



**Fixed Radio Systems;  
Characteristics and requirements for  
point-to-point equipment and antennas;  
Part 2: Digital systems operating in frequency bands  
from 1,3 GHz to 86 GHz;  
Harmonised Standard covering the essential requirements  
of article 3.2 of Directive 2014/53/EU**

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# Contents

Intellectual Property Rights .....	9
Foreword.....	9
Modal verbs terminology.....	9
Introduction .....	9
1 Scope .....	10
1.1 Generality .....	10
1.1.1 Applicability .....	10
1.1.2 Operating frequency bands .....	10
1.2 Spectral efficiency classes .....	10
1.3 System alternatives .....	11
1.4 Channel arrangements and utilization .....	12
1.5 Payload flexibility .....	12
1.6 Specific Requirements for frequency bands .....	12
2 References .....	13
2.1 Normative references .....	13
2.2 Informative references .....	14
3 Definitions, symbols and abbreviations .....	17
3.1 Definitions .....	17
3.2 Symbols .....	17
3.3 Abbreviations .....	17
4 Technical requirements specifications .....	18
4.1 General requirements .....	18
4.1.1 Requirements framework .....	18
4.1.2 Minimum RIC density .....	19
4.1.3 Payload flexibility .....	20
4.1.4 System identification and traffic loading .....	20
4.1.5 Environmental profile .....	21
4.2 Transmitter requirements .....	22
4.2.0 General: system loading .....	22
4.2.1 Transmitter power and power tolerance .....	22
4.2.1.1 Maximum power and EIRP .....	22
4.2.1.2 Combined TX power output and EIRP limits .....	22
4.2.1.3 Output power tolerance .....	23
4.2.2 Transmitter power and frequency control .....	23
4.2.2.1 Power Control (ATPC and RTPC) .....	23
4.2.2.1.0 General background .....	23
4.2.2.1.1 Automatic Transmit Power Control (ATPC) .....	23
4.2.2.1.2 Remote Transmit Power Control (RTPC) .....	24
4.2.2.2 Remote Frequency Control (RFC) .....	24
4.2.3 Radio Frequency (RF) spectrum mask .....	24
4.2.3.1 Limits background .....	24
4.2.3.2 Limits .....	27
4.2.4 Discrete CW components exceeding the spectrum mask limit .....	40
4.2.4.1 Discrete CW components at the symbol rate .....	40
4.2.4.2 Other discrete CW components exceeding the spectrum mask limit .....	40
4.2.5 Unwanted emissions in the <i>spurious domain</i> - external .....	41
4.2.6 Dynamic Change of Modulation Order .....	42
4.2.7 Radio frequency tolerance .....	42
4.2.8 Emission limitations outside the allocated band .....	43
4.3 Receiver requirements .....	43
4.3.0 General: System loading .....	43
4.3.1 Unwanted emissions in the <i>spurious domain</i> - external .....	43
4.3.2 BER as a function of receiver input signal level RSL .....	43
4.3.3 Receiver selectivity .....	44

4.3.3.1	Introduction.....	44
4.3.3.2	Co-channel "external", first and second adjacent channel interference sensitivity .....	45
4.3.3.2.1	Requirements basics .....	45
4.3.3.2.2	Limits for co-channel and first adjacent channel .....	45
4.3.3.2.3	Limits for second adjacent channel interference .....	46
4.3.3.3	CW spurious interference (blocking & spurious response rejection) .....	46
4.4	Antenna Characteristics.....	47
4.4.1	Integral antennas or dedicated antennas.....	47
4.4.1.1	Introduction.....	47
4.4.1.2	Radiation Pattern Envelope (Off-axis EIRP density).....	47
4.4.1.3	Antenna gain .....	47
4.4.1.4	Antenna Cross-Polar Discrimination (XPD) .....	48
4.4.2	Guidelines for <i>stand-alone</i> antennas.....	48
5	Testing for compliance with technical requirements.....	48
5.1	Environmental and other conditions for testing.....	48
5.1.1	Environmental conditions .....	48
5.1.2	Test interpretation and measurement uncertainty .....	49
5.1.3	Other basic conditions .....	49
5.2	Test methods for the transmitter.....	50
5.2.0	General test summary .....	50
5.2.1	Transmitter power and power tolerance.....	51
5.2.1.1	Transmitter power and EIRP .....	51
5.2.1.2	Combined TX power output and EIRP limits .....	51
5.2.1.3	Output power tolerance .....	52
5.2.2	Transmitter power and frequency control.....	52
5.2.2.1	Transmitter Power Control (ATPC and RTPC) .....	52
5.2.2.1.1	ATPC.....	52
5.2.2.1.2	RTPC.....	52
5.2.2.2	Remote Frequency Control (RFC) .....	52
5.2.3	RF spectrum mask .....	52
5.2.4	Discrete CW components exceeding the spectrum mask limit .....	53
5.2.5	Unwanted emissions in the spurious domain - external.....	53
5.2.6	Dynamic Change of Modulation Order .....	53
5.2.7	Radio frequency tolerance .....	54
5.3	Test methods for the receiver .....	54
5.3.0	General test summary .....	54
5.3.1	Unwanted emissions in the spurious domain - external.....	55
5.3.2	BER as a function of receiver input signal level (RSL).....	55
5.3.3	Receiver selectivity.....	56
5.3.3.1	Void.....	56
5.3.3.2	Co-channel "external", first and second adjacent channel interference sensitivity .....	56
5.3.3.2.1	Co-channel and first adjacent channel .....	56
5.3.3.2.2	Second adjacent channel.....	56
5.3.3.3	CW spurious interference.....	56
5.4	Additional antenna test methods for systems with integral or dedicated antenna .....	56
5.4.0	General test summary .....	56
5.4.1	Radiation Pattern Envelope (Off-axis EIRP density).....	57
5.4.2	Antenna gain.....	57
5.4.3	Antenna Cross-Polar Discrimination (XPD).....	57

<b>Annex A (normative):</b>	<b>Relationship between the present document and the essential requirements of Directive 2014/53/EU .....</b>	<b>58</b>
-----------------------------	---------------------------------------------------------------------------------------------------------------	-----------

<b>Annex B (normative):</b>	<b>Frequency bands from 1,4 GHz to 2,6 GHz .....</b>	<b>60</b>
-----------------------------	------------------------------------------------------	-----------

B.1	Introduction .....	60
B.2	General characteristics .....	60
B.2.1	Frequency characteristics and channel arrangements .....	60
B.2.2	Transmission capacities.....	60
B.3	Transmitter .....	61

B.3.1	General requirements .....	61
B.3.2	RF spectrum masks options .....	61
B.4	Receiver .....	62
B.4.1	General requirements .....	62
B.4.2	BER as a function of receiver input signal level (RSL) .....	62
B.4.3	Co-channel "external" and adjacent channels interference sensitivity .....	63

**Annex C (normative):      Frequency bands from 3 GHz to 11 GHz (channel separation up to 30 MHz and 56/60 MHz) .....65**

C.1	Introduction .....	65
C.2	General characteristics .....	65
C.2.1	Frequency characteristics and channel arrangements .....	65
C.2.2	Transmission capacities .....	66
C.3	Transmitter .....	67
C.3.1	General requirements .....	67
C.3.2	RF spectrum masks .....	67
C.4	Receiver .....	67
C.4.1	General requirements .....	67
C.4.2	BER as a function of Receiver input Signal Level (RSL) .....	67
C.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	69

**Annex D (normative):      Frequency bands from 3 GHz to 11 GHz (channel separation 40 MHz) .....70**

D.1	Introduction .....	70
D.2	General characteristics .....	70
D.2.1	Frequency characteristics and channel arrangements .....	70
D.2.2	Transmission capacities .....	70
D.3	Transmitter .....	71
D.3.1	General requirements .....	71
D.3.2	RF spectrum masks .....	71
D.4	Receiver .....	72
D.4.1	General requirements .....	72
D.4.2	BER as a function of Receiver input Signal Level (RSL) .....	72
D.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	73

**Annex E (normative):      Frequency bands 13 GHz, 15 GHz and 18 GHz.....74**

E.1	Introduction .....	74
E.2	General characteristics .....	74
E.2.1	Frequency characteristics and channel arrangements .....	74
E.2.2	Transmission capacities .....	75
E.3	Transmitter .....	75
E.3.1	General requirements .....	75
E.3.2	RF spectrum masks .....	75
E.4	Receiver .....	76
E.4.1	General requirements .....	76
E.4.2	BER as a function of Receiver input Signal Level (RSL) .....	76
E.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	78

**Annex F (normative):      Frequency bands from 23 GHz to 42 GHz .....80**

F.1	Introduction .....	80
F.2	General characteristics .....	80
F.2.1	Frequency characteristics and channel arrangements .....	80
F.2.2	Transmission capacities .....	81

F.3	Transmitter .....	81
F.3.1	General requirements .....	81
F.3.2	RF spectrum masks .....	81
F.4	Receiver .....	82
F.4.1	General requirements .....	82
F.4.2	BER as a function of Receiver input Signal Level (RSL) .....	82
F.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	85

## **Annex G (normative): Frequency bands from 50 GHz to 55 GHz .....86**

G.1	Introduction .....	86
G.2	General characteristics .....	86
G.2.1	Frequency characteristics and channel arrangements .....	86
G.2.2	Transmission capacities .....	87
G.3	Transmitter .....	87
G.3.1	General requirements .....	87
G.3.2	RF spectrum masks .....	87
G.4	Receiver .....	87
G.4.1	General requirements .....	87
G.4.2	BER as a function of Receiver input Signal Level (RSL) .....	88
G.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	88

## **Annex H (normative): Frequency band 57 GHz to 66 GHz .....89**

H.1	Introduction .....	89
H.2	General characteristics .....	89
H.2.1	Frequency characteristics and channel arrangements .....	89
H.2.2	Transmission capacities .....	89
H.3	Transmitter .....	90
H.3.1	General requirements .....	90
H.3.2	Combined TX power output and EIRP limits .....	90
H.3.2.1	Maximum power and EIRP .....	90
H.3.2.2	Equipment without ATPC as permanent feature .....	91
H.3.2.3	Equipment implementing ATPC as permanent feature .....	91
H.3.3	RF spectrum masks .....	93
H.3.4	Emissions outside the 57 GHz to 66 GHz range .....	94
H.4	Receiver .....	94
H.4.1	General requirements .....	94
H.4.2	BER as a function of Receiver input Signal Level (RSL) .....	94
H.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	95
H.5	Minimum antenna gain .....	96

## **Annex I (normative): Frequency band 64 GHz to 66 GHz .....97**

I.1	Introduction .....	97
I.2	General characteristics .....	97
I.2.1	Frequency characteristics and channel arrangements .....	97
I.2.2	Transmission capacities .....	98
I.2.2.1	Channel arrangement based on $N \times 50$ MHz .....	98
I.2.2.2	Channel arrangement based on $N \times 30$ MHz .....	98
I.3	Transmitter .....	99
I.3.1	General requirements .....	99
I.3.2	Combined TX power and EIRP limits .....	99
I.3.2.1	Generality .....	99
I.3.2.2	Equipment without ATPC as permanent feature .....	99
I.3.2.3	Equipment implementing ATPC as permanent feature .....	100
I.3.3	RF spectrum mask .....	102

I.3.4	Emissions outside the 64 GHz to 66 GHz range .....	102
I.4	Receiver.....	102
I.4.1	General requirements .....	102
I.4.2	BER as a function of Receiver input Signal Level (RSL) .....	102
I.4.2.1	Channel arrangement based on $N \times 50$ MHz .....	102
I.4.2.2	Channel arrangement based on $N \times 30$ MHz .....	102
I.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	103
I.4.3.1	Channel arrangement based on $N \times 50$ MHz .....	103
I.4.3.2	Channel arrangement based on $N \times 30$ MHz .....	104
I.5	Minimum antenna gain.....	104
<b>Annex J (normative):</b>	<b>Frequency bands from 71 GHz to 86 GHz .....</b>	<b>105</b>
J.1	Introduction .....	105
J.2	General characteristics .....	105
J.2.1	Frequency characteristics and channel arrangements .....	105
J.2.2	Transmission capacities .....	106
J.3	Transmitter .....	106
J.3.1	General requirements .....	106
J.3.2	Combined maximum transmitter power and EIRP .....	107
J.3.2.1	Generality .....	107
J.3.2.2	Equipment without ATPC as permanent feature .....	107
J.3.2.3	Equipment implementing ATPC as permanent feature.....	108
J.3.3	RF spectrum masks .....	110
J.3.4	Emissions outside the 71 GHz to 76 GHz and 81 GHz to 86 GHz ranges .....	110
J.3.4.1	General requirement .....	110
J.3.4.2	Requirement for emissions above 86 GHz band edge .....	110
J.3.4.3	Conformance statement (see note).....	111
J.4	Receiver.....	111
J.4.1	General requirements .....	111
J.4.2	BER as a function of Receiver input Signal Level (RSL) .....	111
J.4.3	Co-channel "external" and adjacent channel interference sensitivity .....	113
J.5	Minimum antenna gain.....	114
<b>Annex K:</b>	<b>Void .....</b>	<b>115</b>
<b>Annex L:</b>	<b>Void .....</b>	<b>116</b>
<b>Annex M:</b>	<b>Void .....</b>	<b>117</b>
<b>Annex N (normative):</b>	<b>Definition of equivalent data rates for packet data, PDH/SDH and other signals on the traffic interface.....</b>	<b>118</b>
N.1	Introduction .....	118
N.2	General characteristics .....	118
N.2.1	Frequency characteristics and channel arrangements .....	118
N.2.2	Transmission capacities .....	118
N.3	System parameters.....	121
N.3.0	Introduction .....	121
N.3.1	Transmitter .....	121
N.3.2	Receiver.....	121
N.3.3	FER as a function of BER .....	121
<b>Annex O (normative):</b>	<b>Test report in relation to flexible systems applications .....</b>	<b>123</b>
O.1	Wide radio-frequency band covering units .....	123
O.2	Multirate/multiformat equipment .....	125
O.2.0	Introduction .....	125

O.2.1	Generic required tests in the test report .....	126
O.2.2	Reduced set of required tests in the test report .....	126
O.2.2.0	Introduction .....	126
O.2.2.1	Reduced transmitter tests .....	126
O.2.2.2	Reduced receiver tests .....	127
O.2.3	Bandwidth adaptive test set requirements .....	128
O.3	BER and C/I measurement in <i>multi-channels</i> systems (including <i>channels-aggregation</i> ) when common SDH or Ethernet single/multiple-interfaces payload is provided .....	128
O.3.0	Introduction .....	128
O.3.1	Case 1: multi-interfaces/two-channels systems where each interface payload is transmitted on one channel only .....	129
O.3.2	Case 2: single interface or multi-interfaces/two-channels system where each payload interface is transmitted equally split on both channels .....	129
O.4	Test provisions for <i>channels-aggregation</i> equipment .....	131
O.4.1	General requirements and test method .....	131
O.4.2	Limits combination for <i>single-port</i> case .....	133
<b>Annex P (informative):</b>	<b>Impact of power control (ATPC and/or RTPC), mixed-mode and bandwidth adaptive operation on spectrum mask and link design requirements.....</b>	<b>136</b>
P.0	Introduction .....	136
P.1	ATPC and RTPC implementation background .....	136
P.2	Mixed-mode operation impact .....	137
P.2.1	Basic concepts .....	137
P.3	Bandwidth adaptive operation impact .....	138
P.3.1	Basic concepts .....	138
P.3.2	Bandwidth (channel) occupancy .....	138
P.4	Impact on frequency co-ordination .....	138
P.5	Impact on article 3.2 "essential" parameters and operating conditions .....	139
<b>Annex Q (informative):</b>	<b>Typical interference sensitivity behaviour for frequency planning purpose.....</b>	<b>141</b>
<b>Annex R (informative):</b>	<b>Technical background for receiver selectivity and C/I interference sensitivity evaluation.....</b>	<b>142</b>
R.1	Receiver selectivity .....	142
R.1.1	Introduction .....	142
R.1.2	Graphical representation of WBSEL .....	143
R.2	C/I interference sensitivity .....	143
R.2.1	Introduction .....	143
R.2.2	Ideal selectivity and best case C/I value for 2nd adjacent CS .....	144
<b>Annex S (informative):</b>	<b>Bibliography.....</b>	<b>147</b>
<b>Annex T (informative):</b>	<b>Change History .....</b>	<b>148</b>
History .....		149



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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.64] 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 [4].

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
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## 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).

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## 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 [4].

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# 1 Scope

## 1.1 Generality

### 1.1.1 Applicability

The present document specifies the essential parameters for Point-to-point (P-P) Digital Fixed Radio Systems (DFRS) operating in frequency bands allocated to Fixed Service (FS) from 1,3 GHz to 86 GHz.

Systems in the scope of the present document are generally intended to operate in full frequency division duplex (FDD) and covers also unidirectional applications. Time division duplex (TDD) applications, when possibly applicable in a specific band, are explicitly mentioned as appropriate in annexes B through J.

The present document intends to cover the provisions of the Directive 2014/53/EU [i.1] regarding article 3.2 (see note 1).

NOTE 1: In particular recital 10 of the Directive 2014/53/EU [i.1] highlights the similar importance of TX and RX characteristics in the avoidance of harmful interference and in efficient use of shared or adjacent channels.

In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of article 3 of the Directive 2014/53/EU [i.1] may apply to equipment within the scope of the present document.

NOTE 2: A list of such ENs is included on the web site <http://www.newapproach.org>.

For the correct understanding and application of the requirements in the present document, the definitions summarized in ETSI EN 302 217-1 [4] are also relevant; those definitions are generally hereby identified with the use of *italic characters* (e.g. *mixed-mode*).

Common provisions applicable for all bands are defined in clause 1.2 to clause 1.5, while band specific provisions are defined in clause 1.6.

### 1.1.2 Operating frequency bands

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 and J represents the relevant annex); "*channel-aggregation*" (see definition in ETSI EN 302 217-1 [4]) systems may operate each "*aggregated-channel*" in different bands among those listed in the above mentioned tables.

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

For channel arrangements of different bands refer to ECC and/or ITU-R recommendations; whenever a different national band arrangement is used in one EC member state, those provisions apply as well.

The above ECC and/or Recommendation ITU-Rs 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).

## 1.2 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) required in clause 4.1.2. *Radio Interface Capacity* (RIC) is defined in ETSI EN 302 217-1 [4].

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 polarisation (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).

## 1.3 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 [5], 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 1.2; 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 [4]; additional information on *Mixed-mode* systems can be found in annex P of the present document and in ETSI TR 103 103 [i.35].

## 1.4 Channel arrangements and utilization

Requirements for different bands are described in the individual annexes 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.

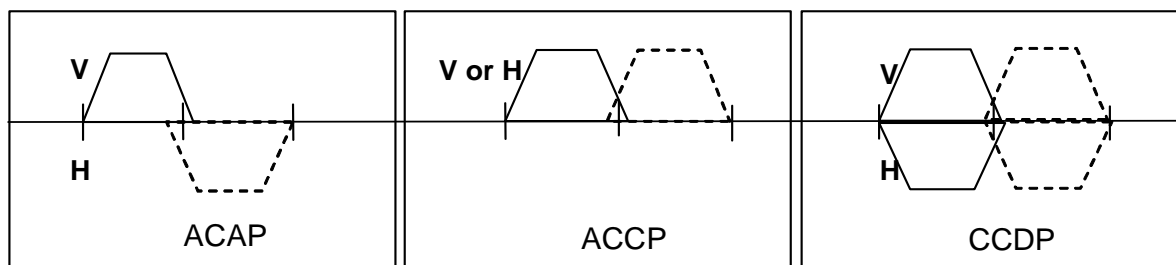


Figure 1: Examples of adjacent channel arrangements on the same route

## 1.5 Payload flexibility

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.

All baseband payload interfaces are possible provided that they met the overall minimum RIC required under the provisions of clause 4.1.2 and clause 4.1.3.

NOTE: Information on applicable base-band interfaces can be found in ETSI EN 302 217-1 [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 [4]; 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.30].

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 2,7 GHz:  
Systems with channel separations ranging from 0,025 MHz to 14 MHz for indicative payloads capacity ranging from 0,0096 Mbit/s to 38 Mbit/s. See detailed summary in table B.2.

- Annex C: Frequency bands from 3 GHz to 11 GHz (channel separation up to 30 MHz and 56/60 MHz): Systems with channel separations ranging from 1,75 MHz to 30 MHz and 56/60 MHz for minimum RIC payload rates ranging from 2 Mbit/s up to about 430 Mbit/s. See detailed summary in table C.2.
- Annex D: Frequency bands from 3 GHz to 11 GHz (channel separation 40 MHz): Systems with channel separations 40 MHz for minimum RIC payload rates from about 137 Mbit/s to about 300 Mbit/s or hierarchic from STM-1 to  $2 \times$  STM-1 (ACAP or ACCP) and STM-4/4  $\times$  STM-1 for CCDP operation or spread over  $2 \times 40$  MHz channels). See detailed summary in 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 110 MHz) for minimum RIC payload rates ranging from 2 Mbit/s up to about 430 Mbit/s and up to 860 Mbit/s in 18 GHz band. See detailed summary in table E.2.
- Annex F: Frequency bands from 23 GHz to 42 GHz: Systems with channel separations ranging from 3,5 MHz to 112 MHz for minimum RIC payload rates ranging from 2 Mbit/s up to about 860 Mbit/s. See detailed summary in 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 ranging from 2 Mbit/s up to about 128 Mbit/s. See detailed summary in table G.2.
- Annex H: Frequency bands from 57 GHz to 66 GHz: Systems with channel separations  $N \times 50$  MHz granularity up to 2 000 MHz. for minimum RIC payload rates ranging from about 28,5 Mbit/s up to about 3 000 Mbit/s. See detailed summary in table H.2.
- Annex I: Frequency band from 64 GHz to 66 GHz: Systems with channel separations  $N \times 50$  MHz or  $N \times 30$  MHz up to about 2 000 MHz for minimum RIC payload rates ranging from about 17 Mbit/s up to about 3 000 Mbit/s. See detailed summary in 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 ranging from about 35 Mbit/s up to about 3 000 Mbit/s. See detailed summary in table J.2.

In those annexes further subdivision is made, as appropriate, according to frequency bands, capacities and/or channel separation (see tables 2 and 3 of ETSI EN 302 217-1 [4]).

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## 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 reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://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] 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".
- [4] ETSI EN 302 217-1 (V3.0.5) (06-2016): "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 1: Overview, common characteristics and system-dependent requirements".
- [5] ETSI EN 302 217-4 (V2.0.3) (06-2016): "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4: Antennas".
- [6] IEEE 802.3TM-2012: "IEEE Standard for Ethernet".
- [7] ITU Radio Regulations (2012).
- [8] Recommendation ITU-T O.151 (10-1992) / Corrigendum 1 (05-2002): "Error performance measuring equipment operating at the primary rate and above".
- [9] Recommendation ITU-T O.181 (05-2002): "Equipment to assess error performance on STM-N interfaces".
- [10] Recommendation ITU-T O.191 (02-2000): "Equipment to measure the cell transfer performance of ATM connections".

## 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 reference 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 74-01 (Cardiff 2011): "Unwanted emissions in the spurious domain".
- [i.4] CEPT/ERC/REC(01)02 (2010): "Preferred channel arrangement for digital fixed service systems operating in the frequency band 31.8 - 33.4 GHz".
- [i.5] 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.6] CEPT/ERC/REC 12-03: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 17.7 GHz to 19.7 GHz".
- [i.7] 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.8] CEPT/ERC/REC 12-06 (2010): "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.7 GHz to 11.7 GHz".
- [i.9] CEPT/ERC/REC 12-07: "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.10] CEPT/ERC/REC 12-08: "Harmonized radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3600 MHz to 4200 MHz".
- [i.11] 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.12] CEPT/ERC/REC 12-12 (2015): "Radio frequency channel arrangement for fixed service systems operating in the band 55.78-57.0 GHz".
- [i.13] 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.14] 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.15] CEPT/ERC/REC 14-03: "Harmonized radio frequency channel arrangements for low and medium capacity systems in the band 3400 MHz to 3600 MHz".
- [i.16] CEPT/ERC/REC T/R 12-01 (2010): "Harmonized radio frequency channel arrangements for analogue and digital terrestrial fixed systems operating in the band 37-39.5 GHz".
- [i.17] CEPT/ERC/REC T/R 13-01 (2010): "Preferred channel arrangements for fixed services in the range 1-3 GHz".
- [i.18] CEPT/ERC/REC T/R 13-02 (2010): "Preferred channel arrangements for fixed services in the range 22.0 - 29.5 GHz".
- [i.19] 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.20] ECC/REC(01)05: "List of parameters of digital point-to-point fixed radio links used for national planning".
- [i.21] 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.22] ECC/REC (02)06 (2011): "Preferred channel arrangements for digital fixed service systems operating in the frequency range 7125-8500 MHz".
- [i.23] ECC/Recommendation (05)02 (2009): "Use of the 64 - 66 GHz frequency band for Fixed Service".
- [i.24] 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.25] ECC/REC(09)01: "Use of the 57 - 64 GHz frequency band for point-to-point Fixed Wireless Systems".
- [i.26] ECC/REC(14)06: "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.27] ECC Report 198: "Adaptive modulation and ATPC operations in fixed point-to-point systems - Guideline on coordination procedures".
- [i.28] ETSI EN 302 326-2: "Fixed Radio Systems; Multipoint Equipment and Antennas; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment".
- [i.29] ETSI TR 100 028 (all Parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [i.30] ETSI TR 101 506: "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements under the article 3.2 of 1999/05/EC Directive to Fixed Radio Systems".

- [i.31] 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.32] 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.33] 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.34] 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.35] 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.36] Recommendation ITU-R F.382-8: "Radio-frequency channel arrangements for fixed wireless systems operating in the 2 and 4 GHz bands".
- [i.37] 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.38] 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.39] Recommendation ITU-R F.385-10: "Radio-frequency channel arrangements for fixed wireless systems operating in the 7 110-7 900 MHz band".
- [i.40] 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.41] Recommendation ITU-R F.387-12: "Radio-frequency channel arrangements for fixed wireless systems operating in the 10.7-11.7 GHz band".
- [i.42] 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.43] Recommendation ITU-R F.595-10: "Radio-frequency channel arrangements for fixed wireless systems operating in the 17.7-19.7 GHz band".
- [i.44] 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.45] Recommendation ITU-R F.636-4: "Radio-frequency channel arrangements for fixed wireless systems operating in the 14.4-15.35 GHz band".
- [i.46] Recommendation ITU-R F.637-4: "Radio-frequency channel arrangements for fixed wireless systems operating in the 21.2-23.6 GHz band".
- [i.47] Recommendation ITU-R F.746-10: "Radio-frequency arrangements for fixed service systems".
- [i.48] Recommendation ITU-R F.747-1: "Radio-frequency channel arrangements for fixed wireless systems operating in the 10-10.68 GHz band".
- [i.49] 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.50] 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.51] Recommendation ITU-R F.1098-1: "Radio-frequency channel arrangements for fixed wireless systems in the 1 900 - 2 300 MHz band".



- [i.52] 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.53] Void.
- [i.54] Recommendation ITU-R F.1191-3: "Necessary and occupied bandwidths and unwanted emissions of digital fixed service systems".
- [i.55] 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.56] Recommendation ITU-R F.1243-0: "Radio-frequency channel arrangements for digital radio systems operating in the range 2 290-2 670 MHz".
- [i.57] Recommendation ITU-R F.1496-1: "Radio-frequency channel arrangements for fixed wireless systems operating in the band 51.4-52.6 GHz".
- [i.58] Recommendation ITU-R F.1497-2: "Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz".
- [i.59] 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.60] Recommendation ITU-R F.2005: "Radio-frequency channel and block arrangements for fixed wireless systems operating in the 42 GHz (40.5 to 43.5 GHz) band".
- [i.61] Recommendation ITU-R F.2006: "Radio-frequency channel and block arrangements for fixed wireless systems operating in the 71-76 and 81-86 GHz bands".
- [i.62] Recommendation ITU-R SM.329-12: "Unwanted emissions in the spurious domain".
- [i.63] 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.64] 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.

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## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI EN 302 217-1 [4] apply.

### 3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 302 217-1 [4] apply.

### 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 302 217-1 [4] apply.

## 4 Technical requirements specifications

### 4.1 General requirements

#### 4.1.1 Requirements framework

Guidance and description of the phenomena relevant to "essential requirements" under article 3.2 of the 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.30] and in ETSI TR 103 103 [i.35].

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 [4].

In the case of wide radio-frequency bands covering units and *multirate/multiformat* equipment, these specifications shall be met at any frequency, at any rate/format; the latter, for *mixed-mode* and/or *bandwidth-adaptive* systems, is intended as any rate/format defined as *reference-mode* (see note). However the tests, required for generating a test report and/or declaration of conformity, in order to fulfil any conformity assessment procedure with respect to the Directive 2014/53/EU [i.1], shall be carried out in accordance with the principles set out in annex O.

Only the declared (and therefore assessed) *reference-modes* can be used for planning purpose related to licensing conditions (where required). Modes not declared as *reference-mode* shall in no case be used for that purpose, but used only as additional modes in dynamic *mixed-mode* operation in accordance with the relevant requirement in clause 4.2.6.

NOTE 0: The terms *multirate/multiformat*, *mixed-mode*, *bandwidth-adaptive* and *reference-mode* are defined in ETSI EN 302 217-1 [4]. It is generally intended that the chosen *reference-modes* are those more suitable for the link planning purpose.

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) All TX and RX requirements in the present document shall be met by each *aggregated channel* when both emissions are turned on and operating according normal operating conditions specified by the manufacturer.
- 2) The manufacturer shall declare the equipment operating prescriptions in term 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 term of different receive power ratio (see note 1);
  - c) for *channel-aggregation/dual-port* only the mutual limitations also in term 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.
- 3) For assessment purpose according 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 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 two channels operate in non-contiguous or non-overlapping bands, also with different configurations as declared by the manufacturer); in this case, according 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 condition as declared by the manufacturer.

NOTE 1: RX power ratio may be needed for managing TX power tolerances of the two *aggregated channels*, 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 D of ETSI EN 302 217-1 [4]. RX power ratio may be function of the aggregated channels frequency separation.

NOTE 2: TX power ratio may be needed for different applications in particular for *dual-port* equipment where different nominal levels in different links direction are possibly needed or in case of *single-port* when differential RSL with fading on one of the channels can lead to TX power ratio (e.g. due to ATPC intervention). This may also imply 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 in this clause 4 (e.g. clause 5.2.2.1.1 refers to the ATPC test according 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 Minimum RIC density

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

Reference modulation index	Spectral efficiency class	Minimum RIC density (Mbit/s/MHz) (see note 1 and note 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, are rounded to the suitably closer Mbit/s integer or its fraction. Tables X.2 (where X = B, C, D, E, F, G, H, I and 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 only in annexes D and J.		

The minimum RIC density figures in table 1 are valid only for systems operating on the most common channel separation (CS) such as:

- 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) and "about" 112 MHz (i.e. 110 MHz or 112 MHz) the RIC density of actual systems is evaluated only over the "nominal" 14 MHz, 28 MHz, 56 MHz and 112 MHz channel width. In some bands also 40 MHz are also used.
- 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: For "*channels-aggregation*" equipment minimum RIC is defined for each *aggregated-channel* used.

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.

### 4.1.3 Payload flexibility

For quick identification of the system, the capacities in tables X.2 (where X = B, C, D, E, F, G, H, I and 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.

NOTE: Information on applicable base-band interfaces can be found in ETSI EN 302 217-1 [4].

Tables N.1a through 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 term 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.

Market interest and 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 tables G.2, H.2 and 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  $N \times$  single channel capacity might actually be aggregated for carrying a higher capacity level signal (see example) in more than one radio frequency channel/polarisation (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:  $N \times$  STM-1 ( $N = 1,2$ ) capacity might be aggregated for carrying STM-4 signal in more than one radio frequency channel/polarisation; also  $N \times$  Ethernet capacity might be aggregated for carrying a 1000baseT (or multiple 1000base T) signal in more than one radio frequency channel/polarisation.

### 4.1.4 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 1.2, to which the minimum RIC density, required in clause 4.1.2, is associated.
- 4) Actual declared maximum total RIC transmitted over the channel with the selected spectral efficiency class evaluated accordingly clause 4.1.3.

When *mixed-mode* and/or *bandwidth-adaptive* systems are concerned, the identification shall be related only to the *reference-modes*. These can be an arbitrary declared subset of the classes provided in clause 1.2 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. 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.  $2,28 \text{ Mbit/s} \times 10/4/\text{MHz} = 5,7 \text{ Mbit/s/MHz}$ ) 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 term of related minimum RIC.

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.

All the requirements are intended to be met loading the system with the maximum possible RIC, which shall be evaluated and declared by the supplier according to the definition in ETSI EN 302 217-1 [4] (see note 1). 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 and J represents the relevant annex) (see note 2). 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 tables N.1a to N.1h in annex N.

NOTE 1: More guidance on the system RIC evaluation can be found in ETSI TR 102 565 [i.34].

NOTE 2: Some systems described in table B.2, for CS equal to 2 MHz or for CS lower than 1,75 MHz, do not specify a minimum RIC but only an indicative channel capacity (*gross bit rate*).

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  $4 \times \text{STM-1}$  or  $2 \times \text{STM-1}$  (according to the maximum loading required for the equipment) capacities at the base band interface. Similar loading principles apply also for higher Ethernet BaseT interfaces transmitted over multiple radio systems.

NOTE 3: For each technical requirement in the present document, there might be additional characteristics, not considered relevant to article 3.2 of the 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 suppliers is required; these additional requirements, when identified, may be found in ETSI EN 302 217-1 [4].

## 4.1.5 Environmental profile

The required environmental profile for operation of the equipment shall be declared by the supplier. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the required operational environmental profile.

For testing the compliance to technical requirements see also ETSI EN 301 126-1 [1] and clause 5 of the present document.

**NOTE:** With the generic term of environmental profile, it is here intended 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 the 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 [4].

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 [8]
SDH	Recommendation ITU-T O.181 [9]
ATM	Recommendation ITU-T O.191 [10]
Ethernet interface (packet data) (see note 1)	IEEE 802.3 [6]
Other than the above (see note 1)	Relevant standards which the interface refers to (see note 2)
NOTE 1: As a general approach, all system characteristics and spectral efficiency classes are defined only in term of "minimum RIC". However, when the BER requirements are considered, they can be directly tested when conventional PDH or SDH interfaces are provided; while, whenever equipment offers different standardized base-band interfaces, annex N gives the criteria for defining an equivalent error rate for conformance purpose.	
NOTE 2: When standard interfaces are provided they shall comply with ITU-T standards or other standardized interface declared by the supplier. However, in some applications of these radio relay systems, interface parts may be integrated with other systems and therefore standard interfaces (X, X' reference sections) 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 tolerance

#### 4.2.1.1 Maximum power and EIRP

Unless differently specified in the relevant frequency dependent annexes, this parameter is not relevant for assessment under article 3.2 of Directive 2014/53/EU [i.1] (see note 1).

NOTE 1: Testing EIRP requirements is necessary for assessment of equipment with integral antenna only; however also equipment placed on the market without antennas should, in principle, refer, when relevant in common practice, to such limitation (e.g. defining the maximum associated antenna gain).

NOTE 2: The maximum power possibly generated by the radio system is assumed to be limited according the relevant provisions given in the Radio Regulations [7], either in term of EIRP of the systems (e.g. in article 21 and, for some specific frequency bands, in footnotes under article 5) (see note 1) or in term of maximum output power density fed to the antenna (e.g. footnote 5.482 for 10,6 GHz to 10,68 GHz band, footnote 5.522A for 18,6 GHz to 18,8 GHz band and footnote 5.557A for 55,78 GHz to 56,26 GHz band). Those limits are not considered related to equipment assessment under article 3.2 of Directive 2014/53/EU [i.1]. Those limits, when considered for purposes not in the scope of the present document are also assumed inclusive of tolerances and, if applicable, ATPC/RTPC influence.

For guidance, in addition to the absolute maximum transmitter power, typical values of transmitter highest power for real equipment, of feeder loss and length, and of antenna diameter and gain are provided in ETSI TR 102 243-1 [i.33] in order to support inter and intra-compatibility and sharing analysis.

#### 4.2.1.2 Combined TX power output and EIRP limits

When conventional link-by-link planning is made on the basis of the actual antenna used in each station, the maximum EIRP is defined in the link license.

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

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.

NOTE: In some frequency bands, or parts of frequency bands, ECC and/or Recommendations ITU-R already define specific limits in terms of output power and/or EIRP (or output power and/or EIRP density) in order to improve the compatibility with other Radio Services sharing these frequency bands with the FS. When retained appropriate, the present document endorses and suitably expands those provisions.

#### 4.2.1.3 Output power tolerance

The nominal transmitter power shall be declared by the supplier.

Within the environmental profile declared by the supplier for the intended limits of usage of the equipment, the tolerance of the nominal transmitter power shall be contained within the following limits:

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

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

### 4.2.2 Transmitter power and frequency control

#### 4.2.2.1 Power Control (ATPC and RTPC)

##### 4.2.2.1.0 General background

*Automatic Transmit Power Control* (ATPC) and *Remote Transmit Power Control* (RTPC) are commonly optional features.

ATPC and RTPC functions are usually implemented through an attenuator inserted along the transmitting chain (e.g. at IF or at RF level or at both levels) and can be realized in a mixed configuration, e.g.:

- ATPC only is implemented;
- RTPC only is implemented;
- ATPC + RTPC are implemented with separate attenuator functions;
- ATPC + RTPC are implemented with a single attenuator supplying both functions.

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

ATPC is an optional feature. Equipment with ATPC will be subject to a supplier's declaration of ATPC ranges (see note) and related tolerances. The supplier 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 ETSI EN 302 217-1 [4] while for additional clarification on ATPC and RTPC impact on requirements see annex P and ETSI TR 103 103 [i.35]. General background for ATPC operation may also be found in annex D of ETSI EN 302 217-1 [4].

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

Equipment with RTPC will be subject to a supplier's declaration with respect to RTPC ranges and related tolerances.

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 annex P and ETSI TR 103 103 [i.35].

#### 4.2.2.2 Remote Frequency Control (RFC)

*Remote Frequency Control* (RFC) functionality is an optional feature.

Equipment with RFC will be subject to a supplier's declaration of RFC ranges and related change frequency procedure.

RFC setting procedure (i.e. the hardware/software mechanisms that permits 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.

### 4.2.3 Radio Frequency (RF) spectrum mask

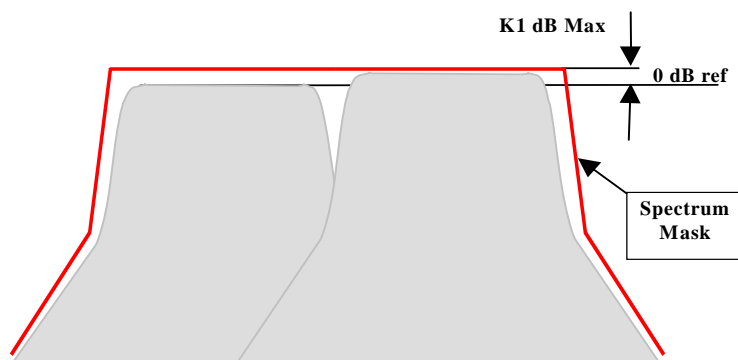
#### 4.2.3.1 Limits background

The 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, disregarding the level of the possible residual of the carrier (see note). The actual carrier frequency is identified with the  $f_0$  corner point; spectrum masks are shown in frequencies relative to  $f_0$ ; the spectrum mask is assumed to be symmetrical with respect to the centre frequency  $f_0$ .

When "*multi-carrier*" systems are concerned (see definition in ETSI EN 302 217-1 [4]) 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). 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: This is intended for avoid uncertainty due to the unmodulated spectral line that, due to modulation imperfection, 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.



**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 [4]), 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 discrete points (i.e.  $f_x$  MHz/ $K_x$  dB) identifying the frequency offset from  $f_0$  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 discrete points is dependent on the number of segments on the actual mask.



It is also assumed that the value associated with the final discrete point on the graph extends to a point equal to  $2,5$  times the channel separation (i.e.  $2,5 \times CS$ ) or, for emissions bandwidth  $> 500$  MHz, to a reduced extension according Recommendation ITU-R SM.1539-1 [i.63] (i.e.  $1,5 \times CS + 500$  MHz) on each side of the centre frequency.

The following figures 3 to 6 give the typical curves and their respective spectrum mask tabular representation. For all spectrum masks, the upper limit for frequencies is  $2,5 \times CS$  where  $CS$  is the channel separation.

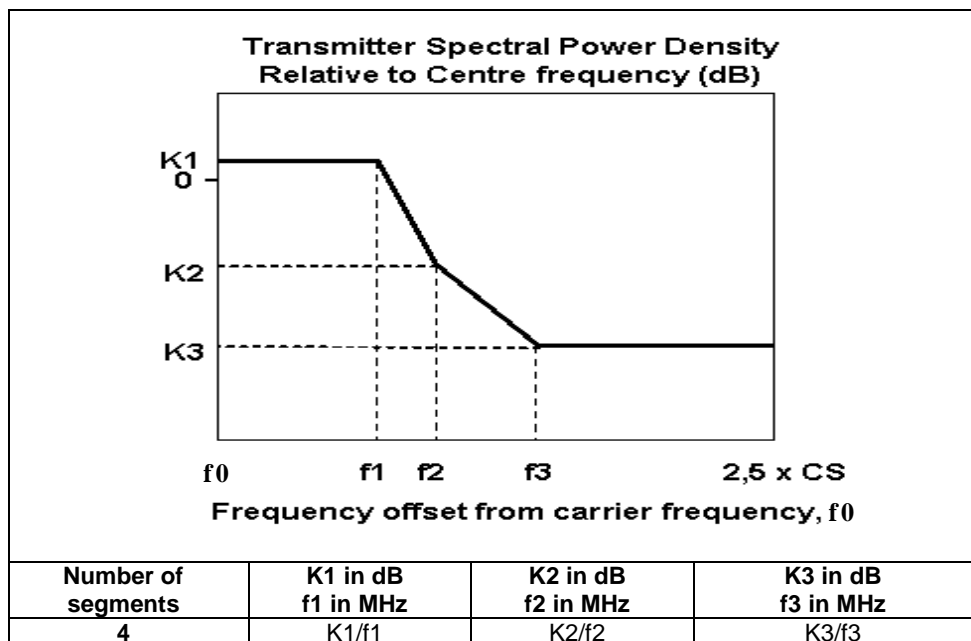


Figure 3: Four segment spectrum mask

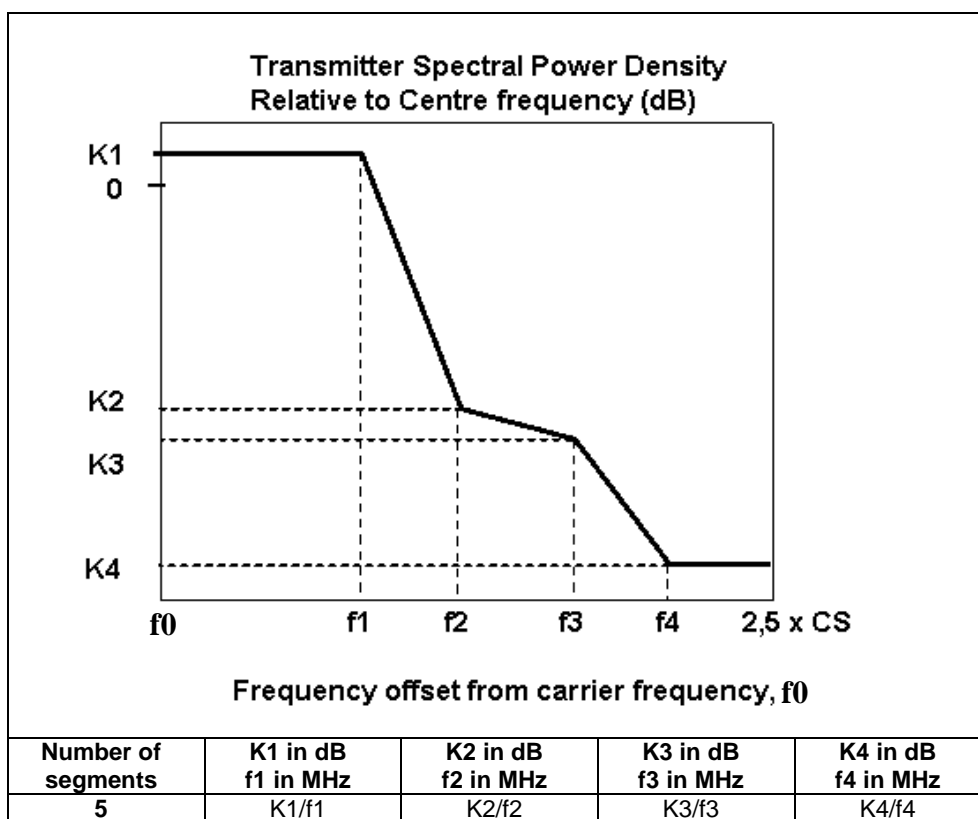


Figure 4: Five segment spectrum mask

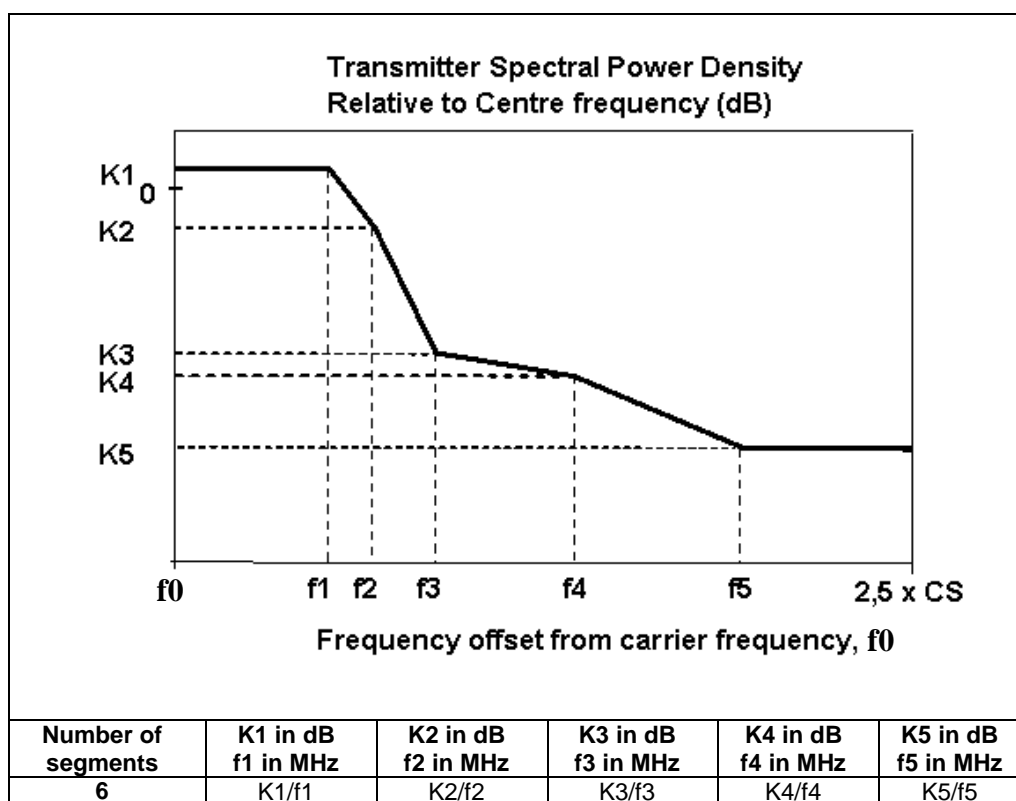


Figure 5: Six segment spectrum mask

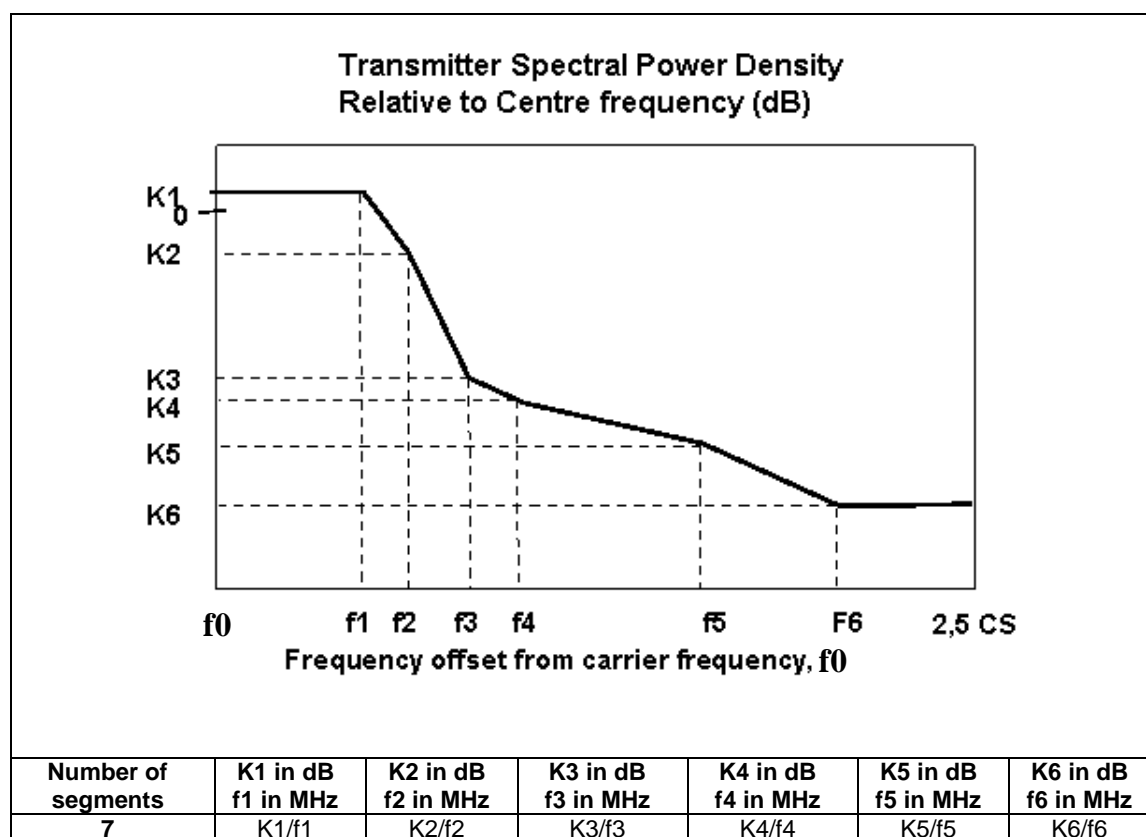


Figure 6: Seven segment spectrum mask

### 4.2.3.2 Limits

The spectral emission shall comply with spectral power density of the masks provided in tables 3a through 3m for CS size equal to 1,75 MHz and equal to or higher than 3,5 MHz.

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.

The masks do not include frequency tolerance. Only systems specified in annex B are an exception to this general rule; in that case  $f_0$  identifies the nominal carrier frequency and the spectrum mask includes an allowance for the frequency tolerance.

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.

Other modes, not considered valid as *Reference Mode* in the manufacturer declaration may be activated during dynamic operation (see example), but 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* may be 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. The license conditions will reference only to one of the possible *Reference mode* according the operator and/or the national authority needs. When the dynamic operation is enabled, modulation formats, other than the three related to the *Reference Modes*, can be operated, intermediate to them (e.g. 8PSK, 32QAM and 64QAM), higher (e.g. 256QAM, 1024QAM) or lower (e.g. PSK) or even in reduced bandwidths (when *bandwidth adaptive* systems are concerned).

**NOTE 1:** For *mixed-mode* systems, these requirements apply only for the assessment of essential requirements under article 3.2 of the Directive 2014/53/EU [i.1]. It is assumed that, when operational, the system should be subject to different considerations, related to the unique actual *Reference Mode* used for co-ordination purpose; see clause P.2.

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 [4]). 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 *channel aggregation* systems, each *aggregated channel* emission shall be compliant to its relevant channel RF spectrum mask when the second channel is operating within the manufacturer prescription. Clause O.4.1 describes the general assessment test cases and clause O.4.2 the specific joint envelope mask definition for "single port" equipment 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.

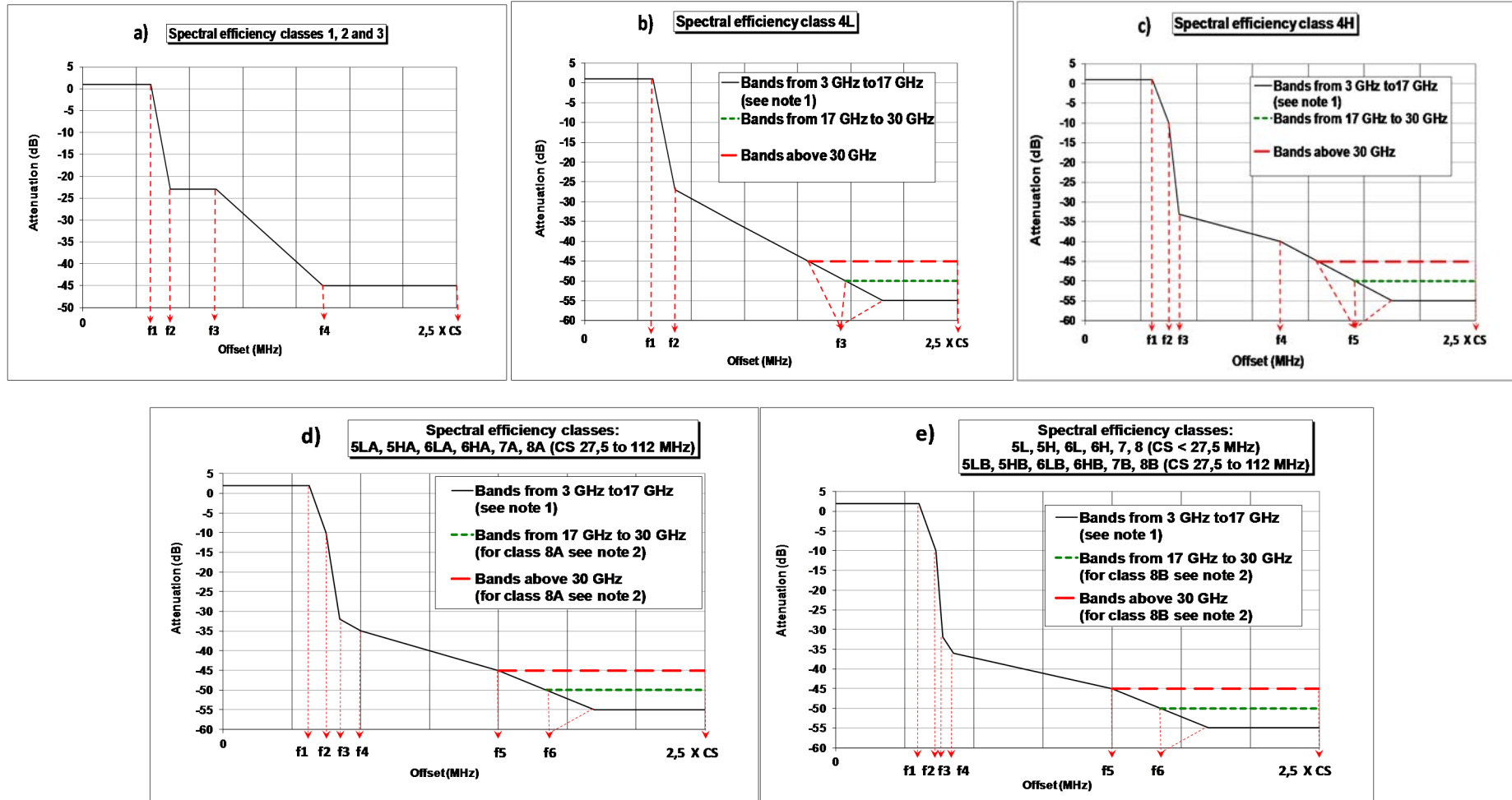
Tables 3a through 3h give all the corner points, graphically shown in figure 7, for the foreseen channel separations, spectral efficiency classes and minimum RIC capacity for all frequency bands up to 57 GHz.

Tables 3i through 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 and J represents the annex number) in the relevant annexes.

NOTE 3: In particular:

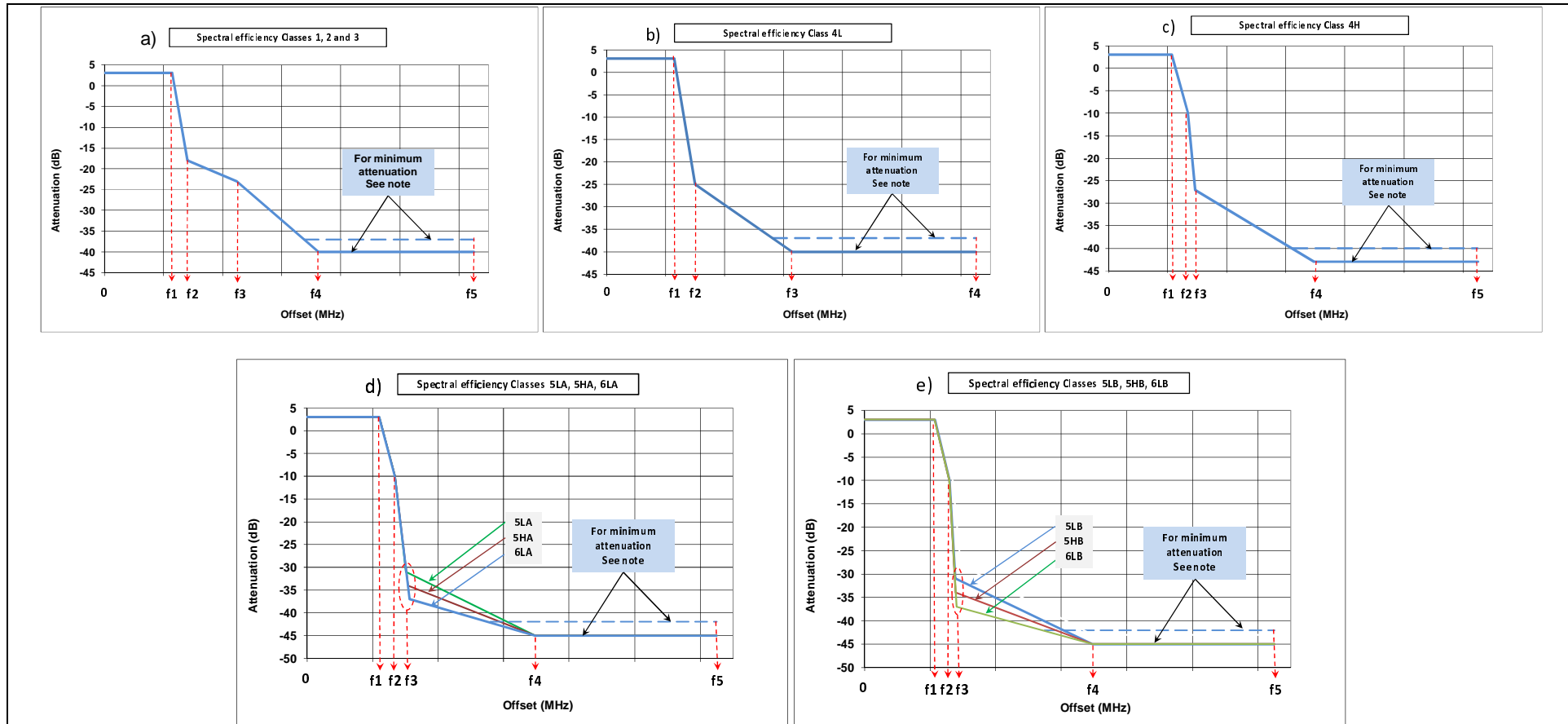
- some class 1 systems are defined only for bands from 1,4 GHz to 2,5 GHz and for 50 GHz and above;
- systems for CS = 1,75 MHz are defined only for classes up to 4L and bands up to 18 GHz;
- systems for CS = 3,5 MHz are not defined for classes higher than 4L and in 42 GHz band;
- classes 6H, 7 and 8 systems are defined only for CS  $\geq$  13,75 MHz;
- systems for CS = 40 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  $\geq$  27,5 MHz.



NOTE 1: See note (1) in tables 3a through 3g.

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 notes (2) and (3) in tables 3d through 3f and notes (1) and (2) in table 3g.

**Figure 7: Spectrum masks (frequency bands in the range below 57 GHz)**



NOTE: The noise floor attenuation depends on the CS; see tables 2k, 2l and 2m for details.

Figure 8: Spectrum masks (frequency bands above 57 GHz)

Table 3a: 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 7(a)	1	0,85	-23	1,05	-23	1,7	-45	3				
2	2	2													
3	3	3													
4	4L	4	Figure 7(b)	1	0,8	-28	1,1	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	3,5 <sup>(1)</sup> 3,1 <sup>(2)</sup> 2,6 <sup>(3)</sup>						
<p>(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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers may choose to produce and assess different products.</p> <p>(2) For systems in frequency bands within the range from 17 GHz to 30 GHz.</p> <p>(3) For systems in frequency bands in the range above 30 GHz.</p>															
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 7(b)		K3/f3 = -60 dB/4 MHz									

Table 3b: 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 7(a)	1	1,7	-23	2,1	-23	3,4	-45	6				
2	2	4													
3	3	6													
4	4L	8	Figure 7(b)	1	1,6	-28	2,2	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	7 <sup>(1)</sup> 6,2 <sup>(2)</sup> 5,2 <sup>(3)</sup>						
<p>(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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers may choose to produce and assess different products.</p> <p>(2) For systems in frequency bands within the range from 17 GHz to 30 GHz.</p> <p>(3) For systems in frequency bands in the range above 30 GHz.</p>															
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 7(b)		K3/f3 = -60 dB/8 MHz									

Table 3c: 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 7(a)	1	3,4	-23	4,2	-23	6,8	-45	12				
2	2	8													
3	3	12													
4	4L	16	Figure 7(b)	1	3,2	-28	4,4	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	14 <sup>(1)</sup> 12,4 <sup>(2)</sup> 10,4 <sup>(3)</sup>						
5	4H	24	Figure 7(c)	1	3	-10	3,75	-33	4,2	-40	8,75	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	13,75 <sup>(1)</sup> 12,075 <sup>(2)</sup> 10,425 <sup>(3)</sup>		
6	5L	29 (ACCP)	Figure 7(e)	1	3	-10	3,625	-32	3,875	-36	4,25	-45	10	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)(4)</sup>	13,5 <sup>(1)</sup> 11,75 <sup>(2)</sup> 10 <sup>(3)(4)</sup>
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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers 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 7(b)	K3/f3 = -60 dB/16 MHz											
5	4H	24	Figure 7(c)	K5/f5 = -60 dB/15,425 MHz											
6, 7, 8	5L, 5H, 6L	29, 34, and 39 (all ACCP)	Figure 7(e)	K6/f6 = -60 dB/15,25 MHz											



**Table 3d: Spectrum masks: Corner points for  $CS = 13,75 \text{ MHz} \leq CS \leq 15 \text{ MHz}$   
(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 7(a)	1	6,8	-23	8,4	-23	13,6	-45	24				
2	2	16													
3	3	24													
4	4L	32	Figure 7(b)	1	6,4	-28	8,8	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	28 <sup>(1)</sup> 24,8 <sup>(2)</sup> 20,8 <sup>(3)</sup>						
5	4H	49	Figure 7(c)	1	6	-10	7,5	-33	8,4	-40	17,5	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	27,5 <sup>(1)</sup> 24,15 <sup>(2)</sup> 20,85 <sup>(3)</sup>		
6	5L	58 (ACCP)	Figure 7(e)	1	6	-10	7,25	-32	7,75	-36	8,5	-45	20	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)(4)</sup>	27 <sup>(1)</sup> 23,5 <sup>(2)</sup> 20 <sup>(3)(4)</sup>
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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers 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 43,5 GHz.															
(3) For all but class 8B systems in frequency bands in the range above 30 GHz.															
(4) For all but class 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	32	Figure 7(b)	K3/f3 = -60 dB/32 MHz											
5	4H	49	Figure 7(c)	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 7(e)	K6/f6 = -60 dB/30,5 MHz											

Table 3e: Spectrum masks: Corner points for  $CS = 27,5 \text{ MHz} \leq CS \leq 30 \text{ MHz}$  (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 7(a)	2	12,8	-23	16,4	-23	25	-45	45				
2	2	32													
3	3	48													
4	4L	64	Figure 7(b)	2	12,8	-27	17	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	56 <sup>(1)</sup> 49 <sup>(2)</sup> 42 <sup>(3)</sup>						
5	4H	98	Figure 7(c)	2	12	-10	15	-33	16,8	-40	35	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	55 <sup>(1)</sup> 48,3 <sup>(2)</sup> 41,7 <sup>(3)</sup>		
6	5LA	117 (ACAP)	Figure 7(d)	2	12,5	-10	15	-32	17	-35	20	-45	40		
7	5HA	137 (ACAP)													
8	6LA	156 (ACAP)													
9	6HA	176 (ACAP)													
10	7A	196 (ACAP)													
11	8A	215 (ACAP)	Figure 7(e)	2	12	-10	14,5	-32	15,5	-36	17	-45	40		
6	5LB	117 (ACCP)													
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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers 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 43,5 GHz.															
(3) For all but classes 8A and 8B systems in frequency bands in the range above 30 GHz.															
(4) For all but 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 7(b)	K3/f3 = -60 dB/63 MHz											
5	4H	98	Figure 7(c)	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 7(d)	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 7(e)	K6/f6 = -60 dB/61 MHz											

Table 3f: Spectrum masks: Corner points for  $CS = 55 \text{ MHz} \leq CS \leq 60 \text{ MHz}$  (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 7(a)	2	25,6	-23	32,8	-23	50	-45	90				
2	2	64													
3	3	96													
4	4L	128	Figure 7(b)	2	25,6	-27	34	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	112 <sup>(1)</sup> 98 <sup>(2)</sup> 84 <sup>(3)</sup>						
5	4H	196	Figure 7(c)	2	24	-10	30	-33	33,6	-40	70	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)</sup>	110 <sup>(1)</sup> 96,6 <sup>(2)</sup> 83,4 <sup>(3)</sup>		
6	5LA	235 (ACAP)	Figure 7(d)	2	25	-10	30	-32	34	-35	40	-45	80	-55 <sup>(1)</sup> -50 <sup>(2)</sup> -45 <sup>(3)(4)</sup>	108 <sup>(1)</sup> 94 <sup>(2)</sup> 80 <sup>(3)(4)</sup>
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 7(e)	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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers 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 43,5 GHz.															
(3) For all but classes 8A and 8B systems in frequency bands in the range above 30 GHz.															
(4) For all but 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 7(b)	K3/f3 = -60 dB/126,0 MHz											
5	4H	196	Figure 7(c)	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 7(d)	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 7(e)	K6/f6 = -60 dB/122 MHz											

**Table 3g: Spectrum masks: Corner points for CS = 110 MHz to 112 MHz (Nominal 112 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														
1	1	64	Figure 7(a)	2	51,2	-23	65,6	-23	100	-45	180				
2	2	128													
3	3	191													
4	4L	256	Figure 7(b)	2	51,2	-27	68	-50 <sup>(1)</sup> -45 <sup>(2)</sup>	196 <sup>(1)</sup> 168 <sup>(2)</sup>						
5	4H	392	Figure 7(c)	2	48	-10	60	-33	67,2	-40	140	-50 <sup>(1)</sup> -45 <sup>(2)</sup>	193,2 <sup>(1)</sup> 166,8 <sup>(2)</sup>		
6	5LA	470 (ACAP)	Figure 7(d)	2	50	-10	60	-32	68	-35	80	-45	160		
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 7(e)	2	48	-10	58	-32	62	-36	68	-45	160	-50 <sup>(1)</sup> -45 <sup>(2)(3)</sup>	188 <sup>(1)</sup> 160 <sup>(2)(3)</sup>
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 43,5 GHz.														
(2)	For all but classes 8A and 8B systems in frequency bands in the range above 30 GHz.														
(3)	For all but classes 8A and 8B systems in frequency bands in the range above 30 GHz; corner points 5 and 6 are coincident.														

Table 3h: 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 7(d)	2	18	-10	21,5	-32	24,5	-35	29	-45	57		
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 7(e)	2	17,2	-10	20,8	-32	22,2	-36	24,5	-45	57	-55 <sup>(1)</sup>	77 <sup>(1)</sup>
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 under article 8 of Directive 2014/53/EU [i.1]. For fulfilling one or both requirements, equipment suppliers 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 7(d)	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 7(e)	K6/f6 = -60 dB/87 MHz											

Table 3i: 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 8(a)	2	28,7	-18	35	-23	56	-40	90,7	-40	156,3
2	2	71											
3	3	106											
4	4L	142	Figure 8(b)	2	28,7	-25	37,3	-40 <sup>(2)</sup>	78,5	-40	156,3		
5	4H	219	Figure 8(c)	2	27,5	-10	33,5	-28	37,3	-43	87	-43	156,3
6	5LA	262	Figure 8(d)	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 8(e)	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: Spectrum masks: Corner points for CS = 125 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	71	Figure 8(a)	3	57,3	-18	70	-23	112	-40	181,3	-40	312,5
2	2	142											
3	3	212											
4	4L	284	Figure 8(b)	3	57,3	-25	74,5	-40 <sup>(2)</sup>	157	-40	312,5		
5	4H	438	Figure 8(c)	3	55	-10	67	-28	74,5	-43	174	-43	312,5
6	5LA	438	Figure 8(d)	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 8(e)	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: Spectrum masks: Corner points for CS = N × 250 MHz (see note 1)

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	$N \times 142$	Figure 8(a)	3	$N \times 114,5$	-18	$N \times 140$	-23	$N \times 224$	-40 <sup>(2)</sup>	$N \times 362,5$	-40 <sup>(2)</sup>	<sup>(1)</sup>
2	2	$N \times 285$ <sup>(7)</sup>											
3	3	$N \times 425$ <sup>(7)</sup>											
4	4L	$N \times 570$ <sup>(7)</sup>	Figure 8(b)	3	$N \times 114,5$	-25	$N \times 149$	-40 <sup>(2)</sup>	$N \times 314$	-40 <sup>(2)</sup>	<sup>(1)</sup>		
5	4H	$N \times 875$	Figure 8(c)	3	$N \times 110$	-10	$N \times 134$	-28	$N \times 149$	-43 <sup>(3)</sup>	$N \times 348$	-43 <sup>(3)</sup>	<sup>(1)</sup>
6	5LA	$N \times 1\,050$ <sup>(7)</sup>	Figure 8(d)	3	$N \times 110$	-10	$N \times 134$	-31	$N \times 151$	-45 <sup>(4)</sup>	$N \times 348$	-45 <sup>(4)</sup>	<sup>(1)</sup>
7	5HA	$N \times 1\,225$						-34	$N \times 154$	-45 <sup>(5)</sup>		-45 <sup>(5)</sup>	
8	6LA	$N \times 1\,400$						-37	$N \times 156$	-45 <sup>(6)</sup>		-45 <sup>(6)</sup>	
6	5LB	$N \times 1\,050$ <sup>(7)</sup>	Figure 8(e)	3	$N \times 107$	-10	$N \times 129,5$	-31	$N \times 138$	-45 <sup>(4)</sup>	$N \times 348$	-45 <sup>(4)</sup>	<sup>(1)</sup>
7	5HB	$N \times 1\,225$						-34	$N \times 139$	-45 <sup>(5)</sup>		-45 <sup>(5)</sup>	
8	6LB	$N \times 1\,400$						-37	$N \times 140$	-45 <sup>(6)</sup>		-45 <sup>(6)</sup>	

(1) For CS ≤ 500 MHz this value is CS × 2,5.

For CS > 500 MHz, this value is variable with CS (MHz) according the formula  $CS \times 1,5 + 500$ .

(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; however, equipment characteristics are not presented for all cases. 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: Spectrum masks: Corner points for CS = N × 50 MHz**  
**Frequency range 57 GHz to 66 GHz (see note 1)**

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	N × 28,5 (7)	Figure 8(a)	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 8(b)	3	N × 22,9	-25	N × 29,8	-40 (2)	N × 62,8	-40 (2)	(1)		
5	4H	N × 175	Figure 8(c)	3	N × 22	-10	N × 26,8	-28	N × 29,8	-43 (3)	N × 69,6	-43 (3)	(1)
6	5LA	N × 210	Figure 8(d)	3	N × 22	-10	N × 26,8	-31	N × 30,2	-45 (4)	N × 69,6	-45 (4)	(1)
7	5HA	N × 245						-34	N × 30,8	-45 (5)		-45 (5)	
8	6LA	N × 280						-37	N × 31,2	-45 (6)		-45 (6)	
6	5LB	N × 210	Figure 8(e)	3	N × 21,4	-10	N × 25,9	-31	N × 27,6	-45 (4)	N × 69,6	-45 (4)	(1)
7	5HB	N × 245						-34	N × 27,8	-45 (5)		-45 (5)	
8	6LB	N × 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 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: Spectrum masks: Corner points for CS = N × 30 MHz**  
**Frequency range 64 GHz to 66 GHz (see note 1)**

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	N × 17	Figure 8(a)	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 8(b)	3	N × 13,8	-25	N × 17,9	-40 (2)	N × 37,7	-40 (2)	(1)		
5	4H	N × 105	Figure 8(c)	3	N × 13,2	-10	N × 16,1	-28	N × 17,9	-43 (3)	N × 41,8	-43 (3)	(1)
6	5LA	N × 126	Figure 8(d)	3	N × 13,2	-10	N × 16,1	-31	N × 18,1	-45 (4)	N × 41,8	-45 (4)	(1)
7	5HA	N × 147						-34	N × 18,5	-45 (5)		-45 (5)	
8	6LA	N × 168						-37	N × 18,7	-45 (6)		-45 (6)	
6	5LB	N × 126	Figure 8(e)	3	N × 12,7	-10	N × 15,6	-31	N × 16,6	-45 (4)	N × 41,8	-45 (4)	(1)
7	5HB	N × 147						-34	N × 16,7	-45 (5)		-45 (5)	
8	6LB	N × 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 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.

## 4.2.4 Discrete CW components exceeding the spectrum mask limit

### 4.2.4.1 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 [4] 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 Other discrete CW components exceeding the 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, 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:

$$(10 \log \frac{CS \min}{IFbandwidth} - 10) \text{ (dB)}$$

be calculated, where IF bandwidth (IFbw) is the recommended resolution bandwidth set out in table 6.

If the result is  $\leq 0$  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:

$$10 \log \sum_{i=1}^{i=n} 10^{\frac{X_i}{10}} \leq 10 \log \frac{CS \min}{IFbandwidth} - 10$$

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

**EXAMPLE 1:** 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:** 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:

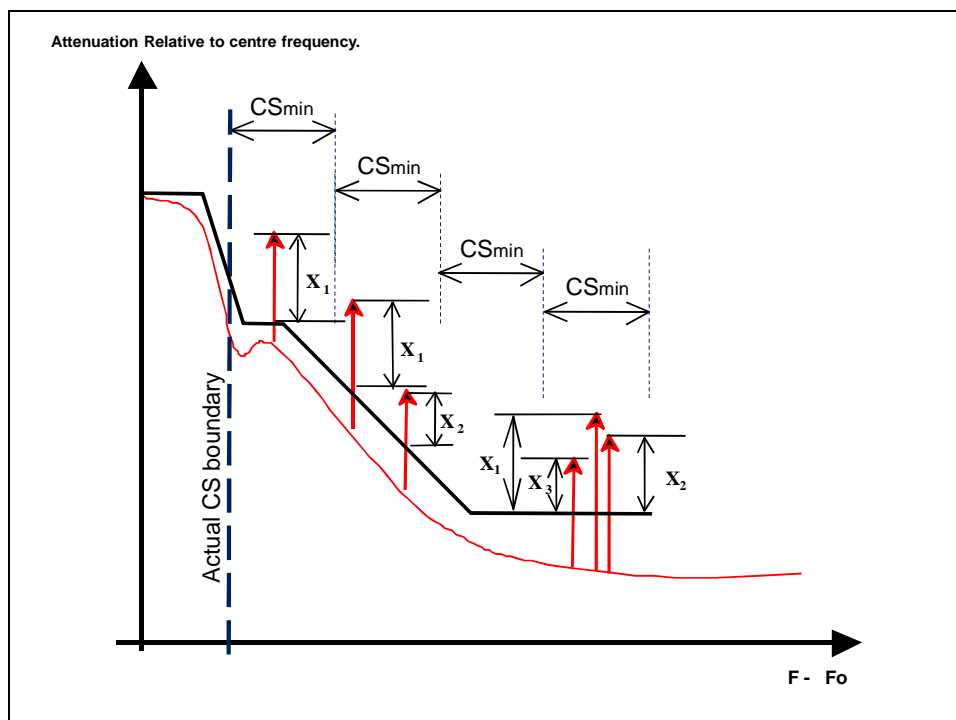
- a) one single line, e.g. in leftmost CSmin slot, exceeding the mask by up to 11 dB;
- b) two lines ( $n = 2$ ), e.g. in next CSmin slot, exceeding the mask e.g. up to  $X_1 = 9$  dB and  $X_2 = 6,5$  dB, respectively;
- c) three lines ( $n = 3$ ), e.g. in rightmost CSmin width, exceeding the mask e.g. 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 $\leq 14$ 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 Unwanted emissions in the *spurious domain* - external

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 (external emissions).

The limits are set out by ETSI EN 301 390 [3] that reprints, for P-P equipment, those in ERC/REC 74-01 [i.3] (see note 1).

The *spurious domain* range is established by Recommendation ITU-R SM.1539-1 [i.63] (see note 2).

The equipment shall comply with the requirements of clause 4.1 of ETSI EN 301 390 [3] for any setting of ATPC and RTPC (if any).

NOTE 1: ERC/REC 74-01 [i.3] based on Recommendation ITU-R SM.329-12 [i.62] and Recommendation ITU-R F.1191-3 [i.54] give the applicable definitions.

NOTE 2: According to Recommendation ITU-R SM.1539-1 [i.63] and Appendix 3 of the ITU Radio Regulations [7], the boundary where the *spurious domains* begins, is considered to be offset from the nominal centre frequency of the emission by  $\pm 250\%$  of the relevant Channel Separation (CS), as far as they do not exceeded 500 MHz. Beyond this value the boundary is evaluated as:  $\pm(500 \text{ MHz} + 1,5 \times \text{CS})$ . 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, each *aggregated-channel* emission shall be compliant to the unwanted emissions in the spurious domain limit applied to its own relevant channel when the second channel is operating within the manufacturer prescription. Clause O.4.1 describes the general assessment test cases and clause O.4.2 the possible specific joint envelope limits definition for *single port* equipment case.

The limits are applicable at reference point C' or at point B' (see figure 1 of ETSI EN 302 217-1 [4]) if C' is not available.

## 4.2.6 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  $10\log(\text{BW}_{\text{max}} / \text{BW}_{\text{min}})$ , but not more than 6 dB (i.e. 4 times band reduction).

The supplier shall declare, for each CS, among the number of possible equipment operational modes, the possible *Reference mode(s)* (among which to select the one used for licensing procedures), which the system is capable to fulfil. For each *Reference mode*, the supplier 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 P.2.

When *channels-aggregation* equipment is concerned, the dynamic change of modulation of the aggregated channels shall be activated according 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.

## 4.2.7 Radio frequency tolerance

For the purpose of the present document the frequency tolerance is as defined in article 1.151 of the Radio Regulations [7] 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 supplier, the maximum allowable RF frequency tolerance shall not exceed, by any reason, the following limits:

Equipment operating in bands below 3 GHz:	No requirement, the frequency tolerance shall be included in the applicable spectral density masks.
Equipment operating in the bands above 57 GHz:	$\pm 50$ ppm

All other cases:  $\pm 15$  ppm

For conformity test purpose the supplier shall state the guaranteed short-term part and the expected ageing part.

## 4.2.8 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 annex.

## 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.  $1 \times 100\text{baseT}$ ) or multiple (e.g.  $10 \times 10\text{baseT}$ ); 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 Unwanted emissions in the *spurious domain* - external

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 (external emissions).

The limits are set out in ETSI EN 301 390 [3] that reprints, for P-P equipment, those in ERC/REC 74-01 [i.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 [4]) if C is not available.

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

NOTE: ERC/REC 74-01 [i.3] based on Recommendation ITU-R SM.329-12 [i.62] and Recommendation ITU-R F.1191-3 [i.54] gives the applicable definitions.

### 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, any BER requirements shall be transformed into FER requirements according to the rules given in clause N.3.

Equipment working at the 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  $\leq 100$  Mbit/s, or  $10^{-6}$  and  $10^{-10}$  for systems with minimum RIC  $> 100$  Mbit/s).

The supplier 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).

When *multi-carrier* systems are concerned, the RSL is intended as 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.

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.

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

- a) when independent baseband signal interconnections according clause O.3.1 are provided, with the other *aggregated channel* (that not under test) operating, according manufacturer prescription, on the second adjacent CS frequency (for *single-port* equipment) or the first adjacent CS frequency (for *dual-port* equipment) with more demanding declared differential RSL ratio between the two channels (e.g. set through different RTPC levels), (see clause 4.1.1);
- b) when common baseband signal interconnections according clause O.3.2 are provided, see prescriptions in table O.1 of annex O;
- c) for *single-port* only, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds specified in annexes B to J will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

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

NOTE 1: For *mixed-mode* systems, these requirements apply only for the assessment of essential requirements under article 3.2 of the Directive 2014/53/EU [i.1]. 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 P.2.

NOTE 2: Actual RSL threshold for link budget definition may be defined by the supplier, generally set to a BER between  $10^{-6}$  and  $10^{-3}$ , according to the type of traffic and quality of service to be provided.

NOTE 3: 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 the reaching the RBER (established in ETSI EN 302 21781 [4]) should be considered.

### 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; informative annex R details the methodology on how to translate C/I requirements into selectivity-like figures.

### 4.3.3.2 Co-channel "external", first and second adjacent channel interference sensitivity

#### 4.3.3.2.1 Requirements basics

In clause 4.3.3.2 and its subclauses 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 "external" 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 to essential requirements under article 3.2 of Directive 2014/53/EU [i.1] and are set out in ETSI EN 302 217-1 [4].

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 with the one under test removed from its nominal centre frequency by one CS frequency according the band specific provided 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 are concerned, the limits are intended as:

- a) when independent baseband signal interconnections according clause O.3.1 are provided:
  - a1) for *single-port* equipment, with the other *aggregated channel* (that not under test) operating, according manufacturer prescription, on the second adjacent CS frequency. For both adjacent channels requirement the interference shall be opposite to the *aggregated channel* not under test.
  - a2) for *dual-port* equipment with the other *aggregated channel* (that not under test) operating, according manufacturer prescription, on the first adjacent CS frequency with more demanding declared differential RSL ratio to that under test (e.g. set through different RTPC levels), see also clause 4.1.1.
- b) when common baseband signal interconnections according clause O.3.2 are provided, see prescriptions in table O.1 of annex O.

When equipment can be optionally configured according 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

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 annexes B to J, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared by the supplier for a  $BER \leq 10^{-6}$  in clause 4.3.2.

The format of such tables is given in table 5.

NOTE: 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.

**Table 5: Co-channel and 1<sup>st</sup> adjacent channel interference sensitivity table format**

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER ≤ 10 <sup>-6</sup> 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.

#### 4.3.3.2.3 Limits for second adjacent channel interference

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

For equipment operating in other bands, the limits of Carrier to Interference ratio (C/I) in case of second adjacent channel interference shall be declared by the manufacturer (see note). That limit shall be in term of maximum C/I values for 1 dB degradation of the RSL limits declared by the manufacturer for a BER  $\leq 10^{-6}$  in clause 4.3.2 and shall not be less demanding than the level of C/I for first adjacent channel for the same 1 dB degradation required in clause 4.3.3.2.

The less demanding level of C/I ratio (i.e. equal to the first adjacent C/I ratio requirement) is automatically obtained as physical 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 shall be guaranteed, but specific assessment procedure of this functionality is not required.

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

NOTE: It is intended that the declared C/I value is within a range coherent with spectrum mask requirement in the present document. Clause R.2.2 gives the appropriate technical background.

#### 4.3.3.3 CW spurious interference (blocking & spurious response rejection)

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 [4]).

Two alternative methods are possible for manufacturer selection.

##### Method 1 (similar to the Co-channel/adjacent channel test methods)

For a receiver operating at 1 dB above the RSL threshold for a BER  $\leq 10^{-6}$  as declared by the supplier in clause 4.3.2, the introduction of a CW interferer at a level specified by ETSI EN 301 390 [3], 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 [4], 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 [3], but excluding frequencies either side of the wanted frequency by up to 250 % of the separation between channels using the same polarization, shall not result in a BER greater than  $10^{-6}$ .

##### Method 2

For a receiver operating at the RSL declared by the supplier in clause 4.3.2 for a BER  $\leq 10^{-6}$  threshold, the introduction of a CW interferer at a level specified by ETSI EN 301 390 [3], but not exceeding the maximum upper RSL limit for BER =  $10^{-6}$  defined in ETSI EN 302 217-1 [4], clause 6.4.1, 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 [3], but excluding frequencies either side of the wanted frequency by up to 250 % of the separation between channels using the same polarization, shall not result in a BER greater than  $10^{-5}$ .

## Common special provisions

When *multi-carrier* systems are concerned, the wanted signal level is intended as 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 are concerned, the limits are intended as:

- a) when independent baseband signal interconnections according clause O.3.1 are provided, with the other *aggregated channel* (that not under test) operating, according manufacturer prescription, on the channel frequency with more demanding differential RSL ratio to that under test (e.g. set through different RTPC levels), (see clause 4.1.1).
- b) when common baseband signal interconnections according clause O.3.2 are provided, see prescriptions in table O.1 of annex O.

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

## 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 annexes B to J where either an *integral antenna* or a *dedicated antenna* is provided. Antenna characteristics relevant to article 3.2 of the Directive 2014/53/EU [i.1] are specified, for the relevant frequency band and antenna class, in ETSI EN 302 217-4 [5].

RPE, gain (including tolerances around the nominal declared value) 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) is considered essential parameter for meeting requirements of article 3.2 of the Directive 2014/53/EU [i.1]; 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 [5] (see note).
- for bands above 3 GHz: only class 2 or higher classes in clauses from 4.4.3 to 4.4.9 of ETSI EN 302 217-4 [5] (see note).

For bands in the range from 57 GHz to 66 GHz, because simplified or no frequency co-ordination procedures are generally applied, *cross-polar* RPE is not considered as essential parameter for meeting requirements of article 3.2 of the Directive 2014/53/EU [i.1], even if the antenna is actually dual polarized. Values given in, for completeness, in clause 4.2.9 of ETSI EN 302 217-4 [5] should be considered for reference purposes.

NOTE: It is assumed that the equipment supplier declares which class the antenna meets.

#### 4.4.1.3 Antenna gain

The antenna gain and tolerance is considered essential parameter for meeting requirements of article 3.2 of the Directive 2014/53/EU [i.1].

According clause 4.6 of ETSI EN 302 217-4 [5] the supplier shall declare the nominal gain and its tolerance (see note).

NOTE: Gain tolerance is generally considered to be equally distributed across the nominal value (i.e.  $\pm$  dB)

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

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

The antenna *cross-polar* discrimination (XPD) is considered essential parameter for meeting requirements of article 3.2 of the 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 [5].

For bands in the range from 57 GHz to 66 GHz, where simplified or no frequency co-ordination procedures are generally applied, XPD is not considered as essential parameter for meeting requirements of article 3.2 of the Directive 2014/53/EU [i.1], even if the antenna is actually dual polarized. Values given in clause 4.5 of ETSI EN 302 217-4 [5] for that range should be considered for reference purposes only.

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

When equipment is placed upon the market without an antenna, and the user therefore sources a *stand-alone antenna* from the marketplace, the equipment manufacturer should consider that:

- a) Under the obligation of article 10, recital 8 of the Directive 2014/53/EU [i.1]: "*Manufacturers shall ensure that the radio equipment is accompanied by instructions...Instructions shall include the information required to use radio equipment in accordance with its intended use*".
- b) Under the provisions of article 18, recital 2 the EU Declaration of conformity: "... *shall have the model structure set out in Annex VI, shall contain the elements set out in that Annex and...*".  
Then, annex VI recital 8 includes: "*where applicable, description of accessories and components, including software, which allow the radio equipment to operate as intended and covered by the EU declaration of conformity*".

Consequently, the equipment manufacturer should provide sufficient guidance that the combination of equipment and *stand-alone antenna* continues to meet the requirements of the Directive 2014/53/EU [i.1]. Therefore, the equipment manufacturer, where the use of *stand-alone antenna* is possible, should include in the equipment instruction (see article 10, recital 8 of the Directive 2014/53/EU [i.1]) the statement that the equipment can operate as intended only if connected to antenna with characteristics conforming to:

- for bands in the range 1 GHz to 3 GHz: RPE of any class according clause 4.4.2 of ETSI EN 302 217-4 [5] and XPD class 1 according clause 4.5.2 of ETSI EN 302 217-4 [5];
- 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 [5] and XPD class 1 according clause 4.5.2 of ETSI EN 302 217-4 [5];
- minimum gain according the minimum value, if any required, in the relevant band annexes of the present document.

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## 5 Testing for compliance with technical requirements

### 5.1 Environmental and other conditions for testing

#### 5.1.1 Environmental conditions

The equipment shall comply with all the requirements of the present document at all times when operating within the boundary limits of the operational environmental profile declared by the supplier, including the limits of any primary/secondary power supply external to the equipment under assessment.

Boundary limits of environmental climatic conditions, which are part of the environmental profile, may be determined by the environmental class of the equipment according to the guidance given in clause 4.4 of ETSI EN 301 126-1 [1].

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile.



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

- a) For radio equipment, with respect to the same principles and procedures, for reference and extreme conditions, set out in clause 4.4 of ETSI EN 301 126-1 [1] for climatic conditions and in table 1 of ETSI EN 301 126-1 [1] and clauses 5.2 and 5.3 of the present document for power supply conditions. The requirement to test at reference or extreme conditions is set out in clauses 5.2 and 5.3 of the present document according to the principles for similar requirements set out in ETSI EN 301 126-1 [1].
- b) For DFRS antennas (directional phenomena of clause 4.4 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].

### 5.1.2 Test interpretation and measurement uncertainty

Test reports should be produced according to the procedure for compiling the technical documentation set out in article 21 and annex V of the Directive 2014/53/EU [i.1].

Interpretation of the results recorded in a test report (of the measurements described in the present document) shall 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 shall 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.29] and, when radiated measurements are concerned, ETSI TR 102 215 [i.32]).

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;
- the value of the measurement uncertainty for the measurement of each parameter should be included in the test report.

### 5.1.3 Other basic conditions

The supplier shall identify the chosen system profile, selected from tables X.2 (where X = B, C, D, E, F, G, H, I and 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.34] 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 [4] 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.34].

When *channels-aggregation* equipment are concerned, both 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 [4]); 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.

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

## 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 the 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) B = Bottom M = Middle T = Top	Other specific conditions
			Ref	Extreme		
5.2.1.1	Maximum power	5.2.1 (transmitter power) 6.3 of ETSI EN 301 126-3-1 [2] (EIRP)	X	X	BMT	See note 3
5.2.1.2	Combined maximum TX power output and EIRP	5.2.1 (transmitter power) 6.3 of ETSI EN 301 126-3-1 [2] (EIRP)	X		BMT	
5.2.1.3	Transmitter output power tolerance	5.2.1	X	X	BMT	See note 3
5.2.2	Transmitter power and frequency control					
5.2.2.1.1	Automatic Transmit Power Control (ATPC)	5.2.3 and 5.2.6	X		M	
5.2.2.1.2	Remote Transmit 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	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	RF Spectrum Mask	5.2.6	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) B = Bottom M = Middle T = Top	Other specific conditions
			Ref	Extreme		
5.2.4	Discrete CW components exceeding the spectrum masks limits	5.2.8	X	X	BMT	See note 3
5.2.5	Unwanted emissions in the spurious domain-external	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. Actual test shall be limited to the practical frequency range set out by clause A.1 of ETSI EN 301 390 [3]
5.2.6	Dynamic Change of Modulation Order	-	X	X	BMT	see note 3 Required for <i>mixed-mode</i> systems only (including <i>bandwidth adaptive</i> systems), according clause 5.2.6 of the present document Test at extremes of temperature limited to spectrum mask and CW components assessment
5.2.7	Radio frequency tolerance	5.2.5	X	X	BMT	see note 3
<p>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, DC regulators on all the DC sources actually used for carrier generation are commonly integral to the radio equipment. When this is the case, such additional tests are considered redundant and not necessary to assess the compliance to the essential requirements of article 3.2 of the Directive 2014/53/EU [i.1]. This will not imply any reduction to the supplier responsibility related to the conformance declaration, which, in any case, shall be valid for the whole declared environmental profile.</p> <p>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.</p> <p>NOTE 3: This clause requires, besides extremes of temperature, testing also at extremes of voltage (see note 1).</p> <p>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.</p>						

## 5.2.1 Transmitter power and power tolerance

### 5.2.1.1 Transmitter power and EIRP

Test methods for the transmitter power and transmitter power tolerance 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].

### 5.2.1.2 Combined TX power output and EIRP limits

When required in the relevant frequency band annexes, 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 Output power tolerance

Test methods for the transmitter power tolerance 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 Control (ATPC and RTPC)

#### 5.2.2.1.1 ATPC

The correct operation of the ATPC function (according to the supplier'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 declared by the manufacturer (see note).

NOTE: In general, 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 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 the 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 supplier 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.

#### 5.2.2.2 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 RF 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 [4]. 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). When sensitivity difficulties are still experienced for reaching the required spectrum mask floor, the supplier shall produce an attachment to the test report with calculated evidence (see similar requirement in clause 5.2.2.1.2 (RTPC test procedure)).

Table 7 shows the recommended spectrum analyser settings.

**Table 7: Spectrum analyser settings for RF power spectrum measurement**

Channel separation (CS) (MHz) (see note 2)	$0,003 < CS \leq 0,03$	$0,03 < CS \leq 0,3$	$0,3 < CS \leq 0,9$	$0,9 < CS \leq 12$	$12 < CS \leq 36$	$36 < CS \leq 150$	$CS > 150$
Centre frequency	$f_0$ (see note 1)						
Sweep width (MHz)	$\geq 5 \times CS$						$\geq 5 \times CS$ (for $CS < 500$ ) $\geq 3 \times CS + 1\,000$ (for $CS \geq 500$ )
Scan time	Auto						
IF bandwidth (kHz)	1	3	10	30	100	300	2 000
Video bandwidth (kHz)	0,003	0,01	0,03	0,1	0,3	0,3	3
NOTE 1: $f_0$ represents either the nominal channel centre frequency (for systems in annex B) or the actual carrier frequency (for systems in all annexes C to J).							
NOTE 2: For <i>channels-aggregation</i> equipment is the CS of each <i>aggregated channel</i> .							

## 5.2.4 Discrete CW components exceeding the 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 Unwanted emissions in the spurious domain - external

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 clause A.1 of ETSI EN 301 390 [3]. The test shall be carried out at reference climatic conditions.

## 5.2.6 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 mode (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 ( $k_1 = +3$  dB).

The maximum spectral density in the "max-hold" condition, disregarding, if any, residual of the carrier due to modulation imperfection, shall not exceed, the spectral power density mask of the *Reference mode*, set as described above.

### 5.2.7 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.

## 5.3 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 the 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 the 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 supplier. The supplier 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) B = Bottom M = Middle T = Top	Other specific conditions (see note 3)
			Ref	Extreme		
5.3.1	Unwanted emissions in the spurious domain-external	5.3.2	X		BMT	Actual test shall be limited to the practical frequency range specified by clause A.1 of ETSI EN 301 390 [3]
5.3.2	BER as a function of receiver input signal level (RSL)	5.3.3.1	X	X	BMT at Nominal M at Extreme	
5.3.3.2	Co-channel "external", first and second adjacent channel interference sensitivity	5.3.3.2.1 (co-channel)	X		M	
		5.3.3.2.1 (first adjacent channel)	X		M	To be produced for the lower or for the upper frequency of first adjacent channel, arbitrarily selected by supplier
		5.3.3.2.2 (second adjacent channel)	X		M	To be produced for the lower or for the upper frequency of second adjacent channel, arbitrarily selected by supplier (see note 5)
5.3.3.3	CW spurious interference	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 [3]
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 <i>preset/mixed-mode</i> systems.						
NOTE 5: Test conditionally required; see clause 5.3.3.2.2.						

### 5.3.1 Unwanted emissions in the spurious domain - external

The test shall be limited to the practical frequency ranges specified by clause A.1 of ETSI EN 301 390 [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

#### 5.3.3.2 Co-channel "external", first and second adjacent channel interference sensitivity

##### 5.3.3.2.1 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 in 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 supplier.

##### 5.3.3.2.2 Second adjacent channel

When minimum C/I level of compliance (i.e. the same as required for first adjacent) in clause 4.3.3.2.3 is selected specific test assessment is not 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 CW spurious interference

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 [3]. 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 Additional antenna test methods for systems with integral or dedicated antenna

### 5.4.0 General test summary

The tests, carried out to generate the test report in order to fulfil any conformity assessment procedure with respect to the 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 be 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) B = Bottom T = Top	Other specific conditions
			Reference	Extreme		
5.4	Antenna directional requirements					
5.4.1	Radiation Pattern Envelope (RPE) (Off-axis EIRP density)	6.1	X		BT	
5.4.2	Antenna gain	6.3	X		BT	
5.4.3	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].						
NOTE 2: For more detailed information on frequency to be tested for wideband antennas, see ETSI EN 302 217-4 [5].						

### 5.4.1 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].

### 5.4.2 Antenna gain

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

### 5.4.3 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].

## Annex A (normative): 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.1] 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**

<b>Harmonised Standard ETSI EN 302 217-2</b> The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.1]				
<b>Requirement</b>			<b>Requirement Conditionality</b>	
<b>No</b>	<b>Description</b>	<b>Reference: Clause No</b>	<b>U/C</b>	<b>Condition</b>
<b>Transmitting requirements</b>				
1	Maximum power and EIRP	4.2.1.1	U	
2	Combined TX power output and EIRP limits	4.2.1.2	C	Required when specific limitations are reported in the frequency dependent annexes and only applies to systems with integral or dedicated antennas
3	Output power tolerance	4.2.1.3	U	
4	Automatic Transmit Power Control (ATPC)	4.2.2.1.1	C	Only applies if ATPC is provided
5	Remote Transmit Power Control (RTPC)	4.2.2.1.2	C	Only applies if RTPC is provided
6	Remote Frequency Control (RFC)	4.2.2.2	C	Only applies if RFC is provided
7	Radio Frequency Spectrum mask	4.2.3	U	
8	Discrete CW components exceeding the spectrum mask limit	4.2.4	U	
9	Unwanted emissions in the spurious domain	4.2.5	U	
10	Dynamic Change of Modulation Order	4.2.6	C	Applies only to <i>mixed-mode</i> equipment
11	Radio frequency tolerance	4.2.7	U	
<b>Receiver requirements</b>				
12	Unwanted emissions in the spurious domain	4.3.1	U	
13	Sensitivity - BER as a function of receiver input signal level	4.3.2	U	
14	Co-channel interference sensitivity	4.3.3.2.2	U	
15	Adjacent channel interference sensitivity	4.3.3.2.2	U	
16	Second adjacent channel interference sensitivity	4.3.3.2.3	U	
17	CW Spurious interference (blocking and spurious response rejection)	4.3.3.3	U	
<b>Antenna requirements</b>				
18	Off-axis EIRP density - Radiation Pattern Envelope (RPE)	4.4.1.2	C	Only applies to systems with <i>integral antennas</i>
19	Antenna gain	4.4.1.3	C	Only applies to systems with <i>integral antennas</i>
20	Antenna Cross-Polar Discrimination	4.4.1.4	C	Only applies to systems with <i>integral antennas</i>

**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.

**Clause Number** 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 shall be unconditionally applicable (U) or is conditional upon the manufacturers claimed functionality of the equipment (C).

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

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

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

## Annex B (normative): 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 clause B.2.1 and table B.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according 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

In table B.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are set out for reference only. The channel arrangement in itself is not relevant with respect to article 3.2 requirements; only the frequency band and actual channel separation is relevant for defining the set of parameters and test suites for each system mainly designed for that channel separation.

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**

Band (GHz)	Frequency range (MHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC (CEPT/ERC)	ITU-R
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.17]	F.1242-0 [i.55]
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.17]	F.1242-0 [i.55]
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.17]	F.1098-1 [i.51]
2,6	2 520 to 2 593 paired with 2 597 to 2 670	1,75 to 14	See note	F.1243-0 [i.56]
2,4	2 300 to 2 500	1 and 2	-	F.746-10 annex 1 [i.47]
NOTE: This band was also considered, with the same arrangement of Recommendation ITU-R F.1243-0 [i.56], in annex D of T/R 13-01 [i.17] 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, 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 only indicative channel capacity, in term 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  $4 \times 2$  Mbit/s.
- Systems in bands 2,1 GHz and 2,6 GHz  
Typical base band data rates are  $N \times 2$  Mbit/s  
( $N = 1, 2, 4, 8, 16$ ),  $2 \times 8$  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.

**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
Maximum transmitter power	Clause 4.2.1.1
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF spectrum power density mask	Clause 4.2.3.2 (for CS 1,75 MHz or multiple thereof) or in clause B.3.2 (for other CS)
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain- external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	No specific value is requested, however, Radio frequency tolerances shall be included within the spectrum mask. They include tuning accuracy and environmental effects as well as long term ageing (see note)
NOTE: For conformance procedure, the supplier should state the portion of frequency tolerance to be taken into account for the long term ageing; the mask frequency points will be reduced accordingly.	

### B.3.2 RF 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  $f_0$  and attenuation of corner points of spectrum masks for  $CS = 2$  MHz and  $CS < 1,75$  MHz, which shall be used for compliance.

All spectrum masks are inclusive of an allowance for radio frequency tolerance (note). Centre frequency  $f_0$  identifies the nominal carrier frequency; the mask shall be extended up to 2,5 times the relevant CS of each system.

NOTE: It is reminded that for bands included in this annex B, also masks in clause 4.2.3.2, exceptionally, do include the frequency tolerance.

**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
Unwanted emissions in the spurious domain (External)	Clause 4.3.1
BER as a function of RSL	Table B.6
Co-channel "external" and adjacent channels interference sensitivity	Table B.7
CW spurious interference	Clause 4.3.3.4

### B.4.2 BER as a function of receiver input signal level (RSL)

The supplier shall declare the RSL threshold(s) (dBm) for  $BER \leq 10^{-6}$ , which shall not be worse than the corresponding RSL upper bound values indicated in table B.6. The declared Receiver Signal Levels (RSL) shall produce a  $BER \leq 10^{-6}$ .

NOTE: RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Frequency band (GHz)	Co-polar channel separation	RSL for BER $\leq 10^{-6}$ (dBm) (see note 1)	RSL for BER $\leq 10^{-8}$ (dBm)
Reference index	Class				
1	1 (see note 2)	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
4	4L	2,1 and 2,6	14 MHz	-85	-83,5
		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: For systems operating on CS < 1,75 MHz, only RSL for BER  $\leq 10^{-6}$  is standardized; however, in previously published ENs these systems were also required to meet a specific RSL for BER  $\leq 10^{-3}$ , which were set 4 dB lower than the RSL for BER  $\leq 10^{-6}$ . This figure, given here for information only, may be used for deriving a typical RSL versus BER curve.

NOTE 2: 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 3: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

### B.4.3 Co-channel "external" and 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 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 declared for BER  $\leq 10^{-6}$  in 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 $\leq 10^{-6}$ 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)	Channel separation (MHz) (see note)	C/I for BER $\leq 10^{-6}$ 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	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



# Annex C (normative): Frequency bands from 3 GHz to 11 GHz (channel separation up to 30 MHz and 56/60 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 clause C.2.1 and table C.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according 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

In table C.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test suites relevant to each system mainly 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**

Band (GHz)	Frequency range (GHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC (CEPT/ERC)	ITU-R
3,5	3,410 to 3,600	1,75 to 14	14-03 [i.15]	-
4	3,600 to 3,800	1,75 to 14	12-08 annex B part 2 [i.10]	-
	3,600 to 4,200	30	12-08 annex A part 2 [i.10]	F.635-6 [i.44]
	3,600 to 4,200	60 (see note)	-	-
	3,800 to 4,200	29	12-08 annex B part 1 [i.10]	F.382-8 [i.36]
	3,800 to 4,200	58 (see note)	-	-
U4	4,400 to 5,000	28 and 56	-	F.1099-4 annex 3 [i.52]
		60	-	F.1099-4 annex 1 [i.52]
L6	5,925 to 6,425	29,65 and 59,3	14-01 [i.13]	F.383-9 [i.37]
		28	-	F.383-9 annex 2 [i.37]
	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.14]	F.384-11 [i.38]
	6,425 to 7,100	30 and 60	14-02 [i.14]	F.384-11 [i.38]
		3,5, 7, 14	14-02 annex 1 [i.14]	F.384-11 annex 2 [i.38]
7	7,125 to 7,425	7 to 28 and 56	-	F.385-10 [i.39]
	7,425 to 7,725		-	F.385-10 [i.39]
	7,250 to 7,550		-	F.385-10 [i.39]
	7,550 to 7,850		-	F.385-10 [i.39]
	7,110 to 7,750	28 and 56	-	F.385-10 annex 3 [i.39]
	7,425 to 7,900	7 to 28 and 56	(02)06 annex 2.2 and annex 3 [i.22]	F.385-10 annex 4 [i.39]
	7,250 to 7,550	3,5 to 28 and 56	-	F.385-10 annex 5 [i.39]
	7,125 to 7,425	1,75 to 28 and 56	(02)06 annexes 1.1, 2.1 and annex 3 [i.22]	F.385-10 annex 1 [i.39]
	7,425 to 7,725		(02)06 annex 1.1 and annex 3 [i.22]	F.385-10 annex 1 [i.39]

Band (GHz)	Frequency range (GHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC (CEPT/ERC)	ITU-R
8	7,725 to 8,275	7, 14, 28 and 56	(02)06 annex 1.2.1 and annex 3 [i.22]	F.386-9 annex 2 [i.40]
		29,65 and 59,3	(02)06 annex 1.2.2 and annex 3 [i.22]	F.386-9 annex 6 [i.40]
	7,725 to 8,275	30 and 60	-	F.386-9 annex 1 [i.40]
	8,025 to 8,500	7 to 28 and 56	-	F.386-9 annex 5 [i.40]
	8,275 to 8,500	7 to 28 and 56	(02)06 annex 1.3 and annex 3 [i.22]	F.386-9 annex 2 [i.40]
	7,900 to 8,400	7 to 28 and 56	-	F.386-9 annex 3 [i.40]
10,5	7,900 to 8,500	1,75 to 28 and 56	(02)06 annex 2.3 and annex 3 [i.22]	-
	10,000 to 10,680	3,5 to 28	-	F.747-1 annex 4 [i.48]
	10,500 to 10,680	7	-	F.747-1 annex 1 [i.48]
	10,150 to 10,3 paired with 10,5 to 10,650	3,5 to 28 and 56	12-05 [i.7]	F.747-1 annex 3 [i.48]
11	10,700 to 11,700	7, 14, 28 and 56	12-06 [i.8]	F.387-12 annex 4 [i.41]
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 the CEPT and Recommendations ITU-R provide the about 60 MHz CS only in term of aggregation of about 2 x 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	28 to 30	56 to 60
Min. payload RIC rate Mbit/s (note 1)	Spectral efficiency↓		↓	↓	↓	↓	↓	↓	↓	↓	↓
	Reference Index	Class									
	2	2	2	4	8	16	-	32	64	-	-
	3	3	3	6	12	24	-	48	96	-	-
	4	4L	4	8	16	32	45	64	128	-	-
	5	4H	-	-	24	49	-	98	196	-	-
	6	5L	-	-	29	58	-	-	-	-	-
		5LB, 5LA	-	-	-	-	-	117	235	117	235
	7	5H	-	-	34	68	-	-	-	-	-
		5HB, 5HA	-	-	-	-	-	137	274 (note 2)	137	274 (note 2)
	8	6L	-	-	39	78	-	-	-	-	-
		6LB, 6LA	-	-	-	-	-	156	313	156	313
	9	6H	-	-	-	88	-	-	-	-	-
		6HB, 6HA	-	-	-	-	-	176	352	176	352
10	7	-	-	-	98	-	-	-	-	-	
	7B, 7A	-	-	-	-	-	196	392	196	392	
11	8	-	-	-	107	-	-	-	-	-	
	8B, 8A	-	-	-	-	-	215	431	215	431	

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 1000BaseT or N × 100BaseT capacity are concerned.

## C.3 Transmitter

### C.3.1 General requirements

Table C.3: Transmitter requirements

Requirements	Limits
Maximum transmitter power	Clause 4.2.1.1
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain-external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### C.3.2 RF 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.

## C.4 Receiver

### C.4.1 General requirements

Table C.4: Receiver requirements

Requirements	Limits
Unwanted emissions in the spurious domain (External)	Clause 4.3.1
BER as a function of RSL	Table C.5
Co-channel external and adjacent channel interference sensitivity	Table C.6
CW spurious interference	Clause 4.3.3.4

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

The supplier 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 table C.5. The declared Receiver Signal Levels (RSL) shall produce a BER  $\leq 10^{-6}$  and either  $\leq 10^{-8}$  or  $\leq 10^{-10}$ .

NOTE: RSL values, evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.31] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Co-polar channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm) (see note 2)	RSL for BER $\leq 10^{-8}$ (dBm) (see note 2)	RSL for BER $\leq 10^{-10}$ (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	

Spectral efficiency		Minimum RIC rate (Mbit/s)	Co-polar channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm) (see note 2)	RSL for BER $\leq 10^{-8}$ (dBm) (see note 2)	RSL for BER $\leq 10^{-10}$ (dBm) (see note 2)
Reference index	Class					
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	
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
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
6	5L	29	7	-74	-72,5	-
		58	14 to 15	-71	-69,5	-
	5LA/5L B (note 1)	117	28 to 30 (ACAP/ACCP)	-68	-	-65
		235	56 to 60 (ACAP/ACCP)	-65	-	-62
7	5H	34	7	-72,5	-71	-
		68	14 to 15	-69,5	-68	-
	5HA/5 HB (note 1)	137	28 to 30 (ACAP/ACCP)	-67	-	-64
		274	56 to 60 (ACAP/ACCP)	-64	-	-61
8	6L	39	7	-68	-66,5	-
		78	14 to 15	-65	-63,5	-
	6LA/6L B (note 1)	156	28 to 30 (ACAP/ACCP)	-63	-	-60
		313	56 to 60 (ACAP/ACCP)	-60	-	-57
9	6H	88	14 to 15	-61	-59,5	-
	6HA/6 HB (note 1)	176	28 to 30 (ACAP/ACCP)	-58,5	-	-55,5
		352	56 to 60 (ACAP/ACCP)	-56	-	-53
10	7	98	14 to 15	-57,5	-56	-
	7A/7B (note 1)	196	28 to 30 (ACAP/ACCP)	-55	-	-52
		392	56 to 60 (ACAP/ACCP)	-52,5	-	-49,5
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

NOTE 1: For CS 28 MHz to 30 MHz or 56 MHz to 60 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, 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 may be relaxed by 1,5 dB.

NOTE 2: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

### C.4.3 Co-channel "external" and 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.6, giving maximum C/I values for 1 dB and 3 dB degradation of the RSL limits declared for  $BER \leq 10^{-6}$  in clause C.4.2.

NOTE: For the purpose of frequency co-ordination, intermediate co-channel or adjacent channel sensitivity values may be found in annex Q.

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

Spectral efficiency		Minimum RIC rate (Mbit/s) (see note)	Channel separation (MHz) (see note)	C/I for BER ≤ 10 <sup>-6</sup> RSL degradation of 1 dB or 3 dB							
				Co-channel interference		First adjacent channel interference					
				1 dB	3 dB	1 dB	3 dB				
Reference index	Class										
2	2	2; 4; 8; 16; 32; 64	1,75; 3,5; 7; 14 to 15; 28 to 30; 56 to 60	23	19	0	-4				
3	3	3; 6; 12; 24; 48; 96	1,75; 3,5; 7; 14 to 15; 28 to 30; 56 to 60	27	23	-1	-5				
4	4L	4; 8; 16; 32; 64; 128	1,75; 3,5; 7; 14 to 15; 28 to 30; 56 to 60	30	26,5	-3	-7				
		45	20	30	26,5	-8	-12				
5	4H	24; 49; 98; 196	7; 14 to 15; 28 to 30; 56 to 60	33	29	-5	-9				
6	5L	29; 58	7; 14 to 15	34	30	-3	-7				
	5LB	117; 235	28 to 30; 56 to 60 (ACCP)								
	5LA	117; 235	28 to 30; 56 to 60 (ACAP)								
7	5H	34; 64	7; 14 to 15	37	33	-2	-6				
	5HB	137	28 to 30; 56 to 60 (ACCP)	35	32	-5	-8				
	5HA	137; 274	28 to 30; 56 to 60 (ACAP)	37	33	3	-1				
8	6L	39	7	40	36	0	-4				
		78	14 to 15								
	6LB	156; 313	28 to 30; 56 to 60 (ACCP)					40	36	0	-4
	6LA	156; 313	28 to 30; 56 to 60 (ACAP)					40	36	10	7
9	6H	88	14 to 15	43	39	0	-4				
	6HB	176; 352	28 to 30; 56 to 60(ACCP)								
	6HA	176; 352	28 to 30; 56 to 60 (ACAP)					43	39	10	6
10	7	98	14 to 15	46	42	0	-4				
	7B	196; 392	28 to 30; 56 to 60 (ACCP)								
	7A	196; 392	28 to 30; 56 to 60 (ACAP)					46	42	13	9
11	8	107	14 to 15	50	46	0	-4				
	8B	215; 431	28 to 30; 56 to 60 (ACCP)								
	8A	215; 431	28 to 30; 56 to 60 (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 3 GHz to 11 GHz (channel separation 40 MHz)

## D.1 Introduction

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

In this annex only FDD equipment are considered.

## D.2 General characteristics

### D.2.1 Frequency characteristics and channel arrangements

In table D.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 requirements; only the frequency band and actual channel separation is relevant for defining the set of parameters and test suites relevant to each system designed for that channel separation.

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**

Band (GHz)	Frequency range (GHz)	Recommendations for radio frequency channel arrangements	
		CEPT/ECC	ITU-R
4	3,600 to 4,200	12-08 annex A part 1 [i.10]	F.635-6 [i.44]
U4	4,400 to 5,000	-	F.1099-4 annex 1 and annex 2 [i.52]
U6	6,425 to 7,110	14-02 [i.14]	F.384-11 [i.38]
8	7,725 to 8,275	-	F.386-9 annex 4 [i.40]
11	10,7 to 11,7	12-06 [i.8]	F.387-12 [i.41]

### D.2.2 Transmission capacities

**NOTE:** The use in CEPT countries of 40 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 useable for Directive 2014/53/EU [i.1] self-declaration of conformance) 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
# minimum RIC:	multiplied by 40/28
# RSL thresholds:	increased by 10 log (40/28)
# Co-channel behaviour:	same
# 40 MHz adjacent channel behaviour:	same of that at 28 MHz.

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

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

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 1.2. This is intended for commonality in order to cover also the 40 MHz channel arrangements with STM-1 systems used in the more popular 28 MHz arrangements.

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 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 1000BaseT or N × 100BaseT capacity are concerned.

## D.3 Transmitter

### D.3.1 General requirements

Table D.3: Transmitter requirements

Requirements	Limits
Maximum transmitter power	Clause 4.2.1.1
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain -external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### D.3.2 RF 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
Unwanted emissions in the spurious domain (external)	Clause 4.3.1
BER as a function of RSL	Table D.5
Co channel external and adjacent channel interference sensitivity	Table D.6
CW spurious interference	Clause 4.3.3.4

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

The supplier shall declare 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: RSL values, evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.31] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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 $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)
Reference index	Class					
6	5LB	STM-1 or 137	40 ACCP	4, U4, U6, 8	-69	-66
	5LA/5LB	168		11	-68	-65
				4, U4, U6, 8	-68	-65
				11	-67	-64
7	5HA/5HB	196	40 ACCP	4, U4, U6, 8	-63,5	-60,5
	5HB/28	STM-1 or 137	40 ACCP	11	-63,5	-60,5
				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
NOTE 1: These limits are required when the connection to the same antenna port of even and odd channels, spaced 40 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 may be relaxed by 1,5 dB.						
NOTE 2: For <i>channels-aggregation/single-port</i> equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).						



### D.4.3 Co-channel "external" and adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for  $BER \leq 10^{-6}$  in clause D.4.2.

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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	C/I for $BER \leq 10^{-6}$ 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	40 (ACAP)	33	29	3	0
	5LB	STM-1 or 137	40 (ACCP)	33	29	-4	-8
		168		33	29	-3	-7
7	5HA	196	40 (ACCP)	37	33	7	4
	5HB/28	STM-1 or 137	40 (ACCP)	37	33	-4	-8
	5HB	196	40 (ACCP)	37	33	-3	-7
8	6LA	224	40 (ACAP)	40	36	10	7
	6LB	224	40 (ACCP)	40	36	0	-4
9	6HA	252	40 (ACAP)	43	39	10	7
	6HB	252	40 (ACCP)	43	39	0	-4
10	7A	280	40 (ACAP)	46	42	13	9
	7B	280	40 (ACCP)	46	42	0	-4
11	8A	308	40 (ACAP)	50	46	17	13
	8B	308	40 (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 clause E.2.1 and table E.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according 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

In table E.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test suites relevant to each system designed for that channel separation.

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**

Band (GHz)	Frequency range (GHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC (CEPT/ERC)	ITU-R
13	12,75 to 13,25	1,75 to 28	12-02 [i.5]	F.497-7 [i.42]
13	12,75 to 13,25	56 (note 3)	12-02 [i.5]	F.497-7 [i.42]
15	14,5 to 14,62 paired with 15,23 to 15,35	1,75 to 56	12-07 [i.9]	F.636-4 [i.45]
	14,5 to 15,35		-	
18	17,7 to 19,7	13,75 to 110 or 1,75 to 14 (note 2)	12-03 [i.6] (note 1)	F.595-10 [i.43] (note 1)
NOTE 1: CEPT Recommendation 12-03 [i.6] allows for low-capacity channel arrangements on a national basis. Recommendation ITU-R F.595-10 [i.43] details various channel arrangements including low-capacity channel arrangements.				
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.				
NOTE 3: In the 13 GHz band the CEPT and Recommendations ITU-R provide the 56 MHz CS only in term of aggregation of 2 × 28 MHz CS, subject to their availability and possible national license restrictions.				

## 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)	27,5 /28	55/56	110 (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	117	235	470
	7	5H	-	17	34	68	-	-	-	-	-	-
		5HB, 5HA	-	-	-	-	137 (note 2)	274 (note 2)	548	137 (note 2)	274 (note 2)	548
	8	6L	-	-	39	78	-	-	-	-	-	-
		6LB, 6LA	-	-	-	-	156 (note 2)	313 (note 2)	627	156 (note 2)	314 (note 2)	627
	9	6H	-	-	-	88	-	-	-	-	-	-
		6HB, 6HA	-	-	-	-	176	352	705	176	352	705
	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 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 1000BaseT or N × 100BaseT capacity are concerned.

## E.3 Transmitter

### E.3.1 General requirements

Table E.3: Transmitter requirements

Requirements	Limits
Maximum transmitter power	Clause 4.2.1.1
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF spectrum power density mask	Clause 4.2.3.2
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain - external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### E.3.2 RF 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
Unwanted emissions in the spurious domain (External)	Clause 4.3.1
BER as a function of RSL	Table E.5a (equipment operating in 13 GHz and 15 GHz bands) Table E.5b (equipment operating in 18 GHz band)
Co channel external and adjacent channel interference sensitivity	Table E.6
CW spurious interference	Clause 4.3.3.4

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

The supplier 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 tables E.5a and E.5b. The declared Receiver Signal levels shall produce a BER of  $10^{-6}$  or either  $\leq 10^{-8}$  or  $\leq 10^{-10}$ .

NOTE: RSL values, evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.31] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-8}$ (dBm)	RSL for BER $\leq 10^{-10}$ (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
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 (note)	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 (note)	137	28 (ACAP/ACCP)	-65,5	-	-62,5
		274	56 (ACAP/ACCP)	-62	-	-59

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-8}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)
Reference index	Class					
8	6L	39	7	-67,5	-66	-
		78	14	-64,5	-63	-
	6LA/6LB (note)	156	28 (ACAP/ACCP)	-62	-	-59
		313	56 (ACAP/ACCP)	-59	-	-56
9	6H	88	14	-61	-59,5	-
	6HA/6HB (note)	176	28 (ACAP/ACCP)	-58,5	-	-55,5
		352	56 (ACAP/ACCP)	-56	-	-53
10	7	98	14	-57,5	-56	-
	7A/7B (note)	196	28 (ACAP/ACCP)	-55	-	-52
		392	56 (ACAP/ACCP)	-52,5	-	-49,5
11	8	107	14	-54,5	-	-51,5
	8A/8B (note)	215	28 (ACAP/ACCP)	-51,5	-	-48,5
		431	56 (ACAP/ACCP)	-49	-	-46

NOTE: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed 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)  
for 18 GHz bands**

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-8}$ (dBm)	RSL for BER $\leq 10^{-10}$ (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
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
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
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
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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-8}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)
Reference index	Class					
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
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
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
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
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

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 may be relaxed by 1,5 dB.

NOTE 2: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

### E.4.3 Co-channel "external" and adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for BER  $\leq 10^{-6}$  in clause E.4.2.

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

Spectral efficiency		Minimum RIC rate (Mbit/s) (see note)	Channel separation (MHz) (see note)	C/I for BER ≤ 10 <sup>-6</sup> 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
2	2	2; 4; 8; 16; 32; 64	1,75; 3,5; 7; 14; 28; 56	23	19	0	-4
		16; 32; 64; 128	13,75; 27,5; 55; 110	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	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	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	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 (ACCP)	34	30	-3	-7

Spectral efficiency		Minimum RIC rate (Mbit/s) (see note)	Channel separation (MHz) (see note)	C/I for BER ≤ 10 <sup>-6</sup> 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
7	5LA	117; 235; 470	27,5/28; 55/56; 110 (ACAP)	34	30	4	1
	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	55/56	37	33	-3,5	-7,5
		548	110	37	33	-3,5	-7,5
	5HA	137; 274; 548	27,5/28; 55/56; 110 (ACAP)	37	33	3	-1
8	6L	39; 78	7; 13,75/14	40	36	0	-4
	6LB	156; 313; 627	27,5/28; 55/56; 110 (ACCP)	40	36	0	-4
	6LA	156; 313; 627	27,5/28; 55/56; 110 (ACAP)	40	36	10	7
9	6H	88	13,75/14	43	39	0	-4
	6HB	176; 352; 705	27,5/28; 55/56; 110 (ACCP)				
	6HA	176; 352; 705	27,5/28; 55/56; 110 (ACAP)	43	39	10	6
10	7	98	13,75/14	46	42	0	-4
	7B	196; 392; 784	27,5/28; 55/56; 110 (ACCP)	46	42	0	-4
	7A	196; 392; 784	27,5/28; 55/56; 110 (ACAP)	46	42	13	9
11	8	107	13,75/14	50	46	0	-4
	8B	215; 431; 862	27,5/28; 55/56; 110 (ACCP)				
	8A	215; 431; 862	27,5/28; 55/56; 110 (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 clause F.2.1 and table F.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according 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

In table F.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test suites relevant to each system designed for that channel separation.

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**

Band (GHz)	Frequency range (GHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC (CEPT/ERC)	ITU-R
23	22,0 to 23,6	3,5 to 112	T/R 13-02 annex A [i.18]	F.637-4 [i.46]
26	24,5 to 26,5	3,5 to 112	T/R 13-02 annex B [i.18]	F.748-4 [i.49]
28	27,5 to 29,5	3,5 to 112	T/R 13-02 annex C [i.18]	F.748-4 [i.49]
31	31,0 to 31,3	3,5 to 28/56 (see note 1)	02-02 [i.20]	F.746-10 annex 7 [i.47]
32	31,8 to 33,4	3,5 to 112	01-02 [i.4]	F.1520-3 [i.59]
38	37,0 to 39,5	3,5 to 112	T/R 12-01 [i.16]	F.749-3 [i.50]
42	40,5 to 43,5	7 to 112 (see note 2)	01-04 [i.19]	F.2005 [i.60]
NOTE 1: 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.				
NOTE 2: 2014 revision of ECC/REC(01)04 [i.19] has extended the maximum channel size to 224 MHz. However, the present document has not yet included that channel size.				



## 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	28	56	112
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	-	-
			42	-	8	16	32	64	128	-	-
	3	3	23 to 38	6	12	24	48	96	191	-	-
			42	-	12	24	48	96	191	-	-
	4	4L	23 to 38	8	16	32	64	128	256	-	-
			42	-	16	32	64	128	256	-	-
	5	4H	23 to 42	-	24	49	98	196	392	-	-
	6	5L	23 to 42	-	29	58	-	-	-	-	-
		5LB, 5LA	23 to 42	-	-	-	117	235	470	117	235
	7	5H	23 to 42	-	34	68	-	-	-	-	-
		5HB, 5HA	23 to 42	-	-	-	137 (note 2)	274 (note 2)	548	137 (note 2)	274 (note 2)
	8	6L	23 to 42	-	39	78	-	-	-	-	-
		6LB, 6LA	23 to 42	-	-	-	156	313	627	156	313
	9	6H	23 to 42	-	-	88	-	-	-	-	-
		6HB, 6HA	23 to 42	-	-	-	176	352	705	176	352
	10	7	23 to 42	-	-	98	-	-	-	-	-
		7B, 7A	23 to 42	-	-	-	196	392	784	196	392
	11	8	23 to 42	-	-	107	-	-	-	-	-
		8B, 8A	23 to 42	-	-	-	215	431	862	215	431

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 1000BaseT or N × 100BaseT capacity are concerned.

## F.3 Transmitter

### F.3.1 General requirements

Table F.3: Transmitter requirements

Requirements	Limits
Maximum transmitter power	Clause 4.2.1.1
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain - external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### F.3.2 RF 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
Unwanted emissions in the spurious domain (external)	Clause 4.3.1
BER as a function of RSL	Tables F.5a and F.5b
Co channel external and adjacent channel interference sensitivity	Table F.7
CW spurious interference	Clause 4.3.3.4

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

The supplier 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 F.5a and F.5b. The declared Receiver Signal levels shall produce a  $\text{BER} \leq 10^{-6}$  and either  $\leq 10^{-6}$  or  $\leq 10^{-8}$  as required.

NOTE: RSL values, evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.31] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

Table F.5a: BER performance thresholds for 23 GHz to 42 GHz bands (systems for minimum RIC &lt; 100 Mbit/s) (upper bound)

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 <sup>-6</sup> (dBm)	RSL for BER ≤ 10 <sup>-8</sup> (dBm)	RSL for BER ≤ 10 <sup>-6</sup> (dBm)	RSL for BER ≤ 10 <sup>-8</sup> (dBm)	RSL for BER ≤ 10 <sup>-6</sup> (dBm)	RSL for BER ≤ 10 <sup>-8</sup> (dBm)	RSL for BER ≤ 10 <sup>-6</sup> (dBm)	RSL for BER ≤ 10 <sup>-8</sup> (dBm)	RSL for BER ≤ 10 <sup>-6</sup> (dBm)	RSL for BER ≤ 10 <sup>-8</sup> (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
3	3	64	56	-77	-75,5	-76	-74,5	-76	-74,5	-75	-73,5	-75	-73,5
		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
4	4L	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
		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
5	4H	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
		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
6	5L	98	28	-70	-68,5	-69	-67,5	-69	-67,5	-68	-66,5	-68	-66,5
		29	7	-73	-71,5	-72	-70,5	-71,5	-70	-70,5	-69	-70,5	-69
7	5H	58	14	-70	-68,5	-69	-67,5	-69	-67,5	-68	-66,5	-68	-66,5
		34	7	-70	-68,5	-69	-67,5	-68	-66,5	-67	-65,5	-67	-65,5
8	6L	68	14	-67	-65,5	-66	-64,5	-66	-64,5	-65	-63,5	-64,5	-63
		39	7	-66	-64,5	-65	-63,5	-64,5	-63	-63,5	-62	-63,5	-62
9	6H	78	14	-63,5	-62	-62,5	-61	-62	-60,5	-61	-59,5	-61	-59,5
		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 *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed 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  $\geq 100$  Mbit/s) (upper bound)

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 $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (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
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
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
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
7	5HA/5HB	137	28	-64	-61	-63	-60	-63	-60	-62	-59	-62	-59
		274 (note)	56	-61	-58	-60	-57	-60	-57	-59	-56	-59	-56
		548	112	-58	-55	-57	-54	-57	-54	-56	-53	-56	-53
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
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
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
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

NOTE: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

### F.4.3 Co-channel "external" and adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for  $BER \leq 10^{-6}$  in clause F.4.2.

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

Spectral efficiency		Frequency band (GHz)	Minimum RIC rate (Mbit/s) (see note)	Channel separation (MHz) (see note)	C/I for $BER \leq 10^{-6}$ RSL degradation of 1 dB or 3 dB			
					Co-channel interference		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	7; 14; 28; 56; 112				
3	3	All except 42	6	3,5	23	19	-1	-5
		All	12; 24; 48; 96; 191	7; 14; 28; 56; 112				
4	4L	All except 42	8	3,5	30	26	-1	-5
		All	16; 32; 64; 128; 256	7; 14; 28; 56; 112				
5	4H	All	24; 49; 98; 196; 392	7; 14; 28; 56; 112	30	26	-6	-9,5
6	5L	All	29; 58	7; 14	34	30	-3	-7
	5LB	All	117; 235; 470	28; 56; 112 (ACCP)	34	30	-3	-7
	5LA	All	117; 235; 470	28; 56; 112 (ACAP)	34	30	4	1
7	5H	All	34; 68	7; 14	37	33	-3	-7
	5HB	All	137	28 (ACCP)				
	5HA	All	274; 548	56; 112 (ACCP)	37	33	-3,5	-7,5
8	6L	All	137; 274; 548	28; 56; 112 (ACAP)	37	33	+3	-1
	6LB	All	39; 78	7; 14	40	36	0	-4
	6LA	All	156; 313; 627	28; 56; 112 (ACCP)				
9	6H	All	156; 313; 627	28; 56; 112 (ACAP)	40	36	10	7
	6HB	All	88	14	43	39	0	-4
	6HA	All	176; 352; 705	28; 56; 112 (ACCP)				
10	7	All	176; 352; 705	28; 56; 112 (ACAP)	43	39	10	6
	7B	All	98	14	46	42	0	-4
	7A	All	196; 392; 784	28; 56; 112 (ACCP)				
11	8	All	196; 392; 784	28; 56; 112 (ACAP)	46	42	13	9
	8B	All	107	14	50	46	0	-4
	8A	All	215; 431; 862	28; 56; 112 (ACCP)				
			215; 431; 862	28; 56; 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 G (normative): 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 clause G.2.1 and table G.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according 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

In table G.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test suites relevant to each system designed for that channel separation.

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**

Band (GHz)	Frequency range (GHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC (CEPT/ERC)	ITU-R
50	48,5 to 50,2	3,5 to 28 (see note 1)	12-11 annex A [i.11]	-
52	51,4 to 52,6	3,5 to 56 (see note 1)	12-11 annex B [i.11]	F.1496-1 [i.57]
50 to 52	48,5 to 50,2 paired with 50,9 to 52,6	14 to 56 (see note 2)	12-11 annex C [i.11]	-
55	55,78 to 57,0	3,5 to 56	12-12 [i.12]	F.1497-1 [i.58]
NOTE 1: 2014 revision of ECC/REC(01)04 [i.19] has extended the maximum channel size to 224 MHz. However, the present document has not yet included that channel size.				
NOTE 2: 2015 revision of ERC/REC 12-11 [i.11] 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.				

## 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
Minimum payload RIC rate Mbit/s (note)	Spectral efficiency ↓		Frequency band (GHz) ↓	↓	↓	↓	↓	↓	↓	↓	↓
	Reference index	Class		↓	↓	↓	↓	↓	↓	↓	↓
	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
Maximum transmitter power	Clause 4.2.1.1
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain - external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### G.3.2 RF 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
Unwanted emissions in the spurious domain (external)	Clause 4.3.1
BER as a function of RSL	Table G.6
Co channel external and adjacent channel interference sensitivity	Table G.7
CW spurious interference	Clause 4.3.3.4

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

The supplier 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 table G.5. The declared Receiver Signal levels shall produce a BER  $\leq 10^{-6}$  and either  $\leq 10^{-6}$  or  $\leq 10^{-10}$  as required.

NOTE: RSL values, evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.31] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Band →	50 GHz 50 and 52 GHz Paired			52 GHz and 55 GHz		
Reference index	Class		Channel separation (MHz) ↓	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-8}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-8}$ (dBm)	RSL for BER $\leq 10^{-10}$ (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 *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

## G.4.3 Co-channel "external" and adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for BER  $\leq 10^{-6}$  in clause G.4.2.

**Table G.6: Co-channel and 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 <sup>-6</sup> RSL degradation of 1 dB or 3 dB			
					Co-channel interference		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 ECC/Recommendation (09)01 [i.24] (for the band 57 GHz to 64 GHz) and ECC/Recommendation (05)02 [i.23] (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  $CS = n \times 50$  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:** In the frequency band 64 GHz to 66 GHz the less stringent emission requirements referred in annex I can also be applied. The manufacturer should select the more appropriate according to the actual system and application foreseen.

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 Radio Regulations [7].

## H.2 General characteristics

### H.2.1 Frequency characteristics and channel arrangements

In table H.1, ITU-R and ECC (formerly CEPT/ERC) recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 of the Directive 2014/53/EU [i.1] requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test suites relevant to each system mainly 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**

Band (GHz)	Frequency range (GHz)	Channel separation (MHz)	Recommendations for radio frequency channel arrangements	
			ECC	ITU-R
57 to 64	57 to 64	50 to 2 000 (see note)	(09)01 [i.24]	Annex 2 of F.1497-2 [i.58]
64 to 66	64 to 66	50 to 2 000 (see note)	(05)02 [i.23]	Annex 3.2 of F.1497-2 [i.58]
NOTE: In steps of $n \times 50$ MHz; systems not designed according specific channel arrangement shall declare the <i>occupied bandwidth</i> and should refer to the closest $n \times 50$ 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  $N \times 50$  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	$N \times 50$ ( $N < 40$ )	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	$28,5 \times N$ (note 2)	(285)	(427)	(712)	1 140
	2	2	57	$57 \times N$	(570)	(855)	(1 425)	2 280
	3	3	85	$85 \times N$	(850)	(1 275)	(2 125)	3 400
	4	4L	114	$114 \times N$ (note 3)	(1 140)	(1 710)	2 850	-
	5	4H	175	$175 \times N$ (note 4)	(1 750)	2 625	-	-
	6	5LA/5LB	210	$210 \times N$ (note 4)	(2 100)	3 150	-	-
	7	5HA/5HB	245	$245 \times N$ (note 5)	2 450	-	-	-
	8	6LA/6LB	280	$280 \times N$ (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 summarises the TX requirements.

Table H.3: Transmitter requirements

Requirements	Limits
Combined TX power output and EIRP limits	Clause H.3.2.2 or clause H.3.2.3
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Emissions outside the 57 GHz to 66 GHz range	Clause H.3.4
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain - external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### H.3.2 Combined TX power output and EIRP limits

#### H.3.2.1 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.23] 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 Radio Regulations [7] apply.

In addition, in order of safeguarding a fair and efficient use of the spectrum, maximum Pout and EIRP emissions (referred in clause 4.2.1.1 and 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 as function of the antenna gain ( $G_{ant}$ ).

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 or that less restrictive given in clause I.3.2 of annex I.

### H.3.2.2 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  $45 \text{ dBi} > G_{ant} \geq 38$  dBi.  
 $\leq -28 + 2 \times G_{ant}$  (dBi) for  $38 \text{ dBi} > G_{ant} \geq 30$  dBi.

- 2a) EIRP density (dBm/MHz)  $\leq -10 \text{ dBm/MHz} + G_{ant}$  (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  $30 \text{ dBi} \leq G_{ant} < 38 \text{ dBi}$   
 $\leq +10$  for  $38 \text{ dBi} \leq G_{ant} < 45 \text{ dBi}$   
 $\leq 55 - G_{ant}$  for  $G_{ant} \geq 45 \text{ dBi}$ .

- **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  $\leq -10$  dBm/MHz.  
3b) Minimum  $G_{ant}$  (dBi)  $\geq \text{Pout (dBm)} + 30$ ; or  
 $\geq 30$  (dBi) (whichever is the greater).  
4b) Maximum  $G_{ant}$  (dBi)  $\leq 55 - \text{Pout (dBm)}$   
where Pout is the maximum possible power, including tolerances, delivered to the antenna connector.

NOTE: It is assumed that the above information on antenna gain range, not specifically relevant to article 3.2 of the Directive 2014/53/EU [i.1], is supplied in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1].

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

### H.3.2.3 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.35].

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:

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

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

$$3a_{ATPC}) \quad \text{Minimum } G_{\text{ant}} \text{ (dBi)} \quad \geq 30.$$

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

$$4a_{ATPC}) \quad \text{Pout (dBm)} \quad \leq +10 \quad \text{for } 30 \text{ dBi} \leq G_{\text{ant}} < 45 \text{ dBi} \\ \leq 55 - G_{\text{ant}} \quad \text{for } G_{\text{ant}} \geq 45 \text{ dBi.}$$

$$5a_{ATPC}) \quad \text{Minimum ATPC attenuation (dB)} \geq \text{actual Pout (max delivered in full power ATPC regime) - max Pout (from formula 4a, clause H.3.2.1).}$$

- **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) for not exceeding the above EIRP limitations, i.e.:

$$1b_{ATPC}) \quad \text{Pout (dBm)} \quad \leq +10 \text{ (in any conditions) (see note).}$$

$$2b_{ATPC}) \quad \text{Pout density} \quad \leq -10 \text{ dBm/MHz.}$$

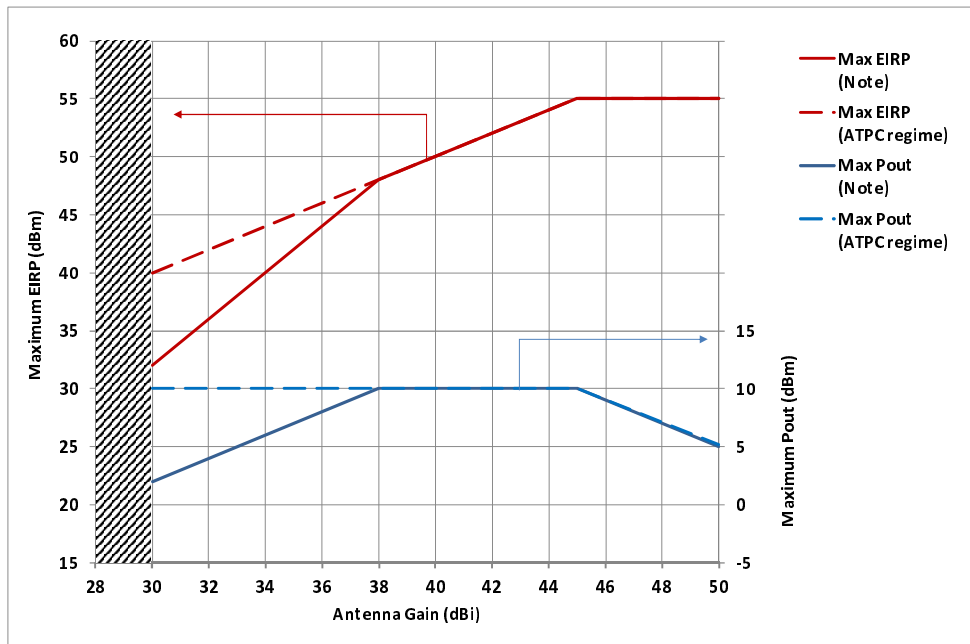
$$3b_{ATPC}) \quad \text{Minimum } G_{\text{ant}} \text{ (dBi)} \quad \geq \text{Pout (dBm)} + 30 \quad \text{or} \\ \geq 30 \text{ (dBi)} \quad \text{(whichever is the greater)} \\ \text{where Pout is intended as the maximum delivered by ATPC regime in unfaded condition.}$$

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

$$5b_{ATPC}) \quad \text{Minimum ATPC attenuation (dB)} \geq \text{actual Pout (max delivered in full power ATPC regime) - max Pout (from formula 4a, clause H.3.2.1)}$$

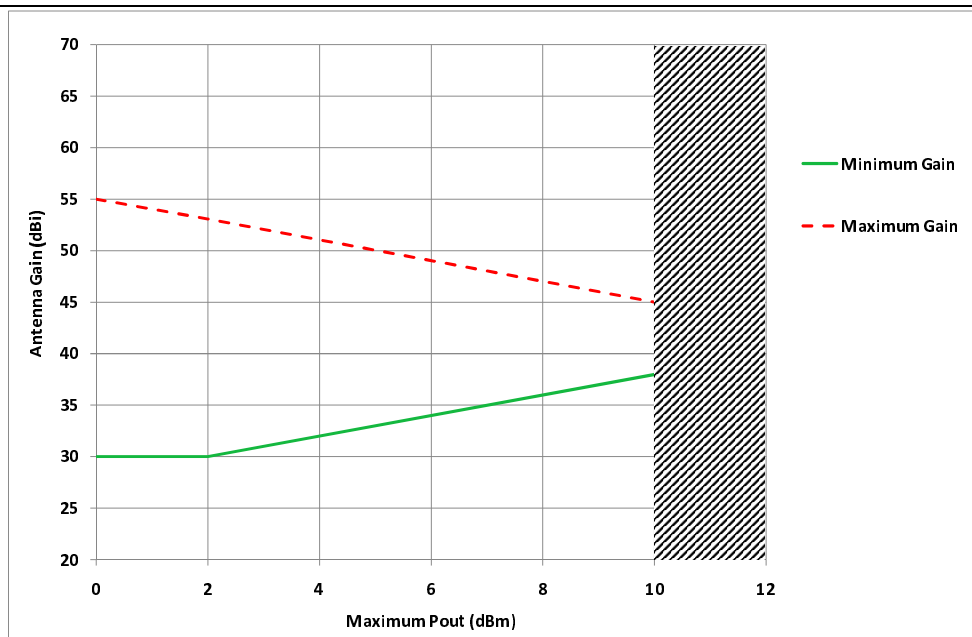
NOTE: It is assumed that the above information on antenna gain range, not specifically relevant to article 3.2 of the Directive 2014/53/EU [i.1], is supplied in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1]. In addition, it should be considered that the Pout limits are generic absolute maximum, but, when coupled with actual antenna within minimum/maximum  $G_{\text{ant}}$  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) for the Pout in unfaded conditions and in formula  $4a_{ATPC}$  (present clause) for the Pout in ATPC regime.

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



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  $30 \leq G_{ant} \text{ (dBi)} \leq 45$ .

**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 RF spectrum masks

The appropriate mask described in clause 4.2.3.2 for  $N \times 50$  MHz case shall apply.

## H.3.4 Emissions 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 [4]) shall remain within the specified band 57 GHz to 66 GHz.

However, out-of-band emissions (i.e. those within the spectrum masks 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.

This requirement does not imply any specific test assessment; compliance evaluation is based on nominal equipment emission characteristics and user instructions (see note 2).

NOTE 1: The ECC channel arrangements in the range 57 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: It is assumed that the above limitation implies (e.g. under article 10.8 of the Directive 2014/53/EU [i.1]) the inclusion in the user instructions of specific instructions on how to meet the requirement (e.g. minimum distance of the carrier from the band edges and/or maximum EIRP, etc.).

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
Unwanted emissions in the spurious domain (External)	Clause 4.3.1
BER as a function of RSL	Clause H.4.2
Co channel external and adjacent channel interference sensitivity	Clause H.4.3
CW spurious interference	Clause 4.3.3.4

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

The supplier 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 table H.5. The declared Receiver Signal levels shall produce a BER  $\leq 10^{-6}$  or either  $\leq 10^{-8}$  or  $\leq 10^{-10}$ .

NOTE: RSL values, evaluated for typical implementation practice, may be found in ETSI TR 101 854 [i.31] and RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm) (see note 2)	RSL for BER $\leq 10^{-10}$ (dBm) (see note 2)
Reference index	Class				
1	1	28,5	50	-73	-71
		$28,5 \times N$ ( $N < 40$ ) (see note 1)	$N \times 50$ ( $N < 40$ )	$-73 + 10\log N$	$-71 + 10\log N$
		1 140	2 000 ( $N = 40$ )	-57	-55

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

NOTE 1: For  $N > 4$  rounded down to the lower Mbit/s integer.  
NOTE 2: Value of  $10\log N$  rounded to the closest 1/2 dB granularity.  
NOTE 3: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

### H.4.3 Co-channel "external" and adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for  $\text{BER} \leq 10^{-6}$  in clause H.4.2.

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

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER $\leq 10^{-6}$ RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
1	1	$28,5 \times N$ ( $1 \leq N \leq 40$ ) (see note)	$N \times 50$ ( $1 \leq N \leq 40$ )	23	19	0	-4
2	2	$57 \times N$ ( $1 \leq N \leq 40$ )					
3	3	$85 \times N$ ( $1 \leq N \leq 40$ )	$N \times 50$ ( $1 \leq N \leq 40$ )	25	21	0	-4
4	4L	$114 \times N$ ( $1 \leq N \leq 25$ )	$N \times 50$ ( $1 \leq N \leq 25$ )	27	23	0	-4
5	4H	$175 \times N$ ( $1 \leq N \leq 15$ )	$N \times 50$ ( $1 \leq N \leq 15$ )	30	26	-2	-6
6	5LB	$210 \times N$ ( $1 \leq N \leq 15$ )	$N \times 50$ (ACCP) ( $1 \leq N \leq 15$ )	33,5	29,5	-6	-10
	5LA	$210 \times N$ ( $1 \leq N \leq 15$ )	$N \times 50$ (ACAP) ( $1 \leq N \leq 15$ )	33,5	29,5	+3	-1

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER $\leq 10^{-6}$ RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
7	5HB	$245 \times N$ ( $1 \leq N \leq 10$ )	$N \times 50$ (ACCP) ( $1 \leq N \leq 10$ )	37	33	-3	-7
	5HA	$245 \times N$ ( $1 \leq N \leq 10$ )	$N \times 50$ (ACAP) ( $1 \leq N \leq 10$ )	37	33	+6	+2
8	6LB	$280 \times N$ ( $1 \leq N \leq 10$ )	$N \times 50$ (ACCP) ( $1 \leq N \leq 10$ )	40,5	36,5	0	-4
	6LA	$280 \times N$ ( $1 \leq N \leq 10$ )	$N \times 50$ (ACAP) ( $1 \leq N \leq 10$ )	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 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; this value shall be respected, tolerance included.

When equipment are supplied without antenna (i.e. are fitted for a *stand alone antenna*), it is assumed that the above information on minimum antenna gain, not specifically relevant to equipment assessment under article 3.2 of the Directive 2014/53/EU [i.1], is indicated in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1].



# 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 ECC/Recommendation (05)02 [i.23].

According 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:

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

Systems not designed according 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 Radio Regulations [7].

## I.2 General characteristics

### I.2.1 Frequency characteristics and channel arrangements

In table I.1, ITU-R and ECC recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 of the Directive 2014/53/EU [i.1] requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test suites relevant to each system mainly 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	
		ECC (CEPT/ERC)	ITU-R
64 to 66	FDD: 30 to 990 (see note 1) TDD: 30 to 1 980 (see note 1)	Annex 3 of (05)02 [i.23]	Annex 3.2 of F.1497-2 [i.58]
64 to 66	FDD: 50 to 950 (see note 2) TDD: 50 to 1 900 (see note 2)	Annex 3 of (05)02 [i.23]	Annex 3.2 of F.1497-2 [i.58]
NOTE 1: In steps of $n \times 30$ MHz; systems not designed according specific channel arrangement shall declare the <i>occupied bandwidth</i> and should refer to the closest $n \times 30$ MHz channel separation.			
NOTE 2: In steps of $n \times 50$ MHz. FDD also extensible up to 1 950 when national regulations foresee go/return conjunction with lower band 57 GHz to 64 GHz. TDD extensible to 1 950 when the national regulations foresee.			

## I.2.2 Transmission capacities

### I.2.2.1 Channel arrangement based on $N \times 50$ 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 $N \times 30$ MHz

Table I.2 gives the minimum RIC as function of spectral efficiency class and CS based on  $N \times 30$  MHz arrangement; specific values are given for the minimum and maximum CS foreseen for each class, while, for intermediate  $N \times 30$  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  $N \times 30$  MHz arrangement

Channel separation (MHz) →			30	$N \times 30$ (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	$17 \times N$	(272)	(425)	561	(697)	1 122
	2	2	34	$34 \times N$	(544)	(850)	1 122	(1 394)	2 244
	3	3	51	$51 \times N$	(816)	(1 275)	1 683	(2 091)	3 366
	4	4L	68	$68 \times N$ (note 2)	(1 088)	(1 700)	2 244	2 788	-
	5	4H	105	$105 \times N$ (note 3)	(1 680)	2 625	-	-	-
	6	5LA/5LB	126	$126 \times N$ (note 3)	(2 016)	3 150	-	-	-
	7	5HA/5HB	147	$147 \times N$ (note 4)	2 352	-	-	-	-
	8	6LA/6LB	168	$168 \times N$ (note 4)	2 688	-	-	-	-
NOTE 1: For equipment assessment with different base band interfaces see annex N.									
NOTE 2: $N < 41$ .									
NOTE 3: $N < 25$ .									
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
Combined TX power and EIRP limits	Clause I.3.2.2 or clause I.3.2.3
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Emissions outside the 57 GHz to 66 GHz range	Clause I.3.4
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain -external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

### I.3.2 Combined TX power and EIRP limits

#### I.3.2.1 Generality

ECC/REC(05)02 [i.23] 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 Radio Regulations [7] apply.

Further emission limitations, in terms of EIRP and/or Pout and/or antenna gain, might be present on a national basis.

In addition, in order of safeguarding a fair and efficient use of the spectrum, maximum Pout and EIRP emissions (referred in clause 4.2.1.1 and clause 4.2.1.2) of equipment in the scope of the present document shall be limited as in following clauses as function of the antenna gain ( $G_{ant}$ ).

#### I.3.2.2 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 Radio Regulation [7] article 21) for  $G_{ant} \geq 50$  dBi.  
 $\leq +85 - 2 \times (50 - G_{ant})$  for  $50 \text{ dBi} > G_{ant} \geq 30$  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  $30 \text{ dBi} \leq G_{ant} < 50$  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)  $\geq Pout \text{ (dBm)} + 15$  or  
 $\geq 30 \text{ (dBi)}$  (whichever is the greater).

- 2b) Maximum  $G_{ant}$  (dBi)  $\leq 85 - Pout \text{ (dBm)}$ .

- 3b)  $P_{out}$  (dBm)  $\leq +35$   
 where  $P_{out}$  is the maximum possible power, including tolerances, delivered to the antenna connector.

NOTE: It is assumed that the above information, not specifically relevant to article 3.2 of the Directive 2014/53/EU [i.1], on antenna gain range is supplied in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1].

The above limitations are visually represented in figures I.1 and I.2.

### I.3.2.3 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 C.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.35].

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  $P_{out}$  in full power ATPC regime:

$$1a_{ATPC}) \quad EIRP \text{ (dBm)} \leq +35 + G_{ant} \text{ (dBi)} \quad \text{or} \\ \leq +85 \quad (\text{whichever is the lower}).$$

$$2a_{ATPC}) \quad G_{ant} \text{ (dBi)} \geq 30.$$

The above limitations automatically imply (see figure I.1) also a limit to the maximum  $P_{out}$  in full power ATPC regime:

$$3a_{ATPC}) \quad P_{out} \text{ (dBm)} \leq +35 \quad \text{for} \quad 30 \leq G_{ant} < 50 \text{ dBi} \\ \leq 85 - G_{ant} \quad \text{for} \quad G_{ant} \geq 50 \text{ dBi}.$$

$$4a_{ATPC}) \quad \text{Minimum ATPC attenuation (dB)} \geq \text{actual } P_{out} \text{ (max delivered in full power ATPC regime)} - \text{maximum } P_{out} \text{ (from formula 3a, clause I.3.2.2)}.$$

- **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) for not exceeding the above EIRP limitations, i.e.:

$$1b_{ATPC}) \quad \text{Minimum } G_{ant} \text{ (dBi)} \geq P_{out} \text{ (dBm)} + 15; \quad \text{or} \\ \geq 30 \text{ (dBi)} \quad (\text{whichever is the greater}) \\ \text{where } P_{out} \text{ is intended as the maximum delivered by ATPC regime in unfaded condition.}$$

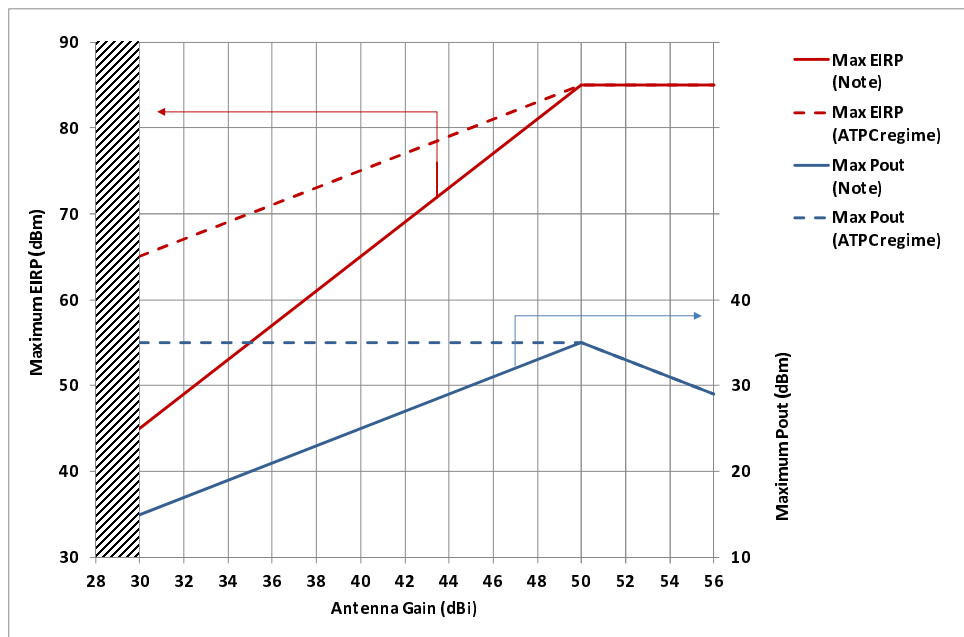
$$2b_{ATPC}) \quad \text{Maximum } G_{ant} \text{ (dBi)} \leq 85 - P_{out} \text{ (dBm)} \\ \text{where } P_{out} \text{ is intended as the maximum delivered in full power ATPC regime.}$$

$$3b_{ATPC}) \quad P_{out} \text{ (dBm)} \leq +35 \text{ (in any conditions) (see note).}$$

$$4b_{ATPC}) \quad \text{Minimum ATPC attenuation (dB)} \geq \text{actual } P_{out} \text{ (max delivered in full power ATPC regime)} - \text{maximum } P_{out} \text{ (from formula 3a clause I.3.2.2)}.$$

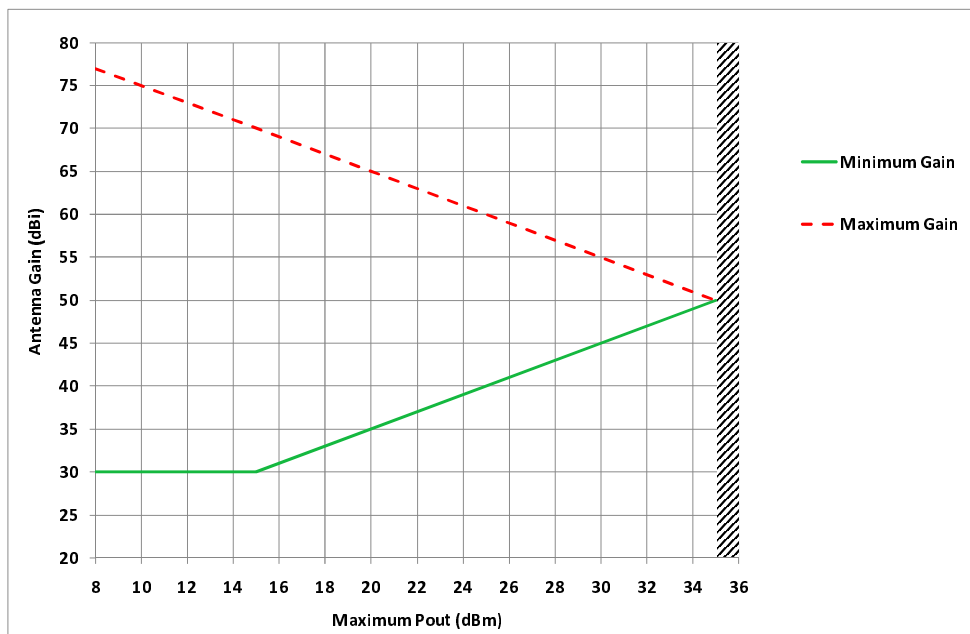
NOTE: It is assumed that the above information, not specifically relevant to article 3.2 of the Directive 2014/53/EU [i.1], on antenna gain range is supplied in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1]. In addition, it should be considered that the  $P_{out}$  limits are generic absolute 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) for the  $P_{out}$  in unfaded conditions and in formula  $3a_{ATPC}$  (present clause) for the  $P_{out}$  in ATPC regime are also satisfied.

The above limitations are visually represented in figures I.1 and I.2.



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  $35 \leq G_{ant} \text{ (dBi)} \leq 55$ .

**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 RF spectrum mask

The appropriate masks described in clause 4.2.3 for  $N \times 50$  MHz or for  $N \times 30$  MHz cases shall apply.

### I.3.4 Emissions 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 [4]) shall remain within the specified band 64 GHz to 66 GHz.

However, out-of-band emissions (i.e. those within the spectrum masks 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 to a maximum of:

- +10 dBm/MHz.

This requirement does not imply any specific test assessment; compliance evaluation is based on nominal equipment emission characteristics and user instructions (see note 2).

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: It is assumed that the above limitation implies (e.g. under article 10.8 of the Directive 2014/53/EU [i.1]) the inclusion in the user instructions of specific indication on how to meet the requirement (e.g. minimum distance of the carrier from the band edges and/or maximum EIRP, etc.)

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.

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## I.4 Receiver

### I.4.1 General requirements

Table I.4 summarizes the RX requirements.

**Table I.4: Receiver requirements**

Requirements	Limits
Unwanted emissions in the spurious domain (External)	Clause 4.3.1
BER as a function of RSL	Clause I.4.2
Co channel external and adjacent channel interference sensitivity	Clause I.4.3
CW spurious interference	Clause 4.3.3.4

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

#### I.4.2.1 Channel arrangement based on $N \times 50$ 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 $N \times 30$ MHz

The supplier 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 table I.5. The declared Receiver Signal levels shall produce a  $BER \leq 10^{-6}$  or either  $\leq 10^{-8}$  or  $\leq 10^{-10}$ .

NOTE: RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Minimum RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm) (see note 1)	RSL for BER $\leq 10^{-10}$ (dBm) (see note 1)
Reference index	Class				
1	1	17	30	-75,2	-73,2
		$17 \times N$ (TDD: $N < 66$ ) (FDD: $N < 33$ )	$N \times 30$ (TDD: $N < 66$ ) (FDD: $N < 33$ )	$-75,2 + 10\log N$	$-73,2 + 10\log N$
		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
		$34 \times N$ (TDD: $N < 66$ ) (FDD: $N < 33$ )	$N \times 30$ (TDD: $N < 66$ ) (FDD: $N < 33$ )	$-73,2 + 10\log N$	$-71,2 + 10\log N$
		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
		$51 \times N$ (TDD: $N < 66$ ) (FDD: $N < 33$ )	$N \times 30$ (TDD: $N < 66$ ) (FDD: $N < 33$ )	$-70,2 + 10\log N$	$-68,2 + 10\log N$
		1 638 (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
		$68 \times N$ (TDD: $N < 41$ ) (FDD: $N < 33$ )	$N \times 30$ (TDD: $N < 41$ ) (FDD: $N < 33$ )	$-67,7 + 10\log N$	$-63,7 + 10\log N$
		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
		$105 \times N$ ( $N < 25$ )	$N \times 30$ ( $N < 25$ )	$-64,2 + 10\log N$	$-60,2 + 10\log N$
		2 625 ( $N = 25$ )	990 ( $N = 25$ )	-50,2	-46,2
6	5LA/5LB	126	30	-60,7	-56,7
		$126 \times N$ ( $N < 25$ )	$N \times 30$ ( $N < 25$ )	$-60,7 + 10\log N$	$-56,7 + 10\log N$
		3 150 ( $N = 25$ )	990 ( $N = 25$ )	-46,7	-42,7
7	5HA/5HB	147	30	-57,2	-53,2
		$147 \times N$ ( $N < 16$ )	$N \times 30$ ( $N < 16$ )	$-57,2 + 10\log N$	$-53,2 + 10\log N$
		2 352 ( $N = 16$ )	480 ( $N = 16$ )	-45	-41
8	6LA/6LB	168	30	-53,2	-49,2
		$168 \times N$ ( $N < 16$ )	$N \times 30$ ( $N < 16$ )	$-53,2 + 10\log N$	$-49,2 + 10\log N$
		2 688 ( $N = 16$ )	480 ( $N = 16$ )	-41	-37

NOTE 1: Value of  $10\log N$  rounded to the closest 1/2 dB granularity.  
NOTE 2: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).

### I.4.3 Co-channel "external" and adjacent channel interference sensitivity

#### I.4.3.1 Channel arrangement based on $N \times 50$ 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 $N \times 30$ MHz

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for  $BER \leq 10^{-6}$  in clause I.4.2.

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

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for $BER \leq 10^{-6}$ RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
1	1	$17 \times N$ (TDD: $1 \leq N \leq 66$ ) (FDD: $1 \leq N \leq 33$ )	$N \times 30$ (TDD: $1 \leq N \leq 66$ ) (FDD: $1 \leq N \leq 33$ )	23	19	0	-4
2	2	$34 \times N$ (TDD: $1 \leq N \leq 66$ ) (FDD: $1 \leq N \leq 33$ )					
3	3	$51 \times N$ (TDD: $1 \leq N \leq 66$ ) (FDD: $1 \leq N \leq 33$ )	$N \times 30$ (TDD: $1 \leq N \leq 66$ ) (FDD: $1 \leq N \leq 33$ )	25	21	0	-4
4	4L	$68 \times N$ (TDD: $1 \leq N \leq 41$ ) (FDD: $1 \leq N \leq 33$ )	$N \times 30$ (TDD: $1 \leq N \leq 41$ ) (FDD: $1 \leq N \leq 33$ )	27	23	0	-4
5	4H	$105 \times N$ ( $1 \leq N \leq 25$ )	$N \times 30$ ( $1 \leq N \leq 25$ )	30	26	-2	-6
6	5LB	$126 \times N$ ( $1 \leq N \leq 25$ )	$N \times 30$ (ACCP) ( $1 \leq N \leq 25$ )	33,5	29,5	-6	-10
	5LA	$126 \times N$ ( $1 \leq N \leq 25$ )	$N \times 30$ (ACAP) ( $1 \leq N \leq 25$ )	33,5	29,5	+3	-1
7	5HB	$147 \times N$ ( $1 \leq N \leq 16$ )	$N \times 30$ (ACCP) ( $1 \leq N \leq 16$ )	37	33	-3	-7
	5HA	$147 \times N$ ( $1 \leq N \leq 16$ )	$N \times 30$ (ACAP) ( $1 \leq N \leq 16$ )	37	33	+6	+2
8	6LB	$168 \times N$ ( $1 \leq N \leq 16$ )	$N \times 30$ (ACCP) ( $1 \leq N \leq 16$ )	40,5	36,5	0	-4
	6LA	$168 \times N$ ( $1 \leq N \leq 16$ )	$N \times 30$ (ACAP) ( $1 \leq N \leq 16$ )	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 gain of 30 dBi; this shall be intended the nominal declared value across which the declared tolerance is evenly spread.

When equipment are supplied without antenna (i.e. are fitted for a *stand alone antenna*), it is assumed that the above information on minimum antenna gain, not specifically relevant to equipment assessment under article 3.2 of the Directive 2014/53/EU [i.1], is indicated in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1].



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# Annex J (normative): Frequency bands from 71 GHz to 86 GHz

## J.1 Introduction

In this frequency band, ECC/Recommendation (05)07 [i.24] 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 ECC/Recommendation (05)07 [i.24] and Recommendation ITU-R F.2006 [i.61].

However, those recommendations provides 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 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 =  $n \times 250$  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 clause J.2.1 and table J.1), can offer various transmission capacities within given channel separations using the necessary spectral efficiency class (according clause J.2.2 and table J.2).

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## J.2 General characteristics

### J.2.1 Frequency characteristics and channel arrangements

In table J.1, ITU-R and ECC recommended frequency channel arrangements, known at the date of publication of the present document, are specified for reference only. The channel arrangement is not relevant to article 3.2 of the Directive 2014/53/EU [i.1] requirements; only the frequency band and actual channel separation are relevant for defining the set of parameters and test methods, provided by the present document, relevant to each system designed for that channel separation.

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	
			ECC	ITU-R
70	71,0 to 76,0	62,5, 125	05-07 [i.24]	F.2006 [i.61]
80	81,0 to 86,0	250 to 2 250 (9 × 250)		
70 paired with 80	71,0 to 76,0 paired with 81,0 to 86,0	62,5, 125 250 to 4 500 (18 × 250)		
70 (upper part) paired with 80 (upper part) (see note 2)	74,0 to 76,0 paired with 84,0 to 86,0	62,5, 125 250 to 1 750 (7 × 250)		
70 and 80	71,0 to 76,0 and 81,0 to 86,0	Free (see note 3)		
70 and 80	71,0 to 76,0 and 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.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  $N \times 250$  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
	2	2	71	142	285	570	855	1 140 (note 1)	1 425	1 710	1 995	2 280
	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	-	-	-
	5	4H	219	438	875	1 750	2 625	-	-	-	-	-
	6	5LA/5LB	262	525	1 050 (note 1)	2 100 (note 1)	3 150 (note 1)	-	-	-	-	-
	7	5HA/5HB	306	612	1 225	2 450	-	-	-	-	-	-
	8	6LA/6LB	350	700	1 400	2 800	-	-	-	-	-	-

NOTE 1: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid.

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
Combined TX power and EIRP limits	Clause J.3.2.2 or clause J.3.2.3
Nominal transmitter power tolerance	Clause 4.2.1.3
Transmitter power and frequency control	Clause 4.2.2
RF Spectrum power density mask	Clause 4.2.3.2
Emissions outside the 71 GHz to 76 GHz and 81 GHz to 86 GHz bands	Clause J.3.4
Discrete CW components exceeding the spectrum mask limit	Clause 4.2.4
Unwanted emissions in the spurious domain-external	Clause 4.2.5
Dynamic Change of Modulation Order	Clause 4.2.6
Radio frequency tolerance	Clause 4.2.7

## J.3.2 Combined maximum transmitter power and EIRP

### J.3.2.1 Generality

ECC/REC(05)07 [i.24] 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 Radio Regulations [7] apply.

Further emission limitations, in terms of EIRP and/or Pout and/or antenna gain, might be present on a national basis.

However, in order of safeguarding a fair and efficient use of the spectrum, maximum Pout and EIRP emissions (referred in clause 4.2.1.1 and clause 4.2.1.2) of equipment in the scope of the present document shall be limited as in following clauses as function of the antenna gain ( $G_{\text{ant}}$ ).

### J.3.2.2 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**

$$\begin{aligned}
 1a) \quad \text{EIRP limit (dBm)} \quad &\leq +85 \text{ (see Radio Regulation [7] article 21)} \quad \text{for} \quad G_{\text{ant}} \geq 55 \text{ dBi.} \\
 &\leq +85 - (55 - G_{\text{ant}}) \quad \text{for} \quad 55 \text{ dBi} > G_{\text{ant}} \geq 45 \text{ dBi.} \\
 &\leq +75 - 2 \times (45 - G_{\text{ant}}) \quad \text{for} \quad 45 \text{ dBi} > G_{\text{ant}} \geq 38 \text{ dBi.}
 \end{aligned}$$

$$2a) \quad \text{Minimum } G_{\text{ant}} \text{ (dBi)} \geq 38.$$

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

$$\begin{aligned}
 3a) \quad \text{Pout (dBm)} \quad &\leq G_{\text{ant}} - 15 \quad \text{for} \quad 38 \text{ dBi} \leq G_{\text{ant}} < 45 \text{ dBi.} \\
 &\leq +30 \quad \text{for} \quad 45 \text{ dBi} \leq G_{\text{ant}} < 55 \text{ dBi.} \\
 &\leq +85 - G_{\text{ant}} \quad \text{for} \quad G_{\text{ant}} \geq 55 \text{ dBi.}
 \end{aligned}$$

- **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.:

$$\begin{aligned}
 1b) \quad \text{Minimum } G_{\text{ant}} \text{ (dBi)} \quad &\geq \text{Pout (dBm)} + 15; \text{ or} \\
 &\geq 38 \text{ (whichever is the greater).}
 \end{aligned}$$

$$2b) \quad \text{Maximum } G_{\text{ant}} \text{ (dBi)} \leq 85 - \text{Pout (dBm).}$$

$$\begin{aligned}
 3b) \quad \text{Pout (dBm)} \quad &\leq +30 \\
 &\text{where Pout is the maximum possible power, including tolerances, delivered to the antenna connector.}
 \end{aligned}$$

NOTE: It is assumed that the above information, not specifically relevant to article 3.2 of the Directive 2014/53/EU [i.1], on antenna gain range is supplied in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1].

The above limitations are visually represented in figures J.1 and J.2.

### J.3.2.3 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.35].

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:

$$1a_{ATPC}) \quad EIRP \text{ (dBm)} \quad \leq +35 + G_{ant} \text{ (dBi)}; \text{ or} \\ \leq +85 \text{ dBm} \quad (\text{whichever is the lower}).$$

$$2a_{ATPC}) \quad \text{Minimum } G_{ant} \text{ (dBi)} \quad \geq 38.$$

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

$$3a_{ATPC}) \quad Pout \text{ (dBm)} \quad \leq +35 \quad \text{for} \quad 38 \text{ dBi} \leq G_{ant} < 50 \text{ dBi} \\ \leq +85 - G_{ant} \quad \text{for} \quad G_{ant} \geq 50 \text{ dBi}.$$

$$4a_{ATPC}) \quad \text{Minimum ATPC attenuation (dB)} \geq \text{actual Pout (max delivered in full power ATPC regime) - maximum Pout (from formula 3a, clause J.3.2.2)}$$

- **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) for not exceeding the above EIRP limitations, i.e.:

$$1b_{ATPC}) \quad \text{Minimum } G_{ant} \text{ (dBi)} \quad \geq Pout \text{ (dBm)} + 15; \text{ or} \\ \geq 38 \text{ (dBi)} \quad (\text{whichever is the greater}) \\ \text{where Pout is intended as the maximum delivered by ATPC regime in unfaded condition.}$$

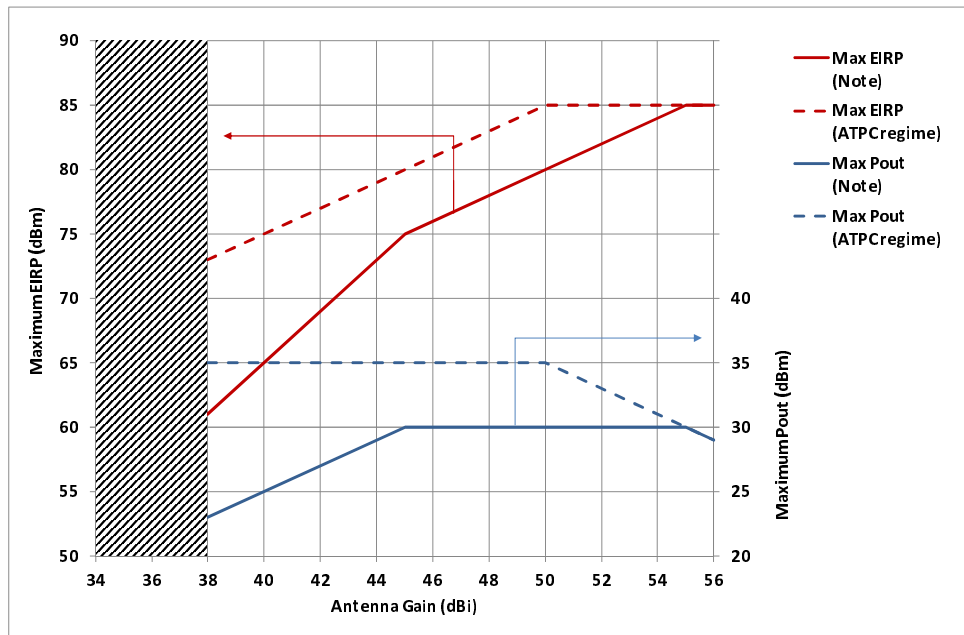
$$2b_{ATPC}) \quad \text{Maximum } G_{ant} \text{ (dBi)} \quad \leq 85 - Pout \text{ (dBm)} \\ \text{where Pout is intended as the maximum delivered in full power ATPC regime.}$$

$$3b_{ATPC}) \quad Pout \text{ (dBm)} \quad \leq +30 \text{ (ATPC regime in unfaded conditions) (see note)} \\ \leq +35 \text{ (full power ATPC regime) (see note).}$$

$$4b_{ATPC}) \quad \text{Minimum ATPC attenuation (dB)} \geq \text{actual Pout (max delivered in full power ATPC regime) - maximum Pout (from formula 3a, clause J.3.2.2).}$$

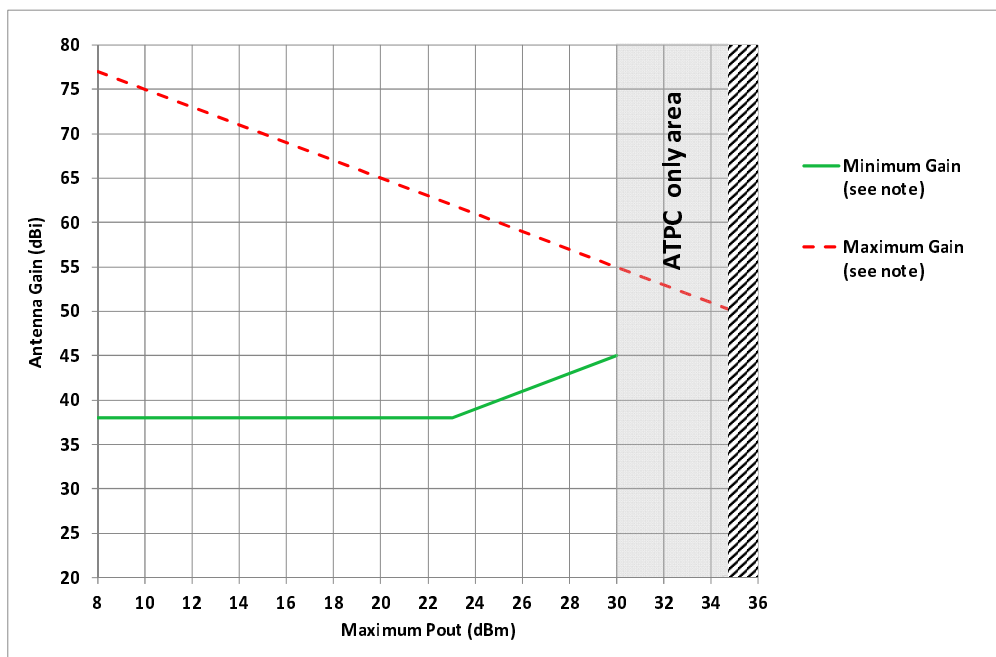
NOTE: It is assumed that the above information, not specifically relevant to article 3.2 of the Directive 2014/53/EU [i.1], on antenna gain range is supplied in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1]. In addition, it should be considered that the Pout limits are generic absolute 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 J.3.2.2) 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 visually represented in figures J.1 and J.2.



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  $38 \leq G_{ant} \text{ (dBi)} \leq 53$ .

**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 RF spectrum masks

The appropriate masks described in clause 4.2.3 for 62,5 MHz, 125 MHz or  $N \times 250$  MHz shall apply.

### J.3.4 Emissions 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 Radio Regulations [7], the unwanted emissions of fixed service systems shall respect, at the antenna port, the limit mask provided in figure J.3.

NOTE: See also ECC/Recommendation (09)01 [i.24].

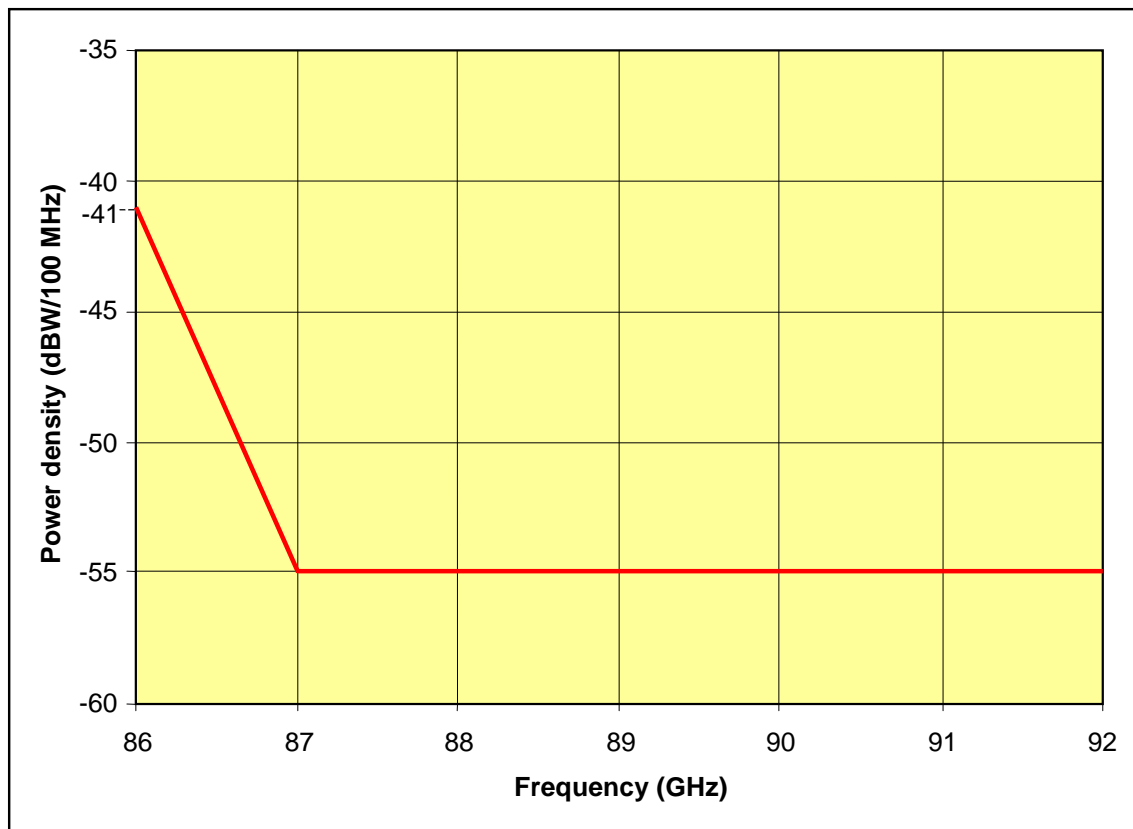


Figure J.3: Unwanted emission power density at the antenna port

It is intended that, at the 86 GHz band edge, the first 100 MHz slot limit is centred at 86,05 GHz.

### J.3.4.3 Conformance statement (see note)

The supplier shall indicate, for each system operation conditions (e.g. modulation format, bandwidth and antenna gain) 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.

NOTE: It is assumed that the above information on antenna gain range, not specifically relevant to the equipment assessment under article 3.2 of the Directive 2014/53/EU [i.1], is supplied in the user instruction as specified in article 10.8 of the 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
Spurious emissions (external)	Clause 4.3.1
BER as a function of RSL	Table J.5
Co channel external and adjacent channel interference sensitivity	Table J.6
CW spurious interference	Clause 4.3.3.4

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

The supplier shall declare 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 declared Receiver Signal levels shall produce a BER of either  $\leq 10^{-6}$  or  $\leq 10^{-10}$  as required.

NOTE: RSL for guaranteeing RBER performance may be found in ETSI EN 302 217-1 [4].

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

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (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 (note 1)	1 000	-58	-56
		1 425	1 250	-57	-55
		1 710	1 500	-56	-54

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER $\leq 10^{-6}$ (dBm)	RSL for BER $\leq 10^{-10}$ (dBm)
Reference index	Class				
3	3	1 995	1 750	-55,5	-53,5
		2 280	2 000	-55	-53
		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 (note 1)	1 250	-54	-52
		2 550	1 500	-53	-51
		2 975	1 750	-52,5	-50,5
		3 400	2 000	-52	-50
		142	62,5	-64,5	-60,5
4	4L	285	125	-61,5	-57,5
		570	250	-58,5	-54,5
		1 140 (note 1)	500	-55,5	-51,5
		1 710	750	-53,5	-49,5
		2 280 (note 1)	1 000	-52,5	-48,5
		2 850	1 250	-51,5	-47,5
		219	62,5	-61	-57
5	4H	438	125	-58	-54
		875	250	-55	-51
		1 750	500	-52	-48
		2 625	750	-50	-46
		262	62,5	-57,5	-53,5
6	5LA/5LB	525	125	-54,5	-50,5
		1 050 (note 1)	250	-51,5	-47,5
		2 100 (note 1)	500	-48,5	-44,5
		3 150 (note 1)	750	-46,5	-42,5
		306	62,5	-54	-50
7	5HA/5HB	612	125	-51	-47
		1 225	250	-48	-44
		2 450	500	-45	-41
		350	62,5	-50	-46
8	6LA/6LB	700	125	-47	-43
		1 400	250	-44	-40
		2 800	500	-41	-37

NOTE 1: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid.

NOTE 2: For *channels-aggregation/single-port* equipment, in the event that the device combining the two received signals is integrated in the equipment, the RSL thresholds will be relaxed by the combining device loss (e.g. 3 dB for a hybrid coupler).



### J.4.3 Co-channel "external" and adjacent channel interference sensitivity

The limits of Carrier to Interference ratio (C/I) in case of co-channel and 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 for  $BER \leq 10^{-6}$  in clause J.4.2.

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

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for $BER \leq 10^{-6}$ RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			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 (note)	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 (note)	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 (note)	500				
		1 710	750				
		2 280 (note)	1 000				
5	4H	2 850	1 250	30	26	-2	-6
		219	62,5				
		438	125				
		875	250				
		1 750	500				
6	5LB	2 625	750	33,5	29,5	-6	-10
		262	62,5 (ACCP)				
		525	125 (ACCP)				
		1 050 (note)	250 (ACCP)				
		2 100 (note)	500 (ACCP)				
	5LA	3 150 (note)	750 (ACCP)	33,5	29,5	+3	-1
		262	62,5 (ACAP)				
		525	125 (ACAP)				
		1 050 (note)	250 (ACAP)				
		2 100 (note)	500 (ACAP)				
		3 150 (note)	750 (ACAP)				

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER $\leq 10^{-6}$ RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
7	5HB	306	62,5 (ACCP)	37	33	-3	-7
		612	125 (ACCP)				
		1 225	250 (ACCP)				
		2 450	500 (ACCP)				
	5HA	306	62,5 (ACAP)	37	33	+6	+2
		612	125 (ACAP)				
		1 225	250 (ACAP)				
		2 450	500 (ACAP)				
8	6LB	350	62,5 (ACCP)	40,5	36,5	0	-4
		700	125 (ACCP)				
		1 400	250 (ACCP)				
		2 800	500 (ACCP)				
	6LA	350	62,5 (ACAP)	40,5	36,5	+9	+5
		700	125 (ACAP)				
		1 400	250 (ACAP)				
		2 800	500 (ACAP)				

NOTE: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid.

## J.5 Minimum antenna gain

Equipment with *integral* antenna or *dedicated antenna* shall be associated to a directional antenna with a minimum gain of 38 dBi; this shall be intended the nominal declared value across which the declared tolerance is evenly spread.

When equipment are supplied without antenna (i.e. are fitted for a *stand alone antenna*), it is assumed that the above information on minimum antenna gain, not specifically relevant to equipment assessment under article 3.2 of the Directive 2014/53/EU [i.1], is indicated in the user instructions as specified in article 10.8 of the Directive 2014/53/EU [i.1].

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Annex K:  
Void

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Annex L:  
Void

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Annex M:  
Void

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## 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.

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### 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.

#### N.2.2 Transmission capacities

Tables from N.1a to 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; tables N.1a through N.1h, valid for CS 1,75 MHz through 112 MHz, give also the minimum transmission capacity in term 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.  $3 \times \text{STM-1}$  plus  $1 \times \text{STM-0}$  in place of  $10 \times \text{STM-0}$ ).

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 supplier may choose which class to declare.

Tables from N.1a to 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.  $N \times 50$  MHz or  $N \times 250$  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 tables H.2, I.2 and 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.  
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.  
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 × 34,368
78	8	6L	40	10 × 8,448
88	9	6H	48 or 42 (if VC12 framed)	3 × 34,368 or 2 × 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 × 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 × STM-0
196	10	7	104	26 × 8,448
215	11	8	112 or 106 (if VC12 framed)	7 × 34,368 or 5 × 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 × 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 × STM-0
235	6	5L	112 or 105 (if VC12 framed)	7 × 34,368 or 5 × STM-0
274	7	5H	144 or 126 (if VC12 framed)	9 × 34,368 or 2 × STM-1
314	8	6L	160 or 147 (if VC12 framed)	10 × 34,368 or 7 × STM-0
352	9	6H	192 or 168 (if VC12 framed)	12 × 34,368 or 8 × STM-0
392	10	7	208 or 189 (if VC12 framed)	13 × 34,368 or 3 × STM-1
431	11	8	224 or 210 (if VC12 framed)	14 × 34,368 or 10 × 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 × STM-0
256	4	4L	128 or 126 (if VC12 framed)	8 × 34,368 or 2 × STM-1
392	5	4H	192 or 168 (if VC12 framed)	12 × 34,368 or 8 × STM-0
470	6	5L	240 or 210 (if VC12 framed)	15 × 34,368 or 10 × STM-0
548	7	5H	288 or 252 (if VC12 framed)	18 × 34,368 or 4 × STM-1 or STM-4
627	8	6L	320 or 294 (if VC12 framed)	20 × 34,368 or 14 × STM-0
705	9	6H	368 or 336 (if VC12 framed)	23 × 34,368 or 16 × STM-0
784	10	7	400 or 378 (if VC12 framed)	25 × 34,368 or 6 × STM-1
862	11	8	432 or 420 (if VC12 framed)	27 × 34,368 or 20 × 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 = 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.  
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 = ~28 MHz.  
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.

## N.3 System parameters

### N.3.0 Introduction

There are no essential requirements under the 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 [4].

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 supplier 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 [4] 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 [4]), 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 supplier 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)**

<b>BER</b>	<b>FER</b>
$10^{-6}$	$5 \times 10^{-4}$
$10^{-8}$	$5 \times 10^{-6}$
$10^{-10}$	$5 \times 10^{-8}$
$10^{-12}$	$5 \times 10^{-10}$

Automatic Repeat Request (ARQ) algorithms may also be used as an error correction method.

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 [4].

In the event that an Ethernet interface is not offered, but other standardized interfaces are used, the supplier shall declare 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.

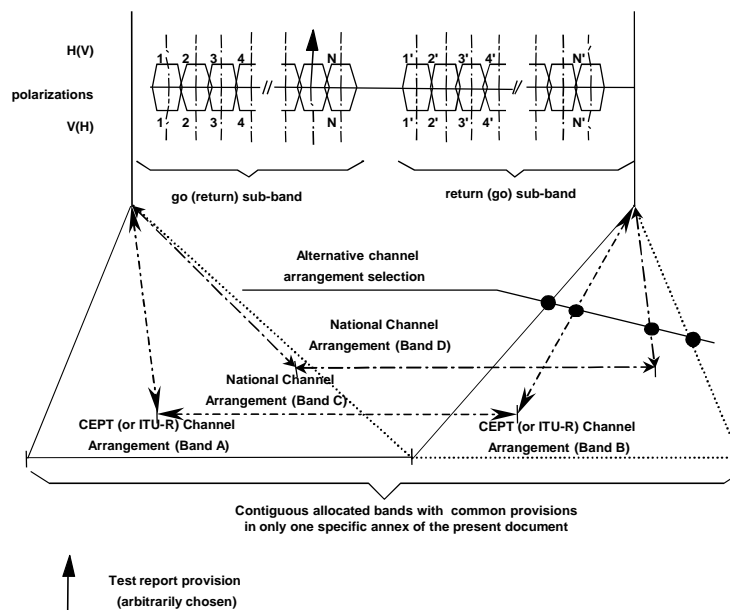
The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any conformity assessment procedure with respect to the Directive 2014/53/EU [i.1], shall be carried out in the following way:

- 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 supplier (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 7, 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 are concerned this applies to one *aggregated channel* only; the other *aggregated channel* shall be tested only at intermediate (M) frequency.  
In any case, the channel not under test is set as described in the relevant clauses.
  - For receiver parameters summarized in table 9, 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 are concerned this applies to one *aggregated channel* only; the other *aggregated channel* shall be tested only at intermediate (M) frequency.  
In any case, the channel not under test is 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).

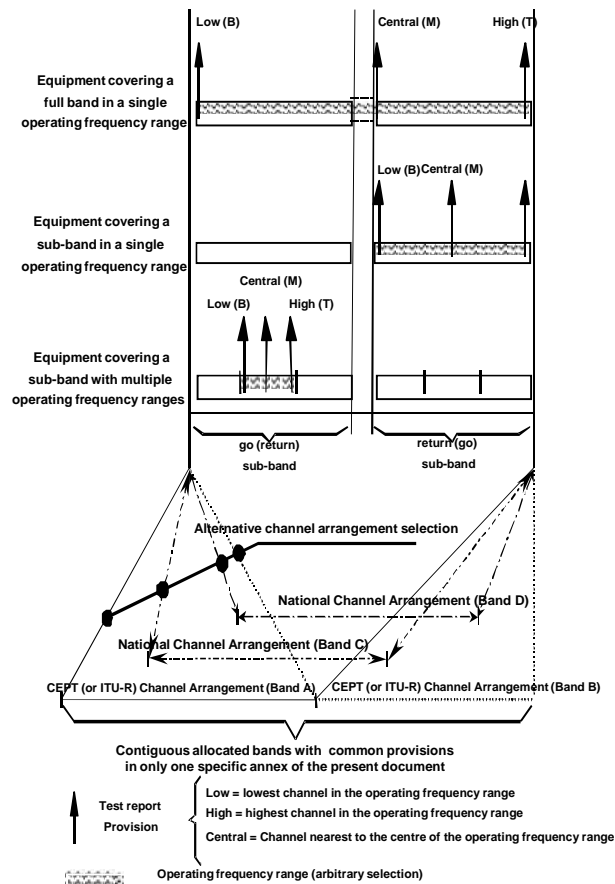
NOTE: In principle, all tests are carried out on the same equipment during a single test session. However, it is permitted to have different test sessions and equipment under test to allow for unpredictable events (e.g. equipment or test instrument failure during the test session that is not immediately 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 supplier, using the above procedures for equipment intended for single channel operation or for covering an operating frequency range (see figures O.1 and 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 supplier, using the above procedures for equipment intended for single channel operation or for covering an operating frequency range (see figures O.1 and 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 equipment

### O.2.0 Introduction

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 network requirements (e.g. propagation variations).

NOTE: As defined in ETSI EN 302 217-1 [4].

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 both emissions are turned on and operating according normal operating conditions within the declared 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 the 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 7 at any possible CS and efficiency classes, each case should be loaded with the highest possible RIC;
- receiver parameters summarized in table 9 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 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 second set in the condition identified in the clause 4.1.1 and clause O.4; this unless clause O.3 conditions apply (i.e. for *multi-channel* operation realised by a *channel-aggregation* system).

## 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* and *mixed-mode* may benefit of a reduced set of required tests as described in following clauses O.2.2.1 and 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:

- 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.
- 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 unwanted emission in the spurious domain test will be reduced to  $\pm 1$  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*.

Figure O.3 graphically show the reduced set of tests.

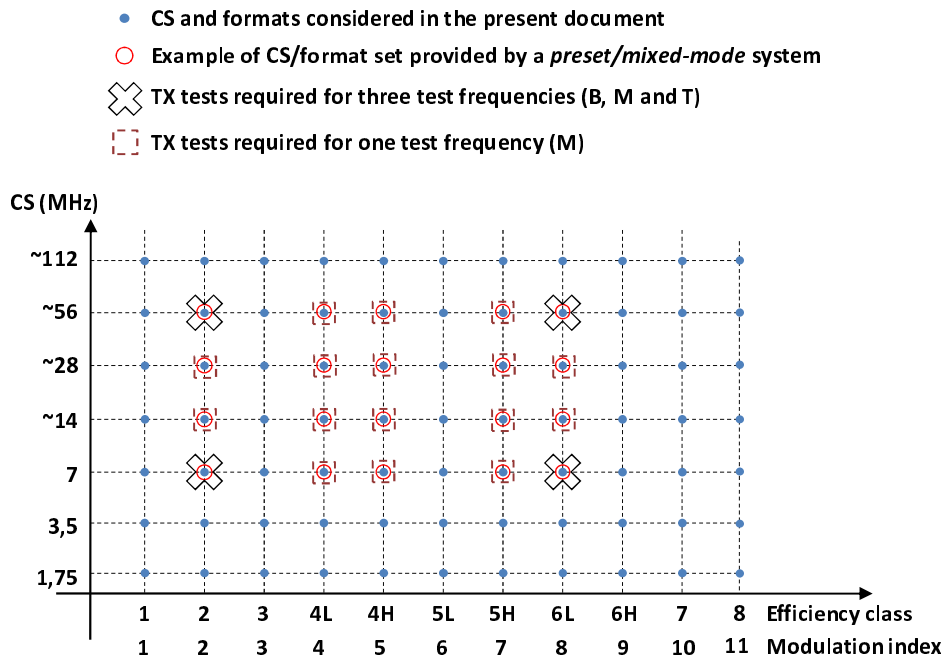


Figure O.3: Example of *Preset/mixed-mode* systems reduced TX test report

### 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 CW spurious interference (clause 4.3.3.4) 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) CW spurious interference 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  $\pm 1$  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*.

Figure O.4 graphically shows the reduced set of tests.

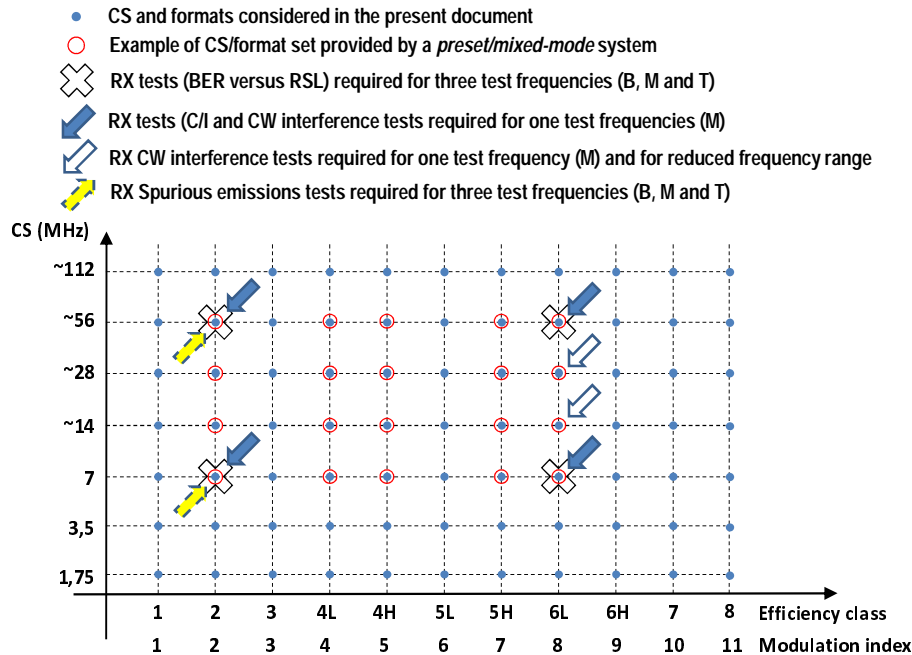


Figure O.4: Example of *Preset/mixed-mode* systems reduced RX test report

### 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 the above clauses O.1 and 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 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. 1000BaseT or several 100BaseT);
- two combined (through the above common BB interface(s)) emissions, over two different (in frequency and/or polarisation) channels on the same path, using either a "multi-channel" configuration of separate RF equipment or both *aggregated-channels* of a *channels-aggregation* equipment (see definition in ETSI EN 302 217-1 [4])). Each channel carrying a half of the total payload.



In order to keep the requirements set out in the standard aligned with single channel single/multiple (e.g.  $N \times 2$  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: 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 [4]).

### O.3.1 Case 1: multi-interfaces/two-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); therefore, the test procedure falls in the general case described in the main body of the present document.

NOTE: The difference may reside in a baseband unit common to both channels; which is irrelevant from the radio performance point of view when no traffic interface split its data over the two channels.

This case fits with the examples of transmission of  $2 \times$  STM-1 (or  $3 \times$  100BaseT) single channel and  $4 \times$  STM-1 (or  $6 \times$  100BaseT) dual channels; each interface is transmitted only over one channel.

Test equipment will be connected to one of the STM-1 or 100BaseT interfaces (as in the single-channel general case). The resulting BER shall comply with the requirements in the standard.

Since each STM-1 (or 100BaseT) 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.

### O.3.2 Case 2: single interface or multi-interfaces/two-channels system where each payload interface is transmitted equally split on both channels

This case fits with the example of transmission of STM-4 (or 1000BaseT) dual channels or fits with the examples of transmission of  $4 \times$  STM-1 (or  $6 \times$  100BaseT) dual channels; each STM-1 or 100BaseT interface is transmitted, equally split (see note), over both channels.

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.

Test equipment will be connected to one interface only, e.g. 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.1.

If dynamic traffic split is implemented, it should be blocked to a fixed 1/2 split.

Table O.1: BER for single interface/two channels system

Clause	Measurement	Test method (see note 1)	BER requirement
4.3.2	BER vs. RSL	<b>Multi-channel:</b> Both channels Simultaneously (same RSL). The attenuation is simultaneously increased until the RSL thresholds, as specified in clause 4.3.2, are reached (see note 2)	As specified
		<b>Channels-aggregation/single-port:</b> Common simulated link on both channels (TX powers shall be balanced for same RSL) spaced on 2 <sup>nd</sup> adjacent. The attenuation is simultaneously increased until the RSL threshold, as specified in clause 4.3.2, is reached on both channels.	
		<b>Channels-aggregation/dual-port:</b> Separate simulated link added to each channels (same RSL shall be obtained) placed on 1 <sup>st</sup> adjacent operation (see note 3). The attenuation is simultaneously increased until the RSL threshold, as specified in clause 4.3.2, is reached on both channels.	
4.3.3.2	Co-channel "external" and adjacent channel Interference	Relative channel frequencies and simulated links arrangement as above for each type of system. The same simulated link(s) attenuation should be added to both channels until the same $10^{-6}$ RSL threshold, as specified in clause 4.3.2, is reached. The interferer and the 1 dB (3 dB) degradation (see note 4) is applied to one channel only	As specified (see note 4)
4.3.3.3 (method 1)	CW spurious interference	Relative channel frequencies and simulated links arrangement as above for each type of system. The same simulated link(s) attenuation should be added to both channels until the same $10^{-6}$ RSL threshold, as specified in clause 4.3.2, is reached. The interferer and the 1 dB degradation (see note 4) is applied to one channel only. The CW interference is applied in the specified frequency range (see note 6).	As specified (see note 4)
4.3.3.3 (method 2)	CW spurious interference	Relative channel frequencies and simulated links arrangement as above for each type of system. The same simulated link(s) attenuation should be added to both channels until the same $10^{-6}$ RSL threshold, as specified in clause 4.3.2, is reached. The interferer is applied to one channel only. The CW interference is applied in the specified frequency range (see note 6).	As specified (see note 5)
<p>NOTE 1: Test frequencies (B, M and T, as required by table 9) apply to one of the two channels, unless when <i>channels-aggregation (dual-band)</i> operation is considered (separate band assessment is required). Also, the required 1<sup>st</sup> or 2<sup>nd</sup> adjacent channels placement may not be applicable (e.g. for <i>dual-band</i> operation); in this case the closest possible frequency shall be used.</p> <p>NOTE 2: Relative frequencies and simulated link arrangement (common or separate) chosen by the supplier.</p> <p>NOTE 3: (informative) 1<sup>st</sup> adjacent channel operation is foreseen with no degradation permitted because the separate simulated links do not generate actual interference for the two channels.</p> <p>NOTE 4: 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 <i>channels-aggregation/single-port</i>, it is impossible to increase RSL power only on the channel under test). In this case the BER requirement shall be halved (i.e. <math>BER \leq 5 \times 10^{-7}</math> valid in all cases save for method 1 of clause 4.3.3.3).</p> <p>NOTE 5: When method 2 of clause 4.3.3.3 is used for <i>channels-aggregation/single-port</i>, the CW interference applied to one aggregated-channel only implies that the requirement is halved i.e. <math>BER \leq 5 \times 10^{-6}</math> instead of <math>\leq 5 \times 10^{-5}</math>.</p> <p>NOTE 6: The single CW interference applied for <i>single-port</i> equipment shall exclude frequencies either side of both <i>aggregated channels</i> frequency by up to 250 %.</p>			

## O.4 Test provisions for *channels-aggregation* equipment

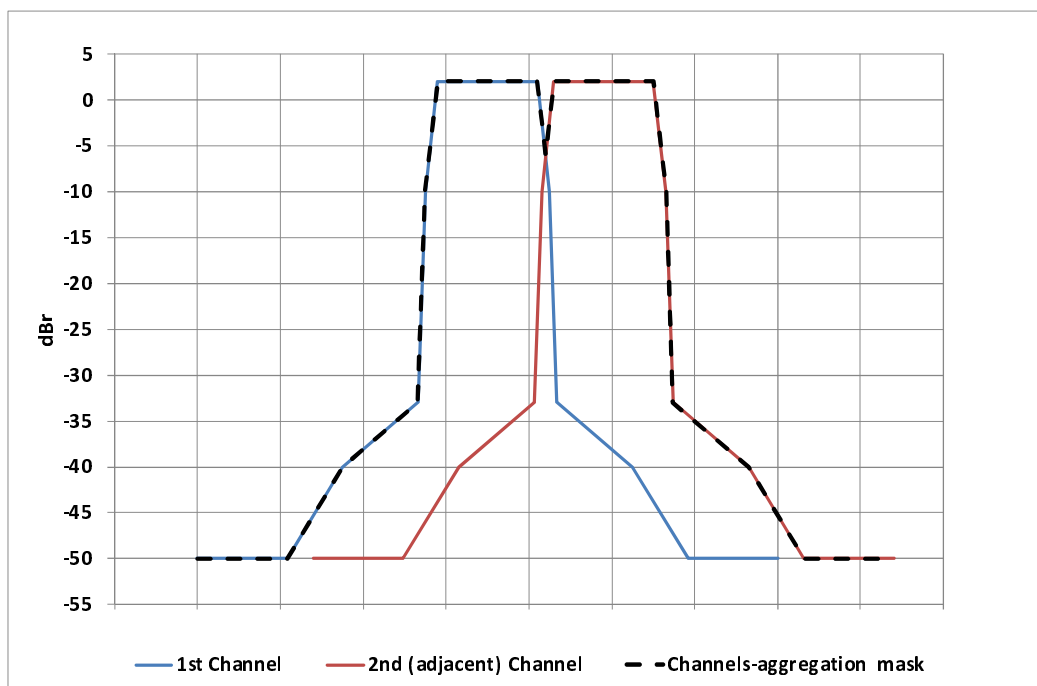
### O.4.1 General requirements and test method

*Channels-aggregation* equipment needs additional consideration for ensuring that the two *aggregated channels* do not interfere each other in the internal TX and RX signal paths so that no impairment of the single-channel requirement is present.

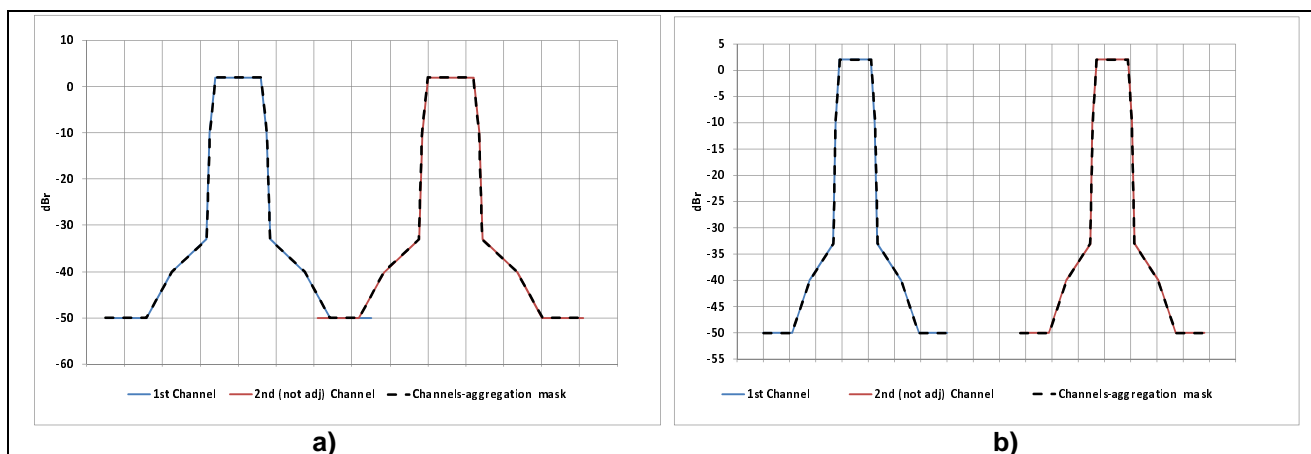
Therefore spectrum mask and unwanted emission in the spurious domain tests shall be carried as described in table O.2.

**Table O.2: *Channels-aggregation* equipment spectral mask and unwanted emission in the spurious domain**

Clause	Measurement	Test method	Compliance Requirement
4.2.4	Spectral Mask	Both channels on: adjacent tuning (see note 4): Single-port Dual-ports	- Combination of two spectral masks. See figure O.5 and clause O.4.2 (see notes 2 and 5) - Normal mask for both channels (see note 2)
4.2.4	Spectral Mask	Both channels on: farthest tuning Single-port Dual-ports	- Sum of two spectral masks. See figure O.6 (see notes 3 and 5) - Normal mask for both channels (see note 3)
4.2.4	Spectral Mask	One channel on, second off and vice versa (2 tests) Single-port	Spectral mask according to 4.2.4.2.1 (conditional test see note 1)
4.2.6	unwanted emission in the spurious domain	Both channels on: farthest tuning Single-port Dual-ports	- Combined limit: see figure O.8 (see note 3) - Normal Limits for both channels (see note 3)
4.2.6	unwanted emission in the spurious domain	One channel is on, while other channel is off (2 tests) Single-port	As specified (conditional test see note 1)
NOTE 1: Additional tests only for single-port case, only if needed for 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 <i>single-band</i> operation, one channel is tested for B, M and T frequencies, with other channel as convenient (i.e. upper for B test, lower for H test, indifferent for M test. For <i>dual-band</i> operation separate B, M and T tests for both channels.			
NOTE 3: For <i>single-band</i> operation, one channel is tested for B, M and T frequencies, with other channel set at farthest possible frequency. For <i>dual-band</i> operation separate B, M and T tests for both channels.			
NOTE 4: Test not required for <i>dual-band operation</i> .			
NOTE 5: Combined limits relaxation according clause O.4 and figures O.7 and O.8 shall apply as well when relevant.			



**Figure O.5: Channels-aggregation equipment: combined adjacent channels spectral mask**



**NOTE:** It should be highlighted that the blanc space in the middle of the two emissions (i.e. spurious domain for both in figure b) is present only when the spacing between the emission is higher than  $5 \times \text{CS}$ . Therefore, in a number of cases, it will not be experienced and figure a) example (here  $4 \times \text{CS}$  case) applies.

**Figure O.6: Channels-aggregation equipment: farthest channels spectral mask**

## O.4.2 Limits combination for *single-port* 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 polarisation 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 both *aggregated channels*; i.e. in masks crossover central to frequency range (C) in figure O.7 and figure O.8a or in the spurious domain frequency ranges (A) of figures O.7 and O.8a and O.8b:
  - 1.1 When discrete CW spectral lines are concerned, the same limit applies.
  - 1.2 When spread spectral densities are concerned the limit may be relaxed on the basis of the actual emissions levels of the individual *aggregated channel* emissions, when second channel is turned off, according the following formula:

$$\text{Combination Relaxation (dB)} = \text{Max} \left[ 10 \log \left( 10^{\frac{M_1}{10}} + 10^{\frac{M_2}{10}} \right), 0 \right] \quad (0.1)$$

where  $M_1$  and  $M_2$  are the margins (-dB) to the relevant limit that each *aggregated channel* emissions have separately shown when the second is turned off (see example 1).

EXAMPLE 1: With second channel turned off, at certain spurious domain frequency 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 relaxed by 1,12 dB.

- 2) In the frequency ranges where inhomogeneous limits apply for each *aggregated channel*; i.e. in frequency ranges (B) of figures O.6 and O.7, 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 normalised into absolute power density in dBm/MHz (rightmost axe in the example figures O.6 and O.7) for comparison to the unwanted emission in the spurious domain levels (see note). Then the following apply:
  - 2.1 When discrete CW spectral lines are concerned, the unwanted emission in the spurious domain of one channel can exceed the mask limit of the other and vice versa (see note 2);
  - 2.2 When spread spectral densities are concerned the combined margin of (see equation O.1) above still apply considering that  $M_1$  is the margin (-dB) of one channel to its own relevant limit (e.g. spectrum mask or spurious domain) while  $M_2$  is the inhomogeneous difference (case by case +dB or -dB, see note 1) between the first channel limit and the second channel emission in that frequency (e.g. spectrum mask "limit" minus spurious domain "actual emission" or vice versa, see examples 2 and 3 and note 3).

NOTE 1: Unless difficult calibration of the test setup is carried on, for conventional QAM formats the normalisation may be made translating the 0 dB reference of the spectrum mask into a power reference of  $[P_{out} - 10 \log(\text{Symbol frequency})]$  dBm/MHz. Depending on the frequency band and system parameters, the spurious domain emission limit (e.g. -50 dBm/MHz or -30 dBm/MHz) may result higher or lower than the spectrum mask limits (e.g. in the specific example of figures O.6 and O.7 the -30 dBm/MHz spurious domain limit is higher than the spectrum mask).

NOTE 2: The level of the CW spectral lines does not benefit of any relaxation because can be verified with very narrow resolution bandwidth not affected by additional spectral density power.

NOTE 3: It is intended that the relaxation 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 examples 2 and 3) independently from the actual value prescribed in table 8 for the system under consideration. Alternatively the spurious emission level should be normalised to the mask resolution bandwidth and similar calculation be done.

EXAMPLE 2: **With reference to figure O.7 lower frequency B range:**

**1) Possible relaxation of the 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  $-50$  dB (level that have been verified to correspond to an absolute power density of  $-41$  dBm/MHz), while the spurious emission 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 normalised to absolute power density,  $M_2 = 3$ ). When both are turned on, at that mask frequency, the mask limit is relaxed by 4,45 dB.

**2) Possible relaxation of the spurious level of red channel:**

Following the same rationale, the spurious emission limit of the red channel, in correspondence of the  $-38$  dBm/MHz spectral emission ( $M_1 = -8$ ) could not be further relaxed 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 (see equation O.1) Combination Relaxation will be 0 dB (total of:  $-30$  dBm/MHz).

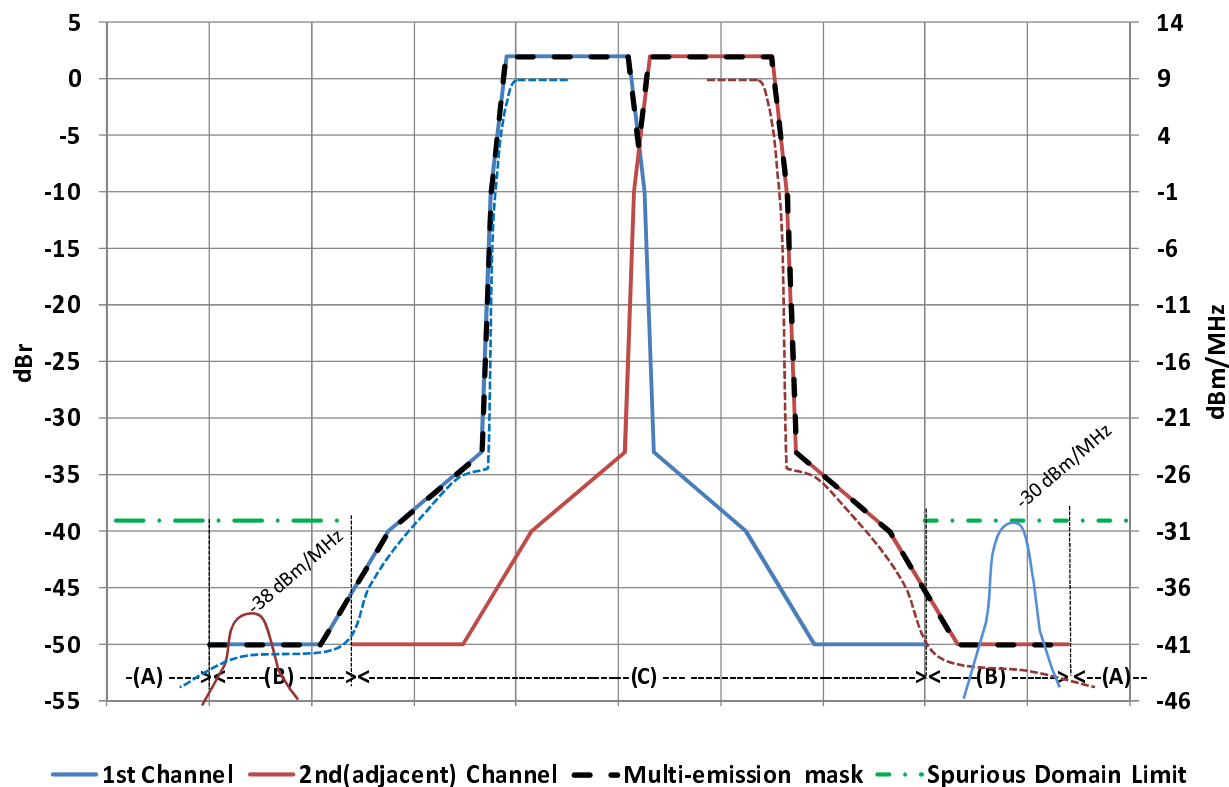
EXAMPLE 3: **With reference to figure O.7 upper frequency B range:**

**1) Possible relaxation of the spectrum mask of red channel:**

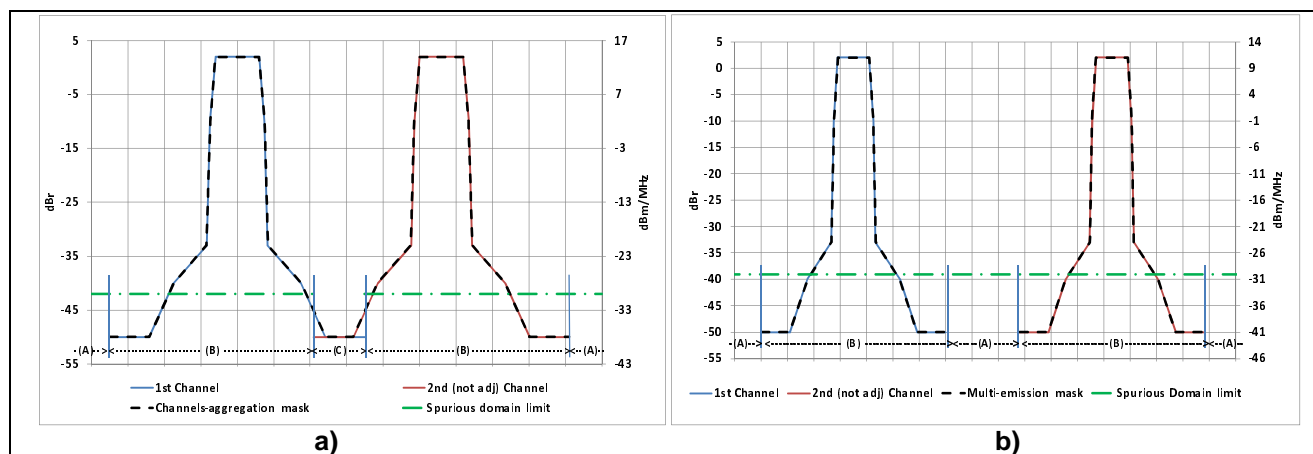
with previous (e.g. the blue one at lower frequency) channel turned off, at certain spectrum mask frequency within upper (B) range under test, the emission of the blue *aggregate channel* had 2 dB margin ( $M_1 = -2$ ) on its mask limit of  $-50$  dB (level that also corresponds to an absolute power density of  $-41$  dBm/MHz), while the spurious emission 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 normalised to absolute power density,  $M_2 = 11$ ). When both are turned on, at that mask frequency, the mask limit is relaxed by 11,21 dB.

**2) Possible relaxation of the spurious 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 relaxed because the combination, through equation O.1 above, of the red mask power of  $-43$  dBm/MHz ( $M_2 = -13$  with respect to the spurious limit of  $-30$  dBm/MHz) results in a positive 0,21 dB.



**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. In 5 × CS spacing case neither range (C) nor range (A) are present in between the two emissions.

**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): Impact of power control (ATPC and/or RTPC), mixed-mode and bandwidth adaptive operation on spectrum mask and link design requirements

### P.0 Introduction

These functionalities have been developed in most fixed radio systems for assisting appropriate network planning and for improving network efficiency and available capacity.

More extensive description of the technical background behind their implementation and use in the network (e.g. deployment, link design and coordination) can be found in ECC Report 198 [i.27] and ETSI TR 103 103 [i.35].

The following clauses, give information relevant to the impact of those functions on essential parameters defined in the present document as well as on possible and link design and coordination aspects.

### P.1 ATPC and RTPC implementation background

It is worth explaining that, in most practical applications, ATPC and RTPC are realized by a single function SW programmable system; therefore it is the supplier that should declare how the available range of attenuation should be subdivided (and possibly limited) in order to meet the requirements described below.

It is important to understand that the total available range of attenuation is, in general, subdivided in two sub-ranges, which, in principle, are independent from any "labelling" as RTPC or ATPC ranges:

- "Initial" Sub-range where the required spectrum mask is still fulfilled.
- "Final" Sub-range where the required spectrum mask is no longer fulfilled.

The ATPC sub-range may be used within two possible scenarios synthesized by table P.1.

**Table P.1: ATPC requirements versus licensing conditions**

Coordination/licensing conditions	Effect on network	Requirement
No ATPC is imposed but the user(s), under his (their) responsibility, apply an ATPC reduction in a homogeneous area for general improvement of the interference situation.	Interference impact on performance and availability is still evaluated with power at nominal level (no ATPC attenuation is considered in the coordination process); therefore: <ul style="list-style-type: none"> <li>• No improvement in the network density.</li> <li>• The user, under his own responsibility, might obtain additional margin against the calculated performance and availability objectives.</li> </ul>	No need for fulfilling the spectrum mask (and NFD) in the ATPC range, which can indifferently use "initial" and/or "final" sub-ranges of attenuation.
ATPC is imposed as pre-condition of coordination/licensing (note 1)	Interference impact on performance and availability is evaluated with power reduced by an ATPC range; therefore: <ul style="list-style-type: none"> <li>• Improvement in the network density could be obtained (note 2).</li> <li>• No additional margin against the calculated performance and availability objectives (note 3).</li> </ul>	Need for fulfilling the spectrum mask (and NFD) in the assumed ATPC range, which is supposed to remain within "initial" sub-range of attenuation.
NOTE 1: The ATPC range is link-by-link dependent, it is usually determined in order to fix the maximum RSL permitted during unfaded periods.		
NOTE 2: In general the use of ATPC pre-condition is possible for new links in a network; if existing links in already dense networks were coordinated without any ATPC, the possible density improvement might be severely reduced.		
NOTE 3: However, in principle and if possible and practical, improvement might still be obtained using the residual ATPC attenuation, under operator responsibility.		



Therefore, from the point of view of equipment use in the network, the RTPC and ATPC "labelling" of the available attenuation range is, in principle, different for the two cases considered in table P.1; figure P.1 summarizes this aspect (see note).

NOTE: The use of ATPC in the license conditions is foreseen in some countries on national basis; in addition, the implementation of ATPC functionality is left, as an option, to manufacturer choice. Therefore, the ATPC assessment for specific licensing conditions is not retained "essential" for Directive 2014/53/EU [i.1] point of view. Nevertheless, the supplier is recommended to define the RTPC/ATPC ranges possibly available for that purpose.

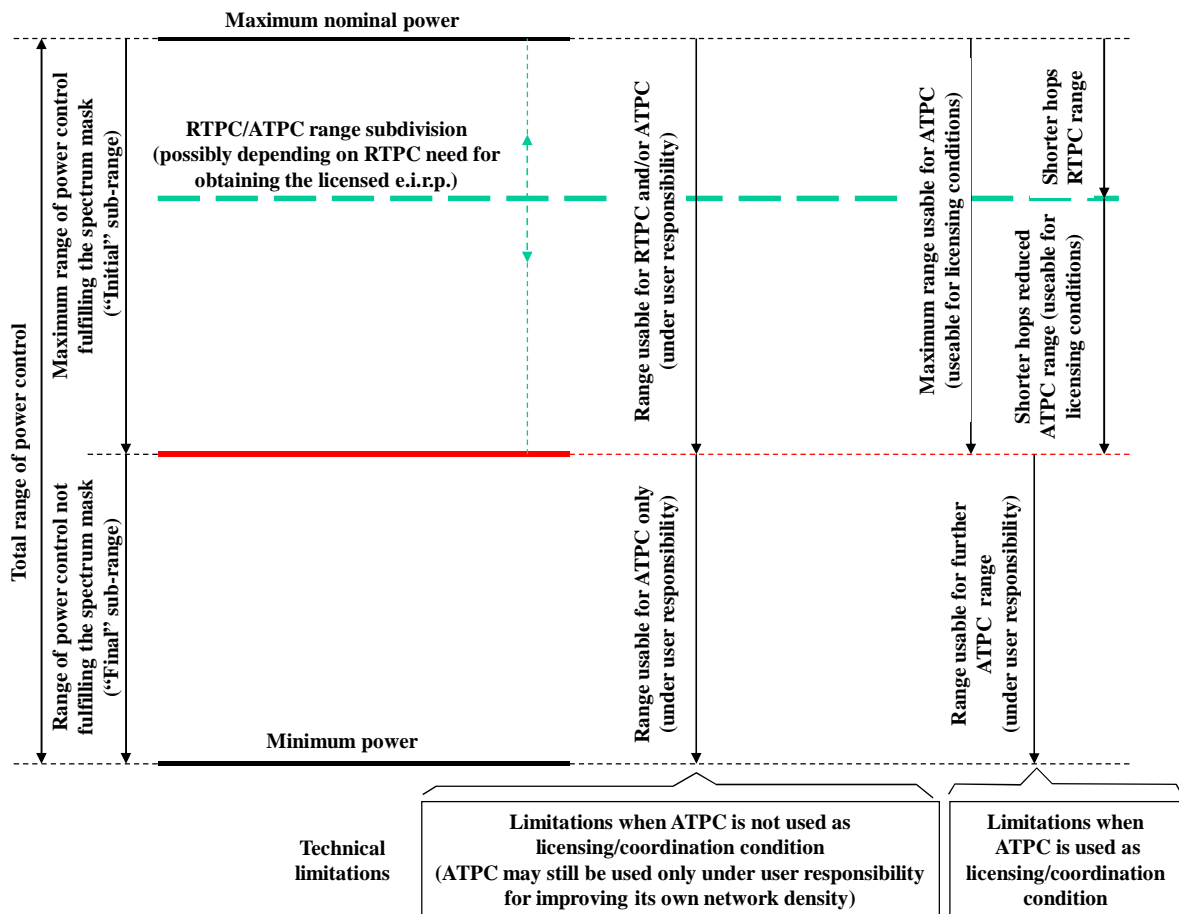


Figure P.1: ATPC/RTPC ranges and licensing/coordination conditions

## P.2 Mixed-mode operation impact

### P.2.1 Basic concepts

*Mixed-mode* systems (see note) can dynamically (on the basis of RSL and other built-in quality parameters) smoothly switch between different modulation formats, increasing/decreasing the payload capacity accordingly. At the same time they can manage the TX power output, reducing it for the higher complexity formats that require higher linearity. Therefore, *mixed-mode* systems have also a built-in ATPC functionality.

NOTE: *Mixed-mode* is a notation used in the present document, for commonality with similar concept previously defined for P-MP systems in ETSI EN 302 326-2 [i.28]. However, in common point-to-point market practice, these systems are more often identified as "adaptive coding and modulation" (ACM) systems.

*Mixed-mode* technology might be combined with variable (more or less redundant) coding techniques for the same format. In addition, further *bandwidth adaptive* functionality could, in principle, be used (e.g. after reaching the simplest modulation format, the system bandwidth is reduced as described in clause P.3) for further enhancing the link availability for a very limited portion of payload (beyond the minimum modulation format). However; the possible use of this feature is irrelevant for the technical descriptions in this clause.

The variable capacity of the *mixed-mode* systems in various propagation conditions implies that part of the maximum payload is gradually lost. This also requires that mechanism for defining different priority steps to portion of the payloads should be provided and the *mixed-mode* system should be able to detect it in order to gradually eliminate lower priority parts.

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## P.3 Bandwidth adaptive operation impact

### P.3.1 Basic concepts

*Bandwidth adaptive* systems can dynamically (on the basis of RSL and other built-in quality parameters) smoothly switch between different bandwidth with the same modulation formats, increasing/decreasing the payload capacity accordingly. In principle, the output power is kept constant because no different linearity requirements are present; therefore, differently from *mixed-mode* ACM systems, *bandwidth adaptive* systems might not have ATPC built-in functions.

These systems are mainly used for high capacity systems in EHF bands (e.g. 70 GHz and 80 GHz) where the radio frequency technology does not (yet) permit:

- The use of high level modulation formats (simplest 2 or 4 levels could only be practical until enhanced radio frequency technology might become popular).
- Enough TX power and RX sensitivity for producing a sufficient fade margin for operating the maximum capacity on relatively long hops in geographical areas with sensible rain-rate.

In principle, this technology might be combined with *Mixed-mode* functionality (e.g. switching also between PSK and QPSK). Still in principle, this technology might also be added to (full) (ACM) systems described in clause P.2 for further enhancing the link availability for a very limited portion of payload (beyond the minimum modulation format).

### P.3.2 Bandwidth (channel) occupancy

When operated in a network requiring coordination (either under administration or user responsibility) the occupied bandwidth or the channel occupancy (when a channel arrangement is provided) and their relevant system characteristics for coordination (*Reference mode*) should be defined for the maximum bandwidth that will be used for the link under consideration.

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## P.4 Impact on frequency co-ordination

The possible operative conditions described in detail in ECC Report 198 [i.27] and ETSI TR 103 103 [i.35], in general implies from time to time the change of modulation format, TX output power and bandwidth. Applied on link by link frequency coordinated bands, the above documents consider the implications deriving from the licensed use of the spectrum.

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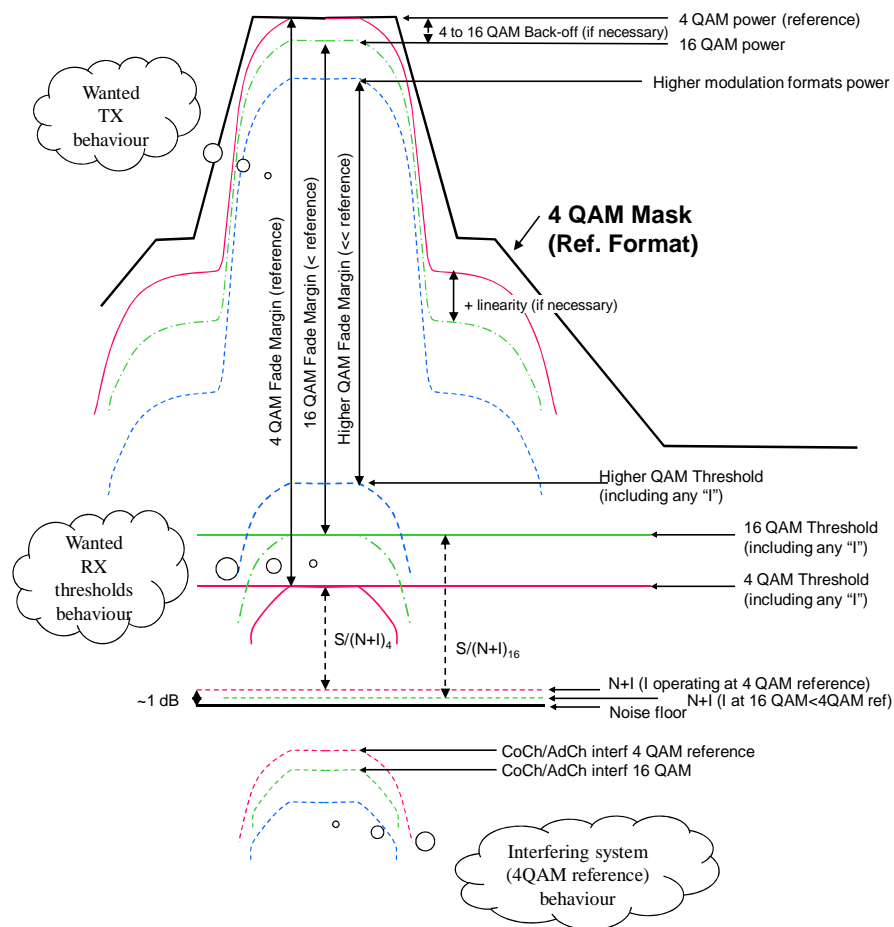
## P.5 Impact on article 3.2 "essential" parameters and operating conditions

From the discussion in previous clauses, for being capable of responding to the above mentioned licensing constraints, the introduction of *mixed-mode* (adaptive) systems within the frame of the present document needed a specific set of parameters related to Directive 2014/53/EU [i.1] article 3.2 "essential requirements".

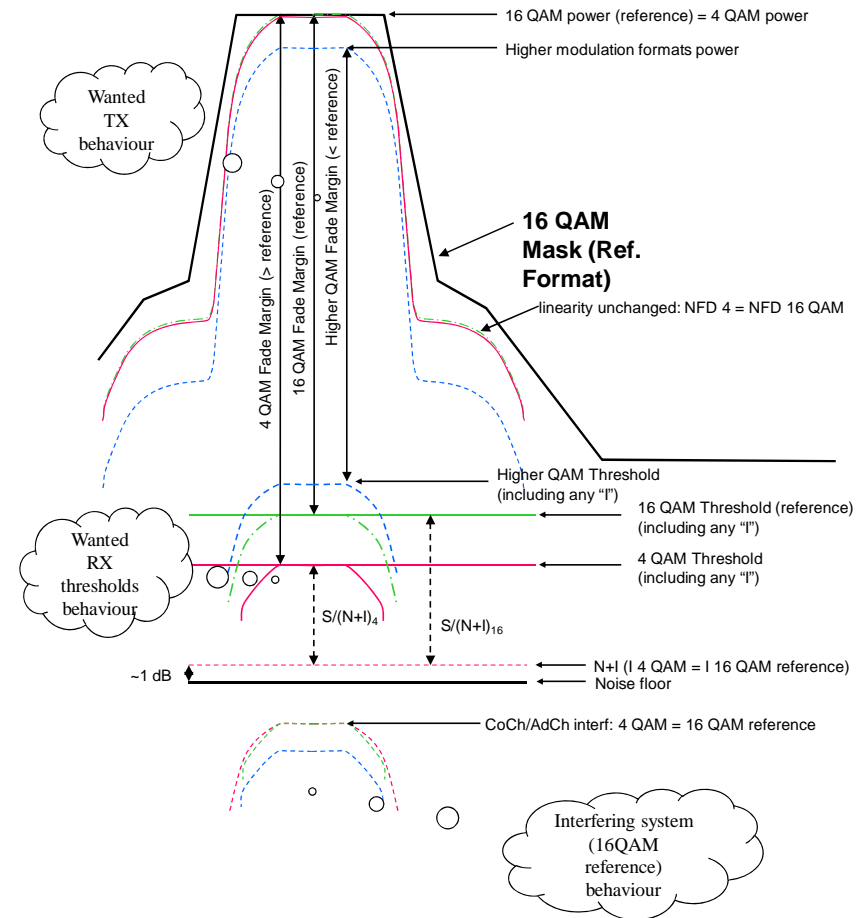
These requirements may be summarized as follows:

- 1) As for any multirate/multiformat equipment, in the scope of the present document, *mixed-mode* systems should demonstrate of being capable of respecting all requirements for each of the rate/format offered (i.e. *mixed-mode* systems are tested as *preset-mode* systems). In this way it is ensured that the any selected "*Reference mode*" (equipment class) can be singularly satisfied (see note).
- 2) A specific set of presetting in term of matching payload capacity, modulation format and transmit power (including RTPC/ATPC operations, see also note in clause P.1) has to be defined and assessed so that, within a licensed constant channel bandwidth and whichever is the instantaneously used mode (format), the TX spectrum mask, will not exceed that of the "*Reference-mode*" equipment class, as defined in the present document, among any possibly declared ones (which will be used for the link-by-link frequency coordination/licensing process) (see note).
- 3) Ensure that requirement 2) above is respected also during dynamic transitions between different modes. A specific requirement and conformance test has been introduced.
- 4) *Bandwidth adaptive* systems should be capable of respecting all requirements for the corresponding maximum bandwidth, which will define the "*reference mode*" (or multiple "*reference modes*" when more than one basic licensed channel size may be "*pre-set*" by the equipment).

NOTE: According requirement 2), mixed-mode systems, when in operation, do not need to meet all spectrum mask requirements in 1), which are tested for Directive 2014/53/EU [i.1] article 3.2 conformance purpose only; from the technical co-ordination point of view, only that of the "*Reference-mode*" equipment class should be respected. Licensing fees, possibly related to system capacity, are not in the scope of the present document, but are responsibility of national administrations.



**Figure P.2: Example of nodal co-channel interference (reference modulation format 4QAM):**  
**Delta Fade Margin (dB) = Delta Thr + Back-off**



**Figure P.3: Example of nodal co-channel interference (reference modulation format 16QAM):**  
**Delta Fade Margin 4/16 = Delta Thr**  
**Delta Fade Margin 16/Higher QAM = Delta Thr + Back-off**

## Annex Q (informative): Typical interference sensitivity behaviour for frequency planning purpose

In annexes B to J, for conformity assessment and declaration, the requirements for co-channel and adjacent channel(s) are limited to discrete guaranteed points at 1 dB and 3 dB degradation of the RSL for  $\text{BER} \leq 10^{-6}$ .

Figure Q.1 shows the typical behaviour for intermediate points which can be used for frequency planning purpose. Two different plots are given that are dependent on the difference between 1 dB and 3 dB RSL degradation.

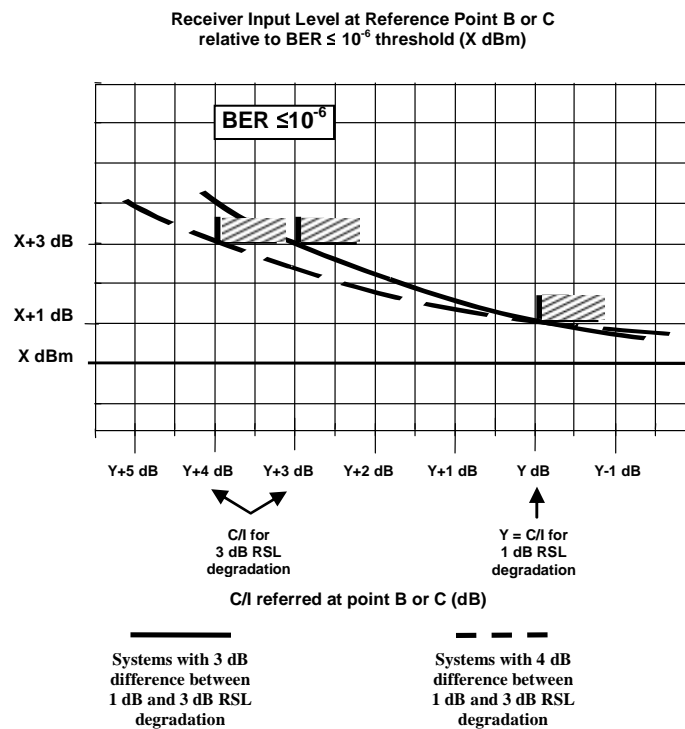


Figure Q.1: Interference threshold degradation versus C/I (typical behaviour)

# Annex R (informative):

## Technical background for receiver selectivity and C/I interference sensitivity evaluation

### R.1 Receiver selectivity

#### R.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:

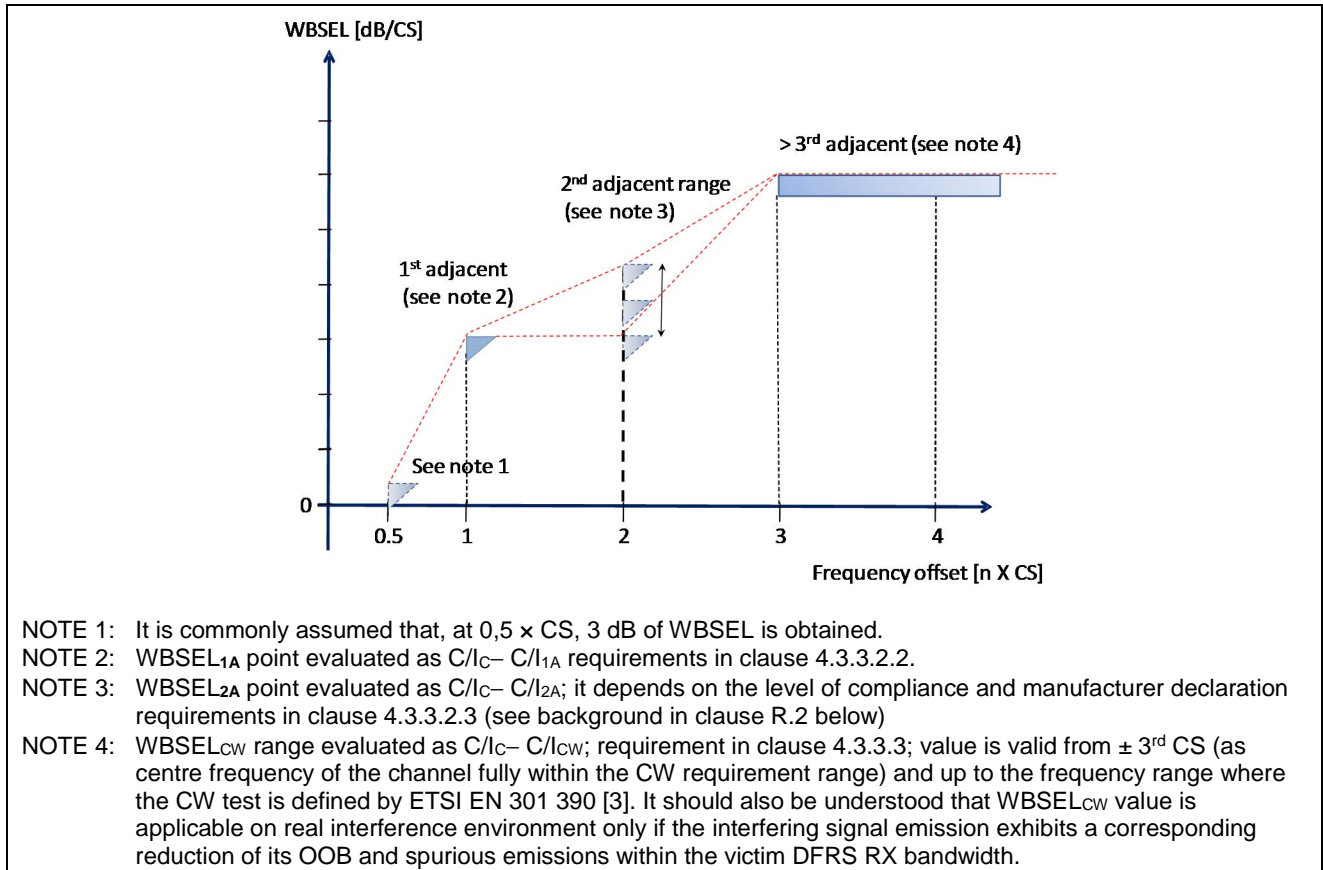
- co-channel interference sensitivity C/I at 1 dB threshold degradation ( $C/I_C$ ) required in clause 4.3.3.2.2;
- first adjacent channel interference sensitivity C/I at 1 dB threshold degradation ( $C/I_{1A}$ ) required in clause 4.3.3.2.2;
- second adjacent channel interference sensitivity C/I at 1 dB threshold degradation ( $C/I_{2A}$ ) required in clause 4.3.3.2.3;
- CW spurious interference 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 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.

## R.1.2 Graphical representation of WBSEL

From the above background it is possible to derive the WBSEL in graphical form as shown in figure R.1.

The graph in figure R.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 3<sup>rd</sup> CS spacing on.



**Figure R.1: wide-band integral selectivity (WBSEL) graphical representation**

Table R.1 shows the WBSEL corner points evaluated for few example systems in the present document.

**Table R.1: Examples of WBSEL corner points (ref. to figure R.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 ÷ 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	1250	27	27 to 32,5	57

## R.2 C/I interference sensitivity

### R.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<sup>st</sup> adjacent NFD. In minor extent, it also depends on 3<sup>rd</sup> order intermodulation effects of the interfering TX (generally controlled by TX spectrum mask, see note). It should be noted that the TX "shaping" part is only marginally controlled by the 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.

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 R.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) The CW C/I ratio, used in the spurious domain frequency range, depends on both filtering and non linear effects (points 3 and 4 above); filter effects, when very far from centre frequency (depending on the operating frequency, the requirement is extended up to 10<sup>th</sup> 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 [i.47] and ETSI TR 101 854 [i.31].

## R.2.2 Ideal selectivity and best case C/I value for 2nd adjacent CS

As described in clauses R.1.2 and R.2.1 above, 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.

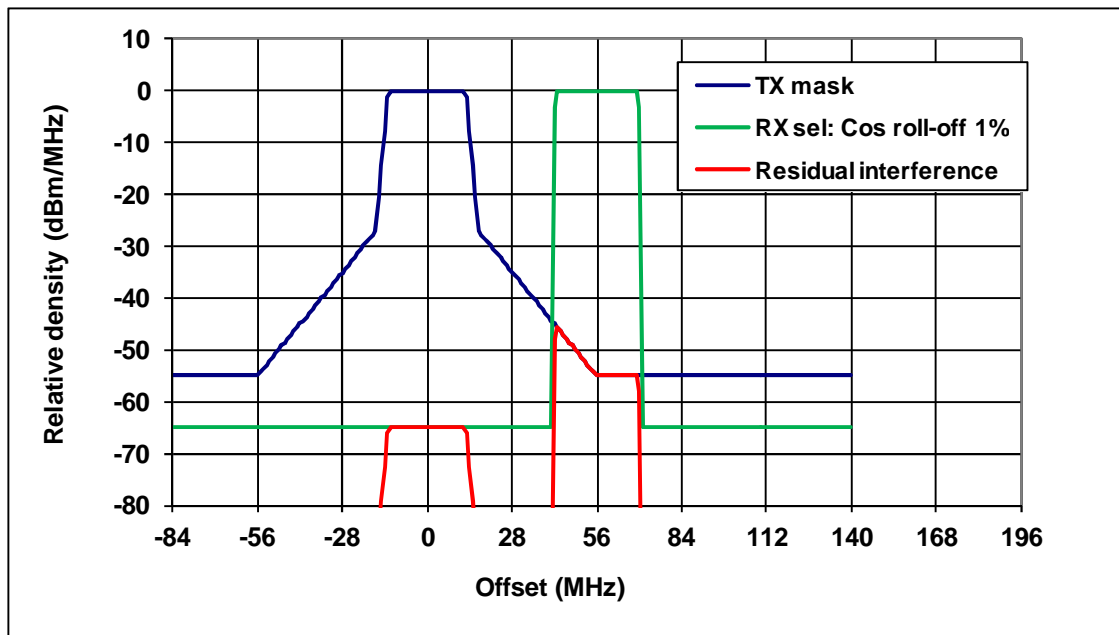
The ideal  $WBSEL_{2A}$  can be calculated as  $NFD_{2A}$  with the same NFD methodology theoretically described in Recommendation ITU-R F.746-10 [i.47] and ETSI TR 101 854 [i.31]. In practice,  $NFD_{2A}$  is the ratio, in dB, of the integral of TX power density (blue envelope in figure R.2) and integral of residual interference power density (red envelope in figure R.2) after RX filtering (green curve in figure R.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 standardisation; 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 tables 3a through 3m does not, in average, count as actual power density for NFD evaluation.

Figure R.2 shows an example of ideal  $NFD_{2A}$  evaluation.



**Figure R.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 R.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 R.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
	5LB, 5HB, 6LB, 6HB, 7B, 8B	51,8	49,2	44,4

Table R.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).

Tables R.4 shows the conversion of ideal  $NFD_{2A}$  into the possible best case  $C/I_{2A}$ .

Table R.3: NFD<sub>2A</sub> ideal values calculated for bands above 57 GHz

Spectral efficiency		NFD <sub>2A</sub> (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	-	-	-
5	4H	42,4	39,4	37,7	-	-	-	-	-
6	5LA	44,4	42,4	40,7	-	-	-	-	-
7	5HA	44,4	44,4	-	-	-	-	-	-
8	6LA	44,4	44,4	-	-	-	-	-	-
6	5LB	44,3	42,3	40,5	-	-	-	-	-
7	5HB	44,3	44,3	-	-	-	-	-	-
8	6LB	44,3	44,3	-	-	-	-	-	-

Table R.4: C/I<sub>2A</sub> best case values calculated for bands below 57 GHz

Current C/I <sub>co</sub> (1dB deg) (reprinted values in dB from clause 4.3.2)					Calculated: C/I <sub>2A</sub> (1dB deg) = (C/I <sub>co</sub> – NFD <sub>2A</sub> ) (NFD <sub>2A</sub> from table R.2)				
Reference Index	Class	Frequency bands (GHz)			Reference Index	Class	Frequency bands (GHz)		
		3 to 17	> 17 to 30	> 30 to 55			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	-15,2	-10,4
7	5H/5HB	37/35	37	37	7	5H/5HB	-14,8/-16,8	-12,2	-7,4
8	6L/6LB	40	40	40	8	6L/6LB	-11,8	-9,2	-4,4
9	6H/6HB	43	43	43	9	6H/6HB	-8,8	-6,2	-1,4
10	7/7B	46	46	46	10	7/7B	-5,8	-3,2	(1,6) (note)
11	8/8B	50	50	50	11	8/8B	-1,8	(0,8) (note)	(5,6) (note)
6	5L/5LA	34	34	34	6	5L/5LA	-17,9	-15,1	-10,4
7	5H/5HA	37	37	37	7	5H/5HA	-14,9	-12,1	-7,4
8	6L/6LA	40	40	40	8	6L/6LA	-11,9	-9,1	-4,4
9	6H/6HA	43	43	43	9	6H/6HA	-8,9	-6,1	-1,4
10	7/7A	46	46	46	10	7/7A	-5,9	-3,1	1,6
11	8/8A	50	50	50	11	8/8A	-1,9	0,9	5,6

NOTE: Positive values for sub-class "B" should not be taken into consideration; in all these cases the 1<sup>st</sup> 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 2<sup>nd</sup> adjacent requirement.

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## Annex S (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 2011".
- 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".

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## Annex T (informative): Change History

Version	Information about changes
V3.1.1	<p>First published version covering Directive 2014/53/EU [i.1]. Major changes are:</p> <ul style="list-style-type: none"><li>- Addition of background and assessment requirements for <i>channels-aggregation</i> systems.</li><li>- Translation of assessment requirements to be applicable under article 3.2 of Directive 2014/53/EU [i.1].</li><li>- 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.</li><li>- Enlarged requirements related to RX interference sensitivity versus frequency (second adjacent channel sensitivity).</li><li>- Consequent revision of assessment methodology for directional antenna parameters.</li><li>- Old spectral power density masks other than those in clause 4.2.4.2.1 completely removed.</li></ul>

## History

Document history		
V1.1.3	December 2004	Publication as ETSI EN 302 217-2-2
V1.1.3	March 2005	Publication as ETSI EN 302 217-3
V1.2.3	September 2007	Publication as ETSI EN 302 217-2-2
V1.2.1	February 2008	Publication as ETSI EN 302 217-3
V1.3.1	April 2009	Publication as ETSI EN 302 217-2-2
V1.3.1	July 2009	Publication as ETSI EN 302 217-3
V1.4.1	July 2010	Publication as ETSI EN 302 217-2-2
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
V3.0.8	June 2016	EN Approval Procedure AP 20160915: 2016-06-17 to 2016-09-15