**3GPP TSG-WG4 Meeting #108-bis *R4-2317616***

**Xiamen, China, Oct 09 – 13, 2023**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.101-1** | **CR** |  | **rev** | **1** | **Current version:** | **18.2.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
|  | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | | |
| ***Title:*** | draft Big CR to TS 38.101-1: 4Tx requirements | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei, HiSilicon | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_ENDC\_ RF\_FR1\_enh2 | | | | |  | ***Date:*** | | | 2023-09-26 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Introduce the RF requirements for 4Tx with 4 layer UL MIMO. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | 1. Remove the limitation to UL MIMO and TxD with 2Tx. 2. Introduce new specific RF requirements for 4Tx. 3. Other changes where the requirements are not applicable for 4Tx. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Requirements for 4Tx are not supported in the specfication. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 6.1, 6.2.2, 6.2D.1, 6.2D.2, 6.2D.3, 6.2D.4, 6.2G.1, 6.2G.2, 6.3D.1, 6.3D.3, 6.3D.4, 6.4D.2.1, 6.4D.2.2, 6.4D.2.3, 6.4D.2.4, 6.5D.1, 6.5D.2, 6.5D.3, 6.5D.4, 7.3D, 7.3G, 7.4D, 7.5D, 7.6D, 7.7D, 7.8D, F.8 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  |  | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | | **X** |  | Test specifications | | | | TS 38.521-1 | | |
| ***(show related CRs)*** | |  |  | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | Put some values of Pcmax tolerance in brackets for further check in next meeting, also add the sentence of reference table on Pcmax tolerance for 4Tx. | | | | | | | | |

## **<Start of Change>**

# 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/4 ports on the same CDM group. The UE may use higher MPR values outside this limitation.

The applicability of transmitter requirements for Band n90 is in accordance with that for Band n41; a UE supporting Band n90 shall meet the minimum requirements for Band n41.

## **<Next Change>**

### 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 and UE power class 1, the allowed maximum power reduction (MPR) is defined in Table 6.2.2-2, Table 6.2.2-1 and Table 6.2.2-5, respectively for channel bandwidths ≤ 100 MHz. For UE power class 1.5 with dual Tx, the allowed maximum power reduction (MPR) is defined in Table 6.2D.2-2 and Table 6.2D.2-3 in accordance with the indicated *modifiedMPR-Behavior* specified in Table L.1-1 for channel bandwidths ≤ 100 MHz. For UE power class 1.5 with 4 Tx, the allowed maximum power reduction is defined in Table 6.2D.2-4, 6.2D.2-5.

If the relative channel bandwidth ≤ 4% for TDD bands or ≤ 3% for FDD band, the ∆MPR is set to zero.

If the relative channel bandwidth > 4% for TDD bands or > 3% for FDD bands, the ∆MPR is defined in Table 6.2.2-3.

Where relative channel bandwidth = 2\*BWChannel / (FUL\_low + FUL\_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.

<<Unchanged parts are omitted>>

## **<Next Change>**

## 6.2D Transmitter power for UL MIMO

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

For UE with two or four 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 all 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 or 4-layer UL MIMO transmission with codebook of . DCI Format for UE configured in PUSCH transmission mode for uplink single-user MIMO shall be used.

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Class 1.5 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) | Class 4 (dBm) | Tolerance (dB) |
| n1 |  |  |  |  | 23 | +2/-3 |  |  |
| n2 |  |  |  |  | 23 | +2/-31 |  |  |
| n3 |  |  |  |  | 23 | +2/-31 |  |  |
| n7 |  |  |  |  | 23 | +2/-31 |  |  |
| n24 |  |  |  |  | 23 | +2/-41 |  |  |
| n25 |  |  |  |  | 23 | +2/-31 |  |  |
| n30 |  |  |  |  | 23 | +2/-3 |  |  |
| n34 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n38 |  |  |  |  | 23 | +2/-3 |  |  |
| n39 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n40 |  |  |  |  | 23 | +2/-3 |  |  |
| n41 | 29 | +2/-31 | 26 | +2/-31 | 23 | +2/-31 |  |  |
| n48 |  |  |  |  | 23 | +2/-3 |  |  |
| n66 |  |  |  |  | 23 | +2/-3 |  |  |
| n70 |  |  |  |  | 23 | +2/-3 |  |  |
| n71 |  |  |  |  | 23 | +2/-3 |  |  |
| n77 | 29 | +2/-3 | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n78 | 29 | +2/-3 | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n79 | 29 | +2/-3 | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n80 |  |  |  |  | 23 | +2/-31 |  |  |
| n84 |  |  |  |  | 23 | +2/-3 |  |  |
| n95 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n97 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n98 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n99 |  |  |  |  | 23 | +2/-41 |  |  |
| 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 | Number of layers | TPMI index |
| Codebook based uplink | DCI format 0\_1 | 2 | 01 |
| Codebook based uplink | DCI format 0\_1 | 4 | 02 |
| NOTE 1: The UE is configured with one SRS resource with the parameter *nrofSRS-Ports* set to 2. | | | |
| NOTE 2: The UE is configured with one SRS resource with the parameter *nrofSRS-Ports* set to 4. | | | |

For UE support uplink full power transmission (ULFPTx) for UL MIMO, the maximum output power requirements specified in Table 6.2D.1-1 shall be met with the PUSCH configurations specified in Table 6.2D.1-3, based upon UE’s support of uplink full power transmission mode.

Table 6.2D.1-3: PUSCH Configuration for uplink full power transmission (ULFPTx)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ULFPTx Mode | Transmission scheme | DCI format | Modulation | Number of layers | Number of Tx Port | TPMI index |
| Mode-1 | Codebook based uplink | DCI format 0\_1 | DFT-s-OFDM, CP-OFDM NOTE3 | 1 | 2 NOTE1 | 2 |
| 4 NOTE4 | 13 |
| CP-OFDM | 2 | 4 | 6 |
| Mode-2 | Codebook based uplink | DCI format 0\_1 | DFT-s-OFDM, CP-OFDM | 1 | 2 NOTE1 | 0 or 1NOTE2 |
| 4 | 4, 5, 6 ,7 or 4, 5, 6 ,7, 8, 9, 10, 11NOTE2 |
| CP-OFDM | 2 | 4 | 1 or 0, 1, 2, 3, 4 ,5NOTE2 |
| Mode-full power | Codebook based uplink | DCI format 0\_1 | DFT-s-OFDM, CP-OFDM | 1 | 2 NOTE1 | 0,1 |
| NOTE 1: The UE is configured with one SRS resource with the parameter *nrofSRS-Ports* set to 2.  NOTE 2: TPMI index selected shall be based upon the full power TPMI reported by the UE [8, TS 38.213].  NOTE 3: For PUSCH configured with ULFPTxModes set to Mode-1, all the transmitter requirement for CP-OFDM based modulation is not needed to be verified if the requirement for UL MIMO has been validated.  NOTE 4: The UE is configured with one SRS resource with the parameter *nrofSRS-Ports* set to 4. | | | | | | |

If the 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 apply for at least one antenna connector for the power class as indicated by the *ue-PowerClass* field in capability signalling with the following exception: for UEs indicating *txDiversity-r16*, the requirements in clause 6.2G for the power class indicated by the *ue-PowerClass*.

A UE with dual Tx indicating the feature *ul-FullPwrMode-r16* or *ul-FullPwrMode2-TPMIGroup-r16* for a band shall meet the requirement in clause 6.2 for at least one antenna connector when scheduled for single antenna-port transmission by DCI format 0\_0 or by DCI format 0\_1 for codebook-based transmission on a single antenna port.

<<Unchanged parts are omitted>>

## **<Next Change>**

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

For UE with two or four 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 6.2.2-1for PC3, Table 6.2D.2-1 for 2Tx PC2 when the UE does not indicate ul-FullPwrMode-r16 or ul-FullPwrMode2-TPMIGroup-r16 for the band and Table 6.2.2-2 for 2Tx PC2 when the UE indicates ul-FullPwrMode-r16 or ul-FullPwrMode2-TPMIGroup-r16 for the band, Table 6.2D.2-2 and Table 6.2D.2-3 for PC1.5 with dual Tx, Table 6.2D.2-4, 6.2D.2-5 for PC1.5 with 4 Tx respectively. For UE power class 1.5 with dual Tx, the allowed maximum power reduction (MPR) defined in Table 6.2D.2-3 is in accordance with the indicated *modifiedMPR-Behavior* specified in Table L.1-1 for channel bandwidths ≤ 100 MHz. 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 connectors.

For UE support uplink full power transmission (ULFPTx) for UL MIMO except the feature *ul-FullPwrMode-r16* or *ul-FullPwrMode2-TPMIGroup-r16*, the allowed MPR for the maximum output power in Table 6.2D.1-1 is specified in Table 6.2.2-1 for PC3, Table 6.2D.2-1 when *TxD* is indicated and Table 6.2.2-2 when *TxD* is not indicated for PC2 , Table 6.2D.2-2 and Table 6.2D.2-3 for PC1.5 with dual Tx, Table 6.2D.2-4, 6.2D.2-5 for PC1.5 with 4 Tx respectively, and the requirements shall be met with the PUSCH configurations specified in Table 6.2D.1-3, based upon UE’s support of uplink full power transmission mode. A UE with dual Tx indicating the feature *ul-FullPwrMode-r16* or *ul-FullPwrMode2-TPMIGroup-r16* for a band shall meet the maximum output power requirement with MPR according to clause 6.2.2. When a UE that indicates PC1.5 for a given band is limited to PC2 by the rules in clause 6.2.1, the MPR requirements in Table 6.2.2-2 apply.

The same MPR requirements shall be applicable to UE with 1-layer UL MIMO transmission (either with or without ULPFTx) as with the UL MIMO configurations of using 2-layer UL MIMO transmission with codebook of.

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 corresponding requirements in clause 6.2D.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signaling. A UE with dual Tx indicating the feature *ul-FullPwrMode-r16* or *ul-FullPwrMode2-TPMIGroup-r16* for a band shall meet the requirement in clause 6.2 with MPR according to clause 6.2.2 for at least one antenna connector when scheduled for single antenna-port transmission by DCI format 0\_0 or by DCI format 0\_1 for codebook-based transmission on a single antenna port with precoding matrix *W*=1 [6.3.1.5 TS 38.211].

Table 6.2D.2-1 Maximum power reduction (MPR) for power class 2 with dual Tx

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | | MPR (dB) | | |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 3.5 | ≤ 1 | 0 |
| QPSK | ≤ 3.5 | ≤ 2 | 0.5 |
| 16 QAM | ≤ 3.5 | ≤ 2.5 | ≤ 1.5 |
| 64 QAM | ≤ 3.5 | ≤ 3 | |
| 256 QAM | ≤ 5.5 | | |
| CP-OFDM | QPSK | ≤ 4.0 | ≤ 3.5 | ≤ 2 |
| 16 QAM | ≤ 4.0 | ≤ 3.5 | ≤ 2.5 |
| 64 QAM | ≤ 4.5 | | |
| 256 QAM | ≤ 8.0 | | |

Table 6.2D.2-2 Maximum power reduction (MPR) for power class 1.5 with dual Tx

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | | MPR (dB) | | |
|  | | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 6 | ≤ [2] | ≤ 0.5 |
|  | QPSK | ≤ 6.5 | ≤ [2.5] | ≤ 0.5 |
|  | 16 QAM | ≤ 6.5 | ≤ [3.5] | ≤ 1.5 |
|  | 64 QAM | ≤ 6.5 | ≤ [4] | ≤ 3.5 |
|  | 256 QAM | ≤ 6.5 | ≤ 6.5 | ≤ [6.5] |
| CP-OFDM | QPSK | ≤ 6.5 | ≤ [4.5] | ≤ 2 |
|  | 16 QAM | ≤ 6.5 | ≤ [4.5] | ≤ 2.5 |
|  | 64 QAM | ≤ 6.5 | ≤ [5] | ≤ 4.5 |
|  | 256 QAM | ≤ 8.5 | ≤ 8.5 | ≤ [8.5] |

Table 6.2D.2-3 Maximum power reduction (MPR) for power class 1.5 with dual Tx

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | | MPR (dB) | | |
|  | | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 6 | ≤ 1.5 | ≤ 0 |
|  | QPSK | ≤ 6.5 | ≤ 2 | ≤ 0 |
|  | 16 QAM | ≤ 6.5 | ≤ 3 | ≤ 1 |
|  | 64 QAM | ≤ 6.5 | ≤ 3.5 | ≤ 3 |
|  | 256 QAM | ≤ 6.5 | ≤ 5.5 | ≤ 5.5 |
| CP-OFDM | QPSK | ≤ 6.5 | ≤ 4 | ≤ 1.5 |
|  | 16 QAM | ≤ 6.5 | ≤ 4 | ≤ 2 |
|  | 64 QAM | ≤ 6.5 | ≤ 4.5 | ≤ 4 |
|  | 256 QAM | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
| NOTE 1: This table is targeted to large FWA form factor with 20 dB or above antenna isolation. | | | | |

Table 6.2D.2-4 Maximum power reduction (MPR) for power class 1.5 with 4 Tx

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | | MPR (dB) | | |
|  | | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 8.0 | ≤ 3.0 | ≤ 2.0 |
|  | QPSK | ≤ 8.5 | ≤ 3.5 | ≤ 2.0 |
|  | 16 QAM | ≤ 8.5 | ≤ 4.0 | ≤ 2.5 |
|  | 64 QAM | ≤ 8.5 | ≤ 4.7 | ≤ 4.5 |
|  | 256 QAM | ≤ 9.5 | ≤ 7.0 | ≤ 7.0 |
| CP-OFDM | QPSK | ≤ 9.5 | ≤ 5.0 | ≤ 3.5 |
|  | 16 QAM | ≤ 9.5 | ≤ 5.0 | ≤ 4.0 |
|  | 64 QAM | ≤ 9.5 | ≤ 7.0 | ≤ 7.0 |
|  | 256 QAM | ≤ 9.5 | ≤ 9.5 | ≤ 9.5 |
| NOTE 1: This table is targeted to vehicular UE or other industrial device form factor with 10dB antenna isolation. | | | | |

Table 6.2D.2-5 Maximum power reduction (MPR) for power class 1.5 with 4 Tx

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | | MPR (dB) | | |
|  | | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 7.5 | [≤ 2.0] | ≤ 0.5 |
|  | QPSK | ≤ 8.0 | [≤ 2.5] | ≤ 0.5 |
|  | 16 QAM | ≤ 8.0 | [≤ 3.5] | ≤ 1.5 |
|  | 64 QAM | ≤ 8.0 | [≤ 4.0] | [≤ 3.5] |
|  | 256 QAM | ≤ 8.0 | [≤ 6.5] | [≤ 6.5] |
| CP-OFDM | QPSK | ≤ 8.0 | [≤ 4.5] | ≤ 2.0 |
|  | 16 QAM | ≤ 8.0 | [≤ 4.5] | ≤ 2.5 |
|  | 64 QAM | ≤ 8.0 | ≤ 5.0 | ≤ 5.0 |
|  | 256 QAM | [≤ 8.5] | [≤ 8.5] | [≤ 8.5] |
| NOTE 1: This table is targeted to large FWA form factor with 20 dB or above antenna isolation. | | | | |

Inner, outer and edge allocations are as defined in section 6.2.2 except for PC1.5 edge allocations which is for LCRB ≤ 4 RBs instead of LCRB ≤ 2 RBs for other power classes.

<<Unchanged parts are omitted>>

## **<Next Change>**

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

For UE with two or four 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 all UE transmit antenna connectors. Unless stated otherwise, an A-MPR of 0 dB shall be used.

For UE support uplink full power transmission (ULFPTx) for UL MIMO, 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 PUSCH configurations specified in Table 6.2D.1-3, based upon UE’s support of uplink full power transmission mode.

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

If the 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 corresponding requirements in clause 6.2D.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signaling. A UE with dual Tx indicating the feature *ul-FullPwrMode-r16* or *ul-FullPwrMode2-TPMIGroup-r16* for a band shall meet the requirement in clause 6.2 for at least one connector with A-MPR according to clause 6.2.3 when scheduled for single antenna-port transmission by DCI format 0\_0 or by DCI format 0\_1 for codebook-based transmission on a single antenna port.

## **<Next Change>**

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

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

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

- PPowerClass, ΔPPowerClass and ∆TC,c are specified in clause 6.2.4 unless otherwise stated;

- MPRc is specified in clause 6.2D.2;

- A-MPRc is specified in clause 6.2D.3.

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

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

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

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

For UE support uplink full power transmission (ULFPTx) for UL MIMO, the tolerance is specified in Table 6.2D.4-1. The requirements shall be met with the PUSCH configurations specified in Table 6.2D.1-3, based upon UE’s support of uplink full power transmission mode.

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

|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) |
| 23 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 |
| 22 ≤ PCMAX,*c* < 23 | 5.0 | 2.0 |
| 21 ≤ PCMAX,*c* < 22 | 5.0 | 3.0 |
| 20 ≤ PCMAX,*c* < 21 | 6.0 | 4.0 |
| 16 ≤ PCMAX,*c* < 20 | 5.0 | |
| 11 ≤ PCMAX,*c* < 16 | 6.0 | |
| -40 ≤ PCMAX,*c* < 11 | 7.0 | |

Table 6.2D.4-2: PCMAX,*c* tolerance in closed-loop spatial multiplexing scheme for 4Tx

|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) |
| [26] ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 |
| [25] ≤ PCMAX,*c* < [26] | 5.0 | 2.0 |
| [24] ≤ PCMAX,*c* < [25] | 5.0 | 3.0 |
| 23 ≤ PCMAX,*c* < 24 | 6.0 | 4.0 |
| 19 ≤ PCMAX,*c* < 23 | 5.0 | |
| 14 ≤ PCMAX,*c* < 19 | 6.0 | |
| -40 ≤ PCMAX,*c* < 14 | 7.0 | |

If the 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 corresponding requirements in clause 6.2D.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signaling.

## **<Next Change>**

## 6.2G Transmitter power for Tx Diversity

### 6.2G.1 UE maximum output power for Tx Diversity

For UE supporting Tx Diversity, the maximum output power as indicated by UE power class in Table 6.2.1-1is defined as the sum of the maximum output power from all UE transmit antenna connectors. The period of measurement shall be at least one sub frame (1 ms).

### 6.2G.2 UE maximum output power reduction for Tx Diversity

For UE supporting Tx diversity, the allowed MPR for the maximum output power is specified in Table 6.2.2-1 for UE power class 3, in Table 6.2D.2-1 for UE power class 2, in Table 6.2D.2-2 and Table 6.2D.2-3 for UE power class 1.5 with dual TX, in Table 6.2D.2-4 and 6.2D.2-5 for UE power class 1.5 with 4 Tx. For UE power class 1.5 with dual Tx, the allowed maximum power reduction (MPR) defined in Table 6.2D.2-3 is in accordance with the indicated *modifiedMPR-Behavior* specified in Table L.1-1 for channel bandwidths ≤ 100 MHz. The maximum output power is defined as the sum of the maximum output power at each UE antenna connector. If a UE that supports PC1.5 has to apply the requirements of PC2 according to the rules in clause 6.2.1, the MPR requirements in Table 6.2.2-2 apply

## **<Next Change>**

## 6.3D Output power dynamics for UL MIMO

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

For UE with two or four transmit antenna connectors in closed-loop spatial multiplexing scheme, the minimum output power is defined as the sum of the mean power from all transmit connectors 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.

<<Unchanged parts are omitted>>

## **<Next Change>**

### 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 or four 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.

## **<Next Change>**

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

For UE supporting UL MIMO, the power control tolerance applies to the sum of output powers from all transmit antenna connectors.

The power control requirements specified in clause 6.3.4 apply to UE with all 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.

## **<Next Change>**

#### 6.4D.2.1 Error Vector Magnitude

For UE with two or four 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 or four 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 or four 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 or four 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

## **<Next Change>**

## 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 all 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 at each transmit antenna connector.

For UE with two or four transmit antenna connectors in closed-loop spatial multiplexing scheme, the occupied bandwidth 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 all UEtransmit antenna connectors.

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

For UE support uplink full power transmission (ULFPTx) for UL MIMO, the requirements in clause 6.5.2 shall apply. The requirements shall be met with the PUSCH configurations specified in Table 6.2D.1-3, based upon UE’s support of uplink full power transmission mode.

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 is defined as the sum of the emissions from all UE transmit antenna connectors.

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

For UE support uplink full power transmission (ULFPTx) for UL MIMO, the requirements in clause 6.5.3 shall apply. The requirements shall be met with the PUSCH configurations specified in Table 6.2D.1-3, based upon UE’s support of uplink full power transmission mode.

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 6.5.3 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 all UE transmit antenna connectors.

For UEs with two or four 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.

## **<Next Change>**

## 7.3D Reference sensitivity for UL MIMO

For UE with two or four 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 Annex A.2.2 for CP-OFDM waveforms shall apply. For UL MIMO, the parameter PUMAX is the total transmitter power over the two or four transmits power over all transmit antenna connectors.

## **<Next Change>**

## 7.3G Reference sensitivity for Tx Diversity

For UE supporting Tx diversity, the minimum requirements specified in Table 7.3.2-1b and Table 7.3.2-1d shall be met with Tx diversity configuration described in clause 6.2G.1. For Tx diversity, the parameter PUMAX is defined in clause 6.2G.4 with the sum of the output power from all UE antenna connectors.

## **<Next Change>**

## 7.4D Maximum input level for UL MIMO

For UE with two or four 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 PCMAX\_L is defined as the total transmitter power over all transmit antenna connectors.

## **<Next Change>**

## 7.5D Adjacent channel selectivity for UL MIMO

For UE(s) with two or four 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 PCMAX\_L is defined as the total transmitter power over all transmit antenna connectors.

## **<Next Change>**

## 7.6D Blocking characteristics for UL MIMO

For UE with two or four 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 PCMAX\_L is defined as the total transmitter power over all transmit antenna connectors.

## **<Next Change>**

## 7.7D Spurious response for UL MIMO

For UE with two or four 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 PCMAX\_L is defined as the total transmitter power over all transmit antenna connectors.

## **<Next Change>**

## 7.8D Intermodulation characteristics for UL MIMO

For UE(s) with two or four 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 PCMAX\_L is defined as the total transmitter power over all transmit antenna connectors.

## **<Next Change>**

# F.8 EVM measurement for multiple Tx

For UE with multiple transmission antennas, if UE indicates IE *txDiversity-r16*, EVM is measured at each antenna connector to get EVMi, and the total EVM is calculated by values of EVMi with weighting factor of linear power at each antenna connector.

where k=2, 4, and Pi denotes the linear power measured at each antenna connector respectively.

## **<End of Change>**