**3GPP TSG-RAN4 Meeting #103-e *R4-2210198***

**Electronic Meeting, May 9th – 20th, 2022**

|  |
| --- |
| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.101-1** | **CR** | **1113** | **rev** |  | **Current version:** | **17.5.0** |  |
|  |
| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
|  |

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

|  |
| --- |
|  |
| ***Title:***  | Increasing the maximum power limit for inter-band UL CA |
|  |  |
| ***Source to WG:*** | Qualcomm Incorporated, Verizon, Vodafone, Deutsche Telekom, US Cellular, T-Mobile USA, AT&T, China Unicom, NTT DOCOMO, INC., China Telecom, Nokia, Nokia Shanghai Bell, CableLabs  |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** | 2022-04-12 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | The maximum output power for CA is limited by PCMAX\_H which prevents a UE from transmitting at a higher power according to the sum of the maximum power in each CC. |
|  |  |
| ***Summary of change:*** | The upper and lower limits of PCMAX are raised to enable higher maximum output power for CA for PC3+PC2 power configurations when [HigherPowerLimitCADC] is signaled. |
|  |  |
| ***Consequences if not approved:*** | The maximum output power potential of the UE cannot be reached for some UE’s. |
|  |  |
| ***Clauses affected:*** | 6.2A.1.3, 6.2A.4.1.3 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **x** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **x** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

### **<<< Start of changes >>>**

#### 6.2A.1.3 UE maximum output power for Inter-band CA

For inter-band downlink carrier aggregation with one uplink carrier assigned to one NR band, the transmitter power requirements in Table 6.2.1-1 apply for power class 3 and other power classes if indicated in clause 5.5A.3.

For inter-band carrier aggregation with two uplink contiguous carrier assigned to one NR band, the transmitter power requirements specified in subclause 6.2A.1.1 apply.

For inter-band carrier aggregation with two uplink non-contiguous carrier assigned to one NR band, the transmitter power requirements specified in subclause 6.2A.1.2 apply. For inter-band uplink carrier aggregation with uplink assigned to two NR bands, UE maximum output power shall be measured over all component carriers from different bands. If each band has separate antenna connectors, maximum output power is defined as the sum of maximum output power from each UE antenna connector. The period of measurement shall be at least one sub frame (1 ms). The maximum output power is specified in Table 6.2A.1.3-1.

Table 6.2A.1.3-1 UE Power Class for uplink inter-band CA (two bands)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Uplink CA Configuration | Class 1 (dBm)  | Tolerance (dB)  | Class 2 (dBm) | Tolerance(dB)  | Class 3 (dBm) | Tolerance (dB)  | Class 4 (dBm) | Tolerance (dB) |
| CA\_n1A-n3A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n5A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n7A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n8A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n18A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n20A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n28A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n40A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n41A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n74A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n1A-n78A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n1A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n5A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n7A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n12A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n14A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n30A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n48A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n2A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n2A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n5A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n7A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n8A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n18A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n20A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n28A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n34A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3-n38A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n40A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n41A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n3A-n74A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n3A-n78A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n3A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n7A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n12A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n14A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n25A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n30A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n48A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n5A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n5A-n78A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n5A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n7A-n25A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n7A-n28A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n7A-n46A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n7A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n7A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n7A-n78A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n8A-n34A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n8A-n39A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n8A-n40A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n8A-n41A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n8A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n8A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n8A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n12A-n30A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n12A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n12A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n13A-n25A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n13A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n13A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n14A-n30A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n14A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n14A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n18A-n28A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n18A-n41A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n18A-n74A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n18A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n18A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n20A-n28A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n20A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n24A-n41A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n24A-n48A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n24A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n25A-n38A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n25A-n41A |  |  | 266,7 | +2/-32 | 23 | +2/-3 |  |  |
| CA\_25A-n48A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n25A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n25A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n25A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n26A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n26A-n70A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n28A-n40A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n28A-n41A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n28A-n46A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n28A-n50A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n28A-n74A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n28A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n28A-n78A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n28A-n79A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n34A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n30A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n30A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n34A-n40A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n38A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n38A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n39A-n40A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n39A-n41A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n39A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n40A-n41A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n40A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n40A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n40A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n41A-n48A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n41A-n50A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n41A-n66A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n41A-n70A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n41A-n71A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n41A-n74A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n41A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n41A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n41A-n79A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n46A-n48A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n46A-n48B |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n46A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n48A-n66A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n48A-n70A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n48A-n71A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n48A-n96A  |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n48B-n96A  |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n48A-n96B  |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n50A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n66A-n71A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n66A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n66A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n70A-n71A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n70A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n71A-n77A |  |  | 266,7 | +2/-3 | 23 | +2/-3 |  |  |
| CA\_n71A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n74A-n77A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n74A-n78A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n77A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n78A-n79A |  |  |  |  | 23 | +2/-3 |  |  |
| CA\_n78A-n92A |  |  |  |  | 23 | +2/-3 |  |  |
| NOTE 1: VoidNOTE 2: An uplink CA configuration in which at least one of the bands 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 at least one of the bands is confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high - 4 MHz and FUL\_high.NOTE 3: PPowerClass is the maximum UE power specified without taking into account the toleranceNOTE 4: For inter-band carrier aggregation the maximum power requirement should apply to the total transmitted power over all component carriers (per UE).NOTE 5: Power class 3 is the default power class unless otherwise stated.NOTE 6: The UE supports PC3 within NR FDD band, and supports either PC3 or PC2 within NR TDD band.NOTE 7: The UE that supports PC3 within an NR TDD or FDD band and supports PC2 or PC1.5 within a second NR TDD band may signal a [HigherPowerLimitCADC] capability whereby the maximum output power indicated in the table may be exceeded in accordance with sub-clause 6.2A.4.1.3. |

If a UE supports a different power class than the default UE power class for the band combination listed in Table 6.2A.1.3-1 and the supported power class enables the higher maximum output power than that of the default power class:

– if the field of UE capability maxUplinkDutyCycle-interBandCA-PC2 is not absent and the average percentage of uplink symbols transmitted in a certain evaluation period is larger than maxUplinkDutyCycle-interBandCA-PC2 as defined in TS 38.331 (The exact evaluation period is no less than one radio frame); or

– if the IE P-Max as defined in TS 38.331 [7] is provided and set to the maximum output power of the default power class or lower;

– shall apply all requirements for the default power class to the supported power class and set the configured transmitted power as specified in clause 6.2A.4;

– else;

– shall apply all requirements for the supported power class and set the configured transmitted power as specified in clause 6.2A.4 (regardless of the average percentage of uplink symbols if the field of UE capability *maxUplinkDutyCycle-interBandCA-PC2* is absent).

The average percentage of uplink symbols is defined as 50% × ( DutyNR, x /maxDutyNR,x + DutyNR, y /maxDutyNR,y, ). DutyNR, x, DutyNR, y represent the actual percentage of uplink symbols transmitted in the same evaluation period (The exact evaluation period is no less than one radio frame) for NR Band x, NR Band y respectively; maxDutyNR,x,maxDutyNR,y represent the field of UE capability *maxUplinkDutyCycle-PC2-FR1* per band as defined in TS 38.331. For NR Band x or NR Band y,

– if power class of one or both of the bands within the band combination is power class 2 and the corresponding UE capability maxUplinkDutyCycle-PC2-FR1 is absent;

– the corresponding maxDutyNR,x or maxDutyNR,y is equal to 50%;

– else if the band is configured with power class 3;

– the corresponding maxDutyNR,x or maxDutyNR,y is equal to 100%.

Table 6.2A.1.3-2 Void

### **<<< Unchanged sections omitted >>>**

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

For uplink carrier aggregation 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* on serving cell *c* shall be set as specified in clause 6.2.4.

For uplink inter-band carrier aggregation, MPR*c* and A-MPR*c* apply per serving cell *c* and are specified in clause 6.2.2 and clause 6.2.3, respectively. 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 component carriers.

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}

Discussions:

Mediatek: support the approach to introduce the new signaling or new power class. They both requires antenna connectors. For legacy UE supporting PC3, UE needs information to differentiate the new from the legacy power class.

Ericsson: It is good to know what UE is expected to report. What is the implication of the report for UE behaviour. It is not only about UE to do and inform network. UE simultaneously reports something else which may have other implication. That issue needs more discussion. Regarding the second change below, if we agree to introduce the new capability, the second change is not needed. What is the technique problem of our CR?

Nokia: regarding questions about the behaivor, we think the behaviour is clear. The sum only applies when UE indicates the certain capability and when delta\_P\_powerclass =0. Then that is different point of value. The CR is clear for this behaviour.

Huawei: I tend to agree with Nokia. For power calss fallback, the high power feature could not be enabled. How does Ericsson proposal deal with fall back? For us, increasing the lower and high limit is our preference. Keeping the low limit unchanged without defining the new signaling is also acceptable. Skyworks asked question about the P\_powerclass\_C. It seems Qualcomm said it is drevied from single band capability. We disagree with it. UE can report PC2 on single band but only support PC3 in CA mode. We have CR to clarify this.

Samsung: as CTC, there are three possible soltuions. We cannot accept to define the new power class and cannot accept just raising the upper bound. For both network is difficult to know the power. WE can accept increasing both upper and lower bound. We support Qualcomm solution. We support Huawei proposal to have signaling.

Ericsson: To Nokia, the expected behaviour of UE fallback by 3dB or other values. That is the question. What is the behaviour in fall back?

Qualcomm: To Ericsson question about fallback, the CR is clear. It reads that “If UE reports the capability and P-power-class =0”. To the point about the skyworks about the P\_PowerClass\_C, the CR and the previous discussion about the capabilities are coupled. 23+23 cannot meat 27.8dBm. For such case, there would be no problem. Two concepts should be coupled.

Verizon: CTC made good summary for three options. We cannot accept new power class. We are OK to increase both upper and lower bounds.

Ericsson: to Qualcomm, we understand that text implies 4.8dB fall back. When do we expect this 4.8dB fallback occur? What is the condition? For other power class, the fallback is 3dB. If the agreement is that fallback is 4.8dB for PC2+PC3, the text works. There is no issue. It impies differen UE behaviors in fallback.

Huawei: To Qualcomm, about PPowerClass,C our comment is 23+26. UE has two PAs. This is about two power class per band. Single band, UE is allowed to report 23 for both bands. The PPowerClass,C should be derived on the new signaling.

Skyworks: On defining per-band per BC power class capability, this is more general approach. This is to address the ambiguity. If the signaling exists, it can address issue.

Qualcomm: to Ericsson, it is different UE behaviour. But it is ambugouus. To Huawei, maybe Huawei is thinking UE reports 26 per bands and when aggregated UE can only do 23+26. That case is not very clear. To Skywork, we are concern on it. It is out of scope of CR. This CR is limited to certain cases. We can generalize it in Rel-18.

Samsung: The example given by Huawei is widley discussed previously in the signaling. 23+26 the actual power is 23+26 but if no accurate signaling, network may think UE power is 26+26. The proposed per-band per BC signaling should be add under PPowerclass,C

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 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; If the UE indicates [HigherPowerLimitCADC] for the combinations in table XXX 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 when the serving cell power class is PC3 or PC2 without taking into account the tolerance; when the serving cell power class is PC1.5, pPowerClass,c is the linear value of 26 dBm

- 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 as specified in clause 6.2.4.

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 when the serving cell power class is PC3 or PC2 without taking into account the tolerance or the linear value of 26 dBm when the serving cell power class is PC1.5. If the UE indicates [HigherPowerLimitCADC], 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:

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; If the UE indicates [HigherPowerLimitCADC], 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 when the serving cell power class is PC3 or PC2 without taking into account the tolerance; when the serving cell power class is PC1.5, pPowerClass,c is the linear value of 26 dBm;

- 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).

TREF and Teval are specified in Table 6.2A.4.1.3-0 when same and different slot patterns are used in aggregated carriers. For each TREF, the PCMAX\_L is evaluated per Teval and given by the minimum value taken over the transmission(s) within the Teval; the minimum PCMAX\_L over the one or more Teval is then applied for the entire TREF. The lesser of PPowerClass,CA and PEMAX,CA shall not be exceeded by the UE during any period of time.

Table 6.2A.4.1.3-0: PCMAX evaluation window for different slot and channel durations

|  |  |  |
| --- | --- | --- |
| TREF | Teval | Teval with frequency hopping |
| TREF of largest slot duration over both UL CCs | Physical channel length | Min(Tno\_hopping, Physical Channel Length) |

If the UE is configured with multiple TAGs and transmissions of the UE on slot *i* for any serving cell in one TAG overlap some portion of the first symbol of the transmission on slot *i* +1 for a different serving cell in another TAG, the UE minimum of PCMAX\_L for slots *i* and *i* + 1 applies for any overlapping portion of slots *i* and *i* + 1. The lesser of PPowerClass,CA and PEMAX,CA shall not be exceeded by the UE during any period of time.

The measured maximum output power PUMAX over all serving cells with same slot pattern shall be within the following range:

 PCMAX\_L – MAX{TL, TLOW(PCMAX\_L) } ≤ PUMAX  ≤ PCMAX\_H + THIGH(PCMAX\_H)

 PUMAX = 10 log10 ∑ pUMAX,c

where pUMAX,c denotes the measured maximum output power for serving cell *c* expressed in linear scale. The tolerances TLOW(PCMAX) and THIGH(PCMAX) for applicable values of PCMAX are specified in Table 6.2A.4.1.3-1. The tolerance TL is the absolute value of the lower tolerance for applicable NR CA configuration as specified in Table 6.2A.1.3-1-2 for inter-band carrier aggregation.

The measured maximum output power PUMAX over all serving cells, when at least one slot has a different transmission numerology or symbol pattern, shall be within the following range:

 P'CMAX\_L– MAX{TL, TLOW (P'CMAX\_L)} ≤ P'UMAX  ≤ P'CMAX\_H + THIGH (P'CMAX\_H)

 P'UMAX = 10 log10 ∑ p'UMAX,c

where p'UMAX,c denotes the average measured maximum output power for serving cell *c* expressed in linear scale over TREF. The tolerances TLOW(P'CMAX) and THIGH(P'CMAX) for applicable values of P'CMAX are specified in Table 6.2A.4.1.3-1 for inter-band carrier aggregation. The tolerance TL is the absolute value of the lower tolerance for applicable NR CA configuration as specified in Table 6.2A.1.3-1 for inter-band carrier aggregation.

where:

 P'CMAX\_L  = MIN{ MIN {10log10∑( pCMAX\_L,f,c(i),i), PPowerClass,CA} over all overlapping slots in TREF}

 P'CMAX\_H = MAX{ MIN{10 log10 ∑ pEMAX,c , PPowerClass,CA} over all overlapping slots in TREF}

If the UE indicates [HigherPowerLimitCADC], PPowerClass,CA is replaced by 10 log10 ∑ pPowerClass,c

Table 6.2A.4.1.3-1: PCMAX tolerance for uplink inter-band CA (two bands)

|  |  |  |
| --- | --- | --- |
| PCMAX(dBm) | ToleranceTLOW(PCMAX)(dB) | ToleranceTHIGH(PCMAX)(dB) |
| 23 ≤ PCMAX ≤ 28 | 3.0 | 2.0 |
| 22 ≤ PCMAX < 23 | 5.0 | 2.0 |
| 21 ≤ PCMAX < 22 | 5.0 | 3.0 |
| 20 ≤ PCMAX < 21 | 6.0 | 4.0 |
| 16 ≤ PCMAX < 20 | 5.0 |
| 11 ≤ PCMAX < 16 | 6.0 |
| -40 ≤ PCMAX < 11 | 7.0 |

### **<<< End of changes >>>**