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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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- x the first digit:
 - 1 presented to TSG for information;
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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".
- [9] ITU-R Recommendation SM.329-10, "Unwanted emissions in the spurious domain".
- [10] 3GPP TS 38.214: "NR; Physical layer procedures for data".

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.

UE transmission bandwidth configuration: Set of resource blocks located within the UE channel bandwidth which may be used for transmitting or receiving by the UE.

Vehicular UE: A UE embedded in a vehicle, permanently connected to an embedded antenna system that radiates externally for NR operating bands.

NOTE: Vehicular UE does not refer to other UE form factors placed inside the vehicle.

3.2 Symbols

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

| | |
|--------------------------------|---|
| ΔF_{Global} | Granularity of the global frequency raster |
| ΔF_{Raster} | Band dependent channel raster granularity |
| Δf_{OOB} | Δ Frequency of Out Of Band emission |
| $\Delta F_{\text{TX-RX}}$ | Δ Frequency of default TX-RX separation of the FDD <i>operating band</i> |
| $\Delta P_{\text{PowerClass}}$ | Adjustment to maximum output power for a given power class |
| Δ_{RB} | The starting frequency offset between the allocated RB and the measured non-allocated RB |
| $\Delta R_{\text{IB},c}$ | Allowed reference sensitivity relaxation due to support for inter-band CA operation, for serving cell c |
| $\Delta R_{\text{IB},4R}$ | Reference sensitivity adjustment due to support for 4 antenna ports |
| Δ_{Shift} | Channel raster offset |
| ΔT_{C} | Allowed operating band edge transmission power relaxation |
| $\Delta T_{\text{C},c}$ | Allowed operating band edge transmission power relaxation for serving cell c |
| $\Delta T_{\text{IB},c}$ | Allowed maximum configured output power relaxation due to support for inter-band CA operation and due to support for SUL operations, for serving cell c |
| BW_{Channel} | Channel bandwidth |
| $BW_{\text{Channel,block}}$ | Sub-block bandwidth, expressed in MHz. $BW_{\text{Channel,block}} = F_{\text{edge,block,high}} - F_{\text{edge,block,low}}$ |
| $BW_{\text{Channel_CA}}$ | Aggregated channel bandwidth, expressed in MHz |
| $BW_{\text{Channel,max}}$ | Maximum channel bandwidth supported among all bands in a release |
| BW_{GB} | $\max(BW_{\text{GB,Channel}(k)})$ |
| $BW_{\text{GB,Channel}(k)}$ | Minimum guard band defined in clause 5.3A.1 of carrier k |
| BW_{DL} | Channel bandwidth for DL |

| | |
|---------------------------|--|
| BW_{UL} | Channel bandwidth for UL |
| $BW_{interferer}$ | Bandwidth of the interferer |
| $Ceil(x)$ | Rounding upwards; $ceil(x)$ is the smallest integer such that $ceil(x) \geq x$ |
| $Floor(x)$ | Rounding downwards; $floor(x)$ is the greatest integer such that $floor(x) \leq x$ |
| F_C | Center frequency of a carrier for a numerology defined by the <i>RF reference frequency</i> on the channel raster mapped to the carrier according to sub-clause 5.4.2.2 |
| $F_{C,block, high}$ | F_C of the highest transmitted/received carrier in a <i>sub-block</i> |
| $F_{C,block, low}$ | F_C of the lowest transmitted/received carrier in a <i>sub-block</i> |
| $F_{C,low}$ | The F_C of the lowest carrier, expressed in MHz |
| $F_{C,high}$ | The F_C of the highest carrier, expressed in MHz |
| F_{DL_low} | The lowest frequency of the downlink <i>operating band</i> |
| F_{DL_high} | The highest frequency of the downlink <i>operating band</i> |
| F_{UL_low} | The lowest frequency of the uplink <i>operating band</i> |
| F_{UL_high} | The highest frequency of the uplink <i>operating band</i> |
| $F_{edge,block,low}$ | The lower <i>sub-block edge</i> , where $F_{edge,block,low} = F_{C,block,low} - F_{offset, low}$. |
| $F_{edge,block,high}$ | The upper <i>sub-block edge</i> , where $F_{edge,block,high} = F_{C,block,high} + F_{offset, high}$. |
| $F_{edge, low}$ | The <i>lower edge of aggregated channel bandwidth</i> , expressed in MHz. $F_{edge,low} = F_{C,low} - F_{offset,low}$. |
| $F_{edge, high}$ | The <i>higher edge of aggregated channel bandwidth</i> , expressed in MHz. $F_{edge,high} = F_{C,high} + F_{offset,high}$. |
| $F_{interferer (offset)}$ | Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured). For intra-band contiguous CA, the $F_{interferer (offset)}$ is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the interferer |
| $F_{interferer}$ | Frequency of the interferer |
| $F_{ioffset}$ | Frequency offset of the interferer (between the center frequency of the interferer and the closest edge of the carrier measured) |
| F_{offset} | Frequency offset from $F_{C,high}$ to the <i>higher edge</i> or $F_{C,low}$ to the <i>lower edge</i> . |
| $F_{offset,high}$ | Frequency offset from $F_{C,high}$ to the upper <i>UE RF Bandwidth edge</i> , or from $F_{C,block, high}$ to the upper sub-block edge |
| $F_{offset,low}$ | Frequency offset from $F_{C,low}$ to the lower <i>UE RF Bandwidth edge</i> , or from $F_{C,block, low}$ to the lower sub-block edge |
| F_{OOB} | The boundary between the NR out of band emission and spurious emission domains |
| F_{REF} | RF reference frequency |
| $F_{REF-Offs}$ | Offset used for calculating F_{REF} |
| $F_{REF, shift}$ | RF reference frequency for Supplementary Uplink (SUL) bands, the uplink of all FDD bands, and TDD bands |
| $F_{uw (offset)}$ | The frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the interferer |
| $GB_{channel}$ | Minimum guard band defined in clause 5.3.3, expressed in kHz |
| L_{CRB} | Transmission bandwidth which represents the length of a contiguous resource block allocation expressed in units of resource blocks |
| $Max()$ | The largest of given numbers |
| $Min()$ | The smallest of given numbers |
| n_{PRB} | Physical resource block number |
| NR_{ACLR} | NR ACLR |
| NR_{RB} | Transmission bandwidth configuration, expressed in units of resource blocks |
| NR_{RB_agg} | The number of the aggregated RBs within the fully allocated aggregated channel bandwidth |
| NR_{RB_agg} | The number of the aggregated RBs within the fully allocated aggregated channel bandwidth |
| | $NR_{RB_agg} = \sum_1^j NR_{RB_j} * 2^{\mu_j}$ for carrier 1 to j, where μ is defined in TS 38.211 [6] |
| $NR_{RB,c}$ | The transmission bandwidth configuration of component carrier c, expressed in units of resource blocks |
| | $NR_{RB,cj} = NR_{RB_j} * 2^{\mu_j}$ for carrier j, where μ is defined in TS 38.211 [6] |
| $NR_{RB,low}$ | The transmission bandwidth configurations according to Table 5.3.2-1 for the lowest assigned component carrier in section 5.3A.1 |
| $NR_{RB,high}$ | The transmission bandwidth configurations according to Table 5.3.2-1 for the highest assigned component carrier in section 5.3A.1 |
| N_{REF} | NR Absolute Radio Frequency Channel Number (NR-ARFCN) |
| $N_{REF-Offs}$ | Offset used for calculating N_{REF} |
| P_{CMAX} | The configured maximum UE output power |
| $P_{CMAX,c}$ | The configured maximum UE output power for serving cell c |
| $P_{CMAX,f,c}$ | The configured maximum UE output power for carrier f of serving cell c in each slot |
| P_{EMAX} | Maximum allowed UE output power signalled by higher layers |

| | |
|---------------------|---|
| $P_{EMAX, c}$ | Maximum allowed UE output power signalled by higher layers for serving cell c |
| $P_{Interferer}$ | Modulated mean power of the interferer |
| $P_{largest\ BW}$ | Power of the largest transmission bandwidth configuration of the component carriers in the bandwidth combination |
| $P_{PowerClass}$ | The nominal UE power (i.e., no tolerance) |
| $P\text{-MPR}_c$ | Power Management Maximum Power Reduction for serving cell c |
| P_{RB} | The transmitted power per allocated RB, measured in dBm |
| P_{UMAX} | The measured configured maximum UE output power |
| P_{uw} | Power of an unwanted DL signal |
| P_w | Power of a wanted DL signal |
| RB_{start} | The lowest RB index of transmitted resource blocks |
| SCS_c | SCS for the component carrier c , expressed in kHz |
| $SCS_{largest\ BW}$ | SCS for the largest transmission bandwidth configuration of the component carriers in the bandwidth combination, expressed in kHz |
| SCS_{low} | SCS for the lowest assigned component carrier in section 5.3A.1, expressed in kHz |
| SCS_{high} | SCS for the highest assigned component carrier in section 5.3A.1, expressed in kHz |
| $T(P_{CMAX, f, c})$ | Tolerance for applicable values of $P_{CMAX, f, c}$ for configured maximum UE output power for carrier f of serving cell c |
| $T_{L, c}$ | Absolute value of the lower tolerance for the applicable <i>operating band</i> as specified in section 6.2.1 |
| SS_{REF} | SS block reference frequency position |
| $UTRA_{ACLR}$ | 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].

| | |
|------------|---|
| 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 nX and component carrier(s) in one sub-block within Band nY where nX and nY are the applicable NR <i>operating bands</i> |
| 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 |
| Rx | 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 |
| SUL | Supplementary uplink |
| 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

- 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
- 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.
- 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
- All the requirements for intra-band contiguous and non-contiguous CA apply under the assumption of the same slot format indicated by *TDD-UL-DL-ConfigurationCommon* and *TDD-UL-DL-ConfigurationDedicated* in the PCell and SCells for NR SA.

4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level clause, 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 | Supplementary 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 clause (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 clause requirements (suffix A, B, C and D) in clauses 5, 6 and 7, the tighter requirements are applicable unless stated otherwise in the additional clause.

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. For a terminal that supports SUL, the current version of the specification assumes the terminal is not configured with UL MIMO on SUL carrier.

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 | 410 MHz – 7125 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) <i>operating band</i> BS receive / UE transmit $F_{UL_low} - F_{UL_high}$ | Downlink (DL) <i>operating band</i> BS transmit / UE receive $F_{DL_low} - F_{DL_high}$ | 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 | TDD ¹ |
| 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 ³ |
| n76 | N/A | 1427 MHz – 1432 MHz | SDL ³ |
| 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 – 1780 MHz | 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.

NOTE 2: UE that complies with the NR Band n75 minimum requirements in this specification shall also comply with the NR Band n76 minimum requirements.

NOTE 3: For SDL bands, downlink configuration for RRM performance testing is same as FDD.

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_n41 ¹ | n41 |
| CA_n77 ¹ | n77 |
| CA_n78 ¹ | n78 |
| CA_n79 ¹ | n79 |

NOTE 1: The minimum requirements only apply for non-simultaneous Tx/Rx between all carriers.

5.2A.2 Inter-band CA

NR inter-band carrier aggregation is designed to operate in the operating bands defined in Table 5.2A.2.1-1, where all operating bands are within FR1.

If the mandatory simultaneous Rx/Tx capability applies for a lower order band combination, when the applicable lower order band combination is a band pair in a higher order band combination, the mandatory simultaneous Rx/Tx capability also applies for the band pair in the higher order band combination.

Table 5.2A.2-1: Void**5.2A.2.1 Inter-band CA (two bands)****Table 5.2A.2.1-1: Inter-band CA operating bands involving FR1 (two bands)**

| NR CA Band | NR Band (Table 5.2-1) |
|--|--------------------------|
| CA_n3-n77 ¹ | n3, n77 |
| CA_n3-n78 ¹ | n3, n78 |
| CA_n3-n79 ¹ | n3, n79 |
| CA_n8-n75 ¹ | n8, n75 |
| CA_n8-n78 ¹ | n8, n78 |
| CA_n8-n79 ¹ | n8, n79 |
| CA_n28-n75 ² | n28, n75 |
| CA_n28-n78 ¹ | n28, n78 |
| CA_n41-n78 | n41, n78 |
| CA_n75-n78 ¹ | n75, n78 |
| CA_n76-n78 ¹ | n76, n78 |
| CA_n77-n79 ⁴ | n77, n79 |
| CA_n78-n79 ³ | n78, n79 |
| <p>NOTE 1: Applicable for UE supporting inter-band carrier aggregation with mandatory simultaneous Rx/Tx capability.</p> <p>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.</p> <p>NOTE 3: For UEs supporting band n77, the minimum requirements apply only when there is non-simultaneous Rx/Tx operation between n78-n79 NR carriers. This restriction applies also for these carriers when applicable NR CA configuration is part of a higher order configuration.</p> <p>NOTE 4: The minimum requirements apply only when there is non-simultaneous Rx/Tx operation between n77-n79 NR carriers. This restriction applies also for these carriers when applicable NR CA configuration is part of a higher order configuration.</p> | |

5.2B Void**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.

If the mandatory simultaneous Rx/Tx capability applies for a lower order band combination, when the applicable lower order band combination is a band pair in a higher order band combination, the mandatory simultaneous Rx/Tx capability also applies for the band pair in the higher order band combination.

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

| NR Band combination for SUL | NR Band (Table 5.2-1) |
|--------------------------------|--------------------------|
| SUL_n78-n80 ² | n78, n80 |
| SUL_n78-n81 ² | n78, n81 |
| SUL_n78-n82 ² | n78, n82 |
| SUL_n78-n83 ² | n78, n83 |
| SUL_n78-n84 ² | n78, n84 |
| SUL_n78-n86 ² | n78, n86 |

| | |
|---|----------|
| SUL_n79-n80 ² | n79, n80 |
| SUL_n79-n81 ² | 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 0 us. | |
| NOTE 2: For UE supporting SUL band combination simultaneous Rx/Tx capability is mandatory. | |
| NOTE 3: For UE supporting SUL band combination, UL MIMO is not configured on SUL carrier. | |

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.

The relationship between the channel bandwidth, the guardband and the maximum transmission bandwidth configuration is shown in Figure 5.3.1-1.

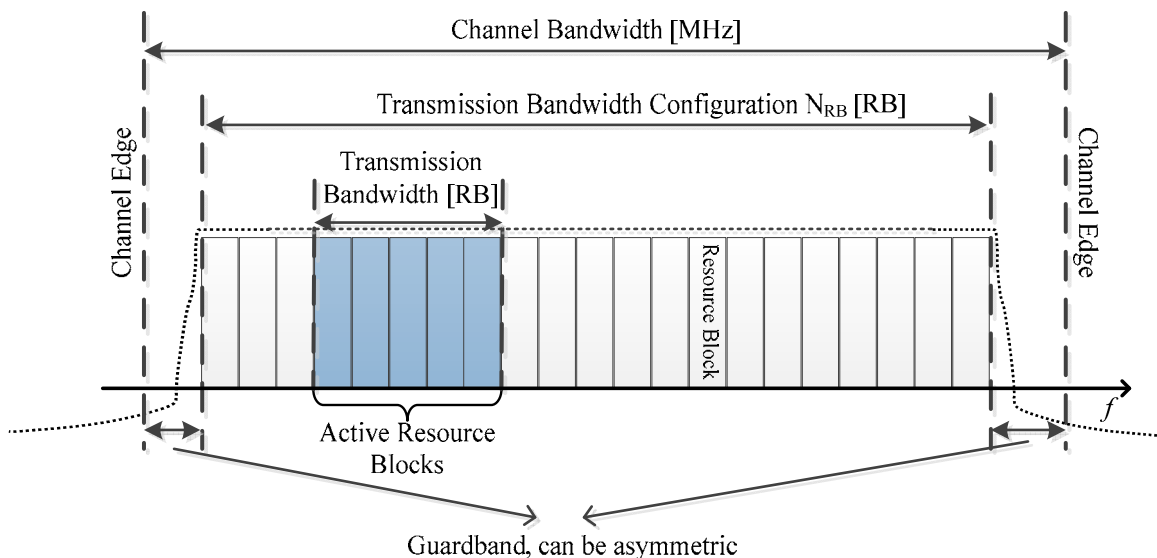


Figure 5.3.1-1: Definition of the channel bandwidth and the maximum transmission bandwidth configuration for one NR channel

5.3.2 Maximum transmission bandwidth configuration

The maximum transmission bandwidth configuration N_{RB} 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 N_{RB}

| 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 |
|-----------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|----|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} | N_{RB} |
| 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 | 50 MHz | 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: $GB_{channel} = (BW_{channel} \times 1000 \text{ (kHz)} - N_{RB} \times SCS \times 12) / 2 - SCS/2$, where N_{RB} are from Table 5.3.2-1 and $GB_{channel}$ expressed in kHz.

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.

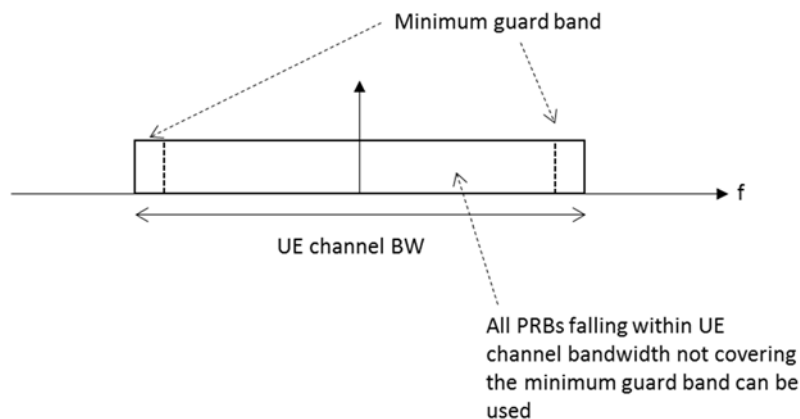


Figure 5.3.3-2: UE PRB utilization

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.

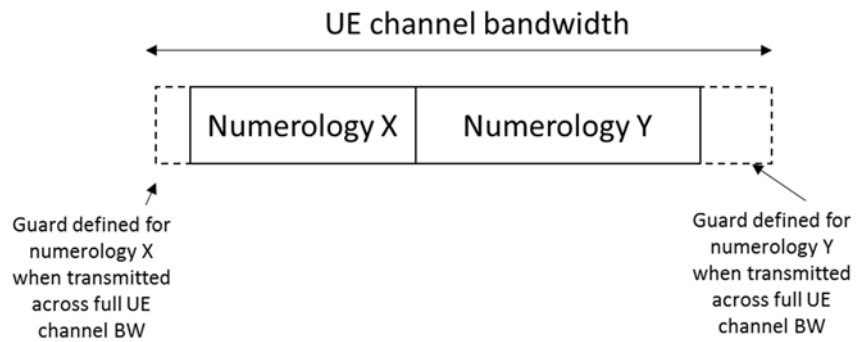


Figure 5.3.3-3 Guard band definition when transmitting multiple numerologies

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

For each numerology, its common resource blocks are specified in Clause 4.4.4.3 in TS 38.211 [6], 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 *UE transmission bandwidth configuration* is indicated by the higher layer parameter *carrierBandwidth* [7] and will fulfil the minimum UE guardband requirement specified in Clause 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 | NR band / SCS / UE Channel bandwidth | | | | | | | | | | | | |
|---------|--------------------------------------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------------|---------|
| | SCS kHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 ⁴ 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 | | | | | | | | |

| NR Band | NR band / SCS / UE Channel bandwidth | | | | | | | | | | | | |
|---------|--------------------------------------|------------------|--------|--------|------------------|------------------|--------|--------|--------|--------|------------------|---------------------|---------|
| | SCS kHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 ⁴ MHz | 100 MHz |
| | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | Yes | Yes | Yes | | | | | | | | |
| n28 | 15 | Yes | Yes | Yes | Yes ⁵ | | | | | | | | |
| | 30 | | Yes | Yes | Yes ⁵ | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| | 15 | Yes | Yes | Yes | | | | | | | | | |
| n34 | 30 | | Yes | Yes | | | | | | | | | |
| | 60 | | Yes | Yes | | | | | | | | | |
| n38 | 15 | Yes | Yes | Yes | Yes | | | | | | | | |
| | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | Yes | Yes | Yes | | | | | | | | |
| | 15 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | | | | |
| n39 | 30 | | Yes | Yes | Yes | Yes | Yes | Yes | | | | | |
| | 60 | | Yes | Yes | Yes | Yes | Yes | Yes | | | | | |
| n40 | 15 | Yes ⁹ | 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 | | |
| | 15 | | Yes | Yes | Yes | | | Yes | Yes | | | | |
| n41 | 30 | | Yes | Yes | Yes | | | Yes | Yes | Yes | Yes | Yes | Yes |
| | 60 | | Yes | Yes | Yes | | | Yes | Yes | Yes | Yes | Yes | Yes |
| n50 | 15 | Yes ⁹ | Yes | Yes | Yes | | | Yes | Yes | | | | |
| | 30 | | Yes | Yes | Yes | | | Yes | Yes | Yes | Yes ³ | | |
| | 60 | | Yes | Yes | Yes | | | Yes | Yes | Yes | Yes ³ | | |
| | 15 | Yes | | | | | | | | | | | |
| n51 | 30 | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| n66 | 15 | Yes | Yes | Yes | Yes | | | Yes | | | | | |
| | 30 | | Yes | Yes | Yes | | | Yes | | | | | |
| | 60 | | Yes | Yes | Yes | | | Yes | | | | | |
| | 15 | Yes | Yes | Yes | Yes ³ | Yes ³ | | | | | | | |
| n70 | 30 | | Yes | Yes | Yes ³ | Yes ³ | | | | | | | |
| | 60 | | Yes | Yes | Yes ³ | Yes ³ | | | | | | | |
| n71 | 15 | Yes | Yes | Yes | Yes | | | | | | | | |
| | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| | 15 | Yes | Yes | Yes | Yes | | | | | | | | |
| n74 | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | Yes | Yes | Yes | | | | | | | | |
| n75 | 15 | Yes | Yes | Yes | Yes | | | | | | | | |
| | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | Yes | Yes | Yes | | | | | | | | |
| | 15 | Yes | | | | | | | | | | | |
| n76 | 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 |
| | 15 | | Yes | Yes | Yes | | | Yes | Yes | | | | |
| n78 | 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 |
| | 15 | Yes | Yes | Yes | Yes | Yes | Yes | | | | | | |
| n80 | 30 | | Yes | Yes | Yes | Yes | Yes | | | | | | |
| | 60 | | Yes | Yes | Yes | Yes | Yes | | | | | | |
| n81 | 15 | Yes | Yes | Yes | Yes | | | | | | | | |

| NR Band | NR band / SCS / UE Channel bandwidth | | | | | | | | | | | | |
|---------|--------------------------------------|-------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|---------------------|---------|
| | SCS kHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 ⁴ MHz | 100 MHz |
| | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| n82 | 15 | Yes | Yes | Yes | Yes | | | | | | | | |
| | 30 | | Yes | Yes | Yes | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| n83 | 15 | Yes | Yes | Yes | Yes ⁵ | | | | | | | | |
| | 30 | | Yes | Yes | Yes ⁵ | | | | | | | | |
| | 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: void
 NOTE 2: void
 NOTE 3: This UE channel bandwidth is applicable only to downlink.
 NOTE 4: This UE channel bandwidth is optional in this release of the specification.
 NOTE 5: For the 20 MHz bandwidth, the minimum requirements are specified for NR UL carrier frequencies confined to either 713-723 MHz or 728-738 MHz.
 NOTE 6: Void.
 NOTE 7: Void.
 NOTE 8: Void.
 NOTE 9: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as an SCell part of DC or CA configuration.

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:

$$\Delta F_{TX-RX} = |(BW_{DL} - BW_{UL})/2|$$

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 |
| n71 | 5 | 10 |
| | 10 | 15 |
| | 15 | 20 |

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 |

NOTE 1: Both centre frequency and BWP-ID shall match between DL and UL carriers as defined in TS 38.331 [7] cl. 6.3.2 and TS 38.213 [8] section 12.
 NOTE 2: In a case a UE is configured with a full width of BWP within both UL/ DL channels, the centre frequency of UL/ DL channels shall be same.
 NOTE 3: A position of Point A is common between UL and DL carriers as defined in TS 38.331 [7] cl. 6.3.2.

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 clause 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.

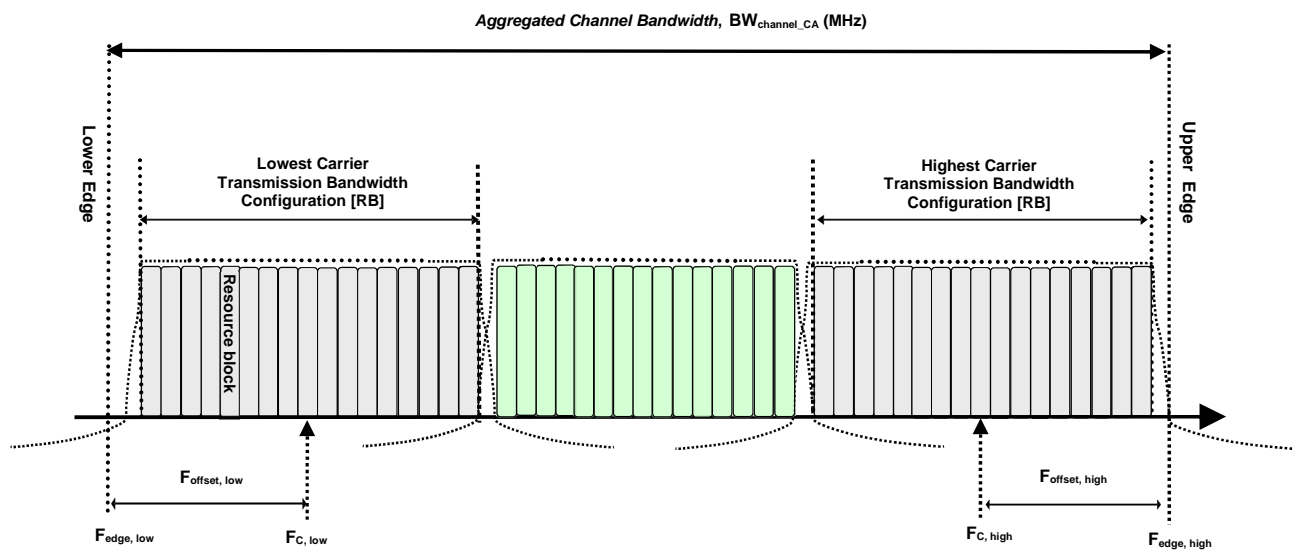


Figure 5.3A.3-1: Definition of *Aggregated Channel Bandwidth* for intra-band carrier aggregation

The *aggregated channel bandwidth*, $BW_{Channel_CA}$, is defined as

$$BW_{Channel_CA} = F_{edge,high} - F_{edge,low} \text{ (MHz)}.$$

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

$$F_{edge,low} = F_{C,low} - F_{offset,low}$$

$$F_{edge,high} = F_{C,high} + F_{offset,high}$$

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

$$F_{\text{offset,low}} = (N_{\text{RB,low}} * 12 + 1) * SCS_{\text{low}} / 2 + BW_{\text{GB}} \text{ (MHz)}$$

$$F_{\text{offset,high}} = (N_{\text{RB,high}} * 12 - 1) * SCS_{\text{high}} / 2 + BW_{\text{GB}} \text{ (MHz)}$$

$$BW_{\text{GB}} = \max(BW_{\text{GB,Channel}(k)})$$

$N_{\text{RB,low}}$ and $N_{\text{RB,high}}$ are the transmission bandwidth configurations according to Table 5.3.2-1 for the lowest and highest assigned component carrier, SCS_{low} and SCS_{high} are the sub-carrier spacing for the lowest and highest assigned component carrier respectively. SCS_{low} , SCS_{high} , $N_{\text{RB,low}}$, $N_{\text{RB,high}}$, and $BW_{\text{GB,Channel}(k)}$ use the largest μ value among the subcarrier spacing configurations supported in the operating band for both of the channel bandwidths according to Table 5.3.5-1 and $BW_{\text{GB,Channel}(k)}$ is the minimum guard band for carrier k according to Table 5.3.3-1 for the said μ value. In case there is no common μ value for both of the channel bandwidths, $\mu=1$ is used for SCS_{low} , SCS_{high} , $N_{\text{RB,low}}$, $N_{\text{RB,high}}$, and $BW_{\text{GB,Channel}(k)}$.

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

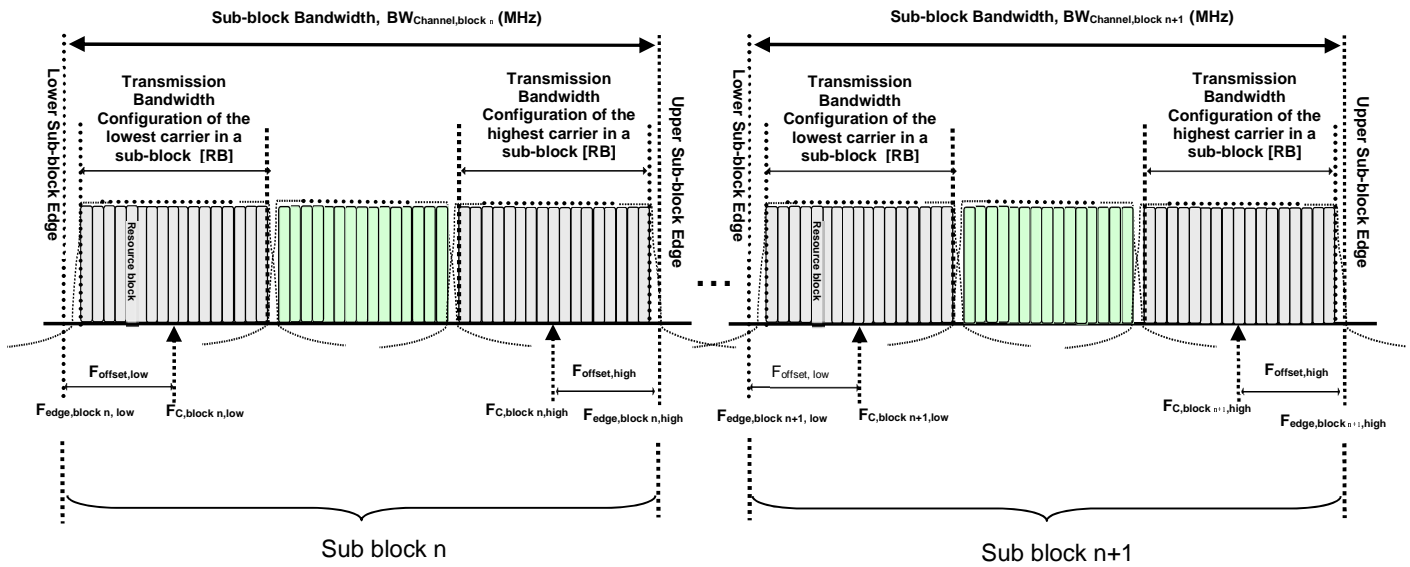


Figure 5.3A.3-2: Definition of sub-block bandwidth for intra-band non-contiguous spectrum

The lower sub-block edge of the Sub-block Bandwidth ($BW_{\text{Channel,block}}$) is defined as

$$F_{\text{edge,block,low}} = F_{\text{C,block,low}} - F_{\text{offset,low}}$$

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

$$F_{\text{edge,block,high}} = F_{\text{C,block,high}} + F_{\text{offset,high}}$$

The Sub-block Bandwidth, $BW_{\text{Channel,block}}$, is defined as follows:

$$BW_{\text{Channel,block}} = F_{\text{edge,block,high}} - F_{\text{edge,block,low}} \text{ (MHz)}$$

The lower and upper frequency offsets $F_{\text{offset,block,low}}$ and $F_{\text{offset,block,high}}$ depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carriers within a sub-block and are defined as

$$F_{\text{offset,block,low}} = (N_{\text{RB,low}} * 12 + 1) * SCS_{\text{low}} / 2 + BW_{\text{GB}} \text{ (MHz)}$$

$$F_{\text{offset,block,high}} = (N_{\text{RB,high}} * 12 - 1) * SCS_{\text{high}} / 2 + BW_{\text{GB}} \text{ (MHz)}$$

$$BW_{\text{GB}} = \max(BW_{\text{GB,Channel}(k)})$$

where $N_{\text{RB,low}}$ and $N_{\text{RB,high}}$ 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. SCS_{low} and SCS_{high} are the sub-carrier spacing for the lowest and highest assigned component carrier within a sub-block, respectively. SCS_{low} , SCS_{high} , $N_{\text{RB,low}}$, $N_{\text{RB,high}}$, and $BW_{\text{GB,Channel}(k)}$ use the largest μ value among the subcarrier spacing configurations supported in the operating band

for both of the channel bandwidths according to Table 5.3.5-1 and $BW_{GB,Channel(k)}$ is the minimum guard band for carrier k according to Table 5.3.3-1 for the said μ value. In case there is no common μ value for both of the channel bandwidths, $\mu=1$ is used for SCS_{low} , SCS_{high} , $N_{RB,low}$, $N_{RB,high}$, and $BW_{GB,Channel(k)}$.

The sub-block gap size between two consecutive sub-blocks W_{gap} is defined as

$$W_{gap} = F_{edge,block\ n+1,low} - F_{edge,block\ n,high} \text{ (MHz)}$$

5.3A.4 Void

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: NR CA bandwidth classes

| NR CA bandwidth class | Aggregated channel bandwidth | Number of contiguous CC | Fallback group |
|--|---|-------------------------|----------------|
| A | $BW_{Channel} \leq BW_{Channel,max}$ | 1 | 1, 2 |
| B | $20 \text{ MHz} \leq BW_{Channel_CA} \leq 100 \text{ MHz}$ | 2 | 2 |
| C | $100 \text{ MHz} < BW_{Channel_CA} \leq 2 \times BW_{Channel,max}$ | 2 | 1 |
| D | $200 \text{ MHz} < BW_{Channel_CA} \leq 3 \times BW_{Channel,max}$ | 3 | |
| E | $300 \text{ MHz} < BW_{Channel_CA} \leq 4 \times BW_{Channel,max}$ | 4 | |
| | | | |
| G | $100 \text{ MHz} < BW_{Channel_CA} \leq 150 \text{ MHz}$ | 3 | 2 |
| H | $150 \text{ MHz} < BW_{Channel_CA} \leq 200 \text{ MHz}$ | 4 | |
| I | $200 \text{ MHz} < BW_{Channel_CA} \leq 250 \text{ MHz}$ | 5 | |
| J | $250 \text{ MHz} < BW_{Channel_CA} \leq 300 \text{ MHz}$ | 6 | |
| K | $300 \text{ MHz} < BW_{Channel_CA} \leq 350 \text{ MHz}$ | 7 | |
| L | $350 \text{ MHz} < BW_{Channel_CA} \leq 400 \text{ MHz}$ | 8 | |
| | | | |
| NOTE 1: $BW_{Channel,max}$ is maximum channel bandwidth supported among all bands in a release | | | |
| NOTE 2: It is mandatory for a UE to be able to fallback to lower order NR CA bandwidth class configuration within a fallback group. It is not mandatory for a UE to be able to fallback to lower order NR CA bandwidth class configuration that belong to a different fallback group | | | |

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,

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2$$

- For NR operating bands with 15 kHz channel raster,

Nominal Channel spacing = $(BW_{\text{Channel}(1)} + BW_{\text{Channel}(2)})/2 + \{-5 \text{ kHz}, 0 \text{ kHz}, 5 \text{ kHz}\}$ for ΔF_{Raster} equals 15 kHz

Nominal Channel spacing = $(BW_{\text{Channel}(1)} + BW_{\text{Channel}(2)})/2 + \{-10 \text{ kHz}, 0 \text{ kHz}, 10 \text{ kHz}\}$ for ΔF_{Raster} equals 30 kHz

where $BW_{\text{Channel}(1)}$ and $BW_{\text{Channel}(2)}$ 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 F_{REF} . 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 ΔF_{Global} .

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 F_{REF} in MHz is given by the following equation, where $F_{\text{REF-Offs}}$ and $N_{\text{REF-Offs}}$ are given in table 5.4.2.1-1 and N_{REF} is the NR-ARFCN.

$$F_{\text{REF}} = F_{\text{REF-Offs}} + \Delta F_{\text{Global}} (N_{\text{REF}} - N_{\text{REF-Offs}})$$

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

| Frequency range (MHz) | ΔF_{Global} (kHz) | $F_{\text{REF-Offs}}$ (MHz) | $N_{\text{REF-Offs}}$ | Range of N_{REF} |
|-----------------------|----------------------------------|-----------------------------|-----------------------|---------------------------|
| 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 ΔF_{Raster} , which may be equal to or larger than ΔF_{Global} .

For SUL bands, for the uplink of all FDD bands defined in Table 5.2-1, and for TDD band n34, n38, and n39

$$F_{\text{REF, shift}} = F_{\text{REF}} + \Delta_{\text{shift}}, \Delta_{\text{shift}} = 0 \text{ kHz or } 7.5 \text{ kHz.}$$

where Δ_{shift} is signalled by the network in higher layer parameter *frequencyShift7p5khz* [7]. For band n34, n38, n39 $F_{\text{REF, shift}}$ is only applicable to uplink transmissions using a 15 kHz SCS.

NOTE: A UE operating n34, n38, n39 should support application of $F_{\text{REF, shift}}$ for UL transmissions. A UE that does not support it will be unable to communicate with a network that signals $\Delta_{\text{shift}} = 7.5 \text{ kHz}$.

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

| | $N_{\text{RB} \bmod 2} = 0$ | $N_{\text{RB} \bmod 2} = 1$ |
|----------------------------|-----------------------------|-----------------------------|
| Resource element index k | 0 | 6 |

| | | |
|--|---|---|
| Physical resource block number n_{PRB} | $n_{PRB} = \left\lfloor \frac{N_{RB}}{2} \right\rfloor$ | $n_{PRB} = \left\lfloor \frac{N_{RB}}{2} \right\rfloor$ |
|--|---|---|

k, n_{PRB}, N_{RB} 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 clause 5.4.2.2.

For NR operating bands with 100 kHz channel raster, $\Delta F_{Raster} = 20 \times \Delta F_{Global}$. 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, $\Delta F_{Raster} = I \times \Delta F_{Global}$, where $I \in \{3,6\}$. Every I^{th} 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, $\Delta F_{Raster} = I \times \Delta F_{Global}$, where $I \in \{1,2\}$. Every I^{th} 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 ΔF_{Raster} , the higher ΔF_{Raster} applies to channels using only the SCS that is equal to or larger than the higher ΔF_{Raster} and SSB SCS is equal to the higher ΔF_{Raster} .

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

| NR operating band | ΔF_{Raster} (kHz) | Uplink Range of N_{REF} (First – <Step size> – Last) | Downlink Range of N_{REF} (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 |
| | 30 | 620000 – <2> – 680000 | 620000 – <2> – 680000 |
| n78 | 15 | 620000 – <1> – 653333 | 620000 – <1> – 653333 |
| | 30 | 620000 – <2> – 653332 | 620000 – <2> – 653332 |
| n79 | 15 | 693334 – <1> – 733333 | 693334 – <1> – 733333 |
| | 30 | 693334 – <2> – 733332 | 693334 – <2> – 733332 |
| n80 | 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 SS_{REF} with corresponding number GSCN. The parameters defining the SS_{REF} and GSCN for all the frequency ranges are in Table 5.4.3.1-1.

The resource element corresponding to the SS block reference frequency SS_{REF} is given in clause 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 SS_{REF} | GSCN | Range of GSCN |
|------------------|---|----------------|---------------|
| 0 – 3000 MHz | $N * 1200\text{kHz} + M * 50\text{ kHz}$, $N=1:2499$, $M \in \{1,3,5\}$ (Note 1) | $3N + (M-3)/2$ | 2 – 7498 |
| 3000 – 24250 MHz | $3000\text{ MHz} + N * 1.44\text{ MHz}$ $N = 0:14756$ | $7499 + N$ | 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.

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

| | |
|----------------------------|-----|
| Resource element index k | 120 |
|----------------------------|-----|

k is the subcarrier number of SS/PBCH block defined in TS 38.211 clause 7.4.3.1 [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 pattern ¹ | Range of GSCN (First – <Step size> – Last) |
|-------------------|--------------|-------------------------------|---|
| n1 | 15 kHz | Case A | 5279 – <1> – 5419 |
| n2 | 15 kHz | Case A | 4829 – <1> – 4969 |
| n3 | 15 kHz | Case A | 4517 – <1> – 4693 |
| n5 | 15 kHz | Case A | 2177 – <1> – 2230 |
| | 30 kHz | Case B | 2183 – <1> – 2224 |
| n7 | 15 kHz | Case A | 6554 – <1> – 6718 |
| n8 | 15 kHz | Case A | 2318 – <1> – 2395 |
| n12 | 15 kHz | Case A | 1828 – <1> – 1858 |
| n20 | 15 kHz | Case A | 1982 – <1> – 2047 |
| n25 | 15 kHz | Case A | 4829 – <1> – 4981 |
| n28 | 15 kHz | Case A | 1901 – <1> – 2002 |
| n34 | 15 kHz | Case A | NOTE 3 |
| | 30 kHz | Case C | 5036 – <1> – 5050 |
| n38 | 15 kHz | Case A | NOTE 2 |
| | 30 kHz | Case C | 6437 – <1> – 6538 |

| | | | |
|--|--------|--------|--------------------|
| n39 | 15 kHz | Case A | NOTE 4 |
| | 30 kHz | Case C | 4712 – <1> – 4789 |
| n40 | 30 kHz | Case C | 5762 – <1> – 5989 |
| | 15 kHz | Case A | 6246 – <3> – 6717 |
| n41 | 30 kHz | Case C | 6252 – <3> – 6714 |
| | 30 kHz | Case C | 3590 – <1> – 3781 |
| n50 | 30 kHz | Case C | 3590 – <1> – 3781 |
| n51 | 15 kHz | Case A | 3572 – <1> – 3574 |
| n66 | 15 kHz | Case A | 5279 – <1> – 5494 |
| | 30 kHz | Case B | 5285 – <1> – 5488 |
| n70 | 15 kHz | Case A | 4993 – <1> – 5044 |
| n71 | 15 kHz | Case A | 1547 – <1> – 1624 |
| n74 | 15 kHz | Case A | 3692 – <1> – 3790 |
| n75 | 15 kHz | Case A | 3584 – <1> – 3787 |
| n76 | 15 kHz | Case A | 3572 – <1> – 3574 |
| n77 | 30 kHz | Case C | 7711 – <1> – 8329 |
| n78 | 30 kHz | Case C | 7711 – <1> – 8051 |
| n79 | 30 kHz | Case C | 8480 – <16> – 8880 |
| NOTE 1: SS Block pattern is defined in clause 4.1 in TS 38.213 [8] | | | |
| NOTE 2: The applicable SS raster entries are GSCN = {6432, 6443, 6457, 6468, 6479, 6493, 6507, 6518, 6532, 6543} | | | |
| NOTE 3: The applicable SS raster entries are GSCN = {5032, 5043, 5054} | | | |
| NOTE 4: The applicable SS raster entries are GSCN = {4707, 4715, 4718, 4729, 4732, 4743, 4747, 4754, 4761, 4768, 4772, 4782, 4786, 4793} | | | |

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 | 300 MHz |
| n71 | -46 MHz |
| n74 | 48 MHz |
| NOTE 1: Void | |

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 a 100 kHz channel raster:

$$\text{Nominal channel spacing} = \left\lceil \frac{BW_{\text{Channel (1)}} + BW_{\text{Channel (2)}} - 2|GB_{\text{Channel (1)}} - GB_{\text{Channel (2)}}|}{0.6} \right\rceil 0.3 \text{ [MHz]}$$

while for NR operating bands without a 100 kHz channel raster:

$$\text{Nominal channel spacing} = \left\lfloor \frac{BW_{\text{Channel (1)}} + BW_{\text{Channel (2)}} - 2|GB_{\text{Channel (1)}} - GB_{\text{Channel (2)}}|}{0.015 * 2^{n+1}} \right\rfloor 0.015 * 2^n \text{ [MHz]}$$

with

$$n = \mu_0$$

where $BW_{\text{Channel(1)}}$ and $BW_{\text{Channel(2)}}$ are the channel bandwidths of the two respective NR component carriers according to Table 5.3.2-1 with values in MHz, μ_0 is the largest μ value among the subcarrier spacing configurations supported in the operating band for both of the channel bandwidths according to Table 5.3.5-1 and $GB_{\text{Channel(i)}}$ is the minimum guard band for channel bandwidth i according to Table 5.3.3-1 for the said μ value with μ as defined in TS 38.211. In case there is no common μ value for both of the channel bandwidths, $\mu_0=1$ is selected and $GB_{\text{Channel(i)}}$ is the minimum guard band for channel bandwidth i according to Table 5.3.3-1 for $\mu=1$ with μ 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 clause.

5.4A.2 Channel raster for CA

For inter-band carrier aggregation, the channel raster requirements in clause 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 clause 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 clause 5.4.4 apply for each operating band.

5.5 Void

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

| NR CA configuration / Bandwidth combination set | | | | | | | | |
|---|--------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|------------------------------------|---------------------------|
| NR CA configuration | Uplink CA configurations | 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) | Maximum aggregated bandwidth (MHz) | Bandwidth combination set |
| CA_n41C | - | 40 | 80, 100 | | | | 180 | 0 |
| | | 50, 60, 80 | 60, 80, 100 | | | | | |
| CA_n77C CA_n78C CA_n79C | - | 50 | 60, 80, 100 | | | | 200 | 0 |
| | | 60 | 60, 80, 100 | | | | | |
| | | 80 | 80, 100 | | | | | |
| | | 100 | 100 | | | | | |

NOTE: Unless otherwise stated, minimum requirements are applicable irrespective of the order of the component carriers.

Table 5.5A.1-2: Void

5.5A.2 Void

5.5A.3 Configurations for inter-band CA

Table 5.5A.3-1: Void

5.5A.3.1 Configurations for inter-band CA (two bands)

Table 5.5A.3.1-1: NR CA configurations and bandwidth 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 | |

| 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 |
|---------------------|-------------------------|---------|-----------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------------------------|
| | | | 30 | | Yes | Yes | Yes | | | | | | | | | |
| | | | 60 | | | | | | | | | | | | | |
| | | | 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 | | | | | | | | | | | | | |
| | | 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 | | | | | | | | | | | | | |
| | | 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 | |
| | | 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 | | | | | | | | | |
| | | 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 | | | | | | | | | | | | | |
| | | 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 | |
| | | 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 | |

| 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 | |
|---------------------|-------------------------|---------|-----------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------------------------|-----|
| | | | 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 |
| | | | | | | | | | | | Yes | Yes | Yes | Yes | | | Yes |

5.5B Void

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 | Bandwidth combination set |
|-------------------|---------|--------------------------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------------------------|
| SUL_n78A-n80A | n78 | 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 | |
| | n80 | 15 | Yes | Yes | Yes | Yes | Yes | Yes | | | | | | | |
| SUL_n78A-n81A | n78 | 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 | |
| | n81 | 15 | Yes | Yes | Yes | Yes | | | | | | | | | |
| SUL_n78A-n82A | n78 | 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 | |
| | n82 | 15 | Yes | Yes | Yes | Yes | | | | | | | | | |
| SUL_n78A-n83A | n78 | 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 | |
| | n83 | 15 | Yes | Yes | Yes | Yes | | | | | | | | | |
| SUL_n78A-n84A | n78 | 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 | |
| | n84 | 15 | Yes | Yes | Yes | Yes | | | | | | | | | |
| SUL_n78A-n86A | n78 | 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 | |
| | n86 | 15 | Yes | Yes | Yes | Yes | | | | | | | | | |
| SUL_n79A-n80A | n79 | 15 | | | | | | | Yes | Yes | | | | | 0 |

| | | | | | | | | | | | | | | | |
|---------------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|-----|--|
| | | 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 | | | | | | | | | |

0

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.

Transmitter requirements for UL MIMO operation apply when the UE transmits on 2 ports on the same CDM group. The UE may use higher MPR values outside this limitation.

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 | $\pm 2^3$ |
| n3 | | | | | 23 | $\pm 2^3$ |
| n5 | | | | | 23 | ± 2 |
| n7 | | | | | 23 | $\pm 2^3$ |
| n8 | | | | | 23 | $\pm 2^3$ |
| n12 | | | | | 23 | $\pm 2^3$ |
| n20 | | | | | 23 | $\pm 2^3$ |
| n25 | | | | | 23 | $\pm 2^3$ |
| n28 | | | | | 23 | +2/-2.5 |
| n34 | | | | | 23 | ± 2 |
| n38 | | | | | 23 | ± 2 |
| n39 | | | | | 23 | ± 2 |
| n40 | | | | | 23 | ± 2 |
| n41 | | | 26 | +2/-3 ³ | 23 | $\pm 2^3$ |
| 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: $P_{\text{PowerClass}}$ is the maximum UE power specified without taking into account the tolerance | | | | | | |
| NOTE 2: Power class 3 is default power class unless otherwise stated | | | | | | |
| NOTE 3: Refers to the transmission bandwidths confined within $F_{\text{UL_low}}$ and $F_{\text{UL_low}} + 4$ MHz or $F_{\text{UL_high}} - 4$ MHz and $F_{\text{UL_high}}$, 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-PC2-FR1* 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-PC2-FR1* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle-PC2-FR1* as defined in TS 38.331 (The exact evaluation period is no less than one radio frame); 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 clause 6.2.4;
- else if the IE *P-Max* as defined in TS 38.331 [7] is not provided or 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-PC2-FR1* as defined in TS 38.331; or
- if the IE *P-Max* as defined in TS 38.331 [7] is not provided or 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-PC2-FR1* 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 as specified in 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 ≤ 100 MHz.

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

Where relative channel bandwidth = $2 \cdot BW_{\text{Channel}} / (F_{\text{UL_low}} + F_{\text{UL_high}})$

The allowed MPR for SRS, PUCCH formats 0, 1, 3 and 4, and PRACH shall be as specified for QPSK modulated DFT-s-OFDM of equivalent RB allocation. The allowed MPR for PUCCH format 2 shall be as specified for QPSK modulated CP-OFDM of equivalent RB allocation.

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 | $\leq 3.5^1$ | $\leq 1.2^1$ | $\leq 0.2^1$ |
| | | $\leq 0.5^2$ | $\leq 0.5^2$ | 0 ² |
| | QPSK | ≤ 1 | | 0 |
| | 16 QAM | ≤ 2 | | ≤ 1 |
| | 64 QAM | ≤ 2.5 | | |
| | 256 QAM | ≤ 4.5 | | |
| CP-OFDM | QPSK | ≤ 3 | | ≤ 1.5 |
| | 16 QAM | ≤ 3 | | ≤ 2 |
| | 64 QAM | ≤ 3.5 | | |
| | 256 QAM | ≤ 6.5 | | |
| NOTE 1: Applicable for UE operating in TDD mode with Pi/2 BPSK modulation and UE indicates support for UE capability <i>powerBoosting-pi2BPSK</i> and if the IE <i>powerBoostPi2BPSK</i> is set to 1 and 40 % or less slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79. The reference power of 0 dB MPR is 26 dBm. | | | | |
| NOTE 2: Applicable for conditions where note 1 does not apply. | | | | |

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 |
| | QPSK | ≤ 3.5 | ≤ 1 | 0 |
| | 16 QAM | ≤ 3.5 | ≤ 2 | ≤ 1 |
| | 64 QAM | ≤ 3.5 | ≤ 2.5 | |
| | 256 QAM | ≤ 4.5 | | |
| CP-OFDM | QPSK | ≤ 3.5 | ≤ 3 | ≤ 1.5 |
| | 16 QAM | ≤ 3.5 | ≤ 3 | ≤ 2 |
| | 64 QAM | ≤ 3.5 | | |
| | 256 QAM | ≤ 6.5 | | |

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

N_{RB} is the maximum number of RBs for a given Channel bandwidth and sub-carrier spacing defined in Table 5.3.2-1.
 $RB_{Start,Low} = \max(1, \text{floor}(L_{CRB}/2))$

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

$$RB_{Start,High} = N_{RB} - RB_{Start,Low} - L_{CRB}$$

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

$$RB_{Start,Low} \leq RB_{Start} \leq RB_{Start,High}, \text{ and}$$

$$L_{CRB} \leq \text{ceil}(N_{RB}/2)$$

where $\text{ceil}(x)$ is the smallest integer greater than or equal to x .

An Edge RB allocation is the one for which the RB(s) is (are) allocated at the lowermost or uppermost edge of the channel with $L_{CRB} \leq 2$ RBs.

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

$$N_{RB_gap} / (N_{RB_alloc} + N_{RB_gap}) \leq 0.25$$

and $N_{RB_alloc} + N_{RB_gap}$ is larger than 106, 51 or 24 RBs for 15 kHz, 30 kHz or 60 kHz respectively where N_{RB_gap} is the total number of unallocated RBs between allocated RBs and N_{RB_alloc} is the total number of allocated RBs. The size and location of allocated and unallocated RBs are restricted by RBG parameters specified in clause 6.1.2.2 of TS 38.214 [10]. For UE that indicates support for *almostContiguousCP-OFDM-UL*, the almost contiguous signals in power class 3, the allowed maximum power reduction defined in Table 6.2.2-1 is increased by

$$\text{CEIL}\{ 10 \log_{10}(1 + N_{RB_gap} / N_{RB_alloc}), 0.5 \} \text{ dB},$$

where $\text{CEIL}\{x, 0.5\}$ means x rounding upwards to closest 0.5dB. The parameter of L_{CRB} which is used to specify valid RB allocation ranges for Outer and Inner RB allocations is replaced by $(N_{RB_alloc} + N_{RB_gap})$ for almost contiguous allocation cases

$$RB_{Start,Low} = \max(1, \text{floor}((N_{RB_alloc} + N_{RB_gap})/2))$$

$$RB_{Start,High} = N_{RB} - RB_{Start,Low} - N_{RB_alloc} - N_{RB_gap}$$

For the UE maximum output power modified by MPR, the power limits specified in clause 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 an NR frequency band number of the

applicable operating band 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 an NR frequency band number of the applicable operating band, the IE field *freqBandIndicatorNR* 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, the total reduction to UE maximum output power is $\max(\text{MPR}, \text{A-MPR})$ where MPR is defined in clause 6.2.2. Outer and inner allocation notation used in clause 6.2.3 is defined in clause 6.2.2. Unless stated otherwise, Edge RB allocations get the same AMPR as Outer RB allocations. In absence of modulation and waveform types the A-MPR applies to all modulation and waveform types.

Table 6.2.3.1-1 specifies the additional requirements with their associated network signalling values and the allowed A-MPR and applicable operating band(s) for each NS value. In case of a power class 3 UE, when IE *powerBoostPi2BPSK* is set to 1, power class 2 A-MPR values apply. The mapping of NR frequency band numbers and values of the *additionalSpectrumEmission* to network signalling labels is specified in Table 6.2.3.1-1A.

For almost contiguous allocations in CP-OFDM waveforms in power class 3, the allowed A-MPR defined in clause 6.2.3 is increased by $\text{CEIL}\{10 \log_{10}(1 + N_{\text{RB_gap}} / N_{\text{RB_alloc}}), 0.5\}$ dB, where $\text{CEIL}\{x, 0.5\}$ means x rounding upwards to closest 0.5dB, $N_{\text{RB_gap}}$ is the total number of unallocated RBs between allocated RBs and $N_{\text{RB_alloc}}$ is the total number of allocated RBs, and the parameter L_{CRB} is replaced by $N_{\text{RB_alloc}} + N_{\text{RB_gap}}$ in specifying the RB allocation regions.

Table 6.2.3.1-1: Additional maximum power reduction (A-MPR)

| Network signalling label | Requirements (clause) | NR Band | Channel bandwidth (MHz) | Resources blocks (N_{RB}) | A-MPR (dB) |
|--------------------------|-----------------------|----------------------------|--|--------------------------------------|----------------------|
| NS_01 | | Table 5.2-1 (NOTE 4) | 5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 90, 100 | Table 5.3.2-1 | N/A |
| NS_03 | 6.5.2.3.3 | n2, n25, n66, n70, n86 | | | Clause 6.2.3.7 |
| NS_03U | 6.5.2.3.3, 6.5.2.4.2 | n2, n25, n66, n86 (NOTE 1) | | | Clause 6.2.3.7 |
| NS_04 | 6.5.2.3.2, 6.5.3.3.1 | n41 | 10, 15, 20, 40, 50, 60, 80, 90, 100 | | Clause 6.2.3.2 |
| NS_05 | 6.5.3.3.4 | n1, n84 | 5, 10, 15, 20 (NOTE 2) | | Clause 6.2.3.4 |
| NS_05U | 6.5.3.3.4, 6.5.2.4.2 | n1, n84 (NOTE 1) | 5, 10, 15, 20 | | Clause 6.2.3.4 |
| NS_06 | 6.5.2.3.4 | n12 | 5, 10, 15 | | N/A |
| NS_10 | | n20, n82 | 15, 20 | Table 6.2.3.3-1 | Table 6.2.3.3-1 |
| NS_17 | 6.5.3.3.2 | n28, n83 | 5, 10 | Table 5.3.2-1 | N/A |
| NS_18 | 6.5.3.3.3 | n28, n83 | 5 | | Table 6.2.3.13-1, A1 |
| | | | 10, 15, 20 | | Table 6.2.3.13-1, A2 |
| NS_35 | 6.5.2.3.1 | n71 | 5, 10, 15, 20 | Table 5.3.2-1 | N/A |
| NS_37 | 6.5.3.3.6 | n74 (NOTE 3) | 10, 15 | Table 6.2.3.8-1 | Table 6.2.3.8-1 |
| NS_38 | 6.5.3.3.7 | n74 | 5, 10, 15, 20 | Table 6.2.3.9-1 | Table 6.2.3.9-1 |
| NS_39 | 6.5.3.3.8 | n74 | 10, 15, 20 | Table 6.2.3.10-1 | Table 6.2.3.10-1 |
| NS_40 | 6.5.3.3.9 | n51 | 5 | | Table 6.2.3.5-1 |
| NS_41 | 6.5.3.3.10 | n50 | 5, 10, 15, 20, 40, 50, 60 | | Table 6.2.3.11-1 |
| NS_42 | 6.5.3.3.11 | n50 | 5, 10, 15, 20, 40, 50, 60 | | Table 6.2.3.12-1 |
| NS_43 | 6.5.3.3.5 | n8, n81 | 5, 10, 15 | | Clause 6.2.3.6 |

| | | | | | |
|--------|----------------------|---|------------|--|-----------------|
| NS_43U | 6.5.3.3.5, 6.5.2.4.2 | n8, n81 (NOTE 1) | 5, 10, 15 | | Clause 6.2.3.6 |
| NS_50 | 6.5.3.3.16 | n39 | 25, 30, 40 | | Clause 6.2.3.19 |
| NS_100 | 6.5.2.4.2 | n1, n2, n3, n5, n8, n25, n66, n80, n81, n84, n86 (NOTE 1) | | | Table 6.2.3.1-2 |

NOTE 1: This NS can be signalled for NR bands that have UTRA services deployed.
 NOTE 2: No A-MPR is applied for 5 MHz BW_{Channel} where the upper channel edge is ≥ 1930 MHz, 10 MHz BW_{Channel} where the upper channel edge is ≥ 1950 MHz and 15 MHz BW_{Channel} where the upper channel edge is ≥ 1955 MHz and 20 MHz BW_{Channel} where the upper channel edge is ≥ 1970 MHz.
 NOTE 3: Applicable when the NR carrier is within 1447.9 – 1462.9 MHz.
 NOTE 4: The NS_01 label with the field *additionalPmax* [7] absent is default for all NR bands.

Table 6.2.3.1-1A: Mapping of network signaling label

| NR band | Value of <i>additionalSpectrumEmission</i> | | | | | | | |
|---------|--|--------|-------|--------|---|---|---|---|
| | 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_43 | NS_43U | | | | |
| n12 | NS_01 | NS_06 | | | | | | |
| n20 | NS_01 | Void | 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 | NS_50 | | | | | | |
| n40 | NS_01 | | | | | | | |
| n41 | NS_01 | NS_04 | | | | | | |
| n50 | NS_01 | NS_41 | NS_42 | | | | | |
| n51 | NS_01 | NS_40 | | | | | | |
| n66 | NS_01 | NS_100 | NS_03 | NS_03U | | | | |
| n70 | NS_01 | NS_03 | | | | | | |
| n71 | NS_01 | NS_35 | | | | | | |
| n74 | NS_01 | NS_37 | NS_38 | NS_39 | | | | |
| n77 | NS_01 | | | | | | | |
| n78 | NS_01 | | | | | | | |
| n79 | NS_01 | | | | | | | |
| n80 | NS_01 | NS_100 | | | | | | |
| n81 | NS_01 | NS_100 | NS_43 | NS_43U | | | | |
| n82 | NS_01 | Void | NS_10 | | | | | |
| n83 | NS_01 | NS_17 | NS_18 | | | | | |
| n84 | NS_01 | NS_100 | NS_05 | NS_05U | | | | |
| n86 | NS_01 | NS_100 | NS_03 | NS_03U | | | | |

NOTE: *additionalSpectrumEmission* corresponds to an information element of the same name defined in clause 6.3.2 of TS 38.331 [7].

Table 6.2.3.1-2: A-MPR for NS_100 (UTRA protection)

| Modulation/Waveform | | Outer (dB) |
|---------------------|-----------|------------|
| DFT-s-OFDM | Pi/2 BPSK | ≤ 2 |
| | QPSK | ≤ 2 |
| | 16 QAM | ≤ 2.5 |
| | 64 QAM | ≤ 3 |
| | 256 QAM | ≤ 4.5 |
| CP-OFDM | QPSK | ≤ 4 |
| | 16 QAM | ≤ 4 |
| | 64 QAM | ≤ 4 |
| | 256 QAM | ≤ 6.5 |
| NOTE 1: Void | | |
| NOTE 2: Void | | |

6.2.3.2 A-MPR for NS_04

For NS_04, A-MPR is not added to MPR. Also, when NS_04 is signalled, MPR shall be set to zero in the P_{CMAX} equations to avoid double counting MPR.

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

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

where $A-MPR'$ is defined as

```

if  $R_{Bstart} \leq f_{start,max,IMD3} / (12 \cdot SCS)$  and  $L_{CRB} \leq AW_{max,IMD3} / (12 \cdot SCS)$  and  $F_C - BW_{channel}/2 < F_{UL\_low} + offset_{IMD3}$ ,
then
    the  $A-MPR'$  is defined according to Table 6.2.3.2-2 PC3_A2 relative to 23 dBm for power class 3
    and PC2_A4 relative to 26 dBm for power class 2,
else,
if  $R_{Bstart} \leq L_{CRB}/2 + \Delta_{start} / (12 \cdot SCS)$  and  $L_{CRB} \leq AW_{max,regrowth} / (12 \cdot SCS)$  and  $F_C - BW_{channel}/2 < F_{UL\_low} + offset_{regrowth}$ ,
then
    the  $A-MPR'$  is defined according to Table 6.2.3.2-2 PC3_A1 relative to 23 dBm for power class 3
    and PC2_A3 relative to 26 dBm 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 |
|---|----------------------|---|---|---|
| | | CP-OFDM | DFT-s-OFDM | |
| Max allocation start in IMD3 region | $f_{start,max,IMD3}$ | 0.33 $BW_{Channel}$ | | $R_{Bstart} \leq f_{start,max,IMD3} / (12SCS)$ |
| Max allocation BW in IMD3 region | $AW_{max,IMD3}$ | 4 MHz | | $L_{CRB} \leq AW_{max,IMD3} / (12SCS)$ |
| Freq. offset required to avoid A-MPR in IMD3 region | $offset_{IMD3}$ | $BW_{Channel} - 6$ MHz | | $F_C - BW_{Channel}/2 \geq F_{UL_low} + offset_{IMD3}$ |
| Right edge of regrowth region | Δ_{start} | 0.08 $BW_{Channel}$ | | $R_{Bstart} \leq L_{CRB}/2 + \Delta_{start} / (12SCS)$ |
| Max allocation BW in regrowth region | $AW_{max,regrowth}$ | 100 MHz | | $L_{CRB} \leq \text{Min}(L_{CRB,Max}, AW_{max,regrowth} / (12SCS))$ |
| Freq. offset required to avoid A-MPR in regrowth region | $offset_{regrowth}$ | Max (10 MHz, $0.25 \cdot BW_{Channel}$ MHz) | Max (10 MHz, $0.45 \cdot BW_{Channel}$ MHz) | $F_C - BW_{Channel}/2 \geq F_{UL_low} + offset_{regrowth}$ |

Table 6.2.3.2-2: A-MPR' values Access

| Modulation/Waveform | | A-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 | ≤ 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 |

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 | RB _{start} | 0 – 10 |
| | LCRB (RBs) | 1 – 20 |
| | A (dB) | ≤ 3 ⁶ |
| 20 | RB _{start} | 0 – 15 |
| | LCRB (RBs) | 1 – 20 |
| | A (dB) | ≤ 6 ⁶ |

NOTE 1: RB_{start} 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 T_{no_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 A-MPR for DFT-s-OFDM is the total backoff and 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 value specified in Table 6.2.3.3-1.

NOTE 6: The A-MPR for CP-OFDM is the total backoff and is obtained by adding the A value in Table 6.2.3.3-1 to the corresponding MPR specified in Table 6.2.2-1.

6.2.3.4 A-MPR for NS_05 and NS_05U

Table 6.2.3.4-1: A-MPR regions for NS_05 and NS_05U

| Channel Bandwidth (MHz) | Carrier Centre Frequency, F_c (MHz) | Region A | | | Region B | | | Region C | | |
|-------------------------|---------------------------------------|---------------------------------------|------------------------------------|-------|---|-----------------------------------|-------|--|---------------------------------------|-------|
| | | RB_{start} | L_{CRB} | A-MPR | RB_{start} | L_{CRB} | A-MPR | RB_{start} | L_{CRB} | A-MPR |
| 5 | $1922.5 \leq F_c < 1927.5$ | $< 1.62 \text{ MHz}/12/\text{SCS}$ | $> 2.52 \text{ MHz}/12/\text{SCS}$ | A3 | | | | | | |
| 10 | $1925 \leq F_c < 1935$ | $\leq 1.62 \text{ MHz}/12/\text{SCS}$ | > 0 | A1 | $> 1.62 \text{ MHz}/12/\text{SCS}$ $\leq 3.60 \text{ MHz}/12/\text{SCS}$ | $> 5.4 \text{ MHz}/12/\text{SCS}$ | A7 | $\geq 7.2 \text{ MHz}/12/\text{SCS}$ | $\leq 1.08 \text{ MHz}/12/\text{SCS}$ | A2 |
| 10 | $1935 \leq F_c < 1945$ | | $> 4.5 \text{ MHz}/12/\text{SCS}$ | A4 | | | | | | |
| 15 | $1927.5 \leq F_c < 1932.5$ | $\leq 3.24 \text{ MHz}/12/\text{SCS}$ | > 0 | A1 | $> 3.24 \text{ MHz}/12/\text{SCS}$ $\leq 5.40 \text{ MHz}/12/\text{SCS}$ | $> 8.1 \text{ MHz}/12/\text{SCS}$ | A7 | $\geq 10.08 \text{ MHz}/12/\text{SCS}$ | $\leq 1.08 \text{ MHz}/12/\text{SCS}$ | A2 |
| 15 | $1932.5 \leq F_c < 1942.5$ | $< 1.62 \text{ MHz}/12/\text{SCS}$ | > 0 | A1 | | | | $\geq 12.24 \text{ MHz}/12/\text{SCS}$ | $\leq 1.08 \text{ MHz}/12/\text{SCS}$ | A2 |
| 15 | $1942.5 \leq F_c < 1947.5$ | | $> 7.2 \text{ MHz}/12/\text{SCS}$ | A5 | | | | | | |
| 20 | $1930 \leq F_c < 1950$ | $\leq 4.86 \text{ MHz}/12/\text{SCS}$ | > 0 | A1 | $> 4.86 \text{ MHz}/12/\text{SCS}$ $\leq 7.20 \text{ MHz}/12/\text{SCS}$ | $> 9.0 \text{ MHz}/12/\text{SCS}$ | A7 | $\geq 13.68 \text{ MHz}/12/\text{SCS}$ | $\leq 1.08 \text{ MHz}/12/\text{SCS}$ | A2 |
| 20 | $1950 \leq F_c < 1960$ | | $> 9.0 \text{ MHz}/12/\text{SCS}$ | A6 | | | | | | |

NOTE 1: The A-MPR values are specified in Table 6.2.3.4-2, 6.2.3.4-3 and 6.2.3.4-10.
NOTE 2: Void

Table 6.2.3.4-2: A-MPR for NS_05 and NS_05U

| Modulation/Waveform | | A1 (dB) | | A2 (dB) | | A3 (dB) | |
|---------------------|-----------|-------------|-------------|-------------|-------|---------|-------|
| | | Outer/Inner | Outer/Inner | Outer/Inner | Outer | Outer | Outer |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 10 | | ≤ 5 | | | |
| | QPSK | ≤ 10 | | ≤ 5 | | | |
| | 16 QAM | ≤ 10 | | ≤ 5 | | | |
| | 64 QAM | ≤ 11 | | ≤ 5 | | | |
| | 256 QAM | ≤ 13 | | ≤ 5 | | | |
| CP-OFDM | QPSK | ≤ 10 | | ≤ 5 | | ≤ 2 | |
| | 16 QAM | ≤ 10 | | ≤ 5 | | | |
| | 64 QAM | ≤ 11 | | ≤ 5 | | | |
| | 256 QAM | ≤ 13 | | | | | |
| NOTE 1: Void | | | | | | | |
| NOTE 2: Void | | | | | | | |

Table 6.2.3.4-3: A-MPR for NS_05

| Modulation/Waveform | | A4 (dB) | | A5 (dB) | | A6 (dB) | | A7 (dB) | |
|---------------------|-----------|---------|-------|---------|-------|---------|-------|-------------|-------------|
| | | Outer | Inner | Outer | Inner | Outer | Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 1 | N/A | ≤ 1 | | ≤ 1 | | N/A | ≤ 6 |
| | QPSK | | | ≤ 1.5 | | ≤ 1.5 | | | ≤ 6 |
| | 16 QAM | | | | | | | | ≤ 6 |
| | 64 QAM | | | | | | | | ≤ 6 |
| | 256 QAM | | | | | | | | ≤ 6 |
| CP-OFDM | QPSK | ≤ 3.5 | | ≤ 3.5 | | ≤ 3.5 | | | ≤ 6 |
| | 16 QAM | ≤ 3.5 | | ≤ 3.5 | | ≤ 3.5 | | | ≤ 6 |
| | 64 QAM | | | | | | | | ≤ 6 |
| | 256 QAM | | | | | | | | ≤ 6 |
| NOTE 1: Void | | | | | | | | | |
| NOTE 2: Void | | | | | | | | | |

Table 6.2.3.4-4 - Table 6.2.3.4-9: Void

Table 6.2.3.4-10: A-MPR for modulation and waveform type for NS_05U

| Modulation/Waveform | | A4 (dB) | | A5 (dB) | | A6 (dB) | | A7 (dB) | |
|---------------------|-----------|---------|-------|---------|-------|---------|-------|-------------|-------------|
| | | Outer | Inner | Outer | Inner | Outer | Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 2 | N/A | ≤ 2 | | ≤ 2 | | N/A | ≤ 6 |
| | QPSK | ≤ 2 | | ≤ 2 | | ≤ 2 | | | ≤ 6 |
| | 16 QAM | ≤ 2.5 | | ≤ 2.5 | | ≤ 2.5 | | | ≤ 6 |
| | 64 QAM | ≤ 3 | | ≤ 3 | | ≤ 3 | | | ≤ 6 |
| | 256 QAM | ≤ 4.5 | | ≤ 4.5 | | ≤ 4.5 | | | ≤ 6 |
| CP-OFDM | QPSK | ≤ 4 | | ≤ 4 | | ≤ 4 | | | ≤ 6 |
| | 16 QAM | ≤ 4 | | ≤ 4 | | ≤ 4 | | | ≤ 6 |
| | 64 QAM | ≤ 4 | | ≤ 4 | ≤ 4 | ≤ 4 | | | ≤ 6 |
| | 256 QAM | ≤ 6.5 | | ≤ 6.5 | | ≤ 6.5 | | | ≤ 6.5 |
| NOTE 1: Void | | | | | | | | | |
| NOTE 2: Void | | | | | | | | | |

6.2.3.5 A-MPR for NS_40

Table 6.2.3.5-1: A-MPR for NS_40

| Modulation/ Waveform | | A (dB) | |
|----------------------|---------|--------------------------|-------|
| | | Channel bandwidth: 5 MHz | |
| | | Outer | Inner |
| DFT-s-OFDM | QPSK | ≤ 15.5 | ≤ 12 |
| | 16 QAM | ≤ 14.5 | ≤ 11 |
| | 64 QAM | ≤ 14.5 | ≤ 10 |
| | 256 QAM | ≤ 12.5 | ≤ 7.5 |
| CP-OFDM | QPSK | ≤ 14.5 | ≤ 10 |
| | 16 QAM | ≤ 14.5 | ≤ 10 |
| | 64 QAM | ≤ 14 | ≤ 8 |
| | 256 QAM | ≤ 11 | ≤ 5.5 |

NOTE 1: The A-MPR for NS_40 is the total backoff and 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 specified in Table 6.2.2-1 and Table 6.2.3.5-1.

6.2.3.6 A-MPR for NS_43 and NS_43U

Table 6.2.3.6-1: A-MPR regions for NS_43

| Channel Bandwidth (MHz) | Carrier Centre Frequency, F _c (MHz) | Region A | | | Region B | | |
|-------------------------|--|---------------------|------|-------|---------------------|------------------|-------|
| | | RB _{start} | LCRB | A-MPR | RB _{start} | LCRB | A-MPR |
| 5 MHz | 902.5 ≤ F _c < 912.5 | | > 15 | A1 | | | |
| 10 MHz | F _c = 910 | | > 40 | A2 | | > 5.4 MHz/12/SCS | A4 |
| | | | > 45 | A3 | | > 7.2 MHz/12/SCS | A5 |
| 15 MHz | F _c = 907.5 | < 1.8 MHz /12/SCS | > 0 | A6 | > 1.8 MHz/12/SCS | ≥ 7.2 MHz/12/SCS | A6 |
| | | > 12.24 MHz/12/SCS | > 0 | A6 | < 6.12 MHz/12/SCS | | |

NOTE 1: The A-MPR values are specified in Table 6.2.3.6-2.
 NOTE 2: 15 kHz SCS unless otherwise stated
 NOTE 3: Void

Table 6.2.3.6-2: A-MPR for NS_43

| Modulation/Waveform | | A1 (dB) | | A2 (dB) | | A3 (dB) | | A4 (dB) | | A5 (dB) | | A6 (dB) |
|---------------------|-----------|---------|-------|---------|-------|---------|-------|---------|-------|---------|-------|---------------|
| | | Outer | Inner | Outer | Inner | Outer | Inner | Outer | Inner | Outer | Inner | Outer / Inner |
| DFT-s-OFDM | Pi/2 BPSK | | | ≤ 1.5 | | | | | | | | ≤ 9 |
| | QPSK | ≤ 2 | | | | | | ≤ 2.5 | | | | ≤ 9 |
| | 16 QAM | | | | | | | | | ≤ 2.5 | | ≤ 9 |
| | 64 QAM | | | | | ≤ 2.5 | | | | | | ≤ 9 |
| | 256 QAM | | N/A | | N/A | | N/A | | N/A | | N/A | ≤ 9 |
| CP-OFDM | QPSK | ≤ 3.5 | | | | | | | | ≤ 4 | | ≤ 9 |
| | 16 QAM | ≤ 3.5 | | | | | | | | ≤ 4 | | ≤ 9 |
| | 64 QAM | | | | | ≤ 4 | | | | | | ≤ 9 |
| | 256 QAM | | | | | | | | | | | ≤ 9 |

Table 6.2.3.6-3: Void

When NS_43U is signalled for 5 and 10 MHz channel bandwidths A-MPR is defined in Table 6.2.3.1-2 except for DFT-s-OFDM QPSK when L_{CRB} > 5.4 MHz/12/SCS the A-MPR is 2.5 dB. For 15 MHz channel bandwidth Table 6.2.3.6-4 applies.

Table 6.2.3.6-4: A-MPR for for NS_43U

| Modulation/Waveform | | 15 MHz |
|---------------------|-----------|------------------|
| | | Outer/Inner (dB) |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 9 |
| | QPSK | ≤ 9 |
| | 16 QAM | ≤ 9 |
| | 64 QAM | ≤ 9 |
| | 256 QAM | ≤ 9 |
| CP-OFDM | QPSK | ≤ 9 |
| | 16 QAM | ≤ 9 |
| | 64 QAM | ≤ 9 |
| | 256 QAM | ≤ 9 |

6.2.3.7 A-MPR for NS_03 and NS_03U

Table 6.2.3.7-1 A-MPR for NS_03

| Modulation/Waveform | | Outer (dB) | Inner (dB) |
|---------------------|-----------|------------|------------|
| DFT-s-OFDM | PI/2 BPSK | ≤ 1.5 | N/A |
| | QPSK | ≤ 2 | |
| | 16 QAM | ≤ 3 | |
| | 64 QAM | ≤ 3.5 | |
| | 256 QAM | ≤ 5.5 | |
| CP-OFDM | QPSK | ≤ 4 | |
| | 16 QAM | ≤ 4 | |
| | 64 QAM | ≤ 4.5 | |
| | 256 QAM | ≤ 7.5 | |
| NOTE 1: Void | | | |
| NOTE 2: Void | | | |

In case UE operates in a band where NS_03U applies and it receives *additionalSpectrumEmission* value of 3 then A-MPR values specified in Table 6.2.3.7-1 apply with an exception that DFT-s-OFDM Pi/2 BPSK A-MPR is 2 dB.

6.2.3.8 A-MPR for NS_37

Table 6.2.3.8-1: A-MPR regions for B11/B21 protection (NS_37) (1447.9 - 1462.9 MHz)

| Channel Bandwidth (MHz) | Carrier Centre Frequency, F _c (MHz) | Region A (Outer/Inner) | | | Region B (Outer/Inner) | | | Region C (Outer/Inner) | | |
|--|--|------------------------|------------------|-------|------------------------|-------------------|-------|------------------------|-------------------|-------|
| | | RB _{start} | LCRB | A-MPR | RB _{start} | LCRB | A-MPR | RB _{start} | LCRB | A-MPR |
| 10 | 1452.9 < F _c ≤ 1457.9 | ≥ 0 | > 7.2 MHz/12/SCS | ≤ A1 | N/A | N/A | N/A | N/A | N/A | N/A |
| 15 | F _c = 1455.4 | ≥ 0 | > 9.9 MHz/12/SCS | ≤ A1 | < 0.54 MHz/12/SCS | < 1.08 MHz/12/SCS | ≤ A2 | > 13.86 MHz/12/SCS | < 1.08 MHz/12/SCS | ≤ A2 |
| NOTE 1: The A-MPR values are specified in Table 6.2.3.8-2 | | | | | | | | | | |
| NOTE 2: Void | | | | | | | | | | |
| NOTE 3: Void | | | | | | | | | | |
| NOTE 4: No A-MPR for SCS = 60 kHz for region B and C only. | | | | | | | | | | |

Table 6.2.3.8-2: A-MPR for NS_37

| Modulation/Waveform | | A1 (dB) | | A2 (dB) |
|---------------------|-----------|---------|-------|-------------|
| | | Outer | Inner | Outer/Inner |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 1 | N/A | ≤ 3 |

| | | | | |
|--------------|---------|-------|--|-----|
| | QPSK | ≤ 1.5 | | ≤ 3 |
| | 16 QAM | ≤ 2.5 | | ≤ 3 |
| | 64 QAM | ≤ 3 | | ≤ 3 |
| | 256 QAM | | | |
| CP-OFDM | QPSK | ≤ 3.5 | | ≤ 3 |
| | 16 QAM | ≤ 3.5 | | ≤ 3 |
| | 64 QAM | | | |
| | 256 QAM | | | |
| NOTE 1: Void | | | | |
| NOTE 2: Void | | | | |

6.2.3.9 A-MPR for NS_38

Table 6.2.3.9-1: A-MPR for EESS (NS_38) Protection (1430 – 1470 MHz)

| Channel Bandwidth (MHz) | Carrier Centre Frequency, F _c (MHz) | Region A Outer/Inner | | | Region B Outer/Inner | |
|-------------------------|--|---|------------------|------------|---------------------------------------|------------|
| | | RB _{start} | L _{CRB} | A-MPR (dB) | RB _{start} +L _{CRB} | A-MPR (dB) |
| 5 | 1432.5 ≤ F _c < 1434.55 | ≤ -1.8 MHz/12/SCS + L _{CRB} /2 | > 3.6 MHz/12/SCS | ≤ 7 | ≤ 2.16 MHz/12/SCS | ≤ 5.5 |
| 10 | 1435 ≤ F _c < 1442 | ≤ -1.8 MHz/12/SCS + L _{CRB} /2 | > 3.6 MHz/12/SCS | ≤ 12 | ≤ 2.16 MHz/12/SCS | ≤ 9 |
| 15 | 1437.5 ≤ F _c < 1447.5 | ≤ -1.8 MHz/12/SCS + L _{CRB} /2 | > 3.6 MHz/12/SCS | ≤ 13 | ≤ 3.6 MHz/12/SCS | ≤ 10 |
| 20 | 1440 ≤ F _c < 1450 | ≤ -1.8 MHz/12/SCS + L _{CRB} /2 | > 3.6 MHz/12/SCS | ≤ 13 | ≤ 5.4 MHz/12/SCS | ≤ 10 |

NOTE 1 - 4: Void

6.2.3.10 A-MPR for NS_39

Table 6.2.3.10-1: A-MPR for own RX (NS_39) Protection (1440 – 1470 MHz)

| Channel Bandwidth, MHz | Carrier Centre Frequency, F _c , MHz | Region A (Outer/Inner) | |
|------------------------|--|---------------------------------------|------------|
| | | RB _{start} +L _{CRB} | A-MPR (dB) |
| 10 | 1460 < F _c ≤ 1465 | > 7.9 MHz/12/SCS | ≤ 6 |
| 15 | 1452.5 < F _c ≤ 1462.5 | > 11.2 MHz/12/SCS | ≤ 6 |
| 20 | 1450 < F _c ≤ 1460 | > 14.4 MHz/12/SCS | ≤ 6 |

NOTE 1 - 4: Void

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, F _c (MHz) | Region A Outer/Inner | | | Region B Outer/Inner | |
|-------------------------|--|--------------------------------------|------------------|------------|---------------------------------------|------------|
| | | RB _{start} | L _{CRB} | A-MPR (dB) | RB _{start} +L _{CRB} | A-MPR (dB) |
| 5 | - | - | - | - | - | - |
| 10 | 1437 ≤ F _c < 1442 | ≤ -4.5 MHz/12/SCS + L _{CRB} | > 4.5 MHz/12/SCS | ≤ 9 | < 1.8 MHz/12/SCS | ≤ 9 |
| 15 | 1439.5 ≤ F _c < 1447.5 | ≤ -5.4 MHz/12/SCS + L _{CRB} | > 5.4 MHz/12/SCS | ≤ 11 | < 3.42 MHz/12/SCS | ≤ 9 |
| 20 | 1442 ≤ F _c < 1450 | ≤ -5.4 MHz/12/SCS + L _{CRB} | > 5.4 MHz/12/SCS | ≤ 12 | < 5.04 MHz/12/SCS | ≤ 9 |

| | | | | | | |
|----|------------------------|--|-----------------------------------|-------------|-------------------------------------|-------------|
| 40 | $1452 \leq F_C < 1497$ | $\leq -7.2 \text{ MHz}/12/\text{SCS} + L_{\text{CRB}}$ | $> 7.2 \text{ MHz}/12/\text{SCS}$ | ≤ 13.5 | $< 11.7 \text{ MHz}/12/\text{SCS}$ | ≤ 13.5 |
| 50 | $1457 \leq F_C < 1492$ | $\leq -7.2 \text{ MHz}/12/\text{SCS} + L_{\text{CRB}}$ | $> 7.2 \text{ MHz}/12/\text{SCS}$ | ≤ 13.5 | $< 15.12 \text{ MHz}/12/\text{SCS}$ | ≤ 13.5 |
| 60 | $1462 \leq F_C < 1487$ | $\leq -7.2 \text{ MHz}/12/\text{SCS} + L_{\text{CRB}}$ | $> 7.2 \text{ MHz}/12/\text{SCS}$ | ≤ 13.5 | $< 18.72 \text{ MHz}/12/\text{SCS}$ | ≤ 13.5 |

NOTE 1 - 4: Void

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, F_C (MHz) | Region A | | Region B | | | |
|-------------------------|---------------------------------------|--|------------------------|--|---|------------------|------------------|
| | | $RB_{\text{start}}+L_{\text{CRB}}$ | A-MPR Outer/Inner (dB) | RB_{start} | $RB_{\text{start}}+L_{\text{CRB}}$ | A-MPR Inner (dB) | A-MPR Outer (dB) |
| 5 | $1512 \leq F_C \leq 1514.5$ | $> 3.1 \text{ MHz} / 12 / \text{SCS}$ | ≤ 7 | $< 0.90 \text{ MHz} / 12 / \text{SCS}$ | $\leq 3.1 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 4 |
| 10 | $1497 \leq F_C \leq 1512$ | $> 6.2 \text{ MHz} / 12 / \text{SCS}$ | ≤ 8 | $< 0.90 \text{ MHz} / 12 / \text{SCS}$ | $\leq 6.2 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 5 |
| 15 | $1502 \leq F_C \leq 1509.5$ | $> 9.3 \text{ MHz} / 12 / \text{SCS}$ | ≤ 8 | $< 3.06 \text{ MHz} / 12 / \text{SCS}$ | $\leq 9.3 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 5 |
| 20 | $1497 \leq F_C \leq 1507$ | $> 12.4 \text{ MHz} / 12 / \text{SCS}$ | ≤ 8 | $< 4.50 \text{ MHz} / 12 / \text{SCS}$ | $\leq 12.4 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 5 |
| 40 | $1477 \leq F_C \leq 1497$ | $> 24.8 \text{ MHz} / 12 / \text{SCS}$ | ≤ 8 | $< 5.40 \text{ MHz} / 12 / \text{SCS}$ | $\leq 24.8 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 5 |
| 50 | $1467 \leq F_C \leq 1492$ | $> 31 \text{ MHz} / 12 / \text{SCS}$ | ≤ 8 | $< 7.20 \text{ MHz} / 12 / \text{SCS}$ | $\leq 31 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 5 |
| 60 | $1462 \leq F_C \leq 1487$ | $> 37.2 \text{ MHz} / 12 / \text{SCS}$ | ≤ 8 | $< 7.20 \text{ MHz} / 12 / \text{SCS}$ | $\leq 37.2 \text{ MHz} / 12 / \text{SCS}$ | ≤ 1.5 | ≤ 5 |

NOTE 1 - 5: Void

6.2.3.13 A-MPR for NS_18

Table 6.2.3.13-1: A-MPR for NS_18

| Modulation/Waveform | | A1 (dB) | | A2 (dB) |
|---------------------|-----------|------------|-------|-------------|
| | | Outer | Inner | Inner/Outer |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 2 | N/A | ≤ 5 |
| | QPSK | ≤ 2 | | ≤ 5 |
| | 16 QAM | ≤ 3 | | ≤ 6 |
| | 64 QAM | ≤ 4 | | ≤ 7 |
| | 256 QAM | ≤ 6 | | ≤ 9 |
| CP-OFDM | QPSK | ≤ 5 | | ≤ 6.5 |
| | 16 QAM | ≤ 5 | | ≤ 7 |
| | 64 QAM | ≤ 5.5 | | ≤ 8.5 |
| | 256 QAM | ≤ 8.5 | | ≤ 11.5 |

NOTE 1: Void
NOTE 2: Void

- 6.2.3.14 Void
 6.2.3.15 Void
 6.2.3.16 Void
 6.2.3.17 Void
 6.2.3.18 Void
 6.2.3.19 A-MPR for NS_50

Table 6.2.3.19-1: A-MPR regions for NS_50

| Channel Bandwidth (MHz) | $RB_{start} * 12 * SCS$ (MHz) | $LCRB * 12 * SCS$ (MHz) | A-MPR |
|-------------------------|-------------------------------|--|-------|
| 25 MHz | $\leq LCRB * 12 * SCS - 5$ | > 5 | A7 |
| | ≤ 6.48 | ≤ 1.44 | A8 |
| | | ≤ 3.6 | A9 |
| 30 MHz | $\leq LCRB * 12 * SCS - 5$ | > 5 | A7 |
| | ≤ 8.64 | ≤ 1.44 | A8 |
| | | ≤ 3.6 | A9 |
| 40 MHz | ≤ 4.32 | > 0 | A1 |
| | $> 4.32, \leq 10.44$ | ≤ 10.8 | A3 |
| | $> 4.32, \leq 18$ | > 10.8 | A2 |
| | $> 18, \leq 31.68$ | $> \max(31.68 - RB_{start} * 12 * SCS, 0)$ | A6 |
| | > 31.68 | > 0 | A5 |

NOTE 1: The A-MPR values are specified in Table 6.2.3.19-2.

Table 6.2.3.19-2: A-MPR for NS_50

| Modulation/Waveform | | A1 (dB) | A2 (dB) | A3 (dB) | A5 (dB) | A6 (dB) | A7 (dB) | A8 (dB) | A9 (dB) |
|---------------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|
| | | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Inner |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 11 | ≤ 7 | ≤ 3 | ≤ 5 | ≤ 2 | ≤ 4 | ≤ 2 | |
| | QPSK | ≤ 11 | ≤ 7 | ≤ 3 | ≤ 5 | ≤ 2 | ≤ 5 | ≤ 2 | |
| | 16 QAM | ≤ 11 | ≤ 7 | ≤ 3 | ≤ 5 | ≤ 2 | ≤ 5 | ≤ 2.5 | |
| | 64 QAM | ≤ 11 | ≤ 7 | ≤ 3 | ≤ 5 | | ≤ 5 | | |
| CP-OFDM | 256 QAM | ≤ 11 | ≤ 7 | | ≤ 5 | | ≤ 5 | | |
| | QPSK | ≤ 12 | ≤ 8 | ≤ 4.5 | ≤ 5 | ≤ 3.5 | ≤ 6.5 | | ≤ 3.0 |
| | 16 QAM | ≤ 12 | ≤ 8 | ≤ 4.5 | ≤ 5 | ≤ 3.5 | ≤ 6.5 | | ≤ 3.0 |
| | 64 QAM | ≤ 12 | ≤ 8 | ≤ 4.5 | ≤ 5 | | ≤ 6.5 | | |
| | 256 QAM | ≤ 12 | ≤ 8 | | | | ≤ 6.5 | | |

6.2.4 Configured transmitted power

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

$$P_{CMAX,L,f,c} \leq P_{CMAX,f,c} \leq P_{CMAX,H,f,c} \text{ with}$$

$$P_{CMAX,L,f,c} = \min \{ P_{EMAX,c} - \Delta T_{C,c}, (P_{PowerClass} - \Delta P_{PowerClass}) - \max(\max(MPR_c, A-MPR_c) + \Delta T_{IB,c} + \Delta T_{C,c} + \Delta T_{RxSRS}, P-MPR_c) \}$$

$$P_{CMAX,H,f,c} = \min \{ P_{EMAX,c}, P_{PowerClass} - \Delta P_{PowerClass} \}$$

where

$P_{EMAX,c}$ is the value given by either the p -Max IE or the field *additionalPmax* of the *NR-NS-PmaxList* IE, whichever is applicable according to TS 38.331[7];

$P_{\text{PowerClass}}$ 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 *powerBoostPi2BPSK* is set to 1, $P_{\text{EMAX},c}$ is increased by +3 dB for a power class 3 UE operating in TDD bands n40, n41, n77, n78, and n79 with $\text{PI}/2$ BPSK modulation and UE indicates support for UE capability *powerBoosting-pi2BPSK* and 40% or less symbols in certain evaluation period are used for UL transmission when $P_{\text{EMAX},c} \geq 20$ dBm (The exact evaluation period is no less than one radio frame).

When the IE *powerBoostPi2BPSK* is set to 1, $\Delta P_{\text{PowerClass}} = -3$ dB for a power class 3 UE operating in TDD bands n40, n41, n77, n78, and n79 with $\text{PI}/2$ BPSK modulation and UE indicates support for UE capability *powerBoosting-pi2BPSK* and 40% or less slots in radio frame are used for UL transmission.

$\Delta P_{\text{PowerClass}} = 3$ dB for a power class 2 UE when P-max of 23 dBm or lower is indicated; or when the field of UE capability *maxUplinkDutyCycle-PC2-FRI* is absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than 50%; or when the field of UE capability *maxUplinkDutyCycle-PC2-FRI* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle-PC2-FRI* as defined in TS 38.331 (The exact evaluation period is no less than one radio frame); otherwise $\Delta P_{\text{PowerClass}} = 0$ dB;

$\Delta T_{\text{IB},c}$ is the additional tolerance for serving cell c as specified in clause 6.2A.4.2 for NR CA, clause 6.2C.2 for SUL, or TS 38.101-3 clause 6.2B.4.2 for EN-DC; $\Delta T_{\text{IB},c} = 0$ dB otherwise; In case the UE supports more than one of band combinations for CA, SUL or DC, and an operating band belongs to more than one band combinations then

- a) When the operating band frequency range is ≤ 1 GHz, the applicable additional $\Delta T_{\text{IB},c}$ shall be the average value for all band combinations defined in clause 6.2A.4.2, 6.2C.2 in this specification and 6.2B.4.2 in TS 38.101-3 [3], truncated to one decimal place that apply for that operating band among the supported band combinations. In case there is a harmonic relation between low band UL and high band DL, then the maximum $\Delta T_{\text{IB},c}$ among the different supported band combinations involving such band shall be applied
- b) When the operating band frequency range is > 1 GHz, the applicable additional $\Delta T_{\text{IB},c}$ shall be the maximum value for all band combinations defined in clause 6.2A.4.2, 6.2C.2 in this specification and 6.2B.4.2 in TS 38.101-3 [3] for the applicable operating bands.

$\Delta T_{\text{C},c} = 1.5$ dB when NOTE 3 in Table 6.2.1-1 in 38.101-1 applies for a serving cell c, otherwise $\Delta T_{\text{C},c} = 0$ dB ;

MPR_c and A-MPR_c for serving cell c are specified in clause 6.2.2 and clause 6.2.3, respectively;

ΔT_{RxsRS} is applied during SRS transmission occasions with *usage* in *SRS-ResourceSet* set as 'antennaSwitching' when

- a) UE transmits SRS on the second SRS resource in every configured SRS resource set when the *SRS-TxSwitch* capability is indicated as 't1r2'
- b) UE transmits SRS on the second, third and fourth SRS resources of the total 4 SRS resources from all configured SRS resource set(s) consisting of one SRS port when the *SRS-TxSwitch* capability is indicated as 't1r4' or 't1r4-t2r4' but in 't1r4' mode.
- c) UE transmits SRS from the SRS port pair on the second SRS resource in every configured SRS resource set consisting of two SRS ports when the *SRS-TxSwitch* capability is indicated as 't2r4' or 't1r4-t2r4' but in 't2r4' mode, or
- d) UE transmits SRS to a DL-only carrier.

The value of ΔT_{RxsRS} is 4.5 dB for n79 and 3 dB for bands whose $F_{\text{UL},\text{high}}$ is lower than the $F_{\text{UL},\text{low}}$ of n79 when the device is power class 3 in the band, or when the device is power class 2 in the band and $\Delta P_{\text{PowerClass}} = 3$ dB. The value of ΔT_{RxsRS} is 7.5 dB for n79 and 6 dB for bands whose $F_{\text{UL},\text{high}}$ is lower than the $F_{\text{UL},\text{low}}$ of n79 when the device is power class 2 in the band and $\Delta P_{\text{PowerClass}} = 0$ dB.

For other SRS transmissions ΔT_{RxsRS} is zero;

P-MPR_c is the power management maximum 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 specifications;

- 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 $P\text{-MPR}_c$ for serving cell c only for the above cases. For UE conducted conformance testing $P\text{-MPR}_c$ shall be 0 dB

NOTE 1: $P\text{-MPR}_c$ was introduced in the $P_{\text{CMAX},f,c}$ equation such that the UE can report to the gNB the available maximum output transmit power. This information can be used by the gNB for scheduling decisions.

NOTE 2: $P\text{-MPR}_c$ may impact the maximum uplink performance for the selected UL transmission path.

T_{REF} and T_{eval} are specified in Table 6.2.4-1. For each T_{REF} , the $P_{\text{CMAX},L,c}$ for serving cell c are evaluated per T_{eval} and given by the minimum value taken over the transmission(s) within the T_{eval} ; the minimum $P_{\text{CMAX},L,f,c}$ over one or more T_{eval} is then applied for the entire T_{REF}

Table 6.2.4-1: Evaluation and reference periods for P_{cm}

| T_{REF} | T_{eval} | T_{eval} with frequency hopping |
|-------------------------|-------------------------|--|
| Physical channel length | Physical channel length | Min($T_{\text{no_hopping}}$, Physical Channel Length) |

The measured configured maximum output power $P_{\text{UMAX},f,c}$ shall be within the following bounds:

$$P_{\text{CMAX},L,f,c} - \text{MAX}\{T_{L,c}, T(P_{\text{CMAX},L,f,c})\} \leq P_{\text{UMAX},f,c} \leq P_{\text{CMAX},H,f,c} + T(P_{\text{CMAX},H,f,c}).$$

where the tolerance $T(P_{\text{CMAX},f,c})$ for applicable values of $P_{\text{CMAX},f,c}$ is specified in Table 6.2.4-1. The tolerance $T_{L,c}$ 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: P_{CMAX} tolerance

| $P_{\text{CMAX},f,c}$ (dBm) | Tolerance $T(P_{\text{CMAX},f,c})$ (dB) |
|-------------------------------------|---|
| $23 < P_{\text{CMAX},c} \leq 33$ | 2.0 |
| $21 \leq P_{\text{CMAX},c} \leq 23$ | 2.0 |
| $20 \leq P_{\text{CMAX},c} < 21$ | 2.5 |
| $19 \leq P_{\text{CMAX},c} < 20$ | 3.5 |
| $18 \leq P_{\text{CMAX},c} < 19$ | 4.0 |
| $13 \leq P_{\text{CMAX},c} < 18$ | 5.0 |
| $8 \leq P_{\text{CMAX},c} < 13$ | 6.0 |
| $-40 \leq P_{\text{CMAX},c} < 8$ | 7.0 |

6.2A Transmitter power for CA

6.2A.1 UE maximum output power for CA

6.2A.1.1 Void

6.2A.1.2 Void

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 clause 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 (1 ms). 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_n3A-n78A | | | | | 23 | +2/-3 | | |
| CA_n8A-n78A | | | | | 23 | +2/-3 | | |
| <p>NOTE 1: Void</p> <p>NOTE 2: For an NR CA configuration with one uplink carrier assigned to one NR band, if the uplink NR band has NOTE 3 in Table 6.2.1-1, the band is allowed to reduce the lower tolerance limit by 1.5 dB when the transmission bandwidths of the band(s) is confined within F_{UL_low} and $F_{UL_low} + 4$ MHz or $F_{UL_high} - 4$ MHz and F_{UL_high}. An uplink NR CA configuration in which at least one of the bands has NOTE 3 in Table 6.2.1-1 is allowed to reduce the lower tolerance limit by 1.5 dB when the transmission bandwidths of at least one of the bands is confined within F_{UL_low} and $F_{UL_low} + 4$ MHz or $F_{UL_high} - 4$ MHz and F_{UL_high}.</p> <p>NOTE 3: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance</p> <p>NOTE 4: For inter-band carrier aggregation the maximum power requirement should apply to the total transmitted power over all component carriers (per UE).</p> <p>NOTE 5: Power class 3 is the default power class unless otherwise stated</p> | | | | | | | | |

6.2A.2 UE maximum output power reduction for CA

6.2A.2.1 Void

6.2A.2.2 Void

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

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the requirements in subclause 6.2.2 apply.

For inter-band carrier aggregation with uplink assigned to two NR bands, the requirements in clause 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 Void

6.2A.3.1.2 Void

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

Unless otherwise stated, for inter-band carrier aggregation with one uplink carrier assigned to one NR band, the requirements in subclause 6.2.3 apply.

Unless specified in Table 6.2A.3.1.3-1, for inter-band carrier aggregation with uplink assigned to two NR bands, the requirements in clause 6.2.3 apply only to the indicated carrier. The requirements in Table 6.2A.3.1.3-1 are specified in terms of an additional spectrum emission requirement with their associated network signalling values and the allowed A-MPR. Unless otherwise stated, the combined requirements and allowed A-MPR are applicable on both bands when both component carriers are active.. Additional spurious emission requirements are signalled by the network to indicate that the UE shall meet the additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

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, the total reduction to UE maximum output power is $\max(\text{MPR}, \text{A-MPR})$ where MPR is defined in clause 6.2.2. In case of a power class 3 UE, when IE `powerBoostPi2BPSK` is set to 1, power class 2 A-MPR values apply.

For almost contiguous allocations in CP-OFDM waveforms in power class 3, the allowed A-MPR defined in clause 6.2.3 is increased by $\text{CEIL}\{ 10 \log_{10}(1 + \text{NRB_gap} / \text{NRB_alloc}), 0.5 \}$ dB, where `NRB_gap` is the total number of unallocated RBs between allocated RBs and `NRB_alloc` is the total number of allocated RBs, and the parameter `LCRB` is replaced by `NRB_alloc + NRB_gap` in specifying the RB allocation regions.

Unless otherwise specified, $\pi/2$ BPSK in following A-MPR tables refers to both variants of $\pi/2$ BPSK referenced in 6.2.2 tables 6.2.2-1.

The emission requirements specified in Table 6.2A.3.1.3-1 also apply 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 6.2A.3.1.3-1: Additional Requirements for uplink inter-band carrier aggregation (two-bands)

| NR CA combination | Band | Applied NS | Requirements (clause) | A-MPR (table/clause) | Note |
|--|------|------------|-----------------------|----------------------|------|
| CA_n3-n78 | n3 | 100 | 6.5.2.4.2 | Table 6.2.3.1-2 | 1 |
| CA_n8-n78 | n8 | 43 | 6.5.3.3.5 | Clause 6.2.3.6 | 1 |
| | | 43U | 6.5.3.3.5, 6.5.2.4.2 | Clause 6.2.3.6 | |
| NOTE 1: NS_05U, NS_43U and NS_100 can be signalled for NR bands that have UTRA services deployed and the requirements in clause 6.5.2.4.2 are only applicable to the signalling carrier. | | | | | |

6.2A.4 Configured output power for CA

6.2A.4.1 Configured transmitted power level

6.2A.4.1.1 Void

6.2A.4.1.2 Void

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 $P_{\text{CMAX},c}$ for serving cell c and its total configured maximum output power P_{CMAX} .

The configured maximum output power $P_{\text{CMAX},c}$ on serving cell c shall be set as specified in clause 6.2.4.

For uplink inter-band carrier aggregation, MPR_c and A-MPR_c apply per serving cell c and are specified in clause 6.2.2 and clause 6.2.3, respectively. P-MPR_c accounts for power management for serving cell c . $P_{\text{CMAX},c}$ is calculated under the assumption that the transmit power is increased independently on all component carriers.

The total configured maximum output power P_{CMAX} shall be set within the following bounds:

$$P_{\text{CMAX,L}} \leq P_{\text{CMAX}} \leq P_{\text{CMAX,H}}$$

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,

$$P_{\text{CMAX,L}} = \text{MIN} \left\{ 10 \log_{10} \sum \text{MIN} \left[p_{\text{EMAX},c} / (\Delta t_{\text{C},c}), p_{\text{PowerClass},c} / (\text{MAX}(m_{\text{pr},c}, a\text{-}m_{\text{pr},c}) \cdot \Delta t_{\text{C},c} \cdot \Delta t_{\text{IB},c} \cdot \Delta t_{\text{RxsRS},c}), p_{\text{PowerClass},c} / p_{\text{mpr},c} \right], P_{\text{EMAX,CA}}, P_{\text{PowerClass,CA}} \right\}$$

$$P_{\text{CMAX,H}} = \text{MIN} \left\{ 10 \log_{10} \sum p_{\text{EMAX},c}, P_{\text{EMAX,CA}}, P_{\text{PowerClass,CA}} \right\}$$

where

- $p_{\text{EMAX},c}$ is the linear value of $P_{\text{EMAX},c}$ which is given by IE *P-Max* for serving cell c in [7];
- $P_{\text{PowerClass,CA}}$ 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;
- $p_{\text{PowerClass},c}$ is the linear value of the maximum UE power for serving cell c specified in Table 6.2.1-1 without taking into account the tolerance;
- $m_{\text{pr},c}$ and $a\text{-}m_{\text{pr},c}$ are the linear values of MPR_c and A-MPR_c as specified in clause 6.2.2 and clause 6.2.3, respectively;
- $p_{\text{mpr},c}$ is the linear value of P-MPR_c ;
- $\Delta t_{\text{RxsRS},c}$ is the linear value of $\Delta T_{\text{RxsRS},c}$;

- $\Delta t_{C,c}$ is the linear value of $\Delta T_{C,c}$. $\Delta t_{C,c} = 1.41$ when NOTE 2 in Table 6.2A.1.3-1 applies for a serving cell c , otherwise $\Delta t_{C,c} = 1$;
- $\Delta t_{IB,c}$ is the linear value of the inter-band relaxation term $\Delta T_{IB,c}$ of the serving cell c as specified in clause 6.2A.4.2 for NR CA, clause 6.2C.2 for SUL, or TS 38.101-3 clause 6.2B.4.2 for EN-DC; otherwise $\Delta t_{IB,c} = 1$; In case the UE supports more than one of band combinations for CA, SUL or DC, and an operating band belongs to more than one band combinations then
 - a) When the operating band frequency range is ≤ 1 GHz, the applicable additional $\Delta T_{IB,c}$ shall be the average value for all band combinations defined in clause 6.2A.4.2, 6.2C.2 in this specification and 6.2B.4.2 in TS 38.101-3 [3], truncated to one decimal place that apply for that operating band among the supported band combinations. In case there is a harmonic relation between low band UL and high band DL, then the maximum $\Delta T_{IB,c}$ among the different supported band combinations involving such band shall be applied
 - b) When the operating band frequency range is > 1 GHz, the applicable additional $\Delta T_{IB,c}$ shall be the maximum value for all band combinations defined in clause 6.2A.4.2, 6.2C.2 in this specification and 6.2B.4.2 in TS 38.101-3 [3] for the applicable operating bands.
- $P_{EMAX,CA}$ is the value indicated by p -NR-FRI or by p -UE-FRI whichever is the smallest if both are present. 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 $P_{CMAX,c(i),i}$ for serving cell $c(i)$ of slot numerology type i , and its total configured maximum output power P_{CMAX} .

The configured maximum output power $P_{CMAX,c(i),i}(p)$ in slot p of serving cell $c(i)$ on slot numerology type i shall be set within the following bounds:

$$P_{CMAX_L,f,c(i),i}(p) \leq P_{CMAX,f,c(i),i}(p) \leq P_{CMAX_H,f,c(i),i}(p)$$

where $P_{CMAX_L,f,c(i),i}(p)$ and $P_{CMAX_H,f,c(i),i}(p)$ are the limits for a serving cell $c(i)$ of slot numerology type i as specified in clause 6.2.4.

The total UE configured maximum output power $P_{CMAX}(p,q)$ 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:

$$P_{CMAX_L}(p,q) \leq P_{CMAX}(p,q) \leq P_{CMAX_H}(p,q)$$

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

$$P_{CMAX_L}(p,q) = \text{MIN} \{ 10 \log_{10} [p_{CMAX_L,f,c(i),i}(p) + p_{CMAX_L,f,c(i),j}(q)], P_{PowerClass,CA}, P_{EMAX,CA} \}$$

$$P_{CMAX_H}(p,q) = \text{MIN} \{ 10 \log_{10} [p_{CMAX_H,f,c(i),i}(p) + p_{CMAX_H,f,c(i),j}(q)], P_{PowerClass,CA}, P_{EMAX,CA} \}$$

where $p_{CMAX_L,f,c(i),i}$ and $p_{CMAX_H,f,c(i),i}$ are the respective limits $P_{CMAX_L,f,c(i),i}$ and $P_{CMAX_H,f,c(i),i}$ expressed in linear scale.

T_{REF} and T_{eval} are specified in Table 6.2A.4.1.3-0 when same and different slot patterns are used in aggregated carriers. For each T_{REF} , the P_{CMAX_L} is evaluated per T_{eval} and given by the minimum value taken over the transmission(s) within the T_{eval} ; the minimum P_{CMAX_L} over the one or more T_{eval} is then applied for the entire T_{REF} . The lesser of $P_{PowerClass,CA}$ and $P_{EMAX,CA}$ shall not be exceeded by the UE during any period of time.

Table 6.2A.4.1.3-0: P_{CMAX} evaluation window for different slot and channel durations

| T_{REF} | T_{eval} | T_{eval} with frequency hopping |
|---|-------------------------|---|
| T_{REF} of largest slot duration over both UL CCs | Physical channel length | Min($T_{no_hopping}$, 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 P_{CMAX_L} for slots i and $i + 1$ applies for any overlapping portion of slots i and $i + 1$. The lesser of $P_{PowerClass,CA}$ and $P_{EMAX,CA}$ shall not be exceeded by the UE during any period of time.

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

$$P_{CMAX_L} - \text{MAX}\{T_L, T_{LOW}(P_{CMAX_L})\} \leq P_{UMAX} \leq P_{CMAX_H} + T_{HIGH}(P_{CMAX_H})$$

$$P_{UMAX} = 10 \log_{10} \sum p_{UMAX,c}$$

where $p_{UMAX,c}$ denotes the measured maximum output power for serving cell c expressed in linear scale. The tolerances $T_{LOW}(P_{CMAX})$ and $T_{HIGH}(P_{CMAX})$ for applicable values of P_{CMAX} are specified in Table 6.2A.4.1.3-1. The tolerance T_L 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.

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

$$P'_{CMAX,L} - \text{MAX}\{T_L, T_{LOW}(P'_{CMAX,L})\} \leq P'_{UMAX} \leq P'_{CMAX,H} + T_{HIGH}(P'_{CMAX,H})$$

$$P'_{UMAX} = 10 \log_{10} \sum p'_{UMAX,c}$$

where $p'_{UMAX,c}$ denotes the average measured maximum output power for serving cell c expressed in linear scale over T_{REF} . The tolerances $T_{LOW}(P'_{CMAX})$ and $T_{HIGH}(P'_{CMAX})$ for applicable values of P'_{CMAX} are specified in Table 6.2A.4.1.3-1 for inter-band carrier aggregation. The tolerance T_L 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:

$$P'_{CMAX,L} = \text{MIN}\{ \text{MIN}\{10\log_{10}\sum(p_{CMAX,L,f,c(i),i}), P_{PowerClass,CA}\} \text{ over all overlapping slots in } T_{REF}\}$$

$$P'_{CMAX,H} = \text{MAX}\{ \text{MIN}\{10\log_{10}\sum(p_{EMAX,c}), P_{PowerClass,CA}\} \text{ over all overlapping slots in } T_{REF}\}$$

Table 6.2A.4.1.3-1: P_{CMAX} tolerance for uplink inter-band CA (two bands)

| P_{CMAX} (dBm) | Tolerance $T_{LOW}(P_{CMAX})$ (dB) | Tolerance $T_{HIGH}(P_{CMAX})$ (dB) |
|--------------------------|--|---|
| $P_{CMAX} = 23$ | 3.0 | 2.0 |
| $22 \leq P_{CMAX} < 23$ | 5.0 | 2.0 |
| $21 \leq P_{CMAX} < 22$ | 5.0 | 3.0 |
| $20 \leq P_{CMAX} < 21$ | 5.0 | 4.0 |
| $16 \leq P_{CMAX} < 20$ | 5.0 | |
| $11 \leq P_{CMAX} < 16$ | 6.0 | |
| $-40 \leq P_{CMAX} < 11$ | 7.0 | |

6.2A.4.2 $\Delta T_{IB,c}$ for CA

For the UE which supports inter-band NR CA configuration, $\Delta T_{IB,c}$ in tables below applies. Unless otherwise stated, $\Delta T_{IB,c}$ is set to zero.

6.2A.4.2.1 Void

6.2A.4.2.2 Void

6.2A.4.2.3 $\Delta T_{IB,c}$ for Inter-band CA (two bands)

Table 6.2A.4.2.3-1: $\Delta T_{IB,c}$ due to NR CA (two bands)

| Inter-band CA combination | NR Band | $\Delta T_{IB,c}$ (dB) |
|---------------------------|---------|------------------------|
| CA_n3-n77 | n3 | 0.6 |
| | n77 | 0.8 |
| CA_n3-n78 | n3 | 0.6 |
| | n78 | 0.8 |
| CA_n3-n79 | n3 | 0.3 |
| | n79 | 0.8 |
| CA_n8-n75 | n8 | 0.3 |
| CA_n8-n78 | n8 | 0.6 |
| | n78 | 0.8 |
| CA_n8-n79 | n8 | 0.3 |
| | n79 | 0.8 |

| | | |
|---|-----|------------------|
| CA n28-n75 | n28 | 0.3 |
| CA_n28-n78 | n28 | 0.5 |
| | n78 | 0.8 |
| CA_n41-n78 ¹ | n41 | 0.3 |
| | n78 | 0.8 |
| CA_n75-n78 | n78 | 0.8 |
| CA_n76-n78 | n78 | 0.8 |
| CA n77-n79 | n77 | 0.5 |
| | n79 | 0.5 |
| CA_n78-n79 | n78 | 0.5 |
| | | 1.5 ² |
| | n79 | 0.5 |
| | | 1.5 ² |
| 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. | | |
| NOTE 2: The requirements only apply for UE supporting inter-band carrier aggregation with simultaneous Rx/Tx capability, and NR UL carrier frequencies are confined to 3700 MHz-3800MHz for n78 and 4400 MHz-4500MHz for n79. Simultaneous Rx/Tx capability does not apply for UEs supporting band n78 with a n77 implementation. | | |

6.2B Void

6.2C Transmitter power for SUL

6.2C.1 Configured transmitted power for SUL

When a UE is configured with both NR UL and NR SUL carriers in a serving cell with active transmission either on the UL carrier or SUL carrier, the configured transmit power requirements specified in clause 6.2.4 are applicable for the UL carrier and the SUL carrier, respectively.

6.2C.2 $\Delta T_{IB,c}$

For the UE which supports SUL band combination, $\Delta T_{IB,c}$ in Tables below applies. Unless otherwise stated, $\Delta T_{IB,c}$ is set to zero.

Table 6.2C.2-1: $\Delta T_{IB,c}$ due to SUL

| Band combination for SUL | NR Band | $\Delta T_{IB,c}$ (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 power class 2 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 defined as the sum of the maximum output power from both UE antenna connectors. The period of measurement shall be at least one sub frame (1 ms).

The requirements shall be met with the UL MIMO configurations of using 2-layer UL MIMO transmission with codebook of $\frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$. 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/-3 ¹ | 23 | +2/-3 ¹ | | |
| n77 | | | 26 | +2/-3 | 23 | +2/-3 | | |
| n78 | | | 26 | +2/-3 | 23 | +2/-3 | | |
| n79 | | | 26 | +2/-3 | 23 | +2/-3 | | |

NOTE 1: 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

NOTE 2: Power class 3 is the default power class unless otherwise stated

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 scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 6.2.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signalling.

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 defined as the sum of the maximum output power from both UE antenna connector for the power class as indicated by the *ue-PowerClass* field in capability signalling.

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

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 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 clause 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 defined as the sum of the maximum output power from both 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 clause 6.2D.4 apply.

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 6.2.3 apply for the power class as indicated by the *ue-PowerClass* field in capability signalling.

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 $P_{\text{CMAX},c}$, the lower bound $P_{\text{CMAX}_L,c}$, and the higher bound $P_{\text{CMAX}_H,c}$ specified in clause 6.2.4 shall apply to UE supporting UL MIMO, where

- $P_{\text{PowerClass}}$, $\Delta P_{\text{PowerClass}}$ and $\Delta T_{C,c}$ are specified in clause 6.2D.1;
- MPR_c is specified in clause 6.2D.2;
- A-MPR_c is specified in clause 6.2D.3.

The measured configured maximum output power $P_{\text{UMAX},c}$ for serving cell c shall be within the following bounds:

$$P_{\text{CMAX}_L,c} - \text{MAX}\{T_L, T_{\text{LOW}}(P_{\text{CMAX}_L,c})\} \leq P_{\text{UMAX},c} \leq P_{\text{CMAX}_H,c} + T_{\text{HIGH}}(P_{\text{CMAX}_H,c})$$

where $T_{\text{LOW}}(P_{\text{CMAX}_L,c})$ and $T_{\text{HIGH}}(P_{\text{CMAX}_H,c})$ are defined as the tolerance and applies to $P_{\text{CMAX}_L,c}$ and $P_{\text{CMAX}_H,c}$ separately, while T_L 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 multiplexing 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: $P_{\text{CMAX},c}$ tolerance in closed-loop spatial multiplexing scheme

| $P_{\text{CMAX},c}$ (dBm) | Tolerance $T_{\text{LOW}}(P_{\text{CMAX}_L,c})$ (dB) | Tolerance $T_{\text{HIGH}}(P_{\text{CMAX}_H,c})$ (dB) |
|-----------------------------------|---|--|
| $P_{\text{CMAX},c} = 26$ | 3.0 | 2.0 |
| $23 \leq P_{\text{CMAX},c} < 26$ | 3.0 | 2.0 |
| $22 \leq P_{\text{CMAX},c} < 23$ | 5.0 | 2.0 |
| $21 \leq P_{\text{CMAX},c} < 22$ | 5.0 | 3.0 |
| $20 \leq P_{\text{CMAX},c} < 21$ | 5.0 | 4.0 |
| $16 \leq P_{\text{CMAX},c} < 20$ | 5.0 | |
| $11 \leq P_{\text{CMAX},c} < 16$ | 6.0 | |
| $-40 \leq P_{\text{CMAX},c} < 11$ | 7.0 | |

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 6.2.4 apply for the power class as indicated by the *ue-PowerClass* field in capability signalling.

6.3 Output power dynamics

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 at least one sub-frame 1 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 on any of its ports..

The transmit OFF power is defined as the mean power in a duration of at least one sub-frame (1 ms) 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 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 clauses, following definitions apply:

- A slot or long subslot transmission is a transmission with more than 2 symbols.
- A short subslot transmission is a 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: 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 long subslot boundaries

The transmit power time mask for slot and a long subslot transmission boundaries 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 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 clause 6.3.3.8 apply.

The transmit power time mask for short subslot transmission boundaries defines the transient periods allowed between short subslot transmissions. The time masks in 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 0.5 ms or span the boundary of 0.5 ms of the subframe, the measurement period will plus 0.032552 μs

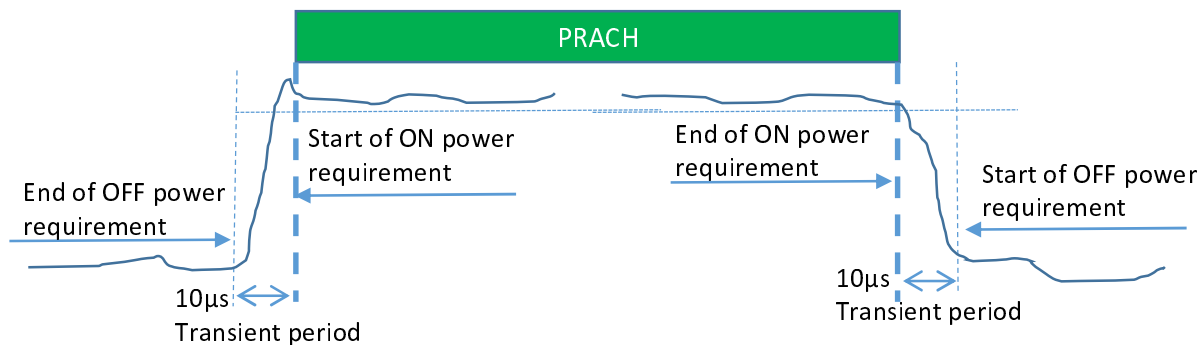


Figure 6.3.3.4-1: PRACH ON/OFF time mask

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; See Figure 6.3.3.6-1

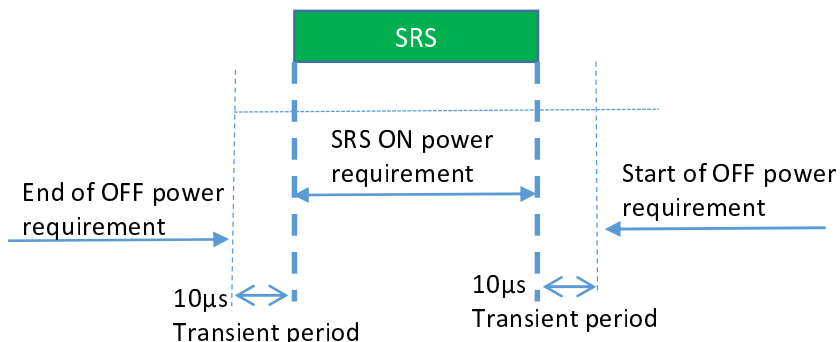


Figure 6.3.3.6-1: Single SRS time mask for NR UL transmission

For SRS transmission mapped to two or more OFDM symbols the ON power is defined as the mean power for each symbol duration excluding any transient period. For consecutive SRS transmissions without power change, Figure 6.3.3.6-2 applies.

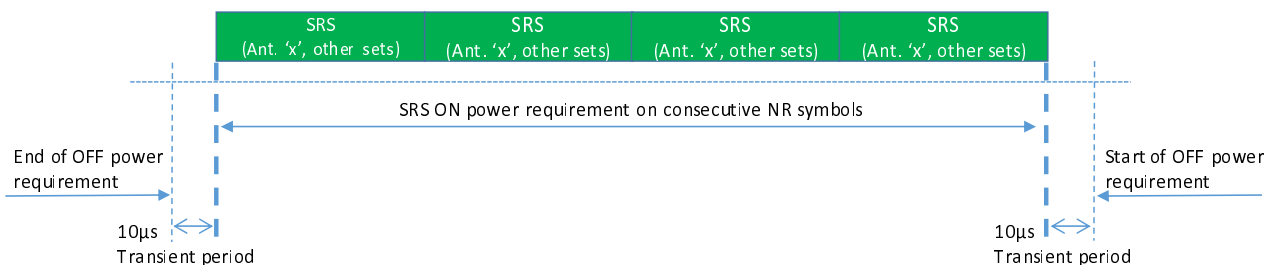


Figure 6.3.3.6-2: Consecutive SRS time mask for the case when no power change is required with SRS usage other than antenna switching.

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

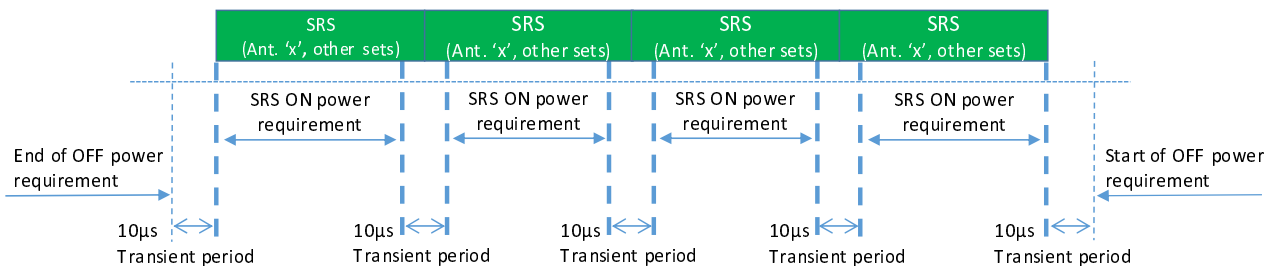


Figure 6.3.3.6-3: Consecutive SRS time mask for the case when power change is required and when 15 kHz and 30 kHz SCS is used in FR1 with SRS usage other than antenna switching.

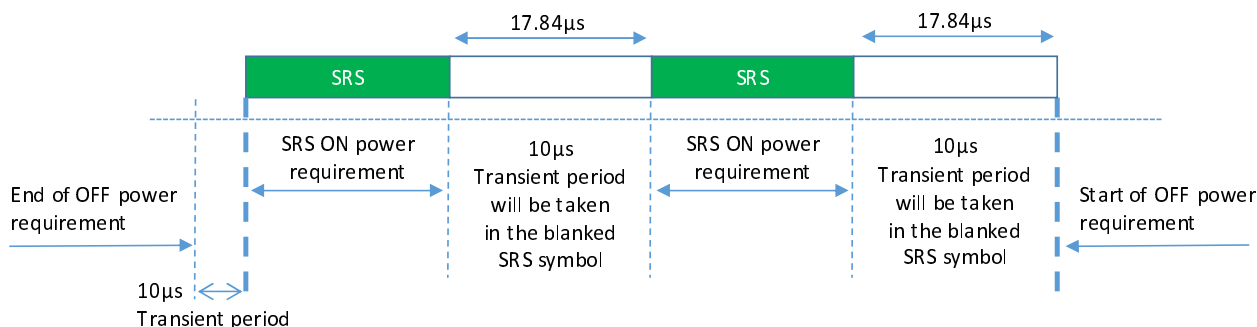


Figure 6.3.3.6-4: Consecutive SRS time mask for the case when power change is required and when 60 kHz SCS is used in FR1

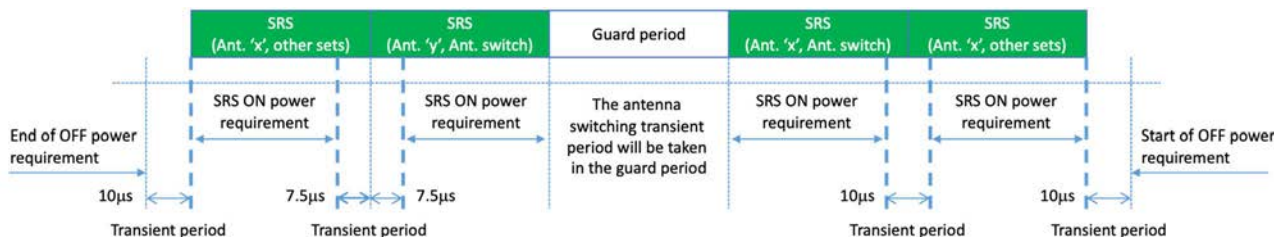


Figure 6.3.3.6-5: FR1 Time mask for 15 kHz and 30 kHz SCS for the case when consecutive SRS switching usage is between antenna switching & other sets

where "other sets" belongs to a "usage set" other than the set for antenna switching. The usage sets for SRS switching are defined in clause 6.2.1 of TS 38.214 [10].

NOTE: Guard period of one symbol is defined between two SRS resources of an SRS resource set for antenna switching for 15kHz, 30kHz and 60kHz SCS in Table 6.2.1.2-1 of TS 38.214 [10].

The above transient period applies to all the transmit CCs in CA with the CC sounding SRS. UE RF requirements do not apply during this transient period.

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.

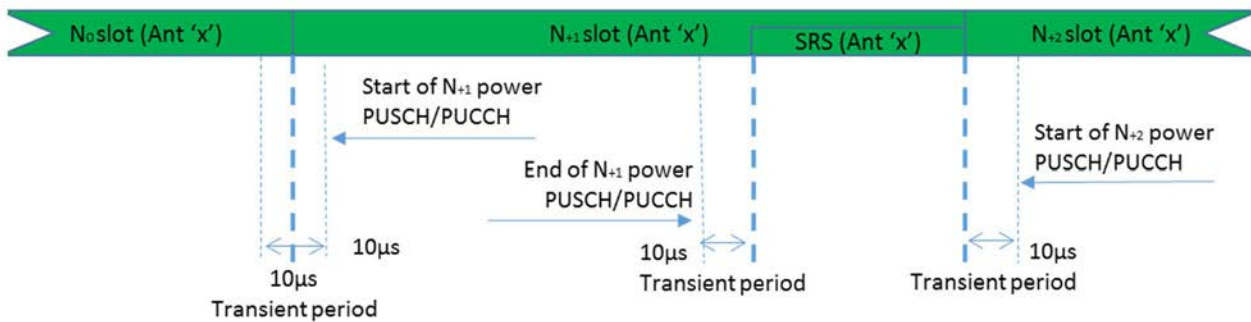


Figure 6.3.3.7-1: PUCCH/PUSCH/SRS time mask when there is a transmission before or after or both before and after SRS, when sounded on the same antenna (Ant 'x')

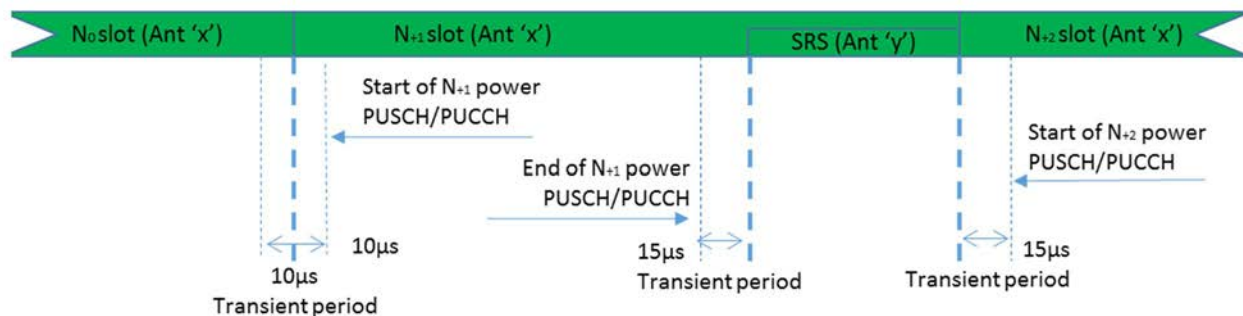


Figure 6.3.3.7-2: PUCCH/PUSCH/SRS time mask when there is a transmission before or after or both before and after SRS, when sounded on a different ports (Ant 'x' and Ant 'y' are different antenna ports)

This transient period of 15 usec applies before and after SRS transmission to all the transmit CCs in CA with the CC sounding SRS. UE RF requirements do not apply during this transient period.

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.

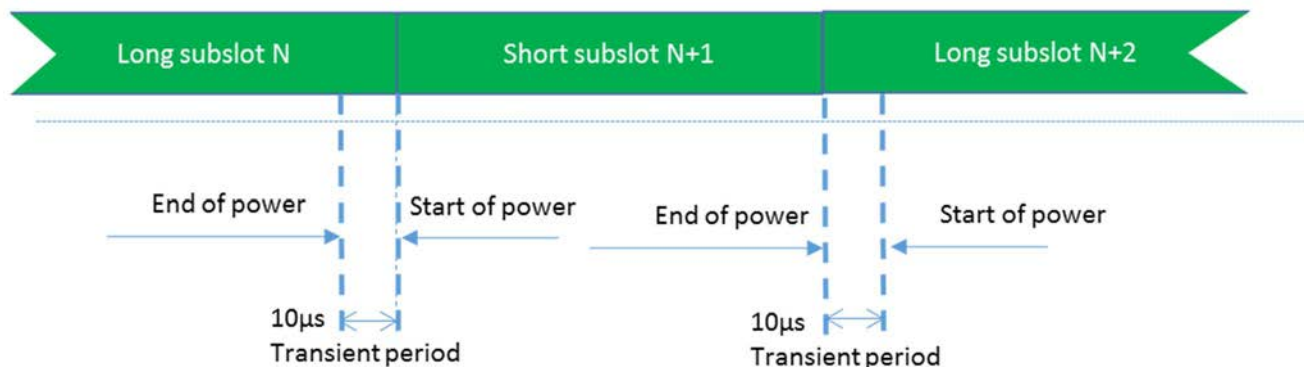


Figure 6.3.3.8-1: Consecutive slot or long subslot transmission and short subslot transmission time mask

6.3.3.9 Transmit power time mask for consecutive short subslot transmission 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

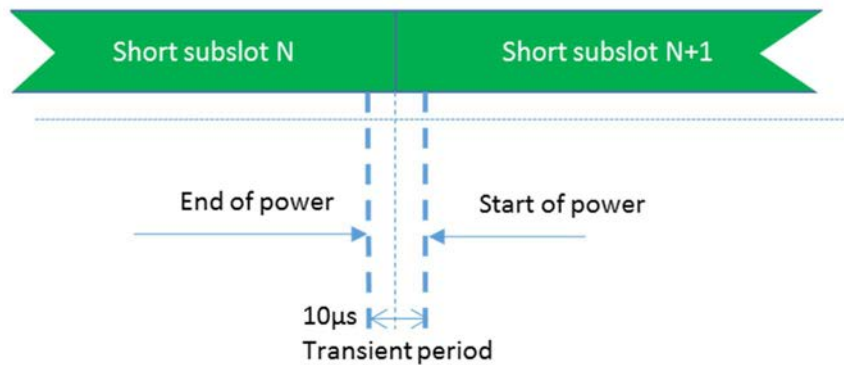


Figure 6.3.3.9-2: Consecutive short subslot transmissions time mask

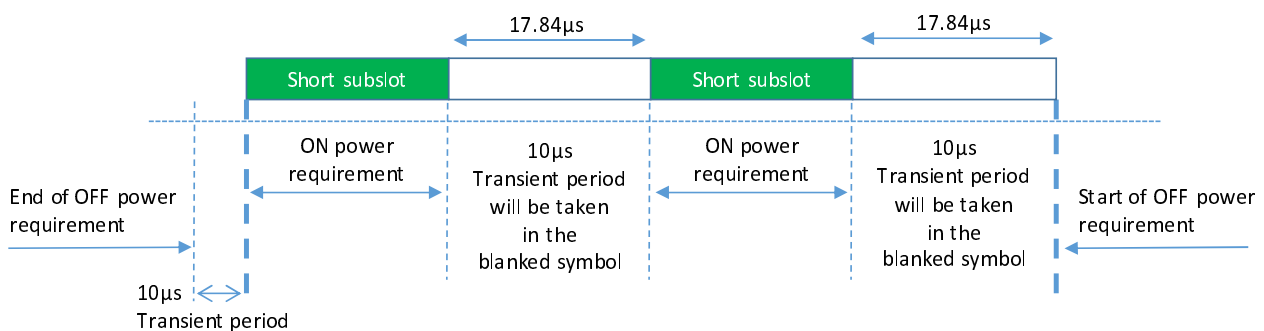


Figure 6.3.3.9-3: Consecutive short subslot (1 symbol gap) time mask for the case when transient period is required on both sides of the symbol and when 60 kHz SCS is used in FR1

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 (1 ms) at the start of a contiguous transmission or non-contiguous transmission with a transmission gap larger than 20 ms. 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 clause 6.3.1 and the maximum output power as specified in 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 (1 ms) relatively to the power of the most recently transmitted reference sub-frame (1 ms) if the transmission gap between these sub-frames is less than or equal to 20 ms.

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 clause 6.3.1 and the measured P_{UMAX} as defined in clause 6.2.4.

To account for RF Power amplifier mode changes, 2 exceptions are allowed for each of two test patterns. The test patterns are a monotonically increasing power sweep and a monotonically decreasing power sweep over a range bounded by the requirements of minimum power and maximum power specified in clauses 6.3.1 and 6.2.1, respectively. For those exceptions, the power tolerance limit is a maximum of ± 6.0 dB in Table 6.3.4.3-1.

Table 6.3.4.3-1: Relative power tolerance

| Power step ΔP (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) |
|--|---|--|------------|
| $\Delta P < 2$ | ± 2.0 (NOTE) | ± 2.5 | ± 2.0 |
| $2 \leq \Delta P < 3$ | ± 2.5 | ± 3.5 | ± 2.5 |
| $3 \leq \Delta P < 4$ | ± 3.0 | ± 4.5 | ± 3.0 |
| $4 \leq \Delta P < 10$ | ± 3.5 | ± 5.5 | ± 3.5 |
| $10 \leq \Delta P < 15$ | ± 4.0 | ± 7.0 | ± 4.0 |
| $15 \leq \Delta P$ | ± 5.0 | ± 8.0 | ± 5.0 |
| 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 $\Delta P \leq 1$ 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 in a sub-frame (1 ms) 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 TS 38.213 [8] 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 clause 6.3.1 and the maximum output power as specified in clause 6.2.1.

Table 6.3.4.4-1: Aggregate power tolerance

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

6.3A Output power dynamics for CA

6.3A.1 Minimum output power for CA

6.3A.1.1 Void

6.3A.1.2 Void

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

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the minimum output power requirements in clause 6.3.1 apply.

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 clause 6.3.1.

6.3A.2 Transmit OFF power for CA

6.3A.2.1 Void

6.3A.2.2 Void

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

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the transmit OFF power requirements in subclause 6.3.2 apply.

For inter-band carrier aggregation with uplink assigned to two NR bands, the transmit OFF power specified in clause 6.3.2 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 on any of its ports.

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

6.3A.3.1 Void

6.3A.3.2 Void

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

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the transmit ON/OFF time mask requirements in subclause 6.3.3 apply.

For inter-band carrier aggregation with uplink assigned to two NR bands, the general output power ON/OFF time mask specified in clause 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 clause 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 Void

6.3A.4.2 Void

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 (1 ms). The minimum output power shall not exceed the values specified in Table 6.3.1-1.

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 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 (1 ms) 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 clause 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 clause 6.3.3.1 apply to each transmit antenna connector. The requirements shall be met with the UL MIMO configurations described in clause 6.2D.1.

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 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 clause 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 clause 6.2D.1.

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 6.3.4 apply.

6.4 Transmit signal quality

6.4.1 Frequency error

The UE basic measurement interval of modulated carrier frequency is 1 UL slot. The mean value of basic measurements of UE modulated carrier frequency shall be accurate to within ± 0.1 PPM observed over a period of 1 ms of cumulated measurement intervals compared to the carrier frequency received from the NR Node B.

6.4.2 Transmit modulation quality

6.4.2.0 General

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 clause 6.4.2 are defined using the measurement methodology specified in Annex F.

In case the parameter 3300 or 3301 is reported from UE via the parameter *txDirectCurrentLocation* in *UplinkTxDirectCurrentList* IE (as defined in TS 38.331 [7]), carrier leakage measurement requirement in clause 6.4.2.2 and 6.4.2.3 shall be waived, and the RF correction with regard to the carrier leakage and IQ image shall be omitted during the calculation of transmit modulation quality.

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 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 one slot for PUCCH and PUSCH in the time domain. The EVM measurement interval is reduced by any symbol that contains an allowable power transient in the measurement interval, as defined in clause 6.3.3.

The RMS average of the basic EVM measurements over 10 subframes for the average EVM case, and over 60 subframes for the reference signal EVM case, for the different modulation 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 13 PRACH preamble formats and all 5 PUCCH formats 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 | ≥ Table 6.3.1-1 + 10 dB |
| 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 | $\max \left\{ -25 - 10 \cdot \log_{10} (N_{RB} / L_{CRB}), \right.$ $20 \cdot \log_{10} EVM - 3 - 5 \cdot (\Delta_{RB} - 1) / L_{CRB},$ $\left. -57 \text{ dBm} + 10 \log_{10} (SCS / 15 \text{ kHz}) - \overline{P_{RB}} \right\}$ | | 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 | |
| <p>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 $\overline{P_{RB}} - 30$ dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply. $\overline{P_{RB}}$ is defined in NOTE 10.</p> <p>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. For pi/2 BPSK with Spectrum Shaping, the limit is expressed as a ratio of measured power in one non-allocated RB to the measured power in the allocated RB with highest PSD.</p> <p>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.</p> <p>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.</p> <p>NOTE 5: The applicable frequencies for this limit depend on the parameter <i>txDirectCurrentLocation</i> in <i>UplinkTxDirectCurrent</i> IE, and are those that are enclosed either in the RB containing the carrier leakage frequency, or in the two RBs immediately adjacent to the carrier leakage frequency but excluding any allocated RB.</p> <p>NOTE 6: L_{CRB} is the Transmission Bandwidth (see clause 5.3).</p> <p>NOTE 7: N_{RB} is the Transmission Bandwidth Configuration (see clause 5.3).</p> <p>NOTE 8: EVM is the limit specified in Table 6.4.2.1-1 for the modulation format used in the allocated RBs.</p> <p>NOTE 9: Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB} = 1$ or $\Delta_{RB} = -1$ for the first adjacent RB outside of the allocated bandwidth).</p> <p>NOTE 10: $\overline{P_{RB}}$ is an average of the transmitted power over 10 sub-frames normalized by the number of allocated RBs, measured in dBm.</p> <p>NOTE 11: For almost contiguous allocations defined in sub-clause 6.2.2, $L_{CRB} = N_{RB_alloc} + N_{RB_gap}$ with no in-gap emission requirement.</p> | | | | |

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) |
|---|---------------------|
| $F_{UL_Meas} - F_{UL_Low} \geq 3$ MHz and $F_{UL_High} - F_{UL_Meas} \geq 3$ MHz (Range 1) | 4 (p-p) |
| $F_{UL_Meas} - F_{UL_Low} < 3$ MHz or $F_{UL_High} - F_{UL_Meas} < 3$ MHz (Range 2) | 8 (p-p) |
| NOTE 1: F_{UL_Meas} refers to the sub-carrier frequency for which the equalizer coefficient is evaluated | |
| NOTE 2: F_{UL_Low} and F_{UL_High} refer to each NR frequency band specified in Table 5.2-1 | |

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

| Frequency range | Maximum Ripple (dB) |
|---|---------------------|
| $F_{UL_Meas} - F_{UL_Low} \geq 5$ MHz and $F_{UL_High} - F_{UL_Meas} \geq 5$ MHz (Range 1) | 4 (p-p) |
| $F_{UL_Meas} - F_{UL_Low} < 5$ MHz or $F_{UL_High} - F_{UL_Meas} < 5$ MHz (Range 2) | 12 (p-p) |
| NOTE 1: F_{UL_Meas} refers to the sub-carrier frequency for which the equalizer coefficient is evaluated | |
| NOTE 2: F_{UL_Low} and F_{UL_High} refer to each NR frequency band specified in Table 5.2-1 | |

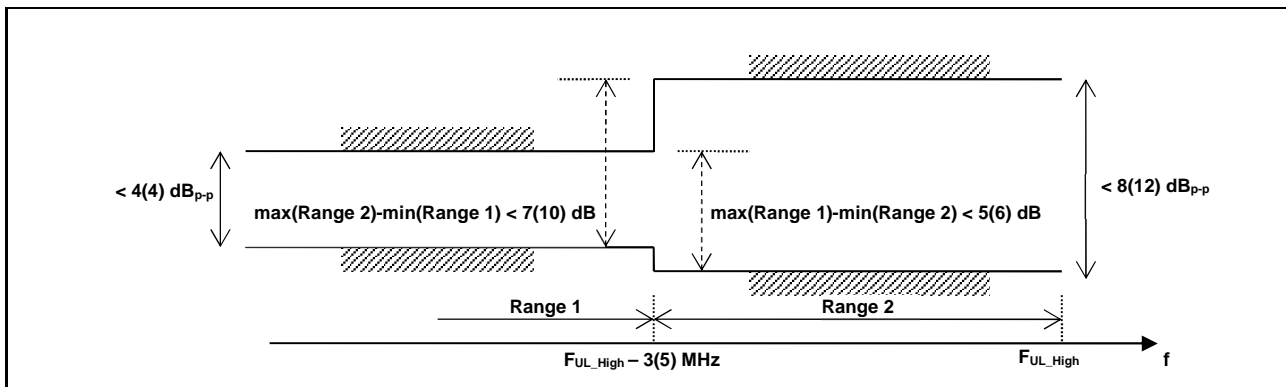


Figure 6.4.2.4-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation of the coefficients indicated (the ETC minimum requirement are within brackets).

6.4.2.4.1 Requirements for Pi/2 BPSK modulation

These requirements apply if the IE *powerBoostPi2BPSK* is set to 1 for power class 3 UE operating in TDD bands n40, n41, n77, n78 and n79 with Pi/2 BPSK modulation and UE indicates support for UE capability *powerBoosting-pi2BPSK* 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. The limiting mask shall be placed to minimize the change in equalizer coefficients in a sum of squares sense.

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_{UL_Meas} - F_{center} \leq X$ MHz (Range 1) | X1 | 6 (p-p) |
| $ F_{UL_Meas} - F_{center} > X$ MHz (Range 2) | X2 | 14 (p-p) |
| NOTE 1: F_{UL_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 6.4.2.4.1-1 for description of X1, X2 | | |

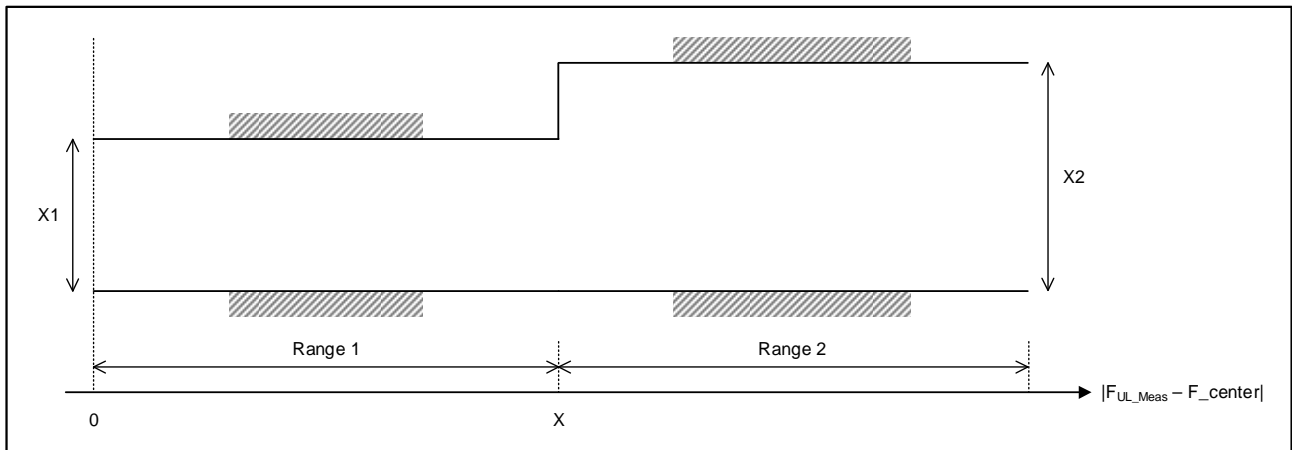


Figure 6.4.2.4.1-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation.

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

$$|\tilde{a}_t(t,0)| \geq |\tilde{a}_t(t,\tau)| \quad \forall \tau \neq 0$$

$$20\log_{10} |\tilde{a}_t(t,\tau)| < -15 \text{ dB} \quad 1 < \tau < M - 1,$$

where $|\tilde{a}_t(t,\tau)| = \text{IDFT}\{|\tilde{a}_t(t,f)| e^{j\varphi(t,f)}\}$, f is the frequency of the M allocated subcarriers, $\tilde{a}_t(t,f)$ and $\varphi(t,f)$ are the amplitude and phase response.

0 dB reference is defined as $20\log_{10} |\tilde{a}_t(t,0)|$.

6.4A Transmit signal quality for CA

6.4A.1 Frequency error for CA

6.4A.1.1 Void

6.4A.1.2 Void

6.4A.1.3 Frequency error for inter-band CA

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the frequency error requirements in subclause 6.4.1 apply.

For inter-band carrier aggregation with uplink assigned to two NR bands, the frequency error requirements defined in clause 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 Void

6.4A.2.2 Void

6.4A.2.3 Transmit modulation quality for inter-band CA

For inter-band carrier aggregation with one uplink carrier assigned to one NR band, the transmit modulation quality requirements in subclause 6.4.2 apply.

For inter-band carrier aggregation with uplink assigned to two NR bands, the transmit modulation quality requirements shall apply on each component carrier as defined in clause 6.4.2 with all component carriers active: PCC with PRB allocation and SCC without PRB allocation and without CSI reporting and SRS configured.

6.4D Transmit signal quality for UL MIMO

6.4D.0 General

For a UE supporting UL MIMO, the requirements in this section are defined per layer or as the sum of emissions from both antennas to account for the UL MIMO scheme.

Alternatively, when applicable, requirements may be verified per antenna connector using an UL MIMO transmission with codebook of $\frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ and a configuration defined in Table 6.4D.0-1.

Table 6.4D.0-1: UL MIMO configuration for per connector measurements

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

6.4D.1 Frequency error for UL MIMO

For UE(s) supporting UL MIMO, the basic measurement interval of modulated carrier frequency is 1 UL slot. The mean value of basic measurements of UE modulated carrier frequency per layer shall be accurate to within ± 0.1 PPM observed over a period of 1 ms of cumulated measurement intervals compared to the carrier frequency received from the NR Node B.

6.4D.2 Transmit modulation quality for UL MIMO

6.4D.2.0 General

For UE supporting UL MIMO, the transmit modulation quality requirements are specified based on measurements made 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

In case the parameter 3300 or 3301 is reported from UE via the parameter *txDirectCurrentLocation* in *UplinkTxDirectCurrentList* IE (as defined in TS 38.331 [7]), carrier leakage measurement requirement in clause 6.4D.2.2 and 6.4D.2.3 shall be waived, and the RF correction with regard to the carrier leakage and IQ image shall be omitted during the calculation of transmit modulation quality.

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 clause 6.4.2.1 apply per layer. 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 clause 6.4.2.2 apply per layer. 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 clause 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 clause 6.4.2.4 apply per layer. 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 connectors in any slot within the specified time window from the last transmitted SRS on the same antenna connectors, 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 connector 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 (Δf_{OOB}) starting from the \pm edge of the assigned NR channel bandwidth. For frequencies offset greater than Δf_{OOB} , the spurious requirements in clause 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: General NR spectrum emission mask

| Spectrum emission limit (dBm) / Channel bandwidth | | | | | | | | | | | | | |
|---|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|-----------------------|
| Δf_{OOB} (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 |
| $\pm 0-1$ | -13 | -13 | -13 | -13 | -13 | -13 | -13 | | | | | | 1 % channel bandwidth |
| $\pm 0-1$ | | | | | | | | -24 | -24 | -24 | -24 | -24 | 30 kHz |
| $\pm 1-5$ | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | 1 MHz |
| $\pm 5-6$ | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | |
| $\pm 6-10$ | -25 | | | | | | | | | | | | |
| $\pm 10-15$ | -25 | | | | | | | | | | | | |
| $\pm 15-20$ | | -25 | -25 | -25 | -25 | -25 | -25 | -25 | -25 | -25 | -25 | | |
| $\pm 20-25$ | | | | | | | | | | | | | |
| $\pm 25-30$ | | | | | | | | | | | | | |
| $\pm 30-35$ | | | | | | | | | | | | | |
| $\pm 35-40$ | | | | | | | | | | | | | |
| $\pm 40-45$ | | | | | | | -25 | | | | | | |
| $\pm 45-50$ | | | | | | | | | | | | | |
| $\pm 50-55$ | | | | | | | | -25 | | | | | |
| $\pm 55-60$ | | | | | | | | | | | | | |
| $\pm 60-65$ | | | | | | | | | -25 | | | | |
| $\pm 65-80$ | | | | | | | | | | | | | |
| $\pm 80-85$ | | | | | | | | | | -25 | | | |
| $\pm 85-90$ | | | | | | | | | | | | | |
| $\pm 90-95$ | | | | | | | | | | | -25 | | |
| $\pm 95-100$ | | | | | | | | | | | | | |

Table 6.5.2.3.2-3: n41 SEM with "NS_04"

| Δf_{OOB} MHz | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | | | | | | | | | Measurement bandwidth |
|--|---|-----|-----|-----|-----|----|----|----|-----|-----------------------|
| | 10 | 15 | 20 | 40 | 50 | 60 | 80 | 90 | 100 | |
| $\pm 0 - 1$ | -10 | -10 | -10 | -10 | | | | | | 2 % channel bandwidth |
| | | | | | -10 | | | | | 1 MHz |
| $\pm 1 - 5$ | -10 | | | | | | | | | 1 MHz |
| $\pm 5 - X$ | -13 | | | | | | | | | |
| $\pm X - (BW_{\text{Channel}} + 5 \text{ MHz})$ | -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 signalling values "NS_03" and "NS_03U"

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" or "NS_03U" 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" and "NS_03U"

| Δf_{OOB} (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | | | | | Measurement bandwidth |
|----------------------------------|---|-----|-----|-----|-----|-----------------------|
| | 5 | 10 | 15 | 20 | 40 | |
| $\pm 0-1$ | -13 | -13 | -13 | -13 | -13 | 1 % of channel BW |
| $\pm 1-6$ | -13 | -13 | -13 | -13 | -13 | 1 MHz |
| $\pm 6-10$ | -25 | -13 | -13 | -13 | -13 | 1 MHz |
| $\pm 10-15$ | | -25 | -13 | -13 | -13 | 1 MHz |
| $\pm 15-20$ | | | -25 | -13 | -13 | 1 MHz |
| $\pm 20-25$ | | | | -25 | -13 | 1 MHz |
| $\pm 25-40$ | | | | | -13 | 1 MHz |
| $\pm 40-45$ | | | | | -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 signalling 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"

| Δf_{OOB} (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | | | Measurement bandwidth |
|----------------------------------|---|----|----|-----------------------|
| | 5 | 10 | 15 | |
| | | | | |

| | | | | |
|---------------|-----|-----|-----|---------|
| $\pm 0 - 0.1$ | -15 | -18 | -20 | 30 kHz |
| $\pm 0.1 - 1$ | -13 | -13 | -13 | 100 kHz |
| $\pm 1 - 6$ | -13 | -13 | -13 | 1 MHz |
| $\pm 6 - 10$ | -25 | | | |
| $\pm 10 - 15$ | -25 | | | |
| $\pm 15 - 20$ | | -25 | | |

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.

6.5.2.3.5 Void

6.5.2.3.6 Void

6.5.2.3.7 Void

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 (NR_{ACLR}) 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 -50 dBm then the NR_{ACLR} 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 (MHz) | 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 2 | Power class 3 |
|---------|---------------|---------------|
| NR ACLR | 31 dB | 30 dB |

6.5.2.4.2 UTRA ACLR

UTRA adjacent channel leakage power ratio ($UTRA_{ACLR}$) 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.

$UTRA_{ACLR}$ is specified for the first adjacent UTRA channel ($UTRA_{ACLR1}$) which center frequency is ± 2.5 MHz from NR channel edge and for the 2nd adjacent UTRA channel ($UTRA_{ACLR2}$) 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 $\alpha = 0.22$ and bandwidth of 3.84 MHz. The assigned NR channel power is measured with a rectangular filter with measurement bandwidth specified in Table 6.5.2.4.1-1.

If the measured adjacent channel power is greater than -50 dBm then the $UTRA_{ACLR1}$ and $UTRA_{ACLR2}$ 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 |
|----------------|---------------|
| $UTRA_{ACLR1}$ | 33 dB |
| $UTRA_{ACLR2}$ | 36 dB |

UTRA ACLR requirement is applicable when the network signalling value NS_03U, NS_05U, NS_43U or NS_100 is signalled by the network in the field *additionalSpectrumEmission*.

6.5.3 Spurious emissions

6.5.3.0 General

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 [9] 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 F_{OOB} (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 (N_{RB}) and channel bandwidths.

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

| Channel bandwidth | OOB boundary F_{OOB} (MHz) |
|-------------------|------------------------------|
| $BW_{Channel}$ | $BW_{Channel} + 5$ |

Table 6.5.3.1-2: Requirement for general spurious emissions limits

| Frequency Range | Maximum Level | Measurement bandwidth | NOTE |
|--|---------------|-----------------------|------|
| $9 \text{ kHz} \leq f < 150 \text{ kHz}$ | -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 | 4 |
| | -25 dBm | 1 MHz | 3 |
| 12.75 GHz ≤ f < 5 th 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 for which the upper frequency edge of the UL Band is greater than 2.55 GHz and less than or equal to 5.2 GHz | | | |
| NOTE 2: Applies for Band that the upper frequency edge of the UL Band more than 5.2 GHz | | | |
| NOTE 3: Applies for Band n41, CA configurations including Band n41, and EN-DC configurations that include n41 specified in clause 5.2B of TS 38.101-3 [3] when NS_04 is signalled. | | | |
| NOTE 4: Does not apply for Band n41, CA configurations including Band n41, and EN-DC configurations that include n41 specified in subclause 5.2B of TS 38.101-3 [3] 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, 52, 65, 67, 68, 69, 72, 73, 74, 75, 76, NR Band n78, n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | NR Band n77 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA Band 3, 34 | F _{DL_low} | - | F _{DL_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, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 42, 50, 51, 53, 66, 70, 71, 74, 85 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 2, 25 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| | E-UTRA Band 43, 48 | F _{DL_low} | - | F _{DL_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 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 3 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| | E-UTRA Band 11, 18, 19, 21 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 22, 42, 52, NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| n5 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 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 NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |

| NR Band | Spurious emission for UE co-existence | | | | | | |
|----------|--|-----------------------|---|----------------------|---------------------|-----------|------------|
| | Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| | E-UTRA Band 41, 52, 53 NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA Band 11, 21 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| | | | | | | | |
| n7 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 17, 20, 22, 26, 27, 28, 29, 30, 31, 32, 33, 34, 40, 42, 43, 50, 51, 52, 65, 66, 67, 68, 72, 74, 75, 76, 85, NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | 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 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA band 3, 7, 22, 41, 42, 43, 52, NR Band n77, n78, n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA 8 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| | E-UTRA Band 11, 21 | F _{DL_low} | - | F _{DL_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, 53, 70, 71, 74 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 4, 48, 50, 51, 66 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA Band 12, 85 | F _{DL_low} | - | F _{DL_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 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 20 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| | E-UTRA Band 38, 42, 52, 69, NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | Frequency range | 758 | - | 788 | -50 | 1 | |
| n25 | E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 42, 53, 66, 70, 71, 85 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 2 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| | E-UTRA Band 25 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| | E-UTRA Band 43, 48 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| n28, n83 | E-UTRA Band 1, 4, 22, 32, 42, 43, 50, 51, 65, 66, 74, 75, 76, NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA Band 1 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 19, 25 |
| | E-UTRA Band 2, 3, 5, 7, 8, 18, 19, 20, 25, 26, 27, 31, 34, 38, 40, 41, 52, 72, 73 NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 11, 21 | F _{DL_low} | - | F _{DL_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, | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 5 |

| NR Band | Spurious emission for UE co-existence | | | | | | |
|----------|---|-----------------------|---|----------------------|---------------------|-----------|------------|
| | Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| | 33, 38,39, 40, 41, 42, 43, 44, 45, 50, 51, 52, 65, 67, 69, 72, 74, 75, 76, NR Band n78, n79 | | | | | | |
| | NR Band n77 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| n38 | E-UTRA Band 1, 2, 3, 4, 5, 8, 12, 13, 14, 17, 20, 22, 27, 28, 29, 30, 31, 32, 33, 34, 40, 42, 43, 50, 51, 52, 65, 66, 67, 68, 72, 74, 75, 76, 85 | F _{DL_low} | - | F _{DL_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, 52, 74, NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | NR Band n77, n78 | F _{DL_low} | - | F _{DL_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, 11, 18, 19, 20, 21, 22, 26, 27, 28, 31, 32, 33, 34, 38, 39, 42, 43, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 74, 75, 76, NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | Frequency range | 1884.5 | | 1915.7 | -41 | 0.3 | 8 |
| n41 | E-UTRA Band 1, 2, 3, 4, 5, 8, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 34, 39, 42, 44, 45, 48, 50, 51, 52, 65, 66, 70, 71, 73, 74, 85, NR Band n77, n78 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA Band 11, 18, 19, 21 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | Frequency range | 1884.5 | | 1915.7 | -41 | 0.3 | 8 |
| 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, 52, 65, 66, 67, 68, 85 | F _{DL_low} | - | F _{DL_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 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| n66, n86 | E-UTRA Band 2, 4, 5, 7, 12, 13, 14, 17, 25, 26, 27, 28, 29, 30, 38, 41, 43, 50, 51, 53, 66, 70, 71, 74, 85 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 42, 48 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| n70 | E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 48, 66, 70, 71, 85 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| n71 | E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 30, 48, 53, 66, 85 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | E-UTRA Band 2, 25, 41, 70 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | E-UTRA Band 29 | F _{DL_low} | - | F _{DL_high} | -38 | 1 | 15 |
| | E-UTRA Band 71 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 15 |
| n74 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 26, 28, | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |

| NR Band | Spurious emission for UE co-existence | | | | | | |
|--|---|-----------------------|---|----------------------|---------------------|-----------|--------|
| | Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| | 29, 31, 34, 38, 39, 40, 41, 42, 43, 48, 52, 65, 66, 67, 68, 85 NR Band n77, n78 | | | | | | |
| | NR Band n79 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | 2 |
| | 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 | 1475 | - | 1488 | -28 | 1 | 15, 42 |
| | Frequency range | 1475 | - | 1488 | -50 | 1 | 15, 45 |
| n77 | E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 39, 40, 41, 65, 74 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| n78 | E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 32, 34, 39, 40, 41, 65, 74, 75, 76 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| n79 | E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 28, 34, 39, 40, 41, 42, 65, 74 | F _{DL_low} | - | F _{DL_high} | -50 | 1 | |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8 |
| <p>NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101</p> <p>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 (2 MHz + N x L_{CRB} x RB_{size} kHz), 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.</p> <p>NOTE 3: 15 kHz SCS is assumed when RB is mentioned in the note when channel bandwidth is less than or equal to 50MHz, lowest SCS is assumed when channel bandwidth is larger than 50 MHz. The transmission bandwidth in terms of RB position and range is not limited to 15 kHz SCS and shall scale with SCS accordingly.</p> <p>NOTE 4: Void</p> <p>NOTE 5: For non-synchronised TDD operation to meet these requirements some restriction will be needed for either the operating band or protected band</p> <p>NOTE 6: N/A</p> <p>NOTE 7: Void</p> <p>NOTE 8: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz.</p> <p>NOTE 9: Void</p> <p>NOTE 10: Void</p> <p>NOTE 11: Void</p> <p>NOTE 12: Void</p> <p>NOTE 13: Void</p> <p>NOTE 14: Void</p> <p>NOTE 15: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.</p> <p>NOTE 16: Void</p> <p>NOTE 17: Void</p> <p>NOTE 18: Void</p> <p>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.</p> <p>NOTE 20: Void</p> <p>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.</p> | | | | | | | |

| NR Band | Spurious emission for UE co-existence | | | | |
|---------|---|-----------------------|---------------------|-----------|------|
| | Protected band | Frequency range (MHz) | Maximum Level (dBm) | MBW (MHz) | NOTE |
| | 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 carriers 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 5.3.1-1) 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 5.3.1-1) 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: Void | | | | |
| | NOTE 29: Void | | | | |
| | NOTE 30: Void | | | | |
| | NOTE 31: Void | | | | |
| | NOTE 32: Void | | | | |
| | NOTE 33: This requirement is only applicable for carriers with bandwidth up to 20MHz and 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 718-728 MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with $RB_{start} > 1$ and $RB_{start} < 48$. | | | | |
| | 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: Void | | | | |
| | NOTE 37: Void | | | | |
| | NOTE 38: Void | | | | |
| | NOTE 39: Void | | | | |
| | NOTE 40: Void | | | | |
| | NOTE 41: Applicable for cases 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 5 and 10 MHz bandwidth, and when the lower edge of the assigned NR UL channel bandwidth frequency is greater than or equal to 1440 MHz for 15 and 20 MHz bandwidth. This requirement shall be verified with UE transmission power configured as high as possible but no higher than 15 dBm. | | | | |
| | NOTE 42: Applicable when upper edge of the assigned NR UL channel bandwidth frequency is more than 1460 MHz and less than or equal to 1470 MHz for 5 MHz bandwidth, and when the upper edge of the assigned NR UL channel bandwidth frequency is more than 1460 MHz and less than or equal to 1465 MHz for 10 MHz bandwidth. | | | | |
| | NOTE 43: Void | | | | |
| | NOTE 44: Void | | | | |
| | NOTE 45: Applicable when upper edge of the assigned NR UL channel bandwidth frequency is equal to or less than 1460 MHz. | | | | |
| | NOTE 46: Applicable for 5 MHz bandwidth and when the NR carrier is within 1447.9 – 1462.9 MHz. | | | | |

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.

6.5.3.3.1 Requirement for network signalling 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 6.5.3.3.1-1. This requirement also applies for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.1-1: Additional requirements for "NS_04"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|------------------------|---|-----------------------|
| | 10, 15, 20, 40, 50, 60, 80, 90, 100 | |
| $2495 \leq f < 2496$ | -13 | 1 % of Channel BW |
| $2490.5 \leq f < 2495$ | -13 | 1 MHz |
| $0.009 < f < 2490.5$ | -25 | 1 MHz |

6.5.3.3.2 Requirement for network signalling 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.2-1: Additional requirements for "NS_17"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth | NOTE |
|--|---|-----------------------|------|
| | 5, 10 | | |
| $470 \leq f \leq 710$ | -26.2 | 6 MHz | 1 |
| NOTE 1: 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. | | | |

6.5.3.3.3 Requirement for network signalling 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.3-1: Additional requirements for "NS_18"

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

6.5.3.3.4 Requirement for network signalling values "NS_05" and "NS_05U"

When "NS_05" or "NS_05U" 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.4-1: Additional requirements for "NS_05" and "NS_05U"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|-----------------------|---|-----------------------|
| | 5, 10, 15, 20 | |
| 1884.5 ≤ f ≤ 1915.7 | -41 | 300 kHz |

6.5.3.3.5 Requirement for network signalling values "NS_43" and "NS_43U"

When "NS_43" or "NS_43U" 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.5-1: Additional requirement for "NS_43" and "NS_43U"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|--|---|-----------------------|
| | 5, 10, 15 | |
| 860 ≤ f ≤ 890 | -40 | 1 MHz |
| NOTE 1: Applicable for 5 MHz and 15 MHz channel BW confined between 900 MHz and 915 MHz and for 10 MHz channel BW confined between 905 MHz and 915 MHz | | |

6.5.3.3.6 Requirement for network signalling 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.6-1: Additional requirement for "NS_37"

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

6.5.3.3.7 Requirement for network signalling 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.7-1: Additional requirements for NR channels assigned within 1430-1452MHz for "NS_38"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|---|---|-----------------------|
| | 5, 10, 15, 20 | |
| 1400 ≤ f ≤ 1427 | -32 | 27 MHz |
| NOTE 1: This requirement shall be verified with UE transmission power configured as high as possible but no higher than 15 dBm. | | |

6.5.3.3.8 Requirement for network signalling 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 F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.8-1: Additional requirements for "NS_39"

| Frequency range | Channel bandwidth (MHz) / |
|-----------------|---------------------------|
|-----------------|---------------------------|

| (MHz) | Spectrum emission limit (dBm) | Measurement bandwidth |
|-------------------------|-------------------------------|-----------------------|
| | 5, 10, 15, 20 | |
| $1475 \leq f \leq 1488$ | -28 | 1 MHz |

6.5.3.3.9 Requirement for network signalling value "NS_40"

When "NS_40" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.9-1. This requirement also applies for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.9-1: Additional requirements for NR channels assigned within 1427-1432MHz for "NS_40"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|---|---|-----------------------|
| | 5 | |
| $1400 \leq f \leq 1427$ | -32 | 27 MHz |
| NOTE 1: This requirement shall be verified with UE transmission power configured as high as possible but no higher than 15 dBm. | | |

6.5.3.3.10 Requirement for network signalling value "NS_41"

When "NS_41" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.10-1. This requirement also applies for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.10-1: Additional requirements for NR channels assigned within 1432-1517 MHz for "NS_41"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|---|---|-----------------------|
| | 5, 10, 15, 20, 40, 50, 60 | |
| $1400 \leq f \leq 1427$ | -32 | 27 MHz |
| NOTE 1: This requirement shall be verified with UE transmission power configured as high as possible but no higher than 15 dBm. | | |

6.5.3.3.11 Requirement for network signalling value "NS_42"

When "NS_42" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.11-1. This requirement also applies for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.11-1: Additional requirements for NR channels assigned within 1432-1517 MHz for "NS_42"

| Frequency range (MHz) | Channel bandwidth (MHz) / Spectrum emission limit (dBm) | Measurement bandwidth |
|-------------------------|---|-----------------------|
| | 5, 10, 15, 20, 40, 50, 60 | |
| $1518 \leq f \leq 1520$ | -0.8 | 1 MHz |
| $1520 < f \leq 1559$ | -30 | 1 MHz |

- 6.5.3.3.12 Void
- 6.5.3.3.13 Void
- 6.5.3.3.14 Void
- 6.5.3.3.15 Void
- 6.5.3.3.16 Requirement for network signalling value "NS_50"

When "NS_50" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5.3.3.16-1. This requirement also applies for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

Table 6.5.3.3.16-1: Additional requirements for "NS_50"

| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
|--|-----------------------|---|------|---------------------|-----------|---------|
| Frequency range | 1805 | - | 1855 | -40 | 1 | 1 |
| Frequency range | 1855 | - | 1880 | -15.5 | 5 | 1, 2, 3 |
| NOTE 1: This requirement is applicable for carriers with aggregated channel bandwidths confined in 1885-1920 MHz for 25MHz and 30MHz channel BWs and confined in 1880-1920 MHz for 40MHz channel BW. | | | | | | |
| NOTE 2: The requirement also applies for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.6.3.1-1 and Table 6.6.3.1A-1 from the edge of the channel bandwidth. | | | | | | |
| NOTE 3: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band. | | | | | | |

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 | $BW_{Channel}$ | |
| Interference signal frequency offset from channel center | $BW_{Channel}$ | $2 * BW_{Channel}$ |
| Interference CW signal level | -40 dBc | |
| Intermodulation product | < -29 dBc | < -35 dBc |
| Measurement bandwidth | The maximum transmission bandwidth configuration among the different SCS's for the channel BW as defined in Table 6.5.2.4.1-1 | |
| Measurement offset from channel center | $BW_{Channel}$ and $2 * BW_{Channel}$ | $2 * BW_{Channel}$ and $4 * BW_{Channel}$ |

6.5A Output RF spectrum emissions for CA

6.5A.0 General

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

6.5A.1 Occupied bandwidth for CA

6.5A.1.1 Void

6.5A.1.2 Void

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

This clause contains requirements for out of band emissions for UE configured of carrier aggregation.

6.5A.2.2 Spectrum emission mask

6.5A.2.2.1 Void

6.5A.2.2.2 Void

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 clauses 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 Void

6.5A.2.3.2 Void

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 Void

6.5A.2.4.1.2 Void

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 clause 6.5.2.4.1.

6.5A.2.4.2 UTRA ACLR

6.5A.2.4.2.1 Void

6.5A.2.4.2.2 Void

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 clause 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 F_{OOB} 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.

NOTE: For inter-band carrier aggregation with uplink assigned to two NR bands the requirements in Table 6.5.3.1-2 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 6.5.3.1-2 would be considered to be verified by the measurements verifying the one uplink inter-band CA spurious emission requirement.

6.5A.3.2 Spurious emissions for UE co-existence

6.5A.3.2.1 Void

6.5A.3.2.2 Void

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.3.2.3-1 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.3.2.3-1 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.3.2.3-1 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 combination | Spurious emission | | | | | | NOTE |
|-------------------|---|-----------------------|---|----------------|---------------------|-----------|------|
| | Protected Band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | |
| CA_n3-n78 | E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 39, 40, 41, 65, 74 | F_{DL_low} | - | F_{DL_high} | -50 | 1 | |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| CA_n8-n78 | E-UTRA Band 1, 8, 11, 20, 21, 28, 34, 39, 40, 65, 74 | F_{DL_low} | - | F_{DL_high} | -50 | 1 | |
| | E-UTRA Band 3, 7, 41 | F_{DL_low} | - | F_{DL_high} | -50 | 1 | 2 |
| | | | | | | | |
| | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |

NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 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 $(2 \text{ MHz} + N \times L_{\text{CRB}} \times 180\text{kHz})$, 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 -1915.7 MHz

NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OoB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

NOTE 5: Void

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.4.1 Void

6.5A.4.2 Void

6.5A.4.3 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 apply to the sum of the powers from both UE transmit antenna connectors. The occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel.

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 clause 6.2D.1.

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 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 is defined as the sum of the emissions from both UE transmit antenna connectors.

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

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 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 defined as the sum of the emissions from both UE transmit antenna connectors.

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

If UE is configured for transmission on single-antenna port, the requirements in clause 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 powers from both transmit antenna connector.

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

If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0_0 or by DCI format 0_1 for single antenna port codebook based transmission, the requirements in clause 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 clauses below.

With the exception of clause 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, 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 single carrier REFSSENS requirements in Clause 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.

For Rx requirements other than single carrier REFSSENS in Clause 7, the UE shall be verified with four Rx antenna ports and skip two Rx antenna ports requirements in operating bands where the UE is equipped with four Rx antenna ports, otherwise, the UE shall be verified with two Rx antenna ports.

The above rules apply for all clauses with the exception of clause 7.9.

7.3 Reference sensitivity

7.3.1 General

The reference sensitivity power level REFSSENS 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 clauses of Clause 7 where the value of REFSSENS is used as a reference to set the corresponding requirement:

- when the UE is verified with 2 Rx antenna ports, it shall be verified against those requirements by applying the REFSSENS value in Table 7.3.2-1 with 2 Rx antenna ports tested;
- when the UE is verified with 4 Rx antenna ports, it shall be verified against those requirements by applying the resulting REFSSENS 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.2.2.2, A.3.2 and A.3.3 (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 | -86.8 | | | | | | | | | FDD |
| | 30 | | -95.1 | -93.1 | -88.6 | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n7 ¹ | 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 | -91.4 | -85.8 | | | | | | | | | FDD |
| | 30 | | -94.1 | -91.7 | -87.2 | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n12 | 15 | -97.0 | -93.8 | -84.0 | | | | | | | | | | FDD |
| | 30 | | -94.1 | -84.1 | | | | | | | | | | |
| | 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 |

| 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 |
| | 30 | | -97.1 | -95.1 | | | | | | | | | | |
| | 60 | | -97.5 | -95.4 | | | | | | | | | | |
| n38 ¹ | 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 | | | |
| n41 ¹ | 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 | -99.5 ³ | -96.3 ³ | -94.5 ³ | -89.3 ³ | | | | | | | | | FDD |
| | 30 | | -96.6 ³ | -94.6 ³ | -89.5 ³ | | | | | | | | | |
| | 60 | | -97.0 ³ | -94.9 ³ | -89.6 ³ | | | | | | | | | |

| 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 |
| n75 ⁷ | 15 | -100 | -96.8 | -95.0 | -93.8 | | | | | | | | | SDL |
| | 30 | | -97.1 | -95.1 | -94.0 | | | | | | | | | |
| | 60 | | -97.5 | -95.4 | -94.2 | | | | | | | | | |
| n76 ⁷ | 15 | -100 | | | | | | | | | | | | SDL |
| | 30 | | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n77 ^{1,4} | 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 | |
| n78 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 | |
| n79 ¹ | 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 except for two Rx vehicular UE.

NOTE 2: The transmitter shall be set to P_{UMAX} as defined in clause 6.2.4

NOTE 3: The requirement is modified by -0.5 dB when the assigned NR channel bandwidth is confined within 1475.9 - 1510.9 MHz.

NOTE 4: The requirement is modified by -0.5 dB when the assigned UE channel bandwidth is confined within 3300 - 3800 MHz.

NOTE 6: Void.

NOTE 7: For SDL bands, the reference sensitivity requirements shall be verified by inter-band CA combinations with SDL band, which are supported by UE.

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 $\Delta R_{IB,4R}$ in Table 7.3.2-2 for the applicable operating bands.

Table 7.3.2-2: Four antenna port reference sensitivity allowance $\Delta R_{IB,4R}$

| Operating band | $\Delta R_{IB,4R}$ (dB) |
|---|-------------------------|
| n1, n2, n3, n40, n7, n34, n38, n39, n41, n66, n70 | -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 with 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 | 50 ¹ | 75 ¹ | 100 ¹ | | | | | | | | | FDD |
| | 30 | | 24 | 36 ¹ | 50 ¹ | | | | | | | | | |
| | 60 | | 10 ¹ | 18 | 24 | | | | | | | | | |
| n2 | 15 | 25 | 50 ¹ | 50 ¹ | 50 ¹ | | | | | | | | | FDD |
| | 30 | 10 ¹ | 24 | 24 ¹ | 24 ¹ | | | | | | | | | |
| | 60 | | 10 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| n3 | 15 | 25 | 50 ¹ | 50 ¹ | 50 ¹ | 50 ¹ | 50 ¹ | | | | | | | FDD |
| | 30 | | 24 | 24 ¹ | 24 ¹ | 24 ¹ | 24 ¹ | | | | | | | |
| | 60 | | 10 ¹ | 10 ¹ | 10 ¹ | 10 ¹ | 10 ¹ | | | | | | | |
| n5 | 15 | 25 | 25 ¹ | 20 ¹ | 20 ¹ | | | | | | | | | FDD |
| | 30 | | 12 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n7 | 15 | 25 | 50 ¹ | 75 ¹ | 75 ¹ | | | | | | | | | FDD |
| | 30 | | 24 | 36 ¹ | 36 ¹ | | | | | | | | | |
| | 60 | | 10 ¹ | 18 | 18 ¹ | | | | | | | | | |
| n8 | 15 | 25 | 25 ¹ | 20 ¹ | 20 ¹ | | | | | | | | | FDD |
| | 30 | | 12 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n12 | 15 | 20 ¹ | 20 ¹ | 20 ¹ | | | | | | | | | | FDD |
| | 30 | | 10 ¹ | 10 ¹ | | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n20 | 15 | 25 | 20 ¹ | 20 ² | 20 ² | | | | | | | | | FDD |
| | 30 | | 10 ¹ | 10 ² | 10 ² | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n25 | 15 | 25 | 50 ¹ | 50 ¹ | 50 ¹ | | | | | | | | | FDD |
| | 30 | | 24 | 24 ¹ | 24 ¹ | | | | | | | | | |
| | 60 | | 10 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| n28 | 15 | 25 | 25 ¹ | 25 ¹ | 25 ¹ | | | | | | | | | FDD |
| | 30 | | 10 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n34 | 15 | 25 | 50 | 75 | | | | | | | | | | TDD |
| | 30 | | 24 | 36 | | | | | | | | | | |
| | 60 | | 10 | 18 | | | | | | | | | | |
| n38 | 15 | 25 | 50 | 75 | 100 | | | | | | | | | TDD |
| | 30 | | 24 | 36 | 50 | | | | | | | | | |
| | 60 | | 10 | 18 | 24 | | | | | | | | | |
| n39 | 15 | 25 | 50 | 75 | 100 | 128 | 160 | 216 | | | | | | TDD |
| | 30 | | 24 | 36 | 50 | 64 | 75 | 100 | | | | | | |

| 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 |
| | 60 | | 10 | 18 | 24 | 30 | 36 | 50 | | | | | | |
| n40 | 15 | 25 | 50 | 75 | 100 | 128 | 160 | 216 | 270 | | | | | TDD |
| | 30 | | 24 | 36 | 50 | 64 | 75 | 100 | 128 | 162 | 216 | | | |
| | 60 | | 10 | 18 | 24 | 30 | 36 | 50 | 64 | 75 | 100 | | | |
| n41 | 15 | | 50 | 75 | 100 | | | 216 | 270 | | | | | TDD |
| | 30 | | 24 | 36 | 50 | | | 100 | 128 | 162 | 216 | 243 | 270 | |
| | 60 | | 10 | 18 | 24 | | | 50 | 64 | 75 | 100 | 120 | 135 | |
| n50 | 15 | 25 | 50 | 75 | 100 | | | 216 | 270 | | | | | TDD |
| | 30 | | 24 | 36 | 50 | | | 100 | 128 | 162 | NOTE 3 | | | |
| | 60 | | 10 | 18 | 24 | | | 50 | 64 | 75 | NOTE 3 | | | |
| n51 | 15 | 25 | | | | | | | | | | | | TDD |
| | 30 | | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n66 | 15 | 25 | 50 ¹ | 75 ¹ | 100 ¹ | | | 216 | | | | | | FDD |
| | 30 | | 24 | 36 ¹ | 50 ¹ | | | 100 ¹ | | | | | | |
| | 60 | | 10 ¹ | 18 | 24 | | | 50 ¹ | | | | | | |
| n70 | 15 | 25 | 50 ¹ | 75 ¹ | NOTE 3 | NOTE 3 | | | | | | | | FDD |
| | 30 | | 24 | 36 ¹ | NOTE 3 | NOTE 3 | | | | | | | | |
| | 60 | | 10 ¹ | 18 | NOTE 3 | NOTE 3 | | | | | | | | |
| n71 | 15 | 25 | 25 ¹ | 20 ¹ | 20 ¹ | | | | | | | | | FDD |
| | 30 | | 12 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| n74 | 15 | 25 | 25 ¹ | 25 ¹ | 25 ¹ | | | | | | | | | FDD |
| | 30 | | 10 ¹ | 10 ¹ | 10 ¹ | | | | | | | | | |
| | 60 | | 5 ¹ | 5 ¹ | 5 ¹ | | | | | | | | | |
| n77 | 15 | | 50 | 75 | 100 | | | 216 | 270 | | | | | TDD |
| | 30 | | 24 | 36 | 50 | | | 100 | 128 | 162 | 216 | 243 | 270 | |
| | 60 | | 10 | 18 | 24 | | | 50 | 64 | 75 | 100 | 120 | 135 | |
| n78 | 15 | | 50 | 75 | 100 | | | 216 | 270 | | | | | TDD |
| | 30 | | 24 | 36 | 50 | | | 100 | 128 | 162 | 216 | 243 | 270 | |
| | 60 | | 10 | 18 | 24 | | | 50 | 64 | 75 | 100 | 120 | 135 | |
| n79 | 15 | | | | | | | 216 | 270 | | | | | TDD |
| | 30 | | | | | | | 100 | 128 | 162 | 216 | | 270 | |
| | 60 | | | | | | | 50 | 64 | 75 | 100 | | 135 | |

NOTE 1: 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: For band n20; for 15 kHz SCS, in the case of 15 MHz channel bandwidth, the UL resource blocks shall be located at RB_{start} 11 and in the case of 20 MHz channel bandwidth, the UL resource blocks shall be located at RB_{start} 16; for 30 kHz SCS, in the case of 15 MHz channel bandwidth, the UL resource blocks shall be located at RB_{start} 6 and in the case of 20 MHz channel bandwidth, the UL resource blocks shall be located at RB_{start} 8; for 60 kHz SCS, in the case of 15 MHz channel bandwidth, the UL resource blocks shall be located at RB_{start} 3 and in the case of 20 MHz channel bandwidth, the UL resource blocks shall be located at RB_{start} 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 $\Delta R_{IB,c}$

For a UE supporting CA, SUL or DC band combination, the minimum requirement for reference sensitivity in Table 7.3.2-1 shall be increased by the amount given by $\Delta R_{IB,c}$ defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3] for the applicable operating bands.

In case the UE supports more than one of band combinations for CA, SUL or DC, and an operating band belongs to more than one band combinations then

- When the operating band frequency range is ≤ 1 GHz, the applicable additional $\Delta R_{IB,c}$ shall be the average value for all band combinations defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3], truncated to one decimal place that apply for that operating band among the supported band combinations. In case there is a harmonic relation between low band UL and high band DL, then the maximum $\Delta R_{IB,c}$ among the different supported band combinations involving such band shall be applied
- When the operating band frequency range is > 1 GHz, the applicable additional $\Delta R_{IB,c}$ shall be the maximum value for all band combinations defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3] for the applicable operating bands.

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. For operations with 4 Rx antenna ports, the MSD in the applicable bands shall be increased by the absolute value of $\Delta R_{IB,4R}$ in Table 7.3.2-2 when $MSD > 0$.

For reference sensitivity exception test points where the specified carrier frequency does not correspond to a valid NR-ARFCN, the closest NR-ARFCN as specified in clause 5.4.2 applies.

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 Annexes A.2.2.2, A.2.3.2, A.3.2, and A.3.3 (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, Table 7.3.2-2, and Table 7.3.2-3.

7.3A.2.2 Void

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 Annexes A.2.2.2, A.3.2, and A.3.3 (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, Table 7.3.2-2 and Table 7.3.2-3 modified in accordance with 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 clause 7.3A.4.

7.3A.2.4 Void

7.3A.3 $\Delta R_{IB,c}$ for CA

7.3A.3.1 General

For a UE supporting a CA configuration, the $\Delta R_{IB,c}$ applies for both SC and CA operation.

7.3A.3.2 $\Delta R_{IB,c}$ for Inter-band CA

For the UE which supports inter-band carrier aggregation, the minimum requirement for reference sensitivity in clause 7.3A.2 shall be increased by the amount given by $\Delta R_{IB,c}$ defined in clause 7.3A.3.2 for the applicable operating bands. Unless otherwise stated, $\Delta R_{IB,c}$ is set to zero.

In case the UE supports more than one of band combinations for CA, SUL or DC, and an operating band belongs to more than one band combinations then

- When the operating band frequency range is ≤ 1 GHz, the applicable additional $\Delta R_{IB,c}$ shall be the average value for all band combinations defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3], truncated to one decimal place that apply for that operating band among the supported band combinations. In case there is a harmonic relation between low band UL and high band DL, then the maximum $\Delta R_{IB,c}$ among the different supported band combinations involving such band shall be applied
- When the operating band frequency range is > 1 GHz, the applicable additional $\Delta R_{IB,c}$ shall be the maximum value for all band combinations defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3] for the applicable operating bands.

7.3A.3.2.1 $\Delta R_{IB,c}$ for two bands

Table 7.3A.3.2.1-1: $\Delta R_{IB,c}$ due to CA (two bands)

| Inter-band CA combination | NR Band | $\Delta R_{IB,c}$ (dB) |
|---------------------------|---------|------------------------|
| CA_n3-n77 | n3 | 0.2 |
| | n77 | 0.5 |
| CA_n3-n78 | n3 | 0.2 |
| | n78 | 0.5 |
| CA_n3-n79 | n79 | 0.5 |
| CA_n8-n78 | n8 | 0.2 |
| | n78 | 0.5 |
| CA_n8-n79 | n79 | 0.5 |
| CA_n28-n75 | n28 | 0.2 |
| CA_n28-n78 | n28 | 0.2 |
| | n78 | 0.5 |
| CA_n41-n78 ¹ | n78 | 0.5 |
| CA_n75-n78 | n78 | 0.5 |
| CA_n76-n78 | 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 Void

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 | n77 ^{1,2} | | 23.9 | 22.1 | 20.9 | | | 17.9 | 16.9 | 16.1 | 14.8 | 14.3 | 13.8 |
| | n77 ³ | | 1.1 | 0.8 | 0.3 | | | | | | | | |
| n3 | n78 ^{1,2} | | 23.9 | 22.1 | 20.9 | | | 17.9 | 16.9 | 16.1 | 14.8 | 14.3 | 13.8 |
| | n78 ³ | | 1.1 | 0.8 | 0.3 | | | | | | | | |
| n8 | n78 ^{4,5} | | 10.8 | 9.1 | 8.0 | | | 5.1 | 4.2 | 3.5 | 2.3 | 2.1 | 1.4 |
| n8 | n79 ^{6,7} | | | | | | | [6.8] | 6.2 | [5.6] | 4.9 | | 4.4 |
| n28 | n75 ^{1,2} | 28.1 | 25.3 | 24.0 | 22.8 | | | | | | | | |
| | n78 ^{6,7} | | [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 and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: ΔF_{HD} = 10 MHz for CA_n3-n77, CA_n3-n78.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor \cdot 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm (20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor \cdot 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} the carrier frequency of a high band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the low band.

NOTE 6: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 5th transmitter harmonic is within the downlink transmission bandwidth of a high band.

NOTE 7: The requirements should be verified for UL NR-ARFCN of a low band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.5 \rfloor \cdot 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} the carrier frequency of a high band in MHz and $BW_{Channel}^{LB}$ 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 | | 25 | 36 | 50 | | | 50 | 50 | 50 | 50 | 50 | 50 |
| n3 | n78 | | 25 | 36 | 50 | | | 50 | 50 | 50 | 50 | 50 | 50 |
| 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 | | 10 | 15 | 20 | | | 25 | 25 | 25 | 25 | 25 | 25 |

NOTE 1: 15 kHz SCS is assumed for UL band.

NOTE 2: The UL configuration applies regardless of the channel bandwidth of the low band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.

NOTE 3: Unless stated otherwise, UL resource blocks shall be centred within the transmission bandwidth configuration for the channel bandwidth.

Table 7.3A.4-3: Void

Table 7.3A.4-3a: Void

Sensitivity degradation is allowed for a band if it is impacted by receiver harmonic mixing due to another band part of the same CA configuration. Reference sensitivity exceptions are specified in Table 7.3A.4-4 with uplink configuration specified in Table 7.3A.4-4a. Sensitivity degradation is not required for receiver even order harmonic mixing with aggressor 3rd order and above harmonic interference.

Table 7.3A.4-4: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

| NR Band / Channel bandwidth of the affected DL band | | | | | | | | | | | | |
|---|------------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| 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) |
| n78 | n28 ³ | 31 | 28 | 26.2 | 25 | | | | | | | |
| n78 | n41 ² | | 10.4 | 10.4 | 10.4 | | 7.2 | 6.2 | 5.5 | 4.5 | | 4.5 |
| n79 | n8 ³ | 25 | 21.8 | 19.4 | 13.8 | | | | | | | |

NOTE 1: Void
 NOTE 2: The requirements should be verified for DL NR-ARFCN of the Victim (lower) band (superscript LB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.15 \rfloor 0.1$ and $F_{UL,low}^{HB} + BW_{Channel}^{HB} / 2 \leq f_{UL}^{HB} \leq F_{UL,high}^{HB} - BW_{Channel}^{HB} / 2$ with f_{UL}^{HB} the UL carrier frequency and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band, both in MHz.
 NOTE 3: The requirements should be verified for DL EARFCN of the victim (lower) band (superscript LB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.5 \rfloor 0.1$ and $F_{UL,low}^{HB} + BW_{Channel}^{HB} / 2 \leq f_{UL}^{HB} \leq F_{UL,high}^{HB} - BW_{Channel}^{HB} / 2$ with f_{UL}^{HB} the UL carrier frequency and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band, both in MHz.

Table 7.3A.4-4a: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

| NR Band / SCS / Channel bandwidth of the affected DL band | | | | | | | | | | | | | |
|---|---------|-----------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| 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 |
| n78 | n28 | 15 | 25 | 25 | 25 | 25 | | | | | | | |
| n78 | n41 | 30 | | 50 | 50 | 50 | | 50 | 50 | 50 | 50 | | 50 |
| n79 | n8 | 15 | 25 | 50 | 75 | 100 | | | | | | | |

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.

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 inter-band Reference sensitivity QPSK P_{REFSENS} and uplink/downlink configurations

| Band / Channel bandwidth / N _{RB} / Duplex mode | | | | | | | | Source of IMD |
|--|---------|-------------------------|----------------|---------------------|-------------------------|----------|-------------|-------------------|
| NR CA band combination | NR band | UL F _c (MHz) | UL/DL BW (MHz) | UL L _{CRB} | DL F _c (MHz) | MSD (dB) | Duplex mode | |
| CA_n3-n78 | n3 | 1740 | 5 | 25 | 1835 | [26] | FDD | IMD2 ⁴ |
| | n78 | 3575 | 10 | 25 | 3575 | N/A | TDD | N/A |

| | | | | | | | | |
|-----------|-----|-------|----|----|-------|-------|-----|-------------------|
| CA_n3-n78 | n3 | 1765 | 5 | 25 | 1860 | [8.0] | FDD | IMD4 ⁴ |
| | n78 | 3435 | 10 | 25 | 3435 | N/A | TDD | N/A |
| CA_n8-n78 | n8 | 897.5 | 5 | 25 | 942.5 | 8.3 | FDD | IMD4 |
| | n78 | 3635 | 10 | 50 | 3635 | N/A | TDD | N/A |

NOTE 1: Both of the transmitters shall be set min(+20 dBm, P_{CMAX_L,f,c}) as defined in clause 6.2A.4
 NOTE 2: RB_{START} = 0, 15 kHz 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).
 NOTE 4: This band is subject to IMD5 also which MSD is not specified.
 NOTE 5: Void.

7.3A.6 Reference sensitivity exceptions due to cross band isolation for CA

Sensitivity degradation is allowed for a band if it is impacted by UL of another band part of the same NR CA configuration due to cross band isolation issues. Reference sensitivity exceptions for the victim band are specified in Table 7.3A.6-1 with uplink configuration of the aggressor band specified in Table 7.3A.6-2.

Table 7.3A.6-1: Reference sensitivity exceptions (MSD) due to cross band isolation for NR CA FR1

| NR Band / Channel bandwidth of the affected DL band | | | | | | | | | | | | | |
|---|------------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| UL band | DL band | 5 MHz (dB) | 10 MHz (dB) | 15 MHz (dB) | 20 MHz (dB) | 25 MHz (dB) | 30 MHz (dB) | 40 MHz (dB) | 50 MHz (dB) | 60 MHz (dB) | 80 MHz (dB) | 90 MHz (dB) | 100 MHz (dB) |
| n41 | n78 | | 8.3 | 8.3 | 8.3 | | | 6.3 | 5.3 | 4.5 | 4.0 | 3.9 | 3.8 |
| n78 | n41 ¹ | | 4.5 | 4.5 | 4.5 | | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| n78 | n79 | | | | | | | 2 | 2 | 2 | 2 | | 2 |
| n79 | n78 | | 2.6 | 2.6 | 2.6 | | | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 |

NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.
 NOTE 2: The requirements only apply for UEs supporting inter-band carrier aggregation with simultaneous Rx/Tx capability. Simultaneous Rx/Tx capability does not apply for UEs supporting band n78 with a n77 implementation.

Table 7.3A.6.2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for NR CA FR1

| NR Band / SCS / Channel bandwidth of the affected DL band | | | | | | | | | | | | | | |
|---|---------|----------------------|-------|------------------|------------------|------------------|--------|--------|------------------|------------------|------------------|------------------|------------------|------------------|
| UL band | DL band | SCS of UL band (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 |
| n41 | n78 | 15 | | 100 | 100 | 100 | | | 100 | 100 | 100 | 100 | 100 | 100 |
| n78 | n41 | 30 | | 270 | 270 | 270 | | | 270 | 270 | 270 | 270 | 270 | 270 |
| n78 | n79 | 30 | | | | | | | 270 ² | 270 ² | 270 ² | 270 ² | | 270 ² |
| n79 | n78 | 30 | | 270 ² | 270 ² | 270 ² | | | 270 ² | 270 ² | 270 ² | 270 ² | 270 ² | 270 ² |

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.
 NOTE 2: The requirements only apply for UEs supporting inter-band carrier aggregation with simultaneous Rx/Tx capability. Simultaneous Rx/Tx capability does not apply for UEs supporting band n78 with a n77 implementation.

7.3B Void

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 and Table 7.3.2-2 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 with reference measurement channels as specified in Annexes A.2.2.2, A.3.2, and A.3.3 (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), unless sensitivity degradation is allowed in this clause of this specification. These exceptions also apply to any higher order CA or DC combination containing one of the exception combinations in this clause as subset.

Table 7.3C.2-1: Supplementary uplink configuration for reference sensitivity

| Downlink band/ Uplink band / Channel bandwidth / N _{RB} | | | | | | | | |
|--|-------------|---------|-------|--------|--------|--------|--------|--------|
| Downlink band | Uplink band | SCS kHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| n78 | n80 | 15 | 25 | 50 | 75 | 100 | 128 | 160 |
| n78 | n81 | 15 | 25 | 50 | 75 | 100 | | |
| n78 | n82 | 15 | 25 | 50 | 75 | 100 | | |
| n78 | n83 | 15 | 25 | 50 | 75 | 100 | | |
| n78 | n84 | 15 | 25 | 50 | 75 | 100 | | |
| n78 | n86 | 15 | 25 | 50 | 75 | 100 | | |
| n79 | n80 | 15 | 25 | 50 | 75 | 100 | | |
| n79 | n81 | 15 | 25 | 50 | 75 | 100 | | |

For the UE that supports any of the SUL operation given in Table 7.3C.2-2, exceptions to the requirements specified in Table 7.3.2-1 are 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)

| 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 |
| | | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB |
| n80 | n78 ^{1,2} | | 23.9 | 22.1 | 20.9 | | | 17.9 | 16.8 | 16.0 | 14.8 | 14.3 | 13.8 |
| | n78 ³ | | 1.1 | 0.8 | 0.3 | | | | | | | | |
| n82 | n78 ^{4,5} | | 10.8 | 9.1 | 8 | | | 6 | 4.0 | 3.2 | 2.0 | 1.5 | 1.0 |
| n81 | n78 ^{4,5} | | 10.8 | 9.1 | 8 | | | 5.1 | 4.2 | 3.5 | 2.3 | 1.5 | 1.4 |
| n83 | n78 ^{6,7} | | 10.4 | 8.9 | 7.8 | | | 4.7 | 3.7 | 3 | 1.7 | 1.2 | 0.7 |
| n86 | n78 ^{1,2} | | 23.9 | 22.1 | 20.9 | | | 17.9 | 16.8 | 16.0 | 14.8 | 14.3 | 13.8 |
| | n78 ³ | | 1.1 | 0.8 | 0.3 | | | | | | | | |
| n81 | n79 ^{6,7} | | | | | | | [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 and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: ΔF_{HD} = 10 MHz for SUL_n78-n80, SUL_n78-n86.

NOTE 2: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor \cdot 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm (20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor \cdot 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 6: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 5th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.

NOTE 7: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.5 \rfloor \cdot 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower 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 | | | 50 | 50 | 50 | 50 | 50 | 50 |
| n81 | n78 | | 16 | 25 | 25 | | | 25 | 25 | 25 | 25 | 25 | 25 |
| n81 | n79 | | | | | | | 25 | 25 | 25 | 25 | | 25 |
| n82 | n78 | | 16 | 20 | 20 | | | 20 | 20 | 20 | 20 | 20 | 20 |
| n83 | n78 | | 10 | 15 | 20 | | | 25 | 25 | 25 | 25 | 25 | 25 |
| n86 | n78 | | 25 | 36 | 50 | | | 100 | 100 | 100 | 100 | 100 | 100 |

NOTE 1: 15 kHz SCS is assumed for UL band.
 NOTE 2: The UL configuration applies regardless of the channel bandwidth of the low band.
 NOTE 3: Unless stated otherwise, UL resource blocks shall be centered within the transmission bandwidth configuration for the channel bandwidth.

7.3C.3 ΔR_{IB,c} for SUL

7.3C.3.1 General

For a UE supporting a SUL configuration, the ΔR_{IB,c} applies for both SC and SUL operation.

7.3C.3.2 SUL band combination

For the UE which supports SUL band combination, the minimum requirement for reference sensitivity in clause 7.3C.2 shall be increased by the amount given in ΔR_{IB,c} defined in clause 7.3C.3.2 for the applicable operating bands. Unless otherwise stated, ΔR_{IB,c} is set to zero.

In case the UE supports more than one of band combinations for CA, SUL or DC, and an operating band belongs to more than one band combinations then

- When the operating band frequency range is ≤ 1 GHz, the applicable additional ΔR_{IB,c} shall be the average value for all band combinations defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3], truncated to one decimal place that apply for that operating band among the supported band combinations. In

case there is a harmonic relation between low band UL and high band DL, then the maximum $\Delta R_{IB,c}$ among the different supported band combinations involving such band shall be applied

- When the operating band frequency range is > 1 GHz, the applicable additional $\Delta R_{IB,c}$ shall be the maximum value for all band combinations defined in clause 7.3A, 7.3B, 7.3C in this specification and 7.3A, 7.3B in TS 38.101-3 [3] for the applicable operating bands.

7.3C.3.2.1 $\Delta R_{IB,c}$ for two bands

Table 7.3C.3.2.1-1: $\Delta R_{IB,c}$ due to SUL (two bands)

| Band combination for SUL | NR Band | $\Delta R_{IB,c}$ (dB) |
|--------------------------|---------|------------------------|
| SUL_n78-n80 | n78 | 0.5 |
| SUL_n78-n81 | n78 | 0.5 |
| SUL_n78-n82 | n78 | 0.5 |
| SUL_n78-n83 | n78 | 0.5 |
| SUL_n78-n84 | n78 | 0.5 |
| SUL_n78-n86 | n78 | 0.5 |

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 clause 7.3 shall be met with the UL MIMO configurations described in clause 6.2D.1 and the reference measurement channels as specified in Annexes A.2.2 for CP-OFDM waveforms shall apply. For UL MIMO, the parameter P_{UMAX} 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 $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2 and A.3.3 (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 | -25 ² | | | | -24 ² | -23 ² | -22 ² | -21 ² | -20 ² | | | | |
| | | -27 ³ | | | | -26 ³ | -25 ³ | -24 ³ | -23 ³ | -22 ³ | | | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{CMAX,L,f,c}$ at the minimum uplink configuration specified in Table 7.3.2-3 with $P_{CMAX,L,f,c}$ as defined in clause 6.2.4. | | | | | | | | | | | | | | |
| NOTE 2: Reference measurement channel is A.3.2.3 or A.3.3.3 for 64 QAM. | | | | | | | | | | | | | | |
| NOTE 3: Reference measurement channel is A.3.2.4 or A.3.3.4 for 256 QAM. | | | | | | | | | | | | | | |

7.4A Maximum input level for CA

7.4A.1 Maximum input level for Intra-band contiguous CA

For intra-band contiguous carrier aggregation maximum input level is defined as the maximum mean power received at the UE antenna port, over the Transmission bandwidth configuration of each CC.

The throughput shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2 and A.3.3 (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 7.4A.1-1 for each component carrier.

Table 7.4A.1-1: Maximum input level for Intra-band contiguous CA

| Rx Parameter | Units | NR CA Bandwidth Class | | |
|--|-------|--|--|--|
| | | C | | |
| Power in largest transmission bandwidth configuration CC, $P_{\text{largest BW}}$ | dBm | -23 ² | | |
| | | -25 ³ | | |
| Power in each other CC | dBm | $P_{\text{largest BW}} + 10 \cdot \log\{(N_{\text{RB},c} \cdot \text{SCS}_c) / (N_{\text{RB},\text{largest BW}} \cdot \text{SCS}_{\text{largest BW}})\}$ | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{\text{CMAX}_L,f,c}$ at the minimum uplink configuration specified in Table 7.3.2-3 with $P_{\text{CMAX}_L,f,c}$ as defined in clause 6.2.4. | | | | |
| NOTE 2: Reference measurement channel is A.3.2.3 or A.3.3.3 for 64 QAM. | | | | |
| NOTE 3: Reference measurement channel is A.3.2.4 or A.3.3.4 for 256 QAM. | | | | |

7.4A.2 Void

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 clause 7.4 for each component carrier while all downlink carriers are active.

The throughput shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2 and A.3.3 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1) for each component carrier.

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 clause 7.4 shall be met with the UL MIMO configurations described in clause 6.2D.1. For UL MIMO, the parameter P_{CMAX_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 $F_{\text{DL_high}} < 2700$ MHz and $F_{\text{UL_high}} < 2700$ MHz and the minimum requirements specified in Table 7.5-2 for NR bands with $F_{\text{DL_low}} \geq 3300$ MHz and $F_{\text{UL_low}} \geq 3300$ 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 $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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 5.2-1), the requirements only apply for carriers assigned in the paired part.

Table 7.5-1: ACS for NR bands with $F_{\text{DL_high}} < 2700$ MHz and $F_{\text{UL_high}} < 2700$ 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 $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ 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 $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ 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 | | | | |
| $P_{interferer}$ | dBm | REFSENS + 45.5 dB | REFSENS + 45.5 dB | REFSENS + 42.5 dB | REFSENS + 39.5 dB | REFSENS + 38.5 dB |
| $BW_{interferer}$ | MHz | 5 | 5 | 5 | 5 | 5 |
| $F_{interferer}$ (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 | | | | |
| $P_{interferer}$ | dBm | REFSENS + 38 dB | REFSENS + 36.5 dB | REFSENS + 35.5 dB | REFSENS + 35 dB | REFSENS + 33.5 dB |
| $BW_{interferer}$ | MHz | 5 | 5 | 5 | 5 | 5 |
| $F_{interferer}$ (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 | | | | |
| $P_{interferer}$ | dBm | REFSENS + 33 dB | REFSENS + 32.5 dB | | | |
| $BW_{interferer}$ | MHz | 5 | 5 | | | |
| $F_{interferer}$ (offset) | MHz | 47.5 / -47.5 | 52.5 / -52.5 | | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | | | | | | |
| NOTE 2: The absolute value of the interferer offset $F_{interferer}$ (offset) shall be further adjusted to $(\lceil F_{interferer} / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. | | | | | | |
| NOTE 3: The interferer consists of the NR interferer RMC specified in Annexes A.3.2.2 and A.3.3.2 with one sided dynamic OCNNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1. | | | | | | |

Table 7.5-4: Test parameters for NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ 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 |
| $P_{interferer}$ | dBm | -25 | | | | |
| $BW_{interferer}$ | MHz | 5 | 5 | 5 | 5 | 5 |
| $F_{interferer}$ (offset) | MHz | 5 | 7.5 | 10 | 12.5 | 15 |
| | | / | / | / | / | / |
| | | -5 | -7.5 | -10 | -12.5 | -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 |
| $P_{interferer}$ | dBm | -25 | | | | |
| $BW_{interferer}$ | MHz | 5 | 5 | 5 | 5 | 5 |
| $F_{interferer}$ (offset) | MHz | 17.5 | 22.5 | 27.5 | 32.5 | 42.5 |
| | | / | / | / | / | / |
| | | -17.5 | -22.5 | -27.5 | -32.5 | -42.5 |
| RX parameter | Units | Channel bandwidth | | | | |
| | | 90 MHz | 100 MHz | | | |
| Power in transmission bandwidth configuration | dBm | -44 | -43.5 | | | |
| $P_{interferer}$ | dBm | -25 | | | | |
| $BW_{interferer}$ | MHz | 5 | 5 | | | |
| $F_{interferer}$ (offset) | MHz | 47.5 | 52.5 | | | |
| | | / | / | | | |
| | | -47.5 | -52.5 | | | |
| NOTE 1: The transmitter shall be set to 24 dB below $P_{C_{MAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{C_{MAX_L,f,c}}$ defined in clause 6.2.4. | | | | | | |
| NOTE 2: The absolute value of the interferer offset $F_{interferer}$ (offset) shall be further adjusted to $(\lceil F_{interferer} / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. | | | | | | |
| NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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 | | | | | | |

Table 7.5-5: Test parameters for NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ 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 | | | | |
| $P_{interferer}$ | dBm | REFSENS + 45.5 dB | | | | |
| $BW_{interferer}$ | MHz | 10 | 15 | 20 | 40 | 50 |
| $F_{interferer}$ (offset) | MHz | 10 | 15 | 20 | 40 | 50 |
| | | / | / | / | / | / |
| | | -10 | -15 | -20 | -40 | -50 |
| RX parameter | Units | Channel bandwidth | | | | |
| | | 60 MHz | 80 MHz | 90 MHz | 100 MHz | |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB | | | | |
| $P_{interferer}$ | dBm | REFSENS + 45.5 dB | REFSENS + 45.5 dB | REFSENS + 45.5 dB | REFSENS + 45.5 dB | |
| $BW_{interferer}$ | MHz | 60 | 80 | 90 | 100 | |

| | | | | | | |
|---|-----|----------------|----------------|----------------|------------------|--|
| F _{interferer} (offset) | MHz | 60 / -60 | 80 / -80 | 90 / -90 | 100 / -100 | |
| NOTE 1: The transmitter shall be set to 4 dB below P _{CMAX_L,f,c} at the minimum UL configuration specified in Table 7.3.2-3 with P _{CMAX_L,f,c} defined in clause 6.2.4. | | | | | | |
| NOTE 2: The absolute value of the interferer offset F _{interferer} (offset) shall be further adjusted to $(\lceil F_{interferer} / SCS \rceil + 0.5) SCS$ 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 Annexes A.3.2.2 and A.3.3.2 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. | | | | | | |

Table 7.5-6: Test parameters for NR bands with F_{DL_low} ≥ 3300 MHz and F_{UL_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 | | | | |
| P _{interferer} | dBm | -25 | | | | |
| BW _{interferer} | MHz | 10 | 15 | 20 | 40 | 50 |
| F _{interferer} (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 | | | | |
| P _{interferer} | dBm | -25 | -25 | -25 | -25 | |
| BW _{interferer} | MHz | 60 | 80 | 90 | 100 | |
| F _{interferer} (offset) | MHz | 60 / -60 | 80 / -80 | 90 / -90 | 100 / -100 | |
| NOTE 1: The transmitter shall be set to 24 dB below P _{CMAX_L,f,c} at the minimum UL configuration specified in Table 7.3.2-3 with P _{CMAX_L,f,c} defined in clause 6.2.4. | | | | | | |
| NOTE 2: The absolute value of the interferer offset F _{interferer} (offset) shall be further adjusted to $(\lceil F_{interferer} / SCS \rceil + 0.5) SCS$ 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 Annexes A.3.2.2 and A.3.3.2 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. | | | | | | |

7.5A Adjacent channel selectivity for CA

7.5A.1 Adjacent channel selectivity for Intra-band contiguous CA

For intra-band contiguous carrier aggregation the downlink SCC(s) shall be configured at nominal channel spacing to the PCC. The UE shall fulfil the minimum requirement specified in Table 7.5A.1-1 and 7.5A.1-1a 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.2.2, A.3.2, and A.3.3 (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 Tables 7.5A.1-2, 7.5A.1-2a, 7.5A.1-3 and 7.5A.1-3a.

Table 7.5A.1-1: ACS for intra-band contiguous CA with F_{DL_low} ≥ 3300 MHz and F_{UL_low} ≥ 3300 MHz

| Rx Parameter | Units | NR CA bandwidth class | | |
|--------------|-------|-----------------------|--|--|
| | | C | | |
| ACS | dB | 33.0 | | |

Table 7.5A.1-1a: ACS for intra-band contiguous CA with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz

| | | NR CA bandwidth class |
|--------------|-------|-----------------------|
| Rx Parameter | Units | C |
| ACS | dB | 17.0 |

Table 7.5A.1-2: Test parameters for intra-band contiguous CA with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz, case 1

| Rx Parameter | Units | NR CA bandwidth class |
|--|-------|--|
| | | C |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + 14 dB |
| $P_{Interferer}$ | dBm | Aggregated power + 31.5 dB |
| $BW_{Interferer}$ | MHz | $BW_{channel\ CA}$ |
| $F_{Interferer}$ (offset) | MHz | $\frac{BW_{channel\ CA}/2 + F_{offset}}{-BW_{channel\ CA}/2 - F_{offset}}$ |
| <p>NOTE 1: The transmitter shall be set to 4 dB below $P_{C_{MAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{C_{MAX_L,f,c}}$ defined in clause 6.2.4 .</p> <p>NOTE 2: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to $(\lceil F_{interferer} / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with an SCS equal to that of the closest carrier.</p> <p>NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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.</p> | | |

Table 7.5A.1-2a: Test parameters for intra-band contiguous CA with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz, case 1

| Rx Parameter | Units | NR CA bandwidth class |
|--|-------|--|
| | | C |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + 14 dB |
| $P_{Interferer}$ | dBm | Aggregated power + 15.5 dB |
| $BW_{Interferer}$ | MHz | 5 |
| $F_{Interferer}$ (offset) | MHz | $\frac{2.5 + F_{offset}}{-2.5 - F_{offset}}$ |
| <p>NOTE 1: The transmitter shall be set to 4 dB below $P_{C_{MAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{C_{MAX_L,f,c}}$ defined in clause 6.2.4.</p> <p>NOTE 2: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to $(\lceil F_{interferer} / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with 15 kHz SCS.</p> <p>NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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.</p> | | |

Table 7.5A.1-3: Test parameters for intra-band contiguous CA with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz, case 2

| Rx Parameter | Units | NR CA bandwidth class | |
|--|-------|-----------------------|--|
| | | C | |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | -56.5 | |
| $P_{Interferer}$ | dBm | -25 | |

| | | | |
|----------------------------------|-----|--|--|
| $BW_{\text{Interferer}}$ | MHz | $BW_{\text{channel CA}}$ | |
| $F_{\text{Interferer (offset)}}$ | MHz | $BW_{\text{channel CA}}/2 + F_{\text{offset}}$ / $-BW_{\text{channel CA}}/2 - F_{\text{offset}}$ | |

NOTE 1: The transmitter shall be set to 24 dB below $P_{\text{CMAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{\text{CMAX_L,f,c}}$ defined in clause 6.2.4.

NOTE 2: The absolute value of the interferer offset $F_{\text{Interferer (offset)}}$ shall be further adjusted to $(\lceil F_{\text{Interferer}} / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with an SCS equal to that of the closest carrier.

NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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.

Table 7.5A.1-3a: Test parameters for intra-band contiguous CA with $F_{\text{DL_high}} < 2700$ MHz and $F_{\text{UL_high}} < 2700$ MHz, case 2

| Rx Parameter | Units | NR CA Bandwidth Class |
|--|-------|--|
| | | C |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | $-40.5 + 10\log(N_{\text{RB,c}}/N_{\text{RB_agg}})$ |
| $P_{\text{Interferer}}$ | dBm | -25 |
| $BW_{\text{Interferer}}$ | MHz | 5 |
| $F_{\text{Interferer (offset)}}$ | MHz | $2.5 + F_{\text{offset}}$ / $-2.5 - F_{\text{offset}}$ |

NOTE 1: The transmitter shall be set to 24 dB below $P_{\text{CMAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{\text{CMAX_L,f,c}}$ defined in clause 6.2.4.

NOTE 2: The absolute value of the interferer offset $F_{\text{Interferer (offset)}}$ shall be further adjusted to $(\lceil F_{\text{Interferer}} / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with 15 kHz SCS.

NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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.

7.5A.2 Void

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 clause 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.2.2, A.3.2, and A.3.3 (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).

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 clause 7.5 shall be met with the UL MIMO configurations described in clause 6.2D.1. For UL MIMO, the parameter $P_{\text{CMAX_L}}$ 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 $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz 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.3.2 and A.3.3 (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 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 5.2-1), the requirements only apply for carriers assigned in the paired part.

Table 7.6.2-1: In-band blocking parameters for NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz

| RX parameter | Units | Channel bandwidth | | | | |
|--|-------|--|---------|--------|--------|--------|
| | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel bandwidth specific value below | | | | |
| | dB | 6 | 6 | 7 | 9 | 10 |
| $BW_{interferer}$ | MHz | 5 | | | | |
| $F_{offset, case 1}$ | MHz | 7.5 | | | | |
| $F_{offset, case 2}$ | 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 bandwidth specific value below | | | | |
| | dB | 11 | 12 | 13 | 14 | 15 |
| $BW_{interferer}$ | MHz | 5 | | | | |
| $F_{offset, case 1}$ | MHz | 7.5 | | | | |
| $F_{offset, case 2}$ | MHz | 12.5 | | | | |
| RX parameter | Units | Channel bandwidth | | | | |
| | | 90 MHz | 100 MHz | | | |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel bandwidth specific value below | | | | |
| | dB | 15.5 | 16 | | | |
| $BW_{interferer}$ | MHz | 5 | | | | |
| $F_{offset, case 1}$ | MHz | 7.5 | | | | |
| $F_{offset, case 2}$ | MHz | 12.5 | | | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | | | | | | |
| NOTE 2: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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 and 15 kHz SCS. | | | | | | |

Table 7.6.2-2: In-band blocking for NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz

| NR band | Parameter | Unit | Case 1 | Case 2 | Case 3 |
|--|---------------------------|------------------|--|--|--------|
| | | $P_{interferer}$ | dBm | -56 | -44 |
| n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n34, n38, n39, n40, n41, n50, n51, n66, n70, n74, n75, n76 | $F_{interferer}$ (offset) | MHz | $-BW_{Channel}/2 - F_{offset, case 1}$ and $BW_{Channel}/2 + F_{offset, case 1}$ | $\leq -BW_{Channel}/2 - F_{offset, case 2}$ and $\geq BW_{Channel}/2 + F_{offset, case 2}$ | |
| | $F_{interferer}$ | MHz | NOTE 2 | $F_{DL_low} - 15$ to $F_{DL_high} + 15$ | |

| | | | | | |
|---|-------------------------|-----|--------|---|---------------------------|
| n71 | $F_{\text{interferer}}$ | MHz | NOTE 2 | $F_{\text{DL_low}} - 12$ to $F_{\text{DL_high}} + 15$ | $F_{\text{DL_low}} - 12$ |
| NOTE 1: The absolute value of the interferer offset $F_{\text{interferer}}$ (offset) shall be further adjusted to $(\lceil F_{\text{interferer}} / \text{SCS} \rceil + 0.5) \text{SCS}$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. | | | | | |
| NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: $-BW_{\text{Channel}}/2 - F_{\text{offset, case 1}}$; b: $BW_{\text{Channel}}/2 + F_{\text{offset, case 1}}$ | | | | | |

For NR bands with $F_{\text{DL_low}} \geq 3300$ MHz and $F_{\text{UL_low}} \geq 3300$ 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 to $3 \cdot BW_{\text{Channel}}$ below or above the UE receive band where BW_{Channel} is the bandwidth of the wanted signal. The throughput of the wanted signal shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (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 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 $F_{\text{DL_low}} \geq 3300$ MHz and $F_{\text{UL_low}} \geq 3300$ MHz

| RX parameter | Units | Channel bandwidth | | | | |
|---|-------|--|--------|--------|---------|--------|
| | | 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel bandwidth specific value below | | | | |
| | dB | 6 | | | | |
| $BW_{\text{interferer}}$ | MHz | 10 | 15 | 20 | 40 | 50 |
| $F_{\text{offset, case 1}}$ | MHz | 15 | 22.5 | 30 | 60 | 75 |
| $F_{\text{offset, case 2}}$ | 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 bandwidth specific value below | | | | |
| | dB | 6 | | | | |
| $BW_{\text{interferer}}$ | MHz | 60 | 80 | 90 | 100 | |
| $F_{\text{offset, case 1}}$ | MHz | 90 | 120 | 135 | 150 | |
| $F_{\text{offset, case 2}}$ | MHz | 150 | 200 | 225 | 250 | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{\text{CMAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{\text{CMAX_L,f,c}}$ defined in clause 6.2.4. | | | | | | |
| NOTE 2: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 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 | | | | | | |

Table 7.6.2-4: In-band blocking for NR bands with $F_{\text{DL_low}} \geq 3300$ MHz and $F_{\text{UL_low}} \geq 3300$ MHz

| NR band | Parameter | Unit | Case 1 | Case 2 |
|--|----------------------------------|-------------------------|--|--|
| | | $P_{\text{interferer}}$ | dBm | -56 |
| n77, n78, n79 | $F_{\text{interferer}}$ (offset) | MHz | $-BW_{\text{Channel}}/2 - F_{\text{offset, case 1}}$ and $BW_{\text{Channel}}/2 + F_{\text{offset, case 1}}$ | $\leq -BW_{\text{Channel}}/2 - F_{\text{offset, case 2}}$ and $\geq BW_{\text{Channel}}/2 + F_{\text{offset, case 2}}$ |
| | $F_{\text{interferer}}$ | | NOTE 2 | $F_{\text{DL_low}} - 3 \cdot BW_{\text{Channel}}$ to $F_{\text{DL_high}} + 3 \cdot BW_{\text{Channel}}$ |
| NOTE 1: The absolute value of the interferer offset $F_{\text{interferer}}$ (offset) shall be further adjusted to $(\lceil F_{\text{interferer}} / \text{SCS} \rceil + 0.5) \text{SCS}$ 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: $-BW_{\text{Channel}}/2 - F_{\text{offset, case 1}}$; b: $BW_{\text{Channel}}/2 + F_{\text{offset, case 1}}$ | | | | |
| NOTE 3: BW_{Channel} denotes the channel bandwidth of the wanted signal. | | | | |

7.6.3 Out-of-band blocking

For NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ 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 $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (with one sided dynamic OCN 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 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 5.2-1), 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 $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz

| Channel bandwidth | Power in transmission bandwidth configuration [dBm] |
|---|---|
| 5 MHz | REFSENS + 6.0 dB |
| 10 MHz | REFSENS + 6.0 dB |
| 15 MHz | REFSENS + 7.0 dB |
| 20 MHz | REFSENS + 9.0 dB |
| 25 MHz | REFSENS + 10.0 dB |
| 30 MHz | REFSENS + 11.0 dB |
| 40 MHz | REFSENS + 12.0 dB |
| 50 MHz | REFSENS + 13.0 dB |
| 60 MHz | REFSENS + 14.0 dB |
| 80 MHz | REFSENS + 15.0 dB |
| 90 MHz | REFSENS + 15.5 dB |
| 100 MHz | REFSENS + 16.0 dB |
| NOTE: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | |

Table 7.6.3-2: Out of-band blocking for NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ 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 | $P_{interferer}$ | dBm | -44 | -30 | -15 |
| | $F_{interferer}$ (CW) | MHz | $-60 < f - F_{DL_low} < -15$ or $15 < f - F_{DL_high} < 60$ | $-85 < f - F_{DL_low} \leq -60$ or $60 \leq f - F_{DL_high} < 85$ | $1 \leq f \leq F_{DL_low} - 85$ or $F_{DL_high} + 85 \leq f \leq 12750$ |
| NOTE 1: The power level of the interferer ($P_{interferer}$) for Range 3 shall be modified to -20 dBm for $F_{interferer} > 6000$ MHz. | | | | | |
| NOTE 2: For band 51 the F_{DL_high} of band 50 is applied as F_{DL_high} for band 51. For band 50, the F_{DL_low} of band 51 is applied as F_{DL_low} for band 50. | | | | | |
| NOTE 3: For band 76 the F_{DL_high} of band 75 is applied as F_{DL_high} for band 76. For band 75, the F_{DL_low} of band 76 is applied as F_{DL_low} for band 75. | | | | | |
| NOTE 4: For UEs supporting both bands 38 and 41, the F_{DL_high} and F_{DL_low} of band 41 is applied as F_{DL_high} and F_{DL_low} for band 38. | | | | | |
| NOTE 5: Void. | | | | | |
| NOTE 6: Void. | | | | | |
| NOTE 7: For UE supporting both bands 25 and 70, the F_{DL_high} of band 70 is applied as F_{DL_high} for band 25, and the F_{DL_low} of band 25 is applied as F_{DL_low} for band 70. | | | | | |

For interferer frequencies across ranges 1, 2 and 3 in Table 7.6.3-2, a maximum of

$$\lfloor \max \{24, 6 \cdot \lceil n \cdot N_{RB} / 6 \rceil \} / \min \{ \lfloor n \cdot N_{RB} / 10 \rfloor, 5 \} \rfloor$$

exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of $\min(BW_{Channel}/2, 5)$ MHz with N_{RB} the number of resource blocks in the downlink transmission bandwidth configuration, $BW_{Channel}$ is 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 subclause 7.7 apply.

For NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range up to $3 \cdot BW_{Channel}$ below or from $3 \cdot BW_{Channel}$ above the UE receive band, where $BW_{Channel}$ is the channel bandwidth. The throughput of the wanted signal shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (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 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 $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| RX parameter | Units | Channel bandwidth | | | | |
|---|-------|--|--------|--------|---------|--------|
| | | 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel bandwidth 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 bandwidth specific value below | | | | |
| | dB | 9 | 9 | 9 | 9 | |
| NOTE: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | | | | | | |

Table 7.6.3-4: Out of-band blocking for NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| NR band | Parameter | Unit | Range1 | Range 2 | Range 3 |
|---|-----------------------|------|---|---|--|
| n77, n78 (NOTE 3) | $P_{interferer}$ | dBm | -44 | -30 | -15 |
| | $F_{interferer}$ (CW) | MHz | $-60 < f - F_{DL_low} \leq -3 \cdot BW_{Channel}$ or $3 \cdot BW_{Channel} \leq f - F_{DL_high} < 60$ | $-200 < f - F_{DL_low} \leq -$ $MAX(60, 3 \cdot BW_{Channel})$ or $MAX(60, 3 \cdot BW_{Channel}) \leq f - F_{DL_high} < 200$ | $1 \leq f \leq F_{DL_low} -$ $MAX(200, 3 \cdot BW_{Channel})$) or $F_{DL_high} +$ $MAX(200, 3 \cdot BW_{Channel})$) $\leq f \leq 12750$ |
| n79 (NOTE 4) | $F_{interferer}$ (CW) | MHz | N/A | $-150 < f - F_{DL_low} \leq -$ $MAX(60, 3 \cdot BW_{Channel})$ or $MAX(60, 3 \cdot BW_{Channel}) \leq f - F_{DL_high} < 150$ | $1 \leq f \leq F_{DL_low} -$ $MAX(150, 3 \cdot BW_{Channel})$) or $F_{DL_high} +$ $MAX(150, 3 \cdot BW_{Channel})$) $\leq f \leq 12750$ |
| NOTE 1: The power level of the interferer ($P_{interferer}$) for Range 3 shall be modified to -20 dBm for $F_{interferer} > 6000$ MHz. | | | | | |
| NOTE 2: $BW_{Channel}$ denotes the channel bandwidth of the wanted signal | | | | | |
| NOTE 3: The power level of the interferer ($P_{interferer}$) for Range 3 shall be modified to -20 dBm, for $F_{interferer} > 2700$ MHz and $F_{interferer} < 4800$ MHz. For $BW_{Channel} > 15$ MHz, the requirement for Range 1 is not applicable and Range 2 applies from the frequency offset of $3 \cdot BW_{Channel}$ from the band edge. For $BW_{Channel} > 60$ MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of $3 \cdot BW_{Channel}$ from the band edge. | | | | | |

NOTE 4: The power level of the interferer ($P_{\text{Interferer}}$) for Range 3 shall be modified to -20 dBm, for $F_{\text{Interferer}} > 3650$ MHz and $F_{\text{Interferer}} < 5750$ MHz. For $BW_{\text{Channel}} > 40$ MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of $3 \cdot BW_{\text{Channel}}$ from the band edge.

For interferer frequencies across ranges 1, 2 and 3 in Table 7.6.3-4, a maximum of

$$\lfloor \max \{24, 6 \cdot \lceil n \cdot N_{RB} / 6 \rceil \} / \min \{ \lfloor n \cdot N_{RB} / 10 \rfloor, 5 \} \rfloor$$

exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of $\min(BW_{\text{channel}}/2, 5)$ MHz with N_{RB} the number of resource blocks in the downlink transmission bandwidth configuration, BW_{Channel} 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 subclause 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 $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (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 7.6.4-1. For operating bands with an unpaired DL part (as noted in Table 5.2-1), 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 | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n34, n38, n39, n40, n41, n50, n51, n66, n70, n71, n74, n75, n76 | P_w | dBm | P _{REFSENS} + channel-bandwidth specific value below | | | | | | | | | | | |
| | | | 16 | 13 | 14 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| | P_{uw} (CW) | dBm | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 |
| | F_{uw} (offset SCS= 15 kHz) | MHz | 2.7075 | 5.2125 | 7.7025 | 10.2075 | 13.0275 | 15.6075 | 20.5575 | 25.7025 | NA | NA | NA | NA |
| | F_{uw} (offset SCS= 30 kHz) | MHz | NA | NA | NA | NA | NA | NA | NA | NA | 30.855 | 40.935 | 45.915 | 50.865 |

NOTE 1: The transmitter shall be set a 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4
 NOTE 2: Reference measurement channel is specified in Annexes A.3.2 and A.3.3 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 P_{REFSENS} power level is specified in Table 7.3.2-1 and Table 7.3.2-2 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 the downlink 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 and 7.6A.2.1-a 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 $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

Table 7.6A.2.1-1: In-band blocking parameters for intra-band contiguous CA with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| Rx Parameter | Unit | NR CA bandwidth class | | |
|--|------|---|--|--|
| | | C | | |
| Pw in Transmission Bandwidth Configuration, per CC | dB | REFSENS + CA bandwidth class specific value below | | |
| | | 6 | | |
| $BW_{interferer}$ | MHz | $BW_{channel\ CA}$ | | |
| $F_{offset, case\ 1}$ | MHz | $BW_{channel\ CA} + BW_{channel\ CA}/2$ | | |
| $F_{offset, case\ 2}$ | MHz | $BW_{interferer} + F_{offset, case\ 1}$ | | |
| NOTE 1: The transmitter shall be set to 4dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | | | | |
| NOTE 2: The interferer consists of the Reference measurement channel specified in Annexes A.3.2 and A.3.3 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1 | | | | |

Table 7.6A.2.1-1a: In-band blocking parameters for intra-band contiguous CA with $F_{DL_low} < 2700$ MHz and $F_{UL_low} < 2700$ MHz

| Rx Parameter | Units | NR CA bandwidth class | |
|--|-------|--|--|
| | | C | |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + NR CA bandwidth class specific value below | |
| | | 19.0 | |
| $BW_{interferer}$ | MHz | 5 | |
| $F_{offset, case\ 1}$ | MHz | 7.5 | |
| $F_{offset, case\ 2}$ | MHz | 12.5 | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | | | |
| NOTE 2: The interferer consists of the Reference measurement channel specified in Annexes A.3.2 and A.3.3 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1 | | | |

Table 7.6A.2.1-2: In-band blocking for intra-band contiguous CA with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| NR band | Parameter | Unit | Case 1 | Case 2 |
|---------------|---------------------------|------|--|--|
| | | | $P_{interferer}$ | dBm |
| n77, n78, n79 | $F_{interferer}$ (offset) | MHz | $-F_{offset} - F_{offset, case\ 1}$ and $F_{offset} + F_{offset, case\ 1}$ | $\leq -F_{offset} - F_{offset, case\ 2}$ and $\geq F_{offset} + F_{offset, case\ 2}$ |
| | $F_{interferer}$ | MHz | NOTE 2 | $F_{DL_low} - 3BW_{channel\ CA}$ to $F_{DL_high} + 3BW_{channel\ CA}$ |

NOTE 1: The absolute value of the interferer offset $F_{\text{interferer}}$ (offset) shall be further adjusted to $(\lceil |F_{\text{interferer}}| / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with an SCS equal to that of the closest carrier.

NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: $-F_{\text{offset}} - F_{\text{offset, case 1}}$; b: $F_{\text{offset}} + F_{\text{offset, case 1}}$

NOTE 3: $BW_{\text{channel CA}}$ denotes the aggregated channel bandwidth of the wanted signal

Table 7.6A.2.1-2a: In-band blocking for intra-band contiguous CA with $F_{\text{DL_low}} < 2700$ MHz and $F_{\text{UL_low}} < 2700$ MHz

| NR band | Parameter | Unit | Case 1 | Case 2 |
|---------|----------------------------------|------|--|--|
| | | | $P_{\text{interferer}}$ | |
| n41 | $F_{\text{interferer}}$ (offset) | MHz | $-F_{\text{offset}} - F_{\text{offset, case 1}}$ and $F_{\text{offset}} + F_{\text{offset, case 1}}$ | $\leq -F_{\text{offset}} - F_{\text{offset, case 2}}$ and $\geq F_{\text{offset}} + F_{\text{offset, case 2}}$ |
| | $F_{\text{interferer}}$ | MHz | NOTE 2 | $F_{\text{DL_low}} - 15$ to $F_{\text{DL_high}} + 15$ |

NOTE 1: The absolute value of the interferer offset $F_{\text{interferer}}$ (offset) shall be further adjusted to $(\lceil |F_{\text{interferer}}| / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with 15 kHz SCS.

NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: $-F_{\text{offset}} - F_{\text{offset, case 1}}$; b: $F_{\text{offset}} + F_{\text{offset, case 1}}$

NOTE 3: $BW_{\text{channel CA}}$ denotes the aggregated channel bandwidth of the wanted signal

7.6A.2.2 Void

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 clause 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, $P_{\text{interferer}}$ power defined in Table 7.6.2-2 and 7.6.2-4 is increased by the amount given by $\Delta R_{\text{IB,c}}$ in Table 7.3A.3.2.

The throughput of each carrier shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

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 aggregation 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 UE shall fulfil the minimum requirement in presence of an interfering signal specified in Tables 7.6A.3-1 and Tables 7.6A.3-2 being on either side of the aggregated signal. The throughput of each carrier shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

Table 7.6A.3-1: Out-of-band blocking parameters for intra-band contiguous CA

| RX parameter | Units | CA bandwidth class | |
|---|-------|---|--|
| | | C | |
| Power in transmission bandwidth configuration | dBm | REFSENS + CA bandwidth class specific value below | |
| | dB | 9 | |

NOTE 1: The transmitter shall be set to 4 dB below $P_{\text{CMAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{\text{CMAX_L,f,c}}$ defined in clause 6.2.4.

Table 7.6A.3-2: Out of-band blocking for intra-band contiguous CA

| NR band | Parameter | Unit | Range1 | Range 2 | Range 3 |
|--|------------------------------|------|---|---|---|
| | $P_{\text{interferer}}$ | dBm | -45 | -30 | -15 |
| n41 | $F_{\text{interferer}}$ (CW) | MHz | $-60 < f - F_{\text{DL_low}} < -15$ or $15 < f - F_{\text{DL_high}} < 60$ | $-85 < f - F_{\text{DL_low}} \leq -60$ or $60 \leq f - F_{\text{DL_high}} < 85$ | $1 \leq f \leq F_{\text{DL_low}} - 85$ or $F_{\text{DL_high}} + 85 \leq f \leq 12750$ |
| n77, n78 (NOTE 3) | $F_{\text{interferer}}$ (CW) | MHz | N/A | N/A | $1 \leq f \leq F_{\text{DL_low}} - \text{MAX}(200, 3 \cdot \text{BW}_{\text{Channel_CA}})$ or $F_{\text{DL_high}} + \text{MAX}(200, 3 \cdot \text{BW}_{\text{Channel_CA}}) \leq f \leq 12750$ |
| n79 (NOTE 4) | $F_{\text{interferer}}$ (CW) | MHz | N/A | N/A | $1 \leq f \leq F_{\text{DL_low}} - \text{MAX}(150, 3 \cdot \text{BW}_{\text{Channel_CA}})$ or $F_{\text{DL_high}} + \text{MAX}(150, 3 \cdot \text{BW}_{\text{Channel_CA}}) \leq f \leq 12750$ |
| NOTE 1: The power level of the interferer ($P_{\text{interferer}}$) for Range 3 shall be modified to -20 dBm for $F_{\text{interferer}} > 6000$ MHz. | | | | | |
| NOTE 2: $\text{BW}_{\text{Channel_CA}}$ denotes the aggregated channel bandwidth of the wanted signal | | | | | |
| NOTE 3: The power level of the interferer ($P_{\text{interferer}}$) for Range 3 shall be modified to -20 dBm, for $F_{\text{interferer}} > 2700$ MHz and $F_{\text{interferer}} < 4800$ MHz. For $\text{BW}_{\text{Channel_CA}} > 15$ MHz, the requirement for Range 1 is not applicable and Range 2 applies from the frequency offset of $3 \cdot \text{BW}_{\text{Channel_CA}}$ from the band edge. For $\text{BW}_{\text{Channel_CA}} > 60$ MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of $3 \cdot \text{BW}_{\text{Channel_CA}}$ from the band edge. | | | | | |
| NOTE 4: The power level of the interferer ($P_{\text{interferer}}$) for Range 3 shall be modified to -20 dBm, for $F_{\text{interferer}} > 3650$ MHz and $F_{\text{interferer}} < 5750$ MHz. For $\text{BW}_{\text{Channel_CA}} > 40$ MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of $3 \cdot \text{BW}_{\text{Channel_CA}}$ from the band edge | | | | | |

For interferer frequencies across ranges 1, 2 and 3 in Table 7.6A.3-2, a maximum of

$$\lfloor \max \{24, 6 \cdot \lceil n \cdot N_{\text{RB}} / 6 \rceil \} / \min \{ \lfloor n \cdot N_{\text{RB}} / 10 \rfloor, 5 \} \rfloor$$

exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of $\min(\text{BW}_{\text{channel}}/2, 5)$ MHz with N_{RB} the number of resource blocks in the downlink transmission bandwidth configuration, $\text{BW}_{\text{channel}}$ is 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 subclause 7.7A.1 apply.

7.6A.3.2 Void

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 clause 7.6.3 for each component carrier while all downlink carriers are active.

For inter-band carrier aggregation with component carriers in operating bands < 2.7 GHz including n48, and for $F_{\text{DL_Low}(j)} - 15 \text{ MHz} \leq f \leq F_{\text{DL_High}(j)} + 15 \text{ MHz}$, the appropriate adjacent channel selectivity and in-band blocking requirements in the respective subclauses 7.5 and 7.6.2 shall be applied for carrier j . For inter-band carrier aggregation with component carriers in operating bands > 2.7 GHz excluding n48, and for $F_{\text{DL_Low}(j)} - 3 \cdot \text{BW}_{\text{channel}} \leq f \leq F_{\text{DL_High}(j)} + 3 \cdot \text{BW}_{\text{channel}}$, the appropriate adjacent channel selectivity and in-band blocking requirements in the respective subclauses 7.5 and 7.6.2 shall be applied for carrier j . $F_{\text{DL_Low}(j)}$ and $F_{\text{DL_High}(j)}$ denote the respective lower and upper frequency limits of the operating band containing carrier j , $j = 1, \dots, X$, with carriers numbered in increasing order of carrier frequency and X the number of component carriers in the band combination. $\text{BW}_{\text{channel}}$ denotes the channel bandwidth of the wanted signal component carrier j . If CW interferer falls in a gap between $F_{\text{DL_High}(j)}$ and $F_{\text{DL_Low}(j+1)}$ where the corresponding OOB ranges 1 and 2 overlap, then the lower level interferer limit of the overlapping OOB ranges applies.

For inter-band carrier aggregation with uplink assigned to two NR bands, the out-of-band blocking requirements specified in clause 7.6.3 shall be met with the transmitter power for the uplink set to 7 dB below $P_{\text{CMAX,L,f,c}}$ for each serving cell c.

For the UE which supports inter-band CA configuration in Table 7.3A.3.2.1-1, $P_{\text{interferer}}$ power defined in Table 7.6.3-2 and 7.6.3-4 is increased by the amount given by $\Delta R_{\text{IB,c}}$ in Table 7.3A.3.2.1-1.

For inter-band CA combination listed in Table 7.6A.3.3-1, exceptions to the requirement specified in Table 7.6A.3.3-2 are allowed when the second order intermodulation product of the lower frequency band UL carrier and the CW interfering signal fully or partially overlaps with the higher frequency band DL carrier.

Table 7.6A.3.3-1: CA band combination with exceptions allowed

| CA band combination |
|---------------------|
| CA_n8-n78 |
| CA_n8-n79 |
| CA_n28-n78 |

Table 7.6A.3.3-2: Requirement for out-of-band blocking exceptions

| Parameter | Unit | Level |
|--|------|------------------|
| $P_{\text{Interferer}}$ (CW) | dBm | -44 ¹ |
| NOTE 1: The requirement applies when $ f_{\text{interferer}} \pm f_{\text{UL}}^{\text{LB}} - f_{\text{DL}}^{\text{HB}} \leq (BW_{\text{UL}}^{\text{LB}} + BW_{\text{DL}}^{\text{HB}})/2$, where $f_{\text{UL}}^{\text{LB}}$ and $f_{\text{DL}}^{\text{HB}}$ are the carrier frequencies for lower frequency band UL and higher frequency band DL, respectively. $BW_{\text{UL}}^{\text{LB}}$ and $BW_{\text{DL}}^{\text{HB}}$ are the channel bandwidths configured for lower frequency band UL carrier and higher frequency band DL carrier in MHz, respectively. | | |

For all interferer frequency ranges specified in clause 7.6.3 a maximum of

$$\lfloor \max \{24, 6 \cdot \lceil n \cdot N_{\text{RB}} / 6 \rceil \} / \min \{ \lfloor n \cdot N_{\text{RB}} / 10 \rfloor, 5 \} \rfloor$$

exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of $\min(BW_{\text{channel}}/2, 5)$ MHz with N_{RB} the number of resource blocks in the downlink transmission bandwidth configuration, BW_{channel} 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 subclause 7.7 apply.

The throughput of each carrier shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

7.6A.4 Narrow band blocking for CA

7.6A.4.1 Narrow band blocking for Intra-band contiguous CA

For intra-band contiguous carrier aggregation, 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 7.6A.4.1-1 with the uplink configuration. For UE(s) supporting one uplink, the uplink configuration of the PCC shall be in accordance with Table 7.3.2-3. The UE shall fulfil the minimum requirement in presence of an interfering signal specified in Table 7.6A.4.1-1 being on either side of the aggregated signal. The throughput of each carrier shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (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 7.6A.4.1-1.

Table 7.6A.4.1-1: Narrow-band blocking for intra-band contiguous CA

| NR band | Parameter | Unit | NR CA bandwidth class |
|---------|---|------|--|
| | | | C |
| n41 | P_w in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + NA CA Bandwidth Class specific value below |
| | | | 16 |

| | | | |
|--|---|-----|---|
| | P_{UW} (CW) | dBm | -55 |
| | F_{UW} (offset for $\Delta f = 15$ kHz, 30 kHz) | MHz | - $F_{offset} - 0.2$ / + $F_{offset} + 0.2$ |
| <p>NOTE 1: The transmitter shall be set a 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4.</p> <p>NOTE 2: Reference measurement channel is specified in Annexes A.3.2 and A3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.</p> <p>NOTE 3: The PREFSENS power level is specified in Table 7.3.2-1 and Table 7.3.2-2 for two and four antenna ports, respectively.</p> <p>NOTE 4: The F_{UW} (offset) is the frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the interferer and shall be further adjusted to $\lfloor F_{interferer} / SCS + 0.5 \rfloor SCS + 0.5 SCS$ MHz to be offset from the sub-carrier raster.</p> | | | |

7.6A.4.2 Void

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 clause 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.3.2.1-1, P_{UW} power defined in Table 7.6.4-1 is increased by the amount given by $\Delta R_{IB,c}$ in Table 7.3A.3.2.1-1.

The throughput of each carrier shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

7.6C Blocking characteristics for SUL

7.6C.1 General

7.6C.2 In-band blocking for SUL

For SUL operation, the in-band blocking requirement for downlink bands specified in clause 7.6.2 shall be met.

7.6C.3 Out-of-band blocking for SUL

For SUL operation, the out-of-band blocking requirement for downlink bands specified in clause 7.6.3 shall be met. For operation band combination listed in Table 7.6C.3-1, exceptions to the requirement specified in Table 7.6C.3-2 are allowed when the second order intermodulation product of the SUL carrier and the CW interfering signal fully or partially overlaps with the DL carrier.

Table 7.6C.3-1: SUL operating band combination with exceptions allowed

| NR Band combination for SUL |
|-----------------------------|
| SUL_n78-n81 |
| SUL_n78-n82 |
| SUL_n78-n83 |
| SUL_n79-n81 |

Table 7.6C.3-2: Requirement for out-of-band blocking exceptions

| Parameter | Unit | Level |
|--|------|------------------|
| $P_{Interferer}$ (CW) | dBm | -44 ¹ |
| <p>NOTE 1: The requirement applies when $f_{Interferer} \pm f_{SUL} - f_{DL} \leq (BW_{SUL} + BW_{DL})/2$, where BW_{SUL} and BW_{DL} are the channel bandwidths configured for SUL and DL (victim) bands in MHz, respectively.</p> | | |

For all interferer frequency ranges specified in clause 7.6.3 a maximum of

$$\lfloor \max \{24, 6 \cdot \lceil n \cdot N_{RB} / 6 \rceil \} / \min \{ \lfloor n \cdot N_{RB} / 10 \rfloor, 5 \} \rfloor$$

exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a step size of $\min(BW_{channel}/2, 5)$ MHz with N_{RB} the number of resource blocks in the downlink transmission bandwidth configuration, $BW_{channel}$ 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 subclause 7.7 apply.

7.6C.4 Narrow band blocking for SUL

Narrow band blocking is not specified for SUL band combination.

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 clause 7.6 shall be met with the UL MIMO configurations described in clause 6.2D.1. For UL MIMO, the parameter P_{CMAX_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 for which a response is obtained, i.e. for which the out-of-band blocking limit as specified in clause 7.6.3 is not met.

The throughput shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (with one sided dynamic OCN 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 $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz and in Table 7.7-1a for NR bands with $F_{DL_high} \geq 3300$ MHz and $F_{UL_high} \geq 3300$ MHz and for the interferer as specified in Table 7.7-2. The 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 5.2-1), the requirements only apply for carriers assigned in the paired part.

Table 7.7-1: Spurious response parameters for NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz

| RX parameter | Units | Channel bandwidth | | | | |
|---|-------|--|---------|--------|--------|--------|
| | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel bandwidth 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 bandwidth 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 bandwidth specific value below | | | | |
| | dB | 15.5 | 16 | | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. | | | | | | |

Table 7.7.1-1a: Spurious response parameters for NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| RX parameter | Units | Channel bandwidth | | | | |
|---|-------|--|--------|--------|---------|--------|
| | | 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel bandwidth 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 bandwidth specific value below | | | | |
| | dB | 9 | 9 | 9 | 9 | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{C_{MAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{C_{MAX_L,f,c}}$ defined in clause 6.2.4. | | | | | | |

Table 7.7-2: Spurious response

| Parameter | Unit | Level |
|-----------------------|------|-------------------------------|
| $P_{Interferer}$ (CW) | dBm | -44 |
| $F_{Interferer}$ | 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

| RX parameter | Units | NR CA bandwidth class | | |
|---|-------|---|--|--|
| | | C | | |
| Power in transmission bandwidth configuration | dBm | REFSENS + CA bandwidth class specific value below | | |
| | dB | 9 | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{C_{MAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{C_{MAX_L,f,c}}$ defined in clause 6.2.4. | | | | |

Table 7.7A-2: Spurious response for CA

| Parameter | Unit | Level |
|-----------------------|------|-------------------------------|
| $P_{Interferer}$ (CW) | dBm | -44 |
| $F_{Interferer}$ | MHz | Spurious response frequencies |

7.7A.2 Void

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 clause 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.3.2.1-1, $P_{interferer}$ power defined in Table 7.7-2 is increased by the amount given by $\Delta R_{IB,c}$ in Table 7.3A.3.2.1-1.

The throughput of each carrier shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

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 clause 7.7 shall be met with the UL MIMO configurations described in clause 6.2D.1. For UL MIMO, the parameter P_{CMAX_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 receive 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 $\geq 95\%$ of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2 and A.3.3 (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 $F_{\text{DL_high}} < 2700$ MHz and $F_{\text{UL_high}} < 2700$ MHz and Table 7.8.2-2 for NR bands with $F_{\text{DL_low}} \geq 3300$ MHz and $F_{\text{UL_low}} \geq 3300$ MHz. The 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 5.2-1), the requirements only apply for carriers assigned in the paired part.

Table 7.8.2-1: Wide band intermodulation parameters for NR bands with $F_{\text{DL_high}} < 2700$ MHz and $F_{\text{UL_high}} < 2700$ 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 |
| P_w 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 |
| $P_{\text{Interferer 1}}$ (CW) | dBm | -46 | | | | | | | | | | | |
| $P_{\text{Interferer 2}}$ (Modulated) | dBm | -46 | | | | | | | | | | | |
| $BW_{\text{Interferer 2}}$ | MHz | 5 | | | | | | | | | | | |
| $F_{\text{Interferer 1}}$ (Offset) | MHz | -BW/2 - 7.5 / +BW/2 + 7.5 | | | | | | | | | | | |
| $F_{\text{Interferer 2}}$ (Offset) | MHz | $2 * F_{\text{Interferer 1}}$ | | | | | | | | | | | |

- NOTE 1: The transmitter shall be set to 4 dB below $P_{\text{CMAX}_L, f, c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{\text{CMAX}_L, f, c}$ defined in clause 6.2.4.
- NOTE 2: Reference measurement channel is specified in Annexes A.2.2, A.3.2, and A.3.3 (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)
- NOTE 3: The modulated interferer consists of the Reference measurement channel specified in Annexes A.3.2.2 and A.3.3.2 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 and 15 kHz SCS.
- NOTE 4: The $F_{\text{Interferer 1}}$ (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 $F_{\text{Interferer 2}}$ (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 $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| Rx parameter | Units | Channel bandwidth | | | | | | | |
|---|-------|--|--------|--------|--------|--------|--------|--------|---------|
| | | 10 MHz | 20 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| P_w in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + 6 | | | | | | | |
| $P_{Interferer\ 1}$ (CW) | dBm | -46 | | | | | | | |
| $P_{Interferer\ 2}$ (Modulated) | dBm | -46 | | | | | | | |
| $BW_{Interferer\ 2}$ | MHz | $BW_{Channel}$ | | | | | | | |
| $F_{Interferer\ 1}$ (Offset) | MHz | $-2BW_{Channel}$ / $+2BW_{Channel}$ | | | | | | | |
| $F_{Interferer\ 2}$ (Offset) | MHz | $2 * F_{Interferer\ 1}$ | | | | | | | |
| NOTE 1: The transmitter shall be set to 4dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. NOTE 2: Reference measurement channel is specified in Annexes A.2.2, A.3.2, and A.3.3 (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). NOTE 3: The modulated interferer consists of the Reference measurement channel specified in Annexes A.3.2.2 and A.3.3.2 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 and the same SCS as the wanted signal. NOTE 4: The $F_{Interferer\ 1}$ (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 $F_{Interferer\ 2}$ (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 $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| Rx parameter | Units | NR CA bandwidth class | | |
|--|-------|--|-----|--|
| | | C | | |
| P_w in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + 6 | | |
| $P_{Interferer\ 1}$ (CW) | dBm | | -46 | |
| $P_{Interferer\ 2}$ (Modulated) | dBm | | -46 | |
| $BW_{Interferer\ 2}$ | MHz | $BW_{Channel_CA}$ | | |
| $F_{Interferer\ 1}$ (Offset) | MHz | $-2BW_{Channel_CA}$ / $+2BW_{Channel_CA}$ | | |
| $F_{Interferer\ 2}$ (Offset) | MHz | $2 * F_{Interferer\ 1}$ | | |
| NOTE 1: The transmitter shall be set to 4 dB below $P_{CMAX_L,f,c}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{CMAX_L,f,c}$ defined in clause 6.2.4. NOTE 2: Reference measurement channel is specified in Annexes A.2.2, A.3.2, and A.3.3 (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). | | | | |

NOTE 3: The modulated interferer consists of the Reference measurement channel specified in Annexes A.3.2.2 and A.3.3.2 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 and the same SCS as the closest carrier.

NOTE 4: The $F_{interferer\ 1}$ (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 $F_{interferer\ 2}$ (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 7.8A.2.1-2: Wide band intermodulation parameters for intra-band contiguous CA with $F_{DL_low} < 2700$ MHz and $F_{UL_low} < 2700$ MHz

| Rx parameter | Units | NR CA bandwidth class |
|---|-------|--|
| | | C |
| P_w in Transmission Bandwidth Configuration, per CC | dBm | REFSENS + 22 |
| $P_{Interferer\ 1}$ (CW) | dBm | -46 |
| $P_{Interferer\ 2}$ (Modulated) | dBm | -46 |
| $BW_{Interferer\ 2}$ | MHz | 5 |
| $F_{Interferer\ 1}$ (Offset) | MHz | $-F_{offset}-7.5$ / $F_{offset}+7.5$ |
| $F_{Interferer\ 2}$ (Offset) | MHz | $2 * F_{Interferer\ 1}$ |

NOTE 1: The transmitter shall be set to 4 dB below $P_{C_{MAX_L,f,c}}$ at the minimum UL configuration specified in Table 7.3.2-3 with $P_{C_{MAX_L,f,c}}$ defined in clause 6.2.4.

NOTE 2: Reference measurement channel is specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

NOTE 3: The modulated interferer consists of the Reference measurement channel specified in Annexes A.3.2.2 and A.3.3.2 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 and 15 kHz SCS.

NOTE 4: The $F_{interferer\ 1}$ (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 $F_{interferer\ 2}$ (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 Void

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 clause 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.3.2.1-1, $P_{interferer}$ power defined in Table 7.8.2-1 and 7.8.2-2 is increased by the amount given by $\Delta R_{IB,c}$ in Table 7.3A.3.2.1-1.

The throughput of each carrier shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.3.2, and A.3.3 (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).

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 clause 7.8 shall be met with the UL MIMO configurations described in clause 6.2D.1. For UL MIMO, the parameter $P_{C_{MAX_L}}$ 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 |
|---|-----------------------|---------------|------|
| $30 \text{ MHz} \leq f < 1 \text{ GHz}$ | 100 kHz | -57 dBm | |
| $1 \text{ GHz} \leq f \leq 12.75 \text{ GHz}$ | 1 MHz | -47 dBm | |
| $12.75 \text{ GHz} \leq f \leq 5^{\text{th}}$ 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 | -47 dBm | 3 |
| NOTE 1: Unused PDCCH resources are padded with resource element groups with power level given by PDCCH 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 Void

7.9A.2 Void

7.9A.3 Spurious emissions for Inter-band CA

For inter-band carrier aggregation including an operating band without uplink band, the UE shall meet the Rx spurious emissions requirements specified in clause 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 clauses 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. The measurement channels in the following clauses are applicable to both FDD and TDD.

The active uplink slots for TDD configurations are specified in table A.2.1-1. TDD slot patterns defined for reference sensitivity tests will be used for TDD UL RMCs.

Table A.2.1-1: TDD active uplink slots

| SCS | Active Uplink slots |
|------------|--------------------------------|
| 15 kHz | 4, 9 |
| 30 kHz | 8, 9, 18, 19 |
| 60 kHz | 16, 17, 18, 19, 36, 37, 38, 39 |

A.2.2 Reference measurement channels

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

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | pi/2 BPSK | 0 | 24 | 16 | 2 | 1 | 132 | 132 |
| | 5 | 11 | pi/2 BPSK | 0 | 160 | 16 | 2 | 1 | 660 | 660 |
| | 9 | 11 | pi/2 BPSK | 0 | 288 | 16 | 2 | 1 | 1188 | 1188 |
| | 10 | 11 | pi/2 BPSK | 0 | 320 | 16 | 2 | 1 | 1320 | 1320 |
| | 12 | 11 | pi/2 BPSK | 0 | 384 | 16 | 2 | 1 | 1584 | 1584 |
| | 15 | 11 | pi/2 BPSK | 0 | 480 | 16 | 2 | 1 | 1980 | 1980 |
| | 18 | 11 | pi/2 BPSK | 0 | 576 | 16 | 2 | 1 | 2376 | 2376 |
| | 24 | 11 | pi/2 BPSK | 0 | 768 | 16 | 2 | 1 | 3168 | 3168 |
| | 25 | 11 | pi/2 BPSK | 0 | 808 | 16 | 2 | 1 | 3300 | 3300 |
| | 30 | 11 | pi/2 BPSK | 0 | 984 | 16 | 2 | 1 | 3960 | 3960 |
| | 32 | 11 | pi/2 BPSK | 0 | 1032 | 16 | 2 | 1 | 4224 | 4224 |
| | 36 | 11 | pi/2 BPSK | 0 | 1128 | 16 | 2 | 1 | 4752 | 4752 |
| | 45 | 11 | pi/2 BPSK | 0 | 1416 | 16 | 2 | 1 | 5940 | 5940 |
| | 50 | 11 | pi/2 BPSK | 0 | 1544 | 16 | 2 | 1 | 6600 | 6600 |
| | 60 | 11 | pi/2 BPSK | 0 | 1864 | 16 | 2 | 1 | 7920 | 7920 |
| | 64 | 11 | pi/2 BPSK | 0 | 2024 | 16 | 2 | 1 | 8448 | 8448 |
| | 75 | 11 | pi/2 BPSK | 0 | 2408 | 16 | 2 | 1 | 9900 | 9900 |
| | 80 | 11 | pi/2 BPSK | 0 | 2472 | 16 | 2 | 1 | 10560 | 10560 |
| | 81 | 11 | pi/2 BPSK | 0 | 2536 | 16 | 2 | 1 | 10692 | 10692 |
| | 90 | 11 | pi/2 BPSK | 0 | 2792 | 16 | 2 | 1 | 11880 | 11880 |
| | 100 | 11 | pi/2 BPSK | 0 | 3104 | 16 | 2 | 1 | 13200 | 13200 |
| | 108 | 11 | pi/2 BPSK | 0 | 3368 | 16 | 2 | 1 | 14256 | 14256 |
| | 120 | 11 | pi/2 BPSK | 0 | 3752 | 16 | 2 | 1 | 15840 | 15840 |
| | 128 | 11 | pi/2 BPSK | 0 | 3976 | 24 | 2 | 2 | 16896 | 16896 |
| | 135 | 11 | pi/2 BPSK | 0 | 4104 | 24 | 2 | 2 | 17820 | 17820 |
| | 160 | 11 | pi/2 BPSK | 0 | 4872 | 24 | 2 | 2 | 21120 | 21120 |
| | 162 | 11 | pi/2 BPSK | 0 | 5000 | 24 | 2 | 2 | 21384 | 21384 |
| | 180 | 11 | pi/2 BPSK | 0 | 5512 | 24 | 2 | 2 | 23760 | 23760 |
| | 216 | 11 | pi/2 BPSK | 0 | 6664 | 24 | 2 | 2 | 28512 | 28512 |
| | 243 | 11 | pi/2 BPSK | 0 | 7560 | 24 | 2 | 2 | 32076 | 32076 |
| | 270 | 11 | pi/2 BPSK | 0 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where L_{CRB} ≤ N_{RB}.

Table A.2.2.1-2: Void

Table A.2.2.1-3: Void

A.2.2.2 DFT-s-OFDM QPSK

Table A.2.2.2-1: Reference Channels for DFT-s-OFDM QPSK

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | QPSK | 2 | 48 | 16 | 2 | 1 | 264 | 132 |
| | 5 | 11 | QPSK | 2 | 256 | 16 | 2 | 1 | 1320 | 660 |
| | 9 | 11 | QPSK | 2 | 456 | 16 | 2 | 1 | 2376 | 1188 |
| | 10 | 11 | QPSK | 2 | 504 | 16 | 2 | 1 | 2640 | 1320 |
| | 12 | 11 | QPSK | 2 | 608 | 16 | 2 | 1 | 3168 | 1584 |
| | 15 | 11 | QPSK | 2 | 768 | 16 | 2 | 1 | 3960 | 1980 |
| | 18 | 11 | QPSK | 2 | 928 | 16 | 2 | 1 | 4752 | 2376 |
| | 20 | 11 | QPSK | 2 | 1032 | 16 | 2 | 1 | 5280 | 2640 |
| | 24 | 11 | QPSK | 2 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
| | 25 | 11 | QPSK | 2 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
| | 30 | 11 | QPSK | 2 | 1544 | 16 | 2 | 1 | 7920 | 3960 |
| | 32 | 11 | QPSK | 2 | 1608 | 16 | 2 | 1 | 8448 | 4224 |
| | 36 | 11 | QPSK | 2 | 1800 | 16 | 2 | 1 | 9504 | 4752 |
| | 45 | 11 | QPSK | 2 | 2208 | 16 | 2 | 1 | 11880 | 5940 |
| | 50 | 11 | QPSK | 2 | 2472 | 16 | 2 | 1 | 13200 | 6600 |
| | 60 | 11 | QPSK | 2 | 3104 | 16 | 2 | 1 | 15840 | 7920 |
| | 64 | 11 | QPSK | 2 | 3240 | 16 | 2 | 1 | 16896 | 8448 |
| | 75 | 11 | QPSK | 2 | 3752 | 16 | 2 | 1 | 19800 | 9900 |
| | 80 | 11 | QPSK | 2 | 3976 | 24 | 2 | 2 | 21120 | 10560 |
| | 81 | 11 | QPSK | 2 | 4040 | 24 | 2 | 2 | 21384 | 10692 |
| | 90 | 11 | QPSK | 2 | 4488 | 24 | 2 | 2 | 23760 | 11880 |
| | 100 | 11 | QPSK | 2 | 5000 | 24 | 2 | 2 | 26400 | 13200 |
| | 108 | 11 | QPSK | 2 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
| | 120 | 11 | QPSK | 2 | 5896 | 24 | 2 | 2 | 31680 | 15840 |
| | 128 | 11 | QPSK | 2 | 6408 | 24 | 2 | 2 | 33792 | 16896 |
| | 135 | 11 | QPSK | 2 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
| | 160 | 11 | QPSK | 2 | 7944 | 24 | 2 | 3 | 42240 | 21120 |
| | 162 | 11 | QPSK | 2 | 8064 | 24 | 2 | 3 | 42768 | 21384 |
| | 180 | 11 | QPSK | 2 | 8976 | 24 | 2 | 3 | 47520 | 23760 |
| | 216 | 11 | QPSK | 2 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
| | 243 | 11 | QPSK | 2 | 12040 | 24 | 2 | 4 | 64152 | 32076 |
| | 270 | 11 | QPSK | 2 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where L_{CRB} ≤ N_{RB}.

Table A.2.2.2-2: Void

Table A.2.2.2-3: Void

A.2.2.3 DFT-s-OFDM 16QAM

Table A.2.2.3-1: Reference Channels for DFT-s-OFDM 16QAM

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | 16QAM | 10 | 176 | 16 | 2 | 1 | 528 | 132 |
| | 5 | 11 | 16QAM | 10 | 888 | 16 | 2 | 1 | 2640 | 660 |
| | 9 | 11 | 16QAM | 10 | 1608 | 16 | 2 | 1 | 4752 | 1188 |
| | 10 | 11 | 16QAM | 10 | 1800 | 16 | 2 | 1 | 5280 | 1320 |
| | 12 | 11 | 16QAM | 10 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
| | 15 | 11 | 16QAM | 10 | 2664 | 16 | 2 | 1 | 7920 | 1980 |
| | 18 | 11 | 16QAM | 10 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
| | 24 | 11 | 16QAM | 10 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
| | 25 | 11 | 16QAM | 10 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
| | 30 | 11 | 16QAM | 10 | 5248 | 24 | 1 | 1 | 15840 | 3960 |
| | 32 | 11 | 16QAM | 10 | 5632 | 24 | 1 | 1 | 16896 | 4224 |
| | 36 | 11 | 16QAM | 10 | 6272 | 24 | 1 | 1 | 19008 | 4752 |
| | 45 | 11 | 16QAM | 10 | 7808 | 24 | 1 | 1 | 23760 | 5940 |
| | 50 | 11 | 16QAM | 10 | 8712 | 24 | 1 | 2 | 26400 | 6600 |
| | 60 | 11 | 16QAM | 10 | 10504 | 24 | 1 | 2 | 31680 | 7920 |
| | 64 | 11 | 16QAM | 10 | 11272 | 24 | 1 | 2 | 33792 | 8448 |
| | 75 | 11 | 16QAM | 10 | 13064 | 24 | 1 | 2 | 39600 | 9900 |
| | 80 | 11 | 16QAM | 10 | 14088 | 24 | 1 | 2 | 42240 | 10560 |
| | 81 | 11 | 16QAM | 10 | 14088 | 24 | 1 | 2 | 42768 | 10692 |
| | 90 | 11 | 16QAM | 10 | 15880 | 24 | 1 | 2 | 47520 | 11880 |
| | 100 | 11 | 16QAM | 10 | 17424 | 24 | 1 | 3 | 52800 | 13200 |
| | 108 | 11 | 16QAM | 10 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
| | 120 | 11 | 16QAM | 10 | 21000 | 24 | 1 | 3 | 63360 | 15840 |
| | 128 | 11 | 16QAM | 10 | 22536 | 24 | 1 | 3 | 67584 | 16896 |
| | 135 | 11 | 16QAM | 10 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
| | 160 | 11 | 16QAM | 10 | 28168 | 24 | 1 | 4 | 84480 | 21120 |
| | 162 | 11 | 16QAM | 10 | 28168 | 24 | 1 | 4 | 85536 | 21384 |
| | 180 | 11 | 16QAM | 10 | 31752 | 24 | 1 | 4 | 95040 | 23760 |
| | 216 | 11 | 16QAM | 10 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
| | 243 | 11 | 16QAM | 10 | 43032 | 24 | 1 | 6 | 128304 | 32076 |
| | 270 | 11 | 16QAM | 10 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where L_{CRB} ≤ N_{RB}.

Table A.2.2.3-2: Void

Table A.2.2.3-3: Void

A.2.2.4 DFT-s-OFDM 64QAM

Table A.2.2.4-1: Reference Channels for DFT-s-OFDM 64QAM

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | 64QAM | 18 | 408 | 16 | 2 | 1 | 792 | 132 |
| | 5 | 11 | 64QAM | 18 | 2024 | 16 | 2 | 1 | 3960 | 660 |
| | 9 | 11 | 64QAM | 18 | 3624 | 16 | 2 | 1 | 7128 | 1188 |
| | 10 | 11 | 64QAM | 18 | 3968 | 24 | 1 | 1 | 7920 | 1320 |
| | 12 | 11 | 64QAM | 18 | 4736 | 24 | 1 | 1 | 9504 | 1584 |
| | 15 | 11 | 64QAM | 18 | 6016 | 24 | 1 | 1 | 11880 | 1980 |
| | 18 | 11 | 64QAM | 18 | 7168 | 24 | 1 | 1 | 14256 | 2376 |
| | 24 | 11 | 64QAM | 18 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
| | 25 | 11 | 64QAM | 18 | 9992 | 24 | 1 | 2 | 19800 | 3300 |
| | 30 | 11 | 64QAM | 18 | 12040 | 24 | 1 | 2 | 23760 | 3960 |
| | 32 | 11 | 64QAM | 18 | 12808 | 24 | 1 | 2 | 25344 | 4224 |
| | 36 | 11 | 64QAM | 18 | 14344 | 24 | 1 | 2 | 28512 | 4752 |
| | 45 | 11 | 64QAM | 18 | 17928 | 24 | 1 | 3 | 35640 | 5940 |
| | 50 | 11 | 64QAM | 18 | 19968 | 24 | 1 | 3 | 39600 | 6600 |
| | 60 | 11 | 64QAM | 18 | 24072 | 24 | 1 | 3 | 47520 | 7920 |
| | 64 | 11 | 64QAM | 18 | 25608 | 24 | 1 | 4 | 50688 | 8448 |
| | 75 | 11 | 64QAM | 18 | 30216 | 24 | 1 | 4 | 59400 | 9900 |
| | 80 | 11 | 64QAM | 18 | 31752 | 24 | 1 | 4 | 63360 | 10560 |
| | 81 | 11 | 64QAM | 18 | 32264 | 24 | 1 | 4 | 64152 | 10692 |
| | 90 | 11 | 64QAM | 18 | 35856 | 24 | 1 | 5 | 71280 | 11880 |
| | 100 | 11 | 64QAM | 18 | 39936 | 24 | 1 | 5 | 79200 | 13200 |
| | 108 | 11 | 64QAM | 18 | 43032 | 24 | 1 | 6 | 85536 | 14256 |
| | 120 | 11 | 64QAM | 18 | 48168 | 24 | 1 | 6 | 95040 | 15840 |
| | 128 | 11 | 64QAM | 18 | 51216 | 24 | 1 | 7 | 101376 | 16896 |
| | 135 | 11 | 64QAM | 18 | 54296 | 24 | 1 | 7 | 106920 | 17820 |
| | 160 | 11 | 64QAM | 18 | 63528 | 24 | 1 | 8 | 126720 | 21120 |
| | 162 | 11 | 64QAM | 18 | 64552 | 24 | 1 | 8 | 128304 | 21384 |
| | 180 | 11 | 64QAM | 18 | 71688 | 24 | 1 | 9 | 142560 | 23760 |
| | 216 | 11 | 64QAM | 18 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
| | 243 | 11 | 64QAM | 18 | 96264 | 24 | 1 | 12 | 192456 | 32076 |
| | 270 | 11 | 64QAM | 18 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where L_{CRB} ≤ N_{RB}.

Table A.2.2.4-2: Void

Table A.2.2.4-3: Void

A.2.2.5 DFT-s-OFDM 256QAM

Table A.2.2.5-1: Reference Channels for DFT-s-OFDM 256QAM

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | 256QAM | 20 | 704 | 16 | 2 | 1 | 1056 | 132 |
| | 5 | 11 | 256QAM | 20 | 3496 | 16 | 2 | 1 | 5280 | 660 |
| | 9 | 11 | 256QAM | 20 | 6272 | 24 | 1 | 1 | 9504 | 1188 |
| | 10 | 11 | 256QAM | 20 | 7040 | 24 | 1 | 1 | 10560 | 1320 |
| | 12 | 11 | 256QAM | 20 | 8456 | 24 | 1 | 2 | 12672 | 1584 |
| | 15 | 11 | 256QAM | 20 | 10504 | 24 | 1 | 2 | 15840 | 1980 |
| | 18 | 11 | 256QAM | 20 | 12552 | 24 | 1 | 2 | 19008 | 2376 |
| | 24 | 11 | 256QAM | 20 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
| | 25 | 11 | 256QAM | 20 | 17424 | 24 | 1 | 3 | 26400 | 3300 |
| | 30 | 11 | 256QAM | 20 | 21000 | 24 | 1 | 3 | 31680 | 3960 |
| | 32 | 11 | 256QAM | 20 | 22536 | 24 | 1 | 3 | 33792 | 4224 |
| | 36 | 11 | 256QAM | 20 | 25104 | 24 | 1 | 3 | 38016 | 4752 |
| | 45 | 11 | 256QAM | 20 | 31752 | 24 | 1 | 4 | 47520 | 5940 |
| | 50 | 11 | 256QAM | 20 | 34816 | 24 | 1 | 5 | 52800 | 6600 |
| | 60 | 11 | 256QAM | 20 | 42016 | 24 | 1 | 5 | 63360 | 7920 |
| | 64 | 11 | 256QAM | 20 | 45096 | 24 | 1 | 6 | 67584 | 8448 |
| | 75 | 11 | 256QAM | 20 | 53288 | 24 | 1 | 7 | 79200 | 9900 |
| | 80 | 11 | 256QAM | 20 | 56368 | 24 | 1 | 7 | 84480 | 10560 |
| | 81 | 11 | 256QAM | 20 | 57376 | 24 | 1 | 7 | 85536 | 10692 |
| | 90 | 11 | 256QAM | 20 | 63528 | 24 | 1 | 8 | 95040 | 11880 |
| | 100 | 11 | 256QAM | 20 | 69672 | 24 | 1 | 9 | 105600 | 13200 |
| | 108 | 11 | 256QAM | 20 | 75792 | 24 | 1 | 9 | 114048 | 14256 |
| | 120 | 11 | 256QAM | 20 | 83976 | 24 | 1 | 10 | 126720 | 15840 |
| | 128 | 11 | 256QAM | 20 | 90176 | 24 | 1 | 11 | 135168 | 16896 |
| | 135 | 11 | 256QAM | 20 | 94248 | 24 | 1 | 12 | 142560 | 17820 |
| | 160 | 11 | 256QAM | 20 | 112648 | 24 | 1 | 14 | 168960 | 21120 |
| | 162 | 11 | 256QAM | 20 | 114776 | 24 | 1 | 14 | 171072 | 21384 |
| | 180 | 11 | 256QAM | 20 | 127080 | 24 | 1 | 16 | 190080 | 23760 |
| | 216 | 11 | 256QAM | 20 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
| | 243 | 11 | 256QAM | 20 | 172176 | 24 | 1 | 21 | 256608 | 32076 |
| | 270 | 11 | 256QAM | 20 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where L_{CRB} ≤ N_{RB}.

Table A.2.2.5-2: Void

Table A.2.2.5-3: Void

A.2.2.6 CP-OFDM QPSK

Table A.2.2.6-1: Reference Channels for CP-OFDM QPSK

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | QPSK | 2 | 48 | 16 | 2 | 1 | 264 | 132 |
| | 5 | 11 | QPSK | 2 | 256 | 16 | 2 | 1 | 1320 | 660 |
| | 6 | 11 | QPSK | 2 | 304 | 16 | 2 | 1 | 1584 | 792 |
| | 9 | 11 | QPSK | 2 | 456 | 16 | 2 | 1 | 2376 | 1188 |
| | 10 | 11 | QPSK | 2 | 504 | 16 | 2 | 1 | 2640 | 1320 |
| | 11 | 11 | QPSK | 2 | 552 | 16 | 2 | 1 | 2904 | 1452 |
| | 12 | 11 | QPSK | 2 | 608 | 16 | 2 | 1 | 3168 | 1584 |
| | 13 | 11 | QPSK | 2 | 672 | 16 | 2 | 1 | 3432 | 1716 |
| | 15 | 11 | QPSK | 2 | 768 | 16 | 2 | 1 | 3960 | 1980 |
| | 16 | 11 | QPSK | 2 | 808 | 16 | 2 | 1 | 4224 | 2112 |
| | 18 | 11 | QPSK | 2 | 928 | 16 | 2 | 1 | 4752 | 2376 |
| | 19 | 11 | QPSK | 2 | 984 | 16 | 2 | 1 | 5016 | 2508 |
| | 24 | 11 | QPSK | 2 | 1192 | 16 | 2 | 1 | 6336 | 3168 |
| | 25 | 11 | QPSK | 2 | 1256 | 16 | 2 | 1 | 6600 | 3300 |
| | 26 | 11 | QPSK | 2 | 1288 | 16 | 2 | 1 | 6864 | 3432 |
| | 31 | 11 | QPSK | 2 | 1544 | 16 | 2 | 1 | 8184 | 4092 |
| | 33 | 11 | QPSK | 2 | 1672 | 16 | 2 | 1 | 8712 | 4356 |
| | 38 | 11 | QPSK | 2 | 1928 | 16 | 2 | 1 | 10032 | 5016 |
| | 39 | 11 | QPSK | 2 | 2024 | 16 | 2 | 1 | 10296 | 5148 |
| | 40 | 11 | QPSK | 2 | 2024 | 16 | 2 | 1 | 10560 | 5280 |
| | 47 | 11 | QPSK | 2 | 2408 | 16 | 2 | 1 | 12408 | 6204 |
| | 51 | 11 | QPSK | 2 | 2536 | 16 | 2 | 1 | 13464 | 6732 |
| | 52 | 11 | QPSK | 2 | 2600 | 16 | 2 | 1 | 13728 | 6864 |
| | 53 | 11 | QPSK | 2 | 2664 | 16 | 2 | 1 | 13992 | 6996 |
| | 54 | 11 | QPSK | 2 | 2664 | 16 | 2 | 1 | 14256 | 7128 |
| | 61 | 11 | QPSK | 2 | 3104 | 16 | 2 | 1 | 16104 | 8052 |
| | 65 | 11 | QPSK | 2 | 3240 | 16 | 2 | 1 | 17160 | 8580 |
| | 67 | 11 | QPSK | 2 | 3368 | 16 | 2 | 1 | 17688 | 8844 |
| | 68 | 11 | QPSK | 2 | 3368 | 16 | 2 | 1 | 17952 | 8976 |
| | 78 | 11 | QPSK | 2 | 3848 | 24 | 2 | 2 | 20592 | 10296 |
| | 79 | 11 | QPSK | 2 | 3912 | 24 | 2 | 2 | 20856 | 10428 |
| | 80 | 11 | QPSK | 2 | 3976 | 24 | 2 | 2 | 21120 | 10560 |
| | 81 | 11 | QPSK | 2 | 4040 | 24 | 2 | 2 | 21384 | 10692 |
| | 93 | 11 | QPSK | 2 | 4616 | 24 | 2 | 2 | 24552 | 12276 |
| | 95 | 11 | QPSK | 2 | 4744 | 24 | 2 | 2 | 25080 | 12540 |
| | 106 | 11 | QPSK | 2 | 5256 | 24 | 2 | 2 | 27984 | 13992 |
| | 107 | 11 | QPSK | 2 | 5256 | 24 | 2 | 2 | 28248 | 14124 |
| | 108 | 11 | QPSK | 2 | 5384 | 24 | 2 | 2 | 28512 | 14256 |
| | 109 | 11 | QPSK | 2 | 5384 | 24 | 2 | 2 | 28776 | 14388 |
| | 121 | 11 | QPSK | 2 | 6024 | 24 | 2 | 2 | 31944 | 15972 |
| | 123 | 11 | QPSK | 2 | 6152 | 24 | 2 | 2 | 32472 | 16236 |
| | 133 | 11 | QPSK | 2 | 6664 | 24 | 2 | 2 | 35112 | 17556 |
| | 135 | 11 | QPSK | 2 | 6664 | 24 | 2 | 2 | 35640 | 17820 |
| | 137 | 11 | QPSK | 2 | 6792 | 24 | 2 | 2 | 36168 | 18084 |
| | 160 | 11 | QPSK | 2 | 7944 | 24 | 2 | 3 | 42240 | 21120 |
| | 162 | 11 | QPSK | 2 | 8064 | 24 | 2 | 3 | 42768 | 21384 |
| | 189 | 11 | QPSK | 2 | 9480 | 24 | 2 | 3 | 49896 | 24948 |
| | 216 | 11 | QPSK | 2 | 10752 | 24 | 2 | 3 | 57024 | 28512 |
| | 217 | 11 | QPSK | 2 | 10752 | 24 | 2 | 3 | 57288 | 28644 |
| | 245 | 11 | QPSK | 2 | 12296 | 24 | 2 | 4 | 64680 | 32340 |
| | 270 | 11 | QPSK | 2 | 13320 | 24 | 2 | 4 | 71280 | 35640 |
| | 273 | 11 | QPSK | 2 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.2.6-2: Void

Table A.2.2.6-3: Void

A.2.2.7 CP-OFDM 16QAM

Table A.2.2.7-1: Reference Channels for CP-OFDM 16QAM

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | 16QAM | 10 | 176 | 16 | 2 | 1 | 528 | 132 |
| | 5 | 11 | 16QAM | 10 | 888 | 16 | 2 | 1 | 2640 | 660 |
| | 6 | 11 | 16QAM | 10 | 1064 | 16 | 2 | 1 | 3168 | 792 |
| | 9 | 11 | 16QAM | 10 | 1608 | 16 | 2 | 1 | 4752 | 1188 |
| | 10 | 11 | 16QAM | 10 | 1800 | 16 | 2 | 1 | 5280 | 1320 |
| | 11 | 11 | 16QAM | 10 | 1928 | 16 | 2 | 1 | 5808 | 1452 |
| | 12 | 11 | 16QAM | 10 | 2088 | 16 | 2 | 1 | 6336 | 1584 |
| | 13 | 11 | 16QAM | 10 | 2280 | 16 | 2 | 1 | 6864 | 1716 |
| | 15 | 11 | 16QAM | 10 | 2664 | 16 | 2 | 1 | 7920 | 1980 |
| | 16 | 11 | 16QAM | 10 | 2792 | 16 | 2 | 1 | 8448 | 2112 |
| | 18 | 11 | 16QAM | 10 | 3240 | 16 | 2 | 1 | 9504 | 2376 |
| | 19 | 11 | 16QAM | 10 | 3368 | 16 | 2 | 1 | 10032 | 2508 |
| | 24 | 11 | 16QAM | 10 | 4224 | 24 | 1 | 1 | 12672 | 3168 |
| | 25 | 11 | 16QAM | 10 | 4352 | 24 | 1 | 1 | 13200 | 3300 |
| | 26 | 11 | 16QAM | 10 | 4480 | 24 | 1 | 1 | 13728 | 3432 |
| | 31 | 11 | 16QAM | 10 | 5376 | 24 | 1 | 1 | 16368 | 4092 |
| | 33 | 11 | 16QAM | 10 | 5760 | 24 | 1 | 1 | 17424 | 4356 |
| | 38 | 11 | 16QAM | 10 | 6656 | 24 | 1 | 1 | 20064 | 5016 |
| | 39 | 11 | 16QAM | 10 | 6784 | 24 | 1 | 1 | 20592 | 5148 |
| | 40 | 11 | 16QAM | 10 | 7040 | 24 | 1 | 1 | 21120 | 5280 |
| | 47 | 11 | 16QAM | 10 | 8192 | 24 | 1 | 1 | 24816 | 6204 |
| | 51 | 11 | 16QAM | 10 | 8968 | 24 | 1 | 2 | 26928 | 6732 |
| | 52 | 11 | 16QAM | 10 | 9224 | 24 | 1 | 2 | 27456 | 6864 |
| | 53 | 11 | 16QAM | 10 | 9224 | 24 | 1 | 2 | 27984 | 6996 |
| | 54 | 11 | 16QAM | 10 | 9480 | 24 | 1 | 2 | 28512 | 7128 |
| | 61 | 11 | 16QAM | 10 | 10760 | 24 | 1 | 2 | 32208 | 8052 |
| | 65 | 11 | 16QAM | 10 | 11272 | 24 | 1 | 2 | 34320 | 8580 |
| | 67 | 11 | 16QAM | 10 | 11784 | 24 | 1 | 2 | 35376 | 8844 |
| | 68 | 11 | 16QAM | 10 | 11784 | 24 | 1 | 2 | 35904 | 8976 |
| | 78 | 11 | 16QAM | 10 | 13576 | 24 | 1 | 2 | 41184 | 10296 |
| | 79 | 11 | 16QAM | 10 | 13832 | 24 | 1 | 2 | 41712 | 10428 |
| | 80 | 11 | 16QAM | 10 | 14088 | 24 | 1 | 2 | 42240 | 10560 |
| | 81 | 11 | 16QAM | 10 | 14088 | 24 | 1 | 2 | 42768 | 10692 |
| | 93 | 11 | 16QAM | 10 | 16392 | 24 | 1 | 2 | 49104 | 12276 |
| | 95 | 11 | 16QAM | 10 | 16392 | 24 | 1 | 2 | 50160 | 12540 |
| | 106 | 11 | 16QAM | 10 | 18432 | 24 | 1 | 3 | 55968 | 13992 |
| | 107 | 11 | 16QAM | 10 | 18960 | 24 | 1 | 3 | 56496 | 14124 |
| | 108 | 11 | 16QAM | 10 | 18960 | 24 | 1 | 3 | 57024 | 14256 |
| | 109 | 11 | 16QAM | 10 | 18960 | 24 | 1 | 3 | 57552 | 14388 |
| | 121 | 11 | 16QAM | 10 | 21000 | 24 | 1 | 3 | 63888 | 15972 |
| | 123 | 11 | 16QAM | 10 | 21504 | 24 | 1 | 3 | 64944 | 16236 |
| | 133 | 11 | 16QAM | 10 | 23040 | 24 | 1 | 3 | 70224 | 17556 |
| | 135 | 11 | 16QAM | 10 | 23568 | 24 | 1 | 3 | 71280 | 17820 |
| | 137 | 11 | 16QAM | 10 | 24072 | 24 | 1 | 3 | 72336 | 18084 |
| | 160 | 11 | 16QAM | 10 | 28168 | 24 | 1 | 4 | 84480 | 21120 |
| | 162 | 11 | 16QAM | 10 | 28168 | 24 | 1 | 4 | 85536 | 21384 |
| | 189 | 11 | 16QAM | 10 | 32776 | 24 | 1 | 4 | 99792 | 24948 |
| | 216 | 11 | 16QAM | 10 | 37896 | 24 | 1 | 5 | 114048 | 28512 |
| | 217 | 11 | 16QAM | 10 | 37896 | 24 | 1 | 5 | 114576 | 28644 |
| | 245 | 11 | 16QAM | 10 | 43032 | 24 | 1 | 6 | 129360 | 32340 |
| | 270 | 11 | 16QAM | 10 | 47112 | 24 | 1 | 6 | 142560 | 35640 |
| | 273 | 11 | 16QAM | 10 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.2.7-2: Void

Table A.2.2.7-3: Void

A.2.2.8 CP-OFDM 64QAM

Table A.2.2.8-1: Reference Channels for CP-OFDM 64QAM

| Parameter | Allocated resource blocks (L_{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | 64QAM | 19 | 408 | 16 | 2 | 1 | 792 | 132 |
| | 5 | 11 | 64QAM | 19 | 2024 | 16 | 2 | 1 | 3960 | 660 |
| | 9 | 11 | 64QAM | 19 | 3624 | 16 | 2 | 1 | 7128 | 1188 |
| | 10 | 11 | 64QAM | 19 | 3968 | 24 | 1 | 1 | 7920 | 1320 |
| | 11 | 11 | 64QAM | 19 | 4352 | 24 | 1 | 1 | 8712 | 1452 |
| | 12 | 11 | 64QAM | 19 | 4736 | 24 | 1 | 1 | 9504 | 1584 |
| | 13 | 11 | 64QAM | 19 | 5120 | 24 | 1 | 1 | 10296 | 1716 |
| | 15 | 11 | 64QAM | 19 | 6016 | 24 | 1 | 1 | 11880 | 1980 |
| | 18 | 11 | 64QAM | 19 | 7168 | 24 | 1 | 1 | 14256 | 2376 |
| | 19 | 11 | 64QAM | 19 | 7552 | 24 | 1 | | 15048 | 2508 |
| | 24 | 11 | 64QAM | 19 | 9480 | 24 | 1 | 2 | 19008 | 3168 |
| | 25 | 11 | 64QAM | 19 | 9992 | 24 | 1 | 2 | 19800 | 3300 |
| | 26 | 11 | 64QAM | 19 | 10504 | 24 | 1 | 2 | 20592 | 3432 |
| | 31 | 11 | 64QAM | 19 | 12296 | 24 | 1 | 2 | 24552 | 4092 |
| | 33 | 11 | 64QAM | 19 | 13064 | 24 | 1 | 2 | 26136 | 4356 |
| | 38 | 11 | 64QAM | 19 | 15112 | 24 | 1 | 2 | 30096 | 5016 |
| | 39 | 11 | 64QAM | 19 | 15624 | 24 | 1 | 2 | 30888 | 5148 |
| | 47 | 11 | 64QAM | 19 | 18960 | 24 | 1 | 3 | 37224 | 6204 |
| | 51 | 11 | 64QAM | 19 | 20496 | 24 | 1 | 3 | 40392 | 6732 |
| | 52 | 11 | 64QAM | 19 | 21000 | 24 | 1 | 3 | 41184 | 6864 |
| | 53 | 11 | 64QAM | 19 | 21000 | 24 | 1 | 3 | 41976 | 6996 |
| | 61 | 11 | 64QAM | 19 | 24567 | 24 | 1 | 3 | 48312 | 8052 |
| | 65 | 11 | 64QAM | 19 | 26120 | 24 | 1 | 4 | 51480 | 8580 |
| | 67 | 11 | 64QAM | 19 | 26632 | 24 | 1 | 4 | 53064 | 8844 |
| | 78 | 11 | 64QAM | 19 | 31240 | 24 | 1 | 4 | 61776 | 10296 |
| | 79 | 11 | 64QAM | 19 | 31752 | 24 | 1 | 4 | 62568 | 10428 |
| | 80 | 11 | 64QAM | 19 | 31752 | 24 | 1 | 4 | 63360 | 10560 |
| | 81 | 11 | 64QAM | 19 | 32264 | 24 | 1 | 4 | 64152 | 10692 |
| | 93 | 11 | 64QAM | 19 | 36896 | 24 | 1 | 5 | 73656 | 12276 |
| | 95 | 11 | 64QAM | 19 | 37896 | 24 | 1 | 5 | 75240 | 12540 |
| | 106 | 11 | 64QAM | 19 | 42016 | 24 | 1 | 5 | 83952 | 13992 |
| | 107 | 11 | 64QAM | 19 | 43032 | 24 | 1 | 6 | 84744 | 14124 |
| | 108 | 11 | 64QAM | 19 | 43032 | 24 | 1 | 6 | 85536 | 14256 |
| | 109 | 11 | 64QAM | 19 | 44040 | 24 | 1 | 6 | 86328 | 14388 |
| | 121 | 11 | 64QAM | 19 | 48168 | 24 | 1 | 6 | 95832 | 15972 |
| | 123 | 11 | 64QAM | 19 | 49176 | 24 | 1 | 6 | 97416 | 16236 |
| | 133 | 11 | 64QAM | 19 | 53288 | 24 | 1 | 7 | 105336 | 17556 |
| | 135 | 11 | 64QAM | 19 | 54296 | 24 | 1 | 7 | 106920 | 17820 |
| | 137 | 11 | 64QAM | 19 | 54296 | 24 | 1 | 7 | 108504 | 18084 |
| | 160 | 11 | 64QAM | 19 | 63528 | 24 | 1 | 8 | 126720 | 21120 |
| | 162 | 11 | 64QAM | 19 | 64552 | 24 | 1 | 8 | 128304 | 21384 |
| | 189 | 11 | 64QAM | 19 | 75792 | 24 | 1 | 9 | 149688 | 24948 |
| | 216 | 11 | 64QAM | 19 | 86040 | 24 | 1 | 11 | 171072 | 28512 |
| | 217 | 11 | 64QAM | 19 | 86040 | 24 | 1 | 11 | 171864 | 28644 |
| | 245 | 11 | 64QAM | 19 | 98376 | 24 | 1 | 12 | 194040 | 32340 |
| | 270 | 11 | 64QAM | 19 | 108552 | 24 | 1 | 13 | 213840 | 35640 |
| | 273 | 11 | 64QAM | 19 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.2.8-2: Void

Table A.2.2.8-3: Void

A.2.2.9 CP-OFDM 256QAM

Table A.2.2.9-1: Reference Channels for CP-OFDM 256QAM

| Parameter | Allocated resource blocks (L _{CRB}) | DFT-s-OFDM Symbols per slot (Note 1) | Modulation | MCS Index (Note 2) | 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 | | | | | Bits | Bits | | | Bits | |
| | 1 | 11 | 256QAM | 20 | 704 | 16 | 2 | 1 | 1056 | 132 |
| | 5 | 11 | 256QAM | 20 | 3496 | 16 | 2 | 1 | 5280 | 660 |
| | 9 | 11 | 256QAM | 20 | 6272 | 24 | 1 | 1 | 9504 | 1188 |
| | 10 | 11 | 256QAM | 20 | 7040 | 24 | 1 | 1 | 10560 | 1320 |
| | 11 | 11 | 256QAM | 20 | 7680 | 24 | 1 | 1 | 11616 | 1452 |
| | 12 | 11 | 256QAM | 20 | 8456 | 24 | 1 | 2 | 12672 | 1584 |
| | 13 | 11 | 256QAM | 20 | 9224 | 24 | 1 | 2 | 13728 | 1716 |
| | 15 | 11 | 256QAM | 20 | 10504 | 24 | 1 | 2 | 15840 | 1980 |
| | 18 | 11 | 256QAM | 20 | 12552 | 24 | 1 | 2 | 19008 | 2376 |
| | 19 | 11 | 256QAM | 20 | 13320 | 24 | 1 | 2 | 20064 | 2508 |
| | 24 | 11 | 256QAM | 20 | 16896 | 24 | 1 | 3 | 25344 | 3168 |
| | 25 | 11 | 256QAM | 20 | 17424 | 24 | 1 | 3 | 26400 | 3300 |
| | 26 | 11 | 256QAM | 20 | 18432 | 24 | 1 | 3 | 27456 | 3432 |
| | 31 | 11 | 256QAM | 20 | 22032 | 24 | 1 | 3 | 32736 | 4092 |
| | 33 | 11 | 256QAM | 20 | 23040 | 24 | 1 | 3 | 34848 | 4356 |
| | 38 | 11 | 256QAM | 20 | 26632 | 24 | 1 | 4 | 40128 | 5016 |
| | 39 | 11 | 256QAM | 20 | 27656 | 24 | 1 | 4 | 41184 | 5148 |
| | 47 | 11 | 256QAM | 20 | 32776 | 24 | 1 | 4 | 49632 | 6204 |
| | 51 | 11 | 256QAM | 20 | 35856 | 24 | 1 | 5 | 53856 | 6732 |
| | 52 | 11 | 256QAM | 20 | 36896 | 24 | 1 | 5 | 54912 | 6864 |
| | 53 | 11 | 256QAM | 20 | 36896 | 24 | 1 | 5 | 55968 | 6996 |
| | 61 | 11 | 256QAM | 20 | 43032 | 24 | 1 | 6 | 64416 | 8052 |
| | 65 | 11 | 256QAM | 20 | 46104 | 24 | 1 | 6 | 68640 | 8580 |
| | 67 | 11 | 256QAM | 20 | 47112 | 24 | 1 | 6 | 70752 | 8844 |
| | 78 | 11 | 256QAM | 20 | 55304 | 24 | 1 | 7 | 82368 | 10296 |
| | 79 | 11 | 256QAM | 20 | 55304 | 24 | 1 | 7 | 83424 | 10428 |
| | 80 | 11 | 256QAM | 20 | 56368 | 24 | 1 | 7 | 84480 | 10560 |
| | 81 | 11 | 256QAM | 20 | 57376 | 24 | 1 | 7 | 85536 | 10692 |
| | 93 | 11 | 256QAM | 20 | 65576 | 24 | 1 | 8 | 98208 | 12276 |
| | 95 | 11 | 256QAM | 20 | 67584 | 24 | 1 | 8 | 100320 | 12540 |
| | 106 | 11 | 256QAM | 20 | 73776 | 24 | 1 | 9 | 111936 | 13992 |
| | 107 | 11 | 256QAM | 20 | 75792 | 24 | 1 | 9 | 112992 | 14124 |
| | 108 | 11 | 256QAM | 20 | 75792 | 24 | 1 | 9 | 114048 | 14256 |
| | 109 | 11 | 256QAM | 20 | 75792 | 24 | 1 | 9 | 115104 | 14388 |
| | 121 | 11 | 256QAM | 20 | 86040 | 24 | 1 | 11 | 127776 | 15972 |
| | 123 | 11 | 256QAM | 20 | 86040 | 24 | 1 | 11 | 129888 | 16236 |
| | 133 | 11 | 256QAM | 20 | 94248 | 24 | 1 | 12 | 140448 | 17556 |
| | 135 | 11 | 256QAM | 20 | 94248 | 24 | 1 | 12 | 142560 | 17820 |
| | 137 | 11 | 256QAM | 20 | 96264 | 24 | 1 | 12 | 144672 | 18084 |
| | 160 | 11 | 256QAM | 20 | 112648 | 24 | 1 | 14 | 168960 | 21120 |
| | 162 | 11 | 256QAM | 20 | 114776 | 24 | 1 | 14 | 171072 | 21384 |
| | 189 | 11 | 256QAM | 20 | 131176 | 24 | 1 | 16 | 199584 | 24948 |
| | 216 | 11 | 256QAM | 20 | 151608 | 24 | 1 | 18 | 228096 | 28512 |
| | 217 | 11 | 256QAM | 20 | 151608 | 24 | 1 | 18 | 229152 | 28644 |
| | 245 | 11 | 256QAM | 20 | 172176 | 24 | 1 | 21 | 258720 | 32340 |
| | 270 | 11 | 256QAM | 20 | 188576 | 24 | 1 | 23 | 285120 | 35640 |
| | 273 | 11 | 256QAM | 20 | 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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-2 defined in TS 38.214 [10].

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)

NOTE 4: The RMCs apply to all channel bandwidth where L_{CRB} ≤ N_{RB}.

Table A.2.2.9-2: Void

Table A.2.2.9-3: Void

A.2.3 Reference measurement channels for TDD

The TDD UL RMCs are defined in clause A.2.2 with the active UL slots specified in table A.2.1-1 and TDD slot patterns as defined for reference sensitivity tests.

A.2.3.1 DFT-s-OFDM Pi/2-BPSK

Table A.2.3.1-1: Void

Table A.2.3.1-2: Void

Table A.2.3.1-3: Void

A.2.3.2 DFT-s-OFDM QPSK

Table A.2.3.2-1: Void

Table A.2.3.2-2: Void

Table A.2.3.2-3: Void

A.2.3.3 DFT-s-OFDM 16QAM

Table A.2.3.3-1: Void

Table A.2.3.3-2: Void

Table A.2.3.3-3: Void

A.2.3.4 DFT-s-OFDM 64QAM

Table A.2.3.4-1: Void

Table A.2.3.4-2: Void

Table A.2.3.4-3: Void

A.2.3.5 DFT-s-OFDM 256QAM

Table A.2.3.5-1: Void

Table A.2.3.5-2: Void

Table A.2.3.5-3: Void

A.2.3.6 CP-OFDM QPSK

Table A.2.3.6-1: Void

Table A.2.3.6-2: Void

Table A.2.3.6-3: Void

A.2.3.7 CP-OFDM 16QAM

Table A.2.3.7-1: Void

Table A.2.3.7-2: Void

Table A.2.3.7-3: Void

A.2.3.8 CP-OFDM 64QAM

Table A.2.3.8-1: Void

Table A.2.3.8-2: Void

Table A.2.3.8-3: Void

A.2.3.9 CP-OFDM 256QAM

Table A.2.3.9-1: Void

Table A.2.3.9-2: Void

Table A.2.3.9-3: Void

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 clauses 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 clauses 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 clauses 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.

In case of carrier aggregation scenarios, the k1 values and number of HARQ processes of the Reference Measurement Channels specified in Annex A.3 shall be adapted as specified in table A.3.1-2 and A.3.1-3.

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 |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS (k ₀) | | 0 for CSI-RS resource 1,2,3,4 |
| | OFDM symbols in the PRB used for CSI-RS | | l ₀ = 6 for CSI-RS resource 1 and 3 l ₀ = 10 for CSI-RS resource 2 and 4 |
| | Number of CSI-RS ports | | 1 for CSI-RS resource 1,2,3,4 |
| | CDM Type | | 'No CDM' for CSI-RS resource 1,2,3,4 |
| | Density (ρ) | | 3 for CSI-RS resource 1,2,3,4 |
| | CSI-RS periodicity | Slots | 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 60 kHz SCS: 80 for CSI-RS resource 1,2,3,4 |
| | CSI-RS offset | Slots | 15 kHz SCS: 0 for CSI-RS resource 1 and 2 1 for CSI-RS resource 3 and 4 30 kHz SCS: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4 60 kHz SCS: 2 for CSI-RS resource 1 and 2 3 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | Start PRB 0 Number of PRB = BWP size |
| QCL info | | | TCI state #0 |
| PTRS configuration | | | PTRS is not configured |

Table A.3.1-2: Carrier aggregation test parameters for K1 values

| The number of slots between PDSCH and corresponding HARQ-ACK information | | CCs with the same duplex mode and SCS with Pcell | CCs with different duplex mode and/or SCS with Pcell |
|--|-------------|--|--|
| FDD 15 kHz + FDD 15 kHz CA | FDD PCell | {2} | N/A |
| FDD 15 kHz + FDD 30 kHz CA | 15kHz PCell | {2} | {3} |
| | 30kHz PCell | {2} | {2} |
| FDD 15 kHz + TDD 15 kHz CA | FDD PCell | {2} | {2} |
| | TDD PCell | {4,3,2} | {4,3,2,6,5} |
| FDD 15 kHz + TDD 30 kHz CA | FDD PCell | {2} | {3} |
| | TDD PCell | {8,7,6,5,4,3,2} | {8,6,4,2,10} |
| TDD 15 kHz + TDD 15 kHz CA | TDD PCell | {4,3,2} | N/A |
| TDD 15 kHz + TDD 30 kHz CA | 15kHz PCell | {4,3,2} | {4,4,3,3,2,7,6} |
| | 30kHz PCell | {8,7,6,5,4,3,2} | {7,5,4} |
| FDD 30 kHz + FDD 30 kHz CA | FDD PCell | {2} | N/A |
| FDD 30 kHz + TDD 15 kHz CA | FDD PCell | {2} | {2} |
| | TDD PCell | {4,3,2} | {4,4,3,3,7,7,6,6,5,5} |
| FDD 30 kHz + TDD 30 kHz CA | FDD PCell | {2} | {2} |
| | TDD PCell | {8,7,6,5,4,3,2} | {8,7,6,5,4,3,2,2,10,-} {(NOTE 1)} |
| TDD 30 kHz + TDD 30 kHz CA | TDD PCell | {8,7,6,5,4,3,2} | N/A |

NOTE 1: No PDSCH shall be scheduled in slots 9 and 19 to avoid HARQ conflicts and maximize Throughput. Hence no K1 value is applicable for them.

Table A.3.1-3: Carrier Aggregation test parameters for number of HARQ processes

| HARQ process number | | CCs with the same duplex mode and SCS with Pcell | CCs with different duplex mode and/or SCS with Pcell |
|-------------------------------|-------------|--|--|
| FDD 15 kHz + FDD 15 kHz CA | FDD PCell | 4 | N/A |
| FDD 15 kHz + FDD 30 kHz CA | 15kHz PCell | 8 | 8 |
| | 30kHz PCell | 8 | 8 |
| FDD 15 kHz + TDD 15 kHz CA | FDD PCell | 4 | 8 |
| | TDD PCell | 8 | 8 |
| FDD 15 kHz + TDD 30 kHz CA | FDD PCell | 4 | 8 |
| | TDD PCell | 10 | 8 |
| TDD 15 kHz + TDD 15 kHz CA | TDD PCell | 8 | N/A |
| TDD 15 kHz + TDD 30 kHz CA | 15kHz PCell | 8 | 12 |
| | 30kHz PCell | 8 | 8 |
| FDD 30 kHz + FDD 30 kHz CA | FDD PCell | 8 | N/A |
| FDD 30 kHz + TDD 15 kHz CA | FDD PCell | 8 | 8 |
| | TDD PCell | 8 | 16 |

| | | | |
|-------------------------------|-----------|---|-----|
| FDD 30 kHz + TDD 30 kHz CA | FDD PCell | 8 | 8 |
| | TDD PCell | 8 | 16 |
| TDD 30 kHz + TDD 30 kHz CA | TDD PCell | 8 | N/A |

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 | | | | | | | |
|---|------------|----------|-----------|-----------|-----------|-----------|-----------|------------|-------------|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| 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 μ | | 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 | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 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 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 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 Slots 0,1 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,3,4,5,6,7,8,9 | CBs | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot | | | | | | | | | |
| For Slots 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,3,4,5,6,7,8,9 | Bits | 5400 | 11232 | 17064 | 22896 | 28728 | 34560 | 46656 | 58320 |
| Max. Throughput averaged over 1 frame | Mbps | 1.338 | 2.694 | 4.096 | 5.530 | 6.970 | 8.403 | 11.27 0 | 13.93 92 |

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.3.2.2-2 Fixed reference channel for receiver requirements (SCS 30 kHz, FDD, QPSK 1/3)

| Parameter | Unit | Value | | | | | | | | |
|---|------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 |
| Channel bandwidth | MHz | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Subcarrier spacing configuration ^μ | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of subcarriers | | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 |
| Number of resource blocks | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Number of OFDM symbols per Frame | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Number of OFDM symbols per slot | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Modulation scheme | | 64QAM | | | | | | | | |
| Code rate | | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Code rate | | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Number of HARQ transmissions | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of bits per Slot | | | | | | | | | | |
| | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Bits | 1608 | 2472 | 3368 | 4224 | 4992 | 6912 | 8712 | 10504 | 14088 |
| Number of CRC | Bits | 16 | 16 | 16 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot | | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| Number of Channel Bits per Slot | | | | | | | | | | |
| | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Bits | 5184 | 8208 | 11016 | 14040 | 16848 | 22896 | 28728 | 34992 | 46872 |
| Average throughput | Mbps | 2.734 | 4.202 | 5.726 | 7.181 | 8.486 | 11.750 | 14.810 | 17.857 | 23.950 |

Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.

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).

The first Code Block is transmitted in slot #0 of each frame

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 | | | | | | | | | |
|---|------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 90 |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 90 |
| Spacing configuration μ | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Number of resource blocks | | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 107 | 127 |
| Number of resource blocks per Frame | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Number of subcarriers per Frame | | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Number of subcarriers per TBS Determination | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Modulation | | 64QAM | | | | | | | | | |
| Code Rate | | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Number of HARQ transmissions | | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Number of HARQ transmissions per Slot | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of HARQ transmissions per Slot | | | | | | | | | | | |
| Number of HARQ transmissions per Slot | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Number of HARQ transmissions per Slot | Bits | 736 | 1192 | 1608 | 2024 | 2472 | 3368 | 4224 | 5120 | 6912 | 7808 |
| Number of HARQ transmissions per Slot | Bits | 16 | 16 | 16 | 16 | 16 | 16 | 24 | 24 | 24 | 24 |
| Number of HARQ transmissions per Slot | | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Number of HARQ transmissions per Slot | | | | | | | | | | | |
| Number of HARQ transmissions per Slot | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Number of HARQ transmissions per Slot | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of HARQ transmissions per Slot | | | | | | | | | | | |
| Number of HARQ transmissions per Slot | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Number of HARQ transmissions per Slot | Bits | 2376 | 3888 | 5184 | 6696 | 8208 | 11016 | 14040 | 17064 | 23112 | 26112 |
| Number of HARQ transmissions per Slot | Mbps | 2.650 | 4.291 | 5.789 | 7.286 | 8.899 | 12.125 | 15.206 | 18.432 | 24.883 | 28.125 |

Additional parameters are specified in Table A.3.1-1 and Table A.3.2.1-1.

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).

Number of PBCH blocks is transmitted in slot #0 of each frame

where 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 | | | | | | | |
|---|------|--------|--------|--------|--------|--------|--------|--------|---------|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| 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 ^μ | | 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 | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 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 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 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 Slots 0,1 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,3,4,5,6,7,8,9 | CBs | 2 | 4 | 5 | 7 | 8 | 10 | 13 | 16 |
| Binary Channel Bits per Slot | | | | | | | | | |
| For Slots 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,3,4,5,6,7,8,9 | Bits | 16200 | 33696 | 51192 | 68688 | 86184 | 103680 | 139968 | 174960 |
| Max. Throughput averaged over 1 frame | Mbps | 9.837 | 20.486 | 31.149 | 41.779 | 51.642 | 62.317 | 85.261 | 104.941 |
| 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 | | | | | | | | | |
|---|------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Channel bandwidth | MHz | | | | | | | | | | |
| Subcarrier spacing configuration ^μ | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks | | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| 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 0,1,2 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 3,...,19 | Bits | 11784 | 18432 | 25104 | 31752 | 37896 | 52224 | 64552 | 79896 | 106576 | 135296 |
| 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 0,1,2 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 3,...,19 | CBs | 2 | 3 | 3 | 4 | 5 | 7 | 8 | 10 | 13 | 17 |
| Binary Channel Bits per Slot | | | | | | | | | | | |
| For Slots 0,1,2 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 3,...,19 | Bits | 15552 | 24624 | 33048 | 42120 | 50544 | 68688 | 86184 | 104976 | 140616 | 176904 |
| Max. Throughput averaged over 1 frame | Mbps | 20.033 | 31.334 | 42.677 | 53.978 | 64.423 | 88.781 | 109.738 | 135.823 | 181.179 | 230.003 |
| 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 | | | | | | | | | | |
|---|------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------------|-------------|-------------|-----------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 | |
| Channel bandwidth | MHz | | | | | | | | | | | |
| Subcarrier spacing configuration ^u | | 2 | 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 | 12 |
| Allocated slots per Frame | | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| 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 0,1,2,3 | 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 4,...,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 | 24 |
| LDPC base graph | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot | | | | | | | | | | | | |
| For Slots 0,1,2,3 | 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 4,...,39 | CBs | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 7 | 8 | |
| Binary Channel Bits per Slot | | | | | | | | | | | | |
| For Slots 0,1,2,3 | 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 4,...,39 | Bits | 7128 | 11664 | 15552 | 20088 | 24624 | 33048 | 42120 | 51192 | 69336 | 87480 | |
| Max. Throughput averaged over 1 frame | Mbps | 19.354 | 31.363 | 42.422 | 54.403 | 66.355 | 90.374 | 114.30 7 | 140.17 0 | 188.00 6 | 236.07 4 | |
| 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 | | | | | | | |
|---|------------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Channel bandwidth | MHz | | | | | | | | |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration μ | | 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 | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 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 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 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 Slots 0,1 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,3,4,5,6,7,8,9 | CBs | 3 | 5 | 7 | 9 | 11 | 13 | 18 | 22 |
| Binary Channel Bits per Slot | | | | | | | | | |
| For Slots 0,1 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,3,4,5,6,7,8,9 | Bits | 21600 | 44928 | 68256 | 91584 | 114912 | 138240 | 186624 | 233280 |
| Max. Throughput averaged over 1 frame | Mbps | 13.517 | 27.853 | 42.630 | 57.350 | 72.141 | 86.842 | 114.720 | 144.301 |
| 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 | | | | | | | | | |
|---|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Channel bandwidth | MHz | | | | | | | | | | |
| Subcarrier spacing configuration ^μ | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks | | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| 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 0,1,2 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 3,...,19 | Bits | 16136 | 25608 | 33816 | 44040 | 52224 | 71688 | 90176 | 108552 | 147576 | 184424 |
| 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 0,1,2 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 3,...,19 | CBs | 2 | 4 | 5 | 6 | 7 | 9 | 11 | 13 | 18 | 22 |
| Binary Channel Bits per Slot | | | | | | | | | | | |
| For Slots 0,1,2 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 3,...,19 | Bits | 20736 | 32832 | 44064 | 56160 | 67392 | 91584 | 114912 | 139968 | 187488 | 235872 |
| Max. Throughput averaged over 1 frame | Mbps | 27.431 | 43.534 | 57.487 | 74.868 | 88.781 | 121.870 | 153.299 | 184.538 | 250.879 | 313.521 |
| 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 | | | | | | | | | |
|---|------|--------|----|----|----|----|----|----|----|-----|-----|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Channel bandwidth | MHz | | | | | | | | | | |
| Subcarrier spacing configuration ^μ | | 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 | | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| 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 0,1,2,3 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 4,...,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 0,1,2,3 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 4,...,39 | CBs | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 9 | 11 |
| Binary Channel Bits per Slot | | | | | | | | | | | |
| For Slots 0,1,2,3 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 4,...,39 | Bits | 9504 | 15552 | 20736 | 26784 | 32832 | 44064 | 56160 | 68256 | 92448 | 116640 |
| Max. Throughput averaged over 1 frame | Mbps | 26.726 | 43.344 | 58.090 | 75.600 | 92.189 | 121.73 8 | 158.54 4 | 191.83 7 | 258.07 7 | 324.63 4 |
| 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 ($\mu=0$) | SCS 30 kHz ($\mu=1$) | SCS 60 kHz ($\mu=2$) |
| TDD Slot Configuration pattern (Note 1) | | DDDSU | 7DS2U | 14DS ₁ S ₂ 4U |
| Special Slot Configuration (Note 2) | | 10D+2G+2U | 6D+4G+4U | S ₁ =12D+2G, S ₂ =6G+8U |
| referenceSubcarrierSpacing | | 15 kHz | 30 kHz | 60 kHz |
| UL-DL configuration | dl-UL-TransmissionPeriodicity | 5 ms | 5 ms | 5 ms |
| | nrofDownlinkSlots | 3 | 7 | 14 |
| | nrofDownlinkSymbols | 10 | 6 | 12 |
| | nrofUplinkSlot | 1 | 2 | 4 |
| | nrofUplinkSymbols | 2 | 4 | 8 |
| Number of HARQ Processes | | 8 | 8 | 16 |
| The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) | | 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 = 13 if mod(i,20) = 2 K1 = 12 if mod(i,20) = 3 K1 = 11 if mod(i,20) = 4 K1 = 10 if mod(i,20) = 5 K1 = 9 if mod(i,20) = 6 K1 = 8 if mod(i,20) = 7 K1 = 7 if mod(i,20) = 8 K1 = 6 if mod(i,20) = 9 K1 = 6 if mod(i,20) = 10 K1 = 6 if mod(i,20) = 11 K1 = 6 if mod(i,20) = 12 K1 = 6 if mod(i,20) = 13 where i is slot index per frame; i = {0,...,39} |
| NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. | | | | |
| NOTE 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. | | | | |
| NOTE 3: i is the slot index per frame. | | | | |
| NOTE 4: A -2ms or +3ms time offset to the NR configuration pattern relative to the E-UTRA UL-DL configuration must be apply in the TDD intra-band EN-DC. | | | | |

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 | | | | | | | |
|---|------|-------|------|------|------|------|-------|-------|-------|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| 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 μ | | 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 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 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 0,1,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 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 0,1,3,4,8,9 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,5,6,7 | CBs | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot | | | | | | | | | |
| For Slots 0,1,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,5,6,7 | Bits | 5400 | 11232 | 17064 | 22896 | 28728 | 34560 | 46656 | 58320 |
| Max. Throughput averaged over 1 frame | Mbps | 0.669 | 1.347 | 2.048 | 2.765 | 3.485 | 4.202 | 5.635 | 6.970 |
| 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 | | | | | | | | | |
|---|------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Channel bandwidth | MHz | | | | | | | | | | |
| Subcarrier spacing configuration ^μ | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks | | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 217 | 273 |
| Subcarriers per resource block | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per Frame | | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| 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 0,1,2 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 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,...,19} | Bits | 1608 | 2472 | 3368 | 4224 | 4992 | 6912 | 8712 | 10504 | 14088 | 17928 |
| Transport block CRC | Bits | 16 | 16 | 16 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph | | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot | | | | | | | | | | | |
| For Slots 0,1,2 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 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,...,19} | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| Binary Channel Bits per Slot | | | | | | | | | | | |
| For Slots 0,1,2 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 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,...,19} | Bits | 5184 | 8208 | 11016 | 14040 | 16848 | 22896 | 28728 | 34992 | 46872 | 58968 |
| Max. Throughput averaged over 1 frame | Mbps | 1.769 | 2.719 | 3.705 | 4.646 | 5.491 | 7.603 | 9.583 | 11.554 | 15.497 | 19.721 |
| 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 | | | | | | | | | |
|---|------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration ^u | | 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 | | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| 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 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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, 20) = {0,..., 13} for i from {4,...,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 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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, 20) = {0,..., 13} for i from {4,...,39} | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| Binary Channel Bits per Slot | | | | | | | | | | | |
| For Slots 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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, 20) = {0,...,13} for i from {4,...,39} | Bits | 2376 | 3888 | 5184 | 6696 | 8208 | 11016 | 14040 | 17064 | 23112 | 29160 |
| Max. Throughput averaged over 1 frame | Mbps | 1.766 | 2.861 | 3.859 | 4.858 | 5.933 | 8.083 | 10.138 | 12.288 | 16.589 | 20.909 |
| 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 | | | | | | | |
|---|------|--------|--------|--------|--------|--------|--------|--------|--------|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| 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 ^μ | | 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 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 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 0,1,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 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 0,1,3,4,8,9 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,5,6,7 | CBs | 2 | 4 | 5 | 7 | 8 | 10 | 13 | 16 |
| Binary Channel Bits per Slot | | | | | | | | | |
| For Slots 0,1,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,5,6,7 | Bits | 16200 | 33696 | 51192 | 68688 | 86184 | 103680 | 139968 | 174960 |
| Max. Throughput averaged over 1 frame | Mbps | 4.918 | 10.243 | 15.574 | 20.890 | 20.890 | 31.158 | 42.630 | 52.470 |
| 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 | | | | | | | | | | |
|---|------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|-------------|--------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 | |
| Channel bandwidth | MHz | | | | | | | | | | | |
| Subcarrier spacing configuration ^μ | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks | | 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 | | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| 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 0,1,2 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 {13,...,19} | Bits | 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 0,1,2 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 {3,...,19} | CBs | 2 | 3 | 3 | 4 | 5 | 7 | 8 | 10 | 13 | 17 | |
| Binary Channel Bits per Slot | | | | | | | | | | | | |
| For Slots 0,1,2 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 {3,...,19} | Bits | 15552 | 24624 | 33048 | 42120 | 50544 | 68688 | 86184 | 104976 | 140616 | 176904 | |
| Max. Throughput averaged over 1 frame | Mbps | 12.962 | 20.275 | 27.614 | 34.927 | 41.686 | 57.446 | 71.007 | 87.886 | 117.23 4 | 148.82 6 | |
| 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 | | | | | | | | | | |
|---|------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|--------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 | |
| Channel bandwidth | MHz | | | | | | | | | | | |
| Subcarrier spacing configuration ^u | | 2 | 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 | 12 |
| Allocated slots per Frame | | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| 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 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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 | N/A |
| For Slot i, if mod(i, 20) = {0,..., 13} for i from {4,...,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 | 24 |
| LDPC base graph | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot | | | | | | | | | | | | |
| For Slots 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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 | N/A |
| For Slot i, if mod(i, 20) = {0,..., 13} for i from {4,...,39} | CBs | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 7 | 8 | |
| Binary Channel Bits per Slot | | | | | | | | | | | | |
| For Slots 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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 | N/A |
| For Slot i, if mod(i, 20) = {0,..., 13} for i from {4,...,39} | Bits | 7128 | 11664 | 15552 | 20088 | 24624 | 33048 | 42120 | 51192 | 69336 | 87480 | |
| Max. Throughput averaged over 1 frame | Mbps | 12.902 | 20.909 | 28.282 | 36.269 | 44.237 | 60.250 | 76.205 | 93.446 | 125.338 | 157.382 | |
| 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 | | | | | | | |
|---|------------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Channel bandwidth | MHz | | | | | | | | |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Subcarrier spacing configuration ^μ | | 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 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 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 0,1,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 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 0,1,3,4,8,9 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,5,6,7 | CBs | 3 | 5 | 7 | 9 | 12 | 14 | 18 | 23 |
| Binary Channel Bits per Slot | | | | | | | | | |
| For Slots 0,1,3,4,8,9 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots 2,5,6,7 | Bits | 21600 | 44928 | 68256 | 91584 | 114912 | 138240 | 186624 | 233280 |
| Max. Throughput averaged over 1 frame | Mbps | 6.758 | 13.926 | 21.315 | 28.675 | 36.070 | 43.421 | 57.360 | 72.150 |
| 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 | | | | | | | | | | |
|---|------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|------------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 | |
| Channel bandwidth | MHz | | | | | | | | | | | |
| Subcarrier spacing configuration ^u | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Allocated resource blocks | | 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 | | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| 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 0,1,2 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 {3,...,19} | Bits | 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 0,1,2 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 {3,...,19} | CBs | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | |
| Binary Channel Bits per Slot | | | | | | | | | | | | |
| For Slots 0,1,2 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 {3,...,19} | Bits | 20736 | 32832 | 44064 | 56160 | 67392 | 91584 | 114912 | 139968 | 187488 | 235872 | |
| Max. Throughput averaged over 1 frame | Mbps | 17.750 | 28.169 | 37.198 | 48.444 | 57.446 | 78.857 | 99.194 | 119.40 7 | 162.33 4 | 202.86 6 | |
| 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 | | | | | | | | | |
|---|------|---------|---------|---------|---------|---------|---------|-------------|-------------|-------------|-------------|
| | | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Channel bandwidth | MHz | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 |
| Subcarrier spacing configuration ^μ | | 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 | | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| 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 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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, 20) = {0,..., 13} for i from {4,...,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 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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, 20) = {0,..., 13} for i from {4,...,39} | CBs | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 9 | 12 |
| Binary Channel Bits per Slot | | | | | | | | | | | |
| For Slots 0,1,2,3 and Slot i, if mod(i, 20) = {14,15,16,17,18,19} 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, 20) = {0,..., 13} for i from {4,...,39} | Bits | 9504 | 15552 | 20736 | 26784 | 32832 | 44064 | 56160 | 68256 | 92448 | 116640 |
| Max. Throughput averaged over 1 frame | Mbps | 17.818 | 28.896 | 38.726 | 50.400 | 61.459 | 81.158 | 105.69 6 | 127.89 1 | 172.05 1 | 216.42 2 |
| 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 to SSS | dB | 0 |
| EPRE ratio of PBCH to PBCH DMRS | dB | 0 |
| EPRE ratio of PDCCH to SSS | dB | 0 |
| EPRE ratio of PDCCH to PDCCH DMRS | dB | 0 |
| EPRE ratio of PDSCH to SSS | dB | 0 |
| 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 (normative): Characteristics of the interfering signal

D.1 General

Some RF performance requirements for the NR UE receiver are defined with interfering signals present in addition to the wanted signal.

For NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz, a modulated 5 MHz full bandwidth NR down link signal, and in some cases an additional CW signal, are used as interfering signal. For intra-band contiguous CA bandwidth class C, a modulated 5 MHz NR downlink signal is used. And for some cases an additional CW signal is used.

For NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz, a modulated NR downlink signal which equals to channel bandwidth of the wanted signal for single carrier and inter-band CA cases is used as interfering signal. For intra-band contiguous CA bandwidth Class C, a modulated NR downlink signal which equals to the aggregated channel bandwidth of the wanted signal is used. For intra-band contiguous CA bandwidth class D and E cases, a modulated 50 MHz NR downlink signal is used. And for some cases an additional CW signal is used.

D.2 Interference signals

Table D.2-1 and Table D.2-4 describes the modulated interferer for different channel bandwidth options for NR band lower than 2700MHz.

Table D.2-1: Description of modulated NR interferer for NR bands with $F_{DL_high} < 2700$ MHz and $F_{UL_high} < 2700$ MHz

| | Channel bandwidth | | | | | |
|--|-------------------|--------|--------|--------|--------|---------|
| | 5 MHz | 10MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| RB | NOTE 1 | | | | | |
| BW _{Interferer} | 5 MHz | | | | | |
| | Channel bandwidth | | | | | |
| | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| RB | NOTE 1 | | | | | |
| BW _{Interferer} | 5 MHz | | | | | |
| NOTE 1: The RB configured for interfering signal is the same as maximum RB number defined in Table 5.3.2-1 for each sub-carrier spacing. | | | | | | |

Table D.2-2 and Table D.2-3 describe the modulated interferer for different channel bandwidth options for NR band higher than 3300MHz.

Table D.2-2: Description of modulated NR interferer for NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz

| | Channel bandwidth | | | | | | | | |
|--|-------------------|--------|--------|--------|--------|--------|--------|--------|---------|
| | 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| RB | NOTE 1 | | | | | | | | |
| BW _{Interferer} | 10 MHz | 15 MHz | 20 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| NOTE 1: The RB configured for interfering signal is the same as maximum RB number defined in Table 5.3.2-1 for each sub-carrier spacing. | | | | | | | | | |

Table D.2-3: Description of modulated NR interferer for NR bands with $F_{DL_low} \geq 3300$ MHz and $F_{UL_low} \geq 3300$ MHz for Intra-band contiguous CA

| | Aggregated Channel bandwidth of Bandwidth Class C | | | | | | | | Bandwidth Class D/E |
|--|---|---------|---------|---------|---------|---------|---------|---------|---------------------|
| | 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz | 160 MHz | 180 MHz | 200 MHz | |
| | | | | | | | | | |

| | | | | | | | | | |
|--|---------|---------|---------|---------|---------|---------|---------|---------|-------|
| RB(SCS=30 kHz) | NOTE 1 | | | | | | | | 133 |
| RB(SCS=60 kHz) | NOTE 1 | | | | | | | | 65 |
| BW _{Interferer} | 110 MHz | 120 MHz | 130 MHz | 140 MHz | 150 MHz | 160 MHz | 180 MHz | 200 MHz | 50MHz |
| NOTE 1: The interfering signal shall be configured in the same way as the aggregated bandwidth of the wanted signal. The RB configurations for each component carrier are defined in Table 5.3.2-1 for each sub-carrier spacing. | | | | | | | | | |

Table D.2-4: Description of modulated NR interferer for NR bands with $F_{DL_low} < 2700$ MHz and $F_{UL_low} < 2700$ MHz for Intra-band contiguous CA

| | | | | | | | | | |
|--|--------------------------|--|--|--|--|--|--|--|--|
| | Bandwidth Class C | | | | | | | | |
| RB | NOTE 1 | | | | | | | | |
| BW _{Interferer} | 5 MHz | | | | | | | | |
| NOTE 1: The RB configured for interfering signal is the same as maximum RB number defined in Table 5.3.2-1 for each sub-carrier spacing. | | | | | | | | | |

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 fulfill 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 up 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 | 0,85 * nominal | Nominal | Nominal |
| Lithium | 0,95 * nominal | 1,1 * Nominal | 1,1 * Nominal |
| Mercury/nickel & cadmium | 0,90 * 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 m ² /s ³ |
| 20 Hz to 500 Hz | 0.96 m ² /s ³ 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.0 General

While measuring the transmit modulation quality of carriers, an existence of the carrier leakage needs to be taken into account indicated by the parameter *txDirectCurrentLocation* in *UplinkTxDirectCurrent* IE.

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).

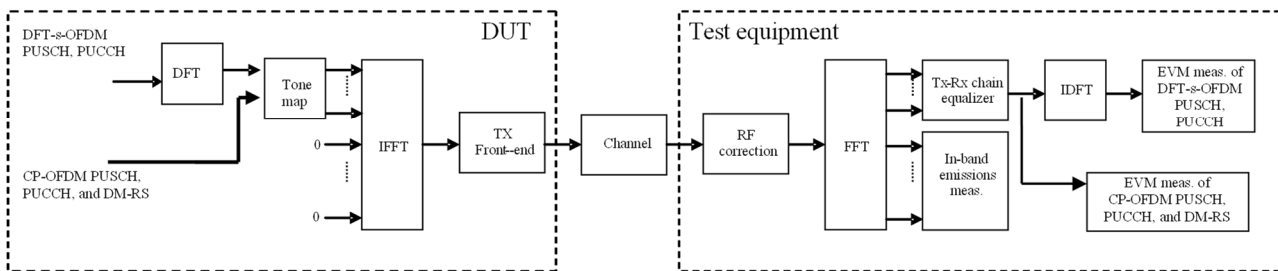


Figure F.1-1: EVM measurement points

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)

$$EVM = \sqrt{\frac{\sum_{v \in T_m} |z'(v) - i(v)|^2}{|T_m| \cdot P_0}}$$

where

T_m is a set of $|T_m|$ modulation symbols with the considered modulation scheme being active within the measurement period,

$z'(v)$ are the samples of the signal evaluated for the EVM,

$i(v)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 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

$$Emissions_{absolute}(\Delta_{RB}) = \begin{cases} \frac{1}{|T_s|} \sum_{t \in T_s} \sum_{f_i + (12 \cdot \Delta_{RB} + 11) \cdot \Delta f}^{\max(f_{\min}, f_i + 12 \cdot \Delta_{RB} \cdot \Delta f)} |Y(t, f)|^2, \Delta_{RB} < 0 \\ \frac{1}{|T_s|} \sum_{t \in T_s} \sum_{f_h + (12 \cdot \Delta_{RB} - 11) \cdot \Delta f}^{\min(f_{\max}, f_h + 12 \cdot \Delta_{RB} \cdot \Delta f)} |Y(t, f)|^2, \Delta_{RB} > 0 \end{cases},$$

where

T_s is a set of $|T_s|$ OFDM symbols with the considered modulation scheme being active within the measurement period,

Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB} = 1$ or $\Delta_{RB} = -1$ for the first adjacent RB),

f_{\min} (resp. f_{\max}) is the lower (resp. upper) edge of the UL UE channel bandwidth,

f_i and f_h are the lower and upper edge of the allocated BW, and

$Y(t, f)$ is the frequency domain signal evaluated for in-band emissions as defined in the clause (ii)

The relative in-band emissions are, given by

$$Emissions_{relative}(\Delta_{RB}) = \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_s| \cdot N_{RB}} \sum_{t \in T_s} \sum_{f_i + (12 \cdot N_{RB} - 1) \Delta f}^{\max(f_{\min}, f_i + 12 \cdot N_{RB} \cdot \Delta f)} |Y(t, f)|^2}$$

where

N_{RB} 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 $\Delta \tilde{t} = \Delta \tilde{c}$, where sample time offsets $\Delta \tilde{t}$ and $\Delta \tilde{c}$ are defined in clause 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 DFT-s-OFDM modulated signals or PRACH signal under test is modified and, in the case of DFT-s-OFDM modulated signals, decoded according to:

$$Z'(t, f) = IDFT \left\{ \frac{FFT \left\{ z(v - \Delta\tilde{t}) \cdot e^{-j2\pi\Delta\tilde{f}v} \right\} e^{j2\pi f \Delta\tilde{t}}}{\tilde{a}(t, f) \cdot e^{j\tilde{\varphi}(t, f)}} \right\}$$

where

$z(v)$ is the time domain samples of the signal under test.

The CP-OFDM modulated signals or PUSCH demodulation reference signal or PUCCH data signal under test is equalised and, in the case of CP-OFDM modulated signals decoded according to:

$$Z'(t, f) = \frac{FFT \left\{ z(v - \Delta\tilde{t}) \cdot e^{-j2\pi\Delta\tilde{f}v} \right\} e^{j2\pi f \Delta\tilde{t}}}{\tilde{a}(t, f) \cdot e^{j\tilde{\varphi}(t, f)}}$$

where

$z(v)$ 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:

$\Delta\tilde{t}$ is the sample timing difference between the FFT processing window in relation to nominal timing of the ideal signal.

$\Delta\tilde{f}$ is the RF frequency offset.

$\tilde{\varphi}(t, f)$ is the phase response of the TX chain.

$\tilde{a}(t, f)$ is the amplitude response of the TX chain.

In the following $\Delta\tilde{t}$ represents the middle sample of the EVM window of length W (defined in the next clauses) or the last sample of the first window half if W is even.

The EVM analyser shall

- detect the start of each slot and estimate $\Delta\tilde{t}$ and $\Delta\tilde{f}$,
- determine $\Delta\tilde{t}$ so that the EVM window of length W 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 $l = 7 \cdot 2^\mu$ 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 $1/T_c$ 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 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 $\Delta\tilde{t}$ is corrected from the signal under test. The EVM analyser shall then

- correct the RF frequency offset $\Delta\tilde{f}$ 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), $Y(t, f)$, 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 $\tilde{a}(t, f)$ and $\tilde{\varphi}(t, f)$ 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 $\tilde{a}(t)$ and $\tilde{\varphi}(t)$ used for phase and amplitude correction and are selected so as to minimize the resulting EVM. The TX chain coefficients are not dependent on frequency, i.e. $\tilde{a}(t, f) = \tilde{a}(t)$ and $\tilde{\varphi}(t, f) = \tilde{\varphi}(t)$. The TX chain coefficients are chosen independently for each preamble transmission and for each $\Delta\tilde{f}$.

At this stage estimates of $\hat{\Delta\tilde{f}}$, $\tilde{a}(t, f)$, $\tilde{\varphi}(t, f)$ and $\Delta\tilde{f}$ are available. $\Delta\tilde{f}$ is one of the extremities of the window W , i.e. $\Delta\tilde{f}$ can be $\Delta\tilde{c} + \alpha - \left\lfloor \frac{W}{2} \right\rfloor$ or $\Delta\tilde{c} + \left\lfloor \frac{W}{2} \right\rfloor$, where $\alpha = 0$ if W is odd and $\alpha = 1$ if W is even. The EVM analyser shall then

- calculate EVM_l with $\Delta\tilde{f}$ set to $\Delta\tilde{c} + \alpha - \left\lfloor \frac{W}{2} \right\rfloor$,
- calculate EVM_h with $\Delta\tilde{f}$ set to $\Delta\tilde{c} + \left\lfloor \frac{W}{2} \right\rfloor$.

F.5 Window length

F.5.1 Timing offset

As a result of using a cyclic prefix, there is a range of $\Delta\tilde{f}$, 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 $\Delta\tilde{f}$ range within which the error vector is close to its minimum.

F.5.2 Window length

The window length W 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

Table F.5.3-1, F.5.3-2, F.5.3-3 below specify the EVM window length (W) for normal CP.

Table F.5.3-1: EVM window length for normal CP for NR, FR1, 15 kHz SCS

| Channel Bandwidth (MHz) | FFT size | Cyclic prefix length for symbols 1-6 and 8-13 in FFT samples | EVM window length W | Ratio of W to total CP length for symbols 1-6 and 8-13 ¹ (%) |
|-------------------------|----------|--|-----------------------|---|
| 5 | 512 | 36 | 18 | 50 |
| 10 | 1024 | 72 | 36 | 50 |
| 15 | 1536 | 108 | 54 | 50 |
| 20 | 2048 | 144 | 72 | 50 |
| 25 | 2048 | 144 | 72 | 50 |
| 30 | 3072 | 216 | 108 | 50 |
| 40 | 4096 | 288 | 144 | 50 |
| 50 | 4096 | 288 | 144 | 50 |

NOTE 1: These percentages are informative and apply to a slot's symbols 1 to 6 and 8 to 13. Symbols 0 and 7 have a longer CP and therefore a lower percentage.

Table F.5.3-2: EVM window length for normal CP for NR, FR1, 30 kHz SCS

| Channel Bandwidth (MHz) | FFT size | Cyclic prefix length for symbols 1-13 in FFT samples | EVM window length W | Ratio of W to total CP length for symbols 1-13 ¹ (%) |
|-------------------------|----------|--|-----------------------|---|
| 5 | 256 | 18 | 9 | 50 |
| 10 | 512 | 36 | 18 | 50 |
| 15 | 768 | 54 | 27 | 50 |
| 20 | 1024 | 72 | 36 | 50 |
| 25 | 1024 | 72 | 36 | 50 |
| 30 | 1536 | 108 | 54 | 50 |
| 40 | 2048 | 144 | 72 | 50 |
| 50 | 2048 | 144 | 72 | 50 |
| 60 | 3072 | 216 | 108 | 50 |
| 70 | 3072 | 216 | 108 | 50 |
| 80 | 4096 | 288 | 144 | 50 |
| 90 | 4096 | 288 | 144 | 50 |
| 100 | 4096 | 288 | 144 | 50 |

NOTE 1: These percentages are informative and apply to a slot's symbols 1 through 13. Symbol 0 has a longer CP and therefore a lower percentage.

Table F.5.3-3: EVM window length for normal CP for NR (60 kHz SCS)

| Channel Bandwidth (MHz) | FFT size | Cyclic prefix length for symbols in FFT samples | EVM window length W | Ratio of W to total CP length ¹ (%) |
|-------------------------|----------|---|-----------------------|--|
| 10 | 256 | 18 | 9 | 50 |
| 15 | 384 | 27 | 14 | 50 |
| 20 | 512 | 36 | 18 | 50 |
| 25 | 512 | 36 | 18 | 50 |
| 30 | 768 | 54 | 27 | 50 |
| 40 | 1024 | 72 | 36 | 50 |
| 50 | 1024 | 72 | 36 | 50 |
| 60 | 1536 | 108 | 54 | 50 |
| 70 | 1536 | 108 | 54 | 50 |
| 80 | 2048 | 144 | 72 | 50 |
| 90 | 2048 | 144 | 72 | 50 |

| | | | | |
|--|------|-----|----|----|
| 100 | 2048 | 144 | 72 | 50 |
| NOTE 1: These percentages are informative and apply to all OFDM symbols within subframe except for symbol 0 of slot 0 and slot 2. Symbol 0 of slot 0 and slot 2 may have a longer CP and therefore a lower percentage. | | | | |

F.5.4 Window length for Extended CP

Table F.5.4-1 below specifies the EVM window length (W) for extended CP. The number of CP samples excluded from the EVM window is the same as for normal CP length.

Table F.5.4-1: EVM window length for extended CP for NR, FR1, 60 kHz SCS

| Channel Bandwidth (MHz) | FFT size | Cyclic prefix length in FFT samples | EVM window length W | Ratio of W to total CP length ¹ (%) |
|--|----------|-------------------------------------|-----------------------|--|
| 10 | 256 | 64 | 54 | 84.4 |
| 15 | 384 | 96 | 80 | 83.3 |
| 20 | 512 | 128 | 106 | 82.8 |
| 25 | 512 | 128 | 110 | 85.9 |
| 30 | 768 | 192 | 164 | 85.4 |
| 40 | 1024 | 256 | 220 | 85.9 |
| 50 | 1024 | 256 | 220 | 85.9 |
| 60 | 1536 | 384 | 330 | 85.9 |
| 70 | 1536 | 384 | 330 | 85.9 |
| 80 | 2048 | 512 | 440 | 85.9 |
| 90 | 2048 | 512 | 440 | 85.9 |
| 100 | 2048 | 512 | 440 | 85.9 |
| NOTE 1: These percentages are informative. | | | | |

F.5.5 Window length for PRACH

The table below specifies the EVM window length for PRACH preamble formats for $L_{RA}= 839$ and $\Delta f^{RA} \in \{1.25, .5\}$ kHz.

Table F.5.5-1 EVM window length for PRACH formats for $L_{RA}= 839$

| Preamble format | Cyclic prefix length N_{CP} | Nominal FFT size ¹ | EVM window length W in FFT samples | Ratio of W to CP ² |
|---|-------------------------------|-------------------------------|--------------------------------------|---------------------------------|
| 0 | 3168 | 24576 | 2307 | 72.8% |
| 1 | 21024 | 24576 | 20163 | 95.9% |
| 2 | 4688 | 24576 | 3827 | 81.6% |
| 3 | 3168 | 6144 | 2952 | 93.2% |
| NOTE 1: The use of other FFT sizes is possible as long as appropriate scaling of the window length is applied | | | | |
| NOTE 2: These percentages are informative | | | | |

The table below specifies the EVM window length for PRACH preamble formats for $L_{RA}= 139$ and $\Delta f^{RA} = 15 \cdot 2^{-\mu}$ kHz where $\mu \in \{0,1,2\}$.

Table F.5.5-2 EVM window length for PRACH formats for $L_{RA}= 139$

| Preamble format | Cyclic prefix length N_{CP} | Nominal FFT size ¹ | EVM window length W in FFT samples | Ratio of W to CP ² |
|-----------------|-------------------------------|-------------------------------|--------------------------------------|---------------------------------|
| A1 | $288 \cdot 2^{-\mu}$ | $2048 \cdot 2^{-\mu}$ | $144 \cdot 2^{-\mu}$ | 50.0% |
| A2 | $576 \cdot 2^{-\mu}$ | $2048 \cdot 2^{-\mu}$ | $432 \cdot 2^{-\mu}$ | 75.0% |

| | | | | |
|---|----------------------|----------------------|----------------------|-------|
| A3 | 864·2 ^{-μ} | 2048·2 ^{-μ} | 720·2 ^{-μ} | 83.3% |
| B1 | 216·2 ^{-μ} | 2048·2 ^{-μ} | 72·2 ^{-μ} | 33.3% |
| B2 | 360·2 ^{-μ} | 2048·2 ^{-μ} | 216·2 ^{-μ} | 60.0% |
| B3 | 504·2 ^{-μ} | 2048·2 ^{-μ} | 360·2 ^{-μ} | 71.4% |
| B4 | 936·2 ^{-μ} | 2048·2 ^{-μ} | 792·2 ^{-μ} | 84.6% |
| C0 | 1240·2 ^{-μ} | 2048·2 ^{-μ} | 1096·2 ^{-μ} | 88.4% |
| C2 | 2048·2 ^{-μ} | 2048·2 ^{-μ} | 1904·2 ^{-μ} | 93.0% |
| NOTE 1: The use of other FFT sizes is possible as long as appropriate scaling of the window length is applied | | | | |
| NOTE 2: These percentages are informative | | | | |

F.6 Averaged EVM

The general EVM is averaged over basic EVM measurements for n slots in the time domain.

$$\overline{EVM} = \sqrt{\frac{1}{n} \sum_{i=1}^n EVM_i^2},$$

where n is

$$n = \begin{cases} 10, & \text{for 15 kHz SCS} \\ 20, & \text{for 30 kHz SCS} \\ 40, & \text{for 60 kHz SCS} \end{cases}$$

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 \overline{EVM}_i is calculated using $\Delta\tilde{\tau} = \Delta\tilde{\tau}_i$ in the expressions above and \overline{EVM}_h is calculated using $\Delta\tilde{\tau} = \Delta\tilde{\tau}_h$.

Thus we get:

$$EVM = \max(\overline{EVM}_i, \overline{EVM}_h)$$

The calculation of the EVM for the demodulation reference signal, EVM_{DMRS} , follows the same procedure as calculating the general EVM, with the exception that the modulation symbol set T_m defined in clause F.2 is restricted to symbols containing uplink demodulation reference signals.

The basic EVM_{DMRS} measurements are first averaged over n slots in the time domain to obtain an intermediate average \overline{EVM}_{DMRS} .

$$\overline{EVM}_{DMRS} = \sqrt{\frac{1}{n} \sum_{i=1}^n EVM_{DMRS,i}^2}$$

In the determination of each $EVM_{DMRS,i}$, the timing is set to $\Delta\tilde{\tau} = \Delta\tilde{\tau}_i$ if $\overline{EVM}_i > \overline{EVM}_h$, and it is set to $\Delta\tilde{\tau} = \Delta\tilde{\tau}_h$ otherwise, where \overline{EVM}_i and \overline{EVM}_h are the general average EVM values calculated in the same n slots over which the intermediate average \overline{EVM}_{DMRS} 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, EVM_{DMRS} ,

$$EVM_{DMRS} = \sqrt{\frac{1}{6} \sum_{j=1}^6 \overline{EVM_{DMRS,j}}^2}$$

The PRACH EVM, $\overline{EVM_{PRACH}}$, is averaged over 2 preamble sequence measurements for long preamble formats as defined in table 6.3.3.1-1 in [6] and averaged over 10 preamble sequence measurements for short preamble formats as defined in table 6.3.3.1-2 in [6].

The EVM requirements shall be tested against the maximum of the RMS average at the window W extremities of the EVM measurements:

Thus $\overline{EVM_{PRACH,1}}$ is calculated using $\Delta \tilde{\tau} = \Delta \tilde{\tau}_l$ and $\overline{EVM_{PRACH,h}}$ is calculated using $\Delta \tilde{\tau} = \Delta \tilde{\tau}_h$.

Thus we get:

$$EVM_{PRACH} = \max(\overline{EVM_{PRACH,l}}, \overline{EVM_{PRACH,h}})$$

F.7 Spectrum Flatness

The data shall be taken from FFT coded data symbols and the demodulation reference symbols of the allocated resource block.

F.8

F.9

F.10 EVM for UL MIMO

F10.1 General

EVM for UL MIMO is measured per layer. A zero-forcing (ZF) MIMO receiver architecture is used so that dual layer transmissions by the UE can be demodulated by the test equipment receiver.

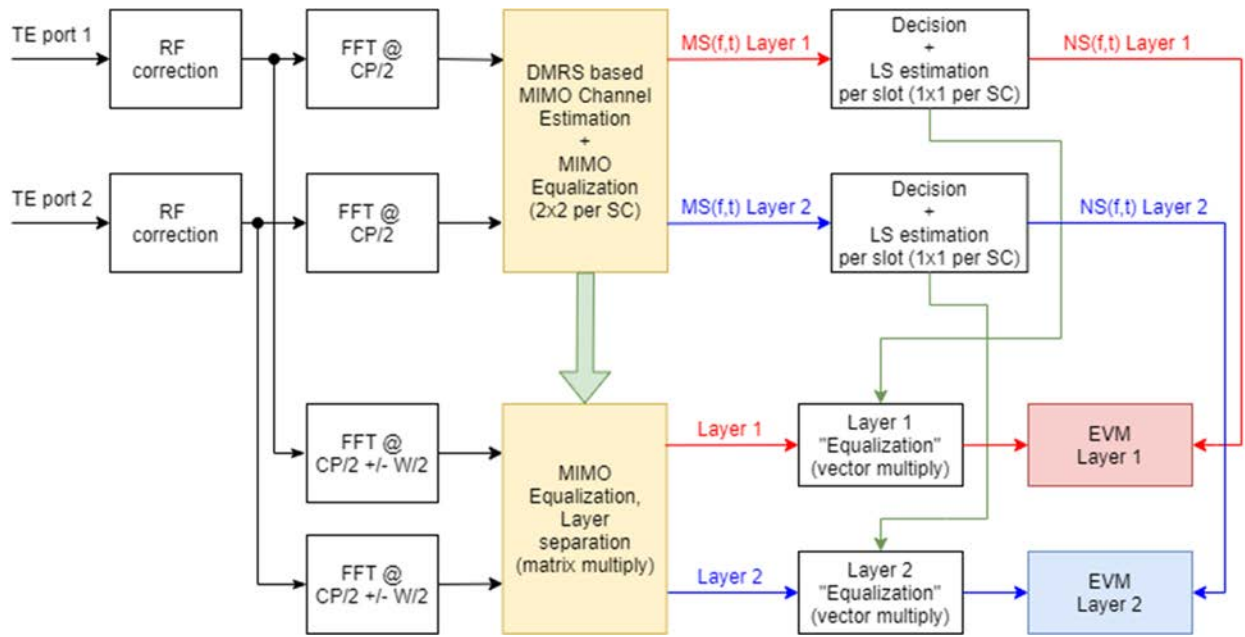


Figure F.10.1-1: EVM calculation block diagram for 2-Layer UL MIMO

The TE receives signals from 2 different ports which are connected to two antenna connectors in the test system.

For UL MIMO measurements a MIMO equalization step as described in section F.10.2 is performed to separate the layers.

Each layer is then processed as described in section F.10.3 to receive the measurement results for each individual layer.

F10.2 MIMO Equalization

The MIMO equalization is based only on reference signals (DMRS) without using any data symbols. For the equalization process all available DMRS symbols shall be used.

The effective 2×2 channel matrix is estimated using reference signals of different subcarriers, e.g. in case of DMRS antenna ports 0 and 2. In case that same subcarriers are used, e.g. DMRS antenna ports 0 and 1, a channel decomposition is necessary taking advantage of the orthogonal codes w_f and w_t and assuming identical channel coefficients for adjacent subcarriers of same CDM group.

Effective channel including the precoding matrix P is:

$$\tilde{H} = HP = \begin{bmatrix} \tilde{h}_{0,0} & \tilde{h}_{0,1} \\ \tilde{h}_{1,0} & \tilde{h}_{1,1} \end{bmatrix}$$

with

$$\tilde{h}_{n,v} = \frac{y_n r_v^*}{|r_v|^2}$$

where y denotes the received symbol on port index n and r the reference signal for layer index v .

Since reference signals of a specific layer are transmitted only on subcarriers of one CDM group channel, interpolation is needed in order to obtain channel coefficients for all subcarriers. Channel interpolation is done using the channel coefficients of active CDM group in all other CDM groups.

The channel coefficients used to calculate the equalizer coefficients are obtained after channel smoothing in frequency domain by computing the moving average of interpolated channel coefficients. The moving average window size is 7. For subcarriers at or near the edge of allocation the window size is reduced accordingly.

The ZF equalizer coefficients are calculated as the inverse of the effective channel matrix, in general:

$$G_{ZF} = \tilde{H}^{-1}$$

F10.3 Layer processing

After performing the MIMO equalization as described in section F.10.2 each layer is processed using the existing procedure as defined in Annex E of TS 38.521-1 [4].

Since the channel estimation is calculated only on the DMRS symbols, an averaging including all 14 symbols of one slot, i.e. data and reference signals, is needed in order to minimize EVM. The averaging is achieved by the least square (LS) equalization method described for single layer in Annex E.3. of TS 38.521-1 [4].

$MS(f,t)$ and $NS(f,t)$ are processed with a LS estimator, to derive one equalizer coefficient per time slot and per allocated subcarrier. $EC(f)$ is defined for each layer as:

$$EC_v(f) = \frac{\sum_{t=0}^{13} NS_v(f,t)^* NS_v(f,t)}{\sum_{t=0}^{13} MS_v(f,t)^* NS_v(f,t)}$$

With $*$ denoting complex conjugation. $EC(f)$ are used to equalize layer data symbols.

EVM equalizer spectral flatness is derived from equalizer coefficients for each layer as follows:

$$c_v = |EC_v(f)| \sqrt{|g_{v,0}|^2 + |g_{v,1}|^2}$$

Annex G (normative):

Difference of relative phase and power errors

G.0 General

This annex gives further information needed for understanding and implementing 6.4D.4. The following terms should be understood as follows:

Relative phase error: refers to the phase difference between signals at different antenna connectors, which should be ideally 0. It should be understood as for a slot i.e. (slot) relative phase. It is calculated based on DMRS symbols of that slot or on SRS symbols.

Difference of relative phase error: refers to the difference between the relative phase error determined per slot and the relative phase error determined based on the SRS transmitted.

G.1 Measurement Point

Figure G.1-1 shows the measurement point for the difference of relative phase and power errors.

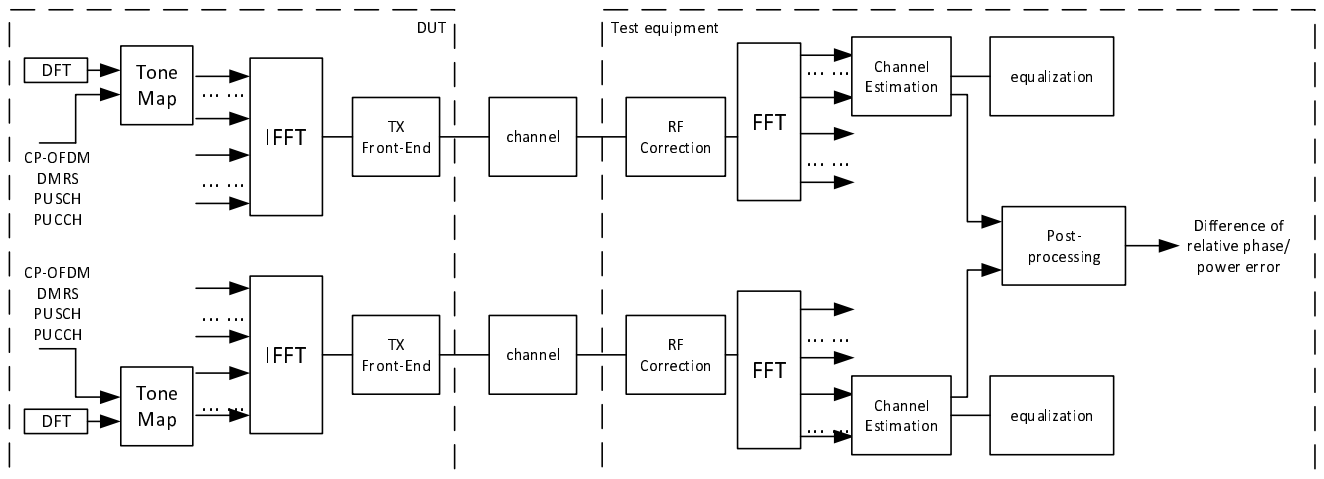


Figure G.1-1 - Measurement point for difference of relative phase/power error for UL coherent MIMO

G.2 Relative Phase Error Measurement

Here are listed the different aspects that may lead to different interpretations.

G.2.1 Symbols and subcarriers used

Phase error is determined based on DMRS REs (DMRS mapping type A with 3 DMRS symbols per slot, the REs corresponding to the odd subcarriers and DMRS symbols are non-allocated for data or DMRS.) and SRS REs (with 4 SRS symbols in the SRS slot, same SRS resource mapping is used for non-codebook-based and codebook-based precoding).

For the DMRS and SRS to occupy identical SCs and maximize their frequency density, DMRS configuration type 1 and SRS comb2 configuration are used.

UL RMC described in Annex A.2 is used.

G.2.2 CFO (carrier frequency offset) correction

The TE performs a CFO correction on a slot-by-slot basis using a common frequency correction at the two uplink antenna connectors.

G.2.3 Steps of the measurement method

Below are detailed the steps necessary to obtain the maximum difference of relative phase error during the 20ms time window.

- 1 Determination for each subcarrier and at each antenna, the SRS relative phase error based on the last SRS transmitted on Ant1 and Ant2, that relative phase error serves as a reference for the calculation of the difference of relative phase error for each slot inside the 20 ms time window.

The output is the “SRS relative phase error” vector for the last SRS transmitted: $[1 \times \textit{number_of_subcarriers}]$.

Calculation for the last SRS transmitted, for each RB of the SRS relative phase errors based on the arithmetic 2mean of the subcarrier SRS relative phase errors determined in previous step.

The output is the “SRS relative phase error” vector for the last SRS transmitted: $[1 \times \textit{number_of_RBs}]$.

- 3 CFO correction on slot-by-slot basis using a common frequency correction for both antenna outputs. 4 Determination for each subcarrier and at each antenna, the phase over the slot being analyzed. The phase is extracted from the channel estimate derived from the 3 DMRS symbols of the slot using the LSE technique.

The output is one vector of dimension $[1 \times \textit{number_of_subcarriers}]$ for each antenna.

- 5 Calculation for a slot for each subcarrier of the relative phase error (difference between the vectors determined in the previous step).

The output is subcarrier relative phase errors of a slot: $[1 \times \textit{number_of_subcarriers}]$.

- 6 Calculation for a slot, for each RB of the relative phase errors based on the arithmetic mean of the subcarrier relative phase errors determined in previous step.

The output is a “slot relative phase error” vector for a slot: $[1 \times \textit{number_of_RBs}]$.

- 7 Calculation for a slot of the difference of relative phase errors based on the “SRS relative phase error” (reference) determined in step 2 and the “slot relative phase error” determined in previous step.

The output is a “difference of relative phase error” vector for a slot: $[1 \times \textit{number_of_RBs}]$.

- 8 Calculation for a slot of the arithmetic mean value of the “difference of relative phase error” vector determined in previous step, this value corresponds to an RB.

The output is a “difference of relative phase error” value for a slot: $[1 \times 1]$.

9 Perform for each slot of the 20ms time window, steps 3 to 8.

The output is a “difference of relative phase error” vector: $[1 \times \textit{number_of_slots}]$.

10 Calculation of the maximum value of the “difference of relative phase error”.

The output is the “difference of relative phase error” that should be verified as complying with the 40° maximum allowable difference of relative phase error requirement: $[1 \times 1]$.

Annex H (normative): ModifiedMPR-Behavior

H.1 Indication of modified MPR behavior

This annex contains the definitions of the bits in the field *modifiedMPR-Behavior* indicated per supported NR band in the IE *RF-Parameters* [7] by a UE supporting an MPR or A-MPR modified in a given version of this specification. A modified MPR or A-MPR behaviour can apply to a supported NR band in stand-alone operation (including CA and NN-DC operation) or in non-standalone operation with the said NR band as part of an EN-DC or NE-DC band combination.

NOTE 1: In the present release, the *modifiedMPR-Behavior* is indicated [7] by an 8-bit bitmap per supported NR band.

Table H.1-1: Definitions of the bits in the field *modifiedMPR-Behavior*

| NR Band | Index of field (bit number) | Definition (description of the supported functionality if indicator set to one) | Notes |
|---------|--------------------------------|--|---|
| n41 | 0 (leftmost bit) | - EN-DC contiguous intraband MPR as defined in clause 6.2B.2.1 of 38.101-3 v15.5.0 | - This bit may be set to 1 by a UE supporting DC_(n)41AA UE EN-DC |
| | 1 | - EN-DC non-contiguous intraband MPR as defined in clause 6.2B.2.2 of 38.101-3 v15.5.0 | - This bit may be set to 1 by a UE supporting DC_41A_n41A EN-DC |
| n71 | 0 (leftmost bit) | - EN-DC contiguous intraband MPR as defined in clause 6.2B.2.1 of 38.101-3 v15.5.0 | - This bit may be set to 1 by a UE supporting DC_(n)71AA UE EN-DC |

Annex I (informative): Void

Annex J (informative): Void

Annex K (informative): Void

Annex L (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#84 Bis | 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#84 Bis | 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 endorsed 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 | 15.1.0 |

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| | | | | | <p>F: R4-1800451 Draft CR for TS 38.101-1: Clarification of 4Rx NR bands, Huawei, HiSilicon</p> <p>F: R4-1801136, Draft CR for TS 38.101-1: REFSSENS for NR bands, Huawei, HiSilicon</p> <p>F: R4-1801137, Draft CR: n71 REFSSENS, Dish Network</p> <p>F: R4-1800395, Draft CR to 38.101-1: corrections to ACS and in-band blocking, Ericsson</p> <p>F: R4-1800396, Draft CR to 38.101-1: corrections to out-of-band blocking, Ericsson</p> <p>F: R4-1800397, Draft CR to 38.101-1: corrections to spurious response, Ericsson</p> <p>F: R4-1800305, Draft CR for NR FR1 wide band intermodulation requirements, MediaTek Inc.</p> <p>F: R4-1800320, Draft CR to 38.101-1: Rx Spurious emission for NR FR1 (section 7.9), ZTE Corporation</p> <p>F: R4-1800473, Draft CR on UE RF requirements for SUL in TS 38.101-1, Huawei</p> <p>F: R4-1800965, Draft CR to TS 38.101-1: Asymmetric CH BW operation, Dish Network</p> <p>F: R4-1800882, Draft CR for correction of UE channel bandwidth for Bands n77 and n78 for TS 38.101-1, Orange UK</p> <p>F: R4-1801012, Draft CR to 38.101-1: Clarifications to UE spectrum utilization section 5.3, Ericsson</p> <p>F: R4-1800030, 38.101-1 n71 draft CR for section 5.4.4 - TX-RX frequency separation, T-Mobile USA Inc</p> <p>F: R4-1801228, Draft CR to 38.101-1: Channel spacing for CA for NR FR1(section 5.4.1.2), ZTE Corporation</p> <p>F: R4-1801231, Correction CR for channel spacing:38.101-1, Samsung</p> <p>F: R4-1801235, Draft CR to TS 38.101-1: Corrections on channel raster calculation in section 5.4.2, ZTE Corporation</p> <p>F: R4-1801318, Draft CR on synchronization raster, Huawei</p> <p>RAN4#86:</p> <p>R4-1803053, Draft CR for new spec structure of 38.101-1, Ericsson</p> <p>R4-1801479, Draft CR to 38.101-1: Default Tx-RX frequency separation for NR FR1(section 5.4.4), ZTE</p> <p>R4-1801581, Draft CR for TS 38.101-1 update of 4Rx bands, Huawei Technologies France</p> <p>R4-1802211, draft CR TS 38.101-1 Uplink configuration for FR1 NR REFSSENS, Skyworks Solutions Inc.</p> <p>R4-1802342, Draft CR for NR FR1 ACS case 2 transmitter power setting correction (Note 1), MediaTek Inc.</p> <p>R4-1802509, Draft CR on 38.101-1 v15.0.0: Remaining ON/OFF masks for FR1 NR UE transmissions, Ericsson</p> <p>R4-1802566, Draft CR to TS 38.101-1: Clarification of mixed numerology guardband size, Ericsson</p> <p>R4-1802978, Draft CR to TS 38.101-1: Corrections on channel raster in Section 5.4.2.3, Intel Corporation</p> <p>R4-1803064, Draft CR for 38.101-1: Correction of errors, Sprint Corporation</p> <p>R4-1803065, Draft CR for 38.101-1 Introduction of n41requirements, Sprint Corporation</p> <p>R4-1803242, Draft CR to 38.101-1: Corrections to n66, Dish Network</p> <p>R4-1803285, Draft CR to 38.101-1: Correction to CH BWs without symmetric uplink Dish Network, Skyworks Solutions Inc.</p> <p>R4-1803436, Introduction of UL subcarrier alignment for additional bands, AT&T</p> <p>R4-1803456, Draft CR for 38.101-1: Spurious Emissions for UE Coexistence, Sprint Corporation</p> <p>R4-1803461, CR on configured transmitted power for TS 38.101-1, Huawei</p> <p>R4-1803452, draft CR for introduction of completed band combinations from 37.865-01-01 into 38.101-1, Ericsson</p> <p>R4-1803567, Draft CR for TS 38.101-1: Sync raster offset in re-farming bands (5.4.3), Ericsson</p> <p>R4-1803365, CR to introduce MPR for PC2 and PC3 and A-MPR for UTRA protection, Nokia</p> | |
| 2018-06 | RAN#80 | RP-181262 | 0011 | F | <p>CR to TS 38.101-1: Implementation of endorsed draft CRs from RAN4 #86bis and RAN4 #87</p> <p>R4-1803900, Draft CR into TS 38.101-1 Introduction of band combinations for SUL, Huawei</p> <p>R4-1804021 CR for clarifications for NR FR1 CA BW Classes Nokia, Nokia Shanghai Bell</p> | 15.2.0 |

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| | | | | | <p>R4-1804140 CR for Narrow Band Blocking requirement for FR1 Intel Corporation</p> <p>R4-1804219 Draft CR for 38.101-1: n41 SEM and additional spurious emissions SPRINT Corporation</p> <p>R4-1804266 Draft CR to 38.101-1 MPR channel bandwidth criteria Skyworks Solutions Inc.</p> <p>R4-1804267 Draft CR to 38.101-1 n3,n5,n8 REFSENS levels Skyworks Solutions Inc.</p> <p>R4-1804268 Draft CR to 38.101-1: Correction to n41 uplink configuration for reference sensitivity Skyworks Solutions Inc.</p> <p>R4-1804370 Draft CR to add missing NR inter-band DL CA in FR1 for TS 38.101-1 NTT DOCOMO, INC.</p> <p>R4-1804581 Draft CR to 38.101-1: On EVM Wording Qualcomm, Inc.</p> <p>R4-1804948 Corrections to 5.3.3 in TS 38.101-1 Nokia, Nokia Shanghai Bell</p> <p>R4-1804877 draft CR introduction completed band combinations 37.865-01-01 -> 38.101-1 Ericsson</p> <p>R4-1805444 Draft CR to TS 38.101-1: Asymmetric CH BW operation Dish Network</p> <p>R4-1805447 draft CR for including SRS antenna switching in configured output power Qualcomm Incorporated</p> <p>R4-1805462 Editorial corrections to UE RF requirements in 38.101-1 Qualcomm Incorporated</p> <p>R4-1805659 Draft CR for CBW for n50 for 38.101-1 Huawei</p> <p>R4-1805664 Draft CR to 38.101-1: Addition of Annex F Rohde & Schwarz</p> <p>R4-1805665 Correction to inner and outer definitions for MPR Qualcomm Incorporated</p> <p>R4-1805684 Draft CR to TS38.101-1: Channel Raster to Resource Element Mapping (Section 5.4.2.2) and RB alignment with different numerologies (Section 5.3.4) ZTE Corporation</p> <p>R4-1805698 Draft CR for 38.101-1 for Rx(Ch7) of Band n77, n78 and n79 RF requirements CMCC</p> <p>R4-1805699 Draft CR to 38.101-1: introduction of Tx/Rx requirements for inter-band CA ZTE Corporation</p> <p>R4-1805751 Draft CR on UE-to-UE coexistence requirements to protect band 29 from NR band 71 LG Electronics France</p> <p>R4-1805783 Draft CR for 38.101-1 for Tx(Ch6) of Band n77, n78 and n79 RF requirements CMCC</p> <p>R4-1805902 Draft CR into TS 38.101-1 Correction on SUL_n78-n80 Huawei, HiSilicon</p> <p>R4-1805904 Draft CR into TS 38.101-1 Introduction of new band combinations for SUL Huawei, HiSilicon</p> <p>R4-1805921 Draft CR on NR UE REFSENS SNR FRC for FR1 Intel Corporation</p> <p>R4-1805981 Draft CR for TS38.101-1: Sync raster Samsung</p> <p>R4-1804548 Draft CR for CA BW class for FR1 NTT DOCOMO, INC.</p> <p>R4-1806170 Draft CR on frequency error for TS 38.101-1 ZTE Corporation</p> <p>R4-1806481 Draft CR for Environmental conditions in TS 38.101-1 Annex NTT DOCOMO, INC.</p> <p>R4-1806657 Draft CR to 38.101-1: Measurement BW for min and off power Skyworks Solutions Inc.</p> <p>R4-1806669 Draft CR to TS38.101-1_introduction of completed band combinations for inter-band 2UL CA ZTE Corporation</p> <p>R4-1806673 Draft CR to TS38.101-1_Remove brackets from Tx and Rx spurious emission table ZTE Corporation</p> <p>R4-1806677 Draft CR on including CA bandwidth class and band combinations for intra-band CA LG Electronics France</p> <p>R4-1806719 Introduction of 7.5 kHz frequency shift for Band n71 Ericsson, T-Mobile</p> <p>R4-1806844 Draft CR for 38.101-1 for Tx(Ch6): missing maximum power requirements for n1 and n8 SoftBank Corp.</p> <p>R4-1806945 Draft CR for TS 38.101-1: Channel raster and NR-ARFCN clarification (5.4.2) Ericsson</p> <p>R4-1807039 Intra-band CA terminology for UE ZTE Corporation</p> <p>R4-1807178 Corrections to n70 TX/RX frequency separation Dish Network</p> <p>R4-1807181 Corrections to spurious emissions UE co-existence table Dish Network</p> <p>R4-1807234 Draft CR into TS 38.101-1 Some Corrections for SUL Huawei, HiSilicon</p> <p>R4-1807269 Corrections to Wide band intermodulation table <2700MHz Dish Network</p> | |
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| | | | | | <p>R4-1807392 to remove the brackets for SU in 38.101-1 Huawei, HiSilicon</p> <p>R4-1807647 Draft CR to TS 38.101-1: Correction to Asymmetric CH BW operation Dish Network</p> <p>R4-1807680 Draft CR on 38.101-1 on channel raster to achieve alignment of data and SSB subcarrier grids Nokia, Nokia Shanghai Bell, Ericsson</p> <p>R4-1807705 CR for TS 38.101-1 A-MPR for n51 Huawei, Hisilicon</p> <p>R4-1807814 Draft CR for 38.101-1: SEM correction for n41 Sprint Corporation</p> <p>R4-1807851 Draft CR for 38.101-1: UE spurious emission protection requirements for n5 Sprint Corporation</p> <p>R4-1807920 General requirements for downlink inter-band CA Qualcomm Incorporated</p> <p>R4-1807923 Resolution bandwidth for ACLR Qualcomm Incorporated</p> <p>R4-1808084 Introduction of n12 into TS 38.101-1 Nokia</p> <p>R4-1808087 Draft CR 38.101-1: Introduction of n2, n25, n66 and n70 Sprint Corporation, Dishnetwork</p> <p>R4-1808090 Draft CR to TS 38.101-1: Inclusion of Simultaneous RxTx UE capability for some band combinations Ericsson, Vodafone, Orange</p> <p>R4-1808107 Draft CR to TS38.101-1_corrections on UE coexistence ZTE Corporation</p> <p>R4-1808111 TP to TS38.101-1 - UE ON/OFF masks Ericsson</p> <p>R4-1808116 Draft CR to 38.101-1: introduction of Band n34,n39 and n40 RF requirements ZTE Corporation,CMCC</p> <p>R4-1808136 Draft CR to 38.101-1: FR1 UE Power Control Qualcomm Incorporated</p> <p>R4-1808141 Correction to MPR for PC2 and spectrum emission mask measurement bandwidth Qualcomm Incorporated</p> <p>R4-1808142 Draft CR for 38.101-1 n41 A-MPR Sprint Corporation, Nokia, Nokia Shanghai Bell, Ericsson</p> <p>R4-1808143 Draft CR for TS 38.101-1 A-MPR for n20 Huawei, HiSilicon</p> <p>R4-1808155 Draft CR for TS 38.101-1: to correct requirements for n71 Samsung</p> <p>R4-1808178 Addition parameters about n50 & n51 in TS 38.101-1 Huawei, Hisilicon, Etisalat (editors note: n50 not implemented per chairmans agreement)</p> <p>R4-1808182 Draft CR for TS 38.101-1 A-MPR for n28 Huawei, HiSilicon</p> <p>R4-1808187 CR for RF requirements for Coherent UL MIMO for FR1 Qualcomm Austria RFFE GmbH</p> <p>R4-1808207 Draft CR to 38.101-1: On EVM Averaging Length, Wording , Qualcomm</p> <p>R4-1808209 Draft CR for 38.101-1 for Tx (Ch6) of HPUE Qualcomm</p> <p>R4-1808466 Draft CR on UL RMC and OCNG pattern for FDD REFSENS tests RD session</p> <p>R4-1808493 Draft CR for TS 38.101-1: Channel and sync raster corrections (5.4) Ericsson</p> <p>R4-1808507 Draft CR for TS38.101-1 on addition of new 90MHz UE CBW for n41/n78 LG Electronics Inc., LG Uplus, Samsung</p> <p>R4-1808176, Draft CR for 38.101-1 : Introduction of A-MPR for n8, SoftBank</p> <p>R4-1808201, Draft CR for 38.101-1 : Introduction of A-MPR for n1, SoftBank</p> <p>R4-1807101, draft CR introduction completed band combinations 37.865-01-01 -> 38.101-1, Ericsson</p> | |
| 2018-09 | RAN#81 | RP-181896 | 0025 | F | <p>Big CR for 38.101-1</p> <p>Endorced draft CRs from RAN4#NR-AH-1807</p> <p>R4-1809335, Draft CR on UL RMC for FR1 RF tests, Qualcomm Incorporated</p> <p>R4-1809337, Draft CR on NR UE REFSENS SNR FRC for FR1, Intel Corporation</p> <p>R4-1809339, Draft CR on measurement of receiver characteristics for FR1 RF Tests, Qualcomm Incorporated</p> <p>R4-1809396, Draft CR on NR UE maximum input level FRC for FR1, Intel</p> <p>R4-1809567, Draft CR on OCNG pattern for FR1 REFSENS tests, Qualcomm Incorporated, Rohde & Schwarz</p> <p>Endorced draft CRs from RAN4#88</p> | 15.3.0 |

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| | | | | | <p>R4-1809714, Draft CR to correct in-band blocking parameters for FR1, Anritsu Corporation</p> <p>R4-1809784, Draft CR to 38.101-1: Corrections on CA bandwidth classes for FR1, ZTE Corporation</p> <p>R4-1809785, Draft CR to TS 38.101-1 for Corrections on UE transmitter power, ZTE Corporation</p> <p>R4-1809793, Draft CR to 38.101-1: Corrections on additional spectrum emission mask, ZTE Corporation</p> <p>R4-1809919, Correction on UE receiver requirement for FR1, CATT</p> <p>R4-1810091, Draft CR TS 38.101-1 - UE ON-OFF mask clean up, Ericsson</p> <p>R4-1810210, Draft CR for TS 38.101-1: MPR inner and outer RB allocations formula correction, MediaTek, Inc.</p> <p>R4-1810229, Draft CR for TS 38.101-1: Spurious emission for UE coexistence table corrections, MediaTek, Inc.</p> <p>R4-1810230, Draft CR for TS38.101-1 to correct 90MHz UE CBW, LG Electronics, Inc.</p> <p>R4-1810232, Draft CR for TS 38.101-1: Table 7.3.2-1 n77 reference sensitivity corrections, MediaTek, Inc.</p> <p>R4-1810369, Draft CR to 38.101-1: Corrections on symbols and abbreviations in section 3, ZTE Corporation</p> <p>R4-1810376, Draft CR: General corrections to n71 requirements, Dish Network</p> <p>R4-1810428, Draft CR on TS38.101-1 for UE maximum output power for UL MIMO, OPPO</p> <p>R4-1810552, Correction of reference tables, OPPO</p> <p>R4-1810729, Draft CR for introduction of Band n74 for TS 38.101-1, NTT DOCOMO, Inc.</p> <p>R4-1810862, Draft CR to 38.101-1: Updates to Transmit Modulation Annex, Rohde & Schwarz</p> <p>R4-1810892, CR to update Table 6.2D.1-2 for FR1, Qualcomm Incorporated</p> <p>R4-1810961, CR on ACS minimum requirement, Intel Corporation</p> <p>R4-1810965, CR on Out-of-Band Blocking minimum requirement, Intel Corporation</p> <p>R4-1810967, CR on Rx Intermodulation characteristics for CA, Intel Corporation</p> <p>R4-1810974, Annex lettering change for 38.101-1, Qualcomm Incorporated</p> <p>R4-1811189, CR to add more details to Coherent UL MIMO spec for FR1, Qualcomm Incorporated</p> <p>R4-1811280, Corrections of NR receiver characteristics titles, Vivo</p> <p>R4-1811455, Draft CR on DL Physical Channel for FR1 RF tests, Qualcomm Europe Inc. (Spain)</p> <p>R4-1811457, NS numbering, Qualcomm Incorporated</p> <p>R4-1811459, Correction on UE transmitter requirement for FR1, CATT</p> <p>R4-1811463, Draft CR for 38.101-1: Addition of missing NR CA configurations n8-n75 and n28-n75, VodafoneItalia SpA</p> <p>R4-1811472, Addition parameters about n51 in TS 38.101-1, Huawei, Hisilicon, Etisalat</p> <p>R4-1811474, CR CP- OFDM almost contiguous allocation, Nokia, Nokia Shanghai Bell</p> <p>R4-1811477, Draft CR to 38.101-1: FR1 Power Control, Qualcomm Incorporated</p> <p>R4-1811478, A-MPR correction for n20 and n28, Huawei, HiSilicon</p> <p>R4-1811490, Draft CR to 38.101-1: Addition of Carrier Leakage table, Rohde & Schwarz</p> <p>R4-1811491, Draft CR for TS38.101-1 on transmit signal quality, OPPO</p> <p>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</p> <p>R4-1811513, A proposal on 2UL co-ex table modification, SoftBank Corp.</p> <p>R4-1811514, Draft CR to TS 38.101-1: Clarification on OCNG, Keysight Technologies UK Ltd</p> <p>R4-1811516, Draft CR on NR DL FRCs for FR1 UE RF requirements, Intel Corporation</p> <p>R4-1811550, Draft CR to TS 38.101-1 on channel bandwidth and spacing descriptions, Ericsson</p> <p>R4-1811553, Draft CR to 38.101-1: Corrections on description of channel raster entries, ZTE Corporation</p> <p>R4-1811783, Measurement period of PRACH time mask, CATT</p> <p>R4-1811792, Draft CR for A-MPR revision for n1, NTT DOCOMO, INC.</p> | |
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| | | | | | | <p>R4-1811798, Draft CR for Pcmx for FR1, Qualcomm Incorporated</p> <p>R4-1811799, Pcmx for inter-band NR CA FR1 draft CR, InterDigital, Inc.</p> <p>R4-1811812, Draft CR to 38.101-1: On FR1 AMPR Band n41 NS_04, Qualcomm Incorporated</p> <p>R4-1811816, CR to update the definition of Long and Short subslot for FR1, Qualcomm</p> <p>R4-1811894, Addition parameters about n50 in TS 38.101-1, Huawei</p> <p>R4-1811896, Draft CR for TS 38.101-1: n41 GSCN range modification, MediaTek Inc.</p> <p>R4-1811285, Draft CR TS 38.101-1: NS_04 A-MPR' and spurious emisison corrections, Sprint</p> | |
| 2018-12 | RAN#82 | RP-182836 | 0029 | 1 | F | <p>Endorced draft CRs from RAN4#88Bis:</p> <p>R4-1812050, CR Simplification of NR NS_08, Nokia</p> <p>R4-1812054, Correction for Inter-band CA operating bands table in TS 38.101-1, Nokia.</p> <p>R4-1812079, draft CR to introduce asymmetric UL DL channel BW combinations for n71, T-Mobile USA Inc.</p> <p>R4-1812121, Draft CR on Note1 Corrections in 38.101 RX tests, Qualcomm</p> <p>R4-1812128, draftCR on 256QAM UL power requirement, Intel Corporation</p> <p>R4-1812200, Draft CR to TS 38.101-1 Add clarification note to PC3 MPR table, Intel Corporation</p> <p>R4-1812217, Draft CR to 38.101-1: Corrections on the descriptions of UE channel bandwidth for CA, ZTE Corporation</p> <p>R4-1812319, Draft CR for TS 38.101-1: REFSSENS UL configuration corrections, MediaTek Inc.</p> <p>R4-1812320, Draft CR for TS 38.101-1: Out-of-band blocking exceptions for CA, MediaTek Inc.</p> <p>R4-1812322, Draft CR for TS 38.101-1: Blocking characteristics for SUL, MediaTek Inc.</p> <p>R4-1812397, Clarification for almost contiguous CP-OFDM, Qualcomm Incorporated</p> <p>R4-1812508, Draft CR to 38.101-1: Corrections on channel raster & SS raster for operating bands, ZTE Corporation</p> <p>R4-1812611, Draft CR to 38.101-1: Some corrections for inter-band CA combinations, ZTE Corporation</p> <p>R4-1813459, Draft CR for TS 38.101-1: Support 4Rx for n38, Huawei</p> <p>R4-1813469, draftCR on applicability of TDD configuratiin for CA in TS 38.101-1, Huawei</p> <p>R4-1813521, Addition of ?TC,c for single carrier Pcmx for FR1, vivo</p> <p>R4-1813798, Draft CR to 38.101-1: Corrections on UE additional maximum output power reduction, ZTE Corporation</p> <p>R4-1813811, Draft CR to 38.101-1: Correction to n12 reference sensitivity power levels, Skyworks Solutions Inc.</p> <p>R4-1813812, Band n41 spurious emission limits, Qualcomm Incorporated</p> <p>R4-1813813, Draft CR for TS 38.101-1: P-Max for 5G NR HPUE, CMCC</p> <p>R4-1814158, CR on Spurious emissions for UE co-existence, Intel Corporation</p> <p>R4-1814159, Draft CR for CA ACS/IBB for Bandwidth class C, Qualcomm</p> <p>R4-1813843, Draft CR to 38.101-1: Update of Annex F, Rohde & Schwarz</p> <p>R4-1813845, Correction for PI/2 PBSK requiriements, Nokia</p> <p>Endorsed draft CR's from RAN4#89</p> <p>R4-1815950, dCR on TS38.101-1 merging draft CRs from RAN4#88Bis, Qualcomm Incorporated</p> <p>R4-1814752, DraftCR to TS 38.101-1 pi/2 BPSK in n41, CMCC</p> <p>R4-1814824, n50 A-MPR, Qualcomm Incorporated</p> <p>R4-1814959, Changes to Max input power UL and DL configuratgions in FR1, OPPO</p> <p>R4-1814970, NR FR1 relative power tolerance CR, Nokia</p> <p>R4-1814972, A-MPR for NS_03 and NS_03U and re-formulation of NS_100, Nokia</p> <p>R4-1815060, draft CR for adding note about the fallback of NR CA in FR1 for TS 38.101-1, NTT DOCOMO, INC.</p> <p>R4-1815392, Draft CR to 38.101-1: Update to NS_04 requirements, Rohde & Schwarz</p> <p>R4-1815563, Draft CR to 38.101-1 on Clarification on 7.5 KHz raster shift in NR re-farmed bands, Ericsson</p> | 15.4.0 |

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| | | | | | | <p>R4-1815863, Draft CR for 38.101-1: Nominal carrier spacing for 30 kHz raster, SPRINT Corporation</p> <p>R4-1815898, draft CR on CA configuration on bandwidth class F, Huawei</p> <p>R4-1815917, draftCR on DL RMC for TS 38.101-1, Huawei</p> <p>R4-1816162, Draft CR on introduction of SRS switch IL in FR1, OPPO</p> <p>R4-1816199, Draft CR on FR1-FR2 UE-to-UE coexistence for TS38.101-1, LG Electronics France</p> <p>R4-1816200, Draft CR to 38.101-1 on intra-band contiguous CA configurations for FR1, ZTE Corporation</p> <p>R4-1816240, Transient period for SRS Antenna Switching for FR1, Qualcomm</p> <p>R4-1816243, Draft CR to TS38.101-1_Clarifications on MSD and UL configuration tables for inter-band CA, ZTE Corporation</p> <p>R4-1816466, Draft CR on some changes for SUL band combinations to TS 38.101-1, Huawei</p> <p>R4-1816468, Support of 7.5 kHz carrier shift for additional operating bands, Ericsson</p> <p>R4-1816604, TDD configuration for UE Tx test in FR1, Ericsson</p> <p>R4-1816663, Draft CR to 38.101-1 (5.3.4) RB alignment, Huawei</p> <p>R4-1816755, CR to 38.101-1: ACS and IBB intra-band contiguous CA, Intel Corporation</p> <p>Further changes in RAN#82 - 7.5 kHz frequency shift is specified for all FDD bands in clause 5.4.2.1</p> | |
| 2018-12 | RAN#82 | RP-182814 | 0030 | 2 | F | Company CR on 2Rx exception for NR vehicular UE at FR1 | 15.4.0 |
| 2019-03 | RAN#83 | RP-190403 | 0034 | | F | <p>CR to TS 38.101-1: Implementation of endorsed draft CRs from RAN4#90</p> <p>Endorced draft CR from Ran4#90</p> <p>R4-1900032, Editorial corrections for 38.101-1, Qualcomm Incorporated</p> <p>R4-1900031, draftCR on SRS IL for CA, Qualcomm Incorporated</p> <p>R4-1900161, CR on Relative power tolerance, Intel Corporation</p> <p>R4-1900162, CR on Minimum output power, Intel Corporation</p> <p>R4-1900274, Draft CR to TS 38.101-1 on NR general spectrum emission mask, ZTE Corporation</p> <p>R4-1900275, Draft CR to TS 38.101-1 on spurious emisson for network signalled value NS_40, NS_41 and NS_42, ZTE Corporation</p> <p>R4-1900424, Correction of table references and other typos, Ericsson</p> <p>R4-1900508, Draft CR to TS 38.101-1 on UE transmitter power and some other editorial corrections, ZTE Corporation</p> <p>R4-1900723, Draft CR on editorial error of TS38.101-1, LG Electronics Inc.</p> <p>R4-1900727, Update to PRACH EVM window length for FR1, Rohde & Schwarz</p> <p>R4-1900840, Draft CR for 38.101-1 modification of Transmit intermodulation requirement, Huawei</p> <p>R4-1900848, [RAN5 LS]Draft CR for 38.101-1: adding note for inter-band CA spurious emissions, Huawei</p> <p>R4-1901033, Alignment of Foob related description for 38.101-1, vivo</p> <p>R4-1901273, Correction of HARQ-ACK transmission timing for DL RMC for FR1 TDD SCS=60kHz, Ericsson</p> <p>R4-1901766, draft_CR TS 38.101-1 Correction to UL configuration for reference sensitivity, Skyworks Solutions Inc.</p> <p>R4-1901823, draft CR on spurious requirment for TS 38.101-1, Huawei, HiSilicon</p> <p>R4-1901835, draftCR on MSD for CA_n41-n78 for TS 38.101-1, Huawei</p> <p>R4-1901847, Draft CR for 38.101-1: Addition of default power class, Sprint Corporation</p> <p>R4-1901873, Receiver requirement RMC references, Qualcomm Incorporated</p> <p>R4-1901925, Draft CR to 38.101-1 to update and clarify Rx wide band intermod and spurious requirments for BW class C, D, E, Qualcomm Incorporated</p> <p>R4-1901992, Draft CR to 38.101-1. Correct FR1 NS_41 AMPR for n50, Huawei</p> <p>R4-1902001, Draft CR to 38.101-1 on n41 – B40 coexistence, Qualcomm Incorporated</p> <p>R4-1902150, Draft CR to TS38.101-1_Clarifications on MSD and UL configuration tables for inter-band CA, ZTE Corporation</p> | 15.5.0 |

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| | | | | | <p>R4-1902166, Tx ON/OFF time mask for FR1, Qualcomm Inc R4-1902174, Draft CR to 38.101-1: On FR1 A-MPR NS_08 for n8, Qualcomm Incorporated R4-1902175, Draft CR on AMPR requirements for NS_05U and NS_08U to TS 38.101-1, Huawei R4-1902194, [41 DL]Draft CR for 38.101-1 adding DL intra-band CA requirements for frequency less than 2700MHz, Huawei R4-1902196, Draft CR for 7.9A Spurious emissions for CA, CMCC R4-1902223, UE optional bandwidth for FR1, Nokia R4-1902225, CR to 38.101-1 on CA BW Classes fallback groups, Intel Corporation R4-1902233, Draft CR to 38.101-1: SUL clarifications, Nokia R4-1902339, Draft CR to TS 38.101-1 on FR1 extension, Ericsson R4-1902455, Completion of the Pmax specification: additional P-max and P_NR, Ericsson R4-1902468, Draft CR: Introduction of Annex on Characteristics of the Interfering Signal, Samsung R4-1902479, Draft CR on some errors to TS 38.101-1, Huawei R4-1902480, Draft CR for 38.101-1 modification of requirements for network signalled value NS_04, Huawei R4-1902655, CR to 38.101-1 on NR Uplink RBs location, Intel Corporation R4-1901610, Draft CR for 38.101-1 REFSSENS for UL MIMO, Huawei Editorial changes after RAN#83 To align the annex numbering with other specifications (TS 38.101-x series), annexes J and K were added and Change history was numbered as annex L.</p> | |
| 2019-06 | RAN#84 | RP-191240 | 0047 | F | <p>CR to TS 38.101-1: Implementation of endorsed draft CRs from RAN4#90bis and RAN4#91</p> <p>Endorced draft CRs from RAN4#90Bis R4-1902826, Draft CR for 38.101-1 modification of ACS test parameters case 2 for intra-band contiguous CA, Huawei R4-1902926, Draft CR to TS 38.101-1 Correction to Pmax, Intel Corporation R4-1902975, Draft CR on PRACH and PUCCH format description for EVM in FR1, Anritsu corporation R4-1903032, Draft CR on editorial error of TS38.101-1, LG Electronics France R4-1903120, Draft CR on DL power allocation for TS 38.101-1, Intel Corporation R4-1903124, Draft CR on b41-n40 coexistence, Intel Corporation R4-1903151, Draft CR to TS38.101-1_removing DC sections, ZTE Corporation R4-1903195, Draft CR for 38.101-1: remove the bracket of UE capability "powerBoosting-pi2BPSK", Huawei R4-1903392, Draft CR for TS 38.101-1: Corrections to EVM equalizer spectrum flatness requirements, MediaTek Inc. R4-1903473, Draft CR on FREF,Shift, CMCC R4-1903508, Draft CR to TS 38.101-1 on spurious emissions for UE co-existence, ZTE Corporation R4-1904335, DraftCR TS 38.101 Corrections to NS_100 UTRA ACLR frequency band list, Skyworks Solutions Inc. R4-1904460, Draft CR for 38.101-1 CA Pmax, Huawei R4-1904537, Draft CR for TR 38.101-1 correction of A-MPR for NS_04, Huawei R4-1904554, Draft CR to 38.101-1: FR1 power dynamics DTX removal, Qualcomm Incorporated R4-1904927, Draft CR to clarify frequency of carrier leakage in RBs for FR1, Anritsu corporation R4-1904928, Draft CR to TS 38.101-1 on description of UE additional output power reduction, ZTE Corporation R4-1904929, draft Rel-15 CR for editorial corrections in 38.101-1, Ericsson R4-1904941, draft CR to 38.101-1 Correction to Pi/2 BPSK power boosting, Intel Corporation R4-1904957, Draft CR for TR38.101-1 – Update to EVM averaging, Rohde & Schwarz R4-1904958, Draft CR for TR38.101-1 – Update to spectrum flatness, Rohde & Schwarz R4-1904967, Draft CR for 38.101-1 definition of Maximum input level for intra-band contiguous CA, Huawei R4-1904969, Draft CR for 38.101-1: editorial correction, Huawei R4-1904987, Draft CR for correction on TS38.101-1, CATT</p> <p>Endorced draft CRs from RAN4#91</p> | 15.6.0 |

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| | | | | | <p>R4-1905339 removal of A-MPR brackets in FR1 Nokia</p> <p>R4-1905503 Change description 4.2(d) in Applicability of minimum requirements for TS 38.101-1 vivo</p> <p>R4-1905524 [Rx]Draft CR for 38.101-1 Removing the brackets in Rx requirements Huawei</p> <p>R4-1905526 [Rx]Draft CR for 38.101-1 defining NBB requirements<2.7GHz Huawei</p> <p>R4-1905772 Draft CR to TS38.101-1 Almost contiguous MPR Intel Corporation</p> <p>R4-1905795 Correction to a description of PRB for in-band emission in FR1 Anritsu Corporation</p> <p>R4-1905797 Correction to power control in FR1 Anritsu Corporation</p> <p>R4-1906140 draft CR for TS 38.101-1 Rx requirement for CA Huawei</p> <p>R4-1906153 Draft CR for TS 38.101-1: Editorial corrections to intra-band contiguous CA ACS and in-band blocking requirements MediaTek Inc.</p> <p>R4-1906154 Draft CR for TS 38.101-1: Adding symbol definitions for intra-band contiguous CA Rx maximum input level and ACS requirements MediaTek Inc.</p> <p>R4-1906871 Draft CR for TS 38.101-1 UE optional bandwidth for FR1 Huawei</p> <p>R4-1907131 Draft CR to 38.101-1. Clarification to FR1 NS_43 AMPR frequency ranges Qualcomm Incorporated</p> <p>R4-1907135 Draft CR to 38.101-1 rel. 15 to fix missing Exceptions for Out-of-band Blocking Apple</p> <p>R4-1907419 Draft CR for TS 38.101-1: Editorial improvement to EVM equalizer spectrum flatness requirements for Pi/2 BPSK MediaTek Inc.</p> <p>R4-1907429 Draft CR to TS38.101-1 A-MPR for Inter-band CA Intel Corporation</p> <p>R4-1907434 [Rx]Draft CR for 38.101-1 modifying characteristics of the interfering signal in Annex D Huawei</p> <p>R4-1907435 Draft CR to TS38.101-1_introduction of n41C and corrections on Rx requirements for NR intra-band contiguous CA ZTE Corporation</p> <p>R4-1907439 Draft CR to TS 38.101-1 on CA bandwidth class description ZTE Corporation</p> <p>R4-1907471 Draft CR to 38.101-1. Clarify all RB reference so transmission BW applies for all SCS Qualcomm Incorporated</p> <p>R4-1907474 Draft CR for TS 38.101-1 Correction of channel bandwidth set for NR CA Huawei</p> <p>R4-1907477 Draft CR to TS 38.101-1 on maximum aggregated bandwidth for NR CA configurations ZTE Corporation</p> <p>R4-1907481 Correction of RefSens exceptions due to UL harmonic interference for NR CA in 38.101-1 vivo</p> <p>R4-1907687 Correction to CA carrier spacing Ericsson</p> | |
| 2019-09 | RAN#85 | RP-192049 | 0078 | F | <p>CR to TS 38.101-1: Implementation of endorsed draft CRs from RAN4#92 (Rel-15)</p> <p>R4-1907953 Correction to reference sensitivity for Band n74 Qualcomm Incorporated</p> <p>R4-1907955 Correction to reference sensitivity for Band n5 and n8 Qualcomm Incorporated</p> <p>R4-1907985 Update to FR1 EVM definition Rohde & Schwarz</p> <p>R4-1908022 Draft CR to 38.101-1 rel. 15 to fix Out-of-band Blocking issue for bands n51, n76 Apple</p> <p>R4-1908248 Draft CR to 38.101-1 NS_40, NS_41, NS_42 spurious emission requirement Intel Corporation</p> <p>R4-1908249 Draft CR to 38.101-1 A-MPR for NS_05 and NS_05U Intel Corporation</p> <p>R4-1908432 Further correction of RefSens exceptions due to UL harmonic interference for NR CA and SUL in 38.101-1 vivo</p> <p>R4-1908522 Draft CR for TS 38.101-1: Editorial corrections for transmit ON/OFF time mask MediaTek Inc.</p> <p>R4-1908523 Draft CR for TS 38.101-1: Corrections to inter-band CA and SUL OBB additional exception requirement MediaTek Inc.</p> <p>R4-1908572 Draft CR to TS 38.101-1: corrections on Rx requirements for intra-band CA ZTE Corporation,</p> <p>R4-1908632 Draft CR to TS38.101-1: Corrections on EVM window length (Section F.5) ZTE Corporation</p> <p>R4-1908707 Draft CR to TS38.101-1: corrections on the receiver spurious emission (section 7.9) ZTE Corporation</p> <p>R4-1908782 Draft CR: Correction to n70 UE Co-existence Dish Network</p> | 15.7.0 |

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| | | | | | | <p>R4-1908958 draft CR for 38.101-1: adding operating band for intra-band CA Huawei, HiSilicon</p> <p>R4-1908962 draft CR for 38.101-1: editorial correction for NBB, ACS and In-band emissionsHuawei, HiSilicon</p> <p>R4-1909264 Draft CR to TS 38.101-1 on maximum output power reduction for PC3 ZTE corporation</p> <p>R4-1909737 Draft CR for editorial corrections in TS 38.101-1 Google Inc.</p> <p>R4-1909920 Draft CR for TS 38.101-1 Correction of referd table for NBBHuawei, HiSilicon</p> <p>R4-1909954 draftCR 38.101-1 Addition of footnote for n28 Skyworks Solutions Inc.</p> <p>R4-1909959 draftCR to 38.101-1 NS_05 AMPR RBstart correction for CIM3 Qualcomm Incorporated</p> <p>R4-1910247 Draft CR to add simultaneous RX/TX capability requirements in R15 TS 38.101-1 CMCC</p> <p>R4-1910253 draftCR to 38.101-1 NS_43 AMPR MPR threshold change and AMPR reduction Qualcomm Incorporated</p> <p>R4-1910289 Draft CR for 38.101-1: Correction to the Spurious Emission for UE Coexistence table Sprint Corporation, Ericsson, Google</p> <p>R4-1910326 Draft CR: REFSENS for SDL bandsQualcomm, Dish network</p> <p>R4-1910327 Draft CR to TS 38.101-1: Corrections for DL RMC for FR1 tests Intel Corporation</p> <p>R4-1910330 dCR to 38.101-1: Reference signal clarifications Qualcomm Incorporated</p> <p>R4-1910413 Draft CR for 38.101-1 correction for channel raster Huawei, HiSilicon</p> <p>R4-1910592 Draft CR for TS 38.101-1 SUL configured power correction InterDigital Communications</p> <p>R4-1910602 Draft CR for TS 38.101-1: Channel spacing for adjacent NR carriers Huawei</p> <p>R4-1910604 draft CR to TS38.101-1_Addition_of_a_new_note_on_UL_MIMO_for_SUL (section 5.2C) ZTE Wistron Telecom AB</p> | |
| 2019-12 | RAN#86 | RP-193028 | 0095 | | F | CR to 38.101-1: DMRS Exceptions | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0098 | | F | CR for 38.101- RX Out-of-Band Blocking for B38 and B41 | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0102 | 1 | F | CR for 38.101-1 n39 AMPR | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0111 | | F | CR on Sync raster to SSB resource element mapping | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0113 | | F | CR to TS 38.101-1 Almost contiguous A-MPR (R15) | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0117 | | F | CR to 38.101-1 (Rel-15) to clarify measurement interval and observation window on frequency error | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0120 | 1 | F | CR to TS 38.101-1: Replace CBW with symbols defined in the specification | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0127 | 1 | F | CR for TS38.101-1, Clarification and Editorial corrections | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0135 | | F | CR to TS 38.101-1 on A-MPR table cleanup (Rel-15) | 15.8.0 |
| 2019-12 | RAN#86 | RP-193028 | 0136 | | F | CR for TS 38.101-1: Editorial correction for n2 uplink configuration note index in Table 7.3.2-3 | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0139 | | F | CR for TS 38.101-1: Removing CA configurations for CA_n77D/E, CA_n78D/E, and CA_n79D/E | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0141 | 2 | F | CR for TS 38.101-1: CA bandwidth class definition amendment | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0143 | | F | CR for TS 38.101-1: Fix out-of-band blocking issue for n50 and n75 | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0145 | | F | CR to TS 38.101-1 on corrections to channel raster entries for NR band (Rel-15) | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0149 | 1 | F | CR to transmit modulation quality in FR1 | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0152 | | F | Removal of brackets from reciever requirements in 38.101-1 REL-15 | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0156 | | F | CR to 38.101-1: Editorial correction of UL RMCs | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0158 | 1 | F | CR for asynchronous operation for NR CA n78-n79 | 15.8.0 |
| 2019-12 | RAN#86 | RP-193029 | 0176 | | F | CR to 38.101-1-f70 Corrections to Transient Time Masks | 15.8.0 |
| 2019-12 | RAN#86 | | | | | Table of contents updated | 15.8.1 |
| 2019-12 | RAN#86 | | | | | Version number corrected on cover page | 15.8.2 |
| 2020-03 | RAN#87 | RP-200394 | 0202 | | F | CR to TS 38.101-1 on corrections to network signalling value (Rel-15) | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0207 | | F | CR for 38.101- n39 NS flag change due to conflict | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0209 | | F | CR for 38.101-1: n41 and n25 corrections | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0217 | | F | CR to TS 38.101-1: corrections on ACS for intra-band contiguous CA | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0220 | | | CR to TS 38.101-1: Replace CBW with symbols defined in the specification. | 15.9.0 |

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| | | | | | | NOTE: Corresponding Cat F CR to a non-implementable Rel-16 Cat A CR0221.The CR is not implemented in order to maintain consistency between Releases. | |
| 2020-03 | RAN#87 | RP-200394 | 0228 | 1 | F | CR for TS38.101-1, Remove notes for UE channel bandwidth | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0230 | | F | CR for TS38.101-1, Correction of IE RF-Parameters name of maxUplinkDutyCycle | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0243 | | F | CR for 38.101-1: to remove fallback group 1 in table 5.5A.1-1 | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0264 | | F | CR for [agreed] asynchronous operation for NR CA n78-n79 | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | | | | CR for [agreed] asynchronous operation for NR CA n78-n79 NOTE: Corresponding Cat F CR to a non-implementable Rel-16 Cat A CR0275.The CR is not implemented in order to maintain consistency between Releases. | 15.9.0 |
| 2020-03 | RAN#87 | RP-200394 | 0277 | | D | Removal of unnecessary definition of offsetmax,IMD3 from Table 6.2.3.2-1 | 15.9.0 |
| 2020-06 | RAN#88 | RP-200985 | 0299 | | F | CR to asymmetric CBW operation in FR1 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0326 | | F | Maintenance CR to 38101-1 on relative power tolerance R15 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0330 | | F | Update of CSI-RS definition for FR1 DL RMCs | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0334 | | F | Correction to FR1 QPSK UL RMC | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0339 | | F | CR to TS 38.101-1: Replace CBW with symbols defined in the specification. | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0353 | | F | IBE measurements for half Pi BPSK with spectrum shaping | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0375 | | F | CR for 38.101-1 to remove the NR CA configuration for REFSSENS exception due to cross band isolation for CA | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0378 | | F | IBE requirement for almost contiguous allocations | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0399 | | F | TS38.101-1 CR on 30KHz SSB SCS for n40 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0403 | | F | CR for 38.101-1: to add some missing sub-clause title for NR inter-band CA | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0337 | 1 | F | CR to TS 38.101-1: Correction on the CA nominal channel spacing | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0342 | 1 | F | CR for [agreed] asynchronous operation for NR CA n78-n79 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0376 | 1 | F | CR for 38.101-1 to add the REFSSENS exception for inter band CA with SDL | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0384 | 1 | F | OOB blocking for n70 adjacent to n25 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0297 | 1 | F | Corrections of UE co-ex tables for Japan-related bands (R15) | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0309 | 1 | F | CR to TS 38.101-1 R15: corrections on ACS for intra-band contiguous CA | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0301 | 1 | F | CR on ACLR MBW definition in FR1 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0344 | 2 | F | 30k SSB SCS for n50 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0346 | 2 | F | Addition of 30k SSB SCS for Band n38 | 15.10.0 |
| 2020-06 | RAN#88 | RP-200985 | 0350 | 2 | F | Introduction of the Annex modifiedMPR-Behaviour into the NR SA specification | 15.10.0 |
| 2020-09 | RAN#89 | RP-201512 | 0410 | | F | OOB blocking for Inter-band CA | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0425 | 1 | F | CR to TS 38.101-1: corrections on narrow band blocking for intra-band contiguous CA | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0434 | | F | Corrections of Japan-related CA co-ex tables for REL-15 combo | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0441 | 1 | F | 30k SSB for n34 and n39 | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0443 | | F | Correction for 5 MHz channel bandwidth for n40 and n50 (15k SCS) | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0457 | 1 | F | CR for 38.101-1 RFC corrections (R15) | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0461 | 1 | F | CR for 38.101-1 to add the missing MSD for CA_n41A-n78A | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0464 | | F | Correction to configured power with allowance for SRS switching | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0482 | | F | Correction of applicability of 2Rx requirements | 15.11.0 |
| 2020-09 | RAN#89 | RP-201512 | 0490 | | C | 7.5 kHz UL shift for LTE/NR spectrum sharing in Band 38/n38 | 15.11.0 |
| 2020-12 | RAN#90 | RP-202485 | 0494 | 1 | F | CR to 38.101-1: UL MIMO EVM and emission requirements update | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0511 | 1 | F | CR to TS38.101-1 on DC location correction | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0517 | | F | Coexistence cleanup for 38.101-1 Rel15 | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0526 | 1 | F | CR to TS 38.101-1[R15]: Clarification of non-simultaneous Rx/Tx operation for CA_n77-n79 and CA_n78-n79 in TS 38.101-1. | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0541 | | F | CR for 38.101-1 to adjust the structure of NR CA REFSSENS | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0555 | | F | CR Removal of Band 10 protection 38101-1 Rel15 | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0570 | | F | CR for TS 38.101-1: correction of delta Tib for UE supporting multiple band combinations (R15) | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0580 | 1 | F | CR on correction for AMPR NS_38,NS_40 and NS_41 | 15.12.0 |
| 2020-12 | RAN#90 | RP-202485 | 0582 | 1 | F | CR to DMRS position in UL RMC for FR1 | 15.12.0 |
| 2021-03 | RAN#91 | RP-210117 | 0610 | | F | CR for TS38 101-1 Rel-15 Correction for definition of P-MPR | 15.13.0 |
| 2021-03 | RAN#91 | RP-210117 | 0661 | | F | Simplification of n70 | 15.13.0 |
| 2021-03 | RAN#91 | RP-210117 | 0672 | | F | CR to TS38.101-1: Correction on applicability of minimum requirements | 15.13.0 |

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| 2021-03 | RAN#91 | RP-210117 | 0675 | 1 | F | CR to TS38.101-1: Correction on the Aggregated Channel Bandwidth | 15.13.0 |
| 2021-03 | RAN#91 | RP-210117 | 0096 | | F | CR for TS 38.101-1: Cleanup for spurious emissions for UE co-existence table | 15.13.0 |
| 2021-03 | RAN#91 | RP-210117 | 0697 | 2 | F | CR for TS 38.101-1: Correction to FR1 time mask for SRS antenna switching | 15.13.0 |
| 2021-03 | RAN#91 | RP-210117 | 0718 | | F | Corrections to PCMAX for UL CA | 15.13.0 |
| 2021-06 | RAN#92 | RP-211084 | 0734 | | F | Update of FR1 UL RMC tables | 15.14.0 |
| 2021-06 | RAN#92 | RP-211085 | 0766 | | F | CR to TS38.101-1[R15]: Addition of UE co-existence requirements for n40 | 15.14.0 |
| 2021-06 | RAN#92 | RP-211080 | 0777 | 1 | F | Cleanup for UE co-existence 38.101-1 Rel-15 | 15.14.0 |
| 2021-09 | RAN#93 | RP-211910 | 0909 | | B | Introduction of the UL 7.5kHz shift for NR TDD band n34 and n39 | 15.15.0 |
| 2021-09 | RAN#93 | RP-211921 | 0919 | | F | Big CR for TS 38.101-1 Maintenance part1 (Rel-15) | 15.15.0 |
| 2021-12 | RAN#94 | RP-212856 | 0981 | | F | Big CR for TS 38.101-1 Maintenance (Rel-15) | 15.16.0 |
| 2022-03 | RAN#95 | RP-220337 | 1035 | | F | Big CR for TS 38.101-1 Maintenance Part-1 (Rel-15) | 15.17.0 |
| 2022-06 | RAN#96 | RP-221655 | 1119 | | F | Big CR for TS 38.101-1 Maintenance Part-1 (Rel-15) | 15.18.0 |
| 2022-09 | RAN#97 | RP-222026 | 1190 | | F | Big CR for 38.101-1 maintenance part1 (Rel-15) | 15.19.0 |
| 2022-12 | RAN#98-e | RP-223290 | 1208 | | F | Addition of FR1 UL MIMO EVM measurement description | 15.20.0 |
| 2022-12 | RAN#98-e | RP-223290 | 1211 | | F | Addition of FR2 UL MIMO EVM measurement description Note: The CR was not implementable and therefore was not implemented in the specification. | 15.20.0 |
| 2022-12 | RAN#98-e | RP-223291 | 1265 | | F | CR on 'Annex G Difference of relative phase and power errors' for FR1 UL coherent MIMO | 15.20.0 |
| 2022-12 | RAN#98-e | RP-223291 | 1268 | 1 | F | CR on TDD RMC for Intra-band EN-DC - TS 38.101-1 | 15.20.0 |
| 2023-03 | RAN#99 | RP-230504 | 1321 | 1 | F | Addition of configuration for carrier aggregation RMCs | 15.21.0 |
| 2023-03 | RAN#99 | RP-230504 | 1356 | 1 | F | CR to clarify duplex mode of SDL bands | 15.21.0 |
| 2023-03 | RAN#99 | RP-230502 | 1363 | | F | CR on Harmonic mixing MSD for CA_n8A-n79A (R15) | 15.21.0 |
| 2023-03 | RAN#99 | RP-230504 | 1408 | 1 | F | CR for TS 38.101-1 to clarify the inner outer condition for almost contiguous RB allocation | 15.21.0 |
| 2023-03 | RAN#99 | RP-230503 | 1433 | | F | CR to TS 38.101-1 on humidity condition for normal temperature | 15.21.0 |
| 2023-03 | RAN#99 | RP-230504 | 1456 | | F | Output power for NS_38, NS_40, and NS_41 | 15.21.0 |
| 2023-03 | RAN#99 | RP-230504 | 1468 | | F | CR to TS 38.101-1 Rel-15 Minimum guardband | 15.21.0 |
| 2023-06 | RAN#100 | RP-231355 | 1481 | | F | CR to K1 and PdschNumOfHarqProcess for DL-CA | 15.22.0 |
| 2023-06 | RAN#100 | RP-231355 | 1485 | | F | FR1 OOB requirements correction | 15.22.0 |
| 2023-06 | RAN#100 | RP-231355 | 1540 | | F | CR for TS 38.101-1 on corrections to the minimum guardband calculation | 15.22.0 |
| 2023-06 | RAN#100 | RP-231356 | 1602 | | F | CR to 38.101-1 Rel-15 Cat F, FRC correction | 15.22.0 |
| 2023-06 | RAN#100 | RP-231356 | 1631 | 1 | F | CR on correcting n38 UL requirement note 22 | 15.22.0 |
| 2023-09 | RAN#101 | RP-232487 | 1656 | | F | CR for TS 38.101-1 Rel-15 CAT-F: Introducing editorial modification for NS_43 A-MPR region | 15.23.0 |
| 2023-09 | RAN#101 | RP-232505 | 1663 | 1 | F | CR to clarify pi2BPSK note | 15.23.0 |
| 2023-09 | RAN#101 | RP-232487 | 1689 | | F | CR for 38101-1: Almost contiguous NBC change reversal | 15.23.0 |
| 2023-09 | RAN#101 | RP-232496 | 1726 | | D | [NR_RF_TxD] Editorial modification CR for TS 38.101-1 NOTE: This was not implemented because the CR coversheet state it is Rel-17 and not Rel-15, but CR was allocated for Rel-15 | 15.23.0 |
| 2023-09 | RAN#101 | RP-232487 | 1728 | | F | CR for Rel-15 38.101-1 to correct the superscript of inter-band CA_n77-n79 | 15.23.0 |
| 2023-09 | RAN#101 | RP-232502 | 1732 | | D | [NR_newRAT-Core] Editorial modification CR for TS 38.101-1_V2 | 15.23.0 |
| 2023-09 | RAN#101 | RP-232503 | 1747 | 1 | F | [NR_newRAT-Perf] CR: Correction of FRC for maximum input level for 256QAM | 15.23.0 |
| 2023-09 | RAN#101 | RP-232501 | 1755 | 1 | F | [NR_newRAT-Core] CR for TS 38.101-1 to modify MSD due to harmonic mixing interference (R15) | 15.23.0 |
| 2023-09 | RAN#101 | RP-232502 | 1765 | 1 | F | [NR_newRAT-Core] Editorial correction to 6.2A.4 (Rel-15) | 15.23.0 |
| 2023-09 | RAN#101 | RP-232502 | 1769 | | F | [NR_newRAT-Core] Update of FR1 UL MIMO EVM measurement description | 15.23.0 |
| 2023-09 | RAN#101 | RP-232505 | 1783 | | F | CR to TS 38.101-1: correction of Pcmx tolerance for 2Tx (Rel-15) | 15.23.0 |
| 2023-09 | RAN#101 | RP-232501 | 1786 | | F | [NR_newRAT-Core] Correction of intraband contiguous CA ACS requirements | 15.23.0 |
| 2023-09 | RAN#101 | RP-232501 | 1794 | | F | [NR_newRAT-Core] Correction to EVM measurement point | 15.23.0 |
| 2023-12 | RAN#102 | RP-233332 | 1812 | 1 | F | Fc terminology update | 15.24.0 |
| 2023-12 | RAN#102 | RP-233335 | 1827 | | F | UL MIMO Spurious emissions per UE | 15.24.0 |
| 2023-12 | RAN#102 | RP-233332 | 1852 | 3 | F | [NR_newRAT-Core] CR for TS 38.101-1 Rel-15: Introducing missing MSD for harmonic mixing | 15.24.0 |
| 2023-12 | RAN#102 | RP-233332 | 1872 | 1 | F | [NR_newRAT] CR for clarification on applicability of Rx antenna number for Rx requirements for TS 38.101-1 | 15.24.0 |
| 2023-12 | RAN#102 | RP-233332 | 1900 | | F | [NR_newRAT-Core] CR to remove the word capable in power class 3 capable UE - TS38.101-1, Rel-15, Cat-F | 15.24.0 |
| 2023-12 | RAN#102 | RP-233332 | 1926 | 1 | F | [NR_newRAT-Core] CR for 38.101-1 to clarify the applicable bands for additional UTRA ACLR requirements. (R15) | 15.24.0 |
| 2023-12 | RAN#102 | RP-233331 | 1956 | | F | [NR_newRAT] CR to 38.101-1 on FRC correction | 15.24.0 |
| 2023-12 | RAN#102 | RP-233331 | 1960 | | F | [NR_newRAT] CR to 38.101-1 on FRC deletion for 5MHz 30 KHz | 15.24.0 |
| 2023-12 | RAN#102 | RP-233340 | 1969 | | F | Correction of ?T_RxSRS for SRS resource set consisting of two SRS ports | 15.24.0 |

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|---------|---------|-----------|------|--|---|---|---------|
| 2024-03 | RAN#103 | RP-240563 | 2079 | | F | (NR_newRAT-Core) Correct on the NOTE for harmonic mixing MSD valid test point | 15.25.0 |
| 2024-03 | RAN#103 | RP-240563 | 2103 | | F | (NR_newRAT-Core) CR to correct "Supplement" to "Supplementary" in the definition of the suffix used for SUL - TS38.101-1, Rel-15, Cat-F | 15.25.0 |
| 2024-03 | RAN#103 | RP-240564 | 2116 | | F | (NR_newRAT-Core) CR for TS 38.101-1 to correct the Finterferer (offset) for intra-band CA ACS and IBB requirements (R15) | 15.25.0 |
| 2024-03 | RAN#103 | RP-240564 | 2147 | | F | (NR_newRAT-Core) CR to remove the word capable in power class related requirements | 15.25.0 |
| 2024-03 | RAN#103 | RP-240564 | 2151 | | F | (NR_newRAT-Core) CR to TS38.101-1: Correction of band number in uplink configuration for reference sensitivity table | 15.25.0 |
| 2024-06 | RAN#104 | RP-241382 | 2284 | | F | (NR_newRAT-Core) Correct the P _{cm} ax tolerance for inter-band CA | 15.26.0 |
| 2024-06 | RAN#104 | RP-241382 | 2345 | | F | (NR_newRAT-Core) CR for TS 38.101-1 on UE additional spurious emissions (R15) | 15.26.0 |

History

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| V15.2.0 | July 2018 | Publication |
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| V15.5.0 | May 2019 | Publication |
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