**3GPP TSG-RAN WG4 Meeting #111**

 **Fukuoka City, Japan, 20th May - 24th May**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  | **38.101-1** | **CR** | 2357 | **rev** | **-** | **Current version:** | **17.13.0** |  |
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| *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:***  | (NR\_RF\_FR1-Core) CR for TS38101-1 Clarifying transmitted power requirements for NR CA |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** |  NR\_RF\_FR1-Core, NR\_PC2\_CA\_R17\_2BDL\_2BUL-Core, NR\_UE\_PC2\_R17\_CADC\_SUL\_xBDL\_yBUL-Core, NR\_intra\_HPUE\_R17-Core |  | ***Date:*** | 2024-05-20 |
|  |  |  |  |  |
| ***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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* *Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Several power class related UE capabilities have been introduced since Rel-15, but it’s not entirely clear how to determine the effective power class requirements for a band within a band combination (BC) when all or only some of the IEs are signalled.Adding to the complexity, a fallback BC that has the same or lower capabilities than its parent BC is not allowed to be excplicitly reported as per RAN2 specification. Its power class capability should be derived on the basis of capability inheritance. |
|  |  |
| ***Summary of change:*** | A new clause “6.2A.1.0 General” is added to clarify the power class to be applied for a component band within a NR CA BC.Following the principle stated in this new clause, the formulas for determining the configured max output power Pcmax,c for individual serving cells are added to the clause for configured Tx power for inter-band CA. |
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| ***Consequences if not approved:*** | Ambiguity related to the effective power class for a CA configuration remains in the specification. |
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| ***Clauses affected:*** | 6.2A.1, 6.2A.4.1.3 |
|  |  |
|  | **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:*** |  |

<<<Begin of changes>>>

## 6.2A Transmitter power for CA

### 6.2A.1 UE maximum output power for CA

#### 6.2A.1.0 General

The UE Power Classes for UL CA are defined in the sub-clauses below. A UE indicates the power class capability for a CA band combination using the capability field of *powerClass* in the *BandCombination* IE. If the field is absent, the default power class applies to the band combination.

For uplink inter-band CA transmissions, the power class applied for a component band within the CA band combination shall not exceed the power class of the band combination itself. A UE may use the capability field of *ue-PowerClassPerBandPerBC-r17* in the *BandCombination* IE to indicate the power class of each band in a band combination if the maximum output power for a component band is not higher than that indicated by the capability field of *ue-PowerClass* in the *BandNR* IE. If the field is absent, the applied power class is the lower of the following two values: the first one is the power class of the band combination, and the second one is either the power class indicated by the capability field of *ue-PowerClass* if only one uplink carrier is configured on the band, or the default power class if intra-band CA uplink carriers are configured on the band.

#### 6.2A.1.1 UE maximum output power for Intra-band contiguous CA

For uplink intra-band contiguous carrier aggregation, the maximum output power is specified in Table 6.2A.1.1-1. For downlink intra-band contiguous carrier aggregation with a single uplink component carrier configured in the NR band, the maximum output power is specified in Table 6.2.1-1 for power class 3 and other power classes if indicated in clause 5.5A.1.

Table 6.2A.1.1-1: UE Power Class for intra-band contiguous CA

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR CA Configuration | Class 1 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) | Class 4 (dBm) | Tolerance (dB) |
| CA\_n5B |  |  |  |  | 23 | +2/-2 |  |  |
| CA\_n7B |  |  |  |  | 23 | +2/-2 |  |  |
| CA\_n40B |  |  |  |  | 23 | +2/-2 |  |  |
| CA\_n41B |  |  |  |  | 23 | +2/-21 |  |  |
| CA\_n41C |  |  | 26 | +2/-3 | 23 | +2/-21 |  |  |
| CA\_n48B |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n77C |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n78C |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n79C |  |  |  |  | 23 | +2/-3 |  |  |
| NOTE 1: An uplink CA configuration in which the band has NOTE 3 in Table 6.2.1-1 is allowed to reduce the lower tolerance limit by 1.5 dB when the transmission bandwidths of the band are confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high - 4 MHz and FUL\_high.NOTE 2: PPowerClass is the maximum UE power specified without taking into account the tolerance.NOTE 3: For intra-band contiguous carrier aggregation the maximum power requirement shall apply to the total transmitted power over all component carriers (per UE). |

<<<unchanged part omitted >>>

##### 6.2A.4.1.3 Configured transmitted power for Inter-band CA

For uplink carrier aggregation transmissions, the UE is allowed to set its configured maximum output power PCMAX,*c* for serving cell *c* and its total configured maximum output power PCMAX.

The configured maximum output power PCMAX,*c* for each transmission occasion on serving cell *c* shall be set as follows,

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

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

where

- PPowerClass,c is the maximum UE power for serving cell *c* 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, and indicated by *ue-PowerClassPerBandPerBC-r17* if present, *ue-PowerClass* otherwise;

- PEMAX,CA , PPowerClass,CA and ΔPPowerClass,CA are as specified below for the PCMAX of the band combination.

For uplink inter-band carrier aggregation, MPR*c* and A-MPR*c* apply per serving cell *c* and per transmission occasion are specified in clause 6.2.2 and clause 6.2.3, respectively, where the applied power class has the nominal maximum output power of

MIN { PPowerClass,c – ΔPPowerClass,c, PPowerClass,CA – ΔPPowerClass,CA }.

P-MPR*c* accounts for power management for serving cell *c*. PCMAX,*c* is calculated under the assumption that the transmit power is increased independently on all serving cells.

The configured output power $\tilde{P}\_{CMAX,f,c}$ for a reference transmission shall be set as specified above and in accordance with [38.213].

The total configured maximum output power PCMAX shall be set within the following bounds:

 PCMAX\_L ≤ PCMAX ≤ PCMAX\_H

For uplink inter-band carrier aggregation with one serving cell c per operating band when same slot symbol pattern is used in all aggregated serving cells,

 PCMAX\_L = MIN {10log10∑ MIN [ pEMAX,c/(tC,c), pPowerClass.c/(MAX(mprc·∆mprc, a-mprc)·tC,c ·tIB,c·tRxSRS,c), pPowerClass,c/pmprc], PEMAX,CA, PPowerClass,CA-ΔPPowerClass, CA}

 PCMAX\_H = MIN{10 log10 ∑ pEMAX,c , PEMAX,CA, PPowerClass,CA-ΔPPowerClass, CA}

where

- pEMAX,c is the linear value of PEMAX, *c* which is given by IE *P-Max* for serving cell *c* in [7];

- PPowerClass,CA is the maximum output power for the supported UE power class for the band combination specified in Table 6.2A.1.3-1 without taking into account the tolerance specified in the Table 6.2A.1.3-1; If the UE indicates *higherPowerLimit-r17* for an eligible CA configuration as specified in Table 6.2A.1.3-1 and ΔPPowerClass, CA = 0, PPowerClass,CA is replaced by 10 log10 ∑ pPowerClass,c.

- pPowerClass,c is the linear value of the maximum UE power for serving cell *c* specified in Table 6.2.1-1 according to *ue-PowerClassPerBandPerBC-r17* if indicated or ue-PowerClass otherwise without taking into account the tolerance;

- ΔPPowerClass,CA = 3 dB for a power class 2 capable UE when the requirements of default power class are applied as specified in sub-clause 6.2.A.1.3; otherwise ΔPPowerClass, CA = 0 dB;

- mpr *c* and a-mpr *c* are the linear values of MPR *c* and A-MPR *c* as specified in clause 6.2.2 and clause 6.2.3, respectively;

- ∆mpr *c* is the linear value of ∆MPR *c* as specified in clause 6.2.2;

- pmprc is the linear value of P-MPR*c*;

- ∆tRxSRS,c is the linear value of ∆TRxSRS,c;

- tC,c is the linear value of TC,ctC,c = 1.41 when NOTE 2 in Table 6.2A.1.3-1 applies for a serving cell *c*, otherwise tC,c = 1;

- tIB,c is the linear value of the inter-band relaxation term TIB,c of the serving cell *c* as specified in clause 6.2A.4.2 for NR CA, clause 6.2C.2 for SUL, or TS 38.101-3 clause 6.2B.4.2 for EN-DC; otherwise tIB,c In case the UE supports more than one of band combinations for CA, SUL or DC, and an operating band belongs to more than one band combinations then

a) When the operating band frequency range is ≤ 1 GHz, the applicable additional 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.

- PEMAX,CA is the value indicated by *p-NR-FR1* or by *p-UE-FR1* whichever is the smallest if both are present.For uplink inter-band carrier aggregation with one serving cell c per operating band when at least one different numerology/slot pattern is used in aggregated cells, the UE is allowed to set its configured maximum output power PCMAX,c(i),i for serving cell c(i) of slot numerology type *i*, and its total configured maximum output power PCMAX.

The configured maximum output power PCMAX,c(i),i (p) in slot p of serving cell c(i) on slot numerology type *i* shall be set within the following bounds:

PCMAX\_L,f,c(i),i (p) ≤ PCMAX,f,c(i), i (p) ≤ PCMAX\_H,f,c(i),i (p)

where PCMAX\_L,f,c (i),i (p) and PCMAX\_H,f,c(i),i (p) are the limits for a serving cell c(i) of slot numerology type i. .

The total UE configured maximum output power PCMAX (p,q) in a slot p of slot numerology or symbol pattern *i*, and a slot q of slot numerology or symbol pattern *j* that overlap in time shall be set within the following bounds unless stated otherwise:

PCMAX\_L(p,q) ≤ PCMAX (p,q) ≤ PCMAX\_H (p,q)

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

PCMAX\_L (p,q) = MIN {10 log10 [pCMAX\_L,f,c(i),i (p) + pCMAX\_L,f,c(i),j (q)], PPowerClass,CA, PEMAX,CA}

PCMAX\_H (p,q) = MIN {10 log10 [pCMAX\_ H,f,c(i),i (p) + pCMAX\_ H,f,c(i),j (q)], PPowerClass,CA, PEMAX,CA}

where pCMAX\_L,f,c (i),i and pCMAX\_ H,f,c(i),i are the respective limits PCMAX\_L,f,c (i),i and PCMAX\_H,f,c(i),i expressed in linear scale and pPowerClass,c is the linear value of the maximum UE power for serving cell c specified in Table 6.2.1-1 according to *ue-PowerClassPerBandPerBC-r17* if indicated or ue-PowerClass otherwise without taking into account the tolerance; If the UE indicates *higherPowerLimit-r17*, PPowerClass,CA is replaced by 10 log10 ∑ pPowerClass,c.

For combinations of intra-band and inter-band carrier aggregation with UE configured for transmission on three serving cells (up to two contiguously aggregated carriers per operating band), the following apply:

The UE power class for the serving cell(s) on the operating band *Bi* including intra-band carrier aggregation shall be determined by the *ue-PowerClassPerBandPerBC-r17* IE [7] as indicated for the band combination if signalled.

For the case when p and q belong to the same band and k belongs to a different band, but p, q and k are of the same numerology and slot patterns.

 PCMAX\_L = MIN {10log10∑( pCMAX\_L, Bi), PEMAX,CA, PPowerClass.CA }

 PCMAX\_H = MIN{10 log10 ∑ pEMAX,c , PEMAX,CA, PPowerClass.CA }

Where

- pCMAX\_L, Bi is the linear values of PCMAX\_L specified for the specific operating band *Bi*.

- The linear value of PCMAX\_L specified for uplink intra-band contiguous carrier aggregation in subclause 6.2A.4.1.1 applies for operating band supporting two contiguous serving cells, designated by its band index *Bi*. The linear value of PCMAX\_L specified for single carrier in subclause 6.2.4 applies for operating band *Bj* supporting one serving cell.

For the case when p and q belong to the same band and are of the same numerology *i* and slot patterns (p,q),while k belong to a different band and is of different numerology *j* and/or slot pattern on the 3rd cell then:

PCMAX\_L (p,q,k) = MIN {10 log10 [pCMAX\_L,Bi,i(p,q) + pCMAX\_L,c(3),Bj,j(k)], PEMAX,CA, PPowerClass.CA }

PCMAX\_H (p,q,k) = MIN {10 log10 [pCMAX\_ H,Bi,i (p,q) + pCMAX\_ H,c(3), Bj,j(k)], PEMAX,CA, PPowerClass.CA }

Where

- pEMAX,c is the linear value of PEMAX, *c* which is given by IE *P-Max* for serving cell *c* in [7];

- PEMAX,CA is p-UE-FR1 value signalled by RRC and defined in [38.331];

- PPowerClass.CA is the maximum UE power specified in Table 6.2A.1.3-1 without taking into account the tolerance specified in the Table 6.2A.1.3-1 or Table 6.2F.1A.1-1 for shared spectrum bands;

- pCMAX\_L,c(3),Bj,j(k) and pCMAX\_ H,c(3), Bj,j(k)are the linear values of PCMAX\_L and PCMAX\_H respectively, specified for single carrier in subclause 6.2.4 and applies for operating band supporting one serving cell in the *Bj* band on numerology *j*, using slot pattern k;

- pCMAX\_L,Bi,i(p,q) and pCMAX\_ H,Bi,i (p,q) are the linear values of PCMAX\_L respectively PCMAX\_H for uplink intra-band contiguous carrier aggregation specified in subclause 6.2A.4.1.1 which applies for operating band *Bi* on numerology *i*, supporting two contiguous serving cells, using the same slot pattern (p,q).

<<<unchanged part omitted >>>

<<<End of changes>>>