**3GPP TSG-RAN WG4 Meeting # 98-e R4-2103324**

**Electronic Meeting, 25 Jan – 5 Feb, 2021**

**Agenda item:** 11.2.2.5

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for [98e][137] NR\_RF\_FR1\_enh\_Part\_3

**Document for:** Information

# Introduction

The scope of this discussion is the NC UL CA for PC2 according to WI [1]

* *HPUE for TDD intra-band contiguous and non-contiguous UL CA*
	+ *Take n41, n77 and n78 intra-band contiguous UL CA for examples*
		- *The two example intra-band contiguous UL CA configurations are under considerations*
			* *CA\_n41C, CA\_n78C, CA\_n77C*
	+ *Take n77 intra-band non-contiguous UL CA for example*
		- *One example intra-band non-contiguous UL CA configuration is under considerations: CA\_n77(2A)*
	+ *Investigate and specify the 26dBm power class for n41and n78 intra-band contiguous, and n77 intra-band contiguous/non-contiguous UL CA*
		- *Identify the impact of different UE architectures on the requirements*
			* *Power class relation between single CC and intra-band contiguous/non-contiguous CA on HPUE band is clarified if any*
		- *Specify the mechanism to meet SAR requirements if necessary*
			* *Mechanism for HPUE on single carrier can be a start point considering the same UL-DL configuration assumption*
		- *A-MPR requirement*
	+ *Specify MPR requirements*

Discussions are split in to two main parts and one additional part:

* Topic 1: simulation assumptions and detailed requirements for the MPR simulations
* Topic 2: Other requirements for NC UL CA
* Topic 3: Alignment of PC3 NC Ul CA MPR and AMPR.

## Concluded recommended documents to be assigned

Captured here for convenience

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on NC UL CA PC2 simulation assumptions and scenarios | Skyworks |
| #2 | WF on NC UL CA PC2 requirements | ZTE |

# Document handling

In order to avoid too long files names, delegates are encouraged to remove other company acronym from the file name and create a new version number in the file name and add their own company acronym in the filename. The filename inf the drafts folder would look the following:

[137] Summary\_v01\_QC

[137] Summary\_v02\_XX

[137] Summary\_v03\_YY

…

V03 of the file would then contain QC, XX and YY comments.

Please use change marks in your comments to avoid missing any important remark.

The folder for this thread is located in

<https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Inbox/Drafts/%5B98e%5D%5B137%5D%20NR_RF_FR1_enh_Part_3>

We will use sub-folder 1st\_rnd for the 1st round comments and 2nd\_rnd for 2nd round and sub-folders will be created for the possible assigned documents.

# Topic #1: Simulation assumptions

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** |  | **Company** | **Proposals / Observations** |
| [**R4-2100289**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100289.zip) | MPR/A-MPR initial simulation assumptions for PC2 NR intra-band NC CA | LG Electronics France, LG Uplus | **Proposal 1: RAN4 should consider 2PA/2LO RF architecture as baseline for PC2 NR intra-band non-contiguous CA same as PC3 intra-band non-contiguous CA UE to derive MPR/A-MPR requirements in Rel-17****Proposal 2: RAN4 evaluate PC2 MPR requirements based on above [2] simulation assumptions in section2 in Rel-17.**[2] R4-2005661, “WF on intra-band UL non-contiguous CA MPR,” Skyworks, Huawei, Qualcomm**Proposal 3: RAN4 encourage to share the specific regional requirements in n77 for PC2 NR intra-band NC CA UE to derive A-MPR requirements** |
| [**R4-2100572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100572.zip) | PC2 non-contiguous UL CA UE Architecture and MPR/A-MPR evaluation | Skyworks Solutions Inc. | **Observations:*** **PC3 contiguous UL CA -25dBm/MHz IM3 has lower back-off than -30dBm/MHz IM5 specifications which is not logical**
* **PC2 contiguous UL CA non-contiguous allocations back-off similar to PC3 but NS04 1.5dB worse than WC MPR**
* **2xPC3 PA 1RB+1RB worst case back-off is 1-2dB worse than 1xPC3 PA equivalent**
* **PC3 non-contiguous UL CA MPR/NS04 AMPR is similar than PC2 non-contiguous ENDC which is not consistent**
* **R16 38.101-1 is missing NS04 A-MPR for 2xPC3 PA**

**Proposal 1: for PC2 baseline architecture and requirements:*** **PC3 non-contiguous UL CA SEM requirement applicable to PC2**
* **PC3 ACLR definition is applicable to PC2 with 31dB ACLR instead of 30 dB**
* **MPR and A-MPR values are derived from a two PC2 PAs and antennas each supporting one of the CC**

**Proposal 3 for PC2 MPR/A-MPR evaluation:** * **Antenna isolation is 10dB and 4dB post-PA losses**
* **Usual PC2 calibration for each PA**
* **Equal PSD and Equal back-off power split**
* **The detailed list of scenarios above are used for PC2 non-contiguous UL CA MPR and NS04 A-MPR evaluation**
 |
| [**R4-2102185**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102185.zip) | Discussion on PC2 intra-band non-contiguous NR CA | ZTE Corporation | **Observation 1: P-MPR solution can be used as basedline SAR solution** **Proposal 1. Capability of MaxUplinkDutyCycle: Reuse the capability for single carrier case****Proposal 2: Pcmax: Use the same power class fallback mechanism as for single carrier****Proposal 3: No changed for the spectrum emission mask, additional spurious emission requirements, UE-to-UE coexistence requirements.** **Proposal 4: The UE maximum output power is 26dBm+ +/-3dB, regardless of the RF implementation architectures.** **Proposal 5: ACLR=31dB for PC2 intra-band non-contiguous UL CA** |

## Open issues summary

### Sub-topic 1-1

Simulation assumptions

It seems companies are aligned with many issues

* PA architecture is 2PA/2LO
* Isolation between antenna ports: 10 dB
* Post PA loss: 4 dB
* Use of equal PSD and equal back off
* ACLR = 31 dBc
* Each PA calibrated for 31dBc ACLR at 29 dBm with 20MHz 100RB0 DFT-s-OFDM QPSK waveform
* Spurious emissions, SEM and UE-to-UE co-ex same as PC3 NC UL CA

**Issue 1-1: Simulation assumptions**

Proposals

Use the assumptions above

* Option 1: Yes
* Option 2: No
* Option 3: Yes but add also [provide input in comments]

Recommended 1st round discussion is to gather more input on assumptions

### Companies comments on sub-topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Option 1. |
| Skyworks | Option 1, consistent with RAN4 assumptions in PC3 UL CA |
| LGE | Option2, the baseline RF architecture is two PC3 (2x23dBm) PA RF architecture for PC2 intra-band NC-CA. RAN4 do not need to consider 2x26dBm PA RF architecture as baseline RF architecture.So, in option1, RAN4 only need to modify the sub-bullet as followEach PA calibrated for 31dBc ACLR at 26dBm (22dBm PA power + post PA loss 4 dBm) with 20MHz 100RB0 DFT-s-OFDM QPSK waveform |
| Huawei | Option 2.We need to decide on RF architecture on intra-band UL NC CA before assumption is confirmed.For RF architecture, for PC2 NC CA, it could be:* 2PA/2LO, each PA 100MHz, 26dBm
* 2PA/2LO, each PA 200MHz, 23dBm
* 1PA/1LO, one PA 200MHz, 26dBm

Whether UL MIMO is supported by each architecture can be analyzedFrom experience of PC3 standardization, the architecture can cover the RF requirements of other architecture could be the reference one. We cannot decide on assumption in this meeting. |
| OPPO | Option 2. From implementation point of view, two PC3 PA architecture might be a possible solution and need to be considered. Similar to the contiguous UL CA discussion, whether two sets of requirements need to be defined can be further discussed. |

### Sub-topic 1-2

Simulation scenarios to be evaluated from Skyworks contribution

Scenarios evaluated:

* Since same MPR is targeted CP-OFDM is used in each carrier but both CP-OFDM and DFT-s-OFDM can be evaluated
* Worst case back-off IMD3 at -13dBm/MHz and -30dBm/MHz for 1RB+1RB at 15kHz and 30kHz SCS for MPR with 31dBc ACLR and
* Worst case back-off IMD3 at -13dBm/MHz and -25dBm/MHz for 1RB+1RB at 15kHz and 30kHz SCS for NS04 A-MPR
* 1RB+1RB separation of ~100, 200, 600MHz to cover variation across BW separation classes
* Other allocations sizes are recommended but the MPR vs allocation BW behavior from PC3 MPR can also be reused
* 20MHz channel 15kHz SCS and 40MHz channel 15kHz SCS with a gap of 20MHz (100MHz class and in gap ACLR)
* 40MHz channel 15kHz SCS and 40MHz channel 15kHz SCS with a gap of 120MHz (200MHz class)
* 100MHz channel 30kHz SCS and 100MHz channel 30kHz SCS with a gap of 400MHz (600MHz class)

**Issue 1-2: Scenarios to be evaluated**

Proposals

* Option 1: Use list from [**R4-2100572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100572.zip) **(Skyworks)**
* Option 2: Use list from R4-2005661
* Option 3: Provide more input

Recommended WF:

It is advised to consider the Skyworks list since it is more updated with the new spec for NC UL CA.

We will collect comment on this issue. Companies are encouraged to considered if there is a need to evaluate mixed numerology and mixed waveform type cases (DFT-s and COP-OFDM)

### Companies comments on sub-topic 1-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | The list we provided for option 1is not meant to be exhaustive and should at least work as a first step evaluation between companies. For mixed numerologies and types. for PC3 work since we agreed to use lowest SCS and CP-OFDM in both CCs it is anyhow the worst case for A-MPR |
| LGE | Scenario is OK to us with 1x PC2 PA and 2xPC3 PA RF architecture. |
| Huawei | For power split:For 1PA: equal PSD splitFor 2PA: equal backoff splitFollowing RF architecture should be considered:* 2PA/2LO, each PA 100MHz, 26dBm
* 2PA/2LO, each PA 200MHz, 23dBm
* 1PA/1LO, one PA 200MHz, 26dBm

 PA calibration point for PC3 PA should be : 26dBm(22dBm+4dB loss) in 20MHz ACLR=31dBm |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | Issue 1-1:It is recommended to take the list above as starting point for sim assumptions. The contentious issue seems to be the PA power but for example, every company is in agreement to use 100 MHz fully allocated 1 dB MPR waveform as starting point. Huawei proposal 200 MHz each PA would mean NC + Contiguous CA (max BW for one CC is 100 MHz for CA\_n77(2A)) which is not in scope of the WID. Tentative agreements: Agree the list of sim assumptions except for the PA power levels. Candidate options:Recommendations for 2nd round: Discuss further PA configurations with the Issue 1-1. Issue 1-2: ScenariosScenarios 1xPA2 and 2xPC3 PA’s seems to be possible to fulfill WID objectives. Tentative agreements and 2nd round actions: Agree scenarios with more details with simulation assumptions.  |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on NC UL CA PC2 simulation assumptions and scenarios | Skyworks |

## Discussion on 2nd round (if applicable)

|  |  |
| --- | --- |
| **WF/LS t-doc Title**  | **Comments** |
| **R4-2103237** WF on NC UL CA PC2 simulation assumptions and scenarios, Skyworks | Company A: Company B: |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Other requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

List of documents is the same as in Topic#1

## Open issues summary

In addition to the MPR simulation assumptions, numerous other issues need to be agreed for the NC UL CA PC2 case. In this section some of the issues are identified

### Sub-topic 2-1

Sub-topic description:

SAR management and use of MaxUplinkDutyCycle. If two points that were applied to contiguous UL CA, can be applied for NC UL CA,

* no need to consider different power class configuration of each CC,
* adopt same UL/DL configuration and synchronized condition.

Then **MaxUplinkDutyCycle** can be used in similar fashion as contiguous UL CA

**Issue 2-1: Use of MaxUplinkDutyCycle**

Proposals

* Option 1: Use **MaxUplinkDutyCycle** as it is defined for contiguous UL CA
* Option 2: Other possibilities? Please be specific in comments

Recommended WF

Apply **MaxUplinkDutyCycle**

### Companies comments on sub-topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Option 1. |
| Skyworks | Option 1 used PC2 contiguous ULCA should be used |
| LGE | Areed to adopt same UL/DL configuration and synchronized condition. Then MaxUplinkDutyCycle can be used in similar fashion as contiguous UL CA as mentioned moderator. |
| Huawei | Clarification: reuse the IE for single carrier, of indicate a new one per band combination? |
| OPPO | OK with option 1. |

### Sub-topic 2-2

Sub-topic description: Pcmax : Re-use of Pcmax from PC3 NC UL CA and fallback as single carrier PC2

**Issue 2-2-1: Re-use of Pcmax from PC3 NC UL CA**

Proposals

* Option 1: Re-use Pcmax from PC3 NC UL CA
* Option 2: Other possibilities? Please be specific

**Issue 2-2-2: Fallback behavior as single carrier PC2**

Proposals

* Option 1: Define same fallback behavior as single carrier PC2
* Option 2: Other possibilities? Please be specific

### Companies comments on sub-topic 2-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Issue 2-2-1: Option 1Issue 2-2-2: Option 1 |
| Skyworks | Issue 2-2-1: Option 1Issue 2-2-2: what exact fallback should we assume? Fall back to PC3 UL CA should be assumed |
| LGE | Issue 2-2-1: support Option 1Issue 2-2-2: Yes, PC2 single operation and PC3 intra-band non-contiguous CA shall be supported. |

### Sub-topic 2-3

Sub-topic description: Power class tolerance +2/- 3 dB

**Issue 2-3: Define power class tolerance +2/- 3 dB**

Proposals

* Option 1: Define +2/- 3 dB as tolerance for power class
* Option 2: Other values. Please justify why

### Companies comments on sub-topic 2-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We make a small modification: It should be +2/-3dB.Option 1. |
| Skyworks | We are fine with +2/-3dB which consistent with PC2 single CC and ENDC. |
| LGE | Support option 1 |
| Huawei | Option 1. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | Tentative agreements:For subtopic 2-1:Agreement is to re-use the contiguous ULCA handling of MaxUplinkDutyCycle. The IE should be the same what is decided in contiguous UL CA for PC2. Understanding is that it should be band combination specific so when UE declares the support of NC UL CA configuration, the parameter that is valid for that configuration is the one that applies for this configuration. Candidate options: 1. Follow contiguous ULCA and use the same IE,
2. Develop NC UL CA dedicated
3. Use the single CC parameter

Recommendations for 2nd round: Capture the agreement above in the WF. Option 1. It should be noted that since issue 2-2-1 agrees to re-use the pcmax, the P-MPR is also available for the UE for SAR mitigation method. This can be confirmed in the 2nd round. For subtopic 2-2:issue 2-2-1:Agreement is to adopt same Pcmax from NC UL CA for PC3. *Moderators note is that there maybe something to correct in the Pcmax since it refers to single CC MPRs and modifications for PC2 are needed,* Recommendations for 2nd round: Capture the agreement above in the WF and discuss further the modifications needed for Pc2. issue 2-2-2:Agreement is to adopt the same fall back behavior as single carrier PC2Recommendations for 2nd round: Capture the agreement above in the WF.  |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on NC UL CA PC2 requirements | ZTE |

## Discussion on 2nd round (if applicable)

|  |  |
| --- | --- |
| **WF/LS t-doc Title**  | **Comments** |
| **R4-2103238,** WF on NC UL CA PC2 requirements, ZTE | Company A: Company B: |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: NC UL CA PC3

Maintenance related issues with PC3 UL CA, proposed to be discussed under this agenda

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| [**R4-2100572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100572.zip) | PC2 non-contiguous UL CA UE Architecture and MPR/A-MPR evaluation | Skyworks Solutions Inc. | **Proposal 2 on consistency checks:** * **While PC2 UL CA contiguous and non-contiguous UL CA cases are evaluated, the PC3 numbers should further be verified for consistency.**
* **Missing PC3 non-contiguous UL CA NS04 A-MPR for two PC3 PA architecture is evaluated (input exists in R4-2010301)**
 |

## Open issues summary

As maintenance to PC3 NC UL CA MPR and A-MPR for NS\_04, a discussion is encouraged since some inconsistencies are observed.

### Sub-topic 3-1

Companies are encouraged to voice opinions on the two issues below. 2nd round actions depend on comments.

**Issue 3-1: PC3 Contiguous and NC UL CA consistency check**

Proposals

* Option 1: MPR should be revised
* Option 2: MPR does not need to be revised
* Option 3: Discussion should happen under maintenance

Recommended WF

Comments from companies and based on comments an action for 2nd round

**Issue 3-2: Missing PC3 NC UL CA A-MPR for NS\_04**

Proposals

* Option 1: Adopt A-MPR

**Proposed NS04 A-MPR curve:**

* **The proposed A-MPR curve coefficients versus total RB bandwidth are:**

**-25dBm/MHz A-MPRCA\_IM3 = 7; 0 ≤B<1.08**

 **6.5; 1.08 ≤B<2.16**

 **6; 2.16 ≤B<3.24**

 **5.5; 3.24 ≤ B < 5.04**

 **5; 5.04 ≤B< 10.08**

 **4; 10.08 ≤B< 16.56**

 **3.5; 16.56 ≤ B < 21.96**

 **3; 21.96 ≤B**

* Option 2: Other proposals for the A-MPR
* Option 3: Discussion should happen under maintenance.

Recommended WF

Comments from companies for input on A-MPR in R4-2010301 as above

### Companies comments on sub-topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | 3-1: for PC2 at least, consistency should be checked across MPR/AMPR and contiguous non contiguous cases. Based on the outcome we may revise PC3 to be more consistent.3.2: based on 2PA MPR values from different companies we are conscious that our proposed values will need some amendment. But we think there is a hole in current set of PC3 NC UL CA requirments. |
| LGE | **Issue 3-1: PC3 Contiguous and NC UL CA consistency check**Prefer Option3: Discussion should happen under NR maintenance. RAN4 shall further check MPR levels to support both RF architecture.**Issue 3-2: Missing PC3 NC UL CA A-MPR for NS\_04**Prefer Option3: Discussion should happen under NR maintenance. RAN4 shall further check MPR levels to support both RF architecture. |
| Huawei | This topic should be discussed in Rel-16 maintenance part. Suggest to move to thread 109 in the 2nd round, in case R-16 CR can be allocated. However we provide comments here:* Issue 3-1: This inconsistence comes from some evaluation that : “n41 filter loading may be playing a strong role in the IMD levels compared to that of the n77 filter. We measure the total power in CC1 and CC2 (equal PSD in each CC) and compute the back-off relative to the total power in CC1 and CC2 at MPR0.” We think we should not revise the value.
* Issue 3-2: In Rel-16, we assume 2\*PC3 23dBm, it can be seen R4-2008471. And AMPR NS04 for -25dBm/MHz is already included in TS 38.101 g60.
 |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | Tentative agreements: Move the treatment of this issue in to the thread 109. We assume moderator is ok since moderator is proposing it. As intermediate alternative work saving conclusion is to close the issue with the Huawei explanation that the filtering is different on band n41 and n77. Candidate options: * Option 1: Continue discussing this issue
* Option 2: Close the issue and not continue the discussion

Recommendations for 2nd round: For this meeting, close the issue and come back in next meeting in maintenance thread to allow all companies to digest the problem.  |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round NA

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# References

[1] RP-202799, “WID revision: RF requirements enhancement for NR frequency range 1”, Huawei, 3GPP TSG-RAN Meeting #90-e, Electronic Meeting, 7th – 11th Dec, 2020