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Technical Specification

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User Equipment (UE) radio transmission and reception;

Part 1: Range 1 Standalone

(Release 15)

** 

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# Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 Scope

The present document establishes the minimum RF requirements for NR User Equipment (UE) operating on frequency Range 1.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

For a specific reference, subsequent revisions do not apply.

For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document in the same Release as the present document.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[3] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[4] 3GPP TS 38.521-1: "NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Range 1 Standalone".

[5] Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".

[6] 3GPP TS 38.211: "NR; Physical channels and modulation".

[7] 3GPP TS 38.331: "Radio Resource Control (RRC) protocol specification".

[8] 3GPP TS 38.213: "NR; Physical layer procedures for control".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**Aggregated Channel Bandwidth**: The RF bandwidth in which a UE transmits and receives multiple contiguously aggregated carriers.

**Carrier aggregation**: Aggregation of two or more component carriers in order to support wider transmission bandwidths.

**Carrier aggregation band**: A set of one or more operating bands across which multiple carriers are aggregated with a specific set of technical requirements.

**Carrier aggregation bandwidth class**: A class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by a UE.

**Carrier aggregation configuration**: A combination of CA operating band(s) and CA bandwidth class(es) supported by a UE.

**Contiguous carriers**: A set of two or more carriers configured in a spectrum block where there are no RF requirements based on co-existence for un-coordinated operation within the spectrum block.

**Contiguous resource allocation**: A resource allocation of consecutive resource blocks within one carrier or across contiguously aggregated carriers. The gap between contiguously aggregated carriers due to the nominal channel spacing is allowed.

**Contiguous spectrum**: Spectrum consisting of a contiguous block of spectrum with no sub-block gaps.

Inter-band carrier aggregation: Carrier aggregation of component carriers in different operating bands.

NOTE: Carriers aggregated in each band can be contiguous or non-contiguous.

**Intra-band contiguous carrier aggregation**: Contiguous carriers aggregated in the same operating band.

**Intra-band non-contiguous carrier aggregation**: Non-contiguous carriers aggregated in the same operating band.

**Sub-block**: This is one contiguous allocated block of spectrum for transmission and reception by the same UE. There may be multiple instances of sub-blocks within an RF bandwidth.

**Sub-block bandwidth**: The bandwidth of one sub-block.

**Sub-block gap**: A frequency gap between two consecutive sub-blocks within an RF bandwidth, where the RF requirements in the gap are based on co-existence for un-coordinated operation.

## 3.2 Symbols

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

ΔFGlobal Granularity of the global frequency raster

ΔFRaster Band dependent channel raster granularity

ΔfOOB Δ Frequency of Out Of Band emission

ΔFTX-RX Δ Frequency of default TX-RX separation of the FDD *operating band*

ΔPPowerClass Adjustment to maximum output power for a given power class

RB The starting frequency offset between the allocated RB and the measured non-allocated RBΔRIB,c Allowed reference sensitivity relaxation due to support for inter-band CA operation, for serving cell *c*

ΔRIB,4R Reference sensitivity adjustment due to support for 4 antenna ports

ΔShift Channel raster offset for SUL

TC Allowed operating band edge transmission power relaxation

TC,*c*Allowed operating band edge transmission power relaxation for serving cell *c*

ΔTIB,c Allowed maximum configured output power relaxation due to support for inter-band CA operation, for serving cell *c*

ΔTIB,c Allowed maximum configured output power relaxation due to support for inter-band CA operation, for serving cell *c*

BWChannel Channel bandwidth

BWChannel,block Sub-block bandwidth, expressed in MHz. BWChannel,block= Fedge,block,high- Fedge,block,low

BWChannel\_CA Aggregated channel bandwidth, expressed in MHz

BWChannel,max Maximum channel bandwidth supported among all bands in a release

BWGB max( BWGB,Channel(*k*) )

BWGB,block,low The minimum guardband for the lowest assigned component carrier within a *sub-block*

BWGB,block,high The minimum guardband for the highest assigned component carrier within a *sub-block*

BWGB,Channel(k) Minimum guard band defined in sub-clause 5.3A.1 of carrier *k*

BWDL Channel bandwidth for DL

BWUL Channel bandwidth for UL

BWinterferer Bandwidth of the interferer

Ceil(x) Rounding upwards; ceil(x) is the smallest integer such that ceil(x) ≥ x

Floor(x) Rounding downwards; floor(x) is the greatest integer such that floor(x) ≤ x

FC *RF reference frequency* on the channel raster, given in table 5.4.2.2-1

FC,block, high Fc of the highest transmitted/received carrier in a *sub-block*

FC,block, low Fc of the lowest transmitted/received carrier in a *sub-block*

FC,low The Fc of the lowest carrier, expressed in MHz

FC,high The Fc of the highest carrier, expressed in MHz

FDL\_low The lowest frequency of the downlink *operating band*

FDL\_high The highest frequency of the downlink *operating band*

FUL\_low The lowest frequency of the uplink *operating band*

FUL\_high The highest frequency of the uplink *operating band*

Fedge,block,low The lower *sub-block* edge, where Fedge,block,low = FC,block,low - Foffset, low.

Fedge,block,high The upper *sub-block* edge, where Fedge,block,high = FC,block,high + Foffset, high.

Fedge\_low The *lower edge* of *aggregated channel bandwidth*, expressed in MHz. Fedge,low = FC,low - Foffset,low.

Fedge\_high The *higher edge* of *aggregated channel bandwidth*, expressed in MHz. Fedge,high = FC,high + Foffset,high.

FInterferer (offset) Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured)

FInterferer Frequency of the interferer

FIoffset Frequency offset of the interferer (between the center frequency of the interferer and the closest edge of the carrier measured)

Foffset Frequency offset from FC\_high to the *higher edge* or FC\_low to the *lower edge.*

Foffset,block,low Separation between lower edge of a *sub-block* and the center of the lowest component carrier within the *sub-block*

Foffset,block,high Separation between higher edge of a *sub-block* and the center of the highest component carrier within the *sub-bloc*k

Foffset,high Frequency offset from FC,high to the upper *UE RF Bandwidth edge*,

Foffset,low Frequency offset from FC,low to the lower *UE RF Bandwidth edge*,

FOOB The boundary between the NR out of band emission and spurious emission domains

FREF RF reference frequency

FREF-Offs Offset used for calculating FREF

FREF,Shift RF reference frequency for Supplementary Uplink (SUL) bands

Fuw (offset) The frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the interferer

GBChannel Minimum guard band defined in sub-clause 5.3.3

LCRB Transmission bandwidth which represents the length of a contiguous resource block allocation

expressed in units of resources blocks

Max() The largest of given numbers

Min() The smallest of given numbers

 Physical resource block number

NRACLR NR ACLR

NRB Transmission bandwidth configuration, expressed in units of resource blocks

NRB,block,low The transmission bandwidth configurations for the lowest assigned component carrier within the *sub-block*

NRB,block,high The transmission bandwidth configurations for the highest assigned component carrier within the *sub-block*

NRB,low The transmission bandwidth configurations according to Table 5.3.2-1 for the lowest assigned component carrier in section 5.3A.1

NRB,high The transmission bandwidth configurations according to Table 5.3.2-1 for the highest assigned component carrier in section 5.3A.1

NREF NR Absolute Radio Frequency Channel Number (NR-ARFCN)

NREF-Offs Offset used for calculating NREF

PCMAX The configured maximum UE output power

PCMAX, *c* The configured maximum UE output power for serving cell *c*

PCMAX, *f*, *c* The configured maximum UE output power for carrier *f* of serving cell *c* in each slot

PEMAX Maximum allowed UE output power signalled by higher layers

PEMAX, *c* Maximum allowed UE output power signalled by higher layers for serving cell *c*

PInterferer Modulated mean power of the interferer

PPowerClass PPowerClass is the nominal UE power (i.e., no tolerance)

P-MPR*c* Maximum allowed UE output power reduction for serving cell *c*

PRB The transmitted power per allocated RB, measured in dBm

PUMAX The measured configured maximum UE output power

Puw Power of an unwanted DL signal

Pw Power of a wanted DL signal

RBstart Indicates the lowest RB index of transmitted resource blocks

SCSblock,low SCS for the lowest assigned component carrier within the *sub-block*

SCSblock,high SCS for the highest assigned component carrier within the *sub-block*

SCSlow SCS for the lowest assigned component carrier in section 5.3A.1

SCShigh SCS for the highest assigned component carrier in section 5.3A.1

T(PCMAX, *f*, *c*) Tolerance for applicable values of PCMAX, *f*, *c* for configured maximum UE output power for carrier *f* of serving cell *c*

TL,c Absolute value of the lower tolerance for the applicable *operating band* as specified in section 6.2.1

SSREF SS block reference frequency position

UTRAACLR UTRA ACLR

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

Abbreviation format (EW)

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

A-MPR Additional Maximum Power Reduction

BS Base Station

BW Bandwidth

BWP Bandwidth Part

CA Carrier Aggregation

CA\_nX-nY Inter-band CA of component carrier(s) in one sub-block within Band X and component carrier(s) in one sub-block within Band Y where X and Y are the applicable NR *operating band*

CC Component Carriers

CP-OFDM Cyclic Prefix-OFDM

CW Continuous Wave

DC Dual Connectivity

DFT-s-OFDM Discrete Fourier Transform-spread-OFDM

DM-RS Demodulation Reference Signal

DTX Discontinuous TransmissionE-UTRA Evolved UTRA

EVM Error Vector Magnitude

FR Frequency Range

FRC Fixed Reference Channel

GSCN Global Synchronization Channel Number

IBB In-band Blocking

IDFT Inverse Discrete Fourier Transformation

ITU‑R Radiocommunication Sector of the International Telecommunication Union

MBW Measurement bandwidth defined for the protected band

MOP Maximum Output Power

MPR Allowed maximum power reduction

MSD Maximum Sensitivity Degradation

NR New Radio

NR-ARFCN NR Absolute Radio Frequency Channel Number

NS Network Signalling

OCNG OFDMA Channel Noise Generator

OOB Out-of-band

P-MPR Power Management Maximum Power Reduction

PRB Physical Resource Block

QAM Quadrature Amplitude Modulation

RE Resource Element

REFSENS Reference Sensitivity

RF Radio Frequency

RMS Root Mean Square (value)

RSRP Reference Signal Receiving PowerRx Receiver

SC Single Carrier

SCS Subcarrier spacing

SDL Supplementary Downlink

SEM Spectrum Emission Mask

SNR Signal-to-Noise Ratio

SRS Sounding Reference SymbolSUL Supplementary uplink

SS Synchronization Symbol

TAE Time Alignment Error

Tx Transmitter

UL-MIMO Uplink Multiple Antenna transmission

# 4 General

## 4.1 Relationship between minimum requirements and test requirements

The present document is a Single-RAT specification for NR UE, covering RF characteristics and minimum performance requirements. Conformance to the present specification is demonstrated by fulfilling the test requirements specified in the conformance specification 3GPP TS 38.521-1 [4].

The Minimum Requirements given in this specification make no allowance for measurement uncertainty. The test specification TS 38.521-1 [4] defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in this specification to create test requirements. For some requirements, including regulatory requirements, the test tolerance is set to zero.

The measurement results returned by the test system are compared - without any modification - against the test requirements as defined by the shared risk principle.

The shared risk principle is defined in Recommendation ITU‑R M.1545 [5].

## 4.2 Applicability of minimum requirements

a) In this specification the Minimum Requirements are specified as general requirements and additional requirements. Where the Requirement is specified as a general requirement, the requirement is mandated to be met in all scenarios

b) For specific scenarios for which an additional requirement is specified, in addition to meeting the general requirement, the UE is mandated to meet the additional requirements.

c) The spurious emissions power requirements are for the long-term average of the power. For the purpose of reducing measurement uncertainty it is acceptable to average the measured power over a period of time sufficient to reduce the uncertainty due to the statistical nature of the signal

## 4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level subclause, shown in Table 4.3-1.

Table 4.3-1: Definition of suffixes

|  |  |
| --- | --- |
| Clause suffix | Variant |
| None | Single Carrier |
| A | Carrier Aggregation (CA) |
| B | Dual-Connectivity (DC) |
| C | Supplement Uplink (SUL) |
| D | UL MIMO |

A terminal which supports the above features needs to meet both the general requirements and the additional requirement applicable to the additional subclause (suffix A, B, C and D) in clauses 5, 6 and 7. Where there is a difference in requirement between the general requirements and the additional subclause requirements (suffix A, B, C and D) in clauses 5, 6 and 7, the tighter requirements are applicable unless stated otherwise in the additional subclause.

A terminal which supports more than one feature in clauses 5, 6 and 7 shall meet all of the separate corresponding requirements.

For a terminal that supports SUL for the band combination specified in Table 5.2C-1, the current version of the specification assumes the terminal is configured with active transmission either on UL carrier or SUL carrier at any time in one serving cell and the UE requirements for single carrier shall apply for the active UL or SUL carrier accordingly.

# 5 Operating bands and channel arrangement

## 5.1 General

The channel arrangements presented in this clause are based on the operating bands and channel bandwidths defined in the present release of specifications.

NOTE: Other operating bands and channel bandwidths may be considered in future releases.

Requirements throughout the RF specifications are in many cases defined separately for different frequency ranges (FR). The frequency ranges in which NR can operate according to this version of the specification are identified as described in Table 5.1-1.

Table 5.1-1: Definition of frequency ranges

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range |
| FR1 | 450 MHz – 6000 MHz |
| FR2 | 24250 MHz – 52600 MHz |

The present specification covers FR1 operating bands.

## 5.2 Operating bands

NR is designed to operate in the FR1 operating bands defined in Table 5.2-1.

Table 5.2-1: NR operating bands in FR1

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) *operating band* BS receive / UE transmit  FUL\_low  – FUL\_high | Downlink (DL) *operating band* BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n1 | 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |
| n2 | 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| n5 | 824 MHz – 849 MHz | 869 MHz – 894 MHz | FDD |
| n7 | 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| n12 | 699 MHz – 716 MHz | 729 MHz – 746 MHz | FDD |
| n20 | 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |
| n25 | 1850 MHz – 1915 MHz | 1930 MHz – 1995 MHz | FDD |
| n28 | 703 MHz – 748 MHz | 758 MHz – 803 MHz | FDD |
| n34 | 2010 MHz – 2025 MHz | 2010 MHz – 2025 MHz | TDD |
| n38 | 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |
| n39 | 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |
| n40 | 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |
| n41 | 2496 MHz – 2690 MHz | 2496 MHz – 2690 MHz | TDD |
| n50 | 1432 MHz – 1517 MHz | 1432 MHz – 1517 MHz | TDD1 |
| n51 | 1427 MHz – 1432 MHz | 1427 MHz – 1432 MHz | TDD |
| n66 | 1710 MHz – 1780 MHz | 2110 MHz – 2200 MHz | FDD |
| n70 | 1695 MHz – 1710 MHz | 1995 MHz – 2020 MHz | FDD |
| n71 | 663 MHz – 698 MHz | 617 MHz – 652 MHz | FDD |
| n74 | 1427 MHz – 1470 MHz | 1475 MHz – 1518 MHz | FDD |
| n75 | N/A | 1432 MHz – 1517 MHz | SDL |
| n76 | N/A | 1427 MHz – 1432 MHz | SDL |
| n77 | 3300 MHz – 4200 MHz | 3300 MHz – 4200 MHz | TDD |
| n78 | 3300 MHz – 3800 MHz | 3300 MHz – 3800 MHz | TDD |
| n79 | 4400 MHz – 5000 MHz | 4400 MHz – 5000 MHz | TDD |
| n80 | 1710 MHz – 1785 MHz | N/A | SUL |
| n81 | 880 MHz – 915 MHz | N/A | SUL |
| n82 | 832 MHz – 862 MHz | N/A | SUL |
| n83 | 703 MHz – 748 MHz | N/A | SUL |
| n84 | 1920 MHz – 1980 MHz | N/A | SUL |
| n86 | 1710 MHz – 1780MHz | N/A | SUL |
| NOTE 1: UE that complies with the NR Band n50 minimum requirements in this specification shall also comply with the NR Band n51 minimum requirements. | | | |

## 5.2A Operating bands for CA

### 5.2A.1 Intra-band CA

NR intra-band contiguous carrier aggregation is designed to operate in the operating bands defined in Table 5.2A.1-1, where all operating bands are within FR1.

Table 5.2A.1-1: Intra-band contiguous CA operating bands in FR1

|  |  |
| --- | --- |
| NR CA Band | NR Band  (Table 5.2-1) |
| CA\_n77 | n77 |
| CA\_n78 | n78 |
| CA\_n79 | n79 |

### 5.2A.2 Inter-band CA

NR inter-band carrier aggregation is designed to operate in the operating bands defined in Table 5.2A.2-1, where all operating bands are within FR1.

Table 5.2A.2-1: Inter-band CA operating bands involving FR1 (two bands)

|  |  |
| --- | --- |
| NR CA Band | NR Band  (Table 5.2-1) |
| CA\_n3A-n77A | n3, n77 |
| CA\_n3A-n78A | n3, n78 |
| CA\_n3A-n79A | n3, n79 |
| CA\_n8A-n75A | n8, n75 |
| CA n8-n78A | n8, n78 |
| CA\_n8A-n79A | n8, n79 |
| CA\_n28A-n75A2 | n28, n75 |
| CA\_n28A\_n78A | n28, n78 |
| CA\_n41A-n78A | n41, n78 |
| CA\_n75A-n78A1 | n75, n78 |
| CA\_n77A-n79A | n77, n79 |
| CA\_n78A-n79A | n78, n79 |
| NOTE 1: Applicable for UE supporting inter-band carrier aggregation with mandatory simultaneous Rx/Tx capability.  NOTE 2: The frequency range in band n28 is restricted for this band combination to 703-733 MHz for the UL and 758-788 MHz for the DL. | |

## 5.2B Operating bands for DC

### 5.2B.1 General

NR dual connectivity is designed to operate in the operating bands defined in Table 5.2B-1, where all operating bands are within FR1.

Table 5.2B-1: Inter-band DC operating bands involving FR1 (two bands)

|  |  |
| --- | --- |
| NR DC Band | NR Band  (Table 5.2-1) |
|  |  |
| NOTE: Applicable for UE supporting inter-band dual connectivity with mandatory simultaneous Rx/Tx capability. | |

## 5.2C Operating band combination for SUL

NR operation is designed to operate in the operating band combination defined in Table 5.2C-1, where all operating bands are within FR1.

Table 5.2C-1: Operating band combination for SUL in FR1

|  |  |
| --- | --- |
| NR Band combination for SUL | NR Band  (Table 5.2-1) |
| SUL\_n78-n802 | n78, n80 |
| SUL\_n78-n812 | n78, n81 |
| SUL\_n78-n822 | n78, n82 |
| SUL\_n78-n832 | n78, n83 |
| SUL\_n78-n842 | n78, n84 |
| SUL\_n78-n862 | n78, n86 |
| SUL\_n79-n802 | n79, n80 |
| SUL\_n79-n812 | n79, n81 |
| NOTE 1: If a UE is configured with both NR UL and NR SUL carriers in a cell, the switching time between NR UL carrier and NR SUL carrier is 0us.  NOTE 2: For UE supporting SUL band combination simultaneous Rx/Tx capability is mandatory. | |

## 5.3 UE channel bandwidth

### 5.3.1 General

The UE channel bandwidth supports a single NR RF carrier in the uplink or downlink at the UE. From a BS perspective, different UE channel bandwidths may be supported within the same spectrum for transmitting to and receiving from UEs connected to the BS. Transmission of multiple carriers to the same UE (CA) or multiple carriers to different UEs within the BS channel bandwidth can be supported.

From a UE perspective, the UE is configured with one or more BWP / carriers, each with its own UE channel bandwidth. The UE does not need to be aware of the BS channel bandwidth or how the BS allocates bandwidth to different UEs.

The placement of the UE channel bandwidth for each UE carrier is flexible but can only be completely within the BS channel bandwidth.

### 5.3.2 Maximum transmission bandwidth configuration

The maximum transmission bandwidth configuration NRB for each UE channel bandwidth and subcarrier spacing is specified in Table 5.3.2-1.

Table 5.3.2-1: Maximum transmission bandwidth configuration NRB

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5MHz | 10MHz | 15MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB |
| 15 | 25 | 52 | 79 | 106 | 133 | 160 | 216 | 270 | N/A | N/A | N/A | N/A |
| 30 | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 245 | 273 |
| 60 | N/A | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 107 | 121 | 135 |

### 5.3.3 Minimum guardband and transmission bandwidth configuration

The minimum guardband for each UE channel bandwidth and SCS is specified in Table 5.3.3-1,

Table 5.3.3-1: Minimum guardband for each UE channel bandwidth and SCS (kHz)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| 15 | 242.5 | 312.5 | 382.5 | 452.5 | 522.5 | 592.5 | 552.5 | 692.5 | N/A | N/A | N/A | N/A |
| 30 | 505 | 665 | 645 | 805 | 785 | 945 | 905 | 1045 | 825 | 925 | 885 | 845 |
| 60 | N/A | 1010 | 990 | 1330 | 1310 | 1290 | 1610 | 1570 | 1530 | 1450 | 1410 | 1370 |

NOTE: The minimum guardbands have been calculated using the following equation: (CHBW x 1000 (kHz) - RB value x SCS x 12) / 2 - SCS/2, where RB values are from Table 5.3.2-1.

Figure 5.3.3-1: Void

The number of RBs configured in any channel bandwidth shall ensure that the minimum guardband specified in this clause is met.

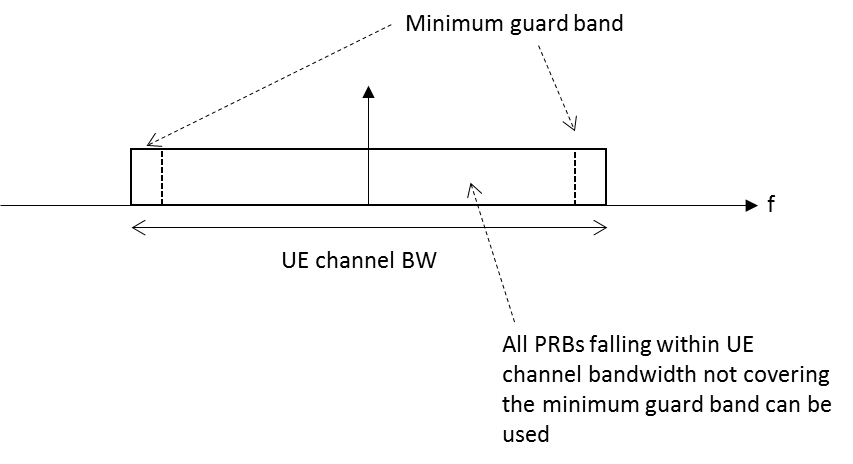


Figure 5.3.3-2: UE PRB utilization

In the case that multiple numerologies are multiplexed in the same symbol due to BS transmission of SSB, the minimum guardband on each side of the carrier is the guardband applied at the configured channel bandwidth for the numerology that is received immediately adjacent to the guard.

If multiple numerologies are multiplexed in the same symbol and the UE channel bandwidth is >50 MHz, the minimum guardband applied adjacent to 15 kHz SCS shall be the same as the minimum guardband defined for 30 kHz SCS for the same UE channel bandwidth.

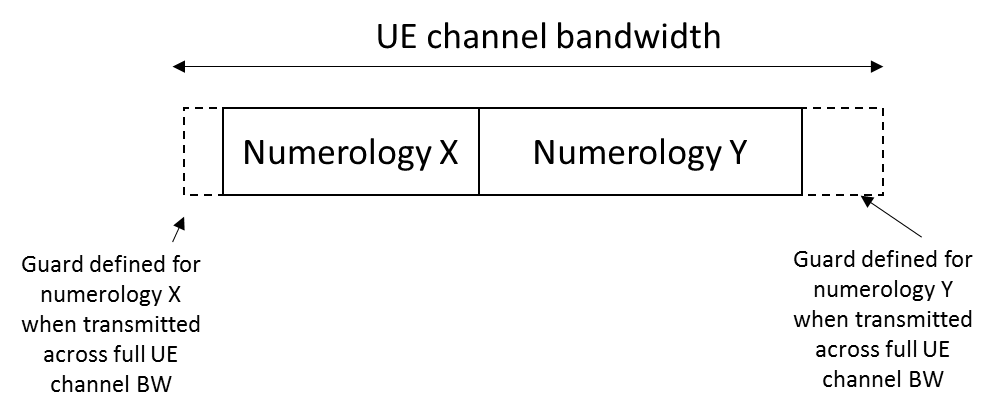


Figure 5.3.3-3 Guard band definition when transmitting multiple numerologies

NOTE: Figure 5.3.3-3 is not intended to imply the size of any guard between the two numerologies. Inter-numerology guard band within the carrier is implementation dependent.

### 5.3.4 RB alignment with different numerologies

For each numerology, its common resource blocks are specified in Section 4.4.4.3 in [9], and the starting point of its transmission bandwidth configuration on the common resource block grid for a given channel bandwidth is indicated by an offset to “Reference point A” in the unit of the numerology. The indicated transmission bandwidth configuration must fulfil the minimum guardband requirement specified in Section 5.3.3.

### 5.3.5 UE channel bandwidth per operating band

The requirements in this specification apply to the combination of channel bandwidths, SCS and operating bands shown in Table 5.3.5-1. The transmission bandwidth configuration in Table 5.3.2-1 shall be supported for each of the specified channel bandwidths. The channel bandwidths are specified for both the TX and RX path.

Table 5.3.5-1 Channel bandwidths for each NR band

|  | NR band / SCS / UE Channel bandwidth | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | SCS  kHz | 5 MHz | 101,2 MHz | 152 MHz | 202 MHz | 252 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| n1 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n2 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n3 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| n5 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n7 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n8 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n12 | 15 | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n20 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n25 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n28 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n34 | 15 | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes |  |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes |  |  |  |  |  |  |  |  |  |
| n38 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n39 | 15 | Yes | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |
| n40 | 15 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |  |  |
| n41 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n50 | 15 | Yes | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes3 |  |  |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes3 |  |  |
| n51 | 15 | Yes |  |  |  |  |  |  |  |  |  |  |  |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n66 | 15 | Yes | Yes | Yes | Yes |  |  | Yes |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  | Yes |  |  |  |  |  |
| n70 | 15 | Yes | Yes | Yes | Yes3 | Yes3 |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes3 | Yes3 |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes3 | Yes3 |  |  |  |  |  |  |  |
| n71 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n74 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n75 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n76 | 15 | Yes |  |  |  |  |  |  |  |  |  |  |  |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n77 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n79 | 15 |  |  |  |  |  |  | Yes | Yes |  |  |  |  |
| 30 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| n80 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| n81 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n82 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n83 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n84 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n86 | 15 | Yes | Yes | Yes | Yes |  |  | Yes |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  | Yes |  |  |  |  |  |
| NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS.  NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS.  NOTE 3: This UE channel bandwidth is applicable only to downlink. | | | | | | | | | | | | | |

### 5.3.6 Asymmetric channel bandwidths

The UE channel bandwidth can be asymmetric in downlink and uplink. In asymmetric channel bandwidth operation, the narrower carrier shall be confined within the frequency range of the wider channel bandwidth.

In FDD, the confinement is defined as a deviation to the default Tx-Rx carrier center frequency separation (defined in table 5.4.4-1) as following:

ΔFTX-RX = | (BWDL – BWUL)/2 |

The operating bands and supported asymmetric channel bandwidth combinations are defined in table 5.3.6-1.

Table 5.3.6-1: FDD asymmetric UL and DL channel bandwidth combinations

|  |  |  |
| --- | --- | --- |
| NR Band | Channel bandwidths for UL (MHz) | Channel bandwidths for DL (MHz) |
| n66 | 5, 10 | 20, 40 |
| 20 | 40 |
| n70 | 5 | 10, 15 |
| 5, 10, 15 | 20, 25 |

In TDD, the operating bands and supported asymmetric channel bandwidth combinations are defined in table 5.3.6-2.

Table 5.3.6-2: TDD asymmetric UL and DL channel bandwidth combinations

|  |  |  |
| --- | --- | --- |
| NR Band | Channel bandwidths for UL (MHz) | Channel bandwidths for DL (MHz) |
| n50 | 60 | 80 |

## 5.3A UE channel bandwidth for CA

### 5.3A.1 General

Figure 5.3A.1-1: Void

Figure 5.3A.1-2: Void

### 5.3A.2 Maximum transmission bandwidth configuration for CA

For carrier aggregation, the maximum transmission bandwidth configuration is defined per component carrier and the requirement is specified in subclause 5.3.2.

### 5.3A.3 Minimum guardband and transmission bandwidth configuration for CA

For intra-band contiguous carrier aggregation, *Aggregated Channel Bandwidth* and *Guard Bands* are defined as follows, see Figure 5.3A.3-1.

**FC\_low**

**Lower Edge**

**Upper Edge**

**Lowest Carrier Transmission Bandwidth Configuration [RB]**

**FC\_high**

**Foffset\_low**

**Highest Carrier Transmission Bandwidth Configuration [RB]**

**Resource block**

***Aggregated UE Channel Bandwidth*, BWchannel\_CA [MHz]**

**Fedge\_low**

**Fedge\_high**

**Foffset\_high**

Figure 5.3A.3-1: Definition of *Aggregated Channel Bandwidth* for intra-band carrier aggregation

The *aggregated channel bandwidth,* BWChannel\_CA, is defined as

BWChannel\_CA = Fedge,high - Fedge,low (MHz).

The lower bandwidth edge Fedge, low and the upper bandwidth edge Fedge,high of the aggregated channel bandwidth are used as frequency reference points for transmitter and receiver requirements and are defined by

Fedge,low = FC,low - Foffset,low

Fedge,high = FC,high + Foffset,high

The lower and upper frequency offsets depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carrier and are defined as

Foffset,low = (NRB,low\*12 + 1)\*SCSlow/2 + BWGB (MHz)

Foffset,high = (NRB,high\*12 - 1)\*SCShigh/2 + BWGB (MHz)

BWGB = max(BWGB,Channel(k))

BWGB,Channel(k) is the minimum guard band defined in sub-clause 5.3.3 of carrier k, while NRB,low and NRB,high are the transmission bandwidth configurations according to Table 5.3.2-1 for the lowest and highest assigned component carrier, respectively.

For intra-band non-contiguous carrier aggregation *Sub-block Bandwidth* and *Sub-block edges* are defined as follows, see Figure 5.3A.3-2.

Figure 5.3A.3-2: Definition of sub-block bandwidth for intra-band non-contiguous spectrum

...

Sub block n

**Transmission Bandwidth Configuration of the highest carrier in a sub-block [RB]**

**Transmission Bandwidth Configuration of the lowest carrier in a sub-block [RB]**

**Fedge,block n, low**

**FC,block n,high**

**Fedge,block n,high**

**Foffset,block n,high**

**Foffset,block n,low**

**FC,block n,low**

**Sub-block Bandwidth, BWChannel,block n [MHz]**

**Lower Sub-block Edge**

**Upper Sub-block Edge**

**Resource block**

Sub block n+1

**Fedge,block n+1, low**

**FC,block n+1,low**

**FC,block n+1,high**

**Fedge,block n+1,high**

**Foffset,block n+1,high**

**Sub-block Bandwidth, BWChannel,block n+1 [MHz]**

**Lower Sub-block Edge**

**Upper Sub-block Edge**

**Transmission Bandwidth Configuration of the highest carrier in a sub-block [RB]**

**Transmission Bandwidth Configuration of the lowest carrier in a sub-block [RB]**

**Resource block**

The lower sub-block edge of the Sub-block Bandwidth (BWChannel,block) is defined as

Fedge,block, low = FC,block,low - Foffset,block, low.

The upper sub-block edge of the Sub-block Bandwidth is defined as

Fedge,block,high = FC,block,high + Foffset,block,high.

The Sub-block Bandwidth, BWChannel,block, is defined as follows:

BWChannel,block = Fedge,block,high - Fedge,block,low (MHz)

The lower and upper frequency offsets Foffset,block,low and Foffset,block,high depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carriers within a sub-block and are defined as

Foffset,block,low = (NRB,low\*12 + 1)\*SCSlow/2 + BWGB,low (MHz)

Foffset,block,high = (NRB,high\*12 - 1)\*SCShigh/2 + BWGB,high(MHz)

where NRB,low and NRB,high are the transmission bandwidth configurations according to Table 5.3.2-1 for the lowest and highest assigned component carrier within a sub-block, respectively. BWGB,low, BWGB,high are the minimum guard band defined in sub-clause 5.3.3 for the lowest and highest assigned component carrier respectively

The sub-block gap size between two consecutive sub-blocks Wgap is defined as

Wgap = Fedge,block n+1,low - Fedge,block n,high (MHz)

### 5.3A.4 RB alignment with different numerologies for CA

### 5.3A.5 UE channel bandwidth per operating band for CA

The requirements for carrier aggregation in this specification are defined for carrier aggregation configurations.

For intra-band contiguous carrier aggregation, a carrier aggregation configuration is a single operating band supporting a carrier aggregation bandwidth class with associated bandwidth combination sets specified in clause 5.5A.1. For each carrier aggregation configuration, requirements are specified for all aggregated channel bandwidths contained in a bandwidth combination set, A UE can indicate support of several bandwidth combination sets per carrier aggregation configuration.For intra-band non-contiguous carrier aggregation, a carrier aggregation configuration is a single operating band supporting two or more sub-blocks, each supporting a carrier aggregation bandwidth class.

For inter-band carrier aggregation, a carrier aggregation configuration is a combination of operating bands, each supporting a carrier aggregation bandwidth class.

Table 5.3A.5-1: CA bandwidth classes

|  |  |  |  |
| --- | --- | --- | --- |
| NR CA bandwidth class | Aggregated channel bandwidth | Number of contiguous CC | Fallback group |
| A | BWChannel\_CA ≤ BWChannel,max | 1 |  |
| B | 20 MHz ≤ BWChannel\_CA ≤ 50 MHz | 2 |  |
| C | 100 MHz < BWChannel\_CA ≤ 2 x BWChannel,max | 2 | 1 |
| D | 200 MHz < BWChannel\_CA ≤ 3 x BWChannel,max | 3 |
| E | 300 MHz < BWChannel\_CA ≤ 4 x BWChannel,max | 4 |
| F | 50 MHz < BWChannel\_CA ≤ 100 MHz | 2 | 2 |
| G | 100 MHz < BWChannel\_CA ≤ 150 MHz | 3 |
| H | 150 MHz < BWChannel\_CA ≤ 200 MHz | 4 |
| I | 200 MHz < BWChannel\_CA ≤ 250 MHz | 5 |
| J | 250 MHz < BWChannel\_CA ≤ 300 MHz | 6 |
| K | 300 MHz < BWChannel\_CA ≤ 350 MHz | 7 |
| L | 350 MHz < BWChannel\_CA ≤ 400 MHz | 8 |
| NOTE: BWChannel, max is maximum channel bandwidth supported among all bands in a release | | | |

## 5.4 Channel arrangement

### 5.4.1 Channel spacing

#### 5.4.1.1 Channel spacing for adjacent NR carriers

The spacing between carriers will depend on the deployment scenario, the size of the frequency block available and the channel bandwidths. The nominal channel spacing between two adjacent NR carriers is defined as following:

- For NR operating bands with 100 kHz channel raster,

Nominal Channel spacing = (BWChannel(1) + BWChannel(2))/2

- For NR operating bands with 15 kHz channel raster,

Nominal Channel spacing = (BWChannel(1) + BWChannel(2))/2+{-5kHz, 0kHz, 5kHz}

where BWChannel(1) and BWChannel(2) are the channel bandwidths of the two respective NR carriers. The channel spacing can be adjusted depending on the channel raster to optimize performance in a particular deployment scenario.

### 5.4.2 Channel raster

#### 5.4.2.1 NR-ARFCN and channel raster

The global frequency channel raster defines a set of RF reference frequencies FREF. The RF reference frequency is used in signalling to identify the position of RF channels, SS blocks and other elements.

The global frequency raster is defined for all frequencies from 0 to 100 GHz. The granularity of the global frequency raster is ΔFGlobal.

RF reference frequencies are designated by an NR Absolute Radio Frequency Channel Number (NR-ARFCN) in the range (0.. 2016666) on the global frequency raster. The relation between the NR-ARFCN and the RF reference frequency FREF in MHz is given by the following equation, where FREF-Offs and NRef-Offs are given in table 5.4.2.1-1 and NREF is the NR-ARFCN.

FREF = FREF-Offs + ΔFGlobal (NREF – NREF-Offs)

Table 5.4.2.1-1: NR-ARFCN parameters for the global frequency raster

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency range (MHz) | ΔFGlobal (kHz) | FREF-Offs (MHz) | NREF-Offs | Range of NREF |
| 0 – 3000 | 5 | 0 | 0 | 0 – 599999 |
| 3000 – 24250 | 15 | 3000 | 600000 | 600000 – 2016666 |

The channel raster defines a subset of RF reference frequencies that can be used to identify the RF channel position in the uplink and downlink. The RF reference frequency for an RF channel maps to a resource element on the carrier. For each operating band, a subset of frequencies from the global frequency raster are applicable for that band and forms a channel raster with a granularity ΔFRaster, which may be equal to or larger than ΔFGlobal.

For SUL bands and Bands n1, n2, n3, n5, n7, n8, n20, n28, n66 and n71 defined in Table 5.2-1.

FREF\_shift = FREF + Δshift, Δshift=0kHz or 7.5kHz.

where Δshift is signalled by the network in higher layer parameter *frequencyShift7p5khz* [7].

The mapping between the channel raster and corresponding resource element is given in Section 5.4.2.2. The applicable entries for each operating band are defined in Section 5.4.2.3

#### 5.4.2.2 Channel raster to resource element mapping

The mapping between the RF reference frequency on the channel raster and the corresponding resource element is given in Table 5.4.2.2-1 and can be used to identify the RF channel position. The mapping depends on the total number of RBs that are allocated in the channel and applies to both UL and DL. The mapping must apply to at least one numerology supported by the UE.

Table 5.4.2.2-1: Channel raster to resource element mapping

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Resource element index | 0 | 6 |
| Physical resource block number |  |  |

,  ,  are as defined in TS 38.211[6].

#### 5.4.2.3 Channel raster entries for each operating band

The RF channel positions on the channel raster in each NR operating band are given through the applicable NR-ARFCN in Table 5.4.2.3‑1, using the channel raster to resource element mapping in subclause 5.4.2.2.

For NR operating bands with 100 kHz channel raster, ΔFRaster = 20 × ΔFGlobal. In this case every 20th NR-ARFCN within the operating band are applicable for the channel raster within the operating band and the step size for the channel raster in Table 5.4.2.3‑1 is given as <20>.

For NR operating bands with 15 kHz channel raster below 3GHz, ΔFRaster *I* × ΔFGlobal, where *I ϵ {3,6}*. Every *Ith* NR‑ARFCN within the operating band are applicable for the channel raster within the operating band and the step size for the channel raster in Table 5.4.2.3‑1 is given as < *I* >.

For NR operating bands with 15 kHz channel raster above 3GHz, ΔFRaster *I* × ΔFGlobal, where *I ϵ {1,2}.* Every *Ith* NR‑ARFCN within the operating band are applicable for the channel raster within the operating band and the step size for the channel raster in table 5.4.2.3-1 is given as <*I*>.

In frequency bands with two ΔFRaster, the higher ΔFRaster applies to channels using only the SCS that equals the higher ΔFRaster.

Table 5.4.2.3-1: Applicable NR-ARFCN per operating band

|  |  |  |  |
| --- | --- | --- | --- |
| NR Operating Band | ΔFRaster  (kHz) | Uplink  Range of NREF  (First – <Step size> – Last) | Downlink  Range of NREF  (First – <Step size> – Last) |
| n1 | 100 | 384000 – <20> – 396000 | 422000 – <20> – 434000 |
| n2 | 100 | 370000 – <20> – 382000 | 386000 – <20> – 398000 |
| n3 | 100 | 342000 – <20> – 357000 | 361000 – <20> – 376000 |
| n5 | 100 | 164800 – <20> – 169800 | 173800 – <20> – 178800 |
| n7 | 100 | 500000 – <20> – 514000 | 524000 – <20> – 538000 |
| n8 | 100 | 176000 – <20> – 183000 | 185000 – <20> – 192000 |
| n12 | 100 | 139800 – <20> – 143200 | 145800 – <20> – 149200 |
| n20 | 100 | 166400 – <20> – 172400 | 158200 – <20> – 164200 |
| n25 | 100 | 370000 – <20> – 383000 | 386000 – <20> – 399000 |
| n28 | 100 | 140600 – <20> – 149600 | 151600 – <20> – 160600 |
| n34 | 100 | 402000 – <20> – 405000 | 402000 – <20> – 405000 |
| n38 | 100 | 514000 – <20> – 524000 | 514000 – <20> – 524000 |
| n39 | 100 | 376000 – <20> – 384000 | 376000 – <20> – 384000 |
| n40 | 100 | 460000 – <20> – 480000 | 460000 – <20> – 480000 |
| n41 | 15 | 499200 – <3> – 537999 | 499200 – <3> – 537999 |
| 30 | 499200 – <6> – 537996 | 499200 – <6> – 537996 |
| n50 | 100 | 286400 – <20> – 303400 | 286400 – <20> – 303400 |
| n51 | 100 | 285400 – <20> – 286400 | 285400 – <20> – 286400 |
| n66 | 100 | 342000 – <20> – 356000 | 422000 – <20> – 440000 |
| n70 | 100 | 339000 – <20> – 342000 | 399000 – <20> – 404000 |
| n71 | 100 | 132600 – <20> – 139600 | 123400 – <20> – 130400 |
| n74 | 100 | 285400 – <20> – 294000 | 295000 – <20> – 303600 |
| n75 | 100 | N/A | 286400 – <20> – 303400 |
| n76 | 100 | N/A | 285400 – <20> – 286400 |
| n77 | 15 | 620000 – <1> – 680000 | 620000 – <1> – 680000 |
| n77  n78 | 30 | 620000 – <2> – 680000 | 620000 – <2> – 680000 |
| 15 | 620000 – <1> – 653333 | 620000 – <1> – 653333 |
| n78  n79 | 30 | 620000 – <2> – 653332 | 620000 – <2> – 653332 |
| 15 | 693334 – <1> – 733333 | 693334 – <1> – 733333 |
| n79  n80 | 30 | 693334 – <2> – 733332 | 693334 – <2> – 733332 |
| 100 | 342000 – <20> – 357000 | N/A |
| n81 | 100 | 176000 – <20> – 183000 | N/A |
| n82 | 100 | 166400 – <20> – 172400 | N/A |
| n83 | 100 | 140600 – <20> –149600 | N/A |
| n84 | 100 | 384000 – <20> – 396000 | N/A |
| n86 | 100 | 342000 – <20> – 356000 | N/A |

### 5.4.3 Synchronization raster

#### 5.4.3.1 Synchronization raster and numbering

The synchronization raster indicates the frequency positions of the synchronization block that can be used by the UE for system acquisition when explicit signalling of the synchronization block position is not present.

A global synchronization raster is defined for all frequencies. The frequency position of the SS block is defined as SSREF with corresponding number GSCN. The parameters defining the SSREF and GSCN for all the frequency ranges are in Table 5.4.3.1-1.

The resource element corresponding to the SS block reference freqeuncy SSREF is given in subclause 5.4.3.2. The synchronization raster and the subcarrier spacing of the synchronization block is defined separately for each band.

Table 5.4.3.1-1: GSCN parameters for the global frequency raster

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range | SS Block frequency position SSREF | GSCN | Range of GSCN |
| 0 – 3000 MHz | N \* 1200kHz + M \* 50 kHz,  N=1:2499, M ϵ {1,3,5} (Note 1) | 3N + (M-3)/2 | 2 – 7498 |
| 3000-24250 MHz | 3000 MHz + N \* 1.44 MHz  N = 0:14756 | 7499 + N | 7499 – 22255 |
| NOTE 1: The default value for operating bands with SCS spaced channel raster is M=3. | | | |

5.4.3.2 Synchronization raster to synchronization block resource element mapping

The mapping between the synchronization raster and the corresponding resource element of the SS block is given in Table 5.4.3.2-1. The mapping depends on the total number of RBs that are allocated in the channel and applies to both UL and DL.

Table 5.4.3.2-1: Synchronization raster to SS block resource element mapping

|  |  |
| --- | --- |
| Resource element index | 0 |
| Physical resource block number  of the SS block |  |

,  ,are as defined in TS 38.211[6].

#### 5.4.3.3 Synchronization raster entries for each operating band

The synchronization raster for each band is give in Table 5.4.3.3-1. The distance between applicable GSCN entries is given by the <Step size> indicated in Table 5.4.3.3-1.

Table 5.4.3.3-1: Applicable SS raster entries per operating band

|  |  |  |  |
| --- | --- | --- | --- |
| NR Operating Band | SS Block SCS | SS Block pattern1 | Range of GSCN  (First – <Step size> – Last) |
| n1 | 15kHz | Case A | 5279 – <1> – 5419 |
| n2 | 15kHz | Case A | 4829 – <1> – 4969 |
| n3 | 15kHz | Case A | 4517 – <1> – 4693 |
| n5 | 15kHz | Case A | 2177 – <1> – 2230 |
| 30kHz | Case B | 2183 – <1> – 2224 |
| n7 | 15kHz | Case A | 6554 – <1> – 6718 |
| n8 | 15kHz | Case A | 2318 – <1> – 2395 |
| n12 | 15kHz | Case A | 1828 - <1> - 1858 |
| n20 | 15kHz | Case A | 1982 – <1> – 2047 |
| n25 | 15 kHz | Case A | 4829 – <1> – 4981 |
| n28 | 15kHz | Case A | 1901 – <1> – 2002 |
| n34 | 15kHz | Case A | 5030 – <1> – 5056 |
| n38 | 15kHz | Case A | 6431 – <1> – 6544 |
| n39 | 15kHz | Case A | 4706 – <1> – 4795 |
| n40 | 15kHz | Case A | 5756 – <1> – 5995 |
| n41 | 15kHz | Case A | 6246 – <3> – 6717 |
| 30 kHz | Case C | 6252 – <3> – 6714 |
| n50 | 15kHz | Case A | 3584 – <1> – 3787 |
| n51 | 15kHz | Case A | 3572 – <1> – 3574 |
| n66 | 15kHz | Case A | 5279 – <1> – 5494 |
| 30kHz | Case B | 5285 – <1> – 5488 |
| n70 | 15kHz | Case A | 4993 – <1> – 5044 |
| n71 | 15kHz | Case A | 1547 – <1> – 1624 |
| n74 | 15kHz | Case A | [3692 – <1> – 3790] |
| n75 | 15kHz | Case A | 3584 – <1> – 3787 |
| n76 | 15kHz | Case A | 3572 – <1> – 3574 |
| n77 | 30kHz | Case C | 7711 – <1> – 8329 |
| n78 | 30kHz | Case C | 7711 – <1> – 8051 |
| n79 | 30kHz | Case C | 8480 – <16> – 8880 |
| NOTE 1: SS Block pattern is defined in section 4.1 in TS 38.213 [8] | | | |

5.4.4 TX–RX frequency separation

The default TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separation for operating bands is specified in Table 5.4.4-1.

Table 5.4.4-1: Default UE TX-RX frequency separation

| **NR Operating Band** | **TX – RX  carrier centre frequency separation** |
| --- | --- |
| n1 | 190 MHz |
| n2 | 80 MHz |
| n3 | 95 MHz |
| n5 | 45 MHz |
| n7 | 120 MHz |
| n8 | 45 MHz |
| n12 | 30 MHz |
| n20 | -41 MHz |
| n25 | 80 MHz |
| n28 | 55 MHz |
| n66 | 400 MHz |
| n70 | 295,3001 MHz |
| n71 | -46 MHz |
| n74 | 48 MHz |
| NOTE 1: Default TX-RX carrier centre frequency separation. | |

## 5.4A Channel arrangement for CA

### 5.4A.1 Channel spacing for CA

For intra-band contiguous carrier aggregation with two or more component carriers, the nominal channel spacing between two adjacent NR component carriers is defined as the following unless stated otherwise:

For NR operating bands with 100 kHz channel raster:



For NR operating bands with 15 kHz channel raster:



with



where BWChannel(1) and BWChannel(2) are the channel bandwidths of the two respective NR component carriers according to Table 5.3.2-1 with values in MHz. and the GBChannel(i) is the minimum guard band defined in sub-clause 5.3.3, while *µ*1 and *µ*2 are the subcarrier spacing configurations of the component carriers as defined in TS 38.211. The channel spacing for intra-band contiguous carrier aggregation can be adjusted to any multiple of least common multiple of channel raster and sub-carrier spacing less than the nominal channel spacing to optimize performance in a particular deployment scenario.

For intra-band non-contiguous carrier aggregation the channel spacing between two NR component carriers in different sub-blocks shall be larger than the nominal channel spacing defined in this subclause.

### 5.4A.2 Channel raster for CA

For inter-band carrier aggregation, the channel raster requirements in subclause 5.4.2 apply for each operating band.

### 5.4A.3 Synchronization raster for CA

For inter-band carrier aggregation, the synchronization raster requirements in subclause 5.4.3 apply for each operating band.

### 5.4A.4 Tx-Rx frequency separation for CA

For inter-band carrier aggregation, the Tx-Rx frequency separation requirements in subclause 5.4.4 apply for each operating band.

## 5.5 Configurations

## 5.5A Configurations for CA

### 5.5A.1 Configurations for intra-band contiguous CA

Table 5.5A.1-1: NR CA configurations and bandwidth combination sets defined for intra-band contiguous CA

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | |
| NR CA configuration | Uplink CA configurations | Component carriers in order of increasing carrier frequency | | | | | | Aggregated  bandwidth (MHz) | Bandwidth combination set |
| Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | |
| CA\_n77C  CA\_n78C  CA\_n79C |  | 50 | 60 |  |  | |  | 110 | 0 |
| 60 | 60 |  |  | |  | 120 |
| 50 | 80 |  |  | |  | 130 |
| 60 | 80 |  |  | |  | 140 |
| 50 | 100 |  |  | |  | 150 |
| 60 | 100 |  |  | |  | 160 |
| 80 | 80 |  |  | |  |
| 80 | 100 |  |  | |  | 180 |
| 100 | 100 |  |  | |  | 200 |
| CA\_n77D, CA\_n78D, CA\_n79D |  | 50 | 60 | 100 |  | |  | 210 |
|  | 60 | 60 | 100 |  | |  | 220 |
|  | 50 | 80 | 100 |  | |  | 230 |
|  | 60 | 80 | 100 |  | |  | 240 |
|  | 50 | 100 | 100 |  | |  | 250 |
|  | 80 | 80 | 100 |  | |  | 260 |
|  | 80 | 90 | 100 |  | |  | 270 |
|  | 80 | 100 | 100 |  | |  | 280 |
|  | 90 | 100 | 100 |  | |  | 290 |
|  | 100 | 100 | 100 |  | |  | 300 |
| CA\_n77E, CA\_n78E, CA\_n79E |  | 50 | 60 | 100 | 100 | |  | 310 |
|  | 60 | 60 | 100 | 100 | |  | 320 |
|  | 50 | 80 | 100 | 100 | |  | 330 |
|  | 60 | 80 | 100 | 100 | |  | 340 |
|  | 50 | 100 | 100 | 100 | |  | 350 |
|  | 80 | 80 | 100 | 100 | |  | 360 |
|  | 80 | 90 | 100 | 100 | |  | 370 |
|  | 80 | 100 | 100 | 100 | |  | 380 |
|  | 90 | 100 | 100 | 100 | |  | 390 |
|  | 100 | 100 | 100 | 100 | |  | 400 |

Table 5.5A.1-2: NR CA configurations and bandwidth combination sets defined for intra-band contiguous CA for fallback group 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | E-UTRA CA configuration / Bandwidth combination set | | | | |
| NR CA configuration | Uplink CA configurations | Component carriers in order of increasing carrier frequency | | | aggregated  bandwidth (MHz]) | Bandwidth combination set |
| Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for the other carrier (MHz |
| CA\_n77F, CA\_n78F, CA\_n79F |  | 40 | 20 |  | 60 | 0 |
| 50 | 20 |  | 70 |
| 40 | 40 |  | 80 |
| 40 | 50 |  | 90 |
| 50 | 50 |  | 100 |
| CA\_n77G, CA\_n78G, CA\_n79G |  | 40 | 20 | 50 | 110 |
| 50 | 20 | 50 | 120 |
| 40 | 40 | 50 | 130 |
| 40 | 50 | 50 | 140 |
| 50 | 50 | 50 | 150 |
| CA\_n77H, CA\_n78H, CA\_n79H |  | 40 | 20 | 50x2 | 160 |
| 50 | 20 | 50x2 | 170 |
| 40 | 40 | 50x2 | 180 |
| 40 | 50 | 50x2 | 190 |
| 50 | 50 | 50x2 | 200 |
| CA\_n77I, CA\_n78I, CA\_n79I |  | 40 | 20 | 50x3 | 210 |
| 50 | 20 | 50x3 | 220 |
| 40 | 40 | 50x3 | 230 |
| 40 | 50 | 50x3 | 240 |
| 50 | 50 | 50x3 | 250 |
| CA\_n77J, CA\_n78J, CA\_n79J |  | 40 | 20 | 50x4 | 260 |
| 50 | 20 | 50x4 | 270 |
| 40 | 40 | 50x4 | 280 |
| 40 | 50 | 50x4 | 290 |
| 50 | 50 | 50x4 | 300 |
| CA\_n77K, CA\_n78K, CA\_n79K |  | 40 | 20 | 50x5 | 310 |
| 50 | 20 | 50x5 | 320 |
| 40 | 40 | 50x5 | 330 |
| 40 | 50 | 50x5 | 340 |
| 50 | 50 | 50x5 | 350 |
| CA\_n77L, CA\_n78L, CA\_n79L |  | 40 | 20 | 50x6 | 360 |
| 50 | 20 | 50x6 | 370 |
| 40 | 40 | 50x6 | 380 |
| 40 | 50 | 50x6 | 390 |
| 50 | 50 | 50x6 | 400 |

### 5.5A.2 Configurations for intra-band non-contiguous CA

Detailed structure of the subclause is TBD.

### 5.5A.3 Configurations for inter-band CA

Table 5.5A.3-1: NR CA configurations and bandwith combinations sets defined for inter-band CA (two bands)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration | NR Band | SCS  (kHz) | 5  MHz | 10  MHz | 15  MHz | 20  MHz | 25 MHz | 30 MHz | 40  MHz | 50  MHz | 60  MHz | 80  MHz | 90 MHz | 100 MHz | Bandwidth combination set |
| CA\_n3A-n77A | - | n3 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| n77 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA\_n3A-n78A | CA\_n3A-n78A | n3 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA\_n3A-n79A | - | n3 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| n79 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes |  | Yes |
| CA\_n8A-n75A | - | n8 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n75 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| CA\_n8A-n78A | CA\_n8A-n78A | n8 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA\_n8A-n79A | - | n8 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n79 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes |  | Yes |
| CA\_n28A-n75A | - | N28 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n75 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| CA\_n28A-n78A | - | n28 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA\_n41A-n78A | - | n41 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes |  | Yes |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA\_n75A-n78A | - | n75 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA n76A-n78A | - | n76 | 15 | Yes |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| CA\_n77A-n79A | - | n77 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n79 | 15 |  |  |  |  |  |  | Yes | Yes |  |  |  |  |
| 30 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| CA\_n78A-n79A | - | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  | 0 |

## 5.5B Configurations for DC

## 5.5C Configurations for SUL

Table 5.5C-1: Supported channel bandwidths per SUL band combination

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SUL configuration** | **NR Band** | **Subcarrier spacing**  **(kHz)** | **5**  **MHz** | **10**  **MHz** | **15**  **MHz** | **20**  **MHz** | **25 MHz** | **30 MHz** | **40**  **MHz** | **50**  **MHz** | **60**  **MHz** | **80**  **MHz** | 90  MHz | **100 MHz** |
| SUL\_n78A-n80A | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n80 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| SUL\_n78A-n81A | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n81 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| SUL\_n78A-n82A | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n82 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| SUL\_n78A-n83A | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n83 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| SUL\_n78A-n84A | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n84 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| SUL\_n78A-n86A | n78 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n86 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |
| SUL\_n79A-n80A | n79 | 15 |  |  |  |  |  |  | Yes | Yes |  |  |  |  |
| 30 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| n80 | 15 | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |  |
| SUL\_n79A-n81A | n79 | 15 |  |  |  |  |  |  | Yes | Yes |  |  |  |  |
| 30 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| 60 |  |  |  |  |  |  | Yes | Yes | Yes | Yes |  | Yes |
| n81 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |

# 6 Transmitter characteristics

## 6.1 General

Unless otherwise stated, the transmitter characteristics are specified at the antenna connector of the UE with a single or multiple transmit antenna(s). For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

## 6.2 Transmitter power

### 6.2.1 UE maximum output power

The following UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth of NR carrier unless otherwise stated. The period of measurement shall be at least one sub frame (1ms).

Table 6.2.1-1: UE Power Class

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NR  band | Class 1 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) |
| n1 |  |  |  |  | 23 | ± 2 |
| n2 |  |  |  |  | 23 | ± 23 |
| n3 |  |  |  |  | 23 | ± 23 |
| n5 |  |  |  |  | 23 | ± 2 |
| n7 |  |  |  |  | 23 | ± 23 |
| n8 |  |  |  |  | 23 | ± 23 |
| n12 |  |  |  |  | 23 | ± 23 |
| n20 |  |  |  |  | 23 | ± 23 |
| n25 |  |  |  |  | 23 | ± 2 |
| n28 |  |  |  |  | 23 | +2 / - 2.5 |
| n34 |  |  |  |  | 23 | ± 2 |
| n38 |  |  |  |  | 23 | ± 2 |
| n39 |  |  |  |  | 23 | ± 2 |
| n40 |  |  |  |  | 23 | ± 2 |
| n41 |  |  | 26 | +2/-33 | 23 | ± 23 |
| n50 |  |  |  |  | 23 | ± 2 |
| n51 |  |  |  |  | 23 | ± 2 |
| n66 |  |  |  |  | 23 | ± 2 |
| n70 |  |  |  |  | 23 | ± 2 |
| n71 |  |  |  |  | 23 | +2 / - 2.5 |
| n74 |  |  |  |  | 23 | ± 2 |
| n77 |  |  | 26 | +2/-3 | 23 | +2/-3 |
| n78 |  |  | 26 | +2/-3 | 23 | +2/-3 |
| n79 |  |  | 26 | +2/-3 | 23 | +2/-3 |
| n80 |  |  |  |  | 23 | ± 2 |
| n81 |  |  |  |  | 23 | ± 2 |
| n82 |  |  |  |  | 23 | ± 2 |
| n83 |  |  |  |  | 23 | ± 2/-2.5 |
| n84 |  |  |  |  | 23 | ± 2 |
| n86 |  |  |  |  | 23 | ± 2 |
| NOTE 1: PPowerClass is the maximum UE power specified without taking into account the tolerance  NOTE 2: Powerclass 3 is default power class unless otherwise stated  NOTE 3: Refers to the transmission bandwidths (Figure 5.3.3-1) confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB | | | | | | |

If a UE supports a different power class than the default UE power class for the band and the supported power class enables the higher maximum output power than that of the default power class:

- if the field of UE capability maxUplinkDutyCycle is absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than 50% (The exact evaluation period is no less than one radio frame); or

- if the field of UE capability *maxUplinkDutyCycle* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle* as defined in TS 38.331 (The exact evaluation period is no less than one radio frame); or

- [may] apply all requirements for the default power class to the supported power class and set the configured transmitted power as specified in sub-clause 6.2.4;

- if the IE P-Max as defined in TS 38.331 [7] is not provided; or

- if the IE P-Max as defined in TS 38.331 [7] is provided and set to the maximum output power of the default power class or lower;

- shall apply all requirements for the default power class to the supported power class and set the configured transmitted power as specified in sub-clause 6.2.4;

- else (i.e the IE *P-Max* as defined in TS 38.331 [7] is provided and set to the higher value than the maximum output power of the default power class and the percentage of uplink symbols transmitted in a certain evaluation period is less than or equal to *maxUplinkDutyCycle* as defined in TS 38.331; or the IE *P-Max* as defined in TS 38.331 [7] is provided and set to the higher value than the maximum output power of the default power class and the percentage of uplink symbols transmitted in a certain evaluation period is less than or equal to 50% when *maxUplinkDutyCycle* is absent. (The exact evaluation period is no less than one radio frame):

- shall apply all requirements for the supported power class and set the configured transmitted power class as specified in sub-clause 6.2.4;

### 6.2.2 UE maximum output power reduction

UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations. For UE Power Class [2] and 3, the allowed maximum power reduction (MPR) is defined in Table 6.2.2-2 and Table 6.2.2-1, respectively for channel bandwidths that meets both following criteria:

Channel bandwidth ≤ 100MHz.

Relative channel bandwidth ≤ 4% for TDD bands and ≤ 3% for FDD bands

Where relative channel bandwith = 2\*BWChannel / (FUL\_low + FUL\_high)

Table 6.2.2-1 Maximum power reduction (MPR) for power class 3

|  |  |  |  |
| --- | --- | --- | --- |
| Modulation |  | MPR (dB) | |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | ≤3.51 | ≤ 1.21 | ≤0.21 |
| 0.52 | 0.52 | 02 |
| DFT-s-OFDM QPSK | ≤ 1 | | 0 |
| DFT-s-OFDM 16 QAM | ≤ 2 | | ≤ 1 |
| DFT-s-OFDM 64 QAM | ≤ 2.5 | | |
| DFT-s-OFDM 256 QAM | 4.5 | | |
| CP-OFDM QPSK | ≤ 3 | | ≤ 1.5 |
| CP-OFDM 16 QAM | ≤ 3 | | ≤ 2 |
| CP-OFDM 64 QAM | ≤ 3.5 | | |
| CP-OFDM 256 QAM | ≤ 6.5 | | |
| NOTE 1: Applicable for UE operating in TDD mode with PI/2 PBSK modulation and if the IE [P-Boost-BPSK] is set to 1 and 40% or less slots in radio frame are used for UL transmission for bands n40, n77, n78 and n79.  NOTE 2: Applicable for UE operating in FDD mode, or in TDD mode in bands other than n40, n77, n78 and n79 and if the IE [P-Boost-BPSK] is set to 0 and if more than 40% of slots in radio frame are used for UL transmission for bands n40, n77, n78 and n79. | | | |

Table 6.2.2-2 Maximum power reduction (MPR) for power class 2

|  |  |  |  |
| --- | --- | --- | --- |
| Modulation | MPR (dB) | | |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | ≤ 3.5 | ≤ 0.5 | 0 |
| DFT-s-OFDM QPSK | ≤ 3.5 | ≤ 1 | 0 |
| DFT-s-OFDM 16 QAM | ≤ 3.5 | ≤ 2 | ≤ 1 |
| DFT-s-OFDM 64 QAM | ≤ 3.5 | ≤ 2.5 | |
| DFT-s-OFDM 256 QAM | ≤ 4.5 | | |
| CP-OFDM QPSK | ≤ 3.5 | ≤ 3 | ≤ 1.5 |
| CP-OFDM 16 QAM | ≤ 3.5 | ≤ 3 | ≤ 2 |
| CP-OFDM 64 QAM | ≤ 3.5 | | |
| CP-OFDM 256 QAM | ≤ 6.5 | | |

Where the following parameters are defined to specify valid RB allocation ranges for Outer and Inner RB allocations:

NRBis the maximum number of RBs for a given Channel bandwidth and sub-carrier spacing defined in Table 5.3.2-1. RBStart,Low = max(1, floor(LCRB/2))

where max() indicates the largest value of all arguments and floor(x) is the greatest integer less than or equal to x.

RBStart,High = NRB – RBStart,Low – LCRB

The RB allocation is an Inner RB allocation if the following conditions are met

RBStart,Low ≤ RBStart ≤ RBStart,High,and

LCRB ≤ ceil(NRB/2)

where ceil(x) is the smallest integer greater than or equal to x.

An Edge RB allocation is one for which the RB’s are allocated at the lowermost or uppermost edge of the channel with LCRB ≤ 2 RB’s.

The RB allocation is an Outer RB allocation for all other allocations which are not an Inner RB allocation or Edge RB allocation.

If CP-OFDM allocation satisfies following conditions it is considered as almost contiguous allocation

NRB\_gap / (NRB\_alloc + NRB\_gap ) ≤ 0.25

and NRB\_alloc + NRB\_gap is larger than 106, 51 or 24 RBs for 15 kHz, 30 kHz or 60 kHz respectively where NRB\_gap is number of unallocated RBs between allocated RBs and NRB\_alloc is number of allocated RBs. For these almost contiguous signals in power class 3, the allowed maximum power reduction defined in Table 6.2.2-1 is increased by

CEIL( 10 log10(1 + NRB\_gap / NRB\_alloc), 0.5 ) dB.

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2.4 apply.

### 6.2.3 UE additional maximum output power reduction

#### 6.2.3.1 General

Additional emission requirements can be signalled by the network. Each additional emission requirement is associated with a unique network signalling (NS) value indicated in RRC signalling by a frequency band number of the applicable operating band [in the field *frequencyBandList*] and an associated value in the field *additionalSpectrumEmission.* Throughout this specification, the notion of indication or signalling of an NS value refers to the corresponding indication of a frequency band [in the field *frequencyBandList*] and an associated value of *additionalSpectrumEmission* in the relevant RRC information elements [7]*.*

To meet the additional requirements, additional maximum power reduction (A-MPR) is allowed for the maximum output power as specified in Table 6.2.1-1. Unless stated otherwise, an A-MPR of 0 dB shall be used.

Table 6.2.3-1 specifies for UE Power Class 3 the additional requirements with their associated network signalling values and the allowed A-MPR and applicable operating band(s) for each NS value. The mapping between network signalling labels and the *additionalSpectrumEmission* IE defined in TS 38.331 [7] is specified in Table 6.2.3-1A. Unless otherwise stated, the allowed A-MPR is in addition to the allowed MPR specified in subclause 6.2.2.

Table 6.2.3-1: Additional maximum power reduction (A-MPR)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Network Signalling label | Requirements (subclause) | NR Band | Channel bandwidth (MHz) | Resources Blocks (*N*RB) | A-MPR (dB) | Value of additionalSpectrumEmission |
| NS\_01 |  |  |  |  | N/A | 1 |
| NS\_03 | 6.5.2.3.3 | n2, n25, n66, |  |  | Table 6.2.3.7-1 | 3 |
| n70 |
| NS\_03U | 6.5.2.3.3, 6.5.2.4.2 | n2, n25, n66 |  |  | FFS |  |
| NS\_04 | 6.5.2.3.1 | n41 | 10, 15, 20, 40, 50, 60 80, 100 |  | Subclause 6.2.3.2 | 4 |
| NS\_05 | 6.5.3.3.4 | n1, n84 | 5, 10, 15, 205 |  | Subclause 6.2.3.4 |  |
| NS\_05U | 6.5.3.3.4, 6.5.2.4.2 | n1, n84 | 5, 10, 15, 20 |  | FFS |  |
| NS\_06 | 6.5.2.3.4 | n12 | 5, 10, 15 | 5.3.5 | N/A | 2 |
| NS\_08 | 6.5.3.3.5 | n8, n81 | 5, 10, 15 |  | Subclause 6.2.3.6 | NS\_08 |
| NS\_08U | 6.5.3.3.5, 6.5.2.4.2 | n8, n81 | 5, 10, 15 |  | FFS | NS\_08U |
| NS\_10 |  | n20, n82 | 15, 20 | Table 6.2.3.3-1 | Table 6.2.3.3-1 | NS\_xx |
| NS\_17 | 6.5.3.3.2 | n28, n83 | 5,10 | Table 5.3.2-1 | [1]3,4 |  |
| NS\_18 | 6.5.3.3.3 | n28, n83 | 5 | ≥ 2 | ≤ 24 |  |
| 10, 15, 20 | ≥ 1 | ≤ 54 |  |
| NS\_35 | 6.5.2.3.1 | n71 | 5, 10, 15, 20 | Table 5.3.2-1 | N/A | 2 |
| NS\_37 | 6.5.3.3.6 | n74(NOTE6) | 10, 15 | Table 6.2.3.8-1 | Table 6.2.3.8-1 | 1 |
| NS\_38 | 6.5.3.3.7 | n74 | 5, 10, 15, 20 | Table 6.2.3.9-1 | Table 6.2.3.9-1 | 2 |
| NS\_39 | 6.5.3.3.8 | n74 | 10, 15, 20 | Table 6.2.3.10-1 | Table 6.2.3.10-1 | 3 |
| NS\_40 | 6.5.2.3.7 | n51 | 5 |  | Table 6.2.3.5-1 |  |
| NS\_41 | 6.5.2.3.6 | n50 | 5, 10, 15, 20, 40, 50, 60 |  | Table 6.2.3.11-1 |  |
| NS\_42 | 6.5.2.3.7 | n50 | 5, 10, 15, 20, 40, 50, 60 |  | Table 6.2.3.12-1 |  |
| NS\_100 | 6.5.2.4.2 | n1, n2, n3, n5, n8, n20, n25, n66, n80, n81, n82, n84,  NOTE 1 |  |  | Table 6.2.3-2 |  |
| NOTE 1: This NS can be signalled for NR bands that have UTRA services deployed  NOTE 2: The total maximum output power reduction for NS\_17 and NS\_18 is obtained by taking the maximum value of MPR + A-MPR specified in Table 6.2.3-1 and Table 6.2.4-1 in TS 36.101 and A-MPR specified in Table 6.2.3-1.  NOTE 3: The A-MPR is 0dB for inner RB allocations for DFT-s-OFDM PI/2 BPSK and QPSK.  NOTE 4: The A-MPR for CP-OFDM shall also add the corresponding MPR specified in Table 6.2.2-1.  NOTE 5: No A-MPR is applied for 5MHz CBW where the lower channel edge is ≥1930MHz,10MHz CBW where the lower channel edge is ≥1950MHz and 15MHz CBW where the lower channel edge is ≥1955MHz.  NOTE 6: Applicable when the NR carrier is within 1447.9 – 1462.9 MHz | | | | | | |

Table 6.2.3-1A: Mapping of Network Signaling label

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Value of additionalSpectrumEmission | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| n1 | NS\_01 | NS\_100 | NS\_05 | NS\_05U |  |  |  |  |
| n2 | NS\_01 | NS\_100 | NS\_03 | NS\_03U |  |  |  |  |
| n3 | NS\_01 | NS\_100 |  |  |  |  |  |  |
| n5 | NS\_01 | NS\_100 |  |  |  |  |  |  |
| n7 | NS\_01 |  |  |  |  |  |  |  |
| n8 | NS\_01 | NS\_100 | NS\_08 | NS\_08U |  |  |  |  |
| n12 | NS\_01 | NS\_06 |  |  |  |  |  |  |
| n20 | NS\_01 | NS\_100 | NS\_10 |  |  |  |  |  |
| n25 | NS\_01 | NS\_100 | NS\_03 | NS\_03U |  |  |  |  |
| n28 | NS\_01 | NS\_17 | NS\_18 |  |  |  |  |  |
| n34 | NS\_01 |  |  |  |  |  |  |  |
| n38 | NS\_01 |  |  |  |  |  |  |  |
| n39 | NS\_01 |  |  |  |  |  |  |  |
| n40 | NS\_01 | NS\_40 |  |  |  |  |  |  |
| n41 | NS\_01 | NS\_04 |  |  |  |  |  |  |
| n51 | NS\_01 |  |  |  |  |  |  |  |
| n66 | NS\_01 | NS\_100 | NS\_03 | NS\_03U |  |  |  |  |
| n70 | NS\_01 | NS\_03 |  |  |  |  |  |  |
| n71 | NS\_01 | NS\_35 |  |  |  |  |  |  |
| n75 | NS\_01 |  |  |  |  |  |  |  |
| n76 | NS\_01 |  |  |  |  |  |  |  |
| n77 | NS\_01 |  |  |  |  |  |  |  |
| n78 | NS\_01 |  |  |  |  |  |  |  |
| n79 | NS\_01 |  |  |  |  |  |  |  |
| n80 | NS\_01 | NS\_100 |  |  |  |  |  |  |
| n81 | NS\_01 | NS\_100 | NS\_08 | NS\_08U |  |  |  |  |
| n82 | NS\_01 | NS\_100 | NS\_10 |  |  |  |  |  |
| n83 | NS\_01 | NS\_17 | NS\_18 |  |  |  |  |  |
| n84 | NS\_01 | NS\_100 | NS\_05 | NS\_05U |  |  |  |  |
| n86 | NS\_01 |  |  |  |  |  |  |  |
| NOTE: additionalSpectrumEmission corresponds to an information element of the same name defined in sub-clause 6.3.2 of TS 38.331 [7]. | | | | | | | | |

Table 6.2.3-2: A-MPR for UTRA protections

|  |  |  |
| --- | --- | --- |
| Modulation | A-MPR | |
| Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | ≤ 1.5 | 0 |
| DFT-s-OFDM QPSK | ≤ 1 | 0 |
| DFT-s-OFDM 16 QAM | ≤ 0.5 | 0 |
| DFT-s-OFDM 64 QAM | ≤ 0.5 | 0 |
| DFT-s-OFDM 256 QAM | 0 | 0 |
| CP-OFDM QPSK | ≤ 1 | 0 |
| CP-OFDM 16 QAM | ≤ 1 | 0 |
| CP-OFDM 64 QAM | ≤ 0.5 | 0 |
| CP-OFDM 256 QAM | 0 | 0 |
| NOTE 1: A-MPR defined in this Table is additive to MPR defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2 | | |

#### 6.2.3.2 A-MPR for NS\_04

If a UE is configured for n41 on the uplink and it receives IE NS\_04 the allowed maximum power reduction applied to tranmissions on n41 is defined as follows. For NS\_04, A-MPR is not added to MPR. Also, when NS\_04 is signalled, MPR shall be set to zero in the PCMAX equations to avoid double-counting MPR.

Allowed maximum power reduction is defined as A-MPR=max(MPR, A-MPR'),

Note that A-MPR'=0dB means only MPR is applied,

where A-MPR' is defined as

if RBstart ≤ fstart,max,IMD3 / (12⋅SCS) and LCRB ≤ AWmax,IMD3 / (12⋅SCS) and FC - BWChannel/2 < FUL\_low + offsetIMD3,  
then

the A-MPR' is defined according to Table 6.2.3.2-2 PC3\_A2 for Power Class 3 and PC2 A4 for Power Class 2,

else,

if RBstart ≤ LCRB/2 + start / (12⋅SCS) and LCRB ≤ AWmax,regrowth / (12⋅SCS) and FC - BWChannel/2 < FUL\_low + offsetregrowth,  
then

the A-MPR' is defined according to Table 6.2.3.2-2 PC3\_A1 for Power Class 3 and PC2 A3 for Power Class 2,

else

A-MPR' = 0 dB and apply MPR.

With the parameters defined in Table 6.2.3.2-1.

Table 6.2.3.2-1: Parameters for region edges and frequency offsets

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | Symbol | Value | | | Related condition |
| OFDM | | DFT-S-OFDM |
| Max allocation start in IMD3 region | fstart,max,IMD3 | 0.33 BWChannel | | | RBstart ≤ fstart,max,IMD3 / (12SCS) |
| Max allocation BW in IMD3 region | AWmax,IMD3 | 4 MHz | | | LCRB ≤ AWmax,IMD3 / (12SCS) |
| Max freq. offset for IMD3 region | offsetmax,IMD3 | BWChannel - 6MHz | | |  |
| Freq. offset required to avoid A-MPR in IMD3 region | offsetIMD3 | offsetmax,IMD3 | | | FC - BWChannel/2 ≥ FUL\_low + offsetIMD3 |
| Right edge of regrowth region | start | 0.08 BWChannel | | | RBstart ≤ LCRB/2 + start / (12SCS) |
| Max allocation BW in regrowth region | AWmax,regrowth | 100 MHz | | | LCRB ≤ Min(LCRB,Max, AWmax,regrowth / (12SCS)) |
| Freq. offset required to avoid A-MPR in regrowth region | offsetregrowth | Max (10 MHz, 0.25\* BWChannel MHz) | Max (10 MHz, 0.45\* BWChannel MHz) | | FC - BWChannel/2 ≥ FUL\_low + offsetregrowth |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 6.2.3.2-2: A-MPR' valuesAccess | Modulation | MPR’ (dB) | | | |
| PC3\_A1 | PC3\_A2 | PC2\_A3 | PC2\_A4 |
| DFT-S-OFDM | pi/2-BPSK | 3.5 | 3.5 | 3.5 | [5.5] |
| QPSK | 4 | 4 | 4.5 | [6] |
| 16-QAM | 4 | 4 | 5 | [6] |
| 64-QAM |  | 4.5 | 5 | [6.5] |
| 256-QAM | 4.5 | 6 | 6.5 | [8] |
| CP-OFDM | QPSK | 5.5 | 5.5 | 6.5 | [7.5] |
| 16-QAM | 5.5 | 5.5 | 6.5 | [7.5] |
| 64-QAM | 5.5 | 5.5 | 6.5 | [7.5] |
| 256-QAM | 6.5 | 8 | 7.5 | [10] |
| NOTE: The A-MPR’ values in this table apply for both A-MPR relative to 23 dBm for PC3 and A-MPR relative to 26 dBm for PC2 | | | | | |

#### 6.2.3.3 A-MPR for NS\_10

Table 6.2.3.3-1: A-MPR for "NS\_10"

|  |  |  |
| --- | --- | --- |
| Channel bandwidth [MHz] | Parameters | Region A |
| 15 | RBstart | [0 – 10] |
| LCRB [RBs] | [1 -20] |
| A-MPR [dB] | ≤ 36 |
| 20 | RBstart | [0 – 15] |
| LCRB [RBs] | [1 -20] |
| A-MPR [dB] | ≤ 66 |
| NOTE 1: RBstart indicates the lowest RB index of transmitted resource blocks  NOTE 2: LCRB is the length of a contiguous resource block allocation  NOTE 3: For intra-subframe frequency hopping which intersects Region A, notes 1 and 2 apply on a per slot basis. For intra-slot or intra-subslot frequency hopping which intersects Region A, notes 1 and 2 apply on a Tno\_hopping basis.  NOTE 4: For intra-subframe frequency hopping which intersect Region A, the larger A-MPR value may be applied for both slots in the subframe. For intra-slot frequency hopping which intersects Region A, the larger A-MPR value may be applied for the slot. For intra-subslot frequency hopping which intersects Region A, the larger A-MPR value may be applied for the subslot.  NOTE 5: The total maximum output power reduction for NS\_10 is obtained by taking the maximum value of MPR + A-MPR specified in Table 6.2.3-1 and Table 6.2.4-1 in TS 36.101 and A-MPR specified in Table6.2.3.3-1.  NOTE 6: The A-MPR for CP-OFDM shall also add the corresponding MPR specified in Table 6.2.2-1. | | |

#### 6.2.3.4 A-MPR for NS\_05

Table 6.2.3.4-1: A-MPR for NS\_05

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Centre Frequency, Fc, MHz | Region A | | | Region B | | | Region C | | |
| Rbstart | LCRB | A-MPR | Rbstart | LCRB | A-MPR | Rbstart | LCRB | A-MPR |
| 5MHz | 1922.5 ≤ FC < 1927.5 | <1.62MHz/12/SCS | >2.52MHz/12/SCS | A3 |  |  |  |  |  |  |
| 10MHz | 1920 ≤ FC < 1935 | <1.62 MHz/12/SCS | >0 | A1 | >1.62MHz/12/SCS  ≤3.60MHz/12/SCS | >5.4MHz/12/SCS | A7 | >7.74MHz/12/SCS | ≤1.08MHz/12/SCS | A2 |
| 10MHz | 1935 ≤ FC < 1945 |  | >4.5MHz/12/SCS | A4 |  |  |  |  |  |  |
| 15MHz | 1927.5 ≤ FC < 1932.5 | <3.24MHz/12/SCS | >0 | A1 | >3.24MHz/12/SCS  ≤5.40MHz/12/SCS | >8.1MHz/12/SCS | A7 | >10.9MHz/12/SCS | ≤1.08MHz/12/SCS | A2 |
| 15MHz | 1932.5 ≤ FC < 1942.5 | <1.62MHz/12/SCS | >0 | A1 |  |  |  | >12.6 MHz/12/SCS | ≤1.08MHz/12/SCS | A2 |
| 15MHz | 1942.5 ≤ FC < 1947.5 |  | >7.2MHz/12/SCS | A5 |  |  |  |  |  |  |
| 20MHz | 1930 ≤ FC < 1950 | <4.86MHz/12/SCS | >0 | A1 | >4.86MHz/12/SCS  ≤7.20MHz/12/SCS | >9.0MHz/12/SCS | A7 | >14.22MHz/12/SCS | ≤1.08MHz/12/SCS | A2 |
| 20MHz | 1950 ≤ FC <1960 |  | >9.0MHz/12/SCS | A6 |  |  |  |  |  |  |
| NOTE 1: The A-MPR values are listed in Table 6.2.3.4-1 and 6.2.3.4-2.  NOTE 2: For any undefined region, MPR applies | | | | | | | | | | |

Table 6.2.3.4-2: A-MPR for modulation and waveform type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Modulation/Waveform** | **A1** | **A2** | **A3** | |
| **Outer/Inner** | **Outer/Inner** | **Outer** | **Inner** |
| DFT-s-OFDM PI/2 BPSK | ≤ 10 | ≤ 5 | ≤ 4 | N/A |
| DFT-s-OFDM QPSK | ≤ 10 | ≤ 5 | ≤ 4.5 | N/A |
| DFT-s-OFDM 16 QAM | ≤ 10 | ≤ 5 | ≤ 6 | N/A |
| DFT-s-OFDM 64 QAM | ≤ 11 | ≤ 5 | ≤ 6 | N/A |
| DFT-s-OFDM 256 QAM | ≤ 13 | ≤ 5 | ≤ 7 | N/A |
| CP-OFDM QPSK | ≤ 10 | ≤ 5 | ≤ 7.5 | ≤ 2 |
| CP-OFDM 16 QAM | ≤ 10 | ≤ 5 | ≤ 7.5 | N/A |
| CP-OFDM 64 QAM | ≤ 11 | ≤ 5 | ≤ 8 | N/A |
| CP-OFDM 256 QAM | ≤ 13 | N/A | ≤ 10 | N/A |
| NOTE 1: The backoff applied is max (MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2 | | | | |

Table 6.2.3.4-3: A-MPR for modulation and waveform type

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | A4 | | A5 | | A6 | | A7 |
| Outer | Inner | Outer | Inner | Outer | Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 1 | N/A | ≤ 1 | N/A | ≤ 1 | N/A | ≤ 6 |
| DFT-s-OFDM QPSK | N/A | ≤ 1.5 | N/A | ≤ 1.5 | ≤ 6 |
| DFT-s-OFDM 16 QAM | N/A | N/A | N/A | N/A | ≤ 6 |
| DFT-s-OFDM 64 QAM | N/A | N/A | N/A | N/A | ≤ 6 |
| DFT-s-OFDM 256 QAM | N/A | N/A | N/A | N/A | ≤ 6 |
| CP-OFDM QPSK | ≤ 3.5 | ≤ 3.5 | N/A | ≤ 3.5 | ≤ 6 |
| CP-OFDM 16 QAM | ≤ 3.5 | ≤ 3.5 | N/A | ≤ 3.5 | ≤ 6 |
| CP-OFDM 64 QAM | N/A | N/A | ≤ 4 | N/A | ≤ 6 |
| CP-OFDM 256 QAM | N/A | N/A | N/A | N/A | ≤ 6 |
| NOTE 1: The backoff applied is max (MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2 | | | | | | | |

Table 6.2.3.4-4 - Table 6.2.3.4-9: Void

#### 6.2.3.5 A-MPR for NS\_40

Table 6.2.3.5-1: A-MPR for "NS\_40"

|  |  |  |
| --- | --- | --- |
| Modulation | A-MPR | |
| Channel bandwidth (MHz): 5 MHz | |
| Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM QPSK | 15.5 | 12 |
| DFT-s-OFDM 16 QAM | 14.5 | 11 |
| DFT-s-OFDM 64 QAM | 14.5 | 10 |
| DFT-s-OFDM 256 QAM | 12.5 | 7.5 |
| CP-OFDM QPSK | 14.5 | 10 |
| CP-OFDM 16 QAM | 14.5 | 10 |
| CP-OFDM 64 QAM | 14 | 8 |
| CP-OFDM 256 QAM | 11 | 5.5 |
| NOTE 1: The total maximum output power reduction for NS\_40 is obtained by taking the maximum value of MPR + A-MPR specified in Table 6.2.3-1 and Table 6.2.4-30a in TS 36.101 and MPR+A-MPR specified in Table 6.2.2-1 and Table 6.2.3.5-1. | | |

#### 6.2.3.6 A-MPR for NS\_08

Table 6.2.3.6-1: A-MPR for NS\_08 for 5 MHz CBW

|  |  |  |  |
| --- | --- | --- | --- |
| Modulation | A-MPR | | Configurations for A-MPR (NOTE 3) |
| Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | 0 | 0 |  |
| DFT-s-OFDM QPSK | ≤ 2 | 0 | LCRB > 15 for 15kHz SCS |
| DFT-s-OFDM 16 QAM | 0 | 0 |  |
| DFT-s-OFDM 64 QAM | 0 | 0 |  |
| DFT-s-OFDM 256 QAM | 0 | 0 |  |
| CP-OFDM QPSK | ≤ 3.5 | 0 | LCRB > 15 for 15kHz SCS |
| CP-OFDM 16 QAM | ≤ 3.5 | 0 | LCRB > 15 for 15kHz SCS |
| CP-OFDM 64 QAM | 0 | 0 |  |
| CP-OFDM 256 QAM | 0 | 0 |  |
| NOTE 1: The total backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2  NOTE 3: When configurations are specified, A-MPR is only applied for the conditions and zero A-MPR is appied for the rest of RB allocations. | | | |

Table 6.2.3.6-2: A-MPR for NS\_08 for 10 MHz CBW

|  |  |  |  |
| --- | --- | --- | --- |
| Modulation | A-MPR | | Configurations for A-MPR (NOTE 3) |
| Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | ≤ 1.5 | 0 | LCRB > 40 for 15kHz SCS |
| DFT-s-OFDM QPSK | ≤ 2.5 | 0 | LCRB > 30 for 15kHz SCS  LCRB > 15 for 30kHz SCS |
| DFT-s-OFDM 16 QAM | ≤ 2.5 | 0 | LCRB > 40 for 15kHz SCS  LCRB > 20 for 30kHz SCS |
| DFT-s-OFDM 64 QAM | ≤ 2.5 | 0 | LCRB > 45 for 15kHz SCS |
| DFT-s-OFDM 256 QAM | 0 | 0 | LCRB > 40 for 15kHz SCS  LCRB > 20 for 30kHz SCS |
| CP-OFDM QPSK | ≤ 4 | 0 | LCRB > 40 for 15kHz SCS  LCRB > 20 for 30kHz SCS |
| CP-OFDM 16 QAM | ≤ 4 | 0 | LCRB > 40 for 15kHz SCS  LCRB > 20 for 30kHz SCS |
| CP-OFDM 64 QAM | ≤ 4 | 0 | LCRB > 45 for 15kHz SCS |
| CP-OFDM 256 QAM | 0 | 0 |  |
| NOTE 1: The total backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2  NOTE 3: When configurations are specified, A-MPR is only applied for the conditions and zero A-MPR is appied for the rest of RB allocations. | | | |

Table 6.2.3.6-3: A-MPR for NS\_08 for 15 MHz CBW

|  |  |  |  |
| --- | --- | --- | --- |
| Modulation | A-MPR | | Configurations for A-MPR (NOTE 3) |
| Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | ≤ 9 | ≤ 9 | NOTE 4 |
| 1DFT-s-OFDM QPSK | ≤ 9 | ≤ 9 | NOTE 4 |
| DFT-s-OFDM 16 QAM | ≤ 9 | ≤ 9 | NOTE 4 |
| DFT-s-OFDM 64 QAM | ≤ 9 | ≤ 9 | NOTE 4 |
| DFT-s-OFDM 256 QAM | ≤ 9 | ≤ 9 | NOTE 4 |
| CP-OFDM QPSK | ≤ 9 | ≤ 9 | NOTE 4 |
| CP-OFDM 16 QAM | ≤ 9 | ≤ 9 | NOTE 4 |
| CP-OFDM 64 QAM | ≤ 9 | ≤ 9 | NOTE 4 |
| CP-OFDM 256 QAM | ≤ 9 | ≤ 9 | NOTE 4 |
| NOTE 1: The total backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2  NOTE 3: When configurations are specified, A-MPR is only applied for the conditions and zero A-MPR is appied for the rest of RB allocations.  NOTE 4: For 15kHz SCS, applicable for RBSTART<10 or >68 and LCRB>0, or 10≤ RBSTART<34 and LCRB>40. For 30kHz SCS, applicable for RBSTART<5 or >34 and LCRB>0, or 5≤ RBSTART<17 and LCRB>12. | | | |

#### 6.2.3.7 A-MPR for NS\_03

Table 6.2.3.7-1 A-MPR for NS\_03

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Modulation | Channel BW / Transmission BW in MHz | | | | | A-MPR | |
| 5 | 10 | 15 | 20 | 40 | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK,  DFT-s-OFDM QPSK,  DFT-s-OFDM 16 QAM | 1.44 | 1.44 – 2.16 | 1.44 – 2.88 | 2.16 – 3.24 | 2.88 – 4.32 | N/A | ≤1 |
| > 1.44 | > 2.16 | > 2.88 | > 3.24 | > 4.32 | ≤1 | ≤2 |
| DFT-s-OFDM 64 QAM | 1.44 | 1.44 – 2.16 | 1.44 – 2.88 | 2.16 – 3.24 | 2.88 – 4.32 | ≤0.5 | ≤0.5 |
| > 1.44 | > 2.16 | > 2.88 | > 3.24 | > 4.32 | ≤1.5 | ≤1.5 |
| DFT-s-OFDM 256 QAM | <1.44 | | | | | ≤0.5 | ≤0.5 |
| ≥1.44 | | | | | ≤1.5 | ≤1.5 |
| CP-OFDM QPSK | 1.44 | 1.44 – 2.16 | 1.44 – 2.88 | 2.16 – 3.24 | 2.88 – 4.32 | N/A | ≤1 |
| > 1.44 | > 2.16 | > 2.88 | > 3.24 | > 4.32 | ≤1 | ≤2 |
| CP-OFDM 16 QAM | 1.44 | 1.44 – 2.16 | 1.44 – 2.88 | 2.16 – 3.24 | 2.88 – 4.32 | N/A | ≤2 |
| > 1.44 | > 2.16 | > 2.88 | > 3.24 | > 4.32 | ≤1 | ≤2 |
| CP-OFDM 64 QAM | > 1.08 | > 1.08 | > 1.44 | > 1.8 | > 2.88 | ≤1 | ≤1 |
| CP-OFDM 256 QAM | > 1.08 | > 1.08 | > 1.44 | > 1.8 | > 2.88 | ≤1 | ≤1 |
| NOTE 1: A-MPR defined in this Table is additive to MPR defined in Table 6.2.2-1  NOTE 2: Inner and outer allocations are defined in clause 6.2.2 | | | | | | | |

#### 6.2.3.8 A-MPR for NS\_37

Table 6.2.3.8-1: A-MPR for B11/B21 protection (NS\_37) for 10MHz, 15MHz (1447.9-1462.9MHz)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Channel Bandwidth, MHz** | **Carrier Centre Frequency, Fc, MHz** | **Region A**  **(Outer/Inner)** | | | **Region B**  **(Outer/Inner)** | | | **Region C**  **(Outer/Inner)** | | |
| RBstart,(MHz/12/SCS) | LCRB  (MHz/12/SCS) | A-MPR | RBstart  (MHz/12/SCS) | LCRB  (MHz/12/SCS) | A-MPR | RBstart  (MHz/12/SCS) | LCRB  (MHz/12/SCS) | A-MPR |
| 10MHz | 1452.9 < FC ≤1457.9 | ≥0 | >40 | ≤ A1 | N/A | N/A | N/A | N/A | N/A | N/A |
| 15MHz | FC =1455.4 | ≥0 | >55 | ≤ A1 | <[0.54] | < [1.08] | [≤ A2] | >[13.86] | < [1.08] | [≤ A2] |
| NOTE 1: A-MPR values in Table 6.2.3.8-2.  NOTE 2: The backoff applied is max (MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 3: For any undefined region, MPR applies  NOTE 4: No A-MPR for SCS=60 kHz. | | | | | | | | | | |

Table 6.2.3.8-2: A-MPR for modulation and waveform type

|  |  |  |  |
| --- | --- | --- | --- |
| Modulation/Waveform | A1 | | A2 |
| Outer | Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 1 | N/A | [≤ 3] |
| DFT-s-OFDM QPSK | ≤ 1.5 | N/A | [≤ 3] |
| DFT-s-OFDM 16 QAM | ≤ 2.5 | N/A | [≤ 3] |
| DFT-s-OFDM 64 QAM | ≤ 3 | N/A | [≤ 3] |
| DFT-s-OFDM 256 QAM | N/A | N/A | [N/A] |
| CP-OFDM QPSK | ≤ 3.5 | N/A | [≤ 3] |
| CP-OFDM 16 QAM | ≤ 3.5 | N/A | [≤ 3] |
| CP-OFDM 64 QAM | N/A | N/A | [N/A] |
| CP-OFDM 256 QAM | N/A | N/A | [N\A] |
| NOTE 1: The backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2 | | | |

#### 6.2.3.9 A-MPR for NS\_38

Table 6.2.3.9-1: A-MPR for EESS (NS\_38) Protection (1430-1470MHz)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Channel Bandwidth, MHz** | **Carrier Centre Frequency, Fc, MHz** | **Region A**  **(Outer/Inner)** | | | **Region B**  **(Outer/Inner)** | |
| RBstart, | **LCRB** | **A-MPR** | Rbstart+LCRB(MHz/12/SCS) | **A-MPR** |
| 10MHz | [1435 ≤ FC < 1442] | [<= -1.8 MHz/12/SCS + LCRB/2] | [>3.6] | [≤ 12] | [≤2.16] | [≤ 9] |
| 15MHz | [1437.5 ≤ FC < 1447.5] | [<= -1.8 MHz/12/SCS + LCRB/2] | [>3.6] | [≤ 13] | [≤3.6] | [≤ 10] |
| 20MHz | [1440 ≤ FC < 1450] | [<= -1.8 MHz/12/SCS + LCRB/2] | [>3.6] | [≤ 13] | [≤5.4] | [≤ 10] |
| NOTE 1: The backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2  NOTE 3: For any undefined region, MPR applies  NOTE 4: A-MPR applies to all modulation and waveform types. | | | | | | |

#### 6.2.3.10 A-MPR for NS\_39

Table 6.2.3.10-1: A-MPR for own RX (NS\_39) Protection for 10MHz,15MHz, 20MHz (1440-1470MHz)

|  |  |  |  |
| --- | --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Centre Frequency, Fc, MHz | Region A  (Outer/Inner) | |
| Rbstart+LCRB(MHz/12/SCS) | A-MPR |
| 10MHz | [1462 < FC ≤1465] | [>7.9] | [≤ 6] |
| 15MHz | [1456.3 < FC ≤ 1462.5] | [>11.2] | [≤ 6] |
| 20MHz | [1450.8 < FC ≤ 1460] | [>14.4] | [≤ 6] |
| NOTE 1: The backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2  NOTE 3: For any undefined region, MPR applies  NOTE 4: A-MPR applies to all modulation and waveform types. | | | |

#### 6.2.3.11 A-MPR for NS\_41

Table 6.2.3.11-1: A-MPR for "NS\_41"

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Centre Frequency, Fc, MHz | Region A  (Outer/Inner) | | | Region B  (Outer/Inner) | | |
| Rbstart | LCRB | A-MPR  [dB] | Rbstart | LCRB | A-MPR  [dB] |
| 5MHz | - | - | - | NA | - | - | NA |
| 10MHz | 1437 ≤ FC < 1442 | <= -4.5MHz/12/SCS + LCRB | >4.5MHz/12/SCS | ≤ 9 | LCRB < 1.7MHz/12/SCS | ≤ 2.7 MHz/12/SCS | ≤ 9 |
| 15MHz | 1439.5 ≤ FC < 1447.5 | <= -5.4MHz/12/SCS + LCRB | >5.4MHz/12/SCS | ≤ 11 | LCRB < 3.42MHz/12/SCS | ≤ 3.6 MHz/12/SCS | ≤ 9 |
| 20MHz | 1442 ≤ FC < 1450 | <= -5.4MHz/12/SCS + LCRB | >5.4MHz/12/SCS | ≤ 12 | LCRB < 5.04MHz/12/SCS | ≤ 5 MHz/12/SCS | ≤ 9 |
| 40MHz | 1452 ≤ FC < 1497 | <= -7.2MHz/12/SCS + LCRB | >7.2MHz/12/SCS | ≤ 13.5 | LCRB < 11.7MHz/12/SCS | ≤ 18 MHz/12/SCS | ≤ 10.5 |
| 50MHz | 1457 ≤ FC < 1492 | <= -7.2MHz/12/SCS + LCRB | >7.2MHz/12/SCS | ≤ 13.5 | LCRB < 15.12MHz/12/SCS | ≤ 18 MHz/12/SCS | ≤ 10.5 |
| 60MHz | 1462 ≤ FC < 1487 | <= -7.2MHz/12/SCS + LCRB | >7.2MHz/12/SCS | ≤ 13.5 | LCRB < 18.72MHz/12/SCS | ≤ 18.72 MHz/12/SCS | ≤ 10.5 |
| NOTE 1: The backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2  NOTE 3: For any undefined region, MPR applies  NOTE 4: A-MPR applies to all modulation and waveform types. | | | | | | | |

#### 6.2.3.12 A-MPR for NS\_42

Table 6.2.3.12-1: A-MPR for "NS\_42"

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Centre Frequency, Fc, MHz | Region A | | Region B | | |
| RBend | A-MPR  (Outer/Inner) | Rbstart | A-MPR  (Inner) | A-MPR  (Outer) |
| 5MHz | 1512 ≤ FC ≤ 1514.5 | >3.1MHz / 12 / SCS | ≤ 7 | <0.9MHz/12/SCS | ≤ 1.5 | ≤ 4 |
| 10MHz | 1497 ≤ FC ≤ 1512 | >6.2MHz / 12 / SCS | ≤ 8 | <0.9MHz/12/SCS | ≤ 1.5 | ≤ 5 |
| 15MHz | 1502 FC ≤ 1509.5 | >9.3MHz / 12 / SCS | ≤ 8 | <3.06MHz/12/SCS | ≤ 1.5 | ≤ 5 |
| 20MHz | 1497 ≤ FC ≤ 1507 | >12.4MHz / 12 / SCS | ≤ 8 | <4.5MHz/12/SCS | ≤ 1.5 | ≤ 5 |
| 40MHz | 1477 ≤ FC ≤ 1497 | >24.8MHz / 12 / SCS | ≤ 8 | <5.4MHz/12/SCS | ≤ 1.5 | ≤ 5 |
| 50MHz | 1467 ≤ FC ≤ 1492 | >31MHz / 12 / SCS | ≤ 8 | <7.2MHz/12/SCS | ≤ 1.5 | ≤ 5 |
| 60MHz | 1462 ≤ FC ≤ 1487 | >37.2MHz / 12 / SCS | ≤ 8 | <7.2MHz/12/SCS | ≤ 1.5 | ≤ 5 |
| NOTE 1: The backoff applied is max(MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2  NOTE 3: For any undefined region, MPR applies  NOTE 4: A-MPR applies to all modulation and waveform types. | | | | | | |

### 6.2.4 Configured transmitted power

The UE is allowed to set its configured maximum output power PCMAX,f,c for carrier f of serving cell c in each slot. The configured maximum output power PCMAX,f,c is set within the following bounds:

PCMAX\_L,f,c ≤ PCMAX,f,c ≤ PCMAX\_H,f,c with

PCMAX\_L,f,c = MIN {PEMAX,c– ∆TC,c, (PPowerClass – ΔPPowerClass) – MAX(MPRc + A-MPRc+ ΔTIB,c + ∆TC,c +∆TRxSRS, P-MPRc) }

PCMAX\_H,f,c = MIN {PEMAX,c, PPowerClass – ΔPPowerClass }

where

PEMAX,c is the value given by IE P-Max for serving cell c, defined in TS 38.331[7];

PPowerClass is the maximum UE power specified in Table 6.2.1-1 without taking into account the tolerance specified in the Table 6.2.1-1;

When the IE [P-Boost-BPSK] is set to 1, PEMAX,c is increased by +3 dB for a power class 3 capable UE operating in TDD bands n40, n77, n78, and n79 with PI/2 BPSK modulation and 40% or less slots in radio frame are used for UL transmission when PEMAX,c ≥ 20 dBm.

When the IE [P-Boost-BPSK] is set to 1, ΔPPowerClass = -3 dB for a power class 3 capable UE operating in TDD bands n40, n77, n78, and n79 with PI/2 BPSK modulation and 40% or less slots in radio frame are used for UL transmission.

ΔPPowerClass = 3 dB for a power class 2 capable UE operating in Band n41, n77, n78 and n79, when P-max of 23 dBm or lower is indicated; or when the field of UE capability *maxUplinkDutyCycle* is absent and the percentage of uplink symbols transmitted in a certain evalutation period is larger than 50%; or when the field of UE capability *maxUplinkDutyCycle* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle* as defined in TS 38.331 (The exact evaluation period is no less than one radio frame); or if *P-Max* is not indicated in the cell, otherwise ΔPPowerClass = 0 dB;

∆TIB,c is the additional tolerance for serving cell c as specified in TS 38.101-3 subclause 6.2A.4.2 and 6.2B.4.2; ∆TIB,c = 0 dB otherwise;

∆TC,c is TBD;

MPRc and A-MPRc for serving cell c are specified in subclause 6.2.2 and subclause 6.2.3, respectively;

∆TRxSRS is 3 dB and is applied when UE transmits SRS to the antenna port that is designated as Rx port. For other SRS transmissions ∆TRxSRS is zero

P-MPRc is the allowed maximum output power reduction for

a) ensuring compliance with applicable electromagnetic energy absorption requirements and addressing unwanted emissions / self desense requirements in case of simultaneous transmissions on multiple RAT(s) for scenarios not in scope of 3GPP RAN spduiecifications;

b) ensuring compliance with applicable electromagnetic energy absorption requirements in case of proximity detection is used to address such requirements that require a lower maximum output power.

The UE shall apply P-MPRc for serving cell c only for the above cases. For UE conducted conformance testing P-MPRc shall be 0 dB

NOTE 1: P-MPRc was introduced in the PCMAX,f,c equation such that the UE can report to the eNB the available maximum output transmit power. This information can be used by the eNB for scheduling decisions.

NOTE 2: P-MPRc may impact the maximum uplink performance for the selected UL transmission path.

TREF and Teval are specified in Table 6.2.4-1. For each TREF, the PCMAX,L,c for serving cell c are evaluated per Teval and given by the minimum value taken over the transmission(s) within the Teval; the minimum PCMAX\_L,f,c over one or more Teval is then applied for the entire TREF

Table 6.2.4-1: Evaluation and reference periods for Pcmax

|  |  |  |
| --- | --- | --- |
| TREF | Teval | Teval with frequency hopping |
| Physical channel length | Physical channel length | Min(*Tno\_hopping*, Physical Channel Length) |

The measured configured maximum output power PUMAX,f,c shall be within the following bounds:

PCMAX\_L,f,c – MAX{TL,c, T(PCMAX\_L,f,c)} ≤ PUMAX,f,c ≤ PCMAX\_H,f,c + T(PCMAX\_H,f,c).

where the tolerance T(PCMAX,f,c) for applicable values of PCMAX,f,c is specified in Table 6.2.4-1. The tolerance TL,c is the absolute value of the lower tolerance for the applicable operating band as specified in Table 6.2.1-1.

Table 6.2.4-1: PCMAX tolerance

|  |  |
| --- | --- |
| PCMAX,f,c (dBm) | Tolerance T(PCMAX,f,c) (dB) |
| 23 < PCMAX,c ≤ 33 | 2.0 |
| 21 ≤ PCMAX,c ≤ 23 | 2.0 |
| 20 ≤ PCMAX,c < 21 | 2.5 |
| 19 ≤ PCMAX,c < 20 | 3.5 |
| 18 ≤ PCMAX,c < 19 | 4.0 |
| 13 ≤ PCMAX,c < 18 | 5.0 |
| 8 ≤ PCMAX,c < 13 | 6.0 |
| -40 ≤ PCMAX,c < 8 | 7.0 |

## 6.2A Transmitter power for CA

### 6.2A.1 UE maximum output power for CA

#### 6.2A.1.1 UE maximum output power for Intra-band contiguous CA

#### 6.2A.1.1 UE maximum output power for Intra-band non-contiguous CA

#### 6.2A.1.3 UE maximum output power for Inter-band CA

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the transmitter power requirements in subclause 6.2 apply.

For inter-band carrier aggregation with uplink assigned to two NR bands, UE maximum output power shall be measured over all component carriers from different bands. If each band has separate antenna connectors, maximum output power is measured as the sum of maximum output power at each UE antenna connector. The period of measurement shall be at least one sub frame (1ms). The maximum output power is specified in Table 6.2A.1.3-1.

Table 6.2A.1.3-1 UE Power Class for uplink inter-band CA (two bands)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR CA Configuration | Class 1 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) | Class 4 (dBm) | Tolerance (dB) |
| CA\_XA-YA |  |  |  |  | 23 | TBD |  |  |
| NOTE 1: Void  NOTE 2: 2 refers to the transmission bandwidths (Figure 5.3.2-1) confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB  NOTE 3: PPowerClass is the maximum UE power specified without taking into account the tolerance  NOTE 4: For inter-band carrier aggregation the maximum power requirement should apply to the total transmitted power over all component carriers (per UE). | | | | | | | | |

### 6.2A.2 UE maximum output power reduction for CA

#### 6.2A.2.1 UE maximum output power reduction forIntra-band contiguous CA

#### 6.2A.2.2 UE maximum output power reduction for Intra-band non-contiguous CA

#### 6.2A.2.3 UE maximum output power reduction for Inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the requirements in subclause 6.2.2 apply for each uplink component carrier.

### 6.2A.3 UE additional maximum output power reduction for CA

##### 6.2A.3.1.1 UE additional maximum output power reduction for Intra-band contiguous CA

##### 6.2A.3.1.2 UE additional maximum output power reduction for Intra-band non-contiguous CA

##### 6.2A.3.1.3 UE additional maximum output power reduction for Inter-band CA

### 6.2A.4 Configured output power for CA

#### 6.2A.4.1 Configured transmitted power level

##### 6.2A.4.1.1 Configured transmitted power for Intra-band contiguous CA

##### 6.2A.4.1.2 Configured transmitted power for Intra-band non-contiguous CA

##### 6.2A.4.1.3 Configured transmitted power for Inter-band CA

For uplink carrier aggregation the UE is allowed to set its configured maximum output power PCMAX,*c* for serving cell *c* and its total configured maximum output power PCMAX.

The configured maximum output power PCMAX,*c* on serving cell *c* shall be set as specified in subclause 6.2.4.

For uplink inter-band carrier aggregation, MPR*c* and A-MPR*c* apply per serving cell *c* and are specified in subclause 6.2.2 and subclause 6.2.3, respectively. P-MPR*c* accounts for power management for serving cell *c*. PCMAX,*c* is calculated under the assumption that the transmit power is increased independently on all component carriers.

The total configured maximum output power PCMAX shall be set within the following bounds:

PCMAX\_L ≤ PCMAX ≤ PCMAX\_H

For uplink inter-band carrier aggregation with one serving cell c per operating band when same slot symbol pattern is used in all aggregated serving cells,

PCMAX\_L = MIN {10log10∑ MIN [ pEMAX,c/(tC,c), pPowerClass/(mprc·a-mprc·tC,c ·tIB,c·tRxSRS,c), pPowerClass/pmprc], PPowerClass}

PCMAX\_H = MIN{10 log10 ∑ pEMAX,c , PPowerClass}

where

- pEMAX,c is the linear value of PEMAX, *c* which is given by IE *P-Max* for serving cell *c* in [7];

- PPowerClass is the maximum UE power specified in Table 6.2A.1.3-1 without taking into account the tolerance specified in the Table 6.2A.1.3-1; pPowerClass is the linear value of PPowerClass;

- mpr *c* and a-mpr *c* are the linear values of MPR *c* and A-MPR *c* as specified in subclause 6.2.2 and subclause 6.2.3, respectively;

- pmprc is the linear value of P-MPR*c*;

- ∆TRxSRS,c is 3 dB and is applied when UE transmits SRS to the antenna port that is designated as Rx port. For other SRS transmissions ∆TRxSRS is zero;

- tC,c is the linear value of TC,ctC,c = 1.41 when NOTE 2 in Table 6.2A.1.3-1 applies for a serving cell *c*, otherwise tC,c = 1;

- tIB,c is the linear value of the inter-band relaxation term TIB,c of the serving cell *c* as specified in Table 6.2A.4.2.3-1; otherwise tIB,c

For uplink inter-band carrier aggregation with one serving cell *c* per operating band when at least one different numerology/slot pattern is used in aggregated cells, the UE is allowed to set its configured maximum output power PCMAX,c(i),i for serving cell c(i) of slot numerology type *i*, and its total configured maximum output power PCMAX.

The configured maximum output power PCMAX,c(i),i (p) in slot p of serving cell c(i) on slot numerology type *i* shall be set within the following bounds:

PCMAX\_L,f,c (i),i (p) ≤ PCMAX,f,c(i), i (p) ≤ PCMAX\_H,f,c(i),i (p)

where PCMAX\_L,f,c (i),i (p and PCMAX\_Hf,c(i),i (p) are the limits for a serving cell c(i) of slot numerology type i as specified in subclause 6.2.4.

The total UE configured maximum output power PCMAX (p,q) in a slot p of slot numerology or symbol pattern *i*, and a slot q of slot numerology or symbol pattern *j* that overlap in time shall be set within the following bounds unless stated otherwise:

PCMAX\_L(p,q) ≤ PCMAX (p,q) ≤ ,PCMAX\_H (p,q)

When slots p and q have different transmissions lengths and belong to different cells on different bands:

PCMAX\_L (p,q) = MIN {10 log10 [pCMAX\_L,f,c (i),i (p) + pCMAX\_L,f,c (i),j (q)], PPowerClass}

PCMAX\_H (p,q) = MIN {10 log10 [pCMAX\_ H,f,c(i),i (p) + pCMAX\_ H,f,c(i),j (q)], PPowerClass}

where pCMAX\_L,f,c (i),i and pCMAX\_ H,f,c(i),i are the respective limits PCMAX\_L,f,c (i),i and PCMAX\_H,f,c(i),i are expressed in linear scale.

TREF and Teval are specified in Table 6.2A.4.1.3-0 when same and different slot patterns are used in aggregated carriers. For each TREF, the PCMAX\_L is evaluated per Teval and given by the minimum value taken over the transmission(s) within the Teval; the minimum PCMAX\_L over the one or more Teval is then applied for the entire TREF. PPowerClass shall not be exceeded by the UE during any period of time.

Table 6.2A.4.1.3-0: PCMAX evaluation window for different Slot and Channel durations

|  |  |  |
| --- | --- | --- |
| TREF | Teval | Teval with frequency hopping |
| TREF of largest slot duration over both UL CCs | Physical channel length | Min(Tno\_hopping, Physical Channel Length) |

If the UE is configured with multiple TAGs and transmissions of the UE on slot *i* for any serving cell in one TAG overlap some portion of the first symbol of the transmission on slot *i* +1 for a different serving cell in another TAG, the UE minimum of PCMAX\_L for slots *i* and *i* + 1 applies for any overlapping portion of slots *i* and *i* + 1. PPowerClass shall not be exceeded by the UE during any period of time.

The measured maximum output power PUMAX over all serving cells with same slot pattern shall be within the following range:

PCMAX\_L – MAX{TL, TLOW(PCMAX\_L) } ≤ PUMAX  ≤ PCMAX\_H + THIGH(PCMAX\_H)

PUMAX = 10 log10 ∑ pUMAX,c

where pUMAX,c denotes the measured maximum output power for serving cell *c* expressed in linear scale. The tolerances TLOW(PCMAX) and THIGH(PCMAX) for applicable values of PCMAX are specified in Table 6.2A.4.1.3-1. The tolerance TL is the absolute value of the lower tolerance for applicable NR CA configuration as specified in Table 6.2.2A-2 for inter-band carrier aggregation.

The measured maximum output power PUMAX over all serving cells, when at least one slot has a different transmission numerology or symbol pattern, shall be within the following range:

P’CMAX\_L– MAX{TL, TLOW (P’CMAX\_L)} ≤ P’UMAX  ≤ P’CMAX\_H + THIGH (P’CMAX\_H)

P’UMAX = 10 log10 ∑ p’UMAX,c

where p’UMAX,c denotes the average measured maximum output power for serving cell *c* expressed in linear scale over TREF. The tolerances TLOW(P’CMAX) and THIGH(P’CMAX) for applicable values of P’CMAX are specified in Table Table 6.2A.4.1.3-1 for inter-band carrier aggregation. The tolerance TL is the absolute value of the lower tolerance for applicable NR CA configuration as specified in Table 6.2A.1.3-1 for inter-band carrier aggregation.

where:

P’CMAX\_L  = MIN{ MIN {10log10∑( pCMAX\_L,f,c (i),i), PPowerClass} over all overlapping slots in TREF}

P’CMAX\_H = MAX{ MIN{10 log10 ∑ pEMAX,c , PPowerClass} over all overlapping Tslots in TREF}

Table 6.2A.4.1.3-1: PCMAX tolerance for uplink inter-band CA (two bands)

|  |  |  |
| --- | --- | --- |
| PCMAX (dBm) | Tolerance TLOW(PCMAX) (dB) | Tolerance THIGH(PCMAX) (dB) |
| PCMAX = 23 | 3.0 | 2.0 |
| 22 ≤ PCMAX < 23 | 5.0 | 2.0 |
| 21 ≤ PCMAX < 22 | 5.0 | 3.0 |
| 20 ≤ PCMAX < 21 | 6.0 | 4.0 |
| 16 ≤ PCMAX < 20 | 5.0 | |
| 11 ≤ PCMA***c*** < 16 | 6.0 | |
| -40 ≤ PCMAX < 11 | 7.0 | |

#### 6.2A.4.2 ΔTIB,c for CA

##### 6.2A.4.2.1 ΔTIB,c for Intra-band contiguous CA

##### 6.2A.4.2.2 ΔTIB,c for Intra-band non-contiguous CA

##### 6.2A.4.2.3 ΔTIB,c for Inter-band CA

ΔTIB,c for NR CA For the UE which supports inter-band NR CA configuration, ΔTIB,c in Tables below applies. Unless otherwise stated, ΔTIB,c is set to zero.

Table 6.2A.4.2.3-1: ΔT**IB,c** due to NR CA (two bands)

|  |  |  |
| --- | --- | --- |
| Inter-band CA configuration | NR Band | ΔTIB,c (dB) |
| CA\_n3-n77 | n3 | 0.6 |
| n77 | 0.8 |
| CA\_n3A-n78A | n3 | 0.6 |
| n78 | 0.8 |
| CA\_n3-n79 | n3 | 0.3 |
| n79 | 0.8 |
| CA n8-n75 | n8 | 0.3 |
| CA n8A-n78A | n8 | 0.6 |
| n78 | 0.8 |
| CA\_n8-n79 | n8 | 0.3 |
| n79 | 0.8 |
| CA n28-n75 | n28 | 0.3 |
| CA\_n28A-n78A | n28 | 0.5 |
| n78 | 0.8 |
| CA\_n41A-n78A1 | n41 | 0.3 |
| n78 | 0.8 |
| CA\_n75-n78 | n78 | 0.8 |
| CA\_n76-n78 | n78 | 0.8 |
| CA n77-n79A | n77 | 0.5 |
| n79 | 0.5 |
| CA\_n78A-n79A | n78 | 0.5 |
| n79 | 0.5 |
| NOTE: The requirements only apply when the sub-frame and Tx-Rx timings are synchronized between the component carriers. In the absence of synchronization, the requirements are not within scope of these specifications. | | |

## 6.2B Transmitter power for DC

## 6.2C Transmitter power for SUL

### 6.2C.1 Configured transmitted power for SUL

For single carrier configured transmit power, as the UL carrier and SUL carrier is a same cell, the configured transmit power is specified for each UL carrier in a serving cell. The configured transmit power requirement for serving cell is applied for each UL carrier.

### 6.2C.2 ΔTIB,c

For the UE which supports SUL band combination, ΔTIB,c in Tables below applies. Unless otherwise stated, ΔTIB,c is set to zero.

Table 6.2C.2-1: ΔTIB,c due to SUL

|  |  |  |
| --- | --- | --- |
| Band combination for SUL | NR Band | ΔTIB,c (dB) |
| SUL\_n78-n80 | n78 | 0.8 |
| n80 | 0.6 |
| SUL\_n78-n81 | n78 | 0.8 |
| n81 | 0.6 |
| SUL\_n78-n82 | n78 | 0.8 |
| n82 | 0.6 |
| SUL\_n78-n83 | n78 | 0.8 |
| n83 | 0.5 |
| SUL\_n78-n84 | n78 | 0.8 |
| n84 | 0.3 |
| SUL\_n78-n86 | n78 | 0.8 |
| n86 | 0.6 |

## 6.2D Transmitter power for UL-MIMO

### 6.2D.1 UE maximum output power for UL-MIMO

For PC2 UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the maximum output power for any transmission bandwidth within the channel bandwidth is specified in Table 6.2D.1-1. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1-2. For UE supporting UL-MIMO, the maximum output power is measured as the sum of the maximum output power at each UE antenna connector. The period of measurement shall be at least one sub frame (1ms).

The requirements shall be met with the UL-MIMO configurations of using 2-layer UL-MIMO transmission with codebook of. DCI Format for UE configured in PUSCH transmission mode for uplink single-user MIMO shall be used.

Table 6.2D.1-1: UE Power Class for UL-MIMO in closed loop spatial multiplexing scheme

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Class 1 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) | Class 4 (dBm) | Tolerance (dB) |
| n41 |  |  | 26 | +2/-31 | 23 | +2/-31 |  |  |
| n77 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n78 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n79 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| NOTE 1: 1 refers to the transmission bandwidths confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB | | | | | | | | |

Table 6.2D.1-2: UL-MIMO configuration in closed-loop spatial multiplexing scheme

|  |  |  |
| --- | --- | --- |
| Transmission scheme | DCI format | Codebook Index |
| Codebook based uplink | DCI format 0\_1 | Codebook index 0 |

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.2.1 apply.

### 6.2D.2 UE maximum output power reduction for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2D.1-1 is specified in Table 6.2.2-1. The requirements shall be met with UL-MIMO configurations defined in Table 6.2D.1-2. For UE supporting UL-MIMO, the maximum output power is measured as the sum of the maximum output power at each UE antenna connector.

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2D.4 apply.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.2.2 apply.

### 6.2D.3 UE additional maximum output power reduction for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the A-MPR values specified in subclause 6.2.3 shall apply to the maximum output power specified in Table 6.2D.1-1. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1-2. For UE supporting UL-MIMO, the maximum output power is measured as the sum of the maximum output power at each UE antenna connector. Unless stated otherwise, an A-MPR of 0 dB shall be used.

For the UE maximum output power modified by A-MPR, the power limits specified in subclause 6.2D.4 apply.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.2.3 apply.

### 6.2D.4 Configured transmitted power for UL-MIMO

For UE supporting UL-MIMO, the transmitted power is configured per each UE.

The definitions of configured maximum output power PCMAX,*c*, the lower bound PCMAX\_L,*c*, and the higher bound PCMAX\_H,*c* specified in subclause 6.2.4 shall apply to UE supporting UL-MIMO, where

PPowerClass,ΔPPowerClass and TC,*c* are specified in subclause 6.2D.1;

MPR,*c* is specified in subclause 6.2D.2;

A-MPR,*c* is specified in subclause 6.2D.3.

The measured configured maximum output power PUMAX,*c* for serving cell *c* shall be within the following bounds:

PCMAX\_L,*c*– MAX{TL, T LOW(PCMAX\_L,*c*)} ≤ PUMAX,*c* ≤ PCMAX\_H,*c*+ T HIGH(PCMAX\_H,*c*)

where TLOW(PCMAX\_L,*c*) and THIGH(PCMAX\_H,*c*) are defined as the tolerance and applies to PCMAX\_L,*c* and PCMAX\_H,*c* separately, while TL is the absolute value of the lower tolerance in Table 6.2D.1-1 for the applicable operating band.

For UE with two transmit antenna connectors in closed-loop spatial amultiplexing scheme, the tolerance is specified in Table 6.2D.4-1. The requirements shall be met with UL-MIMO configurations specified in Table 6.2D.1-2.

Table 6.2D.4-1: PCMAX,*c* tolerance in closed-loop spatial multiplexing scheme

|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) |
| PCMAX,*c* =26 | 3.0 | 2.0 |
| 23 ≤ PCMAX,*c* < 26 | 3.0 | 2.0 |
| 22 ≤ PCMAX,*c* < 23 | 5.0 | 2.0 |
| 21 ≤ PCMAX,*c* < 22 | 5.0 | 3.0 |
| 20 ≤ PCMAX,*c* < 21 | 6.0 | 4.0 |
| 16 ≤ PCMAX,*c* < 20 | 5.0 | |
| 11 ≤ PCMAX,*c* < 16 | 6.0 | |
| -40 ≤ PCMAX,*c* < 11 | 7.0 | |

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.2.4 apply.

## 6.3 Output power dynamics

Detailed structure of the subclause is TBD.

### 6.3.1 Minimum output power

The minimum controlled output power of the UE is defined as the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value.

The minimum output power is defined as the mean power in one sub-frame TBD ms. The minimum output power shall not exceed the values specified in Table 6.3.1-1.

Table 6.3.1-1: Minimum output power

|  |  |  |
| --- | --- | --- |
| Channel bandwidth  (MHz) | Minimum output power  (dBm) | Measurement bandwidth  (MHz) |
| 5 | -40 | 4.515 |
| 10 | -40 | 9.375 |
| 15 | -40 | 14.235 |
| 20 | -40 | 19.095 |
| 25 | -39 | 23.955 |
| 30 | -38.2 | 28.815 |
| 40 | -37 | 38.895 |
| 50 | -36 | 48.615 |
| 60 | -35.2 | 58.35 |
| 80 | -34 | 78.15 |
| 90 | -33.5 | 88.23 |
| 100 | -33 | 98.31 |

### 6.3.2 Transmit OFF power

Transmit OFF power is defined as the mean power in the channel bandwidth when the transmitter is OFF. The transmitter is considered OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During DTX and measurements gaps, the transmitter is not considered OFF.

The transmit OFF power is defined as the mean power in a duration of at least one sub-frame (1ms) excluding any transient periods. The transmit OFF power shall not exceed the values specified in Table 6.3.2-1.

Table 6.3.2-1: Transmit OFF power

|  |  |  |
| --- | --- | --- |
| Channel bandwidth  (MHz) | Transmit OFF power  (dBm) | Measurement bandwidth  (MHz) |
| 5 | -50 | 4.515 |
| 10 | -50 | 9.375 |
| 15 | -50 | 14.235 |
| 20 | -50 | 19.095 |
| 25 | -50 | 23.955 |
| 30 | -50 | 28.815 |
| 40 | -50 | 38.895 |
| 50 | -50 | 48.615 |
| 60 | -50 | 58.35 |
| 80 | -50 | 78.15 |
| 90 | -50 | 88.23 |
| 100 | -50 | 98.31 |

### 6.3.3 Transmit ON/OFF time mask

#### 6.3.3.1 General

The transmit power time mask defines the transient period(s) allowed

between transmit OFF power as defined in sub-clause 6.3.2 and transmit ON power symbols (transmit ON/OFF)

between continuous ON-power transmissions with powerchange or RB hopping is applied.

In case of RB hopping, transition period is shared symmetrically.

Unless otherwise stated the requirements in clause 6.5 apply also in transient periods.

In the following sub-clauses, following definitions apply:

A slot transmission is a Type A transmission.

A long subslot transmission is a Type B transmission with more than 2 symbols.

A short subslot transmission is a Type B transmission with 1 or 2 symbols.

#### 6.3.3.2 General ON/OFF time mask

The general ON/OFF time mask defines the observation period between transmit OFF and ON power and between transmit ON and OFF power for each SCS. ON/OFF scenarios include; the beginning or end of DTX, measurement gap, contiguous, and non-contiguous transmission, etc

The OFF power measurement period is defined in a duration of at least one slot excluding any transient periods. The ON power is defined as the mean power over one slot excluding any transient period.



Figure 6.3.3.2-1: General ON/OFF time mask for NR UL transmission in FR1

#### 6.3.3.3 Transmit power time mask for slot and short or subslot boundaries

The transmit power time mask for slot and a long subslot transmissionboundaries defines the transient periods allowed between slot and long subslot PUSCH transmissions. For PUSCH-PUCCH and PUSCH-SRS transitions and multiplexing the time masks in sub-clause 6.3.3.7 apply.

The transmit power time mask for slot or long subslot and short subslot transmission boundaries defines the transient periods allowed between slot or long subslot and short subslot transmissions. The time masks in sub-clause 6.3.3.8 apply.

The transmit power time mask for short subslot transmissiona boundaries defines the transient periods allowed between short subslot transmissions. The time masks in sub-clause 6.3.3.9 apply.

#### 6.3.3.4 PRACH time mask

The PRACH ON power is specified as the mean power over the PRACH measurement period excluding any transient periods as shown in Figure 6.3.3.4-1. The measurement period for different PRACH preamble format is specified in Table 6.3.3.4-1.

Table 6.3.3.4-1: PRACH ON power measurement period

|  |  |  |
| --- | --- | --- |
| PRACH preamble format | SCS (kHz) | Measurement period (ms) |
| 0 | 1.25 | 0.903125 |
| 1 | 1.25 | 2.284375 |
| 2 | 1.25 | 3.352604 |
| 3 | 5 | 0.903125 |
| A1 | 15 | 0.142708 |
| 30 | 0.071354 |
| A2 | 15 | 0.285417 |
| 30 | 0.142708 |
| A3 | 15 | 0.428125 |
| 30 | 0.2140625 |
| B1 | 15 | 0.140365 |
| 30 | 0.070182 |
| B4 | 15 | 0.83046875 |
| 30 | 0.415234375 |
| A1/B1 | 15 | 0.142708 ms for first six occasion 0.140365 ms for the last occasion |
| 30 | 0.071354 ms for first six occasion 0.070182 ms for the last occasion |
| A2/B2 | 15 | 0.285417 ms for first two occasion 0.278385 ms for the third occasion |
| 30 | 0.142708 ms for first two occasion 0.1391925 ms for the third occasion |
| A3/B3 | 15 | 0.428125 ms for the first occasion 0.41640625 ms for the second occasion |
| 30 | 0.2140625 ms for the first occasion 0.208203125 ms for the second occasion |
| C0 | 15 | 0.10703125 |
| 30 | 0.053515625 |
| C2 | 15 | 0.333333 |
| 30 | 0.166667 |
| NOTE: For PRACH on PRACH occasion start from the beginning of 0.5ms or span the boundary of 0.5ms of the subframe, the measurement period will plus 0.032552μs | | |



Figure 6.3.3.4-1: PRACH ON/OFF time mask

#### 6.3.3.5 Void

#### 6.3.3.6 SRS time mask

For SRS transmission mapped to one OFDM symbol, the ON power is defined as the mean power over the symbol duration excluding any transient period; Figure 6.3.3.6-1



Figure 6.3.3.6-1: Single SRS time mask for NR UL transmission

For SRS transmission mapped to two OFDM symbols the ON power is defined as the mean power for each symbol duration excluding any transient period. See Figure 6.3.3.6-2



Figure 6.3.3.6-2: Consecutive SRS time mask for the case when no power change is required

When power change between consecutive SRS transmissions is required, then Figure 6.3.3.6-3 and Figure 6.3.3.6-4 apply.



Figure 6.3.3.6-3: Consecutive SRS time mask for the case when power change is required and when 15kHz and 30kHz SCS is used in FR1



Figure 6.3.3.6-4: Consecutive SRS time mask for the case when power change is required and when 60kHz SCS is used in FR1

#### 6.3.3.7 PUSCH-PUCCH and PUSCH-SRS time masks

The PUCCH/PUSCH/SRS time mask defines the observation period between sounding reference symbol (SRS) and an adjacent PUSCH/PUCCH symbol and subsequent UL transmissions. The time masks apply for all types of frame structures and their allowed PUCCH/PUSCH/SRS transmissions unless otherwise stated.



Figure 6.3.3.7-1: PUCCH/PUSCH/SRS time mask when there is a transmission before or after or both before and after SRS

When there is no transmission preceding SRS transmission or succeeding SRS transmission, then the same time mask applies as shown in Figure 6.3.3.7-1.

#### 6.3.3.8 Transmit power time mask for consecutive slot or long subslot transmission and short subslot transmission boundaries

The transmit power time mask for consecutive slot or long subslot transmission and short slot transmission boundaries defines the transient periods allowed between such transmissions.

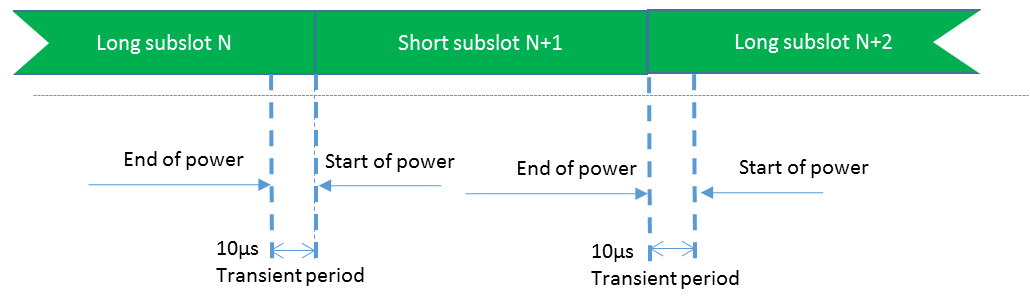


Figure 6.3.3.8-1: Consecutive slot or long subslot transmission and short subslot transmission time mask

#### 6.3.3.9 Transmit power time mask for consecutive short subslot transmissions boundaries

The transmit power time mask for consecutive short subslot transmission boundaries defines the transient periods allowed between short subslot transmissions.

The transient period shall be equally shared as shown on Figure 6.3.3.9-2.

Figure 6.3.3.9-1: Void

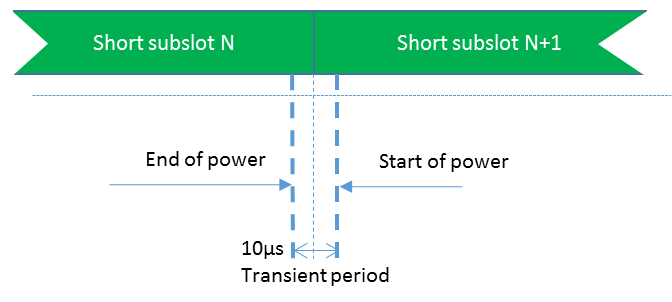


Figure 6.3.3.9-2: Consecutive short subslot transmissions time mask

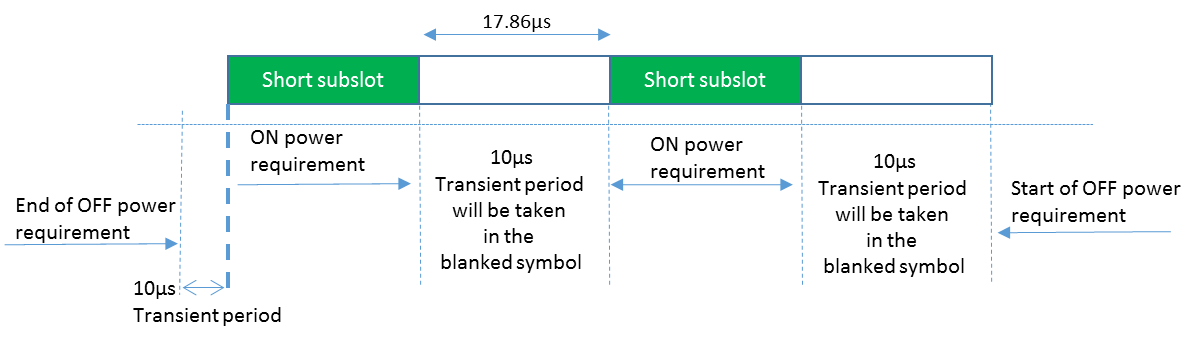


Figure 6.3.3.9-3: Consecutive short subslot (1 symbol gap) time mask for the case when transient period is required on both sides of the symbol and when 60kHz SCS is used in FR1

### 6.3.4 Power control

#### 6.3.4.1 General

The requirements on power control accuracy apply under normal conditions.

#### 6.3.4.2 Absolute power tolerance

The absolute power tolerance is the ability of the UE transmitter to set its initial output power to a specific value for the first sub-frame at the start of a contiguous transmission or non-contiguous transmission with a transmission gap larger than 20ms. The tolerance includes the channel estimation error.

The minimum requirement specified in Table 6.3.4.2-1 apply in the power range bounded by the minimum output power as specified in sub-clause 6.3.1 and the maximum output power as specified in sub-clause 6.2.1.

Table 6.3.4.2-1: Absolute power tolerance

|  |  |
| --- | --- |
| Conditions | Tolerance |
| Normal | ± 9.0 dB |
|  |  |

#### 6.3.4.3 Relative power tolerance

The relative power tolerance is the ability of the UE transmitter to set its output power in a target sub-frame relatively to the power of the most recently transmitted reference sub-frame if the transmission gap between these sub-frames is larger than 20ms.

The minimum requirements specified in Table 6.3.4.3-1 apply when the power of the target and reference sub-frames are within the power range bounded by the minimum output power as defined in sub-clause 6.3.1 and the measured PUMAX as defined in sub-clause 6.2.1.

Table 6.3.4.3-1: Relative power tolerance

|  |  |  |  |
| --- | --- | --- | --- |
| Power step P (Up or down)  (dB) | All combinations of PUSCH and PUCCH transitions (dB) | All combinations of PUSCH/PUCCH and SRS transitions between sub-frames (dB) | PRACH (dB) |
| ΔP < 2 | [± 2.5] (NOTE) | [± 3.0] | [± 2.5] |
| 2 ≤ ΔP < 3 | [± 3.0] | [± 4.0] | [± 3.0] |
| 3 ≤ ΔP < 4 | [± 3.5] | [± 5.0] | [± 3.5] |
| 4 ≤ ΔP ≤ 10 | [± 4.0] | [± 6.0] | [± 4.0] |
| 10 ≤ ΔP < 15 | [± 5.0] | [± 8.0] | [± 5.0] |
| 15 ≤ ΔP | [± 6.0] | [± 9.0] | [± 6.0] |
| NOTE: For PUSCH to PUSCH transitions with the allocated resource blocks fixed in frequency and no transmission gaps other than those generated by downlink subframes, DwPTS fields or Guard Periods: for a power step ΔP ≤ 1 dB, the relative power tolerance for transmission is ± 0.7 dB. | | | |

#### 6.3.4.4 Aggregate power tolerance

The aggregate power control tolerance is the ability of the UE transmitter to maintain its power during non-contiguous transmissions within 21 ms in response to 0 dB commands with respect to the first UE transmission and all other power control parameters as specified in 38.213 kept constant.

The minimum requirement specified in Table 6.3.4.4-1 apply in the power range bounded by the minimum output power as specified in sub-clause 6.3.1 and the maximum output power as specified in sub-clause 6.2.2.

Table 6.3.4.4-1: Aggregate power tolerance

|  |  |  |
| --- | --- | --- |
| TPC command | UL channel | Aggregate power tolerance within 21ms |
| 0 dB | PUCCH | ± 2.5 dB |
| 0 dB | PUSCH | ± 3.5 dB |

## 6.3A Output power dynamics for CA

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the output power dynamics requirements in subclause 6.3 apply.

### 6.3A.1 Minimum output power for CA

#### 6.3A.1.1 Minimum output power for intra-band contiguous CA

#### 6.3A.1.2 Minimum output power for intra-band non-contiguous CA

#### 6.3A.1.3 Minimum output power for inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the minimum output power is defined per carrier and the requirement is specified in subclause 6.3.1.

### 6.3A.2 Transmit OFF power for CA

#### 6.3A.2.1 Transmit OFF power for intra-band contiguous CA

#### 6.3A.2.2 Transmit OFF power for intra-band non-contiguous CA

#### 6.3A.2.3 Transmit OFF power for inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the transmit OFF power specified in subclause 6.3.2.1 is applicable for each component carrier when the transmitter is OFF on all component carriers. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During measurements gaps, the UE is not considered to be OFF.

### 6.3A.3 Transmit ON/OFF time mask for CA

#### 6.3A.3.1 Transmit ON/OFF time mask for intra-band contiguous CA

#### 6.3A.3.2 Transmit ON/OFF time mask for intra-band non-contiguous CA

#### 6.3A.3.3 Transmit ON/OFF time mask for inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the general output power ON/OFF time mask specified in subclause 6.3.3.1 is applicable for each component carrier during the ON power period and the transient periods. The OFF period as specified in subclause 6.3.3.1 shall only be applicable for each component carrier when all the component carriers are OFF.

### 6.3A.4 Power control for CA

#### 6.3A.4.1 Power control for intra-band contiguous CA

#### 6.3A.4.2 Power control for intra-band non-contiguous CA

#### 6.3A.4.3 Power control for inter-band CA

No requirements unique to CA operation are defined.

## 6.3D Output power dynamics for UL-MIMO

### 6.3D.1 Minimum output power for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the minimum output power is defined as the sum of the mean power at each transmit connector in one sub-frame (1ms). The minimum output power shall not exceed the values specified in Table 6.3.1-1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.3.1 apply

### 6.3D.2 Transmit OFF power for UL-MIMO

The transmit OFF power is defined as the mean power at each transmit antenna connector in a duration of at least one sub-frame (1ms) excluding any transient periods.

The transmit OFF power at each transmit antenna connector shall not exceed the values specified in Table 6.3.2-1.

### 6.3D.3 Transmit ON/OFF time mask for UL-MIMO

For UE supporting UL-MIMO, the ON/OFF time mask requirements in subclause 6.3.3 apply at each transmit antenna connector.

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the general ON/OFF time mask requirements specified in subclause 6.3.3.1 apply to each transmit antenna connector. The requirements shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.3.3 apply.

### 6.3D.4 Power control for UL-MIMO

For UE supporting UL-MIMO, the power control tolerance applies to the sum of output power at each transmit antenna connector.

The power control requirements specified in subclause 6.3.4 apply to UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme. The requirements shall be met with UL-MIMO configurations described in sub-clause 6.2D.1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.3.4 apply

## 6.4 Transmit signal quality

### 6.4.1 Frequency error

The UE modulated carrier frequency shall be accurate to within ±0.1 PPM observed over a period of 1 ms compared to the carrier frequency received from the NR Node B.

### 6.4.2 Transmit modulation quality

Transmit modulation quality defines the modulation quality for expected in-channel RF transmissions from the UE. The transmit modulation quality is specified in terms of:

Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)

EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process

Carrier leakage

In-band emissions for the non-allocated RB

All the parameters defined in subclause 6.4.2 are defined using the measurement methodology specified in Annex F.

#### 6.4.2.1 Error Vector Magnitude

The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. Before calculating the EVM the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the carrier leakage shall be removed from the measured waveform before calculating the EVM.

The measured waveform is further equalised using the channel estimates subjected to the EVM equaliser spectrum flatness requirement specified in sub-clause 6.4.2.4. For DFT-s-OFDM waveforms, the EVM result is defined after the front-end FFT and IDFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. For CP-OFDM waveforms, the EVM result is defined after the front-end FFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %.

The basic EVM measurement interval in the time domain is one preamble sequence for the PRACH and the duration of PUCCH/PUSCH channel, or one hop, if frequency hopping is enabled for PUCCH and PUSCH in the time domain. The EVM measurement interval is reduced by any symbols that contains an allowable power transient as defined in subclause 6.3.3.

The RMS average of the basic EVM measurements for 10 sub-frames excluding any transient period for the average EVM case, and 60 sub-frames excluding any transient period for the reference signal EVM case, for the different modulations schemes shall not exceed the values specified in Table 6.4.2.1-1 for the parameters defined in Table 6.4.2.1-2. For EVM evaluation purposes, all PRACH preamble formats 0-4 and all PUCCH formats 1, 1a, 1b, 2, 2a and 2b are considered to have the same EVM requirement as QPSK modulated.

Table 6.4.2.1-1: Requirements for Error Vector Magnitude

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Average EVM Level |
| Pi/2-BPSK | % | 30 |
| QPSK | % | 17.5 |
| 16 QAM | % | 12.5 |
| 64 QAM | % | 8 |
| 256 QAM | % | 3.5 |

Table 6.4.2.1-2: Parameters for Error Vector Magnitude

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Level |
| UE Output Power | dBm | ≥Table 6.3.1-1 |
| UE Output Power for 256 QAM | dBm | ≥ TBD |
| Operating conditions |  | Normal conditions |

#### 6.4.2.2 Carrier leakage

Carrier leakage is an additive sinusoid waveform whose frequency is the same as the modulated waveform carrier frequency. The measurement interval is one slot in the time domain.

In the case that uplink sharing, the carrier leakage may have 7.5 kHz shift with the carrier frequency.

The relative carrier leakage power is a power ratio of the additive sinusoid waveform and the modulated waveform. The relative carrier leakage power shall not exceed the values specified in Table 6.4.2.2-1.

Table 6.4.2.2-1: Requirements for Carrier Leakage

|  |  |
| --- | --- |
| **Parameter** | **Relative Limit [dBc]** |
| Output power > 10 dBm | -28 |
| 0 dBm ≤ Output power ≤10 dBm | -25 |
| -30 dBm ≤ Output power ≤ 0 dBm | -20 |
| -40 dBm ≤ Output power < -30 dBm | -10 |

#### 6.4.2.3 In-band emissions

The in-band emission is defined as the average emission across 12 sub-carriers and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the ratio of the UE output power in a non–allocated RB to the UE output power in an allocated RB.

The basic in-band emissions measurement interval is defined over one slot in the time domain, however, the minimum requirement applies when the in-band emission measurement is averaged over 10 sub-frames. When the PUSCH or PUCCH transmission slot is shortened due to multiplexing with SRS, the in-band emissions measurement interval is reduced by one or more symbols, accordingly.

The average of the basic in-band emission measurement over 10 sub-frames shall not exceed the values specified in Table 6.4.2.3-1.

Table 6.4.2.3-1: Requirements for in-band emissions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter description | Unit | Limit (NOTE 1) | | Applicable Frequencies |
| General | dB |  | | Any non-allocated (NOTE 2) |
| IQ Image | dB | -28 | Image frequencies when output power > 10 dBm | Image frequencies (NOTES 2, 3) |
| -25 | Image frequencies when output power ≤ 10 dBm |
| Carrier leakage | dBc | -28 | Output power > 10 dBm | Carrier leakage frequency (NOTES 4, 5) |
| -25 | 0 dBm ≤ Output power ≤10 dBm |
| -20 | -30 dBm ≤ Output power ≤ 0 dBm |
| -10 | -40 dBm ≤ Output power < -30 dBm |
| NOTE 1: An in-band emissions combined limit is evaluated in each non-allocated RB. For each such RB, the minimum requirement is calculated as the higher of *PRB* - 30 dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply. *PRB* is defined in NOTE 10.  NOTE 2: The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured average power per allocated RB, where the averaging is done across all allocated RBs.  NOTE 3: The applicable frequencies for this limit are those that are enclosed in the reflection of the allocated bandwidth, based on symmetry with respect to the carrier leakage frequency, but excluding any allocated RBs.  NOTE 4: The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured total power in all allocated RBs.  NOTE 5: The applicable frequencies for this limit are those that are enclosed in the RBs containing the carrier leakage frequency if  is odd, or in the two RBs immediately adjacent to the carrier leakage frequency if  is even but excluding any allocated RB.  NOTE 6:  is the Transmission Bandwidth (see Figure 5.3.3).  NOTE 7:  is the Transmission Bandwidth Configuration (see Figure 5.3.3).  NOTE 8:  is the limit specified in Table 6.4.2.1-1 for the modulation format used in the allocated RBs.  NOTE 9:  is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g.  or  for the first adjacent RB outside of the allocated bandwidth.  NOTE 10:  is the transmitted power normalized by the number of allocated RBs, measured in dBm. | | | | |

#### 6.4.2.4 EVM equalizer spectrum flatness

The zero-forcing equalizer correction applied in the EVM measurement process (as described in Annex F) must meet a spectral flatness requirement for the EVM measurement to be valid. The EVM equalizer spectrum flatness is defined in terms of the maximum peak-to-peak ripple of the equalizer coefficients (dB) across the allocated uplink block. The basic measurement interval is the same as for EVM.

The peak-to-peak variation of the EVM equalizer coefficients contained within the frequency range of the uplink allocation shall not exceed the maximum ripple specified in Table 6.4.2.4-1 for normal conditions. For uplink allocations contained within both Range 1 and Range 2, the coefficients evaluated within each of these frequency ranges shall meet the corresponding ripple requirement and the following additional requirement: the relative difference between the maximum coefficient in Range 1 and the minimum coefficient in Range 2 must not be larger than 5 dB, and the relative difference between the maximum coefficient in Range 2 and the minimum coefficient in Range 1 must not be larger than 7 dB (see Figure 6.4.2.4-1).

The EVM equalizer spectral flatness shall not exceed the values specified in Table 6.4.2.4-2 for extreme conditions. For uplink allocations contained within both Range 1 and Range 2, the coefficients evaluated within each of these frequency ranges shall meet the corresponding ripple requirement and the following additional requirement: the relative difference between the maximum coefficient in Range 1 and the minimum coefficient in Range 2 must not be larger than 6 dB, and the relative difference between the maximum coefficient in Range 2 and the minimum coefficient in Range 1 must not be larger than 10 dB (see Figure 6.4.2.4-1).

Table 6.4.2.4-1: Requirements for EVM equalizer spectrum flatness (normal conditions)

|  |  |
| --- | --- |
| Frequency range | Maximum ripple [dB] |
| FUL\_Meas – FUL\_Low ≥ 3 MHz and FUL\_High – FUL\_Meas ≥ 3 MHz  (Range 1) | 4 (p-p) |
| FUL\_Meas – FUL\_Low < 3 MHz or FUL\_High – FUL\_Meas < 3 MHz  (Range 2) | 8 (p-p) |
| NOTE 1: FUL\_Meas refers to the sub-carrier frequency for which the equalizer coefficient is evaluated  NOTE 2: FUL\_Low and FUL\_High refer to each E-UTRA frequency band specified in Table 5.5-1 | |

Table 6.4.2.4-2: Minimum requirements for EVM equalizer spectrum flatness f (extreme conditions)

|  |  |
| --- | --- |
| Frequency range | Maximum Ripple [dB] |
| FUL\_Meas – FUL\_Low ≥ 5 MHz and FUL\_High – FUL\_Meas ≥ 5 MHz  (Range 1) | 4 (p-p) |
| FUL\_Meas – FUL\_Low < 5 MHz or FUL\_High – FUL\_Meas < 5 MHz  (Range 2) | 12 (p-p) |
| NOTE 1: FUL\_Meas refers to the sub-carrier frequency for which the equalizer coefficient is evaluated  NOTE 2: FUL\_Low and FUL\_High refer to each E-UTRA frequency band specified in Table 5.5-1 | |

**f**

**FUL\_High**

**FUL\_High – 3(5) MHz**

**< 4(4) dBp-p**

**Range 1**

**Range 2**

**max(Range 1)-min(Range 2) < 5(6) dB**

**max(Range 2)-min(Range 1) < 7(10) dB**

**< 8(12) dBp-p**

Figure 6.4.2.4-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation of the coefficients indicated (the ETC minimum requirement are within brackets).

##### 6.4.2.4.1 Requirements for pi/2 BPSK modulation

These requirements apply if the IE [P-Boost-BPSK] is set to 1 for power class 3 capable UE operating in TDD bands n40, n77, n78 and n79 with pi/2 BPSK modulation and 40% or less slots in radio frame are used for UL transmission. Otherwise the requirements for EVM equalizer spectrum flatness defined in clause 6.4.2.4 apply.

The EVM equalizer coefficients across the allocated uplink block shall be modified to fit inside the mask specified in Table 6.4.2.4.1-1 for normal conditions, prior to the calculation of EVM.

Table 6.4.2.4.1-1: Mask for EVM equalizer coefficients for pi/2 BPSK, normal conditions

|  |  |  |
| --- | --- | --- |
| Frequency range | Parameter | Maximum ripple [dB] |
| F\_meas – F\_center ≤ X MHz or F\_center – F\_meas ≤ X MHz  (Range 1) | X1 | 6 (p-p) |
| F\_meas – F\_center > X MHz or F\_center – F\_meas > X MHz  (Range 2) | X2 | 14 (p-p) |
| NOTE 1: F\_meas refers to the sub-carrier frequency for which the equalizer coefficient is evaluated  NOTE 2: F\_center refers to the center frequency of an allocated block of PRBs  NOTE 3: X, in MHz, is equal to 25% of the bandwidth of the PRB allocation  NOTE 4: See Figure 6.4.2.4-1 for description of X1, X2 | | |

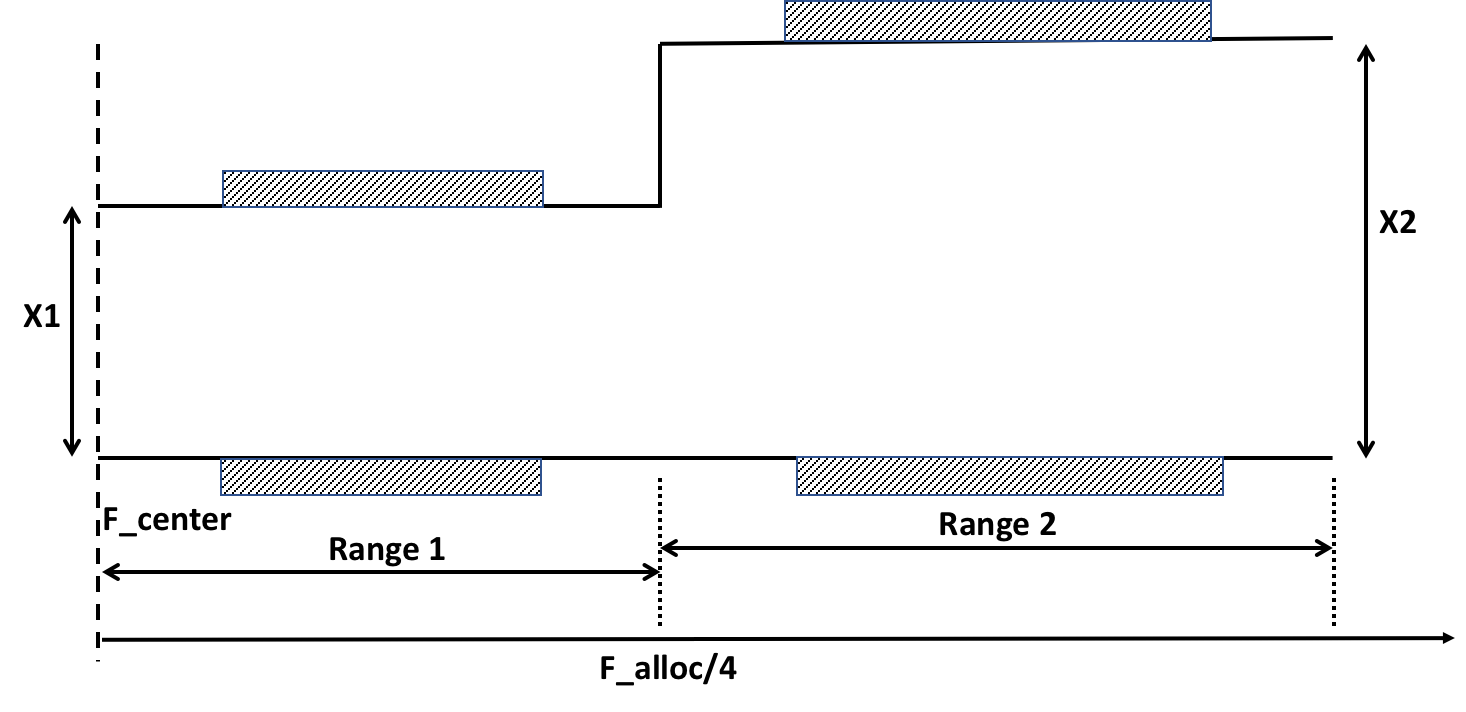


Figure 6.4.2.4.1-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation. F\_center denotes the center frequency of the allocated block of PRBs. F\_alloc denotes the bandwidth of the PRB allocation.

For pi/2 BPSK modulation the UE shall be allowed to employ spectral shaping and the shaping filter shall be restricted so that the impulse response of the shaping filter itself shall meet

│*ãt*(*t*,0)│ ≥ │*ãt*(*t*, *τ*)│ ∀*τ* ≠ 0

20*log*10│*ãt*(*t*,*τ*)│< -15 dB 1< *τ* < M - 1,

where,│*ãt*(*t*, *τ*)│=*IDFT*{│*ãt*(*t*,*f*)│*ejφ (t*,*f)*}, *f* is the frequency of the *M* allocated subcarriers , *ã*(*t*,*f*) and *φ*(*t*,*f*) are the amplitude and phase response.

0dB reference is defined as20*log*10│*ãt*(*t*,0)│.

## 6.4A Transmit signal quality for CA

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the transmit signal quality requirements in subclause 6.4 apply.

### 6.4A.1 Frequency error for CA

#### 6.4A.1.1 Frequency error for intra-band contiguous CA

#### 6.4A.1.2 Frequency error for intra-band non-contiguous CA

#### 6.4A.1.3 Frequency error for inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the frequency error requirements defined in subclause 6.4.1 shall apply on each component carrier with all component carriers active.

### 6.4A.2 Transmit modulation quality for CA

#### 6.4A.2.1 Frequency error for intra-band contiguous CA

#### 6.4A.2.2 Frequency error for intra-band non-contiguous CA

#### 6.4A.2.3 Frequency error for inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the requirements shall apply on each component carrier as defined in clause 6.4.2 with all component carriers active.

## 6.4D Transmit signal quality for UL-MIMO

### 6.4D.1 Frequency error for UL-MIMO

For UE(s) supporting UL-MIMO, the UE modulated carrier frequency at each transmit antenna connector shall be accurate to within ± 0.1 PPM observed over a period of one sub-frame (1 ms) compared to the carrier frequency received from the NR Node B.

### 6.4D.2 Transmit modulation quality for UL-MIMO

For UE supporting UL-MIMO, the transmit modulation quality requirements are specified at each transmit antenna connector.

If UE is configured for transmission on single-antenna port, the requirements specified for single carrier apply.

The transmit modulation quality is specified in terms of:

- Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)

- EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process

- Carrier leakage (caused by IQ offset)

- In-band emissions for the non-allocated RB

6.4D.2.1 Error Vector Magnitude

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the Error Vector Magnitude requirements specified in Table 6.4.2.1-1 which is defined in subclause 6.4.2.1 apply at each transmit antenna connector. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1-2

6.4D.2.2 Carrier leakage

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the Relative Carrier Leakage Power requirements specified in Table 6.4.2.2-1 which is defined in subclause 6.4.2.2 apply at each transmit antenna connector. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1-2

6.4D.2.3 In-band emissions

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the In-band Emission requirements specified in Table 6.4.2.3-1 which is defined in subclause 6.4.2.3 apply at each transmit antenna connector. The requirements shall be met with the uplink MIMO configurations specified in Table 6.2D.1-2

6.4D.2.4 EVM equalizer spectrum flatness for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the EVM Equalizer Spectrum Flatness requirements specified in Table 6.4.2.4-1 and Table 6.4.2.4-2 which are defined in subclause 6.4.2.4 apply at each transmit antenna connector. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1-2

### 6.4D.3 Time alignment error for UL-MIMO

For UE(s) with multiple transmit antenna connectors supporting UL-MIMO, this requirement applies to frame timing differences between transmissions on multiple transmit antenna connectors in the closed-loop spatial multiplexing scheme.

The time alignment error (TAE) is defined as the average frame timing difference between any two transmissions on different transmit antenna connectors.

For UE(s) with multiple transmit antenna connectors, the Time Alignment Error (TAE) shall not exceed 130 ns.

### 6.4D.4 Requirements for coherent UL MIMO

For coherent UL MIMO, Table 6.4D.4-1 lists the maximum allowable difference between the measured relative power and phase errors between different antenna ports in any slot within the specified time window from the last transmitted SRS on the same antenna ports, for the purpose of uplink transmission (codebook or non-codebook usage) and those measured at that last SRS. The requirements in Table 6.4D.4-1 apply when the UL transmission power at each antenna port is larger than 0 dBm for SRS transmission and for the duration of time window.

Table 6.4D.4-1: Maximum allowable difference of relative phase and power errors in a given slot compared to those measured at last SRS transmitted

|  |  |  |
| --- | --- | --- |
| Difference of relative phase error | Difference of relative power error | Time window |
| 40 degrees | 4 dB | 20 msec |

The above requirements when all the following conditions are met within the specified time window:

- UE is not signaled with a change in number of SRS ports in SRS-config, or a change in PUSCH-config

- UE remains in DRX active time (UE does not enter DRX OFF time)

- No measurement gap occurs

- No instance of SRS transmission with the usage antenna switching occurs

- Active BWP remains the same

- EN-DC and CA configuration is not changed for the UE (UE is not configured or de-configured with PScell or SCell(s))

## 6.5 Output RF spectrum emissions

### 6.5.1 Occupied bandwidth

Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel. The occupied bandwidth for all transmission bandwidth configurations (Resources Blocks) shall be less than the channel bandwidth specified in Table 6.5.1-1.

Table 6.5.1-1: Occupied channel bandwidth

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | NR Channel bandwidth | | | | | | | | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| **Occupied channel bandwidth (MHz)** | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 90 | 100 |

### 6.5.2 Out of band emission

#### 6.5.2.1 General

The Out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit is specified in terms of a spectrum emission mask and an adjacent channel leakage power ratio.

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

#### 6.5.2.2 Spectrum emission mask

The spectrum emission mask of the UE applies to frequencies (ΔfOOB) starting from the ± edge of the assigned NR channel bandwidth. For frequencies offset greater than FOOB, the spurious requirements in subclause 6.5.3 are applicable.

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

The power of any UE emission shall not exceed the levels specified in Table 6.5.2.2-1 for the specified channel bandwidth.

Table 6.5.2.2-1: NR General spectrum emission mask

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Spectrum emission limit (dBm) / Channel bandwidth | | | | | | | | | | | | | |
| ΔfOOB  (MHz) | | 5  MHz | 10  MHz | 15  MHz | 20  MHz | 25  MHz | 30 MHz | 40  MHz | 50  MHz | 60  MHz | 80  MHz | 90  MHz | 100  MHz | Measurement bandwidth |
| ± 0-1 | | -13 | -13 | -13 | -13 | -13 | -13 | -13 |  |  |  |  |  | 1 % channel bandwidth |
| ± 0-1 | |  |  |  |  |  |  |  | -24 | -24 | -24 | -24 | -24 | 30 kHz |
| ± 1-5 | | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | 1 MHz |
| ± 5-6 | | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 |
| ± 6-10 | | -25 |
| ± 10-15 | |  | -25 |
| ± 15-20 | |  |  | -25 |
| ± 20-25 | |  |  |  | -25 |
| ± 25-30 | |  |  |  |  | -25 |
| ± 30-35 | |  |  |  |  |  | -25 |
| ± 35-40 | |  |  |  |  |  |  |
| ± 40-45 | |  |  |  |  |  |  | -25 |
| ± 45-50 | |  |  |  |  |  |  |  |
| ± 50-55 | |  |  |  |  |  |  |  | -25 |
| ± 55-60 | |  |  |  |  |  |  |  |  |
| ± 60-65 | |  |  |  |  |  |  |  |  | -25 |
| ± 65-80 | |  |  |  |  |  |  |  |  |  |
| ± 80-90 | |  |  |  |  |  |  |  |  |  | -25 |
| ± 90-95 | |  |  |  |  |  |  |  |  |  |  | -25 |
| ± 95-100 | |  |  |  |  |  |  |  |  |  |  |  |
| ± 100-105 | |  |  |  |  |  |  |  |  |  |  |  | -25 |

#### 6.5.2.3 Additional spectrum emission mask

Additional spectrum emission requirements are signalled by the network with network signalling value indicated by the field *additionalSpectrumEmission*.

##### 6.5.2.3.1 Requirements for network signalled value "NS\_35"

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_35" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.1-1.

Table 6.5.2.3.1-1: Additional requirements for “NS\_35”

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Spectrum emission limit (dBm) / Channel bandwidth | | | | | |
| ΔfOOB  (MHz) | 5  MHz | 10  MHz | 15 MHz | 20 MHz | Measurement bandwidth (unless otherwise stated) |
| ± 0-0.1 | -15 | -18 | -20 | -21 | 30 kHz |
| ± 0.1-6 | -13 | -13 | -13 | -13 | 100 kHz |
| ± 6-10 | -251 | -13 | -13 | -13 | 100 kHz |
| ± 10-15 |  | -251 | -13 | -13 | 100 kHz |
| ± 15-20 |  |  | -251 | -13 | 100 kHz |
| ± 20-25 |  |  |  | -25 | 1 MHz |
| NOTE 1: The measurement bandwidth shall be 1 MHz | | | | | |

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

##### 6.5.2.3.2 Requirements for network signalled value "NS\_04"

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

The n41 SEM transition point from -13 dBm/MHz to -25 dBm/MHz is based on the emission bandwidth. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power. Since the 26-dB emission bandwidth is implementation dependent, the transmission bandwidths occupied by RBs is used for the SEM.

Table 6.5.2.3.2-1: n41 transmission bandwidths for CP-OFDM

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | Channel bandwidths (MHz) | | | | | | | | |
| 10 | 15 | 20 | 40 | 50 | 60 | 80 | 90 | 100 |
| 15 | 9.36 | 14.22 | 19.08 | 38.88 | 48.6 | N.A | N.A | N.A | N.A |
| 30 | 8.64 | 13.68 | 18.36 | 38.16 | 47.88 | 58.32 | 78.12 | 88.02 | 98.28 |
| 60 | 7.92 | 12.96 | 17.28 | 36.72 | 46.8 | 56.88 | 77.04 | 87.12 | 97.20 |

Table 6.5.2.3.2-2: n41 transmission bandwidths for DFT-S-OFDM

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | Channel bandwidths (MHz) | | | | | | | | |
| 10 | 15 | 20 | 40 | 50 | 60 | 80 | 90 | 100 |
| 15 | 9.00 | 13.50 | 18.00 | 38.88 | 48.60 | N/A | N/A | N/A | N/A |
| 30 | 8.64 | 12.96 | 18.00 | 36.00 | 46.08 | 58.32 | 77.76 | 87.48 | 97.20 |
| 60 | 7.20 | 12.96 | 17.28 | 36.00 | 46.08 | 54.00 | 72.00 | 86.40 | 97.20 |

When "NS\_04" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.2-3.

Table 6.5.2.3.2-3: n41 SEM with “NS\_04”

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Spectrum emission limit (dBm) / measurement bandwidth  for each channel bandwidth | | | | | | | | | |
| ΔfOOB  MHz | 10  MHz | 15  MHz | 20  MHz | 40  MHz | 50  MHz | 60  MHz | 80  MHz | 90  MHz | 100  MHz | Measurement bandwidth |
| ± 0 - 1 | -10 | -10 | -10 | -10 |  |  | | | | 2 % channel bandwidth |
|  |  |  |  |  |  | -10 | | | | 1 MHz |
| ± 1 - 5 |  | -10 | | | | | | | | 1 MHz |
| ± 5 - X |  | -13 | | | | | | | |
| ± X - (BWChannel + 5 MHz) |  | -25 | | | | | | | |
| NOTE: X is defined in Table 6.5.2.3.2-1 for CP-OFDM and 6.5.2.3.2-2 for DFT-S-OFDM | | | | | | | | | | |

##### 6.5.2.3.3 Requirements for network signalled value "NS\_03"

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_03", is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.3-1.

Table 6.5.2.3.3-1: Additional requirements for “NS\_03”

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Spectrum emission limit (dBm)/ Channel bandwidth** | | | | | | |
| **ΔfOOB**  **(MHz)** | **5**  **MHz** | **10**  **MHz** | **15**  **MHz** | **20**  **MHz** | **40 MHz** | **Measurement bandwidth** | |
| ± 0-1 | -13 | -13 | -13 | -13 | -13 | 1 % of channel BW | |
| ± 1-6 | -13 | -13 | -13 | -13 | -13 | 1 MHz | |
| ± 6-10 | -25 | -13 | -13 | -13 | -13 | 1 MHz | |
| ± 10-15 |  | -25 | -13 | -13 | -13 | 1 MHz | |
| ± 15-20 |  |  | -25 | -13 | -13 | 1 MHz | |
| ± 20-25 |  |  |  | -25 | -13 | 1 MHz | |
| ± 25-40 |  |  |  |  | -13 | 1 MHz | |
| ± 40-45 |  |  |  |  | -25 | 1 MHz | |

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

Table 6.5.2.3.3-2: Void

##### 6.5.2.3.4 Requirements for network signalled value "NS\_06"

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_06" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.4-1.

Table 6.5.2.3.4-1: Additional requirements for “NS\_06”

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Spectrum emission limit (dBm) / Channel bandwidth | | | | |
| ΔfOOB  (MHz) | 5  MHz | 10  MHz | 15  MHz | Measurement  bandwidth |
| ± 0 – 0.1 | -15 | -18 | -20 | 30 kHz |
| ± 0.1 – 1 | -13 | -13 | -13 | 100 kHz |
| ± 1 – 6 | -13 | -13 | -13 | 1 MHz |
| ± 6 – 10 | -25 |
| ± 10 – 15 |  | -25 |
| ± 15 – 20 |  |  | -25 |

##### 6.5.2.3.5 Requirements for network signalled value "NS\_40"

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_40" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.5-1.

Table 6.5.2.3.5-1: Additional requirements for NR channels are assigned within 1427-1452MHz

|  |  |  |
| --- | --- | --- |
| **Frequency band**  **(MHz)** | **Channel bandwidth /**  **Spectrum emission limit**  **(dBm)** | **Measurement bandwidth** |
| **27 MHz** |
| 1400 ≤ f ≤ 1427 | -32 | 27 MHz |
| NOTE 1: This requirement shall be verified with UE transmission power of 15 dBm. | | |

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

##### 6.5.2.3.6 Requirements for network signalled value “NS\_41”

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_41" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.6-1.

Table 6.5.2.3.6-1: Additional requirements for NR channels assigned within 1427-1452MHz

|  |  |  |
| --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth /  Spectrum emission limit  (dBm) | Measurement bandwidth |
| 27 MHz |
| 1400 ≤ f ≤ 1427 | -32 | 27 MHz |
| NOTE 1: This requirement shall be verified with UE transmission power of 15 dBm. | | |

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

##### 6.5.2.3.7 Requirements for network signalled value "NS\_42"

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_42" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.2.3.7-1.

Table 6.5.2.3.7-1: Additional requirements for NR channels assigned within 1492-1517MHz

|  |  |  |
| --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth /  Spectrum emission limit  (dBm) | Measurement bandwidth |
| 1 MHz |
| 1518 ≤ f ≤ 1520 | -0.8 | 1 MHz |
| 1520 < f ≤ 1559 | -30 | 1 MHz |

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

#### 6.5.2.4 Adjacent channel leakage ratio

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

##### 6.5.2.4.1 NR ACLR

NR Adjacent Channel Leakage power Ratio (NRACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent NR channel frequency at nominal channel spacing.

The assigned NR channel power and adjacent NR channel power are measured with rectangular filters with measurement bandwidths specified in Table 6.5.2.4.1-1.

If the measured adjacent channel power is greater than–50dBm then the NRACLR shall be higher than the value specified in Table 6.5.2.4.1-2.

Table 6.5.2.4.1-1: NR ACLR measurement bandwidth

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR channel bandwidth / NR ACLR measurement bandwidth | | | | | | | | | | | | |
|  | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| NR ACLR measurement bandwidth | 4.515 | 9.375 | 14.235 | 19.095 | 23.955 | 28.815 | 38.895 | 48.615 | 58.35 | 78.15 | 88.23 | 98.31 |

Table 6.5.2.4.1-2: NR ACLR requirement

|  |  |  |  |
| --- | --- | --- | --- |
|  | Power class 1 | Power class 2 | Power class 3 |
| NR ACLR |  | 31 dB | 30 dB |

##### 6.5.2.4.2 UTRA ACLR

UTRA adjacent channel leakage power ratio (UTRAACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent(s) UTRA channel frequency.

UTRAACLR is specified for the first adjacent UTRA channel (UTRAACLR1) which center frequency is ± 2.5 MHz from NR channel edge and for the 2nd adjacent UTRA channel (UTRAACLR2) which center frequency is ± 7.5 MHz from NR channel edge.

The UTRA channel power is measured with a RRC filter with roll-off factor =0.22 and bandwidth of 3.84 MHz. The assigned NR channel power is measured with a rectangular filter with measurement bandwidth specified in Table 6.5.2.4.2-1.

If the measured adjacent channel power is greater than - 50dBm then the UTRAACLR1 and UTRAACLR2 shall be higher than the value specified in Table 6.5.2.4.2-1.

Table 6.5.2.4.2-1: UTRA ACLR requirement

|  |  |
| --- | --- |
|  | Power class 3 |
| UTRAACLR1 | 33 dB |
| UTRAACLR2 | 36 dB |

UTRA ACLR requirement is applicable when signalled by the network with network signalling value indicated by the field *additionalSpectrumEmission*.

### 6.5.3 Spurious emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions unless otherwise stated. The spurious emission limits are specified in terms of general requirements in line with SM.329 and NR operating band requirement to address UE co-existence.

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

#### 6.5.3.1 General spurious emissions

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth. The spurious emission limits in Table 6.5.3.1-2 apply for all transmitter band configurations (NRB) and channel bandwidths.

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

Table 6.5.3.1-1: Boundary between NR out of band and general spurious emission domain

|  |  |
| --- | --- |
| Channel bandwidth | OOB boundary FOOB (MHz) |
| BWChannel | BWChannel + 5 |

Table 6.5.3.1-2: Requirement for general spurious emissions limits

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | Maximum Level | Measurement bandwidth | NOTE |
| 9 kHz ≤ f < 150 kHz | -36 dBm | 1 kHz |  |
| 150 kHz ≤ f < 30 MHz | -36 dBm | 10 kHz |  |
| 30 MHz ≤ f < 1000 MHz | -36 dBm | 100 kHz |  |
| 1 GHz ≤ f < 12.75 GHz | -30 dBm | 1 MHz |  |
| -25 dBm | 1 MHz |  |
| 12.75 GHz ≤ f < 5th harmonic of the upper frequency edge of the UL operating band in GHz | -30 dBm | 1 MHz | 1 |
| 12.75 GHz < f < 26 GHz | -30 dBm | 1 MHz | 2 |
| NOTE 1: Applies for Band that the upper frequency edge of the UL Band more than 2.69 GHz  NOTE 2: Applies for Band that the upper frequency edge of the UL Band more than 5.2 GHz  NOTE 3: Applies for EN-DC combinations that include n41 when NS\_04 is signalled. | | | |

#### 6.5.3.2 Spurious emissions for UE co-existence

This clause specifies the requirements for NR bands for coexistence with protected bands.

Table 6.5.3.2-1: Requirements for spurious emissions for UE co-existence

| NR Band | Spurious emission for UE co-existence | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| n1, n84 | E-UTRA Band 1, 5, 7, 8, 11, 18, 19, 20, 21, 22, 26, 27, 28, 31, 32, 38, 40, 41, 42, 43, 44, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76,  NR Band n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n77 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 3, 34 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| Frequency range | 1880 | - | 1895 | -40 | 1 | 15, 27 |
| Frequency range | 1895 | - | 1915 | -15.5 | 5 | 15, 26, 27 |
| Frequency range | 1915 | - | 1920 | +1.6 | 5 | 15, 26, 27 |
| n2 | E-UTRA Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 42, 48, 50, 51, 66, 70, 71, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2, 25 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| E-UTRA Band 43 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| n3, n80 | E-UTRA Band 1, 5, 7, 8, 20, 26, 27, 28, 31, 32, 33, 34, 38, 39, 40, 41, 43, 44, 45, 50, 51, 65, 67, 68, 69, 72, 73,74, 75, 76.  NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 3 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| E-UTRA Band 11, 18, 19, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 13 |
| E-UTRA Band 22, 42,  NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 13 |
| n5 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 18, 19, 24, 25, 26, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 50, 51, 65, 66, 70, 71, 73, 74, 85 | FDL\_low | - | FDL\_high | -50 |  |  |
| E-UTRA Band 41, 52 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 11, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 39 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8,39 |
| n7 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 20, 22, 26, 27, 28, 29, 30, 31, 32, 33, 34, 40, 42, 43, 50, 51, 65, 66, 67, 68, 72, 74, 75, 76,  NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 2570 | - | 2575 | +1.6 | 5 | 15, 21, 26 |
| Frequency range | 2575 | - | 2595 | -15.5 | 5 | 15, 21, 26 |
| Frequency range | 2595 | - | 2620 | -40 | 1 | 15, 21 |
| n8, n81 | E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA band 3, 7, 22, 41, 42, 43,  NR Band n77, n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA 8 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| E-UTRA Band 11, 21 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| n12 | E-UTRA Band 2, 5, 13, 14, 17, 24, 25, 26, 27, 30, 41, 48, 50, 51, 71, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 4, 10, 66, 70 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 12, 85 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| n20, n82 | E-UTRA Band 1, 3, 7, 8, 22, 31, 32, 33, 34, 40, 43, 50, 51, 65, 67, 68, 72, 74, 75, 76 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 20 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| E-UTRA Band 38, 42, 69,  NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 758 | - | 788 | -50 | 1 |  |
| n25 | E-UTRA Band 4, 5, 10,12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 42, 48, 66, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| E-UTRA Band 25 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| E-UTRA Band 43 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| n28, n83 | E-UTRA Band 1, 4, 10, 22, 42, 43, 50, 51, 65, 73, 74, 75, 76,  NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 1 | FDL\_low | - | FDL\_high | -50 | 1 | 19, 25 |
| E-UTRA Band 2, 3, 5, 7, 8, 18, 19, 20, 25, 26, 27, 31, 34, 38, 40, 41, 66, 72,  NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 11, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 19, 24 |
| Frequency range | 470 | - | 694 | -42 | 8 | 15, 35 |
| Frequency range | 470 | - | 710 | -26.2 | 6 | 34 |
| Frequency range | 662 | - | 694 | -26.2 | 6 | 15 |
| Frequency range | 758 | - | 773 | -32 | 1 | 15 |
| Frequency range | 773 | - | 803 | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8, 19 |
| n34 | E-UTRA Band 1, 3, 7, 8, 11, 18, 19, 20, 21, 22, 26, 28, 31, 32, 33, 38,39, 40, 41, 42, 43, 44, 45, 50, 51, 65, 67, 69, 72, 74, 75, 76,  NR Band n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 5 |
| NR Band n77 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| n38 | E-UTRA Band 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 17, 20, 22, 27, 28, 29, 30, 31, 32, 33, 34, 40, 42, 43, 50, 51, 65, 66, 67, 68, 72, 74, 75, 76 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 2620 | - | 2645 | -15.5 | 5 | 15, 22, 26 |
| Frequency range | 2645 | - | 2690 | -40 | 1 | 15, 22 |
| n39 | E-UTRA Band 1, 8, 22, 26, 34, 40, 41, 42, 44, 45, 50, 51, 74,  NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 1805 | - | 1855 | -40 | 1 | 33 |
| Frequency range | 1855 | - | 1880 | -15.5 | 5 | 15, 26, 33 |
| n40 | E-UTRA Band 1, 3, 5, 7, 8, 20, 22, 26, 27, 28, 31, 32, 33, 34, 38, 39, 41, 42, 43, 44, 45, 50, 51, 65, 67, 68, 69, 72, 74, 75, 76,  NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 |  |
|  | NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| n41 | E-UTRA Band 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 34, 39, 40, 42, 44, 45, 48, 50, 51, 65, 66, 70, 71, 73, 74,  NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 9, 11, 18, 19, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 30 |
| Frequency range | 1884.5 |  | 1915.7 | -41 | 0.3 | 8, 30 |
| n50 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 20, 26, 28, 29, 31, 34, 38, 39, 40, 41, 42, 43, 48, 65, 66, 67, 68 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| n51 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 20, 26, 28, 29, 31, 34, 38, 39, 40, 41, 42, 43, 48, 65, 66, 67, 68 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| n66, n86 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 20, 26, 28, 29, 31, 34, 38, 39, 40, 41, 42, 43, 48, 65, 66, 67, 68, 70, 71 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 42, 48 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| n70 | E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 29, 30, 41, 48, 66, 70, 71 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| n71 | E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 30, 48, 66, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2, 25, 41, 70 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 29 | FDL\_low | - | FDL\_high | -38 | 1 | 15 |
| E-UTRA Band 71 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| n74 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 26, 28, 29, 31, 34, 38, 39, 40, 41, 42, 43, 48, 65, 66, 67, 68 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| Frequency range | 1400 | - | 1427 | -32 | 27 | 15, 41 |
| Frequency range | 1475 | - | 1488 | -50 | 1 | 42 |
| Frequency range | 1488 | - | 1518 | -50 | 1 | 15 |
| n77, n78 | E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 39, 40, 41, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| NR Band n257 | 26500 | - | 29500 | -5 | 100 |  |
| n79 | E-UTRA Band 1, 3, 5, 8, 11, 18, 19, 21, 28, 34, 39, 40, 41, 42, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| NR Band n257 | 26500 | - | 29500 | -5 | 100 |  |
| n80 | See n3 |  |  |  |  |  |  |
| n81 | See n8 |  |  |  |  |  |  |
| n82 | See n20 |  |  |  |  |  |  |
| n83 | See n28 |  |  |  |  |  |  |
| n84 | See n1 |  |  |  |  |  |  |
| n86 | See n66 |  |  |  |  |  |  |
| NOTE 1: FDL\_low and FDL\_high refer to each frequency band specified in Table 5.2-1 or Table 5.5-1 in TS 36.101  NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 3: 15 kHz SCS is assumed when RB is mentioned in the note.  NOTE 4: N/A  NOTE 5: For non-synchronised TDD operation to meet these requirements some restriction will be needed for either the operating band or protected band  NOTE 6: N/A  NOTE 7: Applicable when co-existence with PHS system operating in 1884.5 - 1919.6 MHz.  NOTE 8: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz.  NOTE 9: N/A  NOTE 10: N/A  NOTE 11: Whether the applicable frequency range should be 793-805MHz instead of 799-805MHz is TBD  NOTE 12: The emissions measurement shall be sufficiently power averaged to ensure a standard deviation < 0.5 dB  NOTE 13: This requirement applies for 5, 10, 15 and 20 MHz NR channel bandwidth allocated within 1744.9MHz and 1784.9MHz.  NOTE 14: N/A  NOTE 15: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.  NOTE 16: N/A  NOTE 17: N/A  NOTE 18: N/A  NOTE 19: Applicable when the assigned NR carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.  NOTE 20: N/A  NOTE 21: This requirement is applicable for any channel bandwidths within the range 2500 - 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 - 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.  NOTE 22: This requirement is applicable for power class 3 UE for any channel bandwidths within the range 2570 - 2615 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2605.5 - 2607.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2597 - 2605 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB. For power class 2 UE for any channel bandwidths within the range 2570 - 2615 MHz, NS\_44 shall apply. For power class 2 or 3 UE for carriers with channel bandwidth overlapping the frequency range 2615 - 2620 MHz the requirement applies with the maximum output power configured to +19 dBm in the IE P-Max.  NOTE 23: Void  NOTE 24: As exceptions, measurements with a level up to the applicable requirement of -38 dBm/MHz is permitted for each assigned NR carrier used in the measurement due to 2nd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.3.3-1) for which the 2nd harmonic totally or partially overlaps the measurement bandwidth (MBW).  NOTE 25: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned NR carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.3.3-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).  NOTE 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.  NOTE 27: This requirement is applicable for any channel bandwidths within the range 1920 - 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 - 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.  NOTE 28: N/A  NOTE 29: N/A  NOTE 30: This requirement applies when the NR carrier is confined within 2545-2575MHz or 2595-2645MHz and the channel bandwidth is 10 or 20 MHz  NOTE 31: N/A  NOTE 32: Void  NOTE 33: This requirement is only applicable for carriers with bandwidth confined within 1885-1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz.  NOTE 34: This requirement is applicable for 5 and 10 MHz NR channel bandwidth allocated within 718-728MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and RBstart<48.  NOTE 35: This requirement is applicable in the case of a 10 MHz NR carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.  NOTE 36: This requirement is applicable for NR channel bandwidth allocated within 1920-1980 MHz.  NOTE 37: Applicable when the upper edge of the channel bandwidth frequency is greater than 1980MHz.  NOTE 38: Applicable when NS\_33 or NS\_34 is configured by the pre-configured radio parameters.  NOTE 39: Void.  NOTE 40: In the frequency range x-5950MHz, SE requirement of -30dBm/MHz should be applied; where x = max (5925, fc + 15), where fc is the channel centre frequency.  NOTE 41: Applicable for 1.4 MHz bandwidth, and when the lower edge of the assigned NR UL channel bandwidth frequency is greater than or equal to 1427 MHz + the channel BW assigned for 3, 5 and 10 MHz bandwidth, and when the lower edge of the assigned E-UTRA UL channel bandwidth frequency is greater than or equal to 1440 MHz for 15 and 20 MHz bandwidth.  NOTE 42: Applicable for 1.4 , 3 and 5 MHz bandwidth, and when the upper edge of the assigned NR UL channel bandwidth frequency is less than or equal to 1467 MHz assigned for10 MHz bandwidth, and when the upper edge of the assigned NR UL channel bandwidth frequency is less than or equal to 1463.8 MHz for 15 MHz bandwidth, and when the upper edge of the assigned NR UL channel bandwidth frequency is less than or equal to 1460.8 MHz for 20 MHz bandwidth. | | | | | | | |

NOTE: To simplify Table 6.5.3.2-1, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.

#### 6.5.3.3 Additional spurious emissions

These requirements are specified in terms of an additional spectrum emission requirement. Additional spurious emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

##### 6.5.3.3.1 Requirement for network signalled value "NS\_04"

When "NS 04" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.3.3.1-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.1-1: Additional requirements

|  |  |  |
| --- | --- | --- |
| Frequency range  (MHz) | Channel bandwidth / Spectrum emission limit (dBm) | Measurement bandwidth |
| 10, 15, 20, 40, 50, 60, 80, 90, 100 MHz |
| 2495 ≤ f < 2496 | -13 | 1% of Channel BW |
| 2490.5 ≤ f < 2495 | -13 | 1 MHz |
| 0 < f < 2490.5 | -25 | 1 MHz |

6.5.3.3.2 Requirement for network signalled value “NS\_17”

When “NS\_17” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.2-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.2-1: Additional requirements

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency range**  **(MHz)** | **Channel bandwidth / Spectrum emission limit (dBm)** | **Measurement bandwidth** | **NOTE** |
| **5, 10 MHz** |
| 470 ≤ f ≤ 710 | -26.2 | 6 MHz | 1 |
| NOTE 1: Applicable when the assigned E-UTRA carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz. | | | |

##### 6.5.3.3.3 Requirement for network signalled value “NS\_18”

When “NS\_18” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3. 3-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.3-1: Additional requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range  (MHz) | Channel bandwidth / Spectrum emission limit (dBm) | Measurement bandwidth | NOTE |
| 5, 10, 15, 20 MHz |
| 692-698 | -26.2 | 6 MHz |  |

6.5.3.3.4 Requirement for network signalled value “NS\_05”

When “NS\_05” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.4-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.4-1: Additional requirements

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Frequency band**  **(MHz)** | **Channel bandwidth / Spectrum emission limit (dBm)** | | | | **Measurement bandwidth** | **NOTE** |
| **5MHz** | **10MHz** | **15MHz** | **20MHz** |
| 1884.5 f 1915.7 | -41 | -41 | -41 | -41 | 300 KHz |  |

##### 6.5.3.3.5 Requirement for network signalled value “NS\_08”

When “NS08” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.5-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.5-1: Additional requirement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency range  (MHz) | Channel bandwidth / Spectrum emission limit (dBm) | | | Measurement bandwidth |
| 5 MHz | 10 MHz | 15 MHz |
| 860 ≤ f ≤ 890 | -40 | -40 | -40 | 1 MHz |

##### 6.5.3.3.6 Requirement for network signalled value “NS\_37”

When “NS 37” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.6-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.6-1: Additional requirement

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth / Spectrum emission limit (dBm) | | | | Measurement bandwidth |
| 5MHz | 10MHz | 15MHz | **20MHz** |
| 1475.9 ≤ f ≤ 1510.9 | -35 | -35 | -35 | -35 | 1 MHz |

##### 6.5.3.3.7 Requirement for network signalled value “NS\_38”

When “NS 38” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.7-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.7-1: Additional requirements

|  |  |  |
| --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth /  Spectrum emission limit  (dBm) | Measurement bandwidth |
| 5 MHz, 10 MHz, 15 MHz, 20 MHz |
| 1400 ≤ f ≤ 1427 | -32 | 27MHz |
| NOTE 1: This requirement shall be verified with UE transmission power of 15 dBm. | | |

##### 6.5.3.3.8 Requirement for network signalled value “NS\_39”

When “NS 39” is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.8-1. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.8-1: Additional requirements

|  |  |  |
| --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth /  Spectrum emission limit  (dBm) | Measurement bandwidth |
| 5 MHz, 10 MHz, 15 MHz, 20 MHz |
| 1475 ≤ f ≤ 1488 | -28 | 1MHz |

### 6.5.4 Transmit intermodulation

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

UE transmit intermodulation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product when an interfering CW signal is added at a level below the wanted signal at each transmitter antenna port with the other antenna port(s) if any terminated. Both the wanted signal power and the intermodulation product power are measured through NR rectangular filter with measurement bandwidth shown in Table 6.5.4-1.

The requirement of transmit intermodulation is specified in Table 6.5.4-1.

Table 6.5.4-1: Transmit Intermodulation

|  |  |  |
| --- | --- | --- |
| Wanted signal  channel bandwidth | BWChannel | |
| Interference signal  frequency offset from channel center | BWChannel | 2\*BWChannel |
| Interference CW signal level | -40dBc | |
| Intermodulation product | < -29dBc | < -35dBc |
| Measurement bandwidth | The maximum transmission bandwidth configuration among the different SCSs for the channel BW as defined in Table 6.5.2.1.1-1 | |
| Measurement offset from channel center | BWChannel and 2\*BWChannel | 2\*BWChannel and 4\*BWChannel |

## 6.5A Output RF spectrum emissions for CA

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the output RF spectrum emissions requirements in subclause 6.5 apply.

### 6.5A.1 Occupied bandwidth for CA

#### 6.5A.1.1 Occupied bandwidth for Intra-band contiguous CA

#### 6.5A.1.2 Occupied bandwidth for Intra-band non-contiguous CA

#### 6.5A.1.3 Occupied bandwidth for Inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the occupied bandwidth is defined per component carrier. Occupied bandwidth is the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on assigned channel bandwidth on the component carrier. The occupied bandwidth shall be less than the channel bandwidth specified in Table 6.5.1-1.

### 6.5A.2 Out of band emission for CA

#### 6.5A.2.1 General

Detailed structure of the subclause is TBD

#### 6.5A.2.2 Spectrum emission mask

##### 6.5A.2.2.1 Spectrum emission mask for Intra-band contiguous CA

##### 6.5A.2.2.2 Spectrum emission mask for Intra-band non-contiguous CA

##### 6.5A.2.2.3 Spectrum emission mask for Inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the spectrum emission mask of the UE is defined per component carrier while both component carriers are active and the requirements are specified in subclauses 6.5.2.1 and 6.5.2.2. If for some frequency spectrum emission masks of component carriers overlap then spectrum emission mask allowing higher power spectral density applies for that frequency. If for some frequency a component carrier spectrum emission mask overlaps with the channel bandwidth of another component carrier, then the emission mask does not apply for that frequency.

#### 6.5A.2.3 Additional spectrum emission mask

##### 6.5A.2.3.1 Additional spectrum emission mask for Intra-band contiguous CA

##### 6.5A.2.3.2 Additional spectrum emission mask for Intra-band non-contiguous CA

##### 6.5A.2.3.3 Additional spectrum emission mask for Inter-band CA

#### 6.5A.2.4 Adjacent channel leakage ratio

##### 6.5A.2.4.1 NR ACLR

###### 6.5A.2.4.1.1 NR ACLR for Intra-band contiguous CA

###### 6.5A.2.4.1.2 NR ACLR for Intra-band non-contiguous CA

###### 6.5A.2.4.1.3 NR ACLR for Inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the NR Adjacent Channel Leakage power Ratio (NRACLR) is defined per component carrier while both component carriers are active and the requirement is specified in subclause 6.5.2.4.1.

##### 6.5A.2.4.2 UTRA ACLR

###### 6.5A.2.4.2.1 UTRA ACLR for Intra-band contiguous CA

###### 6.5A.2.4.2.2 UTRA ACLR for Intra-band non-contiguous CA

###### 6.5A.2.4.2.3 UTRA ACLR for Inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the UTRA Adjacent Channel Leakage power Ratio (UTRAACLR) is defined per component carrier while both component carrier are active and the requirement is specified in subclause 6.5.2.4.2.

### 6.5A.3 Spurious emission for CA

#### 6.5A.3.1 General spurious emissions

For inter-band carrier aggregation with uplink assigned to two NR bands, the spurious emission requirement Table 6.5.3.1-2 apply for the frequency ranges that are more than FOOB as defined in Table 6.5.3.1-1 away from edges of the assigned channel bandwidth on a component carrier. If for some frequency a spurious emission requirement of individual component carrier overlaps with the spectrum emission mask or channel bandwidth of another component carrier then it does not apply.

#### 6.5A.3.2 Spurious emissions for UE co-existence

##### 6.5A.3.2.1 Spurious emissions for UE co-existence for Intra-band contiguous CA

##### 6.5A.3.2.2 Spurious emissions for UE co-existence for Intra-band non-contiguous CA

##### 6.5A.3.2.3 Spurious emissions for UE co-existence for Inter-band CA

For inter-band carrier aggregation with the uplink assigned to two NR bands, the requirements in Table 6.5A.3.2-1 apply on each component carrier with all component carriers are active.

NOTE: For inter-band carrier aggregation with uplink assigned to two NR bands the requirements in Table 6.5A.3.2-1 could be verified by measuring spurious emissions at the specific frequencies where second and third order intermodulation products generated by the two transmitted carriers can occur; in that case, the requirements for remaining applicable frequencies in Table 6.5A.3.2-1 would be considered to be verified by the measurements verifying the one uplink inter-band CA UE to UE co-existence requirements.

Table 6.5A.3.2.3-1: Requirements for uplink inter-band carrier aggregation (two bands)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR CA Configuration | Spurious emission | | | | | | |
| Protected Band | Frequency range (Mhz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_n3A-n78A | E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 39, 40, 41, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| NR Band n257 | 26500 | - | 29500 | -5 | 100 |  |
| CA\_n8A-n78A | E-UTRA Band 1,8, 20, 28, 34, 39, 40,65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 3, 7,41 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 11, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 5 |
| Frequency range | 860 | - | 890 | -40 | 1 | 4,5 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| NR Band n257 | 26500 | - | 29500 | -5 | 100 |  |
| NR Band n258 | 24250 | - | 27500 | -5 | 100 |  |
| NOTE 1: FDL\_low and FDL\_high refer to each frequency band specified in Table 5.2-1 or Table 5.5-1 in TS 36.101  NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz  NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.  NOTE 5: This requirement is applicable only for the following cases: - for carriers of 5 MHz channel bandwidth when carrier centre frequency (Fc) is within the range 902.5 MHz ≤ Fc < 907.5 MHz with an uplink transmission bandwidth less than or equal to 20 RB - for carriers of 5 MHz channel bandwidth when carrier centre frequency (Fc) is within the range 907.5 MHz ≤ Fc ≤ 912.5 MHz without any restriction on uplink transmission bandwidth. - for carriers of 10 MHz channel bandwidth when carrier centre frequency (Fc) is Fc = 910 MHz with an uplink transmission bandwidth less than or equal to 32 RB with RBstart > 3. | | | | | | | |

NOTE: To simplify Table 6.5A.3.2.3-1, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.

### 6.5A.4 Transmit intermodulation for CA

##### 6.5A.3.2.1 Transmit intermodulation for Intra-band contiguous CA

##### 6.5A.3.2.2 Transmit intermodulation for Intra-band non-contiguous CA

##### 6.5A.3.2.3 Transmit intermodulation for Inter-band CA

For inter-band carrier aggregation with uplink assigned to two NR bands, the transmit intermodulation requirement is specified in Table 6.5.4-1 which shall apply on each component carrier with both component carriers active.

## 6.5D Output RF spectrum emissions for UL-MIMO

### 6.5D.1 Occupied bandwidth for UL-MIMO

For UE supporting UL-MIMO, the requirements for occupied bandwidth is specified at each transmit antenna connector. The occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel at each transmit antenna connector.

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the occupied bandwidth at each transmitter antenna shall be less than the channel bandwidth specified in table 6.5.1-1. The requirements shall be met with UL-MIMO configurations described in sub-clause 6.2D.1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.5.1 apply

### 6.5D.2 Out of band emission for UL-MIMO

For UE supporting UL-MIMO, the requirements for Out of band emissions resulting from the modulation process and non-linearity in the transmitters are specified at each transmit antenna connector.

For UEs with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the requirements in subclasuse 6.5.2 apply to each transmit antenna connector. The requirements shall be met with UL-MIMO configurations described in sub-clause 6.2D.1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.5.2 apply.

### 6.5D.3 Spurious emission for UL-MIMO

For UE supporting UL-MIMO, the requirements for Spurious emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products are specified at each transmit antenna connector.

For UEs with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the requirements specified in subclasuse 6.5.3 apply to each transmit antenna connector. The requirements shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.5.3 apply.

### 6.5D.4 Transmit intermodulation for UL-MIMO

For UE supporting UL-MIMO, the transmit intermodulation requirements are specified at each transmit antenna connector and the wanted signal is defined as the sum of output power at each transmit antenna connector.

For UEs with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the requirements specified in subclause 6.5.4 apply to each transmit antenna connector. The requirements shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1.

If UE is configured for transmission on single-antenna port, the requirements in subclause 6.5.4 apply.

# 7 Receiver characteristics

## 7.1 General

Unless otherwise stated the receiver characteristics are specified at the antenna connector(s) of the UE. For UE(s) with an integral antenna only, a reference antenna(s) with a gain of 0 dBi is assumed for each antenna port(s). UE with an integral antenna(s) may be taken into account by converting these power levels into field strength requirements, assuming a 0 dBi gain antenna. For UEs with more than one receiver antenna connector, identical interfering signals shall be applied to each receiver antenna port if more than one of these is used (diversity).

The levels of the test signal applied to each of the antenna connectors shall be as defined in the respective sections below.

With the exception of subclause 7.3, the requirements shall be verified with the network signalling value NS\_01 configured (Table 6.2.3-1).

All the parameters in clause 7 are defined using the UL reference measurement channels specified in Annexes A.2.2 and A.2.3, the DL reference measurement channels specified in Annex A.3.2 and using the set-up specified in Annex C.3.1.

## 7.2 Diversity characteristics

The UE is required to be equipped with a minimum of two Rx antenna ports in all operating bands except for the bands n7, n38, n41, n77, n78, n79 where the UE is required to be equipped with a minimum of four Rx antenna ports. This requirement applies when the band is used as a standalone band or as part of a band combination.

For the requirements in Section 7, the UE shall be verified with two Rx antenna ports in all supported frequency bands. Additional requirements for four Rx ports shall be verified in operating bands where the UE is equipped with four Rx antenna ports.

The above rules apply for all subclauses with the exception of subclause 7.9.

## 7.3 Reference sensitivity

### 7.3.1 General

The reference sensitivity power level REFSENS is the minimum mean power applied to each one of the UE antenna ports for all UE categories, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

In later subclauses of Section 7 where the value of REFSENS is used as a reference to set the corresponding requirement:

in all bands, the UE shall be verified against those requirements by applying the REFSENS value in Table 7.3.2-1 with 2 Rx antenna ports tested;

for bands where the UE is required to be equipped with 4 Rx antenna ports, the UE shall additionally be verified against those requirements by applying the resulting REFSENS value derived from the requirement in Table 7.3.2-2 with 4 Rx antenna ports tested.

### 7.3.2 Reference sensitivity power level

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.3.2-1 and Table 7.3.2-2.

Table 7.3.2-1: Two antenna port reference sensitivity QPSK PREFSENS

| Operating band / SCS / Channel bandwidth / Duplex-mode | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | SCS kHz | 5  MHz (dBm) | 10  MHz (dBm) | 15  MHz (dBm) | 20  MHz (dBm) | 25  MHz (dBm) | 30 MHz (dBm) | 40  MHz (dBm) | 50  MHz (dBm) | 60  MHz (dBm) | 80  MHz (dBm) | 90  MHz (dBm) | 100 MHz (dBm) | Duplex Mode |
| n1 | 15 | -100.0 | -96.8 | -95.0 | -93.8 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -97.1 | -95.1 | -94.0 |  |  |  |  |  |  |  |  |
| 60 |  | -97.5 | -95.4 | -94.2 |  |  |  |  |  |  |  |  |
| n2 | 15 | -98.0 | -94.8 | -93.0 | -91.8 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -95.1 | -93.1 | -92.0 |  |  |  |  |  |  |  |  |
| 60 |  | -95.5 | -93.4 | -92.2 |  |  |  |  |  |  |  |  |
| n3 | 15 | -97.0 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 |  |  |  |  |  |  | FDD |
| 30 |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 |  |  |  |  |  |  |
| 60 |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 |  |  |  |  |  |  |
| n5 | 15 | -98.0 | -94.8 | -93.0 | -90.8 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -95.1 | -93.1 | -91.0 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n71 | 15 | -98.0 | -94.8 | -93.0 | -91.8 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -95.1 | -93.1 | -92.0 |  |  |  |  |  |  |  |  |
| 60 |  | -95.5 | -93.4 | -92.2 |  |  |  |  |  |  |  |  |
| n8 | 15 | -97.0 | -93.8 | -92.0 | -90.0 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -94.1 | -92.1 | -90.2 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n12 | 15 | -97.0 | -93.8 | -92.0 |  |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -94.1 | -92.1 |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n20 | 15 | -97.0 | -93.8 | -91.0 | -89.8 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -94.1 | -91.1 | -90.0 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n25 | 15 | -96.5 | -93.3 | -91.5 | -90.3 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -93.6 | -91.6 | -90.5 |  |  |  |  |  |  |  |  |
| 60 |  | -94.0 | -91.9 | -90.7 |  |  |  |  |  |  |  |  |
| n28 | 15 | -98.5 | -95.5 | -93.5 | -90.8 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -95.6 | -93.6 | -91.0 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n34 | 15 | -100.0 | -96.8 | -95.0 |  |  |  |  |  |  |  |  |  | TDD |
| 30 |  | -97.1 | -95.1 |  |  |  |  |  |  |  |  |  |
| 60 |  | -97.5 | -95.4 |  |  |  |  |  |  |  |  |  |
| n38 | 15 | -100.0 | -96.8 | -95.0 | -93.8 |  |  |  |  |  |  |  |  | TDD |
| 30 |  | -97.1 | -95.1 | -94.0 |  |  |  |  |  |  |  |  |
| 60 |  | -97.5 | -95.4 | -94.2 |  |  |  |  |  |  |  |  |
| n39 | 15 | -100.0 | -96.8 | -95.0 | -93.8 | -92.7 | -91.9 | -90.6 |  |  |  |  |  | TDD |
| 30 |  | -97.1 | -95.1 | -94.0 | -92.8 | -92.0 | -90.7 |  |  |  |  |  |
| 60 |  | -97.5 | -95.4 | -94.2 | -93.0 | -92.1 | -90.9 |  |  |  |  |  |
| n40 | 15 | -100.0 | -96.8 | -95.0 | -93.8 | -92.7 | -91.9 | -90.6 | -89.6 |  |  |  |  | TDD |
| 30 |  | -97.1 | -95.1 | -94.0 | -92.8 | -92.0 | -90.7 | -89.7 | -88.9 | -87.6 |  |  |
| 60 |  | -97.5 | -95.4 | -94.2 | -93.0 | -92.1 | -90.9 | -89.8 | -89.1 | -87.6 |  |  |
| n411 | 15 |  | -94.8 | -93.0 | -91.8 |  |  | -88.6 | -87.6 |  |  |  |  | TDD |
| 30 |  | -95.1 | -93.1 | -92.0 |  |  | -88.7 | -87.7 | -86.9 | -85.6 | -85.1 | -84.7 |
| 60 |  | -95.5 | -93.4 | -92.2 |  |  | -88.9 | -87.8 | -87.1 | -85.6 | -85.1 | -84.7 |
| n50 | 15 | -100.0 | -96.8 | -95.0 | -93.8 |  |  | -90.6 | -89.6 |  |  |  |  | TDD |
| 30 |  | -97.1 | -95.1 | -94.0 |  |  | -90.7 | -89.7 | -88.9 | -87.6 |  |  |
| 60 |  | -97.5 | -95.4 | -94.2 |  |  | -90.9 | -89.8 | -89.1 | -87.6 |  |  |
| n51 | 15 | -100.0 |  |  |  |  |  |  |  |  |  |  |  | TDD |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n66 | 15 | -99.5 | -96.3 | -94.5 | -93.3 |  |  | -90.1 |  |  |  |  |  | FDD |
| 30 |  | -96.6 | -94.6 | -93.5 |  |  | -90.2 |  |  |  |  |  |
| 60 |  | -97.0 | -94.9 | -93.7 |  |  | -90.4 |  |  |  |  |  |
| n70 | 15 | -100.0 | -96.8 | -95.0 | -93.8 | -92.7 |  |  |  |  |  |  |  | FDD |
| 30 |  | -97.1 | -95.1 | -94.0 | -92.8 |  |  |  |  |  |  |  |
| 60 |  | -97.5 | -95.4 | -94.2 | -93.0 |  |  |  |  |  |  |  |
| n71 | 15 | -97.2 | -94.0 | -91.6 | -86.0 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -94.3 | -91.9 | -87.4 |  |  |  |  |  |  |  |  |
| 60 | - |  |  |  |  |  |  |  |  |  |  |  |
| n74 | 15 | -99.53 | -96.33 | -94.53 | -93.33 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | -96.63 | -94.63 | -93.53 |  |  |  |  |  |  |  |  |
| 60 |  | -97.03 | -94.93 | -93.73 |  |  |  |  |  |  |  |  |
| n77 (3.3 to 3.8 GHz)1 | 15 |  | -95.8 | -94.0 | -92.7 |  |  | -89.6 | -88.6 |  |  |  |  | TDD |
| 30 |  | -96.1 | -94.1 | -92.9 |  |  | -89.7 | -88.7 | -87.9 | -86.6 | -86.1 | -85.6 |
| 60 | - | -96.5 | -94.4 | -93.1 |  |  | -89.9 | -88.8 | -88.0 | -86.7 | -86.2 | -85.7 |
| n77 1 | 15 |  | -95.3 | -93.5 | -92.2 |  |  | -89.1 | -88.1 |  |  |  |  | TDD |
| 30 |  | -95.6 | -93.6 | -92.4 |  |  | -89.2 | -88.2 | -87.4 | -86.1 | -85.6 | -85.1 |
| 60 | - | -96.0 | -93.9 | -92.6 |  |  | -89.4 | -88.3 | -87.5 | -86.2 | -85.7 | -85.2 |
| n781 | 15 |  | -95.8 | -94.0 | -92.7 |  |  | -89.6 | -88.6 |  |  |  |  | TDD |
| 30 |  | -96.1 | -94.1 | -92.9 |  |  | -89.7 | -88.7 | -87.9 | -86.6 | -86.1 | -85.6 |
| 60 |  | -96.5 | -94.4 | -93.1 |  |  | -89.9 | -88.8 | -88.0 | -86.7 | -86.2 | -85.7 |
| n791 | 15 |  |  |  |  |  |  | -89.6 | -88.6 |  |  |  |  | TDD |
| 30 |  |  |  |  |  |  | -89.7 | -88.7 | -87.9 | -86.6 |  | -85.6 |
| 60 |  |  |  |  |  |  | -89.9 | -88.8 | -88.0 | -86.7 |  | -85.7 |
| NOTE 1: Four Rx antenna ports shall be the baseline for this operating band  NOTE 2: The transmitter shall be set to PUMAX as defined in subclause 6.2.4  NOTE 3: 3 indicates that the requirement is modified by -0.5 dB when the assigned NR channel bandwidth is confined within 1475.9-1510.9 MHz. | | | | | | | | | | | | | | |

For UE(s) equipped with 4 Rx antenna ports, reference sensitivity for 2Rx antenna ports in Table 7.3.2-1 shall be modified by the amount given in ΔRIB,4R in Table 7.3.2-2 for the applicable operating bands.

Table 7.3.2-2: Four antenna port reference sensitivity allowance ΔRIB,4R

|  |  |
| --- | --- |
| Operating band | ΔRIB,4R (dB) |
| n7, n38, n41 | -2.7 |
| n77, n78, n79 | -2.2 |

The reference receive sensitivity (REFSENS) requirement specified in Table 7.3.2-1 and Table 7.3.2-2 shall be met for an uplink transmission using QPSK DFT-s-OFDM waveforms and for uplink transmission bandwidth less than or equal to that specified in Table 7.3.2-3.

Table 7.3.2-3: Uplink configuration for reference sensitivity

| Operating band / SCS / Channel bandwidth / Duplex mode | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | SCS kHz | 5  MHz | 10  MHz | 15  MHz | 20  MHz | 25 MHz | 30 MHz | 40  MHz | 50  MHz | 60  MHz | 80  MHz | 90  MHz | 100 MHz | Duplex Mode |
| n1 | 15 | 25 | 501 | 751 | 1001 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 24 | 361 | 501 |  |  |  |  |  |  |  |  |
| 60 |  | 101 | 18 | 24 |  |  |  |  |  |  |  |  |
| n2 | 15 | 25 | 501 | 501 | 501 |  |  |  |  |  |  |  |  | FDD |
| 30 | 101 | 24 | 241 | 241 |  |  |  |  |  |  |  |  |
| 60 |  | 101 | 101 | 1011 |  |  |  |  |  |  |  |  |
| n3 | 15 | 25 | 501 | 501 | 501 | 501 | 501 |  |  |  |  |  |  | FDD |
| 30 |  | 24 | 241 | 241 | 241 | 241 |  |  |  |  |  |  |
| 60 |  | 101 | 101 | 101 | 101 | 101 |  |  |  |  |  |  |
| n5 | 15 | 25 | 251 | 251 | 251 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 101 | 101 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n7 | 15 | 25 | 501 | 751 | 751 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 24 | 361 | 361 |  |  |  |  |  |  |  |  |
| 60 |  | 101 | 18 | 181 |  |  |  |  |  |  |  |  |
| n8 | 15 | 25 | 251 | 251 | 251 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 101 | 101 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n12 | 15 | 201 | 201 | 201 |  |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 101 |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n20 | 15 | 25 | 201 | 202 | 202 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 102 | 102 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n25 | 15 | 25 | 50 | 501 | 501 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 24 | 241 | 241 |  |  |  |  |  |  |  |  |
| 60 |  | 10 | 101 | 101 |  |  |  |  |  |  |  |  |
| n28 | 15 | 25 | 251 | 251 | 251 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 101 | 101 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n34 | 15 | 25 | 501 | 751 |  |  |  |  |  |  |  |  |  | TDD |
| 30 |  | 24 | 361 |  |  |  |  |  |  |  |  |  |
| 60 |  | 101 | 18 |  |  |  |  |  |  |  |  |  |
| n38 | 15 | 25 | 501 | 751 | 1001 |  |  |  |  |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 |  |  |  |  |  |  |  |  |
| 60 |  | 101 | 18 | 24 |  |  |  |  |  |  |  |  |
| n39 | 15 | 25 | 501 | 751 | 1001 | 1281 | 160 | 216 |  |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 | 641 | 751 | 1001 |  |  |  |  |  |
| 60 |  | 101 | 18 | 24 | 301 | 361 | 501 |  |  |  |  |  |
| n40 | 15 | 25 | 501 | 751 | 1001 | 1281 | 160 | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 | 641 | 751 | 1001 | 1281 | 162 | 2161 |  |  |
| 60 |  | 101 | 18 | 24 | 301 | 361 | 501 | 641 | 751 | 1001 |  |  |
| n41 | 15 |  | 501 | 751 | 1001 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 |  |  | 1001 | 1281 | 162 | 2161 | 2431 | 2701 |
| 60 |  | 101 | 18 | 24 |  |  | 501 | 641 | 751 | 1001 | 1201 | 135 |
| n50 | 15 | 25 | 501 | 751 | 1001 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 |  |  | 1001 | 1281 | 162 | NOTE 3 |  |  |
| 60 |  | 101 | 18 | 24 |  |  | 501 | 641 | 751 | NOTE 3 |  |  |
| n51 | 15 | 25 |  |  |  |  |  |  |  |  |  |  |  | TDD |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| n66 | 15 | 25 | 501 | 751 | 1001 |  |  | 216 |  |  |  |  |  | FDD |
| 30 |  | 24 | 361 | 501 |  |  | 1001 |  |  |  |  |  |
| 60 |  | 101 | 18 | 24 |  |  | 501 |  |  |  |  |  |
| n70 | 15 | 25 | 501 | 751 | NOTE 3 | NOTE 3 |  |  |  |  |  |  |  | FDD |
| 30 |  | 24 | 361 | NOTE 3 | NOTE 3 |  |  |  |  |  |  |  |
| 60 |  | 101 | 18 | NOTE 3 | NOTE 3 |  |  |  |  |  |  |  |
| n71 | 15 | 25 | 251 | 201 | 201 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 121 | 101 | 101 |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |
| N74 | 15 | 25 | 251 | 251 | 251 |  |  |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 101 | 101 |  |  |  |  |  |  |  |  |
| 60 |  | 51 | 51 | 51 |  |  |  |  |  |  |  |  |
| n77 | 15 |  | 501 | 751 | 1001 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 |  |  | 1001 | 1281 | 162 | 2161 | 2431 | 2701 |
| 60 | - | 101 | 18 | 24 |  |  | 501 | 641 | 751 | 1001 | 1201 | 135 |
| n77 (3.8 to 4.2 GHz) | 15 |  | 501 | 751 | 1001 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 |  |  | 1001 | 1281 | 162 | 2161 | 2431 | 2701 |
| 60 |  | 101 | 18 | 24 |  |  | 501 | 641 | 751 | 1001 | 1201 | 135 |
| n78 | 15 |  | 501 | 751 | 1001 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 361 | 501 |  |  | 1001 | 1281 | 162 | 2161 | 2431 | 2701 |
| 60 |  | 101 | 18 | 24 |  |  | 501 | 641 | 751 | 1001 | 1201 | 135 |
| n79 | 15 |  |  |  |  |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  |  |  |  |  |  | 1001 | 1281 | 162 | 2161 |  | 2701 |
| 60 |  |  |  |  |  |  | 501 | 641 | 751 | 1001 |  | 135 |
| NOTE 1: 1 Refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3.2-1).  NOTE 2: 2 refers to Band 20; for 15kHz SCS, in the case of 15MHz channel bandwidth, the UL resource blocks shall be located at RBstart 11 and in the case of 20MHz channel bandwidth, the UL resource blocks shall be located at RBstart 16; for 30kHz SCS, in the case of 15MHz channel bandwidth, the UL resource blocks shall be located at RBstart 6 and in the case of 20MHz channel bandwidth, the UL resource blocks shall be located at RBstart 8; for 60kHz SCS, in the case of 15MHz channel bandwidth, the UL resource blocks shall be located at RBstart 3 and in the case of 20MHz channel bandwidth, the UL resource blocks shall be located at RBstart 4;  NOTE 3: For DL channel bandwidths that do not have symmetric UL channel bandwidth, highest valid UL configuration with lowest duplex distance shall be used. | | | | | | | | | | | | | | |

Unless given by Table 7.3.2-4, the minimum requirements specified in Tables 7.3.2-1 and 7.3.2-2 shall be verified with the network signalling value NS\_01 (Table 6.2.3-1) configured.

Table 7.3.2-4: Network signaling value for reference sensitivity

|  |  |
| --- | --- |
| Operating band | Network Signalling value |
| n2 | NS\_03 |
| n12 | NS\_06 |
| n25 | NS\_03 |
| n66 | NS\_03 |
| n70 | NS\_03 |
| n71 | NS\_35 |

### 7.3.3 ΔRIB,c

<Editor’s note: Text to be added >

## 7.3A Reference sensitivity for CA

### 7.3A.1 General

The reference sensitivity power level REFSENS is the minimum mean power applied to each one of the UE antenna ports for all UE categories, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

### 7.3A.2 Reference sensitivity power level for CA

#### 7.3A.2.1 Reference sensitivity power level for Intra-band contiguous CA

For intra-band contiguous carrier aggregation, the throughput of each component carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal) with peak reference sensitivity specified in Table 7.3.2-1.

#### 7.3A.2.2 Reference sensitivity power level for Intra-band non-contiguous CA

#### 7.3A.2.3 Reference sensitivity power level for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal) with parameters specified in Table 7.3.2-1, Table 7.3.2-2 and Table 7.3.2-3 modified in accordance with sub-clause 7.3A.3.2. The reference sensitivity is defined to be met with all downlink component carriers active and one of the uplink carriers active. Exceptions to reference sensitivity are allowed in accordance with sub-clause 7.3A.4.

### 7.3A.3 ΔRIB,c for CA

#### 7.3A.3.1 General

For a UE supporting a CA configuration, the ΔRIB,c applies for both SC and CA operation.

#### 7.3A.3.2 ΔRIB,c for Inter-band CA

For the UE which supports inter-band carrier aggregation, the minimum requirement for reference sensitivity in Table 7.3A.3.2-1 shall be increased by the amount given by ΔRIB,c defined in subclause 7.3A.3.2 for the applicable operating bands.

##### 7.3A.3.2.1 ΔRIB,c for two bands

Table 7.3A.3.2.1-1: ΔRIB,c due to CA (two bands)

|  |  |  |
| --- | --- | --- |
| Inter-band CA configuration | NR Band | ΔRIB,c (dB) |
| CA\_n3-n77 | n3 | 0.2 |
| n77 | 0.5 |
| CA\_n3A-n78A | n3 | 0.2 |
| n78 | 0.5 |
| CA\_n3-n79 | n79 | 0.5 |
| CA n8A-n78A | n8 | 0.2 |
| n78 | 0.5 |
| CA\_n8-n79 | n79 | 0.5 |
| CA n28-n75 | n28 | 0.2 |
| CA\_n28A-n78A | n28 | 0.2 |
| n78 | 0.5 |
| CA\_n41A-n78A1 | n78 | 0.5 |
| CA\_n75A-n78A | n78 | 0.5 |
| CA\_n76A-n78A | n78 | 0.5 |
| NOTE 1: The requirements only apply when the sub-frame and Tx-Rx timings are synchronized between the component carriers. In the absence of synchronization, the requirements are not within scope of these specifications. | | |

##### 7.3A.3.2.2 ΔRIB,c for three bands

Table 7.3A.3.2.2-1: ΔRIB,c due to CA (three bands)

|  |  |  |
| --- | --- | --- |
| Inter-band CA configuration | NR Band | ΔRIB,c (dB) |
|  |  |  |
|  |  |
|  |  |

### 7.3A.4 Reference sensitivity exceptions due to UL harmonic interference for CA

Sensitivity degradation is allowed for a band in frequency range 1 if it is impacted by UL harmonic interference from another band in frequency range 1 of the same CA configuration. Reference sensitivity exceptions are specified in Table 7.3A.4-1 with uplink configuration specified in Table 7.3A.4-2.

Table 7.3A.4-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MSD due to harmonic exception for the DL band | | | | | | | | | | | | | |
| UL band | DL band | **5 MHz** | **10 MHz** | **15 MHz** | **20 MHz** | **25 MHz** | **30 MHz** | **40 MHz** | **50 MHz** | **60 MHz** | **80 MHz** | **90 MHz** | **100 MHz** |
| dB | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB |
| n3 | n771,2 |  | 23.9 | 22.1 | 20.9 |  |  | 17.9 | 16.9 | 16.1 |  |  |  |
| n773 |  | 1.1 | 0.8 | 0.3 |  |  |  |  |  |  |  |  |
| n3 | n781,2 |  | 23.9 | 22.1 | 20.9 |  |  | 17.9 | 16.9 | 16.1 |  |  |  |
| n783 |  | 1.1 | 0.8 | 0.3 |  |  |  |  |  |  |  |  |
| n8 | n784,5 |  | 10.8 | 9.1 | 8.0 |  |  | 5.1 | 4.2 | 3.5 | 2.3 |  | 1.4 |
| n8 | n781,2 |  | 10.8 | 9.1 | 8 |  |  | 3.5 | 2.3 | 1.4 |  |  |  |
| n8 | n791,2 |  |  |  |  |  |  | [6.8] | 6.2 | [5.6] | 4.9 |  | 4.4 |
| n28 | n751,2 | 28.1 | 25.3 | 24.0 | 22.8 |  |  |  |  |  |  |  |  |
| n781,2 |  | [10.4] | [8.9] | [7.8] |  |  | [4.7] | [3.7] | [3] | [1.7] | [1.2] | [0.7] |
| NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.  NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band.  NOTE 3: The requirements are only applicable to channel bandwidths with a carrier frequency at  MHz offset from  in the victim (higher band) with , whereandare the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.  NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a high band.  NOTE 5: The requirements should be verified for UL NR‑ARFCN of a low band (superscript LB) such that in MHz and  with the carrier frequency of a high band in MHz and  the channel bandwidth configured in the low band. | | | | | | | | | | | | | |

Table 7.3A.4-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band / Channel bandwidth of the high band | | | | | | | | | | | | | |
| UL band | DL band | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| n3 | n77 |  | 26 | 39 | 53 |  |  | 106 | 133 | 160 |  |  |  |
| n3 | n78 |  | 26 | 39 | 53 |  |  | 106 | 133 | 160 |  | 25 |  |
| n8 | n78 |  | 16 | 25 | 25 |  |  | 25 | 25 | 25 | 25 | 25 | 25 |
| n8 | n79 |  |  |  |  |  |  | 25 | 25 | 25 | 25 |  | 25 |
| n28 | n75 | 12 | 25 | 36 | 50 |  |  |  |  |  |  |  |  |
| n28 | n78 | 5 | 10 | 15 | 20 |  |  |  |  |  |  |  |  |
| NOTE: 15kHz SCS is assumed for UL band. | | | | | | | | | | | | | |

For unsynchronized operation, Rx de-sensing in one band will be caused by another band due to lack of isolation in the band filters. Reference sensitivity exceptions for cross band are specified in Table 7.3A.4-3 with uplink configuration specified in Table 7.3A.4-4.

Table 7.3A.4-3: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel bandwidth | | | | | | | | | | | | |
| NR CA Configuration | NR band | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz | Duplex mode |
| CA\_n41A-n78A | n41 |  | -90.3 | -88.5 | -87.3 | -84.1 | -83.1 |  |  |  |  | TDD |

Table 7.3A.4-3a: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band / Channel bandwidth of the high band | | | | | | | | | | | | | | |
| UL band | DL band | SCS (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| n78 | n41 | 30 | N/A | 273 | 273 | 273 | N/A | N/A | 273 | 273 | 273 | 273 | 273 | 273 |

Table 7.3A.4-4: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | 5 MHz  (dB) | 10 MHz  (dB) | 15 MHz  (dB) | 20 MHz  (dB) | 25 MHz  (dB) | 40 MHz  (dB) | 50 MHz  (dB) | 60 MHz  (dB) | 80 MHz  (dB) | 90 MHz  (dB) | 100 MHz  (dB) |
| n41 | n781 | N/A | 8.3 | 8.0 | 6.9 | N/A | 3.9 | 3 | 2.3 | 1.2 |  | 0.4 |
| n78 | n412 | N/A | 10.4 | 10.4 | 10.4 | N/A | 7.2 | 6.2 | 5.5 | 4.5 |  | 4.5 |
| NOTE 1: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band.  NOTE 2: The requirements should be verified for UL EARFCN of the aggressor (high) band (superscript HB) such that in MHz and  with carrier frequency in the victim (lower) band in MHz and  the channel bandwidth configured in the higher band. | | | | | | | | | | | | |

Table 7.3A.4-4a: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | SCS  (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| n41 | n78 | 30 | N/A | 24 | 24 | 24 | N/A | 24 | 24 | 24 | 24 | 24 | 24 |
| n78 | n41 | 30 | N/A | 50 | 50 | 50 | N/A | 50 | 50 | 50 | 50 | 50 | 50 |

### 7.3A.5 Reference sensitivity exceptions due to intermodulation interference due to 2UL CA

For inter-band carrier aggregation with uplink assigned to two NR bands given in Table 7.3A.5-1 the reference sensitivity is defined only for the specific uplink and downlink test points specified in Table 7.3A.5-1. For these test points the reference sensitivity requirement specified in Table 7.3.2-1 and Table 7.3.2-2 are relaxed by the amount of the corresponding parameter MSD given in Table 7.3A.5-1.

Table 7.3A.5-1: 2DL/2UL interband Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| NR CA  Configuration | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |  |
| CA\_n3A-n78A | n3 | 1740 | 5 | 25 | 1835 | [26] | FDD | IMD24 |
| [28.75] |
| n78 | 3575 | 10 | 25 | 3575 | N/A | TDD | N/A |
| CA\_n3A-n78A | n3 | 1765 | 5 | 25 | 1860 | [8.0] | FDD | IMD44 |
| [10.75] |
| n78 | 3435 | 10 | 25 | 3435 | N/A | TDD | N/A |
| CA\_n8A-n78A | n8 | 897.5 | 5 | 25 | 942.5 | 8.3 | FDD | IMD4 |
| n78 | 3635 | 10 | 52 | 3635 | N/A | TDD | N/A |
| NOTE 1: Both of the transmitters shall be set min(+20 dBm, PCMAX\_L,f,c) as defined in subclause 6.2A.4  NOTE 2: RBSTART = 0, 15kHz SCS is assumed.  NOTE 3: No requirements apply when there is at least one individual RE within the intermodulation generated by the dual uplink is within the downlink transmission bandwidth of the FDD band. The reference sensitivity should only be verified when this is not the case (the requirements specified in clause 7.3 apply).  NOTE4: This band is subject to IMD5 also which MSD is not specified.  NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured. | | | | | | | | |

## 7.3B Reference sensitivity for DC

## 7.3C Reference sensitivity for SUL

### 7.3C.1 General

The reference sensitivity power level REFSENS is the minimum mean power applied to each one of the UE antenna ports for all UE categories, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

### 7.3C.2 Reference sensitivity power level for SUL

For SUL operation, the reference receive sensitivity (REFSENS) requirement for downlink bands specified in Table 7.3.2-1 shall be met for an uplink transmission bandwidth less than or equal to that specified in Table 7.3.2-3 or supplementary uplink transmission bandwidth less than or equal to that specified in Table 7.3C.2-1.

Table 7.3C.2-1: Supplementary Uplink configuration for reference sensitivity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Downlink band/ Uplink band / Channel bandwidth / NRB | | | | | |
| Downlink band | Uplink band | 5  MHz | 10  MHz | 15  MHz | 20  MHz |
| n78 | n80 | 25 | 52 | 79 | 106 |
| n78 | n81 | 25 | 52 | 79 | 106 |
| n78 | n82 | 25 | 52 | 79 | 106 |
| n78 | n83 | 25 | 52 | 79 | 106 |
| n78 | n84 | 25 | 52 | 79 | 106 |
| n78 | n86 | 25 | 52 | 79 | 106 |
| n79 | n80 | 25 | 52 | 79 | 106 |
| n79 | n81 | 25 | 52 | 79 | 106 |

For the UE that supports any of the SUL operation given in Table 7.3C.2-2, exceptions to the requirements specified in Table 7.3.2-1are allowed when the uplink is active in a lower frequency band and is within a specified frequency range such that transmitter harmonics fall within the downlink transmission bandwidth assigned in a higher band as noted in Table 7.3C.2-2. For these exceptions, the UE shall meet the requirements specified in Table 7.3C.2-2 and Table 7.3C.2-3.

Table 7.3C.2-2: Reference sensitivity for SUL operation (exceptions due to harmonic issue)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | **5 MHz** | **10 MHz** | **15 MHz** | **20 MHz** | **25 MHz** | 30 MHz | **40 MHz** | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| dB | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB |
| n80 | n781,2 |  | 23.9 | 22.1 | 20.9 |  |  | 17.9 |  |  |  |  |  |
| n783 |  | 1.1 | 0.8 | 0.3 |  |  |  |  |  |  |  |  |
| n82 | n784,5 |  | 10.8 | 9.1 | 8 |  |  | 6 |  |  |  |  |  |
| n81 | n781,2 |  | 10.8 | 9.1 | 8 |  |  | 5.1 | 4.2 | 3.5 | 2.3 |  | 1.4 |
| n81 | n786,7 |  | 10.4 | 8.9 | 7.8 |  |  | 4.7 | 3.7 | 3 | 1.7 | 1.2 | 0.7 |
| n86 | n781,2 |  | 23.9 | 22.1 | 20.9 |  |  | 17.9 |  |  |  |  |  |
| n783 |  | 1.1 | 0.8 | 0.3 |  |  |  |  |  |  |  |  |
| n81 | n796,7 |  |  |  |  |  |  | [6.8] | 6.2 | [5.6] | 4.9 |  | 4.4 |
| NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.  NOTE 2: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band.  NOTE 3: The requirements are only applicable to channel bandwidths with a carrier frequency at  MHz offset from  in the victim (higher band) with , whereandare the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.  NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.  NOTE 5: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band.  NOTE 6: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band.  NOTE 7: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band. | | | | | | | | | | | | | |

Table 7.3C.2-3: Supplementary Uplink configuration (exceptions due to harmonic issue)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band / Channel bandwidth of the high band | | | | | | | | | | | | | |
| UL band | DL band | 5 MHz (NRB) | 10 MHz (NRB) | 15 MHz (NRB) | 20 MHz (NRB) | 25 MHz (NRB) | 30 MHz (NRB) | 40 MHz (NRB) | 50 MHz (NRB) | 60 MHz (NRB) | 80 MHz (NRB) | 90 MHz (NRB) | 100 MHz (NRB) |
| n80 | n78 |  | 25 | 36 | 50 |  |  | 100 |  |  |  |  |  |
| n81 | n78 |  | 16 | 25 | 25 |  |  | 25 | 25 | 25 | 25 | 25 | 25 |
| n81 | n79 |  |  |  |  |  |  | 25 | 25 | 25 | 25 | 25 | 25 |
| n83 | n78 |  | 10 | 15 | 20 |  |  | 25 | 25 | 25 | 25 | 25 | 25 |
| n86 | n78 |  | 26 | 39 | 53 |  |  | 100 |  |  |  |  |  |

### 7.3C.3 ΔRIB,c for SUL

#### 7.3C.3.1 General

For a UE supporting a SUL configuration, the ΔRIB,c applies for both SC and SUL operation.

#### 7.3C.3.2 SUL band combination

For the UE which supports SUL band combiantion, the minimum requirement for reference sensitivity in Table 7.3C.2-1 shall be increased by the amount given in ΔRIB,c defined in subclause 7.3C.3.2 for the applicable operating bands.

##### 7.3C.3.2.1 ΔRIB,c for two bands

Table 7.3C.3.2.1-1: ΔRIB,c due to SUL (two bands)

|  |  |  |
| --- | --- | --- |
| Band combination for SUL | NR Band | ΔRIB,c (dB) |
| SUL\_n78-n80 | n78 | 0.5 |
| n80 | 0.2 |
| SUL\_n78-n81 | n78 | 0.2 |
| n81 | 0.2 |
| SUL\_n78-n82 | n78 | 0.5 |
| SUL\_n78-n83 | n78 | 0.5 |
| n83 | 0.2 |
| SUL\_n78-n84 | n78 | 0.5 |
| SUL\_n78-n86 | n78 | 0.5 |
| n86 | 0.2 |

## 7.3D Reference sensitivity for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements specified in subclause 7.3 shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1. For UL-MIMO, the parameter PUMAX is the total transmitter power over the two transmits power over the two transmit antenna connectors.

## 7.4 Maximum input level

Maximum input level is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel. The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.4-1.

Table 7.4-1: Maximum input level

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rx Parameter | Units | Channel bandwidth | | | | | | | | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| Power in Transmission Bandwidth Configuration | dBm | -252 | | | | -242 | -232 | -222 | -212 | -202 | | | |
| -273 | | | | -263 | -253 | -243 | -233 | -223 | | | |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3-3 with PCMAX\_L as defined in subclause 6.2.4.  NOTE 2: Reference measurement channel is [TBD] for 64-QAM.  NOTE 3: Reference measurement channel is [TBD] for 256-QAM. | | | | | | | | | | | | | |

## 7.4A Maximum input level for CA

### 7.4A.1 Maximum input level for Intra-band contiguous CA

For carrier aggregation maximum input level is defined as the exact wording TBD, over the aggregated receiver bandwidth, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel over each component carrier. The minimum requirement is the same as the one specified in Table 7.4-1.

### 7.4A.2 Maximum input level for Intra-band non-contiguous CA

### 7.4A.3 Maximum input level for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the maximum input level is defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.4 for each component carrier while all downlink carriers are active.

## 7.4D Maximum input level for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing, the minimum requirements specified in sub-clause 7.4 shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1. For UL-MIMO, the parameter PCMAX\_L is defined as the total transmitter power over the two transmit antenna connectors.

## 7.5 Adjacent channel selectivity

Adjacent channel selectivity (ACS) is a measure of a receiver's ability to receive an NR signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The UE shall fulfil the minimum requirements specified in Table 7.5-1 for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz and the minimum requirements specified in Table 7.5-2. for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz. These requirements apply for all values of an adjacent channel interferer up to -25 dBm and for any SCS specified for the channel bandwidth of the wanted signal. However, it is not possible to directly measure the ACS; instead the lower and upper range of test parameters are chosen as in Table 7.5-3 and Table 7.5-4 for verification of the requirements specified in Table 7.5-1 and as in Table 7.5-5, and Table 7.5-6 for verification of the requirements specified in Table 7.5-2. For these test parameters, the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in [Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1)]. For operating bands with an unpaired DL part (as noted in [Table 5.5-1]), the requirements only apply for carriers assigned in the paired part.

Table 7.5-1: ACS for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| ACS | dB | [33] | [33] | [30] | [27] | [26] |
| RX parameter | Units | Channel bandwidth | | | | |
| 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz |
| ACS | dB | [25.5] | [24] | [23] | [22.5] | [21] |
| RX parameter | Units | Channel bandwidth | | | | |
| 90 MHz | 100 MHz |  |  |  |
| ACS | dB | [20.5] | [20] |  |  |  |

Table 7.5-2: ACS for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| ACS | dB | [33] | [33] | [33] | [33] | [33] |
| RX parameter | Units | Channel bandwidth | | | | |
| 60 MHz | 80 MHz | 90 MHz | 100 MHz |  |
| ACS | dB | [33] | [33] | [33] | [33] |  |

Table 7.5-3: Test parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz, case 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | | | | |
| Pinterferer | dBm | REFSENS + [45.5] dB | REFSENS + [45.5] dB | REFSENS + [42.5] dB | REFSENS + [39.5] dB | REFSENS + [38.5] dB |
| BWinterferer | MHz | 5 | 5 | 5 | 5 | 5 |
| Finterferer (offset) | MHz | 5 / -5 | 7.5 / -7.5 | 10 / -10 | 12.5 / -12.5 | 15 / -15 |
| RX parameter | Units | Channel bandwidth | | | | |
| 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | | | | |
| Pinterferer | dBm | REFSENS + [38] dB | REFSENS + [36.5] dB | REFSENS + [35.5] dB | REFSENS + [35] dB | REFSENS + [33.5] dB |
| BWinterferer | MHz | 5 | 5 | 5 | 5 | 5 |
| Finterferer (offset) | MHz | 17.5 / -17.5 | 22.5 / -22.5 | 27.5 / -27.5 | 32.5  /  -32.5 | 42.5  /  -42.5 |
| RX parameter | Units | Channel bandwidth | | | | |
| 90 MHz | 100 MHz |  |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | |  |  |  |
| Pinterferer | dBm | REFSENS + [33] dB | REFSENS + [32.5] dB |  |  |  |
| BWinterferer | MHz | 5 | 5 |  |  |  |
| Finterferer (offset) | MHz | 47.5  /  -47.5 | 52.5  /  -52.5 |  |  |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the NR interferer RMC specified in […] | | | | | | |

Table 7.5-4: Test parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz, case 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | [-56.5] | [-56.5] | [-53.5] | [-50.5] | [-49.5] |
| Pinterferer | dBm | -25 | | | | |
| BWinterferer | MHz | 5 | 5 | 5 | 5 | 5 |
| Finterferer (offset) | MHz | 5 / -5 | 7.5 / -7.5 | 10 / -10 | 12.5 / -12.5 | 15 / -15 |
| RX parameter | Units | Channel bandwidth | | | | |
| 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz |
| Power in transmission bandwidth configuration | dBm | [-49] | [-47] | [-46.5] | [-46] | [-44.5] |
| Pinterferer | dBm | -25 | | | | |
| BWinterferer | MHz | 5 | 5 | 5 | 5 | 5 |
| Finterferer (offset) | MHz | 17.5 / -17.5 | 22.5 / -22.5 | 27.5 / -27.5 | 32.5  /  -32.5 | 42.5  /  -42.5 |
| RX parameter | Units | Channel bandwidth | | | | |
| 90 MHz | 100 MHz |  |  |  |
| Power in transmission bandwidth configuration | dBm | [-44] | [-43.5] |  |  |  |
| Pinterferer | dBm | -25 | |  |  |  |
| BWinterferer | MHz | 5 | 5 |  |  |  |
| Finterferer (offset) | MHz | 47.5  /  -47.5 | 52.5  /  -52.5 |  |  |  |
| NOTE 1: The transmitter shall be set to 24 dB below […].  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in […] | | | | | | |

Table 7.5-5: Test parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | | | | |
| Pinterferer | dBm | REFSENS + [45.5] dB | | | | |
| BWinterferer | MHz | 10 | 15 | 20 | 40 | 50 |
| Finterferer (offset) | MHz | 10 / -10 | 15 / -15 | 20 / -20 | 40 / -40 | 50 / -50 |
| RX parameter | Units | Channel bandwidth | | | | |
| 60 MHz | 80 MHz | 90 MHz | 100 MHz |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | | | |  |
| Pinterferer | dBm | REFSENS + [45.5] dB | REFSENS + [45.5] dB | REFSENS + [45.5] dB | REFSENS + [45.5] dB |  |
| BWinterferer | MHz | 60 | 80 | 90 | 100 |  |
| Finterferer (offset) | MHz | 60 / -60 | 80 / -80 | 90 / -90 | 100 / -100 |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in […] | | | | | | |

Table 7.5-6: Test parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | [-56.5] | | | | |
| Pinterferer | dBm | -25 | | | | |
| BWinterferer | MHz | 10 | 15 | 20 | 40 | 50 |
| Finterferer (offset) | MHz | 10 / -10 | 15 / -15 | 20 / -20 | 40 / -40 | 50 / -50 |
| RX parameter | Units | Channel bandwidth | | | | |
| 60 MHz | 80 MHz | 90 MHz | 100 MHz |  |
| Power in transmission bandwidth configuration | dBm | [-56.5] | | | |  |
| Pinterferer | dBm | -25 | -25 | -25 | -25 |  |
| BWinterferer | MHz | 60 | 80 | 90 | 100 |  |
| Finterferer (offset) | MHz | 60 / -60 | 80 / -80 | 90 / -90 | 100 / -100 |  |
| NOTE 1: The transmitter shall be set to 24 dB below […].  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in […] | | | | | | |

## 7.5A Adjacent channel selectivity for CA

### 7.5A.1 Adjacent channel selectivity for Intra-band contiguous CA

For intra-band contiguous carrier aggregation with two component carriers and aggregated bandwidth BWChannel\_CA shall be configured at nominal channel spacing tothe PCC. The UE shall fulfil the minimum requirement specified in Table 7.5A.1-1 for an adjacent channel interferer on either side of the aggregated downlink signal at a specified frequency offset and for an interferer power up to -25 dBm.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X) with parameters specified in Tables 7.5A.1-2 and 7.5A.1-3.

Table 7.5A.1-1: ACS for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz |
| ACS | dB | [33] | [33] | [33] | [33] | [33] |
| RX parameter | Units | Channel bandwidth | | | | |
| 160 MHz | 180 MHz | 200 MHz |  |  |
| ACS | dB | [33] | [33] | [33] |  |  |

Table 7.5A.1-2: Test parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | | | | |
| Pinterferer | dBm | REFSENS + [45.5] dB | | | | |
| BWinterferer | MHz | 110 | 120 | 130 | 140 | 150 |
| Finterferer (offset) | MHz | 110 / -110 | 120 / -120 | 130 / -130 | 140 / -140 | 150 / -150 |
| RX parameter | Units | Channel bandwidth | | | | |
| 160 MHz | 180 MHz | 200 MHz |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | REFSENS + 14 dB | REFSENS + 14 dB |  |  |
| Pinterferer | dBm | REFSENS + [45.5] dB | REFSENS + [45.5] dB | REFSENS + [45.5] dB |  |  |
| BWinterferer | MHz | 160 | 180 | 200 |  |  |
| Finterferer (offset) | MHz | 160 / -160 | 180 / -180 | 200 / -200 |  |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in […] | | | | | | |

Table 7.5A.1-3: Test parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz |
| Power in transmission bandwidth configuration | dBm | [-56.5] | | | | |
| Pinterferer | dBm | -25 | | | | |
| BWinterferer | MHz | 110 | 120 | 130 | 140 | 150 |
| Finterferer (offset) | MHz | 110 / -110 | 120 / -120 | 130 / -130 | 140 / -140 | 150 / -150 |
| RX parameter | Units | Channel bandwidth | | | | |
| 160 MHz | 180 MHz | 200 MHz |  |  |
| Power in transmission bandwidth configuration | dBm | [-56.5] | [-56.5] | [-56.5] |  |  |
| Pinterferer | dBm | -25 | -25 | -25 |  |  |
| BWinterferer | MHz | 160 | 180 | 200 |  |  |
| Finterferer (offset) | MHz | 160 / -160 | 180 / -180 | 200 / -200 |  |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in […] | | | | | | |

### 7.5A.2 Adjacent channel selectivity Intra-band non-contiguous CA

Detailed structure of the subclause is TBD.

### 7.5A.3 Adjacent channel selectivity Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the adjacent channel requirements are defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.5 for each component carrier while all downlink carriers are active.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

## 7.5D Adjacent channel selectivity for UL-MIMO

For UE(s) with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements specified in sub-clause 7.5 shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1. For UL-MIMO, the parameter PCMAX\_L is defined as the total transmitter power over the two transmit antenna connectors.

## 7.6 Blocking characteristics

### 7.6.1 General

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occurs.

### 7.6.2 In-band blocking

For NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 in-band blocking (IBB)is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band. The throughput of the wanted signal shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.2-1 and Table 7.6.2-2. The said relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

Table 7.6.2-1: In-band blocking parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 6 | 7 | 9 | 10 |
| BWinterferer | MHz | 5 | | | | |
| FIoffset, case 1 | MHz | 7.5 | | | | |
| FIoffset, case 2 | MHz | 12.5 | | | | |
| RX parameter | Units | Channel bandwidth | | | | |
| 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 11 | 12 | 13 | 14 | 15 |
| BWinterferer | MHz | 5 | | | | |
| FIoffset, case 1 | MHz | 7.5 | | | | |
| FIoffset, case 2 | MHz | 12.5 | | | | |
| RX parameter | Units | Channel bandwidth | | | | |
| 90 MHz | 100 MHz |  |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | |  |  |  |
|  | dB | 15.5 | 16 |  |  |  |
| BWinterferer | MHz | 5 | |  |  |  |
| FIoffset, case 1 | MHz | 7.5 | |  |  |  |
| FIoffset, case 2 | MHz | 12.5 | |  |  |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The interferer consists of the RMC specified in […] | | | | | | |

Table 7.6.2-2: In-band blocking for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 | Case 3 |
| Pinterferer | dBm | -56 | -44 | -15 |
| n1, n2, n3, n5, n7, n8, n12, n20, n25, n28,  n34, n38,  n39, n40, n41, n50, n51, n66, n70, n74, n75, n76 | Finterferer (offset) | MHz | -CBW/2 –  FIoffset, case 1  and  CBW/2 +  FIoffset, case 1 | ≤ -CBW/2 –  FIoffset, case 2  and  ≥ CBW/2 +  FIoffset, case 2 |  |
| Finterferer | MHz | NOTE 2 | FDL\_low – 15  to  FDL\_high + 15 |  |
| n71 | Finterferer | MHz | NOTE 2 | FDL\_low – 12 to FDL\_high + 15 | FDL\_low – 12 |
| NOTE 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -CBW/2 – FIoffset, case 1; b: CBW/2 + FIoffset, case 1 | | | | | |

For NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz in-band blocking (IBB) is defined for an unwanted interfering signal falling into the UE receive band or into an immediately adjacent frequency range up 3CBW below or above the UE receive band with CBW is the bandwidth of the wanted signal. The throughput of the wanted signal shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in [Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1)] with parameters specified in Table 7.6.2-3 and Table 7.6.2-4. The said relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal.

Table 7.6.2-3: In-band blocking parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | | | | |
| BWinterferer | MHz | 10 | 15 | 20 | 40 | 50 |
| FIoffset, case 1 | MHz | 15 | 22.5 | 30 | 60 | 75 |
| FIoffset, case 2 | MHz | 25 | 37.5 | 50 | 100 | 125 |
| RX parameter | Units | Channel bandwidth | | | | |
| 60 MHz | 80 MHz | 90 MHz | 100 MHz |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | |  |
| dB | 6 | | | |  |
| BWinterferer | MHz | 60 | 80 | 90 | 100 |  |
| FIoffset, case 1 | MHz | 90 | 120 | 135 | 150 |  |
| FIoffset, case 2 | MHz | 150 | 200 | 225 | 250 |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The interferer consists of the RMC specified in […] | | | | | | |

Table 7.6.2-4: In-band blocking for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 |
| Pinterferer | dBm | -56 | -44 |
| n77, n78, n79 | Finterferer (offset) | MHz | -CBW/2 –  FIoffset, case 1  and  BW/2 +  FIoffset, case 1 | ≤ -CBW/2 –  FIoffset, case 2  and  ≥ CBW/2 +  FIoffset, case 2 |
| Finterferer |  | NOTE 2 | FDL\_low – 3CBW  to  FDL\_high + 3CBW |
| NOTE 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -CBW/2 – FIoffset, case 1; b: CBW/2 + FIoffset, case 1  NOTE 3: CBW denotes the channel bandwidth of the wanted signal | | | | |

### 7.6.3 Out-of-band blocking

For NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range 15 MHz below or above the UE receive band. The throughput of the wanted signal shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.3-1 and Table 7.6.3-2. The said relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

Table 7.6.3-1: Out-of-band blocking parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 6 | 7 | 9 | 10 |
| RX parameter | Units | Channel bandwidth | | | | |
| 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 11 | 12 | 13 | 14 | 15 |
| RX parameter | Units | Channel bandwidth | | | | |
| 90 MHz | 100 MHz |  |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | |  |  |  |
| dB | 15.5 | 16 |  |  |  |
| NOTE: The transmitter shall be set to 4dB below …. | | | | | | |

Table 7.6.3-2: Out of-band blocking for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Range 1 | Range 2 | Range 3 |
| n1, n2, n3, n5, n7, n8, n12, n20, n25, n28,  n34, n38,  n39, n40, n41, n50, n51, n66, n70, n71, n74, n75, n76 | Pinterferer | dBm | -44 | -30 | -15 |
| Finterferer (CW) | MHz | -60 < f – FDL\_low < -15  or  15 < f – FDL\_high < 60 | -85 < f – FDL\_low ≤ -60  or  60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 85  or  FDL\_high + 85 ≤ f  ≤ 12750 |
| NOTE: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 6000 MHz. | | | | | |

For interferer frequencies across ranges 1, 2 and 3 in Table 7.6.3-2, a maximum of



exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of  MHz withthe number of resource blocks in the downlink transmission bandwidth configuration, the bandwidth of the frequency channel in MHz and *n* = 1,2,3 for SCS = 15,30,60 kHz, respectively. For these exceptions, the requirements in sub-clause 7.7 apply.

For NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range up to 3CBW below or from 3CBW above the UE receive band, where CBW is the channel bandwidth. The throughput of the wanted signal shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.3-3 and Table 7.6.3-4. The said relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal.

Table 7.6.3-3: Out-of-band blocking parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 7 | 9 | 9 | 9 |
| RX parameter | Units | Channel bandwidth | | | | |
| 60 MHz | 80 MHz | 90 MHz | 100 MHz |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | |  |
| dB | 9 | 9 | 9 | 9 |  |
| NOTE: The transmitter shall be set to 4dB below …. | | | | | | |

Table 7.6.3-4: Out of-band blocking for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Range1 | Range 2 | Range 3 |
| n77, n78  (NOTE 3) | Pinterferer | dBm | -44 | -30 | -15 |
| Finterferer (CW) | MHz | -60 < f – FDL\_low ≤ -3CBW  or  3CBW ≤ f – FDL\_high < 60 | -200 < f – FDL\_low ≤ -MAX(60,3CBW)  or  MAX(60,3CBW) ≤ f – FDL\_high < 200 | 1 ≤ f ≤ FDL\_low – MAX(200,3CBW)  or  FDL\_high + MAX(200,3CBW)  ≤ f ≤ 12750 |
| n79  (NOTE 4) | Finterferer (CW) | MHz | N/A | -150 < f – FDL\_low ≤ -MAX(60,3CBW)  or  MAX(60,3CBW) ≤ f – FDL\_high < 150 | 1 ≤ f ≤ FDL\_low – MAX(150,3CBW)  or  FDL\_high + MAX(150,3CBW)  ≤ f ≤ 12750 |
| NOTE 1: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 6000 MHz.  NOTE 2: CBW denotes the channel bandwidth of the wanted signal  NOTE 3: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 2700 MHz and FInterferer < 4800 MHz. For CBW > 15 MHz, the requirement for Range 1 is not applicable and Range 2 applies from the frequency offset of 3CBW from the band edge. For CBW larger than 60 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3CBW from the band edge.  NOTE 4: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 3650 MHz and FInterferer < 5750 MHz. For CBW ≥ 40 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3CBW from the band edge. | | | | | |

For interferer frequencies across ranges 1, 2 and 3 in Table 7.6.3-4, a maximum of



exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of  MHz withthe number of resource blocks in the downlink transmission bandwidth configuration, the bandwidth of the frequency channel in MHz and *n* = 1,2,3 for SCS = 15, 30, 60 kHz, respectively. For these exceptions, the requirements in sub-clause 7.7 apply.

### 7.6.4 Narrow band blocking

This requirement is measure of a receiver's ability to receive a NR signal at its assigned channel frequency in the presence of an unwanted narrow band CW interferer at a frequency, which is less than the nominal channel spacing.

The relative throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.2-1. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

Table 7.6.4-1: Narrow Band Blocking

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Channel Bandwidth | | | | | | | | | | | |
| 5 MHz | | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100MHz |
| n1,n2, n3, n5, n7, n8,  n12, n20,  n25  n28,  n34,  n38,  n39,  n40, n41,  n50, n51, n66, n70, n71,  n74,  n75, n76 | Pw | dBm |  | PREFSENS + channel-bandwidth specific value below | | | | | | | | | | |
| 16 | | 13 | 14 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Puw (CW) | dBm | -55 | | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 |
| Fuw (offset SCS= 15 kHz) | MHz | 2.7075 | | 5.2125 | 7.7025 | 10.2075 | 13.0275 | 20.5575 | NA | NA | NA | NA | NA |
| Fuw (offset SCS= 30 kHz) | MHz | NA | | NA | NA | NA |  |  | TBD | TBD |  |  |  |
| NOTE 1: The transmitter shall be set a 4 dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3.1-2 with PCMAX\_L as defined in subclause 6.2.5.  NOTE 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.  NOTE 3: The PREFSENS power level is specified in Table 7.3.1-1 and Table 7.3.1-1a for two and four antenna ports, respectively. | | | | | | | | | | | | | | |

## 7.6A Blocking characteristics for CA

### 7.6A.1 General

### 7.6A.2 In-band blocking for CA

#### 7.6A.2.1 In-band blocking for Intra-band contiguous CA

For intra-band contiguous carrier aggregation with two component carriers and aggregated bandwidth BWChannel\_CA, the SCC(s) shall be configured at nominal channel spacing to the PCC. The UE shall fulfil the minimum requirement specified in Table 7.6A.2.1-1 for an adjacent channel interferer on either side of the aggregated downlink signal at a specified frequency offset and for an interferer power up to -25 dBm. The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

Table 7.6A.2.1-1: In-band blocking parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | | | | |
| BWinterferer | MHz | 110 | 120 | 130 | 140 | 150 |
| FIoffset, case 1 | MHz | 165 | 180 | 195 | 210 | 225 |
| FIoffset, case 2 | MHz | 275 | 300 | 325 | 350 | 375 |
| RX parameter | Units | Channel bandwidth | | | | |
| 160 MHz | 180 MHz | 200 MHz |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | |  |  |
| dB | 6 | 6 | 6 |  |  |
| BWinterferer | MHz | 160 | 180 | 200 |  |  |
| FIoffset, case 1 | MHz | 240 | 270 | 300 |  |  |
| FIoffset, case 2 | MHz | 400 | 450 | 500 |  |  |
| NOTE 1: The transmitter shall be set to 4dB below […].  NOTE 2: The interferer consists of the RMC specified in […] | | | | | | |

Table 7.6A.2.1-2: In-band blocking for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 |
| Pinterferer | dBm | [-56] | [-44] |
| n77, n78, n79 | Finterferer (offset) | MHz | -CBW/2 –  FIoffset, case 1  and  BW/2 +  FIoffset, case 1 | ≤ -CBW/2 –  FIoffset, case 2  and  ≥ CBW/2 +  FIoffset, case 2 |
| Finterferer |  | NOTE 2 | FDL\_low – 3CBW  to  FDL\_high + 3CBW |
| NOTE 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -CBW/2 – FIoffset, case 1; b: CBW/2 + FIoffset, case 1  NOTE 3: CBW denotes the channel bandwidth of the wanted signal | | | | |

#### 7.6A.2.2 In-band blocking for Intra-band non-contiguous CA

Detailed structure of the subclause is TBD

#### 7.6A.2.3 In-band blocking for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the in-band blocking requirements are defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.6.2 for each component carrier while all downlink carriers are active.

For the UE which supports inter-band CA configuration in Table 7.3A.3.2, Pinterferer power defined in Table 7.6.2-2 and 7.6.2-4 is increased by the amount given by ΔRIB,c in Table 7.3A.3.2.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

### 7.6A.3 Out-of-band blocking for CA

#### 7.6A.3.1 Out-of-band blocking for Intra-band contiguous CA

For intra-band contiguous carrier aggreagations the downlink SCC(s) shall be configured at nominal channel spacing to the PCC. For FDD, the PCC shall be configured closest to the uplink band. All downlink carriers shall be active throughout the test. The uplink output power shall be set as specified in Table 7.6.X with the uplink configuration set according to Table 7.3A-1 for the applicable carrier aggregation configuration. For UE(s) supporting one uplink carrier, the uplink configuration of the PCC shall be in accordance with Table 7.3-2.

The UE shall fulfil the minimum requirement in presence of an interfering signal specified in Tables 7.6.X and Tables 7.6.Y being on either side of the aggregated signal. The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes.

Details for exceptions are TBD.

Table 7.6A.3-1: Out-of-band blocking parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 9 | 9 | 9 | 9 | 9 |
| RX parameter | Units | Channel bandwidth | | | | |
| 160 MHz | 180 MHz | 200 MHz |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | REFSENS + channel specific value below | REFSENS + channel specific value below |  |  |
| dB | 9 | 9 | 9 |  |  |
| NOTE 1: The transmitter shall be set to 4dB below …. | | | | | | |

Table 7.6A.3-2: Out of-band blocking for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Range1 | Range 2 | Range 3 |
| n77, n78  (NOTE 3) | Pinterferer | dBm | -45 | -30 | -15 |
| Finterferer (CW) | MHz | N/A | N/A | 1 ≤ f ≤ FDL\_low – MAX(200,3CBW)  or  FDL\_high + MAX(200,3CBW)  ≤ f ≤ 12750 |
| n79  (NOTE 4) | Finterferer (CW) | MHz | N/A | N/A | 1 ≤ f ≤ FDL\_low – MAX(150,3CBW)  or  FDL\_high + MAX(150,3CBW)  ≤ f ≤ 12750 |
| NOTE 1: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 6000 MHz.  NOTE 2: CBW denotes the channel bandwidth of the wanted signal  NOTE 3: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 2700 MHz and FInterferer < 4800 MHz. For CBW > 15 MHz, the requirement for Range 1 is not applicable and Range 2 applies from the frequency offset of 3CBW from the band edge. For CBW larger than 60 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3CBW from the band edge.  NOTE 4: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 3650 MHz and FInterferer < 5750 MHz. For CBW ≥ 40 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3CBW from the band edge. | | | | | |

#### 7.6A.3.2 Out-of-band blocking for Intra-band non-contiguous CA

Detailed structure of the subclause is TBD

#### 7.6A.3.3 Out-of-band blocking for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the out-of-band blocking requirements are defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.6.3 for each component carrier while all downlink carriers are active.

For inter-band carrier aggregation with uplink assigned to two NR bands, the out-of-band blocking requirements specified in subclause 7.6.3 shall be met with the transmitter power for the uplink set to 7 dB below PCMAX\_L,f,c for each serving cell c.

For the UE which supports inter-band CA configuration in Table 7.3A.3.2, Pinterferer power defined in Table 7.6.3-2 and 7.6.3-4 is increased by the amount given by ΔRIB,c in Table 7.3A.3.2.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

### 7.6A.4 Narrow band blocking for CA

#### 7.6A.4.1 Narrow band blocking for Intra-band contiguous CA

Detailed structure of the subclause is TBD

#### 7.6A.4.2 Narrow band blocking for Intra-band non-contiguous CA

Detailed structure of the subclause is TBD

#### 7.6A.4.3 Narrow band blocking for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the narrow band blocking requirements are defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.6.4 for each component carrier while all downlink carriers are active.

For the UE which supports inter-band CA configuration in Table 7.3A.3.2, PUW power defined in Table 7.6.4-1 is increased by the amount given by ΔRIB,c in Table 7.3A.3.2.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

## 7.6D Blocking characteristics for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements specified in subclause 7.6 shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1. For UL-MIMO, the parameter PCMAX\_L is defined as the total transmitter power over the two transmit antenna connectors.

## 7.7 Spurious response

Spurious response is a measure of the ability of the receiver to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency forwhich a response is obtained, i.e. for which the out-of-band blocking limit as specified in subclause 7.6.3 is not met.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters for the wanted signal as specified in Table 7.7-1 for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz and in Table 7.7-1a for NR bands with FDL\_high ≥ 3300 MHz and FUL\_high ≥ 3300 MHz and for the interferer as specified in Table 7.7-2. The said relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

Table 7.7-1: Spurious response parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 6 | 7 | 9 | 10 |
| RX parameter | Units | Channel bandwidth | | | | |
| 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 11 | 12 | 13 | 14 | 15 |
| RX parameter | Units | Channel bandwidth | | | | |
| 90 MHz | 100 MHz |  |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | |  |  |  |
| dB | 15.5 | 16 |  |  |  |
| NOTE 1: The transmitter shall be set to 4dB below …. | | | | | | |

Table 7.7.1-1a: Spurious response parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 7 | 9 | 9 | 9 |
| RX parameter | Units | Channel bandwidth | | | | |
| 60 MHz | 80 MHz | 90 MHz | 100 MHz |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | |  |
| dB | 9 | 9 | 9 | 9 |  |
| NOTE 1: The transmitter shall be set to 4dB below …. | | | | | | |

Table 7.7-2: Spurious response

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Level |
| PInterferer  (CW) | dBm | -44 |
| FInterferer | MHz | Spurious response frequencies |

## 7.7A Spurious response for CA

### 7.7A.1 Spurious response for Intra-band contiguous CA

Table 7.7A-1: Spurious response parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 9 | 9 | 9 | 9 | 9 |
| RX parameter | Units | Channel bandwidth | | | | |
| 160 MHz | 180 MHz | 200 MHz |  |  |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | REFSENS + channel specific value below | REFSENS + channel specific value below |  |  |
| dB | 9 | 9 | 9 |  |  |
| NOTE 1: The transmitter shall be set to 4dB below …. | | | | | | |

Table 7.7A-2: Spurious response for CA

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Level |
| PInterferer  (CW) | dBm | -44 |
| FInterferer | MHz | Spurious response frequencies |

### 7.7A.2 Spurious response for Intra-band non-contiguous CA

Detailed structure of the subclause is TBD

### 7.7A.3 Spurious response for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the spurious response are defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.7 for each component carrier while all downlink carriers are active.

For the UE which supports inter-band CA configuration in Table 7.3A.3.2, Pinterferer power defined in Table 7.7-2 is increased by the amount given by ΔRIB,c in Table 7.3A.3.2.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

## 7.7D Spurious response for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements specified in subclause 7.7 shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1. For UL-MIMO, the parameter PCMAX\_L is defined as the total transmitter power over the two transmit antenna connectors.

## 7.8 Intermodulation characteristics

### 7.8.1 General

Intermodulation response rejection is a measure of the capability of the receiver to receiver a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal

### 7.8.2 Wide band Intermodulation

The wide band intermodulation requirement is defined using a CW carrier and modulated NR signal as interferer 1 and interferer 2 respectively.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.8.2-1 for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz and Table 7.8.2-2 for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz. The said relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

Table 7.8.1-1: Wide band intermodulation parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rx parameter | Units | Channel bandwidth | | | | | | | | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90  MHz | 100 MHz |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + channel bandwidth specific value below | | | | | | | | | | | |
| 6 | 6 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 15 | 16 |
| PInterferer 1  (CW) | | dBm |  | -46 | | | | | | | | | | |
| PInterferer 2  (Modulated) | | dBm |  | -46 | | | | | | | | | | |
| BWInterferer 2 | | MHz |  | 5 | | | | | | | | | | |
| FInterferer 1  (Offset) | | MHz |  | -BW/2 – 7.5  /  +BW/2 + 7.5 | | | | | | | | | | |
| FInterferer 2  (Offset) | | MHz |  | 2\*FInterferer 1 | | | | | | | | | | |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L,c or PCMAX\_L as defined in TBD.  NOTE 2: Reference measurement channel is TBD.  NOTE 3: The modulated interferer consists of the Reference measurement channel specified in TBD.  NOTE 4: The Finterferer 1 (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the CW interferer and Finterferer 2 (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the modulated interferer. | | | | | | | | | | | | | | |

Table 7.8.2-2: Wide band intermodulation parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rx parameter | Units | Channel bandwidth | | | | | | | |
| 10 MHz | 20 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90  MHz | 100 MHz |
| Pw in Transmission Bandwidth Configuration, per CC | dBm |  | REFSENS + 6 | | | | | | |
| PInterferer 1  (CW) | dBm |  | -46 | | | | | | |
| PInterferer 2  (Modulated) | dBm |  | -46 | | | | | | |
| BWInterferer 2 | MHz |  | BW | | | | | | |
| FInterferer 1  (Offset) | MHz |  | -2BW  /  +2BW | | | | | | |
| FInterferer 2  (Offset) | MHz |  | 2\*FInterferer 1 | | | | | | |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L,c or PCMAX\_L as defined in TBD.  NOTE 2: Reference measurement channel is TBD.  NOTE 3: The modulated interferer consists of the Reference measurement channel specified in TBD.  NOTE 4: The Finterferer 1 (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the CW interferer and Finterferer 2 (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the modulated interferer. | | | | | | | | | |

## 7.8A Intermodulation characteristics for CA

### 7.8A.1 General

### 7.8A.2 Wide band intermodulation for CA

#### 7.8A.2.1 Wide band intermodulation for Intra-band contiguous CA

Table 7.8A.2.1-1: Wide band intermodulation parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rx parameter | Units | Channel bandwidth | | | | | | | | |
| 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz | 160 MHz | 180 MHz |  | 200 MHz |
| Pw in Transmission Bandwidth Configuration, per CC | dBm |  | REFSENS + 6 | | | | | | | |
| PInterferer 1  (CW) | dBm |  | -46 | | | | | | | |
| PInterferer 2  (Modulated) | dBm |  | -46 | | | | | | | |
| BWInterferer 2 | MHz |  | BW | | | | | | | |
| FInterferer 1  (Offset) | MHz |  | -2BW  /  +2BW | | | | | | | |
| FInterferer 2  (Offset) | MHz |  | 2\*FInterferer 1 | | | | | | | |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L,c or PCMAX\_L as defined in TBD.  NOTE 2: Reference measurement channel is TBD.  NOTE 3: The modulated interferer consists of the Reference measurement channel specified in TBD.  NOTE 4: The Finterferer 1 (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the CW interferer and Finterferer 2 (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the modulated interferer. | | | | | | | | | | |

#### 7.8A.2.2 Wide band intermodulation for Intra-band non-contiguous CA

Detailed structure of the subclause is TBD

#### 7.8A.2.3 Wide band intermodulation for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the wide band intermodulation requirements are defined with the uplink active on the band(s) other than the band whose downlink is being tested. The UE shall meet the requirements specified in subclause 7.8 for each component carrier while all downlink carriers are active.

For the UE which supports inter-band CA configuration in Table 7.3A.3.2, Pinterferer power defined in Table 7.8.2-1 and 7.8.2-2 is increased by the amount given by ΔRIB,c in Table 7.3A.3.2.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X (with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.X.X.X).

## 7.8D Intermodulation characteristics for UL-MIMO

For UE(s) with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements in subclause 7.8 shall be met with the UL-MIMO configurations described in sub-clause 6.2D.1. For UL-MIMO, the parameter PCMAX\_L is defined as the total transmitter power over the two transmit antenna connectors.

## 7.9 Spurious emissions

The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector.

The power of any narrow band CW spurious emission shall not exceed the maximum level specified in Table 7.9-1

Table 7.9-1: General receiver spurious emission requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range | Measurement  bandwidth | Maximum level | NOTE |
| 30 MHz ≤ f < 1 GHz | 100 kHz | -57 dBm |  |
| 1 GHz ≤ f ≤ 12.75 GHz | 1 MHz | -47 dBm |  |
| 12.75 GHz ≤ f ≤ 5th harmonic of the upper frequency edge of the DL operating band in GHz | 1 MHz | -47 dBm | 2 |
| 12.75 GHz – 26 GHz | 1 MHz | -47dBm | 3 |
| NOTE 1: Unused PDCCH resources are padded with resource element groups with power level given by PDCCH\_RA/RB as defined in Annex C.3.1.  NOTE 2: Applies for Band that the upper frequency edge of the DL Band more than 2.69 GHz.  NOTE 3: Applies for Band that the upper frequency edge of the DL Band more than 5.2 GHz. | | | |

## 7.9A Spurious emissions for CA

### 7.9A.1 Spurious emissions for Intra-band contiguous CA

Table 7.9A-1: General receiver spurious emission requirements for CA

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range | Measurement  bandwidth | Maximum level | NOTE |
| 30 MHz ≤ f < 1 GHz | 100 kHz | -57 dBm |  |
| 1 GHz ≤ f ≤ 12.75 GHz | 1 MHz | -47 dBm |  |
| 12.75 GHz ≤ f ≤ 5th harmonic of the upper frequency edge of the DL operating band in GHz | 1 MHz | -47 dBm | 2 |
| 12.75 GHz – 26 GHz | 1 MHz | -47dBm | 3 |
| NOTE 1: Unused PDCCH resources are padded with resource element groups with power level given by PDCCH\_RA/RB as defined in Annex C.3.1.  NOTE 2: Applies for Band that the upper frequency edge of the DL Band more than 2.69 GHz.  NOTE 3: Applies for Band that the upper frequency edge of the DL Band more than 5.2 GHz. | | | |

### 7.9A.2 Spurious emissions for Intra-band non-contiguous CA

Detailed structure of the subclause is TBD

### 7.9A.3 Spurious emissions for Inter-band CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink assigned to one NR band, the UE shall meet the Rx spurious emissions requirements specified in subclause 7.9 for each component carrier while all downlink carriers are active.

Annex A (normative):  
Measurement channels

# A.1 General

The throughput values defined in the measurement channels specified in Annex A, are calculated and are valid per datastream (codeword). For multi-stream (more than one codeword) transmissions, the throughput referenced in the minimum requirements is the sum of throughputs of all datastreams (codewords).

The UE category entry in the definition of the reference measurement channel in Annex A is only informative and reveals the UE categories, which can support the corresponding measurement channel. Whether the measurement channel is used for testing a certain UE category or not is specified in the individual minimum requirements.

# A.2 UL reference measurement channels

## A.2.1 General

The measurement channels in the following subclauses are defined to derive the requirements in clause 6 (Transmitter Characteristics) and clause 7 (Receiver Characteristics). The measurement channels represent example configurations of physical channels for different data rates.

## A.2.2 Reference measurement channels for FDD

### A.2.2.1 DFT-s-OFDM Pi/2-BPSK

Table A.2.2.1-1: Reference Channels for DFT-s-OFDM Pi/2-BPSK for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | pi/2 BPSK | 0 | 1/4 | 32 | 16 | 2 | 1 | 132 | 132 |
|  | 5 | 15 | 12 | 11 | pi/2 BPSK | 0 | 1/4 | 384 | 16 | 2 | 1 | 1584 | 1584 |
|  | 5 | 15 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 10 | 15 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 10 | 15 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 15 | 15 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 15 | 15 | 75 | 11 | pi/2 BPSK | 0 | 1/4 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
|  | 20 | 15 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 20 | 15 | 100 | 11 | pi/2 BPSK | 0 | 1/4 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
|  | 25 | 15 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 25 | 15 | 128 | 11 | pi/2 BPSK | 0 | 1/4 | 3976 | 24 | 2 | 2 | 16896 | 16896 |
|  | 30 | 15 | 80 | 11 | pi/2 BPSK | 0 | 1/4 | 2472 | 16 | 2 | 1 | 10560 | 10560 |
|  | 30 | 15 | 160 | 11 | pi/2 BPSK | 0 | 1/4 | 4872 | 24 | 2 | 2 | 21120 | 21120 |
|  | 40 | 15 | 108 | 11 | pi/2 BPSK | 0 | 1/4 | 3368 | 16 | 2 | 1 | 14256 | 14256 |
|  | 40 | 15 | 216 | 11 | pi/2 BPSK | 0 | 1/4 | 6664 | 24 | 2 | 2 | 28512 | 28512 |
|  | 50 | 15 | 135 | 11 | pi/2 BPSK | 0 | 1/4 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
|  | 50 | 15 | 270 | 11 | pi/2 BPSK | 0 | 1/4 | 8448 | 24 | 2 | 3 | 35640 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.1-2: Reference Channels for DFT-s-OFDM Pi/2-BPSK for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | pi/2 BPSK | 0 | 1/4 | 32 | 16 | 2 | 1 | 132 | 132 |
|  | 5 | 30 | 5 | 11 | pi/2 BPSK | 0 | 1/4 | 160 | 16 | 2 | 1 | 660 | 660 |
|  | 5 | 30 | 10 | 11 | pi/2 BPSK | 0 | 1/4 | 320 | 16 | 2 | 1 | 1320 | 1320 |
|  | 10 | 30 | 12 | 11 | pi/2 BPSK | 0 | 1/4 | 384 | 16 | 2 | 1 | 1584 | 1584 |
|  | 10 | 30 | 24 | 11 | pi/2 BPSK | 0 | 1/4 | 768 | 16 | 2 | 1 | 3168 | 3168 |
|  | 15 | 30 | 18 | 11 | pi/2 BPSK | 0 | 1/4 | 576 | 16 | 2 | 1 | 2376 | 2376 |
|  | 15 | 30 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 20 | 30 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 20 | 30 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 25 | 30 | 32 | 11 | pi/2 BPSK | 0 | 1/4 | 1032 | 16 | 2 | 1 | 4224 | 4224 |
|  | 25 | 30 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 30 | 30 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 30 | 30 | 75 | 11 | pi/2 BPSK | 0 | 1/4 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
|  | 40 | 30 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 40 | 30 | 100 | 11 | pi/2 BPSK | 0 | 1/4 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
|  | 50 | 30 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 50 | 30 | 128 | 11 | pi/2 BPSK | 0 | 1/4 | 3976 | 24 | 2 | 2 | 16896 | 16896 |
|  | 60 | 30 | 81 | 11 | pi/2 BPSK | 0 | 1/4 | 2536 | 16 | 2 | 1 | 10692 | 10692 |
|  | 60 | 30 | 162 | 11 | pi/2 BPSK | 0 | 1/4 | 5000 | 24 | 2 | 2 | 21384 | 21384 |
|  | 80 | 30 | 108 | 11 | pi/2 BPSK | 0 | 1/4 | 3368 | 16 | 2 | 1 | 14256 | 14256 |
|  | 80 | 30 | 216 | 11 | pi/2 BPSK | 0 | 1/4 | 6664 | 24 | 2 | 2 | 28512 | 28512 |
|  | 90 | 30 | 120 | 11 | pi/2 BPSK | 0 | 1/4 | 3752 | 16 | 2 | 1 | 15840 | 15840 |
|  | 90 | 30 | 243 | 11 | pi/2 BPSK | 0 | 1/4 | 7560 | 24 | 2 | 2 | 32076 | 32076 |
|  | 100 | 30 | 135 | 11 | pi/2 BPSK | 0 | 1/4 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
|  | 100 | 30 | 270 | 11 | pi/2 BPSK | 0 | 1/4 | 8448 | 24 | 2 | 3 | 35640 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.1-3: Reference Channels for DFT-s-OFDM Pi/2-BPSK for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | pi/2 BPSK | 0 | 1/4 | 32 | 16 | 2 | 1 | 132 | 132 |
|  | 10 | 60 | 5 | 11 | pi/2 BPSK | 0 | 1/4 | 160 | 16 | 2 | 1 | 660 | 660 |
|  | 10 | 60 | 10 | 11 | pi/2 BPSK | 0 | 1/4 | 320 | 16 | 2 | 1 | 1320 | 1320 |
|  | 15 | 60 | 9 | 11 | pi/2 BPSK | 0 | 1/4 | 288 | 16 | 2 | 1 | 1188 | 1188 |
|  | 15 | 60 | 18 | 11 | pi/2 BPSK | 0 | 1/4 | 576 | 16 | 2 | 1 | 2376 | 2376 |
|  | 20 | 60 | 12 | 11 | pi/2 BPSK | 0 | 1/4 | 384 | 16 | 2 | 1 | 1584 | 1584 |
|  | 20 | 60 | 24 | 11 | pi/2 BPSK | 0 | 1/4 | 768 | 16 | 2 | 1 | 3168 | 3168 |
|  | 25 | 60 | 15 | 11 | pi/2 BPSK | 0 | 1/4 | 480 | 16 | 2 | 1 | 1980 | 1980 |
|  | 25 | 60 | 30 | 11 | pi/2 BPSK | 0 | 1/4 | 984 | 16 | 2 | 1 | 3960 | 3960 |
|  | 30 | 60 | 18 | 11 | pi/2 BPSK | 0 | 1/4 | 576 | 16 | 2 | 1 | 2376 | 2376 |
|  | 30 | 60 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 40 | 60 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 40 | 60 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 50 | 60 | 32 | 11 | pi/2 BPSK | 0 | 1/4 | 1032 | 16 | 2 | 1 | 4224 | 4224 |
|  | 50 | 60 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 60 | 60 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 60 | 60 | 75 | 11 | pi/2 BPSK | 0 | 1/4 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
|  | 80 | 60 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 80 | 60 | 100 | 11 | pi/2 BPSK | 0 | 1/4 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
|  | 90 | 60 | 60 | 11 | pi/2 BPSK | 0 | 1/4 | 1864 | 16 | 2 | 1 | 7920 | 7920 |
|  | 90 | 60 | 120 | 11 | pi/2 BPSK | 0 | 1/4 | 3752 | 16 | 2 | 1 | 15840 | 15840 |
|  | 100 | 60 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 100 | 60 | 135 | 11 | pi/2 BPSK | 0 | 1/4 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.2 DFT-s-OFDM QPSK

Table A.2.2.2-1: Reference Channels for DFT-s-OFDM QPSK for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 15 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 5 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 5 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 10 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 10 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 10 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 15 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 15 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 15 | 15 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 15 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 15 | 15 | 75 | 11 | QPSK | 2 | 1/6 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
|  | 20 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 20 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 20 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 20 | 15 | 100 | 11 | QPSK | 2 | 1/6 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
|  | 25 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 25 | 15 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 25 | 15 | 128 | 11 | QPSK | 2 | 1/6 | 6408 | 24 | 2 | 2 | 33792 | 16896 |
|  | 30 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 30 | 15 | 80 | 11 | QPSK | 2 | 1/6 | 3976 | 24 | 2 | 2 | 21120 | 10560 |
|  | 30 | 15 | 160 | 11 | QPSK | 2 | 1/6 | 7944 | 24 | 2 | 3 | 42240 | 21120 |
|  | 40 | 15 | 108 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
|  | 40 | 15 | 216 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
|  | 50 | 15 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
|  | 50 | 15 | 270 | 11 | QPSK | 2 | 1/6 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.2-2: Reference Channels for DFT-s-OFDM QPSK for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 30 | 5 | 11 | QPSK | 2 | 1/6 | 256 | 16 | 2 | 1 | 1320 | 660 |
|  | 5 | 30 | 10 | 11 | QPSK | 2 | 1/6 | 504 | 16 | 2 | 1 | 2640 | 1320 |
|  | 10 | 30 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 10 | 30 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 15 | 30 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 15 | 30 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 20 | 30 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 20 | 30 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 25 | 30 | 32 | 11 | QPSK | 2 | 1/6 | 1608 | 16 | 2 | 1 | 8448 | 4224 |
|  | 25 | 30 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 30 | 30 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 30 | 30 | 75 | 11 | QPSK | 2 | 1/6 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
|  | 40 | 30 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 40 | 30 | 100 | 11 | QPSK | 2 | 1/6 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
|  | 50 | 30 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 50 | 30 | 128 | 11 | QPSK | 2 | 1/6 | 6408 | 24 | 2 | 2 | 33792 | 16896 |
|  | 60 | 30 | 81 | 11 | QPSK | 2 | 1/6 | 4040 | 24 | 2 | 2 | 21384 | 10692 |
|  | 60 | 30 | 162 | 11 | QPSK | 2 | 1/6 | 8064 | 24 | 2 | 3 | 42768 | 21384 |
|  | 80 | 30 | 108 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
|  | 80 | 30 | 216 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
|  | 90 | 30 | 120 | 11 | QPSK | 2 | 1/6 | 5896 | 24 | 2 | 2 | 31680 | 15840 |
|  | 90 | 30 | 243 | 11 | QPSK | 2 | 1/6 | 12040 | 24 | 2 | 4 | 64152 | 32076 |
|  | 100 | 30 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
|  | 100 | 30 | 270 | 11 | QPSK | 2 | 1/6 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.2-3: Reference Channels for DFT-s-OFDM QPSK for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 10 | 60 | 5 | 11 | QPSK | 2 | 1/6 | 256 | 16 | 2 | 1 | 1320 | 660 |
|  | 10 | 60 | 10 | 11 | QPSK | 2 | 1/6 | 504 | 16 | 2 | 1 | 2640 | 1320 |
|  | 15 | 60 | 9 | 11 | QPSK | 2 | 1/6 | 456 | 16 | 2 | 1 | 2376 | 1188 |
|  | 15 | 60 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 20 | 60 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 20 | 60 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 25 | 60 | 15 | 11 | QPSK | 2 | 1/6 | 768 | 16 | 2 | 1 | 3960 | 1980 |
|  | 25 | 60 | 30 | 11 | QPSK | 2 | 1/6 | 1544 | 16 | 2 | 1 | 7920 | 3960 |
|  | 30 | 60 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 30 | 60 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 40 | 60 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 40 | 60 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 50 | 60 | 32 | 11 | QPSK | 2 | 1/6 | 1608 | 16 | 2 | 1 | 8448 | 4224 |
|  | 50 | 60 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 60 | 60 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 60 | 60 | 75 | 11 | QPSK | 2 | 1/6 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
|  | 80 | 60 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 80 | 60 | 100 | 11 | QPSK | 2 | 1/6 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
|  | 90 | 60 | 60 | 11 | QPSK | 2 | 1/6 | 3104 | 16 | 2 | 1 | 15840 | 7920 |
|  | 90 | 60 | 120 | 11 | QPSK | 2 | 1/6 | 5896 | 24 | 2 | 2 | 31680 | 15840 |
|  | 100 | 60 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 100 | 60 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.3 DFT-s-OFDM 16QAM

Table A.2.2.3-1: Reference Channels for DFT-s-OFDM 16QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 15 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 5 | 15 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 10 | 15 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 10 | 15 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 15 | 15 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 15 | 15 | 75 | 11 | 16QAM | 10 | 1/3 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
|  | 20 | 15 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 20 | 15 | 100 | 11 | 16QAM | 10 | 1/3 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
|  | 25 | 15 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 25 | 15 | 128 | 11 | 16QAM | 10 | 1/3 | 22536 | 24 | 1 | 3 | 67584 | 16896 |
|  | 30 | 15 | 80 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42240 | 10560 |
|  | 30 | 15 | 160 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 84480 | 21120 |
|  | 40 | 15 | 108 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
|  | 40 | 15 | 216 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
|  | 50 | 15 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
|  | 50 | 15 | 270 | 11 | 16QAM | 10 | 1/3 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.3-2: Reference Channels for DFT-s-OFDM 16QAM for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 30 | 5 | 11 | 16QAM | 10 | 1/3 | 888 | 16 | 2 | 1 | 2640 | 660 |
|  | 5 | 30 | 10 | 11 | 16QAM | 10 | 1/3 | 1800 | 16 | 2 | 1 | 5280 | 1320 |
|  | 10 | 30 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 10 | 30 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 15 | 30 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 15 | 30 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 20 | 30 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 20 | 30 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 25 | 30 | 32 | 11 | 16QAM | 10 | 1/3 | 5632 | 24 | 1 | 1 | 16896 | 4224 |
|  | 25 | 30 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 30 | 30 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 30 | 30 | 75 | 11 | 16QAM | 10 | 1/3 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
|  | 40 | 30 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 40 | 30 | 100 | 11 | 16QAM | 10 | 1/3 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
|  | 50 | 30 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 50 | 30 | 128 | 11 | 16QAM | 10 | 1/3 | 22536 | 24 | 1 | 3 | 67584 | 16896 |
|  | 60 | 30 | 81 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42768 | 10692 |
|  | 60 | 30 | 162 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 85536 | 21384 |
|  | 80 | 30 | 108 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
|  | 80 | 30 | 216 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
|  | 90 | 30 | 120 | 11 | 16QAM | 10 | 1/3 | 21000 | 24 | 1 | 3 | 63360 | 15840 |
|  | 90 | 30 | 243 | 11 | 16QAM | 10 | 1/3 | 43032 | 24 | 1 | 6 | 128304 | 32076 |
|  | 100 | 30 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
|  | 100 | 30 | 270 | 11 | 16QAM | 10 | 1/3 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.3-3: Reference Channels for DFT-s-OFDM 16QAM for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 10 | 60 | 5 | 11 | 16QAM | 10 | 1/3 | 888 | 16 | 2 | 1 | 2640 | 660 |
|  | 10 | 60 | 10 | 11 | 16QAM | 10 | 1/3 | 1800 | 16 | 2 | 1 | 5280 | 1320 |
|  | 15 | 60 | 9 | 11 | 16QAM | 10 | 1/3 | 1608 | 16 | 2 | 1 | 4752 | 1188 |
|  | 15 | 60 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 20 | 60 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 20 | 60 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 25 | 60 | 15 | 11 | 16QAM | 10 | 1/3 | 2664 | 16 | 2 | 1 | 7920 | 1980 |
|  | 25 | 60 | 30 | 11 | 16QAM | 10 | 1/3 | 5248 | 24 | 1 | 1 | 15840 | 3960 |
|  | 30 | 60 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 30 | 60 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 40 | 60 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 40 | 60 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 50 | 60 | 32 | 11 | 16QAM | 10 | 1/3 | 5632 | 24 | 1 | 1 | 16896 | 4224 |
|  | 50 | 60 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 60 | 60 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 60 | 60 | 75 | 11 | 16QAM | 10 | 1/3 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
|  | 80 | 60 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 80 | 60 | 100 | 11 | 16QAM | 10 | 1/3 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
|  | 90 | 60 | 60 | 11 | 16QAM | 10 | 1/3 | 10504 | 24 | 1 | 2 | 31680 | 7920 |
|  | 90 | 60 | 120 | 11 | 16QAM | 10 | 1/3 | 21000 | 24 | 1 | 3 | 63360 | 15840 |
|  | 100 | 60 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 100 | 60 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.4 DFT-s-OFDM 64QAM

Table A.2.2.4-1: Reference Channels for DFT-s-OFDM 64QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 64QAM | 18 | 1/2 | 9992 | 24 | 1 | 2 | 19800 | 3300 |
|  | 10 | 15 | 50 | 11 | 64QAM | 18 | 1/2 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
|  | 15 | 15 | 75 | 11 | 64QAM | 18 | 1/2 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
|  | 20 | 15 | 100 | 11 | 64QAM | 18 | 1/2 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
|  | 25 | 15 | 128 | 11 | 64QAM | 18 | 1/2 | 51216 | 24 | 1 | 7 | 101376 | 16896 |
|  | 30 | 15 | 160 | 11 | 64QAM | 18 | 1/2 | 63528 | 24 | 1 | 8 | 126720 | 21120 |
|  | 40 | 15 | 216 | 11 | 64QAM | 18 | 1/2 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
|  | 50 | 15 | 270 | 11 | 64QAM | 18 | 1/2 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.4-2: Reference Channels for DFT-s-OFDM 64QAM for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 10 | 11 | 64QAM | 18 | 1/2 | 3968 | 24 | 1 | 1 | 7920 | 1320 |
|  | 10 | 30 | 24 | 11 | 64QAM | 18 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 15 | 30 | 36 | 11 | 64QAM | 18 | 1/2 | 14344 | 24 | 1 | 2 | 28512 | 4752 |
|  | 20 | 30 | 50 | 11 | 64QAM | 18 | 1/2 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
|  | 25 | 30 | 64 | 11 | 64QAM | 18 | 1/2 | 25608 | 24 | 1 | 4 | 50688 | 8448 |
|  | 30 | 30 | 75 | 11 | 64QAM | 18 | 1/2 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
|  | 40 | 30 | 100 | 11 | 64QAM | 18 | 1/2 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
|  | 50 | 30 | 128 | 11 | 64QAM | 18 | 1/2 | 51216 | 24 | 1 | 7 | 101376 | 16896 |
|  | 60 | 30 | 162 | 11 | 64QAM | 18 | 1/2 | 64552 | 24 | 1 | 8 | 128304 | 21384 |
|  | 80 | 30 | 216 | 11 | 64QAM | 18 | 1/2 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
|  | 90 | 30 | 243 | 11 | 64QAM | 18 | 1/2 | 96264 | 24 | 1 | 12 | 192456 | 32076 |
|  | 100 | 30 | 270 | 11 | 64QAM | 18 | 1/2 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.4-3: Reference Channels for DFT-s-OFDM 64QAM for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 10 | 11 | 64QAM | 18 | 1/2 | 3968 | 24 | 1 | 1 | 7920 | 1320 |
|  | 15 | 60 | 18 | 11 | 64QAM | 18 | 1/2 | 7168 | 24 | 1 | 1 | 14256 | 2376 |
|  | 20 | 60 | 24 | 11 | 64QAM | 18 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 25 | 60 | 30 | 11 | 64QAM | 18 | 1/2 | 12040 | 24 | 1 | 2 | 23760 | 3960 |
|  | 30 | 60 | 36 | 11 | 64QAM | 18 | 1/2 | 14344 | 24 | 1 | 2 | 28512 | 4752 |
|  | 40 | 60 | 50 | 11 | 64QAM | 18 | 1/2 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
|  | 50 | 60 | 64 | 11 | 64QAM | 18 | 1/2 | 25608 | 24 | 1 | 4 | 50688 | 8448 |
|  | 60 | 60 | 75 | 11 | 64QAM | 18 | 1/2 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
|  | 80 | 60 | 100 | 11 | 64QAM | 18 | 1/2 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
|  | 90 | 60 | 120 | 11 | 64QAM | 18 | 1/2 | 48168 | 24 | 1 | 6 | 95040 | 15840 |
|  | 100 | 60 | 135 | 11 | 64QAM | 18 | 1/2 | 54296 | 24 | 1 | 7 | 106920 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.5 DFT-s-OFDM 256QAM

Table A.2.2.5-1: Reference Channels for DFT-s-OFDM 256QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 256QAM | 20 | 2/3 | 17424 | 24 | 1 | 3 | 26400 | 3300 |
|  | 10 | 15 | 50 | 11 | 256QAM | 20 | 2/3 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
|  | 15 | 15 | 75 | 11 | 256QAM | 20 | 2/3 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
|  | 20 | 15 | 100 | 11 | 256QAM | 20 | 2/3 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
|  | 25 | 15 | 128 | 11 | 256QAM | 20 | 2/3 | 90176 | 24 | 1 | 11 | 135168 | 16896 |
|  | 30 | 15 | 160 | 11 | 256QAM | 20 | 2/3 | 112648 | 24 | 1 | 14 | 168960 | 21120 |
|  | 40 | 15 | 216 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
|  | 50 | 15 | 270 | 11 | 256QAM | 20 | 2/3 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.5-2: Reference Channels for DFT-s-OFDM 256QAM for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 10 | 11 | 256QAM | 20 | 2/3 | 7040 | 24 | 1 | 1 | 10560 | 1320 |
|  | 10 | 30 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 15 | 30 | 36 | 11 | 256QAM | 20 | 2/3 | 25104 | 24 | 1 | 3 | 38016 | 4752 |
|  | 20 | 30 | 50 | 11 | 256QAM | 20 | 2/3 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
|  | 25 | 30 | 64 | 11 | 256QAM | 20 | 2/3 | 45096 | 24 | 1 | 6 | 67584 | 8448 |
|  | 30 | 30 | 75 | 11 | 256QAM | 20 | 2/3 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
|  | 40 | 30 | 100 | 11 | 256QAM | 20 | 2/3 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
|  | 50 | 30 | 128 | 11 | 256QAM | 20 | 2/3 | 90176 | 24 | 1 | 11 | 135168 | 16896 |
|  | 60 | 30 | 162 | 11 | 256QAM | 20 | 2/3 | 114776 | 24 | 1 | 14 | 171072 | 21384 |
|  | 80 | 30 | 216 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
|  | 90 | 30 | 243 | 11 | 256QAM | 20 | 2/3 | 172176 | 24 | 1 | 21 | 256608 | 32076 |
|  | 100 | 30 | 270 | 11 | 256QAM | 20 | 2/3 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.5-3: Reference Channels for DFT-s-OFDM 256QAM for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 10 | 11 | 256QAM | 20 | 2/3 | 7040 | 24 | 1 | 1 | 10560 | 1320 |
|  | 15 | 60 | 18 | 11 | 256QAM | 20 | 2/3 | 12552 | 24 | 1 | 2 | 19008 | 2376 |
|  | 20 | 60 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 25 | 60 | 30 | 11 | 256QAM | 20 | 2/3 | 21000 | 24 | 1 | 3 | 31680 | 3960 |
|  | 30 | 60 | 36 | 11 | 256QAM | 20 | 2/3 | 25104 | 24 | 1 | 3 | 38016 | 4752 |
|  | 40 | 60 | 50 | 11 | 256QAM | 20 | 2/3 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
|  | 50 | 60 | 64 | 11 | 256QAM | 20 | 2/3 | 45096 | 24 | 1 | 6 | 67584 | 8448 |
|  | 60 | 60 | 75 | 11 | 256QAM | 20 | 2/3 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
|  | 80 | 60 | 100 | 11 | 256QAM | 20 | 2/3 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
|  | 90 | 60 | 120 | 11 | 256QAM | 20 | 2/3 | 83976 | 24 | 1 | 10 | 126720 | 15840 |
|  | 100 | 60 | 135 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 142560 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.6 CP-OFDM QPSK

Table A.2.2.6-1: Reference Channels for CP-OFDM QPSK for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 15 | 13 | 11 | QPSK | 2 | 1/6 | 672 | 16 | 2 | 1 | 3432 | 1716 |
|  | 5 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 10 | 15 | 26 | 11 | QPSK | 2 | 1/6 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
|  | 10 | 15 | 52 | 11 | QPSK | 2 | 1/6 | 2600 | 16 | 2 | 1 | 13728 | 6864 |
|  | 15 | 15 | 40 | 11 | QPSK | 2 | 1/6 | 2024 | 16 | 2 | 1 | 10560 | 5280 |
|  | 15 | 15 | 79 | 11 | QPSK | 2 | 1/6 | 3912 | 24 | 2 | 2 | 20856 | 10428 |
|  | 20 | 15 | 53 | 11 | QPSK | 2 | 1/6 | 2664 | 16 | 2 | 1 | 13992 | 6996 |
|  | 20 | 15 | 106 | 11 | QPSK | 2 | 1/6 | 5256 | 24 | 2 | 2 | 27984 | 13992 |
|  | 25 | 15 | 67 | 11 | QPSK | 2 | 1/6 | 3368 | 16 | 2 | 1 | 17688 | 8844 |
|  | 25 | 15 | 133 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35112 | 17556 |
|  | 30 | 15 | 80 | 11 | QPSK | 2 | 1/6 | 3976 | 24 | 2 | 2 | 21120 | 10560 |
|  | 30 | 15 | 160 | 11 | QPSK | 2 | 1/6 | 7944 | 24 | 2 | 3 | 42240 | 21120 |
|  | 40 | 15 | 108 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
|  | 40 | 15 | 216 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
|  | 50 | 15 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
|  | 50 | 15 | 270 | 11 | QPSK | 2 | 1/6 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.6-2: Reference Channels for CP-OFDM QPSK for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 30 | 6 | 11 | QPSK | 2 | 1/6 | 304 | 16 | 2 | 1 | 1584 | 792 |
|  | 5 | 30 | 11 | 11 | QPSK | 2 | 1/6 | 552 | 16 | 2 | 1 | 2904 | 1452 |
|  | 10 | 30 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 10 | 30 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 15 | 30 | 19 | 11 | QPSK | 2 | 1/6 | 984 | 16 | 2 | 1 | 5016 | 2508 |
|  | 15 | 30 | 38 | 11 | QPSK | 2 | 1/6 | 1928 | 16 | 2 | 1 | 10032 | 5016 |
|  | 20 | 30 | 26 | 11 | QPSK | 2 | 1/6 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
|  | 20 | 30 | 51 | 11 | QPSK | 2 | 1/6 | 2536 | 16 | 2 | 1 | 13464 | 6732 |
|  | 25 | 30 | 33 | 11 | QPSK | 2 | 1/6 | 1672 | 16 | 2 | 1 | 8712 | 4356 |
|  | 25 | 30 | 65 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 17160 | 8580 |
|  | 30 | 30 | 39 | 11 | QPSK | 2 | 1/6 | 2024 | 16 | 2 | 1 | 10296 | 5148 |
|  | 30 | 30 | 78 | 11 | QPSK | 2 | 1/6 | 3848 | 24 | 2 | 2 | 20592 | 10296 |
|  | 40 | 30 | 53 | 11 | QPSK | 2 | 1/6 | 2664 | 16 | 2 | 1 | 13992 | 6996 |
|  | 40 | 30 | 106 | 11 | QPSK | 2 | 1/6 | 5256 | 24 | 2 | 2 | 27984 | 13992 |
|  | 50 | 30 | 67 | 11 | QPSK | 2 | 1/6 | 3368 | 16 | 2 | 1 | 17688 | 8844 |
|  | 50 | 30 | 133 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35112 | 17556 |
|  | 60 | 30 | 81 | 11 | QPSK | 2 | 1/6 | 4040 | 24 | 2 | 2 | 21384 | 10692 |
|  | 60 | 30 | 162 | 11 | QPSK | 2 | 1/6 | 8064 | 24 | 2 | 3 | 42768 | 21384 |
|  | 80 | 30 | 109 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28776 | 14388 |
|  | 80 | 30 | 217 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57288 | 28644 |
|  | 90 | 30 | 123 | 11 | QPSK | 2 | 1/6 | 6152 | 24 | 2 | 2 | 32472 | 16236 |
|  | 90 | 30 | 245 | 11 | QPSK | 2 | 1/6 | 12296 | 24 | 2 | 4 | 64680 | 32340 |
|  | 100 | 30 | 137 | 11 | QPSK | 2 | 1/6 | 6792 | 24 | 2 | 2 | 36168 | 18084 |
|  | 100 | 30 | 273 | 11 | QPSK | 2 | 1/6 | 13576 | 24 | 2 | 4 | 72072 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.6-3: Reference Channels for CP-OFDM QPSK for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 10 | 60 | 6 | 11 | QPSK | 2 | 1/6 | 304 | 16 | 2 | 1 | 1584 | 792 |
|  | 10 | 60 | 11 | 11 | QPSK | 2 | 1/6 | 552 | 16 | 2 | 1 | 2904 | 1452 |
|  | 15 | 60 | 9 | 11 | QPSK | 2 | 1/6 | 456 | 16 | 2 | 1 | 2376 | 1188 |
|  | 15 | 60 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 20 | 60 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 20 | 60 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 25 | 60 | 16 | 11 | QPSK | 2 | 1/6 | 808 | 16 | 2 | 1 | 4224 | 2112 |
|  | 25 | 60 | 31 | 11 | QPSK | 2 | 1/6 | 1544 | 16 | 2 | 1 | 8184 | 4092 |
|  | 30 | 60 | 19 | 11 | QPSK | 2 | 1/6 | 984 | 16 | 2 | 1 | 5016 | 2508 |
|  | 30 | 60 | 38 | 11 | QPSK | 2 | 1/6 | 1928 | 16 | 2 | 1 | 10032 | 5016 |
|  | 40 | 60 | 26 | 11 | QPSK | 2 | 1/6 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
|  | 40 | 60 | 51 | 11 | QPSK | 2 | 1/6 | 2536 | 16 | 2 | 1 | 13464 | 6732 |
|  | 50 | 60 | 33 | 11 | QPSK | 2 | 1/6 | 1672 | 16 | 2 | 1 | 8712 | 4356 |
|  | 50 | 60 | 65 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 17160 | 8580 |
|  | 60 | 60 | 40 | 11 | QPSK | 2 | 1/6 | 2024 | 16 | 2 | 1 | 10560 | 5280 |
|  | 60 | 60 | 79 | 11 | QPSK | 2 | 1/6 | 3912 | 24 | 2 | 2 | 20856 | 10428 |
|  | 80 | 60 | 54 | 11 | QPSK | 2 | 1/6 | 2664 | 16 | 2 | 1 | 14256 | 7128 |
|  | 80 | 60 | 107 | 11 | QPSK | 2 | 1/6 | 5256 | 24 | 2 | 2 | 28248 | 14124 |
|  | 90 | 60 | 61 | 11 | QPSK | 2 | 1/6 | 3104 | 16 | 2 | 1 | 16104 | 8052 |
|  | 90 | 60 | 121 | 11 | QPSK | 2 | 1/6 | 6024 | 24 | 2 | 2 | 31944 | 15972 |
|  | 100 | 60 | 68 | 11 | QPSK | 2 | 1/6 | 3368 | 16 | 2 | 1 | 17952 | 8976 |
|  | 100 | 60 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.7 CP-OFDM 16QAM

Table A.2.2.7-1: Reference Channels for CP-OFDM 16QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 15 | 13 | 11 | 16QAM | 10 | 1/3 | 2280 | 16 | 2 | 1 | 6864 | 1716 |
|  | 5 | 15 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 10 | 15 | 26 | 11 | 16QAM | 10 | 1/3 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
|  | 10 | 15 | 52 | 11 | 16QAM | 10 | 1/3 | 9224 | 24 | 1 | 2 | 27456 | 6864 |
|  | 15 | 15 | 40 | 11 | 16QAM | 10 | 1/3 | 7040 | 24 | 1 | 1 | 21120 | 5280 |
|  | 15 | 15 | 79 | 11 | 16QAM | 10 | 1/3 | 13832 | 24 | 1 | 2 | 41712 | 10428 |
|  | 20 | 15 | 53 | 11 | 16QAM | 10 | 1/3 | 9224 | 24 | 1 | 2 | 27984 | 6996 |
|  | 20 | 15 | 106 | 11 | 16QAM | 10 | 1/3 | 18432 | 24 | 1 | 3 | 55968 | 13992 |
|  | 25 | 15 | 67 | 11 | 16QAM | 10 | 1/3 | 11784 | 24 | 1 | 2 | 35376 | 8844 |
|  | 25 | 15 | 133 | 11 | 16QAM | 10 | 1/3 | 23040 | 24 | 1 | 3 | 70224 | 17556 |
|  | 30 | 15 | 80 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42240 | 10560 |
|  | 30 | 15 | 160 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 84480 | 21120 |
|  | 40 | 15 | 108 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
|  | 40 | 15 | 216 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
|  | 50 | 15 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
|  | 50 | 15 | 270 | 11 | 16QAM | 10 | 1/3 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.7-2: Reference Channels for CP-OFDM 16QAM for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 30 | 6 | 11 | 16QAM | 10 | 1/3 | 1064 | 16 | 2 | 1 | 3168 | 792 |
|  | 5 | 30 | 11 | 11 | 16QAM | 10 | 1/3 | 1928 | 16 | 2 | 1 | 5808 | 1452 |
|  | 10 | 30 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 10 | 30 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 15 | 30 | 19 | 11 | 16QAM | 10 | 1/3 | 3368 | 16 | 2 | 1 | 10032 | 2508 |
|  | 15 | 30 | 38 | 11 | 16QAM | 10 | 1/3 | 6656 | 24 | 1 | 1 | 20064 | 5016 |
|  | 20 | 30 | 26 | 11 | 16QAM | 10 | 1/3 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
|  | 20 | 30 | 51 | 11 | 16QAM | 10 | 1/3 | 8968 | 24 | 1 | 2 | 26928 | 6732 |
|  | 25 | 30 | 33 | 11 | 16QAM | 10 | 1/3 | 5760 | 24 | 1 | 1 | 17424 | 4356 |
|  | 25 | 30 | 65 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 34320 | 8580 |
|  | 30 | 30 | 39 | 11 | 16QAM | 10 | 1/3 | 6784 | 24 | 1 | 1 | 20592 | 5148 |
|  | 30 | 30 | 78 | 11 | 16QAM | 10 | 1/3 | 13576 | 24 | 1 | 2 | 41184 | 10296 |
|  | 40 | 30 | 53 | 11 | 16QAM | 10 | 1/3 | 9224 | 24 | 1 | 2 | 27984 | 6996 |
|  | 40 | 30 | 106 | 11 | 16QAM | 10 | 1/3 | 18432 | 24 | 1 | 3 | 55968 | 13992 |
|  | 50 | 30 | 67 | 11 | 16QAM | 10 | 1/3 | 11784 | 24 | 1 | 2 | 35376 | 8844 |
|  | 50 | 30 | 133 | 11 | 16QAM | 10 | 1/3 | 23040 | 24 | 1 | 3 | 70224 | 17556 |
|  | 60 | 30 | 81 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42768 | 10692 |
|  | 60 | 30 | 162 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 85536 | 21384 |
|  | 80 | 30 | 109 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57552 | 14388 |
|  | 80 | 30 | 217 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114576 | 28644 |
|  | 90 | 30 | 123 | 11 | 16QAM | 10 | 1/3 | 21504 | 24 | 1 | 3 | 64944 | 16236 |
|  | 90 | 30 | 245 | 11 | 16QAM | 10 | 1/3 | 43032 | 24 | 1 | 6 | 129360 | 32340 |
|  | 100 | 30 | 137 | 11 | 16QAM | 10 | 1/3 | 24072 | 24 | 1 | 3 | 72336 | 18084 |
|  | 100 | 30 | 273 | 11 | 16QAM | 10 | 1/3 | 48168 | 24 | 1 | 6 | 144144 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.7-3: Reference Channels for CP-OFDM 16QAM for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 10 | 60 | 6 | 11 | 16QAM | 10 | 1/3 | 1064 | 16 | 2 | 1 | 3168 | 792 |
|  | 10 | 60 | 11 | 11 | 16QAM | 10 | 1/3 | 1928 | 16 | 2 | 1 | 5808 | 1452 |
|  | 15 | 60 | 9 | 11 | 16QAM | 10 | 1/3 | 1608 | 16 | 2 | 1 | 4752 | 1188 |
|  | 15 | 60 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 20 | 60 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 20 | 60 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 25 | 60 | 16 | 11 | 16QAM | 10 | 1/3 | 2792 | 16 | 2 | 1 | 8448 | 2112 |
|  | 25 | 60 | 31 | 11 | 16QAM | 10 | 1/3 | 5376 | 24 | 1 | 1 | 16368 | 4092 |
|  | 30 | 60 | 19 | 11 | 16QAM | 10 | 1/3 | 3368 | 16 | 2 | 1 | 10032 | 2508 |
|  | 30 | 60 | 38 | 11 | 16QAM | 10 | 1/3 | 6656 | 24 | 1 | 1 | 20064 | 5016 |
|  | 40 | 60 | 26 | 11 | 16QAM | 10 | 1/3 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
|  | 40 | 60 | 51 | 11 | 16QAM | 10 | 1/3 | 8968 | 24 | 1 | 2 | 26928 | 6732 |
|  | 50 | 60 | 33 | 11 | 16QAM | 10 | 1/3 | 5760 | 24 | 1 | 1 | 17424 | 4356 |
|  | 50 | 60 | 65 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 34320 | 8580 |
|  | 60 | 60 | 40 | 11 | 16QAM | 10 | 1/3 | 7040 | 24 | 1 | 1 | 21120 | 5280 |
|  | 60 | 60 | 79 | 11 | 16QAM | 10 | 1/3 | 13832 | 24 | 1 | 2 | 41712 | 10428 |
|  | 80 | 60 | 54 | 11 | 16QAM | 10 | 1/3 | 9480 | 24 | 1 | 2 | 28512 | 7128 |
|  | 80 | 60 | 107 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 56496 | 14124 |
|  | 90 | 60 | 61 | 11 | 16QAM | 10 | 1/3 | 10760 | 24 | 1 | 2 | 32208 | 8052 |
|  | 90 | 60 | 121 | 11 | 16QAM | 10 | 1/3 | 21000 | 24 | 1 | 3 | 63888 | 15972 |
|  | 100 | 60 | 68 | 11 | 16QAM | 10 | 1/3 | 11784 | 24 | 1 | 2 | 35904 | 8976 |
|  | 100 | 60 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.8 CP-OFDM 64QAM

Table A.2.2.8-1: Reference Channels for CP-OFDM 64QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 64QAM | 19 | 1/2 | 9992 | 24 | 1 | 2 | 19800 | 3300 |
|  | 10 | 15 | 52 | 11 | 64QAM | 19 | 1/2 | 21000 | 24 | 1 | 3 | 41184 | 6864 |
|  | 15 | 15 | 79 | 11 | 64QAM | 19 | 1/2 | 31752 | 24 | 1 | 4 | 62568 | 10428 |
|  | 20 | 15 | 106 | 11 | 64QAM | 19 | 1/2 | 42016 | 24 | 1 | 5 | 83952 | 13992 |
|  | 25 | 15 | 133 | 11 | 64QAM | 19 | 1/2 | 53288 | 24 | 1 | 7 | 105336 | 17556 |
|  | 30 | 15 | 160 | 11 | 64QAM | 19 | 1/2 | 63528 | 24 | 1 | 8 | 126720 | 21120 |
|  | 40 | 15 | 216 | 11 | 64QAM | 19 | 1/2 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
|  | 50 | 15 | 270 | 11 | 64QAM | 19 | 1/2 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.8-2: Reference Channels for CP-OFDM 64QAM for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 11 | 11 | 64QAM | 19 | 1/2 | 4352 | 24 | 1 | 1 | 8712 | 1452 |
|  | 10 | 30 | 24 | 11 | 64QAM | 19 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 15 | 30 | 38 | 11 | 64QAM | 19 | 1/2 | 15112 | 24 | 1 | 2 | 30096 | 5016 |
|  | 20 | 30 | 51 | 11 | 64QAM | 19 | 1/2 | 20496 | 24 | 1 | 3 | 40392 | 6732 |
|  | 25 | 30 | 65 | 11 | 64QAM | 19 | 1/2 | 26120 | 24 | 1 | 4 | 51480 | 8580 |
|  | 30 | 30 | 78 | 11 | 64QAM | 19 | 1/2 | 31240 | 24 | 1 | 4 | 61776 | 10296 |
|  | 40 | 30 | 106 | 11 | 64QAM | 19 | 1/2 | 42016 | 24 | 1 | 5 | 83952 | 13992 |
|  | 50 | 30 | 133 | 11 | 64QAM | 19 | 1/2 | 53288 | 24 | 1 | 7 | 105336 | 17556 |
|  | 60 | 30 | 162 | 11 | 64QAM | 19 | 1/2 | 64552 | 24 | 1 | 8 | 128304 | 21384 |
|  | 80 | 30 | 217 | 11 | 64QAM | 19 | 1/2 | 86040 | 24 | 1 | 11 | 171864 | 28644 |
|  | 90 | 30 | 245 | 11 | 64QAM | 19 | 1/2 | 98376 | 24 | 1 | 12 | 194040 | 32340 |
|  | 100 | 30 | 273 | 11 | 64QAM | 19 | 1/2 | 108552 | 24 | 1 | 13 | 216216 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.8-3: Reference Channels for CP-OFDM 64QAM for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 11 | 11 | 64QAM | 19 | 1/2 | 4352 | 24 | 1 | 1 | 8712 | 1452 |
|  | 15 | 60 | 18 | 11 | 64QAM | 19 | 1/2 | 7168 | 24 | 1 | 1 | 14256 | 2376 |
|  | 20 | 60 | 24 | 11 | 64QAM | 19 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 25 | 60 | 31 | 11 | 64QAM | 19 | 1/2 | 12296 | 24 | 1 | 2 | 24552 | 4092 |
|  | 30 | 60 | 38 | 11 | 64QAM | 19 | 1/2 | 15112 | 24 | 1 | 2 | 30096 | 5016 |
|  | 40 | 60 | 51 | 11 | 64QAM | 19 | 1/2 | 20496 | 24 | 1 | 3 | 40392 | 6732 |
|  | 50 | 60 | 65 | 11 | 64QAM | 19 | 1/2 | 26120 | 24 | 1 | 4 | 51480 | 8580 |
|  | 60 | 60 | 79 | 11 | 64QAM | 19 | 1/2 | 31752 | 24 | 1 | 4 | 62568 | 10428 |
|  | 80 | 60 | 107 | 11 | 64QAM | 19 | 1/2 | 43032 | 24 | 1 | 6 | 84744 | 14124 |
|  | 90 | 60 | 121 | 11 | 64QAM | 19 | 1/2 | 48168 | 24 | 1 | 6 | 95832 | 15972 |
|  | 100 | 60 | 135 | 11 | 64QAM | 19 | 1/2 | 54296 | 24 | 1 | 7 | 106920 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.2.9 CP-OFDM 256QAM

Table A.2.2.9-1: Reference Channels for CP-OFDM 256QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 256QAM | 20 | 2/3 | 17424 | 24 | 1 | 3 | 26400 | 3300 |
|  | 10 | 15 | 52 | 11 | 256QAM | 20 | 2/3 | 36896 | 24 | 1 | 5 | 54912 | 6864 |
|  | 15 | 15 | 79 | 11 | 256QAM | 20 | 2/3 | 55304 | 24 | 1 | 7 | 83424 | 10428 |
|  | 20 | 15 | 106 | 11 | 256QAM | 20 | 2/3 | 73776 | 24 | 1 | 9 | 111936 | 13992 |
|  | 25 | 15 | 133 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 140448 | 17556 |
|  | 30 | 15 | 160 | 11 | 256QAM | 20 | 2/3 | 112648 | 24 | 1 | 14 | 168960 | 21120 |
|  | 40 | 15 | 216 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
|  | 50 | 15 | 270 | 11 | 256QAM | 20 | 2/3 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.9-2: Reference Channels for CP-OFDM 256QAM for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 11 | 11 | 256QAM | 20 | 2/3 | 7680 | 24 | 1 | 1 | 11616 | 1452 |
|  | 10 | 30 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 15 | 30 | 38 | 11 | 256QAM | 20 | 2/3 | 26632 | 24 | 1 | 4 | 40128 | 5016 |
|  | 20 | 30 | 51 | 11 | 256QAM | 20 | 2/3 | 35856 | 24 | 1 | 5 | 53856 | 6732 |
|  | 25 | 30 | 65 | 11 | 256QAM | 20 | 2/3 | 46104 | 24 | 1 | 6 | 68640 | 8580 |
|  | 30 | 30 | 78 | 11 | 256QAM | 20 | 2/3 | 55304 | 24 | 1 | 7 | 82368 | 10296 |
|  | 40 | 30 | 106 | 11 | 256QAM | 20 | 2/3 | 73776 | 24 | 1 | 9 | 111936 | 13992 |
|  | 50 | 30 | 133 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 140448 | 17556 |
|  | 60 | 30 | 162 | 11 | 256QAM | 20 | 2/3 | 114776 | 24 | 1 | 14 | 171072 | 21384 |
|  | 80 | 30 | 217 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 229152 | 28644 |
|  | 90 | 30 | 245 | 11 | 256QAM | 20 | 2/3 | 172176 | 24 | 1 | 21 | 258720 | 32340 |
|  | 100 | 30 | 273 | 11 | 256QAM | 20 | 2/3 | 192624 | 24 | 1 | 23 | 288288 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.2.9-3: Reference Channels for CP-OFDM 256QAM for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size | Transport block CRC | LDPC Base Graph | Number of code blocks per slot (Note 3) | Total number of bits per slot | Total modulated symbols per slot |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 11 | 11 | 256QAM | 20 | 2/3 | 7680 | 24 | 1 | 1 | 11616 | 1452 |
|  | 15 | 60 | 18 | 11 | 256QAM | 20 | 2/3 | 12552 | 24 | 1 | 2 | 19008 | 2376 |
|  | 20 | 60 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 25 | 60 | 31 | 11 | 256QAM | 20 | 2/3 | 22032 | 24 | 1 | 3 | 32736 | 4092 |
|  | 30 | 60 | 38 | 11 | 256QAM | 20 | 2/3 | 26632 | 24 | 1 | 4 | 40128 | 5016 |
|  | 40 | 60 | 51 | 11 | 256QAM | 20 | 2/3 | 35856 | 24 | 1 | 5 | 53856 | 6732 |
|  | 50 | 60 | 65 | 11 | 256QAM | 20 | 2/3 | 46104 | 24 | 1 | 6 | 68640 | 8580 |
|  | 60 | 60 | 79 | 11 | 256QAM | 20 | 2/3 | 55304 | 24 | 1 | 7 | 83424 | 10428 |
|  | 80 | 60 | 107 | 11 | 256QAM | 20 | 2/3 | 75792 | 24 | 1 | 9 | 112992 | 14124 |
|  | 90 | 60 | 121 | 11 | 256QAM | 20 | 2/3 | 86040 | 24 | 1 | 11 | 127776 | 15972 |
|  | 100 | 60 | 135 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 142560 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

## A.2.3 Reference measurement channels for TDD

TDD slot patterns defined for reference sensitivity tests will be used for UL RMCs defined below.

### A.2.3.1 DFT-s-OFDM Pi/2-BPSK

Table A.2.3.1-1: Reference Channels for DFT-s-OFDM Pi/2-BPSK for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | pi/2 BPSK | 0 | 1/4 | 32 | 16 | 2 | 1 | 132 | 132 |
|  | 5 | 15 | 12 | 11 | pi/2 BPSK | 0 | 1/4 | 384 | 16 | 2 | 1 | 1584 | 1584 |
|  | 5 | 15 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 10 | 15 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 10 | 15 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 15 | 15 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 15 | 15 | 75 | 11 | pi/2 BPSK | 0 | 1/4 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
|  | 20 | 15 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 20 | 15 | 100 | 11 | pi/2 BPSK | 0 | 1/4 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
|  | 25 | 15 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 25 | 15 | 128 | 11 | pi/2 BPSK | 0 | 1/4 | 3976 | 24 | 2 | 2 | 16896 | 16896 |
|  | 30 | 15 | 80 | 11 | pi/2 BPSK | 0 | 1/4 | 2472 | 16 | 2 | 1 | 10560 | 10560 |
|  | 30 | 15 | 160 | 11 | pi/2 BPSK | 0 | 1/4 | 4872 | 24 | 2 | 2 | 21120 | 21120 |
|  | 40 | 15 | 108 | 11 | pi/2 BPSK | 0 | 1/4 | 3368 | 16 | 2 | 1 | 14256 | 14256 |
|  | 40 | 15 | 216 | 11 | pi/2 BPSK | 0 | 1/4 | 6664 | 24 | 2 | 2 | 28512 | 28512 |
|  | 50 | 15 | 135 | 11 | pi/2 BPSK | 0 | 1/4 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
|  | 50 | 15 | 270 | 11 | pi/2 BPSK | 0 | 1/4 | 8448 | 24 | 2 | 3 | 35640 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.3.1-2: Reference Channels for DFT-s-OFDM Pi/2-BPSK for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | pi/2 BPSK | 0 | 1/4 | 32 | 16 | 2 | 1 | 132 | 132 |
|  | 5 | 30 | 5 | 11 | pi/2 BPSK | 0 | 1/4 | 160 | 16 | 2 | 1 | 660 | 660 |
|  | 5 | 30 | 10 | 11 | pi/2 BPSK | 0 | 1/4 | 320 | 16 | 2 | 1 | 1320 | 1320 |
|  | 10 | 30 | 12 | 11 | pi/2 BPSK | 0 | 1/4 | 384 | 16 | 2 | 1 | 1584 | 1584 |
|  | 10 | 30 | 24 | 11 | pi/2 BPSK | 0 | 1/4 | 768 | 16 | 2 | 1 | 3168 | 3168 |
|  | 15 | 30 | 18 | 11 | pi/2 BPSK | 0 | 1/4 | 576 | 16 | 2 | 1 | 2376 | 2376 |
|  | 15 | 30 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 20 | 30 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 20 | 30 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 25 | 30 | 32 | 11 | pi/2 BPSK | 0 | 1/4 | 1032 | 16 | 2 | 1 | 4224 | 4224 |
|  | 25 | 30 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 30 | 30 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 30 | 30 | 75 | 11 | pi/2 BPSK | 0 | 1/4 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
|  | 40 | 30 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 40 | 30 | 100 | 11 | pi/2 BPSK | 0 | 1/4 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
|  | 50 | 30 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 50 | 30 | 128 | 11 | pi/2 BPSK | 0 | 1/4 | 3976 | 24 | 2 | 2 | 16896 | 16896 |
|  | 60 | 30 | 81 | 11 | pi/2 BPSK | 0 | 1/4 | 2536 | 16 | 2 | 1 | 10692 | 10692 |
|  | 60 | 30 | 162 | 11 | pi/2 BPSK | 0 | 1/4 | 5000 | 24 | 2 | 2 | 21384 | 21384 |
|  | 80 | 30 | 108 | 11 | pi/2 BPSK | 0 | 1/4 | 3368 | 16 | 2 | 1 | 14256 | 14256 |
|  | 80 | 30 | 216 | 11 | pi/2 BPSK | 0 | 1/4 | 6664 | 24 | 2 | 2 | 28512 | 28512 |
|  | 90 | 30 | 120 | 11 | pi/2 BPSK | 0 | 1/4 | 3752 | 16 | 2 | 1 | 15840 | 15840 |
|  | 90 | 30 | 243 | 11 | pi/2 BPSK | 0 | 1/4 | 7560 | 24 | 2 | 2 | 32076 | 32076 |
|  | 100 | 30 | 135 | 11 | pi/2 BPSK | 0 | 1/4 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
|  | 100 | 30 | 270 | 11 | pi/2 BPSK | 0 | 1/4 | 8448 | 24 | 2 | 3 | 35640 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.3.1-3: Reference Channels for DFT-s-OFDM Pi/2-BPSK for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | pi/2 BPSK | 0 | 1/4 | 32 | 16 | 2 | 1 | 132 | 132 |
|  | 10 | 60 | 5 | 11 | pi/2 BPSK | 0 | 1/4 | 160 | 16 | 2 | 1 | 660 | 660 |
|  | 10 | 60 | 10 | 11 | pi/2 BPSK | 0 | 1/4 | 320 | 16 | 2 | 1 | 1320 | 1320 |
|  | 15 | 60 | 9 | 11 | pi/2 BPSK | 0 | 1/4 | 288 | 16 | 2 | 1 | 1188 | 1188 |
|  | 15 | 60 | 18 | 11 | pi/2 BPSK | 0 | 1/4 | 576 | 16 | 2 | 1 | 2376 | 2376 |
|  | 20 | 60 | 12 | 11 | pi/2 BPSK | 0 | 1/4 | 384 | 16 | 2 | 1 | 1584 | 1584 |
|  | 20 | 60 | 24 | 11 | pi/2 BPSK | 0 | 1/4 | 768 | 16 | 2 | 1 | 3168 | 3168 |
|  | 25 | 60 | 15 | 11 | pi/2 BPSK | 0 | 1/4 | 480 | 16 | 2 | 1 | 1980 | 1980 |
|  | 25 | 60 | 30 | 11 | pi/2 BPSK | 0 | 1/4 | 984 | 16 | 2 | 1 | 3960 | 3960 |
|  | 30 | 60 | 18 | 11 | pi/2 BPSK | 0 | 1/4 | 576 | 16 | 2 | 1 | 2376 | 2376 |
|  | 30 | 60 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 40 | 60 | 25 | 11 | pi/2 BPSK | 0 | 1/4 | 808 | 16 | 2 | 1 | 3300 | 3300 |
|  | 40 | 60 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 50 | 60 | 32 | 11 | pi/2 BPSK | 0 | 1/4 | 1032 | 16 | 2 | 1 | 4224 | 4224 |
|  | 50 | 60 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 60 | 60 | 36 | 11 | pi/2 BPSK | 0 | 1/4 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
|  | 60 | 60 | 75 | 11 | pi/2 BPSK | 0 | 1/4 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
|  | 80 | 60 | 50 | 11 | pi/2 BPSK | 0 | 1/4 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
|  | 80 | 60 | 100 | 11 | pi/2 BPSK | 0 | 1/4 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
|  | 90 | 60 | 60 | 11 | pi/2 BPSK | 0 | 1/4 | 1864 | 16 | 2 | 1 | 7920 | 7920 |
|  | 90 | 60 | 120 | 11 | pi/2 BPSK | 0 | 1/4 | 3752 | 16 | 2 | 1 | 15840 | 15840 |
|  | 100 | 60 | 64 | 11 | pi/2 BPSK | 0 | 1/4 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
|  | 100 | 60 | 135 | 11 | pi/2 BPSK | 0 | 1/4 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.2 DFT-s-OFDM QPSK

Table A.2.3.2-1: Reference channels for DFT-s-OFDM QPSK for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 15 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 5 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 5 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 10 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 10 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 10 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 15 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 15 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 15 | 15 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 15 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 15 | 15 | 75 | 11 | QPSK | 2 | 1/6 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
|  | 20 | 15 | 20 | 11 | QPSK | 2 | 1/6 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
|  | 20 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 20 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 20 | 15 | 100 | 11 | QPSK | 2 | 1/6 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
|  | 25 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 25 | 15 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 25 | 15 | 128 | 11 | QPSK | 2 | 1/6 | 6408 | 24 | 2 | 2 | 33792 | 16896 |
|  | 30 | 15 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 30 | 15 | 80 | 11 | QPSK | 2 | 1/6 | 3976 | 24 | 2 | 2 | 21120 | 10560 |
|  | 30 | 15 | 160 | 11 | QPSK | 2 | 1/6 | 7944 | 24 | 2 | 3 | 42240 | 21120 |
|  | 40 | 15 | 108 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
|  | 40 | 15 | 216 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
|  | 50 | 15 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
|  | 50 | 15 | 270 | 11 | QPSK | 2 | 1/6 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.3.2-2: Reference channels for DFT-s-OFDM QPSK for 30kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 30 | 5 | 11 | QPSK | 2 | 1/6 | 256 | 16 | 2 | 1 | 1320 | 660 |
|  | 5 | 30 | 10 | 11 | QPSK | 2 | 1/6 | 504 | 16 | 2 | 1 | 2640 | 1320 |
|  | 10 | 30 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 10 | 30 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 15 | 30 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 15 | 30 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 20 | 30 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 20 | 30 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 25 | 30 | 32 | 11 | QPSK | 2 | 1/6 | 1608 | 16 | 2 | 1 | 8448 | 4224 |
|  | 25 | 30 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 30 | 30 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 30 | 30 | 75 | 11 | QPSK | 2 | 1/6 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
|  | 40 | 30 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 40 | 30 | 100 | 11 | QPSK | 2 | 1/6 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
|  | 50 | 30 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 50 | 30 | 128 | 11 | QPSK | 2 | 1/6 | 6408 | 24 | 2 | 2 | 33792 | 16896 |
|  | 60 | 30 | 81 | 11 | QPSK | 2 | 1/6 | 4040 | 24 | 2 | 2 | 21384 | 10692 |
|  | 60 | 30 | 162 | 11 | QPSK | 2 | 1/6 | 8064 | 24 | 2 | 3 | 42768 | 21384 |
|  | 80 | 30 | 108 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
|  | 80 | 30 | 216 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
|  | 90 | 30 | 120 | 11 | QPSK | 2 | 1/6 | 5896 | 24 | 2 | 2 | 31680 | 15840 |
|  | 90 | 30 | 243 | 11 | QPSK | 2 | 1/6 | 12040 | 24 | 2 | 4 | 64152 | 32076 |
|  | 100 | 30 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
|  | 100 | 30 | 270 | 11 | QPSK | 2 | 1/6 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

Table A.2.3.2-3: Reference channels for DFT-s-OFDM QPSK for 60kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 10 | 60 | 5 | 11 | QPSK | 2 | 1/6 | 256 | 16 | 2 | 1 | 1320 | 660 |
|  | 10 | 60 | 10 | 11 | QPSK | 2 | 1/6 | 504 | 16 | 2 | 1 | 2640 | 1320 |
|  | 15 | 60 | 9 | 11 | QPSK | 2 | 1/6 | 456 | 16 | 2 | 1 | 2376 | 1188 |
|  | 15 | 60 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 20 | 60 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 20 | 60 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 25 | 60 | 15 | 11 | QPSK | 2 | 1/6 | 768 | 16 | 2 | 1 | 3960 | 1980 |
|  | 25 | 60 | 30 | 11 | QPSK | 2 | 1/6 | 1544 | 16 | 2 | 1 | 7920 | 3960 |
|  | 30 | 60 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 30 | 60 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 40 | 60 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 40 | 60 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 50 | 60 | 32 | 11 | QPSK | 2 | 1/6 | 1608 | 16 | 2 | 1 | 8448 | 4224 |
|  | 50 | 60 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 60 | 60 | 36 | 11 | QPSK | 2 | 1/6 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
|  | 60 | 60 | 75 | 11 | QPSK | 2 | 1/6 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
|  | 80 | 60 | 50 | 11 | QPSK | 2 | 1/6 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
|  | 80 | 60 | 100 | 11 | QPSK | 2 | 1/6 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
|  | 90 | 60 | 60 | 11 | QPSK | 2 | 1/6 | 3104 | 16 | 2 | 1 | 15840 | 7920 |
|  | 90 | 60 | 120 | 11 | QPSK | 2 | 1/6 | 5896 | 24 | 2 | 2 | 31680 | 15840 |
|  | 100 | 60 | 64 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
|  | 100 | 60 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.3 DFT-s-OFDM 16QAM

Table A.2.3.3-1: Reference channels for DFT-s-OFDM 16QAM for 15kHz SCS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 15 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 5 | 15 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 10 | 15 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 10 | 15 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 15 | 15 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 15 | 15 | 75 | 11 | 16QAM | 10 | 1/3 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
|  | 20 | 15 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 20 | 15 | 100 | 11 | 16QAM | 10 | 1/3 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
|  | 25 | 15 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 25 | 15 | 128 | 11 | 16QAM | 10 | 1/3 | 22536 | 24 | 1 | 3 | 67584 | 16896 |
|  | 30 | 15 | 80 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42240 | 10560 |
|  | 30 | 15 | 160 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 84480 | 21120 |
|  | 40 | 15 | 108 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
|  | 40 | 15 | 216 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
|  | 50 | 15 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
|  | 50 | 15 | 270 | 11 | 16QAM | 10 | 1/3 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.3-2: Reference channels for DFT-s-OFDM 16QAM for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 30 | 5 | 11 | 16QAM | 10 | 1/3 | 888 | 16 | 2 | 1 | 2640 | 660 |
|  | 5 | 30 | 10 | 11 | 16QAM | 10 | 1/3 | 1800 | 16 | 2 | 1 | 5280 | 1320 |
|  | 10 | 30 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 10 | 30 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 15 | 30 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 15 | 30 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 20 | 30 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 20 | 30 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 25 | 30 | 32 | 11 | 16QAM | 10 | 1/3 | 5632 | 24 | 1 | 1 | 16896 | 4224 |
|  | 25 | 30 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 30 | 30 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 30 | 30 | 75 | 11 | 16QAM | 10 | 1/3 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
|  | 40 | 30 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 40 | 30 | 100 | 11 | 16QAM | 10 | 1/3 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
|  | 50 | 30 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 50 | 30 | 128 | 11 | 16QAM | 10 | 1/3 | 22536 | 24 | 1 | 3 | 67584 | 16896 |
|  | 60 | 30 | 81 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42768 | 10692 |
|  | 60 | 30 | 162 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 85536 | 21384 |
|  | 80 | 30 | 108 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
|  | 80 | 30 | 216 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
|  | 90 | 30 | 120 | 11 | 16QAM | 10 | 1/3 | 21000 | 24 | 1 | 3 | 63360 | 15840 |
|  | 90 | 30 | 243 | 11 | 16QAM | 10 | 1/3 | 43032 | 24 | 1 | 6 | 128304 | 32076 |
|  | 100 | 30 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
|  | 100 | 30 | 270 | 11 | 16QAM | 10 | 1/3 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.3-3: Reference channels for DFT-s-OFDM 16QAM for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 10 | 60 | 5 | 11 | 16QAM | 10 | 1/3 | 888 | 16 | 2 | 1 | 2640 | 660 |
|  | 10 | 60 | 10 | 11 | 16QAM | 10 | 1/3 | 1800 | 16 | 2 | 1 | 5280 | 1320 |
|  | 15 | 60 | 9 | 11 | 16QAM | 10 | 1/3 | 1608 | 16 | 2 | 1 | 4752 | 1188 |
|  | 15 | 60 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 20 | 60 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 20 | 60 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 25 | 60 | 15 | 11 | 16QAM | 10 | 1/3 | 2664 | 16 | 2 | 1 | 7920 | 1980 |
|  | 25 | 60 | 30 | 11 | 16QAM | 10 | 1/3 | 5248 | 24 | 1 | 1 | 15840 | 3960 |
|  | 30 | 60 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 30 | 60 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 40 | 60 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 40 | 60 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 50 | 60 | 32 | 11 | 16QAM | 10 | 1/3 | 5632 | 24 | 1 | 1 | 16896 | 4224 |
|  | 50 | 60 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 60 | 60 | 36 | 11 | 16QAM | 10 | 1/3 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
|  | 60 | 60 | 75 | 11 | 16QAM | 10 | 1/3 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
|  | 80 | 60 | 50 | 11 | 16QAM | 10 | 1/3 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
|  | 80 | 60 | 100 | 11 | 16QAM | 10 | 1/3 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
|  | 90 | 60 | 60 | 11 | 16QAM | 10 | 1/3 | 10504 | 24 | 1 | 2 | 31680 | 7920 |
|  | 90 | 60 | 120 | 11 | 16QAM | 10 | 1/3 | 21000 | 24 | 1 | 3 | 63360 | 15840 |
|  | 100 | 60 | 64 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
|  | 100 | 60 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.4 DFT-s-OFDM 64QAM

**Table A.2.3.4-1: Reference channels for DFT-s-OFDM 64QAM for 15kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 64QAM | 18 | 1/2 | 9992 | 24 | 1 | 2 | 19800 | 3300 |
|  | 10 | 15 | 50 | 11 | 64QAM | 18 | 1/2 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
|  | 15 | 15 | 75 | 11 | 64QAM | 18 | 1/2 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
|  | 20 | 15 | 100 | 11 | 64QAM | 18 | 1/2 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
|  | 25 | 15 | 128 | 11 | 64QAM | 18 | 1/2 | 51216 | 24 | 1 | 7 | 101376 | 16896 |
|  | 30 | 15 | 160 | 11 | 64QAM | 18 | 1/2 | 63528 | 24 | 1 | 8 | 126720 | 21120 |
|  | 40 | 15 | 216 | 11 | 64QAM | 18 | 1/2 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
|  | 50 | 15 | 270 | 11 | 64QAM | 18 | 1/2 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.4-2: Reference channels for DFT-s-OFDM 64QAM for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 10 | 11 | 64QAM | 18 | 1/2 | 3968 | 24 | 1 | 1 | 7920 | 1320 |
|  | 10 | 30 | 24 | 11 | 64QAM | 18 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 15 | 30 | 36 | 11 | 64QAM | 18 | 1/2 | 14344 | 24 | 1 | 2 | 28512 | 4752 |
|  | 20 | 30 | 50 | 11 | 64QAM | 18 | 1/2 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
|  | 25 | 30 | 64 | 11 | 64QAM | 18 | 1/2 | 25608 | 24 | 1 | 4 | 50688 | 8448 |
|  | 30 | 30 | 75 | 11 | 64QAM | 18 | 1/2 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
|  | 40 | 30 | 100 | 11 | 64QAM | 18 | 1/2 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
|  | 50 | 30 | 128 | 11 | 64QAM | 18 | 1/2 | 51216 | 24 | 1 | 7 | 101376 | 16896 |
|  | 60 | 30 | 162 | 11 | 64QAM | 18 | 1/2 | 64552 | 24 | 1 | 8 | 128304 | 21384 |
|  | 80 | 30 | 216 | 11 | 64QAM | 18 | 1/2 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
|  | 90 | 30 | 243 | 11 | 64QAM | 18 | 1/2 | 96264 | 24 | 1 | 12 | 192456 | 32076 |
|  | 100 | 30 | 270 | 11 | 64QAM | 18 | 1/2 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.4-3: Reference channels for DFT-s-OFDM 64QAM for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 10 | 11 | 64QAM | 18 | 1/2 | 3968 | 24 | 1 | 1 | 7920 | 1320 |
|  | 15 | 60 | 18 | 11 | 64QAM | 18 | 1/2 | 7168 | 24 | 1 | 1 | 14256 | 2376 |
|  | 20 | 60 | 24 | 11 | 64QAM | 18 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 25 | 60 | 30 | 11 | 64QAM | 18 | 1/2 | 12040 | 24 | 1 | 2 | 23760 | 3960 |
|  | 30 | 60 | 36 | 11 | 64QAM | 18 | 1/2 | 14344 | 24 | 1 | 2 | 28512 | 4752 |
|  | 40 | 60 | 50 | 11 | 64QAM | 18 | 1/2 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
|  | 50 | 60 | 64 | 11 | 64QAM | 18 | 1/2 | 25608 | 24 | 1 | 4 | 50688 | 8448 |
|  | 60 | 60 | 75 | 11 | 64QAM | 18 | 1/2 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
|  | 80 | 60 | 100 | 11 | 64QAM | 18 | 1/2 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
|  | 90 | 60 | 120 | 11 | 64QAM | 18 | 1/2 | 48168 | 24 | 1 | 6 | 95040 | 15840 |
|  | 100 | 60 | 135 | 11 | 64QAM | 18 | 1/2 | 54296 | 24 | 1 | 7 | 106920 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.5 DFT-s-OFDM 256QAM

**Table A.2.3.5-1: Reference channels for DFT-s-OFDM 256QAM for 15kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 256QAM | 20 | 2/3 | 17424 | 24 | 1 | 3 | 26400 | 3300 |
|  | 10 | 15 | 50 | 11 | 256QAM | 20 | 2/3 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
|  | 15 | 15 | 75 | 11 | 256QAM | 20 | 2/3 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
|  | 20 | 15 | 100 | 11 | 256QAM | 20 | 2/3 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
|  | 25 | 15 | 128 | 11 | 256QAM | 20 | 2/3 | 90176 | 24 | 1 | 11 | 135168 | 16896 |
|  | 30 | 15 | 160 | 11 | 256QAM | 20 | 2/3 | 112648 | 24 | 1 | 14 | 168960 | 21120 |
|  | 40 | 15 | 216 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
|  | 50 | 15 | 270 | 11 | 256QAM | 20 | 2/3 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.5-2: Reference channels for DFT-s-OFDM 256QAM for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 10 | 11 | 256QAM | 20 | 2/3 | 7040 | 24 | 1 | 1 | 10560 | 1320 |
|  | 10 | 30 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 15 | 30 | 36 | 11 | 256QAM | 20 | 2/3 | 25104 | 24 | 1 | 3 | 38016 | 4752 |
|  | 20 | 30 | 50 | 11 | 256QAM | 20 | 2/3 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
|  | 25 | 30 | 64 | 11 | 256QAM | 20 | 2/3 | 45096 | 24 | 1 | 6 | 67584 | 8448 |
|  | 30 | 30 | 75 | 11 | 256QAM | 20 | 2/3 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
|  | 40 | 30 | 100 | 11 | 256QAM | 20 | 2/3 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
|  | 50 | 30 | 128 | 11 | 256QAM | 20 | 2/3 | 90176 | 24 | 1 | 11 | 135168 | 16896 |
|  | 60 | 30 | 162 | 11 | 256QAM | 20 | 2/3 | 114776 | 24 | 1 | 14 | 171072 | 21384 |
|  | 80 | 30 | 216 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
|  | 90 | 30 | 243 | 11 | 256QAM | 20 | 2/3 | 172176 | 24 | 1 | 21 | 256608 | 32076 |
|  | 100 | 30 | 270 | 11 | 256QAM | 20 | 2/3 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.5-3: Reference channels for DFT-s-OFDM 256QAM for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 10 | 11 | 256QAM | 20 | 2/3 | 7040 | 24 | 1 | 1 | 10560 | 1320 |
|  | 15 | 60 | 18 | 11 | 256QAM | 20 | 2/3 | 12552 | 24 | 1 | 2 | 19008 | 2376 |
|  | 20 | 60 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 25 | 60 | 30 | 11 | 256QAM | 20 | 2/3 | 21000 | 24 | 1 | 3 | 31680 | 3960 |
|  | 30 | 60 | 36 | 11 | 256QAM | 20 | 2/3 | 25104 | 24 | 1 | 3 | 38016 | 4752 |
|  | 40 | 60 | 50 | 11 | 256QAM | 20 | 2/3 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
|  | 50 | 60 | 64 | 11 | 256QAM | 20 | 2/3 | 45096 | 24 | 1 | 6 | 67584 | 8448 |
|  | 60 | 60 | 75 | 11 | 256QAM | 20 | 2/3 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
|  | 80 | 60 | 100 | 11 | 256QAM | 20 | 2/3 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
|  | 90 | 60 | 120 | 11 | 256QAM | 20 | 2/3 | 83976 | 24 | 1 | 10 | 126720 | 15840 |
|  | 100 | 60 | 135 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 142560 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.6 CP-OFDM QPSK

**Table A.2.3.6-1: Reference channels for CP-OFDM QPSK for 15kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 15 | 13 | 11 | QPSK | 2 | 1/6 | 672 | 16 | 2 | 1 | 3432 | 1716 |
|  | 5 | 15 | 25 | 11 | QPSK | 2 | 1/6 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
|  | 10 | 15 | 26 | 11 | QPSK | 2 | 1/6 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
|  | 10 | 15 | 52 | 11 | QPSK | 2 | 1/6 | 2600 | 16 | 2 | 1 | 13728 | 6864 |
|  | 15 | 15 | 40 | 11 | QPSK | 2 | 1/6 | 2024 | 16 | 2 | 1 | 10560 | 5280 |
|  | 15 | 15 | 79 | 11 | QPSK | 2 | 1/6 | 3912 | 24 | 2 | 2 | 20856 | 10428 |
|  | 20 | 15 | 53 | 11 | QPSK | 2 | 1/6 | 2664 | 16 | 2 | 1 | 13992 | 6996 |
|  | 20 | 15 | 106 | 11 | QPSK | 2 | 1/6 | 5256 | 24 | 2 | 2 | 27984 | 13992 |
|  | 25 | 15 | 67 | 11 | QPSK | 2 | 1/6 | 3368 | 16 | 2 | 1 | 17688 | 8844 |
|  | 25 | 15 | 133 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35112 | 17556 |
|  | 30 | 15 | 80 | 11 | QPSK | 2 | 1/6 | 3976 | 24 | 2 | 2 | 21120 | 10560 |
|  | 30 | 15 | 160 | 11 | QPSK | 2 | 1/6 | 7944 | 24 | 2 | 3 | 42240 | 21120 |
|  | 40 | 15 | 108 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
|  | 40 | 15 | 216 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
|  | 50 | 15 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
|  | 50 | 15 | 270 | 11 | QPSK | 2 | 1/6 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.6-2: Reference channels for CP-OFDM QPSK for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 5 | 30 | 6 | 11 | QPSK | 2 | 1/6 | 304 | 16 | 2 | 1 | 1584 | 792 |
|  | 5 | 30 | 11 | 11 | QPSK | 2 | 1/6 | 552 | 16 | 2 | 1 | 2904 | 1452 |
|  | 10 | 30 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 10 | 30 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 15 | 30 | 19 | 11 | QPSK | 2 | 1/6 | 984 | 16 | 2 | 1 | 5016 | 2508 |
|  | 15 | 30 | 38 | 11 | QPSK | 2 | 1/6 | 1928 | 16 | 2 | 1 | 10032 | 5016 |
|  | 20 | 30 | 26 | 11 | QPSK | 2 | 1/6 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
|  | 20 | 30 | 51 | 11 | QPSK | 2 | 1/6 | 2536 | 16 | 2 | 1 | 13464 | 6732 |
|  | 25 | 30 | 33 | 11 | QPSK | 2 | 1/6 | 1672 | 16 | 2 | 1 | 8712 | 4356 |
|  | 25 | 30 | 65 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 17160 | 8580 |
|  | 30 | 30 | 39 | 11 | QPSK | 2 | 1/6 | 2024 | 16 | 2 | 1 | 10296 | 5148 |
|  | 30 | 30 | 78 | 11 | QPSK | 2 | 1/6 | 3848 | 24 | 2 | 2 | 20592 | 10296 |
|  | 40 | 30 | 53 | 11 | QPSK | 2 | 1/6 | 2664 | 16 | 2 | 1 | 13992 | 6996 |
|  | 40 | 30 | 106 | 11 | QPSK | 2 | 1/6 | 5256 | 24 | 2 | 2 | 27984 | 13992 |
|  | 50 | 30 | 67 | 11 | QPSK | 2 | 1/6 | 3368 | 16 | 2 | 1 | 17688 | 8844 |
|  | 50 | 30 | 133 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35112 | 17556 |
|  | 60 | 30 | 81 | 11 | QPSK | 2 | 1/6 | 4040 | 24 | 2 | 2 | 21384 | 10692 |
|  | 60 | 30 | 162 | 11 | QPSK | 2 | 1/6 | 8064 | 24 | 2 | 3 | 42768 | 21384 |
|  | 80 | 30 | 109 | 11 | QPSK | 2 | 1/6 | 5384 | 24 | 2 | 2 | 28776 | 14388 |
|  | 80 | 30 | 217 | 11 | QPSK | 2 | 1/6 | 10752 | 24 | 2 | 3 | 57288 | 28644 |
|  | 90 | 30 | 123 | 11 | QPSK | 2 | 1/6 | 6152 | 24 | 2 | 2 | 32472 | 16236 |
|  | 90 | 30 | 245 | 11 | QPSK | 2 | 1/6 | 12296 | 24 | 2 | 4 | 64680 | 32340 |
|  | 100 | 30 | 137 | 11 | QPSK | 2 | 1/6 | 6792 | 24 | 2 | 2 | 36168 | 18084 |
|  | 100 | 30 | 273 | 11 | QPSK | 2 | 1/6 | 13576 | 24 | 2 | 4 | 72072 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.6-3: Reference channels for CP-OFDM QPSK for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | QPSK | 2 | 1/6 | 56 | 16 | 2 | 1 | 264 | 132 |
|  | 10 | 60 | 6 | 11 | QPSK | 2 | 1/6 | 304 | 16 | 2 | 1 | 1584 | 792 |
|  | 10 | 60 | 11 | 11 | QPSK | 2 | 1/6 | 552 | 16 | 2 | 1 | 2904 | 1452 |
|  | 15 | 60 | 9 | 11 | QPSK | 2 | 1/6 | 456 | 16 | 2 | 1 | 2376 | 1188 |
|  | 15 | 60 | 18 | 11 | QPSK | 2 | 1/6 | 928 | 16 | 2 | 1 | 4752 | 2376 |
|  | 20 | 60 | 12 | 11 | QPSK | 2 | 1/6 | 608 | 16 | 2 | 1 | 3168 | 1584 |
|  | 20 | 60 | 24 | 11 | QPSK | 2 | 1/6 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
|  | 25 | 60 | 16 | 11 | QPSK | 2 | 1/6 | 808 | 16 | 2 | 1 | 4224 | 2112 |
|  | 25 | 60 | 31 | 11 | QPSK | 2 | 1/6 | 1544 | 16 | 2 | 1 | 8184 | 4092 |
|  | 30 | 60 | 19 | 11 | QPSK | 2 | 1/6 | 984 | 16 | 2 | 1 | 5016 | 2508 |
|  | 30 | 60 | 38 | 11 | QPSK | 2 | 1/6 | 1928 | 16 | 2 | 1 | 10032 | 5016 |
|  | 40 | 60 | 26 | 11 | QPSK | 2 | 1/6 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
|  | 40 | 60 | 51 | 11 | QPSK | 2 | 1/6 | 2536 | 16 | 2 | 1 | 13464 | 6732 |
|  | 50 | 60 | 33 | 11 | QPSK | 2 | 1/6 | 1672 | 16 | 2 | 1 | 8712 | 4356 |
|  | 50 | 60 | 65 | 11 | QPSK | 2 | 1/6 | 3240 | 16 | 2 | 1 | 17160 | 8580 |
|  | 60 | 60 | 40 | 11 | QPSK | 2 | 1/6 | 2024 | 16 | 2 | 1 | 10560 | 5280 |
|  | 60 | 60 | 79 | 11 | QPSK | 2 | 1/6 | 3912 | 24 | 2 | 2 | 20856 | 10428 |
|  | 80 | 60 | 54 | 11 | QPSK | 2 | 1/6 | 2664 | 16 | 2 | 1 | 14256 | 7128 |
|  | 80 | 60 | 107 | 11 | QPSK | 2 | 1/6 | 5256 | 24 | 2 | 2 | 28248 | 14124 |
|  | 90 | 60 | 61 | 11 | QPSK | 2 | 1/6 | 3104 | 16 | 2 | 1 | 16104 | 8052 |
|  | 90 | 60 | 121 | 11 | QPSK | 2 | 1/6 | 6024 | 24 | 2 | 2 | 31944 | 15972 |
|  | 100 | 60 | 68 | 11 | QPSK | 2 | 1/6 | 3368 | 16 | 2 | 1 | 17952 | 8976 |
|  | 100 | 60 | 135 | 11 | QPSK | 2 | 1/6 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.7 CP-OFDM 16QAM

**Table A.2.3.7-1: Reference channels for CP-OFDM 16QAM for 15kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 15 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 15 | 13 | 11 | 16QAM | 10 | 1/3 | 2280 | 16 | 2 | 1 | 6864 | 1716 |
|  | 5 | 15 | 25 | 11 | 16QAM | 10 | 1/3 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
|  | 10 | 15 | 26 | 11 | 16QAM | 10 | 1/3 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
|  | 10 | 15 | 52 | 11 | 16QAM | 10 | 1/3 | 9224 | 24 | 1 | 2 | 27456 | 6864 |
|  | 15 | 15 | 40 | 11 | 16QAM | 10 | 1/3 | 7040 | 24 | 1 | 1 | 21120 | 5280 |
|  | 15 | 15 | 79 | 11 | 16QAM | 10 | 1/3 | 13832 | 24 | 1 | 2 | 41712 | 10428 |
|  | 20 | 15 | 53 | 11 | 16QAM | 10 | 1/3 | 9224 | 24 | 1 | 2 | 27984 | 6996 |
|  | 20 | 15 | 106 | 11 | 16QAM | 10 | 1/3 | 18432 | 24 | 1 | 3 | 55968 | 13992 |
|  | 25 | 15 | 67 | 11 | 16QAM | 10 | 1/3 | 11784 | 24 | 1 | 2 | 35376 | 8844 |
|  | 25 | 15 | 133 | 11 | 16QAM | 10 | 1/3 | 23040 | 24 | 1 | 3 | 70224 | 17556 |
|  | 30 | 15 | 80 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42240 | 10560 |
|  | 30 | 15 | 160 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 84480 | 21120 |
|  | 40 | 15 | 108 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
|  | 40 | 15 | 216 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
|  | 50 | 15 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
|  | 50 | 15 | 270 | 11 | 16QAM | 10 | 1/3 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.7-2: Reference channels for CP-OFDM 16QAM for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5-50 | 30 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 5 | 30 | 6 | 11 | 16QAM | 10 | 1/3 | 1064 | 16 | 2 | 1 | 3168 | 792 |
|  | 5 | 30 | 11 | 11 | 16QAM | 10 | 1/3 | 1928 | 16 | 2 | 1 | 5808 | 1452 |
|  | 10 | 30 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 10 | 30 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 15 | 30 | 19 | 11 | 16QAM | 10 | 1/3 | 3368 | 16 | 2 | 1 | 10032 | 2508 |
|  | 15 | 30 | 38 | 11 | 16QAM | 10 | 1/3 | 6656 | 24 | 1 | 1 | 20064 | 5016 |
|  | 20 | 30 | 26 | 11 | 16QAM | 10 | 1/3 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
|  | 20 | 30 | 51 | 11 | 16QAM | 10 | 1/3 | 8968 | 24 | 1 | 2 | 26928 | 6732 |
|  | 25 | 30 | 33 | 11 | 16QAM | 10 | 1/3 | 5760 | 24 | 1 | 1 | 17424 | 4356 |
|  | 25 | 30 | 65 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 34320 | 8580 |
|  | 30 | 30 | 39 | 11 | 16QAM | 10 | 1/3 | 6784 | 24 | 1 | 1 | 20592 | 5148 |
|  | 30 | 30 | 78 | 11 | 16QAM | 10 | 1/3 | 13576 | 24 | 1 | 2 | 41184 | 10296 |
|  | 40 | 30 | 53 | 11 | 16QAM | 10 | 1/3 | 9224 | 24 | 1 | 2 | 27984 | 6996 |
|  | 40 | 30 | 106 | 11 | 16QAM | 10 | 1/3 | 18432 | 24 | 1 | 3 | 55968 | 13992 |
|  | 50 | 30 | 67 | 11 | 16QAM | 10 | 1/3 | 11784 | 24 | 1 | 2 | 35376 | 8844 |
|  | 50 | 30 | 133 | 11 | 16QAM | 10 | 1/3 | 23040 | 24 | 1 | 3 | 70224 | 17556 |
|  | 60 | 30 | 81 | 11 | 16QAM | 10 | 1/3 | 14088 | 24 | 1 | 2 | 42768 | 10692 |
|  | 60 | 30 | 162 | 11 | 16QAM | 10 | 1/3 | 28168 | 24 | 1 | 4 | 85536 | 21384 |
|  | 80 | 30 | 109 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 57552 | 14388 |
|  | 80 | 30 | 217 | 11 | 16QAM | 10 | 1/3 | 37896 | 24 | 1 | 5 | 114576 | 28644 |
|  | 90 | 30 | 123 | 11 | 16QAM | 10 | 1/3 | 21504 | 24 | 1 | 3 | 64944 | 16236 |
|  | 90 | 30 | 245 | 11 | 16QAM | 10 | 1/3 | 43032 | 24 | 1 | 6 | 129360 | 32340 |
|  | 100 | 30 | 137 | 11 | 16QAM | 10 | 1/3 | 24072 | 24 | 1 | 3 | 72336 | 18084 |
|  | 100 | 30 | 273 | 11 | 16QAM | 10 | 1/3 | 48168 | 24 | 1 | 6 | 144144 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.7-3: Reference channels for CP-OFDM 16QAM for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10-100 | 60 | 1 | 11 | 16QAM | 10 | 1/3 | 176 | 16 | 2 | 1 | 528 | 132 |
|  | 10 | 60 | 6 | 11 | 16QAM | 10 | 1/3 | 1064 | 16 | 2 | 1 | 3168 | 792 |
|  | 10 | 60 | 11 | 11 | 16QAM | 10 | 1/3 | 1928 | 16 | 2 | 1 | 5808 | 1452 |
|  | 15 | 60 | 9 | 11 | 16QAM | 10 | 1/3 | 1608 | 16 | 2 | 1 | 4752 | 1188 |
|  | 15 | 60 | 18 | 11 | 16QAM | 10 | 1/3 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
|  | 20 | 60 | 12 | 11 | 16QAM | 10 | 1/3 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
|  | 20 | 60 | 24 | 11 | 16QAM | 10 | 1/3 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
|  | 25 | 60 | 16 | 11 | 16QAM | 10 | 1/3 | 2792 | 16 | 2 | 1 | 8448 | 2112 |
|  | 25 | 60 | 31 | 11 | 16QAM | 10 | 1/3 | 5376 | 24 | 1 | 1 | 16368 | 4092 |
|  | 30 | 60 | 19 | 11 | 16QAM | 10 | 1/3 | 3368 | 16 | 2 | 1 | 10032 | 2508 |
|  | 30 | 60 | 38 | 11 | 16QAM | 10 | 1/3 | 6656 | 24 | 1 | 1 | 20064 | 5016 |
|  | 40 | 60 | 26 | 11 | 16QAM | 10 | 1/3 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
|  | 40 | 60 | 51 | 11 | 16QAM | 10 | 1/3 | 8968 | 24 | 1 | 2 | 26928 | 6732 |
|  | 50 | 60 | 33 | 11 | 16QAM | 10 | 1/3 | 5760 | 24 | 1 | 1 | 17424 | 4356 |
|  | 50 | 60 | 65 | 11 | 16QAM | 10 | 1/3 | 11272 | 24 | 1 | 2 | 34320 | 8580 |
|  | 60 | 60 | 40 | 11 | 16QAM | 10 | 1/3 | 7040 | 24 | 1 | 1 | 21120 | 5280 |
|  | 60 | 60 | 79 | 11 | 16QAM | 10 | 1/3 | 13832 | 24 | 1 | 2 | 41712 | 10428 |
|  | 80 | 60 | 54 | 11 | 16QAM | 10 | 1/3 | 9480 | 24 | 1 | 2 | 28512 | 7128 |
|  | 80 | 60 | 107 | 11 | 16QAM | 10 | 1/3 | 18960 | 24 | 1 | 3 | 56496 | 14124 |
|  | 90 | 60 | 61 | 11 | 16QAM | 10 | 1/3 | 10760 | 24 | 1 | 2 | 32208 | 8052 |
|  | 90 | 60 | 121 | 11 | 16QAM | 10 | 1/3 | 21000 | 24 | 1 | 3 | 63888 | 15972 |
|  | 100 | 60 | 68 | 11 | 16QAM | 10 | 1/3 | 11784 | 24 | 1 | 2 | 35904 | 8976 |
|  | 100 | 60 | 135 | 11 | 16QAM | 10 | 1/3 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.8 CP-OFDM 64QAM

**Table A.2.3.8-1: Reference channels for CP-OFDM 64QAM for 15kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 64QAM | 19 | 1/2 | 9992 | 24 | 1 | 2 | 19800 | 3300 |
|  | 10 | 15 | 52 | 11 | 64QAM | 19 | 1/2 | 21000 | 24 | 1 | 3 | 41184 | 6864 |
|  | 15 | 15 | 79 | 11 | 64QAM | 19 | 1/2 | 31752 | 24 | 1 | 4 | 62568 | 10428 |
|  | 20 | 15 | 106 | 11 | 64QAM | 19 | 1/2 | 42016 | 24 | 1 | 5 | 83952 | 13992 |
|  | 25 | 15 | 133 | 11 | 64QAM | 19 | 1/2 | 53288 | 24 | 1 | 7 | 105336 | 17556 |
|  | 30 | 15 | 160 | 11 | 64QAM | 19 | 1/2 | 63528 | 24 | 1 | 8 | 126720 | 21120 |
|  | 40 | 15 | 216 | 11 | 64QAM | 19 | 1/2 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
|  | 50 | 15 | 270 | 11 | 64QAM | 19 | 1/2 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.8-2: Reference channels for CP-OFDM 64QAM for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 11 | 11 | 64QAM | 19 | 1/2 | 4352 | 24 | 1 | 1 | 8712 | 1452 |
|  | 10 | 30 | 24 | 11 | 64QAM | 19 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 15 | 30 | 38 | 11 | 64QAM | 19 | 1/2 | 15112 | 24 | 1 | 2 | 30096 | 5016 |
|  | 20 | 30 | 51 | 11 | 64QAM | 19 | 1/2 | 20496 | 24 | 1 | 3 | 40392 | 6732 |
|  | 25 | 30 | 65 | 11 | 64QAM | 19 | 1/2 | 26120 | 24 | 1 | 4 | 51480 | 8580 |
|  | 30 | 30 | 78 | 11 | 64QAM | 19 | 1/2 | 31240 | 24 | 1 | 4 | 61776 | 10296 |
|  | 40 | 30 | 106 | 11 | 64QAM | 19 | 1/2 | 42016 | 24 | 1 | 5 | 83952 | 13992 |
|  | 50 | 30 | 133 | 11 | 64QAM | 19 | 1/2 | 53288 | 24 | 1 | 7 | 105336 | 17556 |
|  | 60 | 30 | 162 | 11 | 64QAM | 19 | 1/2 | 64552 | 24 | 1 | 8 | 128304 | 21384 |
|  | 80 | 30 | 217 | 11 | 64QAM | 19 | 1/2 | 86040 | 24 | 1 | 11 | 171864 | 28644 |
|  | 90 | 30 | 245 | 11 | 64QAM | 19 | 1/2 | 98376 | 24 | 1 | 12 | 194040 | 32340 |
|  | 100 | 30 | 273 | 11 | 64QAM | 19 | 1/2 | 108552 | 24 | 1 | 13 | 216216 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.8-3: Reference channels for CP-OFDM 64QAM for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 11 | 11 | 64QAM | 19 | 1/2 | 4352 | 24 | 1 | 1 | 8712 | 1452 |
|  | 15 | 60 | 18 | 11 | 64QAM | 19 | 1/2 | 7168 | 24 | 1 | 1 | 14256 | 2376 |
|  | 20 | 60 | 24 | 11 | 64QAM | 19 | 1/2 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
|  | 25 | 60 | 31 | 11 | 64QAM | 19 | 1/2 | 12296 | 24 | 1 | 2 | 24552 | 4092 |
|  | 30 | 60 | 38 | 11 | 64QAM | 19 | 1/2 | 15112 | 24 | 1 | 2 | 30096 | 5016 |
|  | 40 | 60 | 51 | 11 | 64QAM | 19 | 1/2 | 20496 | 24 | 1 | 3 | 40392 | 6732 |
|  | 50 | 60 | 65 | 11 | 64QAM | 19 | 1/2 | 26120 | 24 | 1 | 4 | 51480 | 8580 |
|  | 60 | 60 | 79 | 11 | 64QAM | 19 | 1/2 | 31752 | 24 | 1 | 4 | 62568 | 10428 |
|  | 80 | 60 | 107 | 11 | 64QAM | 19 | 1/2 | 43032 | 24 | 1 | 6 | 84744 | 14124 |
|  | 90 | 60 | 121 | 11 | 64QAM | 19 | 1/2 | 48168 | 24 | 1 | 6 | 95832 | 15972 |
|  | 100 | 60 | 135 | 11 | 64QAM | 19 | 1/2 | 54296 | 24 | 1 | 7 | 106920 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

### A.2.3.9 CP-OFDM 256QAM

**Table A.2.3.9-1: Reference channels for CP-OFDM 256QAM for 15kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4 and 9 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4 and 9 (Note 3) | Total number of bits per slot for slots 4 and 9 | Total modulated symbols per slot for slots 4 and 9 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 15 | 25 | 11 | 256QAM | 20 | 2/3 | 17424 | 24 | 1 | 3 | 26400 | 3300 |
|  | 10 | 15 | 52 | 11 | 256QAM | 20 | 2/3 | 36896 | 24 | 1 | 5 | 54912 | 6864 |
|  | 15 | 15 | 79 | 11 | 256QAM | 20 | 2/3 | 55304 | 24 | 1 | 7 | 83424 | 10428 |
|  | 20 | 15 | 106 | 11 | 256QAM | 20 | 2/3 | 73776 | 24 | 1 | 9 | 111936 | 13992 |
|  | 25 | 15 | 133 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 140448 | 17556 |
|  | 30 | 15 | 160 | 11 | 256QAM | 20 | 2/3 | 112648 | 24 | 1 | 14 | 168960 | 21120 |
|  | 40 | 15 | 216 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
|  | 50 | 15 | 270 | 11 | 256QAM | 20 | 2/3 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.9-2: Reference channels for CP-OFDM 256QAM for 30kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 8, 9, 18 and 19 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3) | Total number of bits per slot for slots 8, 9, 18 and 19 | Total modulated symbols per slot for slots 8, 9, 18 and 19 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 5 | 30 | 11 | 11 | 256QAM | 20 | 2/3 | 7680 | 24 | 1 | 1 | 11616 | 1452 |
|  | 10 | 30 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 15 | 30 | 38 | 11 | 256QAM | 20 | 2/3 | 26632 | 24 | 1 | 4 | 40128 | 5016 |
|  | 20 | 30 | 51 | 11 | 256QAM | 20 | 2/3 | 35856 | 24 | 1 | 5 | 53856 | 6732 |
|  | 25 | 30 | 65 | 11 | 256QAM | 20 | 2/3 | 46104 | 24 | 1 | 6 | 68640 | 8580 |
|  | 30 | 30 | 78 | 11 | 256QAM | 20 | 2/3 | 55304 | 24 | 1 | 7 | 82368 | 10296 |
|  | 40 | 30 | 106 | 11 | 256QAM | 20 | 2/3 | 73776 | 24 | 1 | 9 | 111936 | 13992 |
|  | 50 | 30 | 133 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 140448 | 17556 |
|  | 60 | 30 | 162 | 11 | 256QAM | 20 | 2/3 | 114776 | 24 | 1 | 14 | 171072 | 21384 |
|  | 80 | 30 | 217 | 11 | 256QAM | 20 | 2/3 | 151608 | 24 | 1 | 18 | 229152 | 28644 |
|  | 90 | 30 | 245 | 11 | 256QAM | 20 | 2/3 | 172176 | 24 | 1 | 21 | 258720 | 32340 |
|  | 100 | 30 | 273 | 11 | 256QAM | 20 | 2/3 | 192624 | 24 | 1 | 23 | 288288 | 36036 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

**Table A.2.3.9-3: Reference channels for CP-OFDM 256QAM for 60kHz SCS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Channel bandwidth | Subcarrier Spacing | Allocated resource blocks | CP-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | Target Coding Rate | Payload size for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Transport block CRC | LDPC Base Graph | Number of code blocks per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 (Note 3) | Total number of bits per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 | Total modulated symbols per slot for slots 4, 9, 14, 19, 24, 29, 34 and 39 |
| Unit | MHz | KHz |  |  |  |  |  | Bits | Bits |  |  | Bits |  |
|  | 10 | 60 | 11 | 11 | 256QAM | 20 | 2/3 | 7680 | 24 | 1 | 1 | 11616 | 1452 |
|  | 15 | 60 | 18 | 11 | 256QAM | 20 | 2/3 | 12552 | 24 | 1 | 2 | 19008 | 2376 |
|  | 20 | 60 | 24 | 11 | 256QAM | 20 | 2/3 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
|  | 25 | 60 | 31 | 11 | 256QAM | 20 | 2/3 | 22032 | 24 | 1 | 3 | 32736 | 4092 |
|  | 30 | 60 | 38 | 11 | 256QAM | 20 | 2/3 | 26632 | 24 | 1 | 4 | 40128 | 5016 |
|  | 40 | 60 | 51 | 11 | 256QAM | 20 | 2/3 | 35856 | 24 | 1 | 5 | 53856 | 6732 |
|  | 50 | 60 | 65 | 11 | 256QAM | 20 | 2/3 | 46104 | 24 | 1 | 6 | 68640 | 8580 |
|  | 60 | 60 | 79 | 11 | 256QAM | 20 | 2/3 | 55304 | 24 | 1 | 7 | 83424 | 10428 |
|  | 80 | 60 | 107 | 11 | 256QAM | 20 | 2/3 | 75792 | 24 | 1 | 9 | 112992 | 14124 |
|  | 90 | 60 | 121 | 11 | 256QAM | 20 | 2/3 | 86040 | 24 | 1 | 11 | 127776 | 15972 |
|  | 100 | 60 | 135 | 11 | 256QAM | 20 | 2/3 | 94248 | 24 | 1 | 12 | 142560 | 17820 |
| NOTE 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM’ed] with PUSCH data.  NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in 38.214.  NOTE 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit) | | | | | | | | | | | | | |

# A.3 DL reference measurement channels

## A.3.1 General

Unless otherwise stated, Tables A.3.2.2-1, A.3.2.2-2, A.3.2.2-3, A.3.3.2-1, A.3.3.2-2 and A.3.3.2-3 are applicable for measurements of the Receiver Characteristics (clause 7) with the exception of subclauses 7.4 (Maximum input level).

Unless otherwise stated, Tables A.3.2.3-1, A.3.2.3-2, A.3.2.3-3, A.3.3.3-1, A.3.3.3-2 and A.3.3.3-3 are applicable for subclauses 7.4 (Maximum input level) and for UE not supporting PDSCH 256QAM,

Unless otherwise stated, Tables A.3.2.4-1, A.3.2.4-2, A.3.2.4-3, A.3.3.4-1, A.3.3.4-2 and A.3.3.4-3 are applicable for subclauses 7.4 (Maximum input level) and for UE supporting PDSCH 256QAM,

Unless otherwise stated, Tables A.3.2.2-1, A.3.2.2-2, A.3.2.2-3, A.3.3.2-1, A.3.3.2-2 and A.3.3.2-3 also apply for the modulated interferer used in Clauses 7.5, 7.6 and 7.8 with test specific bandwidths.

Table A.3.1-1. Common reference channel parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| CORESET frequency domain allocation |  | Full BW |
| CORESET time domain allocation |  | 2 OFDM symbols at the begin of each slot |
| PDSCH mapping type |  | Type A |
| PDSCH start symbol index (S) |  | 2 |
| Number of consecutive PDSCH symbols (L) |  | 12 |
| PDSCH PRB bundling | PRBs | 2 |
| Dynamic PRB bundling |  | false |
|  |  |  |
| Overhead value for TBS determination |  | 0 |
| First DMRS position for Type A PDSCH mapping |  | 2 |
| DMRS type |  | Type 1 |
| Number of additional DMRS |  | 2 |
| FDM between DMRS and PDSCH |  | Disable |
| TRS configuration |  | 1 slot, periodicity 10 ms, offset 0 |
| PTRS configuration |  | PTRS is not configured |

## A.3.2 DL reference measurement channels for FDD

### A.3.2.1 General

Table A.3.2.1-1 Additional reference channels parameters for FDD

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Number of HARQ Processes |  | 4 |
| K1 value |  | 2 for all slots |

### A.3.2.2 FRC for receiver requirements for QPSK

Table A.3.2.2-1 Fixed reference channel for receiver requirements (SCS 15 kHz, FDD, QPSK 1/3)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Allocated resource blocks |  | 25 | 52 | 79 | 106 | 133 | 160 | 216 | 270 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination | 64QAM | | | | | | | | |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | Bits | 1672 | 3368 | 5120 | 6912 | 8712 | 10504 | 14088 | 17424 |
| Transport block CRC | Bits | 16 | 16 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | CBs | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | Bits | 5400 | 11232 | 17064 | 22896 | 28728 | 34560 | 46656 | 58320 |
| Max. Throughput averaged over 1 frame | Mbps | 1.504 | 3.031 | 4.608 | 6.220 | 7.841 | 9.454 | 12.679 | 15.682 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1..  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame, QPSK 1/3 | | | | | | | | | |

Table A.3.2.2-2 Fixed reference channel for receiver requirements (SCS 30 kHz, FDD, QPSK 1/3)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 90 | 100 |
| Subcarrier spacing configuration |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks |  | 11 | 24 | 38 | 51 | 65 | 78] | 106 | 133 | 162 | 217 | 245 | 273 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination | 64QAM | | | | | | | | | | | | |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | Bits | 736 | 1608 | 2472 | 3368 | 4224 | 4992 | 6912 | 8712 | 10504 | 14088 | 15880 | 17928 |
| Transport block CRC | Bits | 16 | 16 | 16 | 16 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | Bits | 2376 | 5184 | 8208 | 11016 | 14040 | 16848 | 22896 | 28728 | 34992 | 46872 | 52920 | 58968 |
| Max. Throughput averaged over 1 frame | Mbps | 1.398 | 3.055 | 4.697 | 6.399 | 8.025 | 9.485 | 13.133 | 16.553 | 19.958 | 26.767 | 30.172 | 34.063 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1..  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | | | |

Table A.3.2.2-3 Fixed reference channel for receiver requirements (SCS 60 kHz, FDD, QPSK 1/3)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | | |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 90 | 100 |
| Subcarrier spacing configuration |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Allocated resource blocks |  | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 107 | 121 | 135 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS Determination |  | 64QAM | | | | | | | | | | |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | Bits | 736 | 1192 | 1608 | 2024 | 2472 | 3368 | 4224 | 5120 | 6912 | 7808 | 8712 |
| Transport block CRC | Bits | 16 | 16 | 16 | 16 | 16 | 16 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | Bits | 2376 | 3888 | 5184 | 6696 | 8208 | 11016 | 14040 | 17064 | 23112 | 26136 | 29160 |
| Max. Throughput averaged over 1 frame | Mbps | 2.870 | 4.649 | 6.271 | 7.894 | 9.641 | 13.135 | 16.474 | 19.968 | 26.957 | 30.451 | 33.977 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1..  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | | |

### A.3.2.3 FRC for maximum input level for 64QAM

Table A.3.2.3-1 Fixed reference channel for maximum input level receiver requirements (SCS 15 kHz, FDD, 64QAM)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Allocated resource blocks |  | 25 | 52 | 79 | 106 | 133 | [160] | 216 | 270 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination | 64QAM | | | | | | | | |
| Modulation |  | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM |
| Target Coding Rate |  | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | Bits | 12296 | 25608 | 38936 | 52224 | 64552 | 77896 | 106576 | 131176 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | CBs | 2 | 4 | 5 | 7 | 8 | 10 | 13 | 16 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | Bits | 16200 | 33696 | 51192 | 68688 | 86184 | 103680 | 139968 | 174960 |
| Max. Throughput averaged over 1 frame | Mbps | 11.066 | 23.047 | 35.042 | 47.002 | 58.097 | 70.106 | 95.918 | 118.058 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot 0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | |

Table A.3.2.3-2 Fixed reference channel for maximum input level receiver requirements (SCS 30 kHz, FDD, 64QAM)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks |  | 11 | 24 | 38 | 51 | 65 | [78] | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | | | | |
| Modulation |  | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM |
| Target Coding Rate |  | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | Bits | 5376 | 11784 | 18432 | 25104 | 31752 | 37896 | 52224 | 64552 | 79896 | 106576 | 135296 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | CBs | 1 | 2 | 3 | 3 | 4 | 5 | 7 | 8 | 10 | 13 | 17 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | Bits | 7128 | 15552 | 24624 | 33048 | 42120 | 50544 | 68688 | 86184 | 104976 | 140616 | 176904 |
| Max. Throughput averaged over 1 frame | Mbps | 10.214 | 22.390 | 35.021 | 47.698 | 60.329 | 72.002 | 99.226 | 122.649 | 151.802 | 202.494 | 257.062 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot 0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | | |

**Table A.3.2.3-3 Fixed Reference Channel for Maximum input level receiver requirements (SCS 60 kHz, FDD, 64QAM)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Allocated resource blocks |  | 11 | 18 | 24 | 31 | [38] | 51 | 65 | 79 | 107 | 135 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | | | |
| Modulation |  | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM |
| Target Coding Rate |  | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | Bits | 5376 | 8712 | 11784 | 15112 | 18432 | 25104 | 31752 | 38936 | 52224 | 65576 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | CBs | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 7 | 8 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | Bits | 7128 | 11664 | 15552 | 20088 | 24624 | 33048 | 42120 | 51192 | 69336 | 87480 |
| Max. Throughput averaged over 1 frame | Mbps | 20.429 | 33.106 | 44.779 | 57.426 | 70.042 | 95.395 | 120.658 | 147.957 | 198.451 | 249.189 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | |

### A.3.2.4 FRC for maximum input level for 256 QAM

**Table A.3.2.4-1 Fixed reference channel for maximum input level receiver requirements (SCS 15 kHz, FDD, 256QAM)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Allocated resource blocks |  | 25 | 52 | 79 | 106 | 133 | [160] | 216 | 270 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | |
| Modulation |  | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM |
| Target Coding Rate |  | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | Bits | 16896 | 34816 | 53288 | 71688 | 90176 | 108552 | 143400 | 180376 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | CBs | 3 | 5 | 7 | 9 | 12 | 14 | 18 | 23 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,3,4,5,6,7,8,9 | Bits | 21600 | 44928 | 68256 | 91584 | 114912 | 138240 | 186624 | 233280 |
| Max. Throughput averaged over 1 frame | Mbps | 15.206 | 31.334 | 47.959 | 64.519 | 81.158 | 97.697 | 129.060 | 162.338 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot 0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | |

Table A.3.2.4-2 Fixed reference channel for maximum input level receiver requirements (SCS 30 kHz, FDD, 256QAM)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks |  | 11 | 24 | 38 | 51 | 65 | [78] | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination |  | 256QAM | | | | | | | | | | |
| Modulation |  | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM |
| Target Coding Rate |  | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | Bits | 7424 | 16136 | 25608 | 33816 | 44040 | 52224 | 71688 | 90176 | 108552 | 147576 | 184424 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | CBs | 1 | 3 | 4 | 5 | 6 | 7 | 9 | 12 | 14 | 19 | 23 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,…,19 | Bits | 9504 | 20736 | 32832 | 44064 | 56160 | 67392 | 91584 | 114912 | 139968 | 187488 | 235872 |
| Max. Throughput averaged over 1 frame | Mbps | 14.106 | 30.658 | 48.655 | 64.250 | 83.676 | 99.226 | 136.207 | 171.334 | 206.249 | 280.394 | 350.406 |
| Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.  Note 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  Note 3: SS/PBCH block is transmitted in slot 0 of each frame  Note 4: Slot i is slot index per frame | | | | | | | | | | | | |

Table A.3.2.4-3 Fixed reference channel for maximum input level receiver requirements (SCS 60 kHz, FDD, 256QAM)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Allocated resource blocks |  | 11 | 18 | 24 | 31 | [38] | 51 | 65 | 79 | 107 | 135 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination |  | 256QAM | | | | | | | | | |
| Modulation |  | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM |
| Target Coding Rate |  | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | Bits | 7424 | 12040 | 16136 | 21000 | 25608 | 33816 | 44040 | 53288 | 71688 | 90176 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | CBs | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 9 | 12 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slot 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,…,39 | Bits | 9504 | 15552 | 20736 | 26784 | 32832 | 44064 | 56160 | 68256 | 92448 | 116640 |
| Max. Throughput averaged over 1 frame | Mbps | 28.211 | 45.752 | 61.317 | 79.800 | 97.310 | 128.501 | 167.352 | 202.494 | 272.414 | 342.669 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | |

## A.3.3 DL reference measurement channels for TDD

### A.3.3.1 General

Table A.3.3.1-1 Additional reference channels parameters for TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | | Value | | |
| SCS 15 kHz (µ=0) | SCS 30 kHz (µ=1) | SCS 60 kHz (µ=2) |
| UL-DL configuration | *referenceSubcarrierSpacing* | 15 kHz | 30 kHz | 60 kHz |
| *dl-UL-TransmissionPeriodicity* | 5 ms | 5 ms | 1.25 ms |
| *nrofDownlinkSlots* | 3 | 7 | 3 |
| *nrofDownlinkSymbols* | 10 | 6 | 6 |
| *nrofUplinkSlot* | 1 | 2 | 1 |
| *nrofUplinkSymbols* | 2 | 4 | 4 |
| Number of HARQ Processes | | 8 | 8 | 8 |
| K1 value | | K1 = 4 if mod(i,5) = 0 K1 =3 if mod(i,5) = 1 K1 =2 if mod(i,5) = 2 where i is slot index per frame; i = {0,…,9} | K1 =8 if mod(i,10) = 0 K1 =7 if mod(i,10) = 1 K1 =6 if mod(i,10) = 2 K1 =5 if mod(i,10) = 3 K1 =4 if mod(i,10) = 4 K1 =3 if mod(i,10) = 5 K1 =2 if mod(i,10) = 6 where i is slot index per frame; i = {0,…,19} | K1 = 4 if mod(i,5) = 0 K1 =3 if mod(i,5) = 1 K1 =2 if mod(i,5) = 2 where i is slot index per frame; i = {0,…,39} |

### A.3.3.2 FRC for receiver requirements for QPSK

**Table A.3.3.2-1 Fixed reference channel for receiver requirements (SCS 15 kHz, TDD, QPSK 1/3)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Allocated resource blocks |  | 25 | 52 | 79 | 106 | 133 | [160] | 216 | 270 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | Bits | 1672 | 3368 | 5120 | 6912 | 8712 | 10504 | 14088 | 17424 |
| Transport block CRC | Bits | 16 | 16 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | CBs | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | Bits | 5400 | 11232 | 17064 | 22896 | 28728 | 34560 | 46656 | 58320 |
| Max. Throughput averaged over 1 frame | Mbps | 0.836 | 1.684 | 2.560 | 3.456 | 4.356 | 5.252 | 7.044 | 8.712 |
| Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  Note 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  Note 3: SS/PBCH block is transmitted in slot 0 of each frame  Note 4: Slot i is slot index per frame | | | | | | | | | |

**Table A.3.3.2-2 Fixed reference channel for receiver requirements (SCS 30 kHz, TDD, QPSK 1/3)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks |  | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | | | | |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | Bits | 736 | 1608 | 2472 | 3368 | 4224 | 4992 | 6912 | 8712 | 10504 | 14088 | 17928 |
| Transport block CRC | Bits | 16 | 16 | 16 | 16 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | Bits | 2376 | 5184 | 8208 | 11016 | 14040 | 16848 | 22896 | 28728 | 34992 | 46872 | 58968 |
| Max. Throughput averaged over 1 frame | Mbps | 0.957 | 2.090 | 3.214 | 4.378 | 5.491 | 6.490 | 8.986 | 11.326 | 13.655 | 18.314 | 23.306 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | | |

**Table A.3.3.2-3 Fixed reference channel for receiver requirements (SCS 60 kHz, TDD, QPSK 1/3)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | | | | | | | | |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Allocated resource blocks |  | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 107 | 135 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | | | |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | Bits | 736 | 1192 | 1608 | 2024 | 2472 | 3368 | 4224 | 5120 | 6912 | 8712 |
| Transport block CRC | Bits | 16 | 16 | 16 | 16 | 16 | 16 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | Bits | 2376 | 3888 | 5184 | 6696 | 8208 | 11016 | 14040 | 17064 | 23112 | 29160 |
| Max. Throughput averaged over 1 frame | Mbps | 1.619 | 2.622 | 3.538 | 4.453 | 5.438 | 7.410 | 9.293 | 11.264 | 15.206 | 19.166 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | |

### A.3.3.3 FRC for maximum input level for 64QAM

Table A.3.3.3-1 Fixed reference channel for maximum input level receiver requirements (SCS 15 kHz, TDD, 64QAM)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | |
| **Channel bandwidth** | **MHz** | **5** | **10** | **15** | **20** | **25** | **30** | **40** | **50** |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Allocated resource blocks |  | 25 | 52 | 79 | 106 | 133 | [160] | 216 | 270 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | |
| Modulation |  | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM |
| Target Coding Rate |  | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | Bits | 12296 | 25608 | 38936 | 52224 | 64552 | 77896 | 106576 | 131176 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | CBs | 2 | 4 | 5 | 7 | 8 | 10 | 13 | 16 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | Bits | 16200 | 33696 | 51192 | 68688 | 86184 | 103680 | 139968 | 174960 |
| Max. Throughput averaged over 1 frame | Mbps | 6.148 | 12.804 | 19.468 | 26.112 | 32.276 | 38.948 | 53.288 | 65.588 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot 0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | |

Table A.3.3.3-2 Fixed reference channel for maximum input level receiver requirements (SCS 30 kHz, TDD, 64QAM)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | | | | |
| **Channel bandwidth** | **MHz** | **5** | **10** | **15** | **20** | **25** | **30** | **40** | **50** | **60** | **80** | **100** |
| Subcarrier spacing configuration |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks |  | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | | | | |
| Modulation |  | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM |
| Target Coding Rate |  | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | Bits | 5376 | 11784 | 18432 | 25104 | 31752 | 37896 | 52224 | 64552 | 79896 | 106576 | 135296 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | CBs | 1 | 2 | 3 | 3 | 4 | 5 | 7 | 8 | 10 | 13 | 17 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | Bits | 7128 | 15552 | 24624 | 33048 | 42120 | 50544 | 68688 | 86184 | 104976 | 140616 | 176904 |
| Max. Throughput averaged over 1 frame | Mbps | 6.989 | 15.319 | 23.962 | 32.635 | 41.278 | 49.265 | 67.891 | 83.918 | 103.865 | 138.549 | 175.885 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | | |

**Table A.3.3.3-3. Fixed reference channel for maximum input level receiver requirements (SCS 60 kHz, TDD, 64QAM)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | | | |
| **Channel bandwidth** | **MHz** | **10** | **15** | **20** | **25** | **30** | **40** | **50** | **60** | **80** | **100** |
| Subcarrier spacing configuration |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Allocated resource blocks |  | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 107 | 135 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination |  | 64QAM | | | | | | | | | |
| Modulation |  | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM | 64 QAM |
| Target Coding Rate |  | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | Bits | 5376 | 8712 | 11784 | 15112 | 18432 | 25104 | 31752 | 38936 | 52224 | 65576 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | CBs | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 7 | 8 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | Bits | 7128 | 11664 | 15552 | 20088 | 24624 | 33048 | 42120 | 51192 | 69336 | 87480 |
| Max. Throughput averaged over 1 frame | Mbps | 11.827 | 19.166 | 25.925 | 33.246 | 40.550 | 55.229 | 69.854 | 85.659 | 114.893 | 144.267 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | |

### A.3.3.4 FRC for maximum input level for 256 QAM

**Table A.3.3.4-1 Fixed reference channel for maximum input level receiver requirements (SCS 15 kHz, TDD, 256QAM)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | |
| **Channel bandwidth** | **MHz** | **5** | **10** | **15** | **20** | **25** | **30** | **40** | **50** |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Allocated resource blocks |  | 25 | 52 | 79 | 106 | 133 | [160] | 216 | 270 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MCS table for TBS determination |  | 256QAM | | | | | | | |
| Modulation |  | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM |
| Target Coding Rate |  | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | Bits | 16896 | 34816 | 53288 | 71688 | 90176 | 108552 | 143400 | 180376 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | CBs | 3 | 5 | 7 | 9 | 12 | 14 | 18 | 23 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |
| For Slots 0,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 1,2,5,6,7 | Bits | 21600 | 44928 | 68256 | 91584 | 114912 | 138240 | 186624 | 233280 |
| Max. Throughput averaged over 1 frame | Mbps | 8.448 | 17.408 | 26.644 | 35.844 | 45.088 | 54.276 | 71.700 | 90.188 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot 0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | |

**Table A.3.3.4-2 Fixed Reference channel for maximum input level receiver requirements (SCS 30 kHz, TDD, 256QAM)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | | | | |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks |  | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination |  | 256QAM | | | | | | | | | | |
| Modulation |  | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM |
| Target Coding Rate |  | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | Bits | 7424 | 16136 | 25608 | 33816 | 44040 | 52224 | 71688 | 90176 | 108552 | 147576 | 184424 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,19} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19} | Bits | 9504 | 20736 | 32832 | 44064 | 56160 | 67392 | 91584 | 114912 | 139968 | 187488 | 235872 |
| Max. Throughput averaged over 1 frame | Mbps | 9.651 | 20.977 | 33.290 | 43.961 | 57.252 | 67.891 | 93.194 | 117.229 | 141.118 | 191.849 | 239.751 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | | |

**Table A.3.3.4-3 Fixed reference channel for maximum input level receiver requirements (SCS 60 kHz, TDD, 256QAM)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | | | | |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration |  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Allocated resource blocks |  | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 107 | 135 |
| Subcarriers per resource block |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame |  | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination |  | 256QAM | | | | | | | | | |
| Modulation |  | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM | 256 QAM |
| Target Coding Rate |  | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 | 4/5 |
| Maximum number of HARQ transmissions |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | Bits | 7424 | 12040 | 16136 | 21000 | 25608 | 33816 | 44040 | 53288 | 71688 | 90176 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | CBs | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 9 | 12 |
| Binary Channel Bits per Slot |  |  |  |  |  |  |  |  |  |  |  |
| For Slots 0,1 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {2,…,39} | Bits | 9504 | 15552 | 20736 | 26784 | 32832 | 44064 | 56160 | 68256 | 92448 | 116640 |
| Max. Throughput averaged over 1 frame | Mbps | 16.333 | 26.488 | 35.499 | 46.200 | 56.338 | 74.395 | 96.888 | 117.234 | 157.714 | 198.387 |
| NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.  NOTE 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).  NOTE 3: SS/PBCH block is transmitted in slot #0 of each frame  NOTE 4: Slot i is slot index per frame | | | | | | | | | | | |

# A.4 CSI reference measurement channels

# A.5 OFDMA Channel Noise Generator (OCNG)

## A.5.1 OCNG Patterns for FDD

### A.5.1.1 OCNG FDD pattern 1: Generic OCNG FDD Pattern for all unused REs

Table A.5.1.1-1: OP.1 FDD: Generic OCNG FDD Pattern for all unused REs

|  |  |  |
| --- | --- | --- |
| OCNG Appliance  OCNG Parameters | Control Region  (Core Set) | Data Region |
| Resources allocated | All unused REs (Note 1) | All unused REs (Note 2) |
| Structure | PDCCH | PDSCH |
| Content | Uncorrelated pseudo random QPSK modulated data | Uncorrelated pseudo random QPSK modulated data |
| Transmission scheme for multiple  antennas ports transmission | Single Tx port transmission | Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH |
| Subcarrier Spacing | Same as for RMC PDCCH in the active BWP | Same as for RMC PDSCH in the active BWP |
| Power Level | Same as for RMC PDCCH | Same as for RMC PDSCH |
| Note 1: All unused REs in the active CORESETS appointed by the search spaces in use.  Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth. | | |

## A.5.2 OCNG Patterns for TDD

### A.5.2.1 OCNG TDD pattern 1: Generic OCNG TDD Pattern for all unused REs

Table A.5.2.1-1: OP.1 TDD: Generic OCNG TDD Pattern for all unused REs

|  |  |  |
| --- | --- | --- |
| OCNG Appliance  OCNG Parameters | Control Region  (Core Set) | Data Region |
| Resources allocated | All unused REs (Note 1) | All unused REs (Note 2) |
| Structure | PDCCH | PDSCH |
| Content | Uncorrelated pseudo random QPSK modulated data | Uncorrelated pseudo random QPSK modulated data |
| Transmission scheme for multiple  antennas ports transmission | Single Tx port transmission | Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH |
| Subcarrier Spacing | Same as for RMC PDCCH in the active BWP | Same as for RMC PDSCH in the active BWP |
| Power Level | Same as for RMC PDCCH | Same as for RMC PDSCH |
| Note 1: All unused REs in the active CORESETS appointed by the search spaces in use.  Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth. | | |

# A.6 Void

Annex B (informative): Void

Annex C (informative):  
Downlink physical channels

# C.1 General

The following clauses, describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

## C.2 Setup

Table C.2-1 describes the downlink Physical Channels that are required for connection set up.

Table C.2-1: Downlink Physical Channels required  
for connection set-up

|  |
| --- |
| Physical Channel |
| PBCH |
| SSS |
| PSS |
| PDCCH |
| PDSCH |
| PBCH DMRS |
| PDCCH DMRS |
| PDSCH DMRS |
| CSI-RS |

## C.3 Connection

### C.3.1 Measurement of Receiver Characteristics

Unless otherwise stated, Table C.3.1-1 is applicable for measurements on the Receiver Characteristics (clause 7).

Table C.3.1-1: Downlink Physical Channels transmitted during a connection (FDD and TDD)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| SSS transmit power | W | Test specific |
| EPRE ratio of PSS to SSS | dB | 0 |
| EPRE ratio of PBCH DMRS to SSS | dB | 0 |
| EPRE ratio of PBCH to PBCH DMRS | dB | 0 |
| EPRE ratio of PDCCH DMRS to SSS | dB | 0 |
| EPRE ratio of PDCCH to PDCCH DMRS | dB | 0 |
| EPRE ratio of PDSCH DMRS to SSS (Note 1) | dB | 3 |
| EPRE ratio of PDSCH to PDSCH DMRS (Note 1) | dB | -3 |
| EPRE ratio of CSI-RS to SSS | dB | 0 |
| EPRE ratio of PTRS to PDSCH | dB | Test specific |
| EPRE ratio of OCNG DMRS to SSS | dB | 0 |
| EPRE ratio of OCNG to OCNG DMRS (Note 1) | dB | 0 |
| NOTE 1: No boosting is applied to any of the channels except PDSCH DMRS. For PDSCH DMRS, 3 dB power boosting is applied assuming DMRS Type 1 configuration when DMRS and PDSCH are TDM’ed and only half of the DMRS REs are occupied.  NOTE 2: Number of DMRS CDM groups without data for PDSCH DMRS configuration for OCNG is set to 1. | | |

Annex D (informative): Void

Annex E (normative):   
Environmental conditions

# E.1 General

This normative annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

# E.2 Environmental

The requirements in this clause apply to all types of UE(s).

## E.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

Table E.2.1-1: Temperature conditions

|  |  |
| --- | --- |
| +15°C to +35°C | For normal conditions (with relative humidity of 25 % to 75 %) |
| -10°C to +55°C | For extreme conditions (see IEC publications 68‑2‑1 and 68‑2‑2) |

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation.

## E.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

Table E.2.2-1: Voltage conditions

|  |  |  |  |
| --- | --- | --- | --- |
| **Power source** | **Lower extreme**  **voltage** | **Higher extreme**  **voltage** | **Normal conditions**  **voltage** |
| AC mains | 0,9 \* nominal | 1,1 \* nominal | nominal |
| Regulated lead acid battery | 0,9 \* nominal | 1,3 \* nominal | 1,1 \* nominal |
| Non regulated batteries:  Leclanché  Lithium  Mercury/nickel & cadmium | 0,85 \* nominal  0,95 \* nominal  0,90 \* nominal | Nominal  1,1 \* Nominal | Nominal  1,1 \* Nominal  Nominal |

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

## E.2.3 Vibration

The UE shall fulfil all the requirements when vibrated at the following frequency/amplitudes.

Table E.2.3-1: Vibration conditions

|  |  |
| --- | --- |
| **Frequency** | **ASD (Acceleration Spectral Density) random vibration** |
| 5 Hz to 20 Hz | 0,96 m2/s3 |
| 20 Hz to 500 Hz | 0,96 m2/s3 at 20 Hz, thereafter –3 dB/Octave |

Outside the specified frequency range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-1 for extreme operation.

Annex F (normative):   
Transmit modulation

# F.1 Measurement Point

Figure F.1-1 shows the measurement point for the unwanted emission falling into non-allocated RB(s) and the EVM for the allocated RB(s).

DFT

IFFT

TX

Front

-

-end

Channel

RF

correction

FFT

Tx

-

Rx chain

equalizer

In

-

band

emissions

meas.

DFT-s-OFDM PUSCH

0

0

IDFT

DUT

Test equipment

CP-OFDM PUSCH, PUCCH and DM-RS

CP-OFDM PUSCH, PUCCH and DM-RS

Tone map

DFT-s-OFDM PUSCH modulated symbols

Figure F.1-1: EVM measurement points

# F.2 Basic Error Vector Magnitude measurement

The EVM is the difference between the ideal waveform and the measured waveform for the allocated RB(s)

,

where

is a set of  modulation symbols with the considered modulation scheme being active within the measurement period,

 are the samples of the signal evaluated for the EVM,

 is the ideal signal reconstructed by the measurement equipment, and

 is the average power of the ideal signal. For normalized modulation symbols  is equal to 1.

The basic EVM measurement interval is defined over one slot in the time domain for PUCCH and PUSCH and over one preamble sequence for the PRACH.

# F.3 Basic in-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks. The in-band emission requirement is evaluated for PUCCH and PUSCH transmissions. The in-band emission requirement is not evaluated for PRACH transmissions.

The in-band emissions are measured as follows

,

where

is a set of OFDM symbols with the considered modulation scheme being active within the measurement period,

 is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g.  or  for the first adjacent RB),

 (resp. ) is the lower (resp. upper) edge of the UL system BW,

 and  are the lower and upper edge of the allocated BW, and

 is the frequency domain signal evaluated for in-band emissions as defined in the subsection (ii)

The relative in-band emissions are, given by



where

 is the number of allocated RBs

The basic in-band emissions measurement interval is defined over one slot in the time domain. When the PUSCH or PUCCH transmission slot is shortened due to multiplexing with SRS, the in-band emissions measurement interval is reduced by one OFDM symbol, accordingly.

In the evaluation of in-band emissions, the timing is set according to , where sample time offsets  and  are defined in subclause F.4.

# F.4 Modified signal under test

Implicit in the definition of EVM is an assumption that the receiver is able to compensate a number of transmitter impairments.

The PUSCH data or PRACH signal under test is modified and, in the case of PUSCH data signal, decoded according to:



where

 is the time domain samples of the signal under test.

The PUCCH or PUSCH demodulation reference signal or PUCCH data signal under test is equalised and, in the case of PUCCH data signal decoded according to:



where

 is the time domain samples of the signal under test.

To minimize the error, the signal under test should be modified with respect to a set of parameters following the procedure explained below.

Notation:

 is the sample timing difference between the FFT processing window in relation to nominal timing of the ideal signal.

 is the RF frequency offset.

 is the phase response of the TX chain.

 is the amplitude response of the TX chain.

In the following  represents the middle sample of the EVM window of length  (defined in the next subsections) or the last sample of the first window half if is even.

The EVM analyser shall

- detect the start of each slot and estimate  and ,

- determine  so that the EVM window of length  is centred

- on the time interval determined by the measured cyclic prefix minus 16κ samples of the considered OFDM symbol for symbol l for subcarrier spacing configuration µ in a subframe, with l = 0 or l = 7\*2^µ for normal CP, i.e. the first 16κ samples of the CP should not be taken into account for this step. In the determination of the number of excluded samples, a sampling rate of 1/Tc is assumed. If a different sampling rate is used, the number of excluded samples is scaled linearly.

- on the measured cyclic prefix of the considered OFDM symbol symbol for all other symbols for normal CP and for symbol 0 to 11 for extended CP.

- on the measured preamble cyclic prefix for the PRACH

To determine the other parameters a sample timing offset equal to  is corrected from the signal under test. The EVM analyser shall then

- correct the RF frequency offset for each time slot, and

- apply an FFT of appropriate size. The chosen FFT size shall ensure that in the case of an ideal signal under test, there is no measured inter-subcarrier interference.

The carrier leakage shall be removed from the evaluated signal before calculating the EVM and the in-band emissions; however, the removed relative carrier leakage power also has to satisfy the applicable requirement.

At this stage the allocated RBs shall be separated from the non-allocated RBs. In the case of PUCCH and PUSCH EVM, the signal on the non-allocated RB(s), , is used to evaluate the in-band emissions.

Moreover, the following procedure applies only to the signal on the allocated RB(s).

- In the case of PUCCH and PUSCH, the UL EVM analyzer shall estimate the TX chain equalizer coefficients and  used by the ZF equalizer for all subcarriers by time averaging at each signal subcarrier of the amplitude and phase of the reference and data symbols. The time-averaging length is 1 slot. This process creates an average amplitude and phase for each signal subcarrier used by the ZF equalizer. The knowledge of data modulation symbols may be required in this step because the determination of symbols by demodulation is not reliable before signal equalization.

- In the case of PRACH, the UL EVM analyzer shall estimate the TX chain coefficients and  used for phase and amplitude correction and are seleted so as to minimize the resulting EVM. The TX chain coefficients are not dependent on frequency, i.e.  and . The TX chain coefficient are chosen independently for each preamble transmission and for each .

At this stage estimates of , ,  and  are available.  is one of the extremities of the window , i.e. can be  or , where  if  is odd and  if is even. The EVM analyser shall then

- calculate EVMl with  set to ,

- calculate EVMh with  set to .

# F.5 Window length

## F.5.1 Timing offset

As a result of using a cyclic prefix, there is a range of, which, at least in the case of perfect Tx signal quality, would give close to minimum error vector magnitude. As a first order approximation, that range should be equal to the length of the cyclic prefix. Any time domain windowing or FIR pulse shaping applied by the transmitter reduces the  range within which the error vector is close to its minimum.

## F.5.2 Window length

The window length  affects the measured EVM, and is expressed as a function of the configured cyclic prefix length. In the case where equalization is present, as with frequency domain EVM computation, the effect of FIR is reduced. This is because the equalization can correct most of the linear distortion introduced by the FIR. However, the time domain windowing effect can’t be removed.

## F.5.3 Window length for normal CP

Contents in this section are FFS.

## F.5.4 Window length for Extended CP

Contents in this section are FFS.

## F.5.5 Window length for PRACH

Contents in this section are FFS.

# F.6 Averaged EVM

The general EVM is averaged over basic EVM measurements for n slots in the time domain.

,

where n is

for PUCCH, PUSCH.

The EVM requirements shall be tested against the maximum of the RMS average at the window W extremities of the EVM measurements:

Thus is calculated using in the expressions above and is calculated using .

Thus we get:



The calculation of the EVM for the demodulation reference signal, , follows the same procedure as calculating the general EVM, with the exception that the modulation symbol set  defined in clause F.2 is restricted to symbols containing uplink demodulation reference signals.

The basic  measurements are first averaged over n slots in the time domain to obtain an intermediate average .

In the determination of each , the timing is set to  if , and it is set to  otherwise, where  and  are the general average EVM values calculated in the same n slots over which the intermediate average  is calculated. Note that in some cases, the general average EVM may be calculated only for the purpose of timing selection for the demodulation reference signal EVM.

Then the results are further averaged to get the EVM for the demodulation reference signal, ,



The PRACH EVM, , is averaged over TBD preamble sequence measurements for all preamble formats.

The EVM requirements shall be tested against the maximum of the RMS average at the window *W* extremities of the EVM measurements:

Thus is calculated using  and is calculated using .

Thus we get:



# F.7 Spectrum Flatness

The data shall be taken from FFT coded data symbols and the demodulation reference symbols of the allocated resource block.

Annex G (informative): Void

Annex H (informative): Void

Annex I (informative): Void

Annex J (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2017-08 | RAN4#84 | R4-1708909 |  |  |  | Initial Skeleton | 0.0.1 |
| 2017-10 | RAN4#84Bis | R4-1709958 |  |  |  | Added approved TPs in RAN4-NR-AH#3  R4-1709948, TP for TS 38.101-1: minimum output power, Huawei  R4-1709454, TP for TS 38.101-1:UE Tx spurious emission for range 1, ZTE Corporation | 0.1.0 |
| 2017-10 | RAN4#84Bis | R4-1711978 |  |  |  | Embedded approved TPs in RAN4#84Bis  R4-1711556, “TP to TS 38.101: Draft CR to Transmitter power clause”, Nokia  R4-1710962, “TP to TS 38.101-1: Draft CR to Output RF spectrum emissions” Nokia  R4-1711608, “TP for TS38.101-1 on conducted UE transmitter intermodulation for FR1(section 6.5)” ZTE Corporation  Number of TPs by editors | 0.2.0 |
| 2017-12 | RAN4#85 | R4-1713805 |  |  |  | Approved TPs in RAN4#85  R4-1713204, TP on general parts for 38.101-1 NR FR1, Ericsson  R4-1714047, WF on MPR for sub6GHz, NTT DOCOMO, INC.  R4-1714052, TP for TS 38.101-1 introduction of band n71 for transmitter characteristics, T-Mobile USA Inc.  R4-1714162, TP to 38.101-1: ACS, Ericsson  R4-1714163, TP to 36.101-1: In-band blocking, Ericsson  R4-1714446, TP to 36.101-1: Out-of-band blocking and exceptions for spurious response, Ericsson  R4-1714369, TP for NBB requirement for FR1, Intel Corporation  R4-1714529, TP on introducing operating bands for NR-LTE DC including SUL band combinations in 38.101-1, Huawei  R4-1714097, TP for TS 38.101-1: UE RF requirements for standalone SUL, Huawei  R4-1714536, TP for TS 38.101-1: Channel Bandwidth Definition, Qualcomm Incorporated (Note, this TP was further discussed and edited in the reflector)  R4-1714114, TP for TS 38.101-1: Channel Arrangement, Qualcomm Incorporated (Note, this TP was further discussed and edited in the reflector)  R4-1714029, Sub6 Reference Sensitivity, Qualcomm Incorporated  R4-1714329, TP to TR 38.101-01 v0.2.0: ON/OFF mask design for NR UE transmissions for FR1, Ericsson  Band list according to R4-1714542, List of bands and band combinations to be introduced into RAN4 NR core requirements by December 2017, RAN4 Chairmen  Input from:  R4-1714479, TP for TR 38.817-01 NR channel bandwidth, Huawei, HiSilicon | 0.3.0 |
| 2017-12 | RAN4#85 | R4-1714569 |  |  |  | Further corrections and alignments with 38.104 after email review | 0.4.0 |
| 2017-12 | RAN#78 | RP-172475 |  |  |  | v1.0.0 submitted for plenary approval. Contents same as 0.4.0 | 1.0.0 |
| 2017-12 | RAN#78 |  |  |  |  | Approved by plenary – Rel-15 spec under change control | 15.0.0 |
| 2018-03 | RAN#79 | RP-180264 | 0003 |  | F | Implementation of endorced CRs to 38.101-1  Endorsed draft CRs  F: R4-1800400, Editorial corrections for 38.101-1, Qualcomm  B: R4-1801102, Draft CR for 30 MHz CBW support, Huawei  F: R4-1800032, 38.101-1 n71 draft CR for section 6.2.3 - UE A-MPR - NS values, T-Mobile USA Inc.  B: R4-1801121, Draft pCR for TS 38.101-1 version 15.0.0: Remaining ON/OFF masks for FR1 NR UE transmissions, Ericsson  F: R4-1800417, Correction of NR SEM table and additional requirements table, vivo  F: R4-1800033, 38.101-1 n71 draft CR for section 6.5.3.2 Spurious emissions for UE co-existence, T-Mobile USA Inc.  F: R4-1801114, Proposal on protected band numbering in UE specs, Sprint Corporation  F: R4-1800407, Draft CR for TS 38.101-1: Mandatory 4Rx antenna performance for NR UE, Vodafone Group Plc  F: R4-1800451 Draft CR for TS 38.101-1: Clarification of 4Rx NR bands, Huawei, HiSilicon  F: R4-1801136, Draft CR for TS 38.101-1: REFSENS for NR bands, Huawei, HiSilicon  F: R4-1801137, Draft CR: n71 REFSENS, Dish Network  F: R4-1800395, Draft CR to 38.101-1: corrections to ACS and in-band blocking, Ericsson  F: R4-1800396, Draft CR to 38.101-1: corrections to out-of-band blocking, Ericsson  F: R4-1800397, Draft CR to 38.101-1: corrections to spurious response, Ericsson  F: R4-1800305, Draft CR for NR FR1 wide band intermodulation requirements, MediaTek Inc.  F: R4-1800320, Draft CR to 38.101-1: Rx Spurious emission for NR FR1 (section 7.9), ZTE Corporation  F: R4-1800473, Draft CR on UE RF requirements for SUL in TS 38.101-1, Huawei  F: R4-1800965, Draft CR to TS 38.101-1: Asymmetric CH BW operation, Dish Network  F: R4-1800882, Draft CR for correction of UE channel bandwidth for Bands n77 and n78 for TS 38.101-1, Orange UK  F: R4-1801012, Draft CR to 38.101-1: Clarifications to UE spectrum utilization section 5.3, Ericsson  F: R4-1800030, 38.101-1 n71 draft CR for section 5.4.4 - TX–RX frequency separation, T-Mobile USA Inc  F: R4-1801228, Draft CR to 38.101-1: Channel spacing for CA for NR FR1(section 5.4.1.2), ZTE Corporation  F: R4-1801231, Correction CR for channel spacing:38.101-1, Samsung  F: R4-1801235, Draft CR to TS 38.101-1: Corrections on channel raster calculation in section 5.4.2, ZTE Corporation  F: R4-1801318, Draft CR on synchronization raster, Huawei  RAN4#86:  R4-1803053, Draft CR for new spec structure of 38.101-1, Ericsson  R4-1801479, Draft CR to 38.101-1: Default Tx-RX frequency separation for NR FR1(section 5.4.4), ZTE  R4-1801581, Draft CR for TS 38.101-1 update of 4Rx bands, Huawei Technologies France  R4-1802211, draft CR TS 38.101-1 Uplink configuration for FR1 NR REFSENS, Skyworks Solutions Inc.  R4-1802342, Draft CR for NR FR1 ACS case 2 transmitter power setting correction (Note 1), MediaTek Inc.  R4-1802509, Draft CR on 38.101-1 v15.0.0: Remaining ON/OFF masks for FR1 NR UE transmissions, Ericsson  R4-1802566, Draft CR to TS 38.101-1: Clarification of mixed numerology guardband size, Ericsson  R4-1802978, Draft CR to TS 38.101-1: Corrections on channel raster in Section 5.4.2.3, Intel Corporation  R4-1803064, Draft CR for 38.101-1: Correction of errors, Sprint Corporation  R4-1803065, Draft CR for 38.101-1 Introduction of n41requirements, Sprint Corporation  R4-1803242, Draft CR to 38.101-1: Corrections to n66, Dish Network  R4-1803285, Draft CR to 38.101-1: Correction to CH BWs without symmetric uplink Dish Network, Skyworks Solutions Inc.  R4-1803436, Introduction of UL subcarrier alignment for additional bands, AT&T  R4-1803456, Draft CR for 38.101-1: Spurious Emissions for UE Coexistence, Sprint Corporation  R4-1803461, CR on configured transmitted power for TS 38.101-1, Huawei  R4-1803452, draft CR for introduction of completed band combinations from 37.865-01-01 into 38.101-1, Ericsson  R4-1803567, Draft CR for TS 38.101-1: Sync raster offset in re-farming bands (5.4.3), Ericsson  R4-1803365, CR to introduce MPR for PC2 and PC3 and A-MPR for UTRA protection, Nokia | 15.1.0 |
| 2018-06 | RAN#80 | RP-181262 | 0011 |  | F | CR to TS 38.101-1: Implementation of endorsed draft CRs from RAN4 #86bis and RAN4 #87 | 15.2.0 |
| 2018-09 | RAN#81 | RP-181896 | 0025 |  | F | Big CR for 38.101-1  Endorced draft CRs from RAN4#NR-AH-1807  R4-1809335, Draft CR on UL RMC for FR1 RF tests , Qualcomm Incorporated  R4-1809337, Draft CR on NR UE REFSENS SNR FRC for FR1, Intel Corporation  R4-1809339, Draft CR on measurement of receiver characteristics for FR1 RF Tests, Qualcomm Incorporated  R4-1809396, Draft CR on NR UE maximum input level FRC for FR1, Intel  R4-1809567, Draft CR on OCNG pattern for FR1 REFSENS tests, Qualcomm Incorporated, Rohde & Schwarz  Endoirced draft CRs from RAN4#88  R4-1809714, Draft CR to correct in-band blocking parameters for FR1, Anritsu Corporation  R4-1809784, Draft CR to 38.101-1: Corrections on CA bandwidth classes for FR1, ZTE Corporation  R4-1809785, Draft CR to TS 38.101-1 for Corrections on UE transmitter power, ZTE Corporation  R4-1809793, Draft CR to 38.101-1: Corrections on additional spectrum emission mask, ZTE Corporation  R4-1809919, Correction on UE receiver requirement for FR1, CATT  R4-1810091, Draft CR TS 38.101-1 - UE ON-OFF mask clean up, Ericsson  R4-1810210, Draft CR for TS 38.101-1: MPR inner and outer RB allocations formula correction, MediaTek, Inc.  R4-1810229, Draft CR for TS 38.101-1: Spurious emission for UE coexistence table corrections, MediaTek, Inc.  R4-1810230, Draft CR for TS38.101-1 to correct 90MHz UE CBW, LG Electronics, Inc.  R4-1810232, Draft CR for TS 38.101-1: Table 7.3.2-1 n77 reference sensitivity corrections, MediaTek, Inc.  R4-1810369, Draft CR to 38.101-1: Corrections on symbols and abbreviations in section 3, ZTE Corporation  R4-1810376, Draft CR: General corrections to n71 requirements, Dish Network  R4-1810428, Draft CR on TS38.101-1 for UE maximum output power for UL-MIMO, OPPO  R4-1810552, Correction of reference tables, OPPO  R4-1810729, Draft CR for introduction of Band n74 for TS 38.101-1, NTT DOCOMO, Inc.  R4-1810862, Draft CR to 38.101-1: Updates to Transmit Modulation Annex, Rohde & Schwarz  R4-1810892, CR to update Table 6.2D.1-2 for FR1, Qualcomm Incorporated  R4-1810961, CR on ACS minimum requirement, Intel Corporation  R4-1810965, CR on Out-of-Band Blocking minimum requirement, Intel Corporation  R4-1810967, CR on Rx Intermodulation characteristics for CA, Intel Corporation  R4-1810974, Annex lettering change for 38.101-1, Qualcomm Incorporated  R4-1811189, CR to add more details to Coherent UL MIMO spec for FR1, Qualcomm Incorporated  R4-1811280, Corrections of NR receiver characteristics titles, Vivo  R4-1811455, Draft CR on DL Physical Channel for FR1 RF tests, Qualcomm Europe Inc. (Spain)  R4-1811457, NS numbering, Qualcomm Incorporated  R4-1811459, Correction on UE transmitter requirement for FR1, CATT  R4-1811463, Draft CR for 38.101-1: Addition of missing NR CA configurations n8-n75 and n28-n75, VodafoneItalia SpA  R4-1811472, Addition parameters about n51 in TS 38.101-1, Huawei, Hisilicon, Etisalat  R4-1811474, CR CP- OFDM almost contiguous allocation, Nokia, Nokia Shanghai Bell  R4-1811477, Draft CR to 38.101-1: FR1 Power Control, Qualcomm Incorporated  R4-1811478, A-MPR correction for n20 and n28, Huawei, HiSilicon  R4-1811490, Draft CR to 38.101-1: Addition of Carrier Leakage table, Rohde & Schwarz  R4-1811491, Draft CR for TS38.101-1 on transmit signal quality, OPPO  R4-1811493, CR to TS 38.101-1: pi/2 BPSK with Spectrum Shaping, Indian Institute of Tech (M),Indian Institute of Tech (H), CEWiT, Nokia  R4-1811513, A proposal on 2UL co-ex table modification, SoftBank Corp.  R4-1811514, Draft CR to TS 38.101-1: Clarification on OCNG, Keysight Technologies UK Ltd  R4-1811516, Draft CR on NR DL FRCs for FR1 UE RF requirements, Intel Corporation  R4-1811550, Draft CR to TS 38.101-1 on channel bandwidth and spacing descriptions, Ericsson  R4-1811553, Draft CR to 38.101-1: Corrections on description of channel raster entries, ZTE Corporation  R4-1811783, Measurement period of PRACH time mask, CATT  R4-1811792, Draft CR for A-MPR revision for n1, NTT DOCOMO, INC.  R4-1811798, Draft CR for Pcmax for FR1, Qualcomm Incorporated  R4-1811799, Pcmax for inter-band NR CA FR1 draft CR, InterDigital, Inc.  R4-1811812, Draft CR to 38.101-1: On FR1 AMPR Band n41 NS\_04, Qualcomm Incorporated  R4-1811816, CR to update the definition of Long and Short subslot for FR1, Qualcomm  R4-1811894, Addition parameters about n50 in TS 38.101-1, Huawei  R4-1811896, Draft CR for TS 38.101-1: n41 GSCN range modification, MediaTek Inc.  R4-1811285, Draft CR TS 38.101-1: NS\_04 A-MPR’ and spurious emisison corrections, Sprint | 15.3.0 |