**3GPP TSG-RAN WG4 Meeting #109 *R4-2321981***

**Chicago, USA, Nov 13 – 17, 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.101-1** | **CR** | **1940** | **rev** | **1** | **Current version:** | **18.3.0** |  |
|  | | | | | | | | |
| *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:*** | draft TS 38.101-1 big CR for NR\_ENDC\_RF\_FR1\_enh2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei, HiSilicon, vivo, NTT DOCOMO, INC., [Qualcomm Inc., Samsung, LG Electronics, OPPO, Nokia, Nokia Shanghai Bell, Skyworks Solutions Inc., CHTTL, Ericsson, ZTE, SGS Wireless, MediaTek Inc., Xiaomi, Spreadtrum Communications] | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_ENDC\_RF\_FR1\_enh2-Core | | | | |  | ***Date:*** | | | 2023-10-17 |
|  |  | | | |  | |  | | |  |
| ***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, 8Rx for both single carrier as well as CA for CPE/FWA/vehicle/industrial devices and requirements for lower MSD capability. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | **For 4Tx:**   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.   **For 8Rx:**  Single carrier and CA/DC requirements for 8Rx and up to 2T8R requirements for SRS antenna switching.  The following 8Rx requirements are introduced based on the agreements:   * ΔRIB,8R of -4.0dB for n77/n78/n79, -4.5dB for n7, and -4.3dB for n41. * PC3 ΔTRxSRS of 3.0dB for t4r8 for n41/n77/n78 * PC3 ΔTRxSRS of 4.0dB for t1r8 and t2r8 and t2r8-t4r8 for n41/n77/n78 * PC3 ΔTRxSRS of 4.5dB for t1r8-t2r8 for n41/n77/n78 * PC3 ΔTRxSRS of 5.8dB for t1r8-t4r8 and t1r8-t2r8-t4r8 for n41/n77/n78 * PC3 ΔTRxSRS of 4.5dB for t4r8 for n79 * PC3 ΔTRxSRS of 5.5dB for t1r8 and t2r8 and t2r8-t4r8 for n79 * PC3 ΔTRxSRS of 6.0dB for t1r8-t2r8 for n79 * PC3 ΔTRxSRS of 7.3dB for t1r8-t4r8 and t1r8-t2r8-t4r8 for n79 * For ΔTRxSRS for other PCs,   + the same value with PC3 ∆TRxSRS applies   + when the device is capable of 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 3dB larger than PC3 ∆TRxSRS applies   + 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. * Applicability of the number of Rx antenna ports for REFSENS and other Rx requirements for UE supporting 8Rx. * CA/DC 8Rx requirements   + Add the desscription that the MSD in the applicable bands in CA/DC shall be increased by the absolute value of ΔRIB,8R.   **For lower MSD capability:**  The feasiblity study on MSD improvement has been carried out, and the contributions from various companies have been captured in TR 38.881. RAN4 concludes that MSD improvement is feasible and the UE may optionally indicate the actual performance via a new UE capability of [lowerMSD-r18].  The information to be conveyed in this new capability has been agreed in a series of way forwards, including: R4-2314923, R4-2310499, and etc. Additionally, such information has been communicated to RAN2 to facilitate the signalling design for the new UE capability via a number of LS, including R4-2312247, R4-2310276 and R4-2306594. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Requirements for 4Tx/8Rx for CPE/FWA/vehicle/industrial devices and requirements for lower MSD capability are not supported in the specfication. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | For 4Tx  4.2, 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, 6.4D.4, 6.5D.1, 6.5D.2, 6.5D.3, 6.5D.4, 6.5G.2, 7.3D, 7.3G, 7.4D, 7.5D, 7.6D, 7.7D, 7.8D, F.8  For 8Rx  3.2, 6.2.4, 7.2, 7.3.1, 7.3.2, 7.3A, 7.3C  For lower MSD  7.3A | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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:*** | | Update the requirements for 4Tx, 8Rx and lower MSD based on endorsed draft big CRs R4-2321787, R4-2321791 and R4-2321785. | | | | | | | | |

## **<Start of Change>**

## 3.2 Symbols

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

ΔFGlobal Granularity of the global frequency raster

ΔFRaster Band dependent channel raster granularity

ΔfOOB Δ Frequency of Out Of Band emission

ΔFTX-RX Maximum deviation to the Tx-Rx carrier center frequency separation for asymmetric uplink/downlink channel bandwidth operation

∆MPRc Allowed Maximum Power Reduction relaxation for serving cell *c*

ΔPPowerClass Adjustment to maximum output power for a given power class

RB The starting frequency offset between the allocated RB and the measured non-allocated RB

ΔRIB,c Allowed reference sensitivity relaxation due to support for inter-band CA operation, for serving cell *c*

ΔRIBC Allowed reference sensitivity relaxation due to support for intra-band contiguous CA operation

ΔRIBNC Allowed reference sensitivity relaxation due to support for intra-band non-contiguous CA operation

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

ΔRIB,8R Reference sensitivity adjustment due to support for 8 antenna ports

ΔR1RReference sensitivity adjustment due to support for 1 antenna ports

ΔShift Channel raster offset

TC Allowed operating band edge transmission power relaxation

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

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

BWChannel Channel bandwidth

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

BWChannel\_CA Aggregated channel bandwidth, expressed in MHz

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

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

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

BWDL Channel bandwidth for DL

BWUL Channel bandwidth for UL

BWinterferer Bandwidth of the interferer

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

FInterferer Frequency of the interferer

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

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

Foffset,high Frequency offset from FC,high to the upper *UE RF Bandwidth edge*, or from FC,block, high to the upper sub-block edge

Foffset,low Frequency offset from FC,low to the lower *UE RF Bandwidth edge*, or from FC,block, low to the lower sub-block edge

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

FREF RF reference frequency

FREF-Offs Offset used for calculating FREF

FREF, shift RF reference frequency for Supplementary Uplink (SUL) bands, the uplink of all FDD bands, and TDD bands

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

GBChannel Minimum guard band defined in clause 5.3.3, expressed in kHz

LCRB Transmission bandwidth which represents the length of a contiguous resource block allocation expressed in units of resources blocks

Max() The largest of given numbers

Min() The smallest of given numbers

 Physical resource block number

NRACLR NR ACLR

NRB Transmission bandwidth configuration, expressed in units of resource blocks

NRB\_agg The number of the aggregated RBs within the fully allocated aggregated channel bandwidth

for carrier 1 to j, where *μ* is defined in TS 38.211 [6]

NRB,c The transmission bandwidth configuration of component carrier c, expressed in units of resource blocks

for carrier j, where *μ* is defined in TS 38.211 [6]

NRB,largest BW The largest transmission bandwidth configuration of the component carriers in the bandwidth combination, expressed in units of resource blocks

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

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

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

NREF-Offs Offset used for calculating NREF

PCMAX The configured maximum UE output power

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

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

PEMAX Maximum allowed UE output power signalled by higher layers

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

PInterferer Modulated mean power of the interferer

Plargest BW Power of the largest transmission bandwidth configuration of the component carriers in the bandwidth combination

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

P-MPR*c* Power Management Maximum Power Reduction for serving cell *c*

PRB The transmitted power per allocated RB, measured in dBm

PUMAX The measured configured maximum UE output power

Puw Power of an unwanted DL signal

Pw Power of a wanted DL signal

RBstart The lowest RB index of transmitted resource blocks

RBstart\_CA The lowest RB index of transmitted resource blocks for intra-band contiguous CA

SCSc SCS for the component carrier c, expressed in kHz

SCSlargest BW SCS for the largest transmission bandwidth configuration of the component carriers in the bandwidth combination, expressed in kHz

SCSlow SCS for the lowest assigned component carrier in clause 5.3A.1, expressed in kHz

SCShigh SCS for the highest assigned component carrier in clause 5.3A.1, expressed in kHz

*tp* Transient Period value signalled by the UE

*tpstart* Start position of transient period relative to the symbol boundary

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

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

SSREF SS block reference frequency position

UTRAACLR UTRA ACLR

## **<Next Change>**

## 4.2 Applicability of minimum requirements

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

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

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

d) All the requirements for intra-band contiguous and non-contiguous CA apply under the assumption of the same slot format indicated by UL-DL-configuration-common in the PCell and SCells for NR SA.

e) The requirements for Tx diversity are applied for UE which indicates Tx diversity capability by IE *txDiversity-r16*, [*txDiversity2T-r18*] or [*txDiversity4T-r18*]. 2Tx requirements for TxD should be applied to UE indicating [*txDiversity-r16*] or [*txDiversity2T-r18*], and 4Tx requirements should be applied to UE indicating [*txDiversity4T-r18*].

## **<Next 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, Table 6.2.2-4b 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. 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.

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 – 8Rx>**

### 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 and in Table 6.2F.1-1 for shared spectrum access operation, without taking into account the tolerance specified in the Table 6.2.1-1 and in Table 6.2F.1-1 for shared spectrum access operation;

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-PC1dot5-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-PC1dot5-MPE-FR1* is not absent and half the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle-PC1dot5-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-PC1dot5-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-PC1dot5-MPE-FR1* is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than *maxUplinkDutyCycle-PC1dot5-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’ or further indicates *srs-AntennaSwitchingBeyond4RX-r17* as ‘t1r8’;

- 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 and in clause 6.2F.2 and clause 6.2F.3 respectively for shared spectrum access operation;

∆MPRc for serving cell c is specified in clause 6.2.2 and in clause 6.2F.2 for shared spectrum access operation.

∆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

e) UE transmits SRS on the second, third, fourth, fifth, sixth, senventh and eighth SRS resources of the total 8 SRS resources from all configured SRS resource set(s) consisting of one SRS port when the *srs-AntennaSwitchingBeyond4RX-r17* capability is indicated as 't1r8' or 't1r8-t2r8', or

f) UE transmits SRS from the SRS port pair on the second, third and fourth SRS resource in every configured SRS resource set consisting of two SRS ports when the SRS-TxSwitch capability is indicated as ' t2r8' or ' t1r8-t2r8'.

For *SRS-TxSwitch* capabilities indicated as 't1r2', 't1r1-t1r2', 't1r4', 't1r4-t2r4', 't1r1-t1r2-t1r4', 't1r1-t1r2-t2r2-t2r4', 't1r1-t1r2-t2r2-t1r4-t2r4' or 't4r8', the following applies:

* 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 *SRS-TxSwitch* capabilities indicated as 't1r8', 't2r8' or 't2r8-t4r8', the following applies:

* The value of ∆TRxSRS is 5.5 dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 4.0 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 8.5 dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 7.0 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 *SRS-TxSwitch* capability indicated as 't1r8-t2r8', the following applies:

* The value of ∆TRxSRS is 6.0 dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 4.5 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 9.0 dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 7.5 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 *SRS-TxSwitch* capability indicated as 't1r8-t4r8' or 't1r8-t2r8-t4r8', the following applies:

* The value of ∆TRxSRS is 7.3 dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 5.8 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 10.3 dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 8.8 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 and in Table 6.2F.1-1 for shared spectrum access operation.

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 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 codebook-based transmission with precoding matrix of *W=* 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 |  |  | 26 | +2/-31 | 23 | +2/-3 |  |  |
| n2 |  |  |  |  | 23 | +2/-31 |  |  |
| n3 |  |  | 26 | +2/-31 | 23 | +2/-31 |  |  |
| n7 |  |  |  |  | 23 | +2/-31 |  |  |
| n8 |  |  |  |  | 23 | +2/-31 |  |  |
| n13 |  |  |  |  | 23 | +2/-3 |  |  |
| n24 |  |  |  |  | 23 | +2/-41 |  |  |
| n25 |  |  |  |  | 23 | +2/-31 |  |  |
| n28 |  |  |  |  | 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 |  |  | 26 | +2/-31 | 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 |  |  | 26 | +2/-31 | 23 | +2/-31 |  |  |
| n84 |  |  | 26 | +2/-31 | 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. For UE supporting uplink full power transmission (ULFPTx) for 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).

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 | 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 *ul-FullPowerTransmission* set to *fullpowerMode1*, all the transmitter requirement for CP-OFDM based modulation does not need to be verified if the requirements for 2-layer UL MIMO according to Table 6.2D.1-2 has been verified.  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 codebook based transmission with precoding matrix *W*=1 [6.3.1.5 TS 38.211], 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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211].

<<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. For UE support uplink full power transmission (ULFPTx) for UL MIMO, the maximum output power is defined as the sum of the maximum output power from both UE antenna connectors.

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 | 5.0 | 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) |
| 24.5 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 |
| 23.5 ≤ PCMAX,*c* < 24.5 | 5.0 | 2.0 |
| 22.5 ≤ PCMAX,*c* < 23.5 | 5.0 | 3.0 |
| 21.5 ≤ PCMAX,*c* < 22.5 | 6.0 | 4.0 |
| 18 ≤ PCMAX,*c* < 21.5 | 5.0 | |
| 13 ≤ PCMAX,*c* < 18 | 6.0 | |
| -40 ≤ PCMAX,*c* < 13 | 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).

When a UE indicates PC1.5 for a given band it achieves maximum power by means of Tx Diversity in the current version of the spec. Therefore, Tx Diversity is implied for PC1.5 even if the UE does not indicate Tx diversity capability.

### 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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.3.1 apply when *TxD* is not indicated, and the requirements in clause 6.3G.1 apply when *TxD* is indicated.

## **<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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.3.3 apply when *TxD* is not indicated, and the requirements in clause 6.3G.3 apply when *TxD* is indicated.

## **<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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.3.4 apply when *TxD* is not indicated, and the requirements in clause 6.3G.4 apply when *TxD* is indicated.

## **<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>**

### 6.4D.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 any two coherent ports out of the scheduled ports for UL transmission at their respective 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))

- When UE is not configured with uplink switching; or when UE is configured with uplink switching, and ‘fullCoherent’ codebook subset is supported in the corresponding carrier according to the capability *uplinkTxSwitching*-*PUSCH-TransCoherence* and/or *uplinkTxSwitching2T2T-PUSCH-TransCoherence*; or when UE is configured with uplink switching, ‘nonCoherent’ codebook subset is supported in the corresponding carrier according to the capability *uplinkTxSwitching*-*PUSCH-TransCoherence* and/or *uplinkTxSwitching2T2T-PUSCH-TransCoherence*,and uplink switching is not triggered by the switching mechanisms specified in sub-clause 6.1.6 of TS 38.214 [10] between last transmitted SRS and scheduled transmission.

## **<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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.5.1 apply when *TxD* is not indicated, and the requirements in clause 6.5G.1 apply when *TxD* is indicated.

### 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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.5.2 apply when *TxD* is not indicated, and the requirements in clause 6.5G.2 apply when *TxD* is indicated.

### 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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.5.3 apply when *TxD* is not indicated, and the requirements in clause 6.5G.3 apply when *TxD* is indicated.

### 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 with precoding matrix *W*=1 [6.3.1.5 TS 38.211], the requirements in clause 6.5.4 apply when *TxD* is not indicated, and the requirements in clause 6.5G.4 apply when *TxD* is indicated.

## **<Next Change>**

### 6.5G.2 Out of band emission for Tx Diversity

For UE supporting Tx diversity, the requirements for Out of band emissions resulting from the modulation process and non-linearity in the transmitters apply to the sum of the emissions from all UE transmit antenna connectors.

If UE indicates Tx diversity capability, Adjacent Channel Leakage power Ratio (ACLR) is defined as the ratio of sum of the filtered mean power at each antenna connector centred on the assigned channel frequency to sum of the filtered mean power at each antenna connector centred on an adjacent channel frequency.

The requirements specified in clause 6.5.2 apply.

## **<Next Change – 8Rx>**

## 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, n48, n77, n78, n79, n104 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 REFSENS 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, and additional requirements for four and eight Rx ports shall be verified in operating bands where the UE is equipped with eight Rx antenna ports.

For Rx requirements other than single carrier REFSENS 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, the UE shall be verified with eight Rx antenna ports and skip both two and four Rx antenna ports requirements in operating bands where the UE is equipped with eight Rx antenna ports unless UE is not supporting eight Rx ports for band(s) in band combination in which case those band(s) shall be verified with four Rx antenna ports in that band combination, 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.

A Redcap UE is required to be equipped with a minimum of single Rx antenna port and maximum of two Rx antenna ports. Clause 7 requirements for four Rx antenna ports do not apply to a RedCap UE.

## **<Next Change – 8Rx>**

### 7.3.1 General

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

In later clauses of Clause 7 where the value of REFSENS 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 REFSENS value in Table 7.3.2-1a, Table 7.3.2-1b and Table 7.3.2-1c or Table 7.3.2-1d 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 REFSENS value derived from the requirement in Table 7.3.2-2 with 4 Rx antenna ports tested.

when the UE is verified with 8 Rx antenna ports, it shall be verified against those requirements by applying the resulting REFSENS value derived from the requirement in Table 7.3.2-2a with 8 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, A3.2 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 7.3.2-1a, Table 7.3.2-1b, Table 7.3.2-1c, Table 7.3.2-1d and Table 7.3.2-2.

Table 7.3.2-1a: Two antenna port reference sensitivity QPSK PREFSENS for FDD bands

| Operating band / SCS / Channel bandwidth | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | SCS kHz | 3  MHz (dBm) | 5  MHz (dBm) | 10  MHz (dBm) | 15  MHz (dBm) | 20  MHz (dBm) | 25  MHz (dBm) | 30 MHz (dBm) | 35 MHz (dBm) | 40  MHz (dBm) | 45 MHz (dBm) | 50  MHz (dBm) |
| n1 | 15 |  | -100.0 | -96.8 | -95.0 | -93.8 | -92.7 | -91.9 |  | -90.6 | -90.1 | -89.6 |
| 30 |  |  | -97.1 | -95.1 | -94.0 | -92.8 | -92.0 |  | -90.7 | -90.2 | -89.7 |
| 60 |  |  | -97.5 | -95.4 | -94.2 | -93.0 | -92.1 |  | -90.9 | -90.3 | -89.7 |
| n2 | 15 |  | -98 | -94.8 | -93 | -91.8 | -90.7 | -84.1 | -83.6 | -81.5 |  |  |
| 30 |  |  | -95.1 | -93.1 | -92 | -90.8 | -84.2 | -83.7 | -81.6 |  |  |
| 60 |  |  | -95.5 | -93.4 | -92.2 | -90.9 | -84.3 | -83.8 | -81.7 |  |  |
| n3 | 15 |  | -97.0 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 | -86.2 | -82.3 | -81.3 | -79.7 |
| 30 |  |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 | -86.3 | -82.4 | -81.4 | -79.8 |
| 60 |  |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 | -86.4 | -82.6 | -81.5 | -79.9 |
| n5 | 15 |  | -98.0 | -94.8 | -93.0 | -86.8 | -84.8 |  |  |  |  |  |
| 30 |  |  | -95.1 | -93.1 | -88.6 | -84.9 |  |  |  |  |  |
| n71 | 15 |  | -98.0 | -94.8 | -93.0 | -91.8 | -90.7 | -89.9 | -89.2 | -88.6 |  | -81.5 |
| 30 |  |  | -95.1 | -93.1 | -92.0 | -90.8 | -90.0 | -89.3 | -88.7 |  | -81.5 |
| 60 |  |  | -95.5 | -93.4 | -92.2 | -91.0 | -90.1 | -89.4 | -88.9 |  | -81.5 |
| n8 | 15 |  | -97.0 | -93.8 | -91.4 | -85.8 | -83.6 |  | -78.4 |  |  |  |
| 30 |  |  | -94.1 | -91.7 | -87.2 | -84.7 |  | -78.5 |  |  |  |
| n12 | 15 |  | -97.0 | -93.8 | -84.0 |  |  |  |  |  |  |  |
| 30 |  |  | -94.1 | -84.1 |  |  |  |  |  |  |  |
| n13 | 15 |  | -97.0 | -93.8 |  |  |  |  |  |  |  |  |
| 30 |  |  | -94.1 |  |  |  |  |  |  |  |  |
| n14 | 15 |  | -97.0 | -93.8 |  |  |  |  |  |  |  |  |
| 30 |  |  | -94.1 |  |  |  |  |  |  |  |  |
| n18 | 15 |  | -100.0 | -96.8 | -95.0 |  |  |  |  |  |  |  |
| 30 |  |  | -97.1 | -95.1 |  |  |  |  |  |  |  |
| n20 | 15 |  | -97.0 | -93.8 | -91.0 | -89.8 |  |  |  |  |  |  |
| 30 |  |  | -94.1 | -91.1 | -90.0 |  |  |  |  |  |  |
| n24 | 15 |  | -100.0 | -96.8 |  |  |  |  |  |  |  |  |
| 30 |  |  | -97.1 |  |  |  |  |  |  |  |  |
| 60 |  |  | -97.5 |  |  |  |  |  |  |  |  |
| n25 | 15 |  | -96.5 | -93.3 | -91.5 | -90.3 | -89.3 | -82.2 | -81.7 | -79.5 | -77.6 |  |
| 30 |  |  | -93.6 | -91.6 | -90.5 | -89.4 | -82.3 | -81.8 | -79.6 | -77.7 |  |
| 60 |  |  | -94.0 | -91.9 | -90.7 | -89.6 | -82.4 | -81.9 | -79.7 | -77.8 |  |
| n26 | 15 | -99.7 | -97.56 | -94.56 | -92.76 | -87.6 | -84.5 | -81.7 |  |  |  |  |
| 30 |  |  | -94.86 | -92.76 | -87.7 | -84.6 | -81.8 |  |  |  |  |
| n28 | 15 | -100.2 | -98.5 | -95.5 | -93.5 | -90.8 | -84.2 | -78.5 |  |  |  |  |
| 30 |  |  | -95.6 | -93.6 | -91.0 | -84.2 | -78.6 |  |  |  |  |
| n30 | 15 |  | -99.0 | -95.8 |  |  |  |  |  |  |  |  |
| 30 |  |  | -96.1 |  |  |  |  |  |  |  |  |
| n65 | 15 |  | -99.5 | -96.3 | -94.5 | -93.3 |  |  |  |  |  | -89.2 |
| 30 |  |  | -96.6 | -94.6 | -93.5 |  |  |  |  |  | -89.3 |
| 60 |  |  | -97.0 | -94.9 | -93.7 |  |  |  |  |  | -89.4 |
| n66 | 15 |  | -99.5 | -96.3 | -94.5 | -93.3 | -92.2 | -91.4 | -90.7 | -90.1 | -89.6 |  |
| 30 |  |  | -96.6 | -94.6 | -93.5 | -92.3 | -91.5 | -90.8 | -90.2 | -89.7 |  |
| 60 |  |  | -97.0 | -94.9 | -93.7 | -92.5 | -91.6 | -90.9 | -90.4 | -89.8 |  |
|  | 15 |  | -100.0 | -96.8 | -95.0 | -93.8 | -92.7 |  |  |  |  |  |
| n70 | 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 | -84.19  -74.810 | -82.59  -67.110 | -80.79  -64.010 |  |  |  |
| 30 |  |  | -94.3 | -91.9 | -87.4 | -84.29  -74.910 | -82.69  -67.210 | -80.89  -64.110 |  |  |  |
| n74 | 15 |  | -99.53 | -96.33 | -94.53 | -89.33 |  |  |  |  |  |  |
| 30 |  |  | -96.63 | -94.63 | -89.53 |  |  |  |  |  |  |
| 60 |  |  | -97.03 | -94.93 | -89.63 |  |  |  |  |  |  |
| n85 | 15 | -99.2 | -97.0 | -93.8 | -84.0 |  |  |  |  |  |  |  |
|  | 30 |  |  | -94.1 | -84.1 |  |  |  |  |  |  |  |
| n100 | 15 | -102.2 | -100 |  |  |  |  |  |  |  |  |  |
| n105 | 15 |  | -97.28 | -94.0 | -91.6 | -86.9 | -85.1 | -83.8 | -82.5 |  |  |  |
|  | 30 |  |  | -94.3 | -91.9 | -87.9 | -85.5 | -84.3 | -82.6 |  |  |  |
| NOTE 1: Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE. Four Rx antenna ports for RedCap UE is not supported for this operating band.  NOTE 2: The transmitter shall be set to PUMAX 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: Void  NOTE 5: Void  NOTE 6: Values are modified by -0.5dB when carrier channel BW is between 865MHz and 894MHz.  NOTE 7: Void.  NOTE 8: DL channels overlapping the 612-617MHz range have 0.5dB added to the REFSENS  NOTE 9: Applies to UEs that support a maximum uplink BW of 20 MHz in this band.  NOTE 10: Applies to UEs that support optional symmetric UL/DL for this BW. | | | | | | | | | | | | |

**Table 7.3.2-1b: Two antenna port reference sensitivity QPSK PREFSENS for TDD, SDL and FDD with variable duplex operation bands**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Operating band / SCS / Channel bandwidth / REFSENS** | | | | |
| **Operating band** | **SCS**  **kHz** | **Channel bandwidth (MHz)** | **REFSENS (dBm)8** | **Duplex Mode** |
| n297 | 15 | 5,10 | -97 + 10log10(NRB/25) | SDL |
| 30 | 10 | -94.1 + 10log10(NRB/24) |
| n34 | 15 | 5, 10, 15 | -100 + 10log10(NRB/25) | TDD |
| 30 | 10, 15 | -97.1 + 10log10(NRB/24) |
| 60 | 10, 15 | -97.5 + 10log10(NRB/11) |
| n381 | 15 | 5, 10, 15, 20, 25, 30, 40 | -100 + 10log10(NRB/25) | TDD |
| 30 | 10, 15, 20, 25, 30, 40 | -97.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 25, 30, 40 | -97.5 + 10log10(NRB/11) |
| n39 | 15 | 5, 10, 15, 20, 25, 30, 35, 40 | -100 + 10log10(NRB/25) | TDD |
| 30 | 10, 15, 20, 25, 30, 35, 40 | -97.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 25, 30, 35, 40 | -97.5 + 10log10(NRB/11) |
| n40 | 15 | 5, 10, 15, 20, 25, 30, 40, 50 | -100 + 10log10(NRB/25) | TDD |
| 30 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | -97.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | -97.5 + 10log10(NRB/11) |
| n411, n901 | 15 | 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 | -94.8 + 10log10(NRB/52) | TDD |
| 30 | 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | -95.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | -95.5 + 10log10(NRB/11) |
| n481 | 15 | 5, 10, 15, 20, 30, 40, 505 | -99 + 10log10(NRB/25) | TDD |
| 30 | 10, 15, 20, 30, 40, 505, 605, 705, 805, 905, 1005 | -96.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 30, 40, 505, 605, 705, 805, 905, 1005 | -96.5 + 10log10(NRB/11) |
| n50 | 15 | 5, 10, 15, 20, 30, 40, 50 | -100 + 10log10(NRB/25) | TDD |
| 30 | 10, 15, 20, 30, 40, 50, 60, 80 | -97.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 30, 40, 50, 60, 80 | -97.5 + 10log10(NRB/11) |
| n51 | 15 | 5 | -100 | TDD |
| n53 | 15 | 5, 10 | -100 + 10log10(NRB/25) | TDD |
| 30 | 10 | -97.1 |
| 60 | 10 | -97.5 |
| n54 | 15 | 5 | -100 | TDD |
| n677 | 15 | 5, 10, 15, 20 | -100 + 10log10(NRB/25) | SDL |
|  | 30 | 10, 15, 20 | -97.1 + 10log10(NRB/24) |  |
| n757 | 15 | 5,10,15,20,25,30,40,50 | -100 + 10log10(NRB/25) | SDL |
| 30 | 10,15,20,25,30,40,50 | -97.1 + 10log10(NRB/24) |
| 60 | 10,15,20,25,30,40,50 | -97.5 + 10log10(NRB/11) |
| n767 | 15 | 5 | -95.3 + 10log10(NRB/52) | SDL |
| n771,4 | 15 | 10, 15, 20, 25, 30, 40, 50 | -95.3 + 10log10(NRB/52) | TDD |
| 30 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | -95.6 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | -96.0 + 10log10(NRB/11) |
| n781 | 15 | 10, 15, 20, 25, 30, 40, 50 | -95.8 + 10log10(NRB/52) | TDD |
| 30 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | -96.1 + 10log10(NRB/24) |
| 60 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | -96.5 + 10log10(NRB/11) |
| n791 | 15 | 10, 20, 30, 40, 50 | -95.8 + 10log10(NRB/52) | TDD |
| 30 | 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 | -96.1 + 10log10(NRB/24) |
| 60 | 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 | -96.5 + 10log10(NRB/11) |
| n91 | 15 | 5 | -100 | FDD |
| n92 | 15 | 5,10,15,20 | -100 + 10log10(NRB/25) | FDD |
| 30 | 10,15,20 | -97.1 + 10log10(NRB/24) |
| n93 | 15 | 5 | -100 | FDD |
| n94 | 15 | 5,10,15,20 | -100 + 10log10(NRB/25) | FDD |
|  | 30 | 10,15,20 | -97.1 + 10log10(NRB/24) |
| n101 | 15 | 5, 10 | -100 + 10log10(NRB/25) | TDD |
|  | 30 | 10 | -97.1 + 10log10(NRB/24) |  |
| n1041,10 | 15 | 20, 30, 40, 50 | -90.7 + 10log10(NRB/106) | TDD |
|  | 30 | 20, 30, 40, 50, 60, 70, 80, 90, 100 | -90.8 + 10log10(NRB/51) |  |
|  | 60 | 20, 30, 40, 50, 60, 70, 80, 90, 100 | -91.1 + 10log10(NRB/24) |  |
| NOTE 1: Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE. Four Rx antenna ports for RedCap UE is not supported for this operating band.  NOTE 2: The transmitter shall be set to PUMAX as defined in clause 6.2.4.  NOTE 3: Void  NOTE 4: The requirement is modified by -0.5 dB when the assigned UE channel bandwidth is confined within 3300 - 3800 MHz.  NOTE 5: For these bandwidths, the minimum requirements are restricted to operation when carrier is configured as a downlink carrier part of CA configuration.  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.  NOTE 8: The REFSENS value is rounded to the nearest number down to one decimal point. “NRB” in REFSENS formula is the maximum transmission bandwidth configuration as defined in Table 5.3.2-1.  NOTE 9: Void.  NOTE 10: A UE may implement two RX antenna ports for band n104 when conditions are met. The exact conditions are FFS. | | | | |

For power class 2 UEs, certain degradation of the reference sensitivity in Table 7.3.2-1a is allowed. The maximum amount of degradation is specified in Table 7.3.2-1c, and in Table 7.3.2-1d for a UE that indicates *txDiversity-r16* [15].

**Table 7.3.2-1c Reference Sensitivity Degradation from PC3 to PC2 for FDD bands for UE not supporting Tx Diversity**

| Operating Band | 5  MHz (dB) | 10  MHz (dB) | 15  MHz (dB) | 20  MHz (dB) | 25  MHz (dB) | 30 MHz (dB) | 35 MHz (dB) | 40  MHz (dB) | 45 MHz (dB) | 50  MHz (dB) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| n1 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 |
| n3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.8 | 1.1 | 1.5 | 2.3 | 2.8 |
| n25 | 0.8 | 0.8 | 0.9 | 1.1 | 1.3 | 2.7 | 2.8 | 3.5 | 3.7 |  |
| n66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |
| n71 | 0.5 | 0.9 | 0.9 | 2.2 | 2.42  2.53 | 2.52  2.43 | 2.92  3.13 |  |  |  |
| n70 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |
| NOTE 1: The transmitter shall be set to PUMAX as defined in clause 6.2.4  NOTE 2: Applies to UEs that support a maximum uplink BW of 20 MHz in this band.  NOTE 3: Applies to UEs that support optional symmetric UL/DL for this BW. | | | | | | | | | | |

**Table 7.3.2-1d Reference Sensitivity Degradation from PC3 to PC2** **for** **FDD bands for UE** **supporting Tx Diversity**

| Operating Band | 5  MHz (dB) | 10  MHz (dB) | 15  MHz (dB) | 20  MHz (dB) | 25  MHz (dB) | 30 MHz (dB) | 35 MHz (dB) | 40  MHz (dB) | 45 MHz (dB) | 50  MHz (dB) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| n1 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 |
| n3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.6 | 1.7 | 2.8 | 5 | 5.5 | 6.0 |
| n25 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 6.0 | 6.2 | 6.7 | 7.1 |  |
| n66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |
| n71 | 1.1 | 1.1 | 1.7 | 5.5 | 5.92  6.93 | 6.22  7.23 | 6.52  7.33 |  |  |  |
| n70 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |
| NOTE 1: The transmitter shall be set to PUMAX as defined in clause 6.2G.4  NOTE 2: Applies to UEs that support a maximum uplink BW of 20 MHz in this band.  NOTE 3: Applies to UEs that support optional symmetric UL/DL for this BW. | | | | | | | | | | |

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

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

|  |  |
| --- | --- |
| Operating band | ΔRIB,4R (dB) |
| n5, n8, n13, n28, n71, n85, n105 | -2.71 |
| n1, n2, n3, n25, n30, n40, n7, n34, n38, n39, n41, n66, n70 | -2.7 |
| n48, n77, n78, n79, n104 | -2.2 |
| NOTE 1: 4 Rx operation is targeted for FWA form factor | |

For UE(s) equipped with 8 Rx antenna ports, reference sensitivity for 2Rx antenna ports in Table 7.3.2-1a and in Table 7.3.2-1b shall be modified by the amount given in ΔRIB,8R in Table 7.3.2-2a for the applicable operating bands.

Table 7.3.2-2a: Eight antenna port reference sensitivity allowance ΔRIB,8R

|  |  |
| --- | --- |
| Operating band | ΔRIB,8R (dB) |
| n7 | -4.5 |
| n41 | -4.3 |
| n77, n78, n79 | -4.0 |
| NOTE 1: 8 Rx operation is targeted for FWA/CPE/Vehicle/Industrial devices form factor. | |

The reference receive sensitivity (REFSENS) requirement specified in Table 7.3.2-1a, Table 7.3.2-1b, Table 7.3.2-1c, Table 7.3.2-1d, Table 7.3.2-2, and Table 7.3.2-2a shall be met with uplink transmission bandwidth less than or equal to that specified in Table 7.3.2-3.

<<Unchanged parts are omitted>>

## **<Next Change – 8Rx>**

### 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 or 8 Rx antenna ports, the MSD in the applicable bands shall be increased by the absolute value of ΔRIB,4R in Table 7.3.2-2 or ΔRIB,8R in Table 7.3.2-2a 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.

## **<Next Change – 8Rx>**

### 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. For operations with 4 Rx or 8 Rx antenna ports, the MSD in the applicable bands shall be increased by the absolute value of ΔRIB,4R in Table 7.3.2-2 or ΔRIB,8R in Table 7.3.2-2a 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.

## **<Next Change – Lower MSD>**

### 7.3A.7 Lower-MSD requirements for inter-band CA

A UE can report better MSD performance than the minimum requirements as specified in clause 7.3A.4, 7.3A.5 and 7.3A.6 by [*lowerMSD-r18*] capability, except that the reporting for MSD caused by IMD with order higher than 5, IMD of UL intra-band CA or triple-beat is not supported in this release of the specification. The MSD performance after improvement is categorized into different lower-MSD capability classes, which are defined in Table 7.3A.7-1.

Table 7.3A.7-1: Lower-MSD capability classes

|  |  |  |
| --- | --- | --- |
| **Lower-MSD capability class** | **Maximum allowed actual MSD**  **(i.e. Threshold)** | **Remark** |
| I | 0 dB | Actual MSD ≤ 0dB |
| II | 3 dB | Actual MSD ≤ 3dB |
| III | 6 dB | Actual MSD ≤ 6dB |
| IV | 9 dB | Actual MSD ≤ 9dB |
| V | 12 dB | Actual MSD ≤ 12dB |
| VI | 15 dB | Actual MSD ≤ 15dB |
| VII | 18 dB | Actual MSD ≤ 18dB |
| VIII | 22 dB | Actual MSD ≤ 22dB |

The reported lower-MSD capability classes are subject to the same uplink/downlink configurations as defined for the minimum MSD requirements in clause 7.3A.4, 7.3A.5 and 7.3A.6. If a UE can support more than one test points for a given REFSENS exception case, the reported lower-MSD capability class is applicable for the test point having the largest specified MSD value. Otherwise, it’s only applicable for the test point which can be supported by the UE. If one or multiple power classes are requested by the network, the UE can, if supported, report [*lowerMSD-r18*] capability for the requested power classes; otherwise, the UE shall report [*lowerMSD-r18*] capability for the highest supported power class for the given CA configuration.

The UE shall meet one of the following conditions in order to report [*lowerMSD-r18*] capability for a given REFSENS exception case:

* If the specified minimum requirement is tightly bounded by the range of a lower-MSD capability class (i.e, Thresholdi-1 < MSD ≤ Thresholdi, where i and (i-1) are two adjacent lower-MSD capability classes), the actual MSD shall be at least one-level lower (i.e., actual MSD ≤ Thresholdi-1); or
* If the specified minimum requirement is larger than the maximum threshold (corresponding to lower-MSD capability class VIII), the actual MSD shall be no more than the maximum threshold.

Otherwise, the UE cannot report [*lowerMSD-r18*] capability for this REFSENS exception case.

If the special MSD type “ALL” is indicated in the [*lowerMSD-r18*] capability, the reporting conditions as specified above shall be met for each MSD type that has been specified in this release for the given CA configuration.

NOTE: The [*lowerMSD-r18*] capability is verified by reusing the MSD test point parameters and only replacing the minimum MSD requirement value by the threshold of the reported lower-MSD capability class. And, similar to the specified MSD, only the highest supported power class or the power class required by the certification/regulation body per UL configuration is verified.

## **<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 clause 6.2F.1D for shared spectrum access operation, 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 and clause 6.2F.1D for shared spectrum access operation. 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 and clause 6.2F.1D for shared spectrum access operation. 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 and in clause 6.2F.1D for shared spectrum access operation. 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 and in clause 6.2F.1D for shared spectrum access operation. 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 and in clause 6.2F.1D for shared spectrum access operation. 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>**