**3GPP TSG-RAN4 Meeting #102-e** ***R4-2205574***

**Electronic Meeting, 21 Feb - 3 Mar, 2022**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
|  |
|  | **38.101-1** | **CR** | **0986** | **rev** | **-** | **Current version:** | **17.4.0** |  |
|  |
| *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)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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|  |
| ***Title:***  | Big CR for TS 38.101-1 Tx diversity requirements |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon, Qualcomm, vivo |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_RF\_TxD-Core |  | ***Date:*** | 2022-03-07 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *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 canbe 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-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | Running CR to capture agreements after RAN4#100e.  |
|  |  |
| ***Summary of change:*** | **RAN4#101e:**endorsed CR R4-2119977Move PC2, PC1.5 dual-Tx related MPR requirements from Clause 6.2.2, 6.2G.2 to Clause 6.2D.2, and update the references in Annex L.1.endorsed CR R4-2119971Move MPR table from Clause 6.2G.2 to Clause 6.2D.2The updated MPR values for TxD PC2 UE as follow* Update MPR values for CP-OFDM(QPSK & 16QAM) Edge RB from 3.5 to 4.0 dB
* Update MPR values for CP-OFDM 256QAM, from 8.5 to 8.0 dB

**RAN4#101-bis-e:**endorsed CR R4-2202349* Correct PC2 2Tx MPR table with values in R4-2119971
* Move 2Tx tables from 6.2G to 6.2D according to agreements
* Add clarification

**RAN4#102-e:**endorsed CR R4-2206518* Introduce SRS IL for UE with TxD, two sub-bullets added: one for one SRS port, the other for two SRS ports per SRS resource.

endorsed CR R4-2206519* 6.2D.1: The requirements in 6.2 are the baseline for single-port transmissions, an exception granted for TxD. Mode 2 with full-power TPMI or Mode 0 shall meet the fallback rerquirement according to 6.2.
* 6.2D.2: Full power TPMI mode 2 or Mode 0 verified against requirements according to 6.2 shall meet requirements with MPR according to 1 TX.
* 6.2D.3: Full power TPMI mode 2 or Mode 0 verified against requirements according to 6.2 shall meet requirements with A-MPR according to 1 TX.
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| ***Consequences if not approved:*** | The feature of transparent TxD is not completed. |
|  |  |
| ***Clauses affected:*** | 6.2.2, 6.2.4, 6.2D.1, 6.2D.2, 6.2D.3, 6.2D.4, 6.2G.2, Annex L.1 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **x** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **x** |  |  Test specifications | TS 38.521-1  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

## **<Start of 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 in Band n14, 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, 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.

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.

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

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 3.51 | ≤ 1.21 | ≤ 0.21 |
|  |  | ≤ 0.52 | ≤ 0.52 | 02 |
|  | Pi/2 BPSK w Pi/2 BPSK DMRS | ≤ 0.52 |  02 | 02 |
|  | 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 *powerBoosting-pi2BPSK* and if the IE *powerBoostPi2BPSK* 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 UE operating in FDD mode, or in TDD mode in bands other than n40, n41, n77, n78 and n79 with Pi/2 BPSK modulation and if the IE *powerBoostPi2BPSK* is set to 0 and if more than 40 % of slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79.  |

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

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 3.5 | ≤ 0.5 | 0 |
|  | 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 |

Table 6.2.2-3: ∆MPR

|  |  |  |  |
| --- | --- | --- | --- |
| NR Band | Power class | Channel bandwidth | ∆MPR (dB) |
| n28 and n83 | Power class 3 | 30 MHz | 0.5 |
| n40 and n97 | Power class 3 and power class 2 | 100 MHz | 1 |

Table 6.2.2-4 Void

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Table 6.2.2-4a Void

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Table 6.2.2-5 Maximum power reduction (MPR) for power class 1 for Band n14

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 0.5 | ≤ 0.5 | 0 |
|  | Pi/2 BPSK w Pi/2 BPSK DMRS | ≤ 0.5 |  0 | 0 |
|  | 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 |

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

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

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

RBStart,High = NRB – RBStart,Low – LCRB

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

RBStart,Low ≤ RBStart ≤ RBStart,High,and

LCRB ≤ ceil(NRB/2)

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

An Edge RB allocation is the one for which the RB(s) is (are) allocated at the lowermost or uppermost edge of the channel LCRB ≤ 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

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

and NRB\_alloc + NRB\_gap is larger than 106, 51 or 24 RBs for 15 kHz, 30 kHz or 60 kHz SCS respectively where NRB\_gap is the total number of unallocated RBs between allocated RBs and NRB\_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 these almost contiguous signals in power class 2 and 3, the allowed maximum power reduction defined in Table 6.2.2-2 and Table 6.2.2-1 are increased by

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

where CEIL{x,0.5} means x rounding upwards to closest 0.5dB. The parameters of RBStart,Low and RBStart,High to specify valid RB allocation ranges for Outer and Inner RB allocations are defined as following:

RBStart,Low = max(1, floor((NRB\_alloc + NRB\_gap)/2))

RBStart,High = NRB – RBStart,Low – NRB\_alloc –NRB\_gap

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

## **<Next Change>**

### 6.2.4 Configured transmitted power

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

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

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

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

where

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

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

 When the IE *powerBoostPi2BPSK* is set to 1, PEMAX,c is increased by +3 dB for a power class 3 capable 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 symbols in certain evaluation period are used for UL transmission when PEMAX,c ≥ 20 dBm (The exact evaluation period is no less than one radio frame).

 When the IE *powerBoostPi2BPSK* is set to 1, ΔPPowerClass = -3 dB for a power class 3 capable 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.

 ΔPPowerClass =

- 3 dB for a power class 2 capable UE or 6 dB for a power class 1.5 UE when P-max of 23 dBm or lower is indicated; or when the field of UE capability *maxUplinkDutyCycle-PC2-FR1* is absent and the field of UE capability *maxUplinkDutyCycle-MPE-FR1* 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-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 38.306 (The exact evaluation period is no less than one radio frame); or when the field of UE capability *maxUplinkDutyCycle-MPE-FR1* is not absent and half the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle-MPE-FR1* as defined in TS 38.306 (The exact evaluation period is no less than one radio frame).

- 3 dB for a power class 1.5 capable UE when P-max of between 23 dBm and 26 dB is indicated; or when the field of UE capability *maxUplinkDutyCycle-PC2-FR1* is absent and the field of UE capability *maxUplinkDutyCycle-MPE-FR1* is absent and the percentage of uplink symbols transmitted in a certain evaluation period is between 25% and 50%; or when the field of UE capability *maxUplinkDutyCycle-PC2-FR1* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is between *maxUplinkDutyCycle-PC2-FR1* and *maxUplinkDutyCycle-PC2-FR1/2* as defined in TS 38.306 (The exact evaluation period is no less than one radio frame); or when the field of UE capability *maxUplinkDutyCycle-MPE-FR1* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle-MPE-FR1* as defined in TS 38.306 (The exact evaluation period is no less than one radio frame).

- 3dB when the UE is configured with SUL configurations and the requirements of default power class are applied as specified in sub-clause 6.2C.1 on the band where UE indicates power class 2;

- 3dB is applied during SRS transmission occasions with usage in SRS-ResourceSet set as ‘antennaSwitching’ with configured SRS resources in each SRS resource set(s) consisting of one SRS port when PC2 capable UE with txDiversity-r16 capability or PC1.5 capable UE further indicates SRS-TxSwitch capability ‘t1r2’ or ‘t1r4’ or ‘t1r1-t1r2’ or ‘t1r1-t1r2-t1r4’;

- 0 dB otherwise;

 ∆TIB,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; ∆TIB,c = 0 dB otherwise; In case the UE supports more than one of band combinations for V2X operating bands for concurrent operation, 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 ∆TIB,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 ∆TIB,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 ∆TIB,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.

 ∆TC,c = 1.5dB when NOTE 3 in Table 6.2.1-1 in 38.101-1 applies for a serving cell c, otherwise ∆TC,c = 0 dB ;

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

 ∆MPRc for serving cell c is specified in clause 6.2.2.

 ∆TRxSRS 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' or 't1r1-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' or 't1r1-t1r2-t1r4' or, 't1r1-t1r2-t2r2-t1r4-t2r4'

c) UE transmits SRS from the second SRS port pair on the second SRS resource in every configured SRS resource set consisting of two SRS ports when the *SRS-TxSwitch* capabilityis indicated as' t2r4' or ' t1r4-t2r4', or 't1r1-t1r2-t2r2-t2r4' or 't1r1-t1r2-t2r2-t1r4-t2r4', or

d) UE transmits SRS to a DL-only carrier

 The value of ∆TRxSRS is 4.5dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 3 dB for bands whose FUL\_high is lower than the FUL\_low of n79 when the device is capable of power class 3 or power class 5 or power class 1.5 in the band, or when the device is capable of power class 2 in the band and ΔPPowerClass = 3 dB, or when UE indicating *txDiversity-r16*~~.~~.

The value of ∆TRxSRS is 7.5dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 6 dB for bands whose FUL\_high is lower than the FUL\_low of n79 during SRS transmission occasions with configured SRS resources consisting of one SRS port when the device is capable of power class 2 in the band and ΔPPowerClass = 0 dB and not indicating *txDiversity-r16*.

For other SRS transmissions ∆TRxSRS is zero;

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

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

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

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

Table 6.2.4-1: Evaluation and reference periods for Pcmax

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

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

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

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

Table 6.2.4-1: PCMAX tolerance

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

## **<Next Change>**

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

For 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. 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 |  |  |
| 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 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n78 |  |  | 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 |  |  |  |  | 23 | +2/-3 |  |  |
| n97 |  |  |  |  | 23 | +2/-3 |  |  |
| n98 |  |  |  |  | 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 dBNOTE 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 | 0 |
| NOTE 1: The UE is configured with one SRS resource with the parameter *nrofSRS-Ports* set to 2. |

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 | 2 |
| Mode-2 | Codebook based uplink | DCI format 0\_1 | DFT-s-OFDM, CP-OFDM | 1 | 2 | 0 or 1NOTE2 |
| Mode-full power | Codebook based uplink | DCI format 0\_1 | DFT-s-OFDM, CP-OFDM | 1 | 2 | 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. |

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 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.

### 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 6.2.2-1for PC3, Table 6.2D.2-1 for 2Tx PC2, Table 6.2D.2-2 and Table 6.2D.2-3 for PC1.5 respectively. For UE power class 1.5, 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, 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 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.

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 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.

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. |

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.

## **<Next Change>**

### 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 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 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.

### 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. 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) | ToleranceTLOW(PCMAX\_L,*c*) (dB) | ToleranceTHIGH(PCMAX\_H,*c*) (dB) |
| PCMAX,*c* = 26 | 3.0 | 2.0 |
| 23 ≤ PCMAX,*c* < 26 | 3.0 | 2.0 |
| 22 ≤ PCMAX,*c* < 23 | 5.0 | 2.0 |
| 21 ≤ PCMAX,*c* < 22 | 5.0 | 3.0 |
| 20 ≤ PCMAX,*c* < 21 | 6.0 | 4.0 |
| 16 ≤ PCMAX,*c* < 20 | 5.0 |
| 11 ≤ PCMAX,*c* < 16 | 6.0 |
| -40 ≤ PCMAX,*c* < 11 | 7.0 |

If 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.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, Table 6.2D.2-1, Table 6.2D.2-2 and Table 6.2D.2-3 for UE power class 3, 2 and 1.5 respectively. For UE power class 1.5, 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.

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## **<Next Change>**

# L.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 L.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 shall 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 shall be set to 1 by a UE supporting DC\_41A\_n41A EN-DC  |
|  | 2 | - EN-DC contiguous and non-contiguous intraband MPR and A-MPR as defined in 38.101-3 v16.4.0. If this bit is not set the UE uses Rel-15 MPR or A-MPR for EN-DC contiguous and non-contiguous intraband MPR and A-MPR  | -This bit may be set to 1 by a UE supporting DC\_(n)41AA or DC\_41A\_n41A EN-DC  |
|  | 3 | PC 1.5 MPR as defined in Table 6.2D.2-3 of 38.101-1 v17.3.0 | This bit may be set to 1 by a UE supporting power class 1.5. This bit is intended to be set by larger form factor FWA devices. If the bit is not set, MPR in Table 6.2D.2-2 applies. |
| 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 shall be set to 1 by a UE supporting DC\_(n)71AA UE EN-DC  |
| n77 | 0 (leftmost bit) | PC 1.5 MPR as defined in Table 6.2D.2-3 of 38.101-1 v17.3.0 | This bit may be set to 1 by a UE supporting power class 1.5. This bit is intended to be set by larger form factor FWA devices. If the bit is not set, MPR in Table 6.2D.2-2 applies. |
| n78 | 0 (leftmost bit) | PC 1.5 MPR as defined in Table 6.2D.2-3 of 38.101-1 v17.3.0 | This bit may be set to 1 by a UE supporting power class 1.5. This bit is intended to be set by larger form factor FWA devices. If the bit is not set, MPR in Table 6.2D.2-2 applies. |
| n79 | 0 (leftmost bit) | PC 1.5 MPR as defined in Table 6.2D.2-3 of 38.101-1 v17.3.0 | This bit may be set to 1 by a UE supporting power class 1.5. This bit is intended to be set by larger form factor FWA devices. If the bit is not set, MPR in Table 6.2D.2-2 applies. |

## **<End of Change>**