one radio frequency channel/polarization.

# Annex S (informative): Test interpretation and measurement uncertainty

Test reports should be produced according to the procedure for compiling the technical documentation set out in Directive 2014/53/EU [i.1].

Interpretation of the results recorded in a test report of the measurements described in the present document should 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 should 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.26] and, when radiated measurements are concerned, ETSI TR 102 215 [i.29]).

In conclusion:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document; figure S.1 graphically shows this concept;

- the value of the measurement uncertainty for the measurement of each parameter should be included in the test report (see note).

NOTE: Nowadays, this procedure is common within the obligations related to accreditation of test laboratory and to the quality assurance certification of the manufacturer. It should also be mentioned that having as better as possible measurement uncertainty is in the interest of any liable manufacturer; in particular, while it does not affect the pass/fail decision in the first assessment, it may represent a safeguard towards claimed non conformity in future re-testing, possibly with poorer uncertainly.

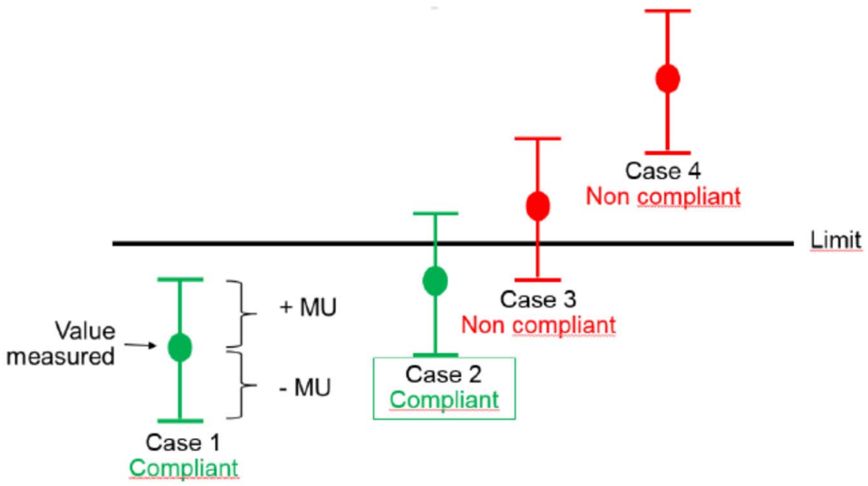



**Figure S.1: Measurement Uncertainty (MU) and compliance to the limit**

# Annex T (informative): Bibliography


- 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).

NOTE: Repealed by Directive 2014/53/EU [i.1].

- ERC/DEC(00)07: "ERC Decision of 19 October 2000 on the shared use of the band 17.7 - 19.7 GHz by the fixed service and Earth stations of the fixed-satellite service (space to Earth)".
- Recommendation ITU-R P.530: "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".
- ECC/REP 173: "Fixed Service in Europe; Current use and future trends post 2016".
- Report Recommendation ITU-R F.2323: "Fixed service use and future trends".
- Recommendation ITU-R F.1101-0: "Characteristics of digital fixed wireless systems below about 17 GHz".
- ETSI EN 302 217-2-2: "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2-2: Digital systems operating in frequency bands where frequency co-ordination is applied; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

# Annex U (informative): Change history

| Version | Information about changes |
|---|---|
| V3.1.1 | First published version covering Directive 2014/53/EU.<br>Major changes (+) are:<br>- Addition of background and assessment requirements for *channels-aggregation* systems.<br>- Translation of assessment requirements to be applicable under article 3.2 of Directive 2014/53/EU.<br>- Consequent change also for bands above 57 GHz of TX emission limitations into conventional spectral power density masks and addition of full set of receiver parameters.<br>- Consequent revision of assessment methodology for directional antenna parameters.<br>- Enlarged requirements related to RX interference sensitivity versus frequency (second adjacent channel sensitivity).<br>- Old spectral power density masks other than those in clause 4.2.4 completely removed.<br>(+) with respect to HS ETSI ETSI EN 302 217-2-2 (V2.2.1). |
| V3.2.2 | - Extension of CS (up to 2 000 MHz) also for spectral efficiency higher than class 3 in 71-86 GHz range.<br>- Inclusion of specific limits of radio frequency tolerance for equipment operating below 3 GHz (EC request).<br>- More detailed deployment applications and requirements for *channels-aggregation* systems. |
| V3.3.0 | - Clarifications about remarks and notes made by GROW-RED (ref. Ares(2020)5066773) for publishing V3.2.2 in the OJEU (e.g note 2 of clause 4.3.2 is removed and the the appropriate test method for requirements in clauses H.3.4, I.3.4 or J.3.4 is added)<br>- Reduction of minimum nominal antenna gain for 71 GHz to 86 GHz (annex J) to 30 dBi.<br>- Introduction of channels-aggregation equipment with number of aggregated channels N>2, distributed among any number of single-channel-ports and multiple-channels-ports, the latter delivering maximum 2 channels.<br>- Introduction of CS = 80 MHz in bands U6 and 11 GHz (annex D), CS = 112 MHz in 11 GHz band (annex C) and CS=220/224 MHz in bands from 18 GHz to 42 GHz (annexes E and F).<br>- Modified frequency tolerance in frequency bands above 57 GHz for relatively small channel size not to exceed 2 % of CS.<br>- Reinstating missing spectrum mask for CS = 20 MHz in U6 band as special case in annex C.<br>- Clarification in clause B.3.2 and in the notes to figures 7a) through 7e) that masks for channels based on N x 1,75 MHz size are valid also below 3 GHz (annex B).<br>- Clarification of the requirements and test of "Dynamic change of modulation" when both ACM and bandwidth adaptation techniques are used.<br>- Alignment to the requirements of CEPT/ERC/REC 74-01 (revision 2019) [3]. |

# History

| Document history | | |
|---|---|---|
| V1.1.3 | December 2004 | Publication as Publication as ETSI EN 302 217 part 2-2 |
| V1.1.3 | March 2005 | Publication as Publication as ETSI EN 302 217 part 3 |
| V1.2.3 | September 2007 | Publication as Publication as ETSI EN 302 217 part 2-2 |
| V1.2.1 | February 2008 | Publication as Publication as ETSI EN 302 217 part 3 |
| V1.3.1 | April 2009 | Publication as Publication as ETSI EN 302 217 part 2-2 |
| V1.3.1 | July 2009 | Publication as Publication as ETSI EN 302 217 part 3 |
| V1.4.1 | July 2010 | Publication as Publication as ETSI EN 302 217 part 2-2 |
| V2.1.1 | July 2013 | Publication as ETSI EN 302 217 part 2-2 and part 3 |
| V2.2.1 | April 2014 | Publication as ETSI EN 302 217 part 2-2 and part 3 |
| V3.1.1 | May 2017 | Publication |
| V3.2.2 | February 2020 | Publication |
| V3.3.0 | June 2021 | EN Approval Procedure AP 20210830: 2021-06-01 to 2021-08-30 |