**3GPP TSG-RAN4 Meeting #101-e** ***R4-2119977***

**Electronic Meeting, November 1, 2021 - November 12, 2021**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
|  |
|  | **38.101-1** | **CR** |  | **rev** | **1** | **Current version:** | **17.3.0** |  |
|  |
| *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 CR TS 38.101-1: Move PC2, PC1.5 MPR to Clause 6.2D |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon, Qualcomm |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_RF\_TxD-Core |  | ***Date:*** | 2021-11-10 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***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)* |
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| ***Reason for change:*** | It was discussed in RAN4#101e meeting that dual Tx related MPR requirements should be captured in 6.2D rather than the general clause and TxD clause.  |
|  |  |
| ***Summary of change:*** | Move 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. |
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| ***Consequences if not approved:*** | The specification will be inconsistent. |
|  |  |
| ***Clauses affected:*** | 6.2.2, 6.2D.1, 6.2D.2, 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:*** | Make changes based on discussion in GTW session. |

## **<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.

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 | 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 with LCRB ≤ 4 RBs for power class 1.5 and LCRB ≤ 2 RBs for other power classes.

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

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

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

and NRB\_alloc + NRB\_gap is larger than 106, 51 or 24 RBs for 15 kHz, 30 kHz or 60 kHz respectively where NRB\_gap is 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 6.2.2-1 is 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>**

### 6.2D.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 |  |  |  |  | 23 | +2/-3 |  |  |
| n38 |  |  |  |  | 23 | +2/-3 |  |  |
| n39 |  |  |  |  | 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 UE not indicating Tx diversity [xx, TS 38.306] is scheduled for single antenna-port PUSCH transmission by DCI format 0\_0 or by DCI format 0\_1 for single antenna port codebook based transmission, the requirements in clause 6.2.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signalling.

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

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2D.1-1 is specified in Table 6.2.2-1 for PC3, Table 6.2D.2-1 for 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 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 requirements in clause 6.2.2 apply for the power class as indicated by the *ue-PowerClass* field in capability signaling.

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. |

## **<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 both UE antenna connectors. The period of measurement shall be at least one sub frame (1 ms).

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

For UE supporting Tx diversity, the allowed MPR for the maximum output power in Table 6.2.1-1 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>**