**3GPP TSG-RAN WG4 Meeting # 111 R4-2408924**

**Fukuoka, Japan, 20th - 24th May, 2024**

**Agenda item:** 6.18 & 6.19

**Source:** Moderator (China Unicom)

**Title:** Topic summary for [111][113] HPUE\_Basket\_FDD

**Document for:** Information

# Introduction

Thread [113] includes the following topics:

1. Topic #1 Issues for Agenda 6.18 (44 contributions)
2. Topic #2 Issues for Agenda 6.19 (16 contributions)

# Topic #1: HPUE for CA with PC2 on FDD carrier

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407668 | China Unicom | *Revised WID Reserved for post-meeting approval* |
| R4-2407669 | China Unicom | *BigCR Reserved for post-meeting approval* |
| R4-2407670 | China Unicom | *TR Reserved for post-meeting approval* |
| R4-2407374 | Murata | **Observation 1**: If the interferer power imbalance is increased, the MSD delta between 1Tx PC2 and 1Tx PC3 is getting smaller especially for lower 1Tx PC3 MSD such as 3dB and 5dB.**Observation 2**: If the interferer power imbalance is increased, the MSD delta between 1Tx PC2 and 1Tx PC3 is almost same especially for larger 1Tx PC3 MSD such as >10dB.**Observation 3**: It is not clear whether reverse IMD impact can be also applied to harmonic or harmonic mixing scenarios as well as cross-band isolation case.**Observation 4**: The MSD difference shows a strong dependency of the interferer power imbalance as well as MSD for 1Tx PC3.**Observation 5**: The MSD Type 1, Type 3 and Type 5 are not scope of this guidelines.**Observation 6**: The case where the aggressor FDD UL band is LB and the victim DL band is VHB/UHB uses separate antenna architecture and 0dB interferer power imbalance is expected.**Observation 7**: [12]dB of interferer power imbalance can be used for simplified MSD calculations except LB + VHB/UHB combination.**Proposal 1**: Use below guidelines for LB PC2 FDD + VHB/UHB CA combo. |
| R4-2407165 | Skyworks | **Proposal:** Band n41 is not affected by cross-band isolation interference from band n66 PC2 operation. |
| R4-2407166 | Skyworks | **Proposal:** Consider introducing the PC3, PC2 single Tx and PC2 dual Tx test points of Table 6, Table 7, Table 8 respectively. |
| R4-2407159 | Skyworks | **Proposal:** For Band n41 10MHz CBW UL3/DL4 Rx harmonic mixing MSD in CA\_n25-n41, consider:* Introducing 0.8dB PC3 MSD test point;
* Adopting the following PC2 test points.
 |
| R4-2407160 | Skyworks | **Proposal:** For Band n77 CBW UL2/DL1 UL harmonic MSD in CA\_n25-n77, consider:* Introducing a single MSD test point for 10MHz CBW.
* Adopting the following PC2 test points.
 |
| R4-2407161 | Skyworks | **Proposal:** For Band n41 UL3/DL1 UL harmonic MSD in CA\_n8-n41, consider adopting the following PC2 test points. |
| R4-2407162 | Skyworks | **Proposal:** For Band n77 UL3/DL1 UL harmonic MSD in CA\_n8-n41, consider adopting the following PC2 test points. |
| R4-2407156 | Skyworks | **Observation 1**: A survey of the agreed Rel-18 PC3 and PC2 Rx harmonic mixing MSD test points indicate that:* + For PC3 MSD greater than 10dB, ΔPC21Tx is ~3dB.
	+ For PC3 MSD less than 10dB, the WF [1] concept of “MSD classes” to derive simply the PC2 (single Tx) and the PC1.5 (dual Tx) MSD from a given PC3 MSD level is feasible. For example, in Table 1 five MSD “classes” may be used to specify the PC2 MSD from the PC3 MSD level with 0.5dB granularity.
	+ ΔPC21Tx is not significantly impacted by different power imbalance assumptions. The 0dB imbalance represents a worst-case and may be used to propose a simplified PC2 1Tx MSD look-up table.

Based on Observation 1, we propose the following PC2 1Tx MSD simplification.**Proposal 1: Consider adopting the PC2 1Tx MSD look-up of Table 4 with five MSD “classes” and a 0.5dB MSD granularity. This table may be used to simplify the PC2 1Tx MSD analysis for PC2 TDD or PC2 FDD band.****For non-existent PC3 MSD, or PC3 MSD less than 0.5dB, the case-by-case analysis may follow the guidelines [5].** **Proposal 2: For PC1.5 consider adopting the MSD simplification of Table 2.****Proposal 3: For PC2 dual-Tx, consider adopting the MSD simplification of Table 6. For cases of non-existent PC3 MSD, or PC3 MSD less than 1dB, the case-by-case analysis may follow the guidelines proposed in [5].**  |
| R4-2408854 | Qualcomm | **Proposal**: MSD for PC2 CA\_n25A-n41A was provided with the following results, which should be accounted in defining requirements for this combination. |
| R4-2408855 | Qualcomm | **Proposal 1**: Evaluate cases above among interested companies to conclude whether MSD is needed. |
| R4-2408856 | Qualcomm | **Proposal**: MSD for PC2 CA\_n41A-n66A was provided with the following results, which should be accounted in defining requirements for this combination. |
| R4-2408857 | Qualcomm | **Proposal 1**: Specify PC3 n71(2A) MSD as follows.**Proposal 2**: Specify 1TX PC2 and 2TX PC2 CA\_n71(2A) MSD as follows. |
| R4-2408859 | Qualcomm | **Proposal 1**: MSD for CA\_n71B PC2 not supporting TX Diversity.**Proposal 2**: MSD for CA\_n71B PC2 supporting TX Diversity. |
| R4-2408844 | Qualcomm | PC2 FDD MSD guidelines were considered, with the following proposals:**Proposal 1:** RAN4 to consider pro’s and con’s on not specifying MSD test points for any band combination types (not limited to FDD PC2 Single UL band combinations) for higher power classes than PC3. Based on the RAN4 assessment, make formal agreement during Rel-19 on the working procedure with MSD test points for UE power classes beyond PC3**Proposal 2**: Until Proposal 1 is agreed, continue specifying Single UL band FDD PC2 MSD test points and verify FDD PC2 accordingly. In parallel to considerations in Proposal 1, continue preparing solutions how to handle MSD’s for UE power classes higher than PC3 in efficient manner **Observation 1**: For instance, the following Single UL band FDD PC2 MSD specification simplification could be considered, if RAN4 agrees to continue specifying PC2 MSD after considerations in Proposal 1* For cases where at least one of the PC3 MSD test points is 5.0dB or more, consider the following rules:
	+ PC2 1TX MSD = PC3 MSD+3dB
	+ PC2 2TX MSD = PC3 MSD+6dB
* For cases where PC3 MSD not specified or is below 5.0dB for all MSD test points, do case by case evaluation:
	+ Interested companies provide their analysis and MSD if any is conclude based on the input
	+ It is not meaningful to agree any rigorous MSD calculation methods in 3GPP
* If more than one MSD test points is specified for PC2, use the same interferer level to calculate the MSD for the wider victim DL BW
 |
| R4- 2409639 | Huawei, HiSilicon | **Proposal 1:** For band n79 REFSENS exception due to H5 from n8 UL, set the MSD to [15.6] dB for 1Tx PC2 and [17.2] dB for 2Tx PC2. |
| R4-2407580 | Murata | **Proposal 1:** Use 2TX PC2 MSD as shown in Table 2-4. |
| R4-2407157 | Skyworks | **Proposal 1:** Consider adopting the text proposal highlighted in blue and MSD test point of Table 2 to introduce the PC3 CA\_n71B SCC 5MHz CBW REFSENS for one uplink carrier.**Proposal 2:** Consider adopting the text proposal highlighted in blue and MSD test point of Table 2 to introduce the PC2 CA\_n71B SCC 5MHz CBW REFSENS for one uplink carrier. |
| R4-2407158 | Skyworks | **Proposal 1:** For PC3, consider adopting the changes of Table 2 where it is proposed to:**Proposal 2:** For PC2, consider adopting the test points of Table 3 and new core requirement text highlighted in blue below. |
| R4-2408318 | Murata | **Observation 1:** The two alternative test points would be adopted, and the legacy test point would be removed because 20MHz+5MHz test point will cause worse interference to SCC DL for all BCS than the legacy test point.**Proposal 1:** For PC3 and PC2 CA\_n71(2A) REFSENS, adopt the test points proposed in table 2. **Proposal 2**: Consider adopting MSD values highlighted in yellow for CA\_n71(2A) proposed in Table 4 and 5. |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 MSD Analysis

*Sub-topic description: Ten issues are covered under this sub-topic:*

***Issue 1-1-1: MSD for PC2 DL\_n25A-n41A-UL\_n25***

***Issue 1-1-2: MSD for PC2 DL\_CA\_n2-n66 and CA\_n25-n66***

***Issue 1-1-3: MSD for PC2 DL\_n41A-n66A-UL\_n66***

***Issue 1-1-4: MSD for PC2 DL\_CA\_n25-n77-UL\_n25***

***Issue 1-1-5: MSD for PC2 DL\_CA\_n8-n41-UL\_n8***

***Issue 1-1-6: MSD for PC2 DL\_n71-n77-UL\_n71***

***Issue 1-1-7: MSD for PC2 DL\_n8-n79-UL\_n8***

***Issue 1-1-8: MSD for PC2 DL\_n71-n85-UL\_n71***

***Issue 1-1-9: MSD for PC2 DL\_n71(2A)-UL\_n71***

***Issue 1-1-9-1: PC3 n71(2A) MSD***

***Issue 1-1-9-2: PC2 CA\_n71(2A) MSD***

***Issue 1-1-9-3: Test points for PC3 and PC2 CA\_n71(2A) REFSENS***

***Issue 1-1-10: MSD for PC2 DL\_n71B-UL\_n71***

***Issue 1-1-10-1: PC3 n71B MSD***

***Issue 1-1-10-2: PC2 CA\_n71B MSD***

*Open issues and candidate options before meeting:*

#### **Issue 1-1-1: MSD for PC2 DL\_n25A-n41A-UL\_n25**

* Proposals
	+ Option 1: (R4-2407159, Skyworks)

For Band n41 10MHz CBW UL3/DL4 Rx harmonic mixing MSD in CA\_n25-n41, consider:

* Introducing 0.8dB PC3 MSD test point;
* Adopting the following PC2 test points.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD3** | **MSD4** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** | **(dB)** |
| n25 | n41 | 5 | 15 | 25 (RBstart=0) | 10 | 1.5 | 1.8 | NOTE 11 | UL4/DL3 |
| NOTE 3: Applicable to UE supporting PC2 with single Tx.NOTE 4: Applicable to UE supporting PC2 with dual Tx. |

* + Option 2: (R4-2408854, Qualcomm)

**PC2 1TX:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n25 | n41 | 1760 | 40 | 15 | 40 (RBstart=176) | 2501 | 10 | 1.2 | >ACLR2 |
| NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.NOTE 2: VoidNOTE 3: The requirements only apply for UEs supporting inter-band carrier aggregation with simultaneous Rx/Tx capability. Simultaneous Rx/Tx capability does not apply for UEs supporting band n78 with a n77 implementation.NOTE 4: VoidNOTE 5: The MSD exceptions are applicable to the case that interference of UL band 3rd order IMD product falls into the affected DL channels. |

 **PC2 2TX:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n25 | n41 | 1760 | 40 | 15 | 40 (RBstart=176) | 2501 | 10 | 1.5 | >ACLR2 |
| NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.NOTE 2: VoidNOTE 3: The requirements only apply for UEs supporting inter-band carrier aggregation with simultaneous Rx/Tx capability. Simultaneous Rx/Tx capability does not apply for UEs supporting band n78 with a n77 implementation.NOTE 4: VoidNOTE 5: The MSD exceptions are applicable to the case that interference of UL band 3rd order IMD product falls into the affected DL channels. |

**RX Mixing PC2:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n25 | n41 | 5 | 15 | 25 (RBstart=0) | 10 | 2.6 | NOTE 11 | UL4/DL3 |

**RX Mixing PC3:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n25 | n41 | 5 | 15 | 25 (RBstart=0) | 10 | 1.5 | NOTE 11 | UL4/DL3 |

* Recommended WF
	+ To consider merging the results from companies.

#### **Issue 1-1-2: MSD for PC2 DL\_CA\_n2-n66 and CA\_n25-n66**

* Proposals
	+ Option 1: (R4-2407166, Skyworks) Consider introducing the PC3, PC2 single Tx and PC2 dual Tx test points of Table 6, Table 7, Table 8 respectively.

**Table 6**: PC3 MSD results.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL Fc** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL Fc** | **DL BW** | **MSD** | **Cross-band****Interference****source** |
| **(MHz)** | **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(MHz)** | **(dB)** |
| n66 | n25 | 1757.5 | 45 | 15 | 240 (RBstart=2) | 1932.5 | 5 | 1.1 | >ACLR2 |
| n66 | n25 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 0.7 | >ACLR2 |
| n66 | n2 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 1.0 | >ACLR2 |

**Table 7**: PC2 single Tx MSD results.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL Fc** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL Fc** | **DL BW** | **MSD** | **Cross-band****Interference****source** |
| **(MHz)** | **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(MHz)** | **(dB)** |
| n66 | n25 | 1757.5 | 45 | 15 | 240 (RBstart=2) | 1932.5 | 5 | 1.9 | >ACLR2 |
| n66 | n2 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 1.7 | >ACLR2 |

**Table 8**: PC2 dual Tx MSD results.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL Fc** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL Fc** | **DL BW** | **MSD** | **Cross-band****Interference****source** |
| **(MHz)** | **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(MHz)** | **(dB)** |
| n66 | n25 | 1757.5 | 45 | 15 | 240 (RBstart=2) | 1932.5 | 5 | 2.8 | >ACLR2 |
| n66 | n2 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 2.5 | >ACLR2 |
| n2 | n66 | 1900 | 20 | 15 | 50 (RBstart=56) | 2112.5 | 5 | 0.7 | >ACLR2 |
| n25 | n66 | 1895 | 40 | 15 | 40 (RBstart=176) | 2112.5 | 5 | 0.7 | >ACLR2 |

* + Option 2: (R4- 2408855, Qualcomm) Evaluate cases above among interested companies to conclude whether MSD is needed.



**PC3:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n66 | n25 | 1757.5 | 45 | 15 | 240 (RBstart=2) | 1932.5 | 5 | 1.4 | >ACLR2 |
| n66 | n2 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 1.2 | >ACLR2 |

**PC2 1TX:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n66 | n25 | 1757.5 | 45 | 15 | 240 (RBstart=2) | 1932.5 | 5 | 2.5 | >ACLR2 |
| n66 | n2 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 2.1 | >ACLR2 |
| n2 | n66 | 1910 | 20 | 15 | 50 (RBstart=56) | 2112.5 | 5 | 0.8 | >ACLR2 |
| n25 | n66 | 1890 | 40 | 15 | 50 (RBstart=176) | 2112.5 | 5 | 0.8 | >ACLR2 |

**PC2 2TX:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n66 | n25 | 1757.5 | 45 | 15 | 240 (RBstart=2) | 1932.5 | 5 | 4.7 | >ACLR2 |
| n66 | n2 | 1760 | 40 | 15 | 216 (RBstart=0) | 1932.5 | 5 | 4 | >ACLR2 |
| n2 | n66 | 1910 | 20 | 15 | 50 (RBstart=56) | 2112.5 | 5 | 1.1 | >ACLR2 |
| n25 | n66 | 1890 | 40 | 15 | 50 (RBstart=176) | 2112.5 | 5 | 1.1 | >ACLR2 |

* Recommended WF
	+ To consider merging the results from companies.

#### **Issue 1-1-3: MSD for PC2 DL\_n41A-n66A-UL\_n66**

* Proposals
	+ Option 1: (R4-2407165, Skyworks) Band n41 is not affected by cross-band isolation interference from band n66 PC2 operation.
	+ Option 2: (R4-2408856, Qualcomm) MSD for PC2 CA\_n41A-n66A was provided with the following results.

**PC2 1TX:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n66 | n41 | 1760 | 45 | 15 | 240 (RBstart=2) | 2501 | 10 | 1.2 | >ACLR2 |

 **PC2 2TX:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n66 | n41 | 1760 | 45 | 15 | 240 (RBstart=2) | 2501 | 10 | 1.4 | >ACLR2 |

* Recommended WF
	+ TBA

#### **Issue 1-1-4: MSD for PC2 DL\_CA\_n25-n77-UL\_n25**

* Proposals
	+ Option 1: (R4-2407160, Skyworks) Introducing a single MSD test point for 10MHz CBW. And adopting the following PC2 test points.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD3** | **MSD4** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** | **(dB)** |
| n25 | n77 | 5 | 15 | 25 (RBstart=0) | 10 | 26.9 | 31.8 | NOTE X | UL2/DL1 |
| NOTE 3: Applicable to UE supporting PC2 with single Tx.NOTE 4: Applicable to UE supporting PC2 with dual Tx. |

* Recommended WF
	+ Option 1

#### **Issue 1-1-5: MSD for PC2 DL\_CA\_n8-n41-UL\_n8**

* Proposals
	+ Option 1: (R4-2407161, Skyworks) For Band n41 UL3/DL1 UL harmonic MSD in CA\_n8-n41, consider adopting the following PC2 test points.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD3** | **MSD4** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** | **(dB)** |
| n8 | n41 | 5 | 15 | 16 (RBstart=0) | 10 | 15.6 | 20.9 | NOTE X | UL3/DL1 |
| n8 | n41 | 5 | 15 | 25 (RBstart=0) | 100 | 4.9 | 7.5 | NOTE X | UL3/DL1 |
| NOTE 3: Applicable to UE supporting PC2 with single Tx.NOTE 4: Applicable to UE supporting PC2 with dual Tx. |

* Recommended WF
	+ Option 1

#### **Issue 1-1-6: MSD for PC2 DL\_n71-n77-UL\_n71**

* Proposals
	+ Option 1: (R4-2407162, Skyworks) For Band n77 UL3/DL1 UL harmonic MSD in CA\_n8-n41, consider adopting the following PC2 test points.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD3** | **MSD4** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** | **(dB)** |
| n71 | n77 | 5 | 15 | 10 (RBstart=0) | 10 | 12.8 | 17.9 | NOTE X | UL5/DL1 |
| NOTE 3: Applicable to UE supporting PC2 with single Tx.NOTE 4: Applicable to UE supporting PC2 with dual Tx. |

* Recommended WF
	+ Option 1

#### **Issue 1-1-7: MSD for PC2 DL\_n8-n79-UL\_n8**

* Proposals
	+ Option 1: (R4-2409639, Huawei, HiSilicon) For band n79 REFSENS exception due to H5 from n8 UL, set the MSD to [15.6] dB for 1Tx PC2 and [17.2] dB for 2Tx PC2.
* Recommended WF
	+ Option 1

#### **Issue 1-1-8: MSD for PC2 DL\_n71-n85-UL\_n71**

* Proposals
	+ Option 1: (R4-2407580, Murata) Use 2TX PC2 MSD as shown in Table.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | UL Fc | UL BW | SCS of UL band | UL RB Allocation | DL Fc | DL BW | MSD | Cross-bandInterferencesource |
| (MHz) | (MHz) | (kHz) | LCRB | (MHz) | (MHz) | (dB) |
| n71 | n85 | 688 | 20 | 15 | 20 (RBstart=86) | 730.5 | 5 | 15.9x | ACLR2 |
| n71 | n85 | 680.5 | 35 | 15 | 20 (Rbstart=168) | 730.5 | 5 | 32.3y | ACLR1 |
| NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.NOTE 2: VoidNOTE 3: The requirements only apply for UEs supporting inter-band carrier aggregation with simultaneous Rx/Tx capability. Simultaneous Rx/Tx capability does not apply for UEs supporting band n78 with a n77 implementation.NOTE x: Applicable to UE not supporting n71 optional maximum symmetrical UL/DL channel bandwidthNOTE y: Applicable to UE supporting n71 optional maximum symmetrical UL/DL channel bandwidth |

* Recommended WF
	+ Option 1

#### **Issue 1-1-9: MSD for PC2 DL\_n71(2A)-UL\_n71**

**Issue 1-1-9-1: PC3 n71(2A) MSD**

* + Proposals
		- Option 1: (R4-2408857, Qualcomm)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| CA configuration | SCS(PCC/SCC)(kHz) | Aggregated channel bandwidth (PCC+SCC) | Wgap / [MHz] | UL PCC allocation(LCRB) | ΔRIBNC (dB) | Duplex mode |
| CA\_n71(2A) | 15/15 | ~~5MHz + 5MHz~~ | ~~W~~~~gap~~~~= 25.0~~ | ~~5~~ | ~~4.0~~ | ~~FDD~~ |
|  |  |  | ~~W~~~~gap~~~~= 5.0~~ | ~~20~~ | ~~0.0~~ |  |
|  |  | ~~10MHz + 5MHz~~ | ~~W~~~~gap~~~~= 20.0~~ | ~~5 (RBstart = 9)~~ | ~~4.6~~ |  |
|  |  |  | ~~W~~~~gap~~~~= 5.0~~ | ~~20 (RBstart = 9)~~ | ~~2.3~~ |  |
|  |  | 15MHz + 10MHz | Wgap = 10.0 | 5 (RBstart = 2) | 22.2 |  |
|  |  |  | ~~W~~~~gap~~~~= 5.0~~ | ~~20 (RBstart = 19)~~ | ~~5.2~~ |  |
|  |  | 25MHz + 5MHz | Wgap = 5.0 | 20 (RBstart = 8) | 23.6 |  |

* + - Option 2: (R4-2407158, Skyworks)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **Wgap / [MHz]** | **UL PCC allocation** | **SCC****ΔRIBNC (dB)** | **Duplex mode** |
| CA\_n71(2A) | 15/15 | ~~5MHz + 5MHz~~ | ~~W~~~~gap~~~~= 25.0~~ | ~~5~~ | ~~4.0~~ | FDD |
| ~~W~~~~gap~~~~= 5.0~~ | ~~20~~ | ~~0.0~~ |
| ~~10MHz + 5MHz~~ | ~~W~~~~gap~~~~= 20.0~~ | ~~5 (RB~~~~start~~ ~~= 9)~~ | ~~4.6~~ |
| ~~W~~~~gap~~~~= 5.0~~ | ~~20 (RB~~~~start~~ ~~= 9)~~ | ~~2.3~~ |
| 15MHz + 10MHz | Wgap = 10.0 | 5 (RBstart = 2) | 22.2 |
| ~~W~~~~gap~~~~= 5.0~~ | ~~20 (RB~~~~start~~ ~~= 19)~~ | ~~5.2~~ |
| 25MHz + 5MHz**X** | Wgap = 5.0 | 20 (RBstart = 8) | 23.7 |
| NOTE 7: The carrier centre frequency of SCC in the DL operating band is configured closer to the UL operating band.NOTE X: Applicable only to Bandwidth Combination Set 4 and 5 and for UEs supporting the symmetrical UL/DL channel bandwidths. |

* + - Option 3: (R4-2408318, Murata)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS** | **Aggregated channel bandwidth (PCC+SCC)** | **Wgap /[MHz]** | **UL PCC allocation** | **ΔRIBNC (dB)** | **Duplex mode** |
| **(kHz)** |
| CA\_n71(2A) | 15/15 | 15MHz + 10MHz | Wgap=10.0 | 5 (RBstart = 2) | 22.2 | FDD |
|
|
| 20MHz + 5MHz | Wgap=10.0 | 20 (RBstart = 0) | [27.0] | FDD |
|
| 25MHz + 5MHz(NOTE 11) | Wgap=5.0 | 20 (RBstart = 8) | [27.1] |
|
| NOTE 7: The carrier centre frequency of SCC in the DL operating band is configured closer to the UL operating band. |
| NOTE 11: Bandwidth Combination Set 4/5 |

* + Recommended WF
	+ To consider merging the results from companies.

**Issue 1-1-9-2: PC2 CA\_n71(2A) MSD**

* + Proposals
		- Option 1: (R4-2408857, Qualcomm)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **Wgap / [MHz]** | **UL PCC allocation** | **ΔRIBNCX (dB)** | **ΔRIBNCY (dB)** | **Duplex mode** |
| CA\_n71(2A) | 15/15 | 15MHz + 10MHz | Wgap =10.0 | 5 (RBstart=2) | 25.2 | 29.6 | FDD |
| 20MHz + 5MHz | Wgap = 10.0 | 20 (RBstart = 0) | 26.6 | 30.9 | FDD |
| NOTE X: Applicable to UE supporting PC2 with single Tx. NOTE Y: Applicable to UE supporting PC2 with dual Tx. |

* + - Option 2: (R4-2407158, Skyworks) Adopting the test points of Table 3 and new core requirement text highlighted in blue below.

For aggregation of two or more downlink FDD carriers with one uplink carrier, the power class 3 reference sensitivity is increased by ΔRIBNC only for the specific uplink and downlink test points which are specified in Table 7.3A.2.2-1. For power class 2, the reference sensitivity power level is increased by ΔRIBNC for specific uplink and downlink test points which are specified in Table 7.3A.2.2-1a. The requirements apply with all downlink carriers active. Unless given by Table 7.3.2-4, the reference sensitivity requirements shall be verified with the network signaling value NS\_01 (Table 6.2.3.1-1) configured.

Table 3: Power class 2 intra-band non-contiguous CA reference sensitivity with one uplink carrier (new Table 7.3A.2.2-1a).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **Wgap / [MHz]** | **UL PCC allocation** | **SCC****ΔRIBNC1 (dB)** | **SCC****ΔRIBNC2 (dB)** | **Duplex mode** |
| CA\_n71(2A) | 15/15 | 15MHz + 10MHz | Wgap = 10.0 | 5 (RBstart = 2) | [24.1] | [30.5] | FDD |
|  |  | 25MHz + 5MHz1 | Wgap = 5.0 | 20 (RBstart = 8) | [25.7] **3** | [32.1] **3** |  |
| NOTE 1: Applicable to UE supporting PC2 with single Tx. NOTE 2: Applicable to UE supporting PC2 with dual Tx.NOTE 3: Applicable only to BCS 4 and 5 and for UEs supporting the optional symmetrical UL/DL channel bandwidths. |

* + - Option 3: (R4-2408318, Murata)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS** | **Aggregated channel bandwidth (PCC+SCC)** | **Wgap [MHz]** | **UL PCC allocation** | **ΔRIBNCX (dB)** | **ΔRIBNCY (dB)** | **BCS** | **Duplex mode** |
| **(kHz)** |
| CA\_n71(2A) | 15/15 | 15MHz + 10MHz | 10 | 5 (RBstart = 2) | [25.1] | [27.3] | All | FDD |
|
|
| 20MHz + 5MHz | 10 | 20 (RBstart = 0) | [28.9] | [32.1] | FDD |
|
| 25MHz + 5MHz | 5 | 20 (RBstart = 8) | [28.8] | [32.2] | 4/5 only |
|
| NOTE X: Applicable to UE supporting PC2 with single Tx. NOTE Y: Applicable to UE supporting PC2 with dual Tx. |

* + Recommended WF
	+ To consider merging the results from companies.

**Issue 1-1-9-3: Test points for PC3 and PC2 CA\_n71(2A) REFSENS**

* + Proposals
		- Option 1: (R4-2408318, Murata)

**Table 2**: CA\_n71(2A) REFSENS one UL test points

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS** | **Aggregated channel bandwidth (PCC+SCC)** | **Wgap /[MHz]** | **UL PCC allocation** | **Duplex mode** |
| **(kHz)** |
| CA\_n71(2A) | 15/15 | ~~15MHz + 10MHz~~ | ~~Wgap=10.0~~ | ~~5 (RB~~~~start~~ ~~= 2)~~ | ~~FDD~~ |
|
|
| 20MHz + 5MHz | Wgap=10.0 | 20 (RBstart = 0) | FDD |
|
| 25MHz + 5MHz(NOTE 11) | Wgap=5.0 | 20 (RBstart = 8) |
|
| NOTE 7: The carrier centre frequency of SCC in the DL operating band is configured closer to the UL operating band. |
| NOTE 11: Bandwidth Combination Set 4/5 |

* + Recommended WF
	+ Option 1

#### **Issue 1-1-10: MSD for PC2 DL\_n71B-UL\_n71**

**Issue 1-1-10-1: PC3 n71B MSD**

* + Proposals
		- Option 1: (R4-2407157, Skyworks)Adopting the text proposal highlighted in blue and MSD test point of Table 2 to introduce the PC3 CA\_n71B SCC 5MHz CBW REFSENS for one uplink carrier.

For power class 3, the reference sensitivity power level is increased by ΔRIBC for specific uplink and downlink test points which are specified in Table 2 (new table “Table 7.3A.2.1-2”). The requirements apply with all downlink carriers active. Unless given by Table 7.3.2-4, the reference sensitivity requirements shall be verified with the network signalling value NS\_01 (Table 6.2.3.1-1) configured**.**

Table 2: Power class 3 intra-band contiguous CA reference sensitivity with one uplink carrier (new Table 7.3A.2.1-2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(PCC/SCC)****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **UL PCC allocation****(LCRB)** | **SCC****ΔRIBC (dB)** | **Duplex mode** |
| CA\_n71B1 | 15/15 | 30MHz + 5MHz | 20 (RBSTART = 0)  | [0.7] | FDD |
| NOTE 1: Applicable only to BCS 4 and 5 and for UEs supporting the optional symmetrical UL/DL channel bandwidths. |

* + Recommended WF
	+ Option 1

**Issue 1-1-10-2: PC2 CA\_n71B MSD**

* + Proposals
		- Option 1: (R4-2407157, Skyworks) Adopting the text proposal highlighted in blue and MSD test point of Table 2 to introduce the PC2 CA\_n71B SCC 5MHz CBW REFSENS for one uplink carrier.

For power class 2, the reference sensitivity power level is increased by ΔRIBC for specific uplink and downlink test points which are specified in Table 3 (new table “Table 7.3A.2.1-3”). The requirements apply with all downlink carriers active. Unless given by Table 7.3.2-4, the reference sensitivity requirements shall be verified with the network signalling value NS\_01 (Table 6.2.3.1-1) configured**.**

Table 3: Power class 2 intra-band contiguous CA reference sensitivity with one uplink carrier (new Table 7.3A.2.1-3).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **UL PCC allocation** | **SCC****ΔRIBNC1 (dB)** | **SCC****ΔRIBNC2 (dB)** | **Duplex mode** |
| CA\_n71B | 15/15 | 30 MHz + 5 MHz | 20 (RBstart = 0) | [1.1] **3** | [1.6] **3** | FDD |
| NOTE 1: Applicable to UE supporting PC2 with single Tx. NOTE 2: Applicable to UE supporting PC2 with dual Tx.NOTE 3: Applicable only to BCS 4 and 5 and for UEs supporting the optional symmetrical UL/DL channel bandwidths. |

* + Option 2: (R4-2408859, Qualcomm)

 MSD for CA\_n71B PC2 not supporting TX Diversity:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(PCC/SCC)****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **UL PCC allocation****(LCRB)** | **ΔRIBC (dB)** | **Duplex mode** |
| CA\_n71B | 15/15 | 30MHz + 5MHz | 20 (RBSTART = 0)  | 6.6 | FDD |

 MSD for CA\_n71B PC2 supporting TX Diversity:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(PCC/SCC)****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **UL PCC allocation****(LCRB)** | **ΔRIBC (dB)** | **Duplex mode** |
| CA\_n71B | 15/15 | 30MHz + 5MHz | 20 (RBSTART = 0)  | 9.7 | FDD |

* + Recommended WF
	+ To consider merging the results from companies.

### Sub-topic 1-2 Guidelines for PC2 FDD Dual-TX MSD

*Sub-topic description*

Discussions are based on the approved “R4-2406574 WF on PC2 FDD MSD Guidelines, Skyworks” from RAN4-110bis meeting.

*Open issues and candidate options before meeting:*

**Issue 1-2: MSD evaluation guidelines**

* Proposals
	+ Option 1: (R4-2407374, Murata)

*“*

*Use below guidelines for LB PC2 FDD + VHB/UHB CA combo*

* Case 1 for LB + VHB/UHB CA combo:

1Tx PC3 MSD is specified and MSD value is >= [10]dB. then MSD class I could be:

* + 1Tx PC2 MSD = 1Tx PC3 MSD + [3]dB
	+ 2Tx PC2 MSD = 1Tx PC2 MSD + [1]dB
* Case 2 for LB + VHB/UHB CA combo:

1Tx PC3 MSD is specified and [5]<= MSD value< [10]dB, then MSD class II could be:

* + 1Tx PC2 MSD = 1Tx PC3 MSD + [2.7]dB
	+ 2Tx PC2 MSD = 1Tx PC2 MSD + [1]dB
* Case 3 for LB + VHB/UHB CA combo:

1Tx PC3 MSD is specified and [3]<= MSD value< [5]dB, then MSD class III could be:

* + 1Tx PC2 MSD = 1Tx PC3 MSD + [2.2]dB
	+ 2Tx PC2 MSD = 1Tx PC2 MSD + [0.8]dB
* Case 4 for LB + VHB/UHB CA combo:

1Tx PC3 MSD is not specified or its value is <[3]dB, then MSD class IV could be:

* + Companies are invited to provide guidelines on how to
		- 1) evaluate or re-evaluate the baseline 1Tx PC3 interference levels,
		- 2) evaluate the 1Tx PC2 MSD and,
		- 3) evaluate the 2Tx PC2 MSD .
* Case 1 for other CA combo:

1Tx PC3 MSD is specified and MSD value is >= [10]dB. then MSD class I could be:

* + 1Tx PC2 MSD = 1Tx PC3 MSD + [3]dB
	+ 2Tx PC2 MSD = 1Tx PC2 MSD + [8.9]dB
* Case 2 for other CA combo:

1Tx PC3 MSD is specified and [5]<= MSD value< [10]dB, then MSD class II could be:

* + 1Tx PC2 MSD = 1Tx PC3 MSD + [2.5]dB
	+ 2Tx PC2 MSD = 1Tx PC2 MSD + [8.2]dB
* Case 3 for other CA combo:

1Tx PC3 MSD is specified and [3]<= MSD value< [5]dB, then MSD class III could be:

* + 1Tx PC2 MSD = 1Tx PC3 MSD + [1.4]dB
	+ 2Tx PC2 MSD = 1Tx PC2 MSD + [6]dB
* Case 4 for other CA combo:

1Tx PC3 MSD is not specified or its value is <[3]dB, then MSD class IV could be::

* + Companies are invited to provide guidelines on how to
		- 1) evaluate or re-evaluate the baseline 1Tx PC3 interference levels,
		- 2) evaluate the 1Tx PC2 MSD and,
		- 3) evaluate the 2Tx PC2 MSD.

*”*

* + Option 2: (R4-2407156, Skyworks)

This document (R4-2407156)  proposes to simplify the PC2 FDD MSD with:

* Single Tx PC2 MSD = PC3 MSD + DPC21TX,  where one example lookup table provides DPC21TX as a function of the agreed PC3 MSD of a given band combination (Proposal 1)
* Dual Tx PC2 MSD = PC3 MSD + DPC22TX, and a set of lookup tables giving DPC22TX as a function of the agreed PC3 MSD and a function of the primary/diversity PC3 interference level imbalance (Proposal 3)

**Proposal 1: Consider adopting the PC2 1Tx MSD look-up of Table 4 with five MSD “classes” and a 0.5dB MSD granularity. This table may be used to simplify the PC2 1Tx MSD analysis for PC2 TDD or PC2 FDD band.**

**Table 4:** PC2 single-Tx simplified MSD based on the concept of five MSD classes.

|  |  |
| --- | --- |
| **Agreed PC3 MSD** | **Proposed** **PC2 1Tx MSD****simplification1** |
| PC3 MSD ≥ 10dB | 3.0dB |
| 5.0dB ≤ PC3 MSD < 10dB | 2.5dB |
| 3.0dB ≤ PC3 MSD < 5.0dB | 2.0dB |
| 1.8dB ≤ PC3 MSD < 3.0dB | 1.5dB |
| 1.0dB ≤ PC3 MSD < 1.8dB | 1.0dB |
| PC3 MSD < 1.0dB or no PC3 MSD | Analysis case by case |
| NOTE 1: This set of PC2 single-Tx MSD class assumes an equal level of interference between the primary antenna and the diversity antenna. |

**For non-existent PC3 MSD, or PC3 MSD less than 0.5dB, the case-by-case analysis may follow the guidelines [5].**

**Proposal 2: For PC1.5 consider adopting the MSD simplification of Table 2.**

**Table 2:** Example of PC1.5 (dual TX) simplified MSD based on five MSD classes.

|  |  |
| --- | --- |
| **Agreed PC3 MSD** | **PC1.5 MSD****simplification1** |
| PC3 MSD ≥ 10dB | [6.0]dB |
| 4.5dB ≤ PC3 MSD < 10dB | [5.0]dB |
| 2.5dB ≤ PC3 MSD < 4.5dB | [4.0]dB |
| 1.5dB ≤ PC3 MSD < 2.5dB | [3.0]dB |
| 0.8dB ≤ PC3 MSD < 1.5dB | [2.0]dB |
| PC3 MSD < 0.8dB or no PC3 MSD | Analysis case by case |
| NOTE 1: This set of PC1.5 MSD assumes an equal level of interference between the primary antenna and the diversity antenna and no reverse IMD. |

**Proposal 3: For PC2 dual-Tx, consider adopting the MSD simplification of Table 6. For cases of non-existent PC3 MSD, or PC3 MSD less than 1dB, the case-by-case analysis may follow the guidelines proposed in [5].**

**Table 6:** MSD class-sets for simplified PC2 dual-TX MSD.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Agreed PC3 MSD** | **PC2 2Tx****MSD1** | **Agreed PC3 MSD** | **PC2 2Tx****MSD2** | **Agreed PC3 MSD** | **PC2 2Tx****MSD3** |
| **[dB]** | **[dB]** | **[dB]** | **[dB]** | **[dB]** |  |
| PC3 MSD ≥ 10dB | [3.0] | PC3 MSD ≥ 13dB | [5.5] | PC3 MSD ≥ 15dB | [8.0] |
| 5.0dB ≤ PC3 MSD < 10dB | [2.5] | 7dB ≤ PC3 MSD < 13dB | [4.5] | 8.5dB ≤ PC3 MSD < 15dB | [7.0] |
| 3.0dB ≤ PC3 MSD < 5.0dB | [2.0] | 4.5dB ≤ PC3 MSD < 7dB | [3.5] | 6.5dB ≤ PC3 MSD < 8.5dB | [6.0] |
| 1.8dB ≤ PC3 MSD < 3.0dB | [1.5] | 2.5dB ≤ PC3 MSD < 4.5dB | [2.5] | 4.5dB ≤ PC3 MSD < 6.5dB | [5.0] |
| 1.0dB ≤ PC3 MSD < 1.8dB | [1.0] | 1.0dB ≤ PC3 MSD < 2.5dB | [1.5] | 3.5dB ≤ PC3 MSD < 4.5dB | [4.0] |
| PC3 MSD < 1.0dB or no PC3 MSD | [FFS] | PC3 MSD < 1.0dB or no PC3 MSD | [FFS] | 2.5dB ≤ PC3 MSD < 3.5dB | [3.0] |
|  | 1.0dB ≤ PC3 MSD < 3.5dB | [2.0] |
| PC3 MSD < 1.0dB or no PC3 MSD | [FFS] |
| NOTE 1: This set of PC2 dual-Tx MSD assumes an equal level of interference between the primary antenna and the diversity antenna.NOTE 2: This set of PC2 dual-Tx MSD assumes an 6dB lower interference on diversity than on primary antenna port. NOTE 3: This set of PC2 dual-Tx MSD assumes an 9dB lower interference on diversity than on primary antenna port.  |

* + Option 3: (R4-2408844, Qualcomm)

**Proposal 1:** RAN4 to consider pro’s and con’s on not specifying MSD test points for any band combination types (not limited to FDD PC2 Single UL band combinations) for higher power classes than PC3. Based on the RAN4 assessment, make formal agreement during Rel-19 on the working procedure with MSD test points for UE power classes beyond PC3

**Proposal 2**: Until Proposal 1 is agreed, continue specifying Single UL band FDD PC2 MSD test points and verify FDD PC2 accordingly. In parallel to considerations in Proposal 1, continue preparing solutions how to handle MSD’s for UE power classes higher than PC3 in efficient manner

**Observation 1**: For instance, the following Single UL band FDD PC2 MSD specification simplification could be considered, if RAN4 agrees to continue specifying PC2 MSD after considerations in Proposal 1

* For cases where at least one of the PC3 MSD test points is 5.0dB or more, consider the following rules:
	+ PC2 1TX MSD = PC3 MSD+3dB
	+ PC2 2TX MSD = PC3 MSD+6dB
* For cases where PC3 MSD not specified or is below 5.0dB for all MSD test points, do case by case evaluation:
	+ Interested companies provide their analysis and MSD if any is conclude based on the input
	+ It is not meaningful to agree any rigorous MSD calculation methods in 3GPP
* If more than one MSD test points is specified for PC2, use the same interferer level to calculate the MSD for the wider victim DL BW
* Recommended WF: To assign a WF on PC2 FDD MSD Guidelines to record the agreements made in this meeting.

### Sub-topic 1-3 TPs/Draft CRs

*Open issues and candidate options before meeting:*

**Issue 1-4: TPs/Draft CRs**

* Proposals

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407215 | AT&T | TP for TR 38.850 Addition of Single UL PC2 FDD for CA\_n2-n66 |
| R4-2407706 | T-Mobile USA | Draft CR for 38.101-1 CA\_n66(2A) with PC2 n66A |
| R4-2407708 | T-Mobile USA | TP for TR 38.850 DL CA\_n71(2A) UL PC2 n71A |
| R4-2407709 | T-Mobile USA | TP for TR 38.850 Replacing TBD MSD for TxD |
| R4-2407710 | T-Mobile USA | TP for TR 38.850 DL CA\_n25A-n41A UL n25A PC2 |
| R4-2407711 | T-Mobile USA | TP for TR 38.850 DL CA\_n25A-n66A UL n25A PC2 n66A PC2 |
| R4-2407712 | T-Mobile USA | TP for TR 38.850 DL CA\_n71B UL PC2 n71A |
| R4-2407946 | CMCC, Huawei, HiSilicon, Murata | (HPUE\_FR1\_FDD\_NR\_CADC\_R18) TP for TR 38.850 to introduce PC2 CA\_n8A-n41A on n8 with TxD |
| R4-2407947 | CMCC, Huawei, HiSilicon, Murata | (HPUE\_FR1\_FDD\_NR\_CADC\_R18)TP for TR 38.850 to introduce PC2 CA\_n8A-n79A on UL n8 with TxD |
| R4-2409196 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n1-n3 |
| R4-2409197 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n1-n3-n7 |
| R4-2409198 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n1-n3-n28 |
| R4-2409199 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n1-n3-n78 |
| R4-2409200 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n1-n7 |
| R4-2409201 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n3-n7 |
| R4-2409202 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n3-n7-n28 |
| R4-2409203 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n3-n7-n78 |
| R4-2409204 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n3-n28 |
| R4-2409205 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n3-n28-n78 |
| R4-2409206 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n3-n78 |
| R4-2409207 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n7-n28 |
| R4-2409208 | Nokia, BT | TP to TR 38.850 to add HP-NRCA n7-n78 |

* Recommended WF
	+ TBA

# Topic #2: HPUE for FDD single band

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407671 | China Unicom | *Revised WID Reserved for post-meeting approval* |
| R4-2407672 | China Unicom | *BigCR Reserved for post-meeting approval* |
| R4-2407673 | China Unicom | *TR Reserved for post-meeting approval* |
| R4-2407624 | Samsung, KDDI | **Observation 1:** From real UE implementation perspective, Samsung UEs(From Galaxy S22) already implemented full-band b/n28 duplex in Japan around three years ago, so far no issue identified in the field nor in the conformance test assuming existing PC3 regulatory requirements (i.e. A-MPR=0) for DTV protection, and the margin is quite enough particularly for LTE.**Observation 2:** From NW implementation perspective, introducing a new set of PC3 A-MPR requirements (i.e., A-MPR≠0) for b/n28 full-band duplex bring NBC issue to legacy NW.**Observation 3:** It has adverse impact to popularize full-band b/n28 duplex if A-MPR relaxation (i.e., A-MPR≠0) is introduced for PC3 for full-band b/n28 duplex.**Proposal 1:** Exiting PC3 A-MPR requirements (i.e., A-MPR=0) should be applicable for the UE with b/n28 full-band duplex implementation as well, for DTV protection in Japan.  |
| R4-2407395 | KDDI, Samsung | **Observation 1:** The WF R4-2406708 proposes a new Rel-19 spectrum WI to enable the B28 and n28 full-band duplexer architecture in NR PC3 and LTE PC3 requirements.**Observation 2:** Existing Japanese operators has already deployed their B28/n28 network based on UL link-budget with A-MPR=0 for PC3.**Proposal 1:** Avoid causing UE’s performance/coverage degradation due to adding a new PC3 A-MPR>0 for NS\_17 from an aspect of MNO operating PC3 B28/n28 with A-MPR=0.**Proposal 2:** Separate PC2 and PC3 A-MPR for NS\_17 on full band duplexer discussions.**Proposal 3:** RAN4 doesn’t technically need any WF/recommendation/conclusions on this topic.**Proposal 4:** New Rel-19 WI(s) should be discussed and concluded in only RAN Plenary. |
| R4-2407067 | Apple | **Proposal 1:** Consider Table 1 and Table 2 when specifying PC2 A-MPR for NS\_15**Observation:** The legacy assumption for band 28 is that a UE deploys dual-duplexer and can be emission compliant with respect to the in-band emission requirements with A-MPR of 0dB. The compliance is achieved through the in-band filter support of the dual-duplexer. In contrast, a full-band duplexer does not feature any in-band filter support and therefore requires the assumption of an advance transmitter. Since RAN4 specifies minimum requirements based on certain RF architecture assumptions any variation needs to be carefully contemplated.**Proposal 2:** Since there is a strong demand from industry to specify full band duplexer requirements for n28 it is proposed to not specify PC2 in Rel-18 but to to create a full-band duplexer work item for Rel-19. The HPUE discussion on n28 should be removed from Rel-18 WID. The new Rel-19 work item could be discussed in the next RAN Plenary meeting. Focus should be laid on minimizing the impact to legacy networks. |
| R4-2407163 | Skyworks | **Observation:** Measurements indicate the following PA back-off to meet the NS\_17 emission requirements:* For PC3: 3.5dB;
* For PC2 single Tx: 2.5dB;
* For PC2 dual-tx: 4.5dB.

**Proposal:** Complete the Band 28/n28 PC2 studies in Release 19 as part a new work item to enable the support for full-band duplexer architectures. |
| R4-2408135 | vivo | **Proposal 1**: To check whether 45MHz UE channel bandwidth is needed by the operator.**Proposal 2**: To keep dual duplexer assumption for NS\_17 in Rel18. The full band duplexer is further discussed in Rel19. |
| R4- 2409637 | Huawei, HiSilicon | **Proposal 1-1:** Define 1Tx PC2 A-MPR for NS\_07 as proposed in option 1 [1],**Proposal 1-2:** For 2Tx PC2 A-MPR for NS\_07, no extra relaxation is allowed for A1.**Observation 2-1:** Based on our evaluation, no A-MPR is needed for BW=10MHz for NS\_46.**Proposal 2-1:** If A-MPR is to be defined for BW=10MHz for NS\_46, propose to revise the carrier centre frequency range as 2563 ≤ FC ≤ 2565.**Proposal 2-2:** In order to avoid misunderstanding, compare and check thoroughly the candidate PC2 A-MPR requirements for NS\_46 in the previous two WFs before finalising the requirements in the spec.**Proposal 3-1:** PC2 A-MPR should cover BW=3MHz for NS\_12, NS\_13 and NS\_15.**Proposal 3-2:** The PC2 A-MPR value A1 for NS\_15 is increased by [3] dB relative to that for PC3. |
| R4- 2409638 | Huawei, HiSilicon | **Observation 1:** The evaluation on PC2 for band n28 under dual-duplexer assumption has been completed for the Rel-18 WI.**Observation 2:** For NS\_18, the same A-MPR requirements are applicable for both duplexer implementations. For NS\_17, A-MPR is needed for PC2, FFS PC3 for full-band duplexers.**Observation 3:** Further study is needed to confirm whether a new NS and corresponding A-MPR are needed for full-duplexer implementation to meet the requirements for spurious emissions for UE co-existence.**Proposal 1:** Clarify the implication of NOTE 34 for band n28 in the requirements for spurious emissions for UE co-existence, and check whether operator’s network follows the requirement in NOTE 34.**Proposal 2:** RAN4 to study and specify requirements for new channel bandwidths and PC2 for band n28 in Rel-19 by considering at least the following aspects:* PC3 REFSENS for new channel bandwidths
* PC3 A-MPR for NS\_17 and NS\_18 using full-band duplexers
* PC2 RSD and PC2 A-MPR for both 1Tx and 2Tx
* Spurious emissions for UE co-existence
 |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1 Issues for n28 PC2

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue 2-1-1: n28 PC3 A-MPR**

* Proposals
	+ Proposal 1: Existing PC3 A-MPR requirements (i.e., A-MPR=0) should be applicable for the UE with b/n28 full-band duplex implementation as well, for DTV protection in Japan. (R4-2407624, Samsung, KDDI, Qualcomm)
	+ Proposal 2: Separate PC2 and PC3 A-MPR for NS\_17 on full band duplexer discussions. (R4-2407395, KDDI, Samsung)
* Recommended WF
	+ PC3 A-MPR=0 for NS\_17
	+ Separate PC2 and PC3 A-MPR for NS\_17 on full band duplexer discussions.

**Issue 2-1-2: RF issues other than A-MPR**

* Proposals
	+ Proposal 1: Clarify the implication of NOTE 34 for band n28 in the requirements for spurious emissions for UE co-existence, and check whether operator’s network follows the requirement in NOTE 34. (TS38.101-1 Table 6.5.3.2-1 NOTE34: This requirement is applicable for 5 and 10 MHz NR channel bandwidth allocated within 718-728 MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and RBstart < 48.) (R4- 2409638, Huawei, HiSilicon)
	+ Proposal 2: To check whether 45MHz UE channel bandwidth is needed by the operator. (R4-2408135, vivo)
* Recommended WF
	+ TBA

**Issue 2-1-3: Rel-18/Rel-19 Timeline**

* Proposals
	+ Proposal 1: Handling of NS\_17
		- * Proposal 1-1: To keep dual duplexer assumption for NS\_17 in Rel18. (R4-2408135, vivo)
			* Proposal 1-2: n28 PC2 is not specified and should be removed from Rel-18 WID. (R4-2407067, Apple)
	+ Proposal 2: A new Rel-19 WI is needed to work on n28 with full-band duplexer, FFS detailed objective (e.g. new channel bandwidth, REFSENS, RSD, A-MPR, co-existence, etc.) . (Apple, Skyworks, vivo, Huawei)
		- * Proposal 2-1: Details of objectives to be discussed in RAN Plenary. (Apple)
	+ Proposal 3: RAN4 doesn’t technically need any WF/recommendation/conclusions on this topic. New Rel-19 WI(s) should be discussed and concluded in only RAN Plenary. (KDDI, Samsung)
	+ Proposal 4: Agree CR R4-2408804 in rel-18. (co-signed by Qualcomm, Samsung, KDDI, Rakuten)
* Recommended WF
	+ On Proposal 1, moderator’s understanding is that n28 PC2 requirements with dual duplexer is already concluded, and shall be kept in Rel-18..

### Sub-topic 2-2 A-MPR

*Sub-topic description: Three issues are covered under this sub-topic:*

**Issue 2-2-1: PC2 A-MPR for n13 NS\_07**

**Issue 2-2-2: PC2 A-MPR for n7 NS\_46**

**Issue 2-2-3: PC2 A-MPR for n26 NS\_12/13/14/15**

*Open issues and candidate options before meeting:*

**Issue 2-2-1: PC2 A-MPR for n13 NS\_07**

* Proposal: (R4- 2409637, Huawei, HiSilicon)
	+ Proposal 1: **Define 1Tx PC2 A-MPR for NS\_07 as proposed in option 1 [**R4-2406573 WF on A-MPR for FDD PC2 HPUE, China Unicom, RAN4#110bis**], i.e.,**

Table 2.1-1: A-MPR for NS\_07 (PC2 1Tx)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 | A5 |
|  | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | 12 + 3 | 9 + 2.5 | 6 + 2.5 | 3 + 2.5 | 3 |
| DFT-s-OFDM QPSK | 12 + 3 | 9 + 2.5 | 6 + 2.5 | 3 + 2.5 | 3 |
| DFT-s-OFDM 16 QAM | 12 + 3 | 9 + 2.5 | 6 + 2.5 | 3 + 2.5 | 3 |
| DFT-s-OFDM 64 QAM | 12 + 3 | 9 + 2.5 | 6 + 2.5 | 3 + 2.5 | 3 |
| DFT-s-OFDM 256 QAM | 12 + 3 | 9 + 2.5 | 6 + 2.5 | 3 + 2.5 | 3 |
| CP-OFDM QPSK | 14 + 3 | 10 + 2.5 | 7 + 2.5 | 3 + 2.5 | 3 |
| CP-OFDM 16 QAM | 14 + 3 | 10 + 2.5 | 7 + 2.5 | 3 + 2.5 | 3 |
| CP-OFDM 64 QAM | 14 + 3 | 10 + 2.5 | 7 + 2.5 | 3 + 2.5 | 3 |
| CP-OFDM 256 QAM | 14 + 3 | 10 + 2.5 | 7 + 2.5 | 3 + 2.5 | 3 |

* + Proposal 2: **For 2Tx PC2 A-MPR for NS\_07, no extra relaxation is allowed for A1.**
* Recommended WF
	+ TBA

**Issue 2-2-2: PC2 A-MPR for n7 NS\_46**

* Proposal: (R4- 2409637, Huawei, HiSilicon)
	+ Proposal 1: **If A-MPR is to be defined for BW=10MHz, propose to revise the carrier centre frequency range as 2563 ≤ FC ≤ 2565.**
	+ Proposal 2: **In order to avoid misunderstanding, compare and check thoroughly the candidate A-MPR requirements in the previous two WFs (**R4-2403629 WF on HPUE for FDD bands, China Unicom, RAN4#110; R4-2321715 WF on HPUE for FDD bands, China Unicom, RAN4#109**) before finalising the requirements in the spec.**
* Recommended WF
	+ TBA

**Issue 2-2-3: PC2 A-MPR for n26 NS\_12/13/14/15**

* Proposals on NS\_15
	+ Option 1: (R4- 2409637, Huawei, HiSilicon) **The PC2 A-MPR value A1 for NS\_15 is increased by [3] dB relative to that for PC3.**

Table 1: PC2 A-MPR for NS\_15 (proposal for A1)

|  |  |
| --- | --- |
| Modulation/Waveform | A1 |
|  | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 9 +3 |
| DFT-s-OFDM QPSK | ≤ 9 +3 |
| DFT-s-OFDM 16 QAM | ≤ 9 +3 |
| DFT-s-OFDM 64 QAM | ≤ 9 +3 |
| DFT-s-OFDM 256 QAM | ≤ 9 +3 |
| CP-OFDM QPSK | ≤ 10.5 +3 |
| CP-OFDM 16 QAM | ≤ 10.5 +3 |
| CP-OFDM 64 QAM | ≤ 10.5 +3 |
| CP-OFDM 256 QAM | ≤ 10.5 +3 |

* + Option 2: (R4-2407067, Apple)

Table 1: A-MPR for NS\_15 (PC2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 | A5 |
|  | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM QPSK | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM 16 QAM | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM 64 QAM | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM 256 QAM | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 9 | ≤ 13.5 | ≤ 4.5 |
| CP-OFDM QPSK | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 4 +3 | ≤ 10.5 +1.5 | ≤ 4.5 |
| CP-OFDM 16 QAM | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 4 +3 | ≤ 10.5 +1.5 | ≤ 4.5 |
| CP-OFDM 64 QAM | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 4 +3 | ≤ 10.5 +1.5 | ≤ 4.5 |
| CP-OFDM 256 QAM | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 9 | ≤ 13.5 | ≤ 6.5 |

Table 2: A-MPR regions for NS\_15 (PC2)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW | Carrier Frequency, Fc, MHz | RBend\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | 840.5 < Fc ≤ 846.5 | ≥3.24 | >0 | A1 |
|  |  | <3.24, ≥2.52 | ≥1.44 | A2 |
|  |  | <0.9 | ≤0.36 | A3 |
|  |  | <2.53, ≥1.8 | ≥1.44 | A5 |
|  |  | <1.08 | >0.36, ≤0.72 | A5 |
| 10MHz | 840 < Fc ≤ 844 | ≥5.76 | >1.08 | A1 |
|  |  | ≥5.76 | ≤1.08 | A4 |
|  |  | <5.76, ≥4.14 | ≥2.7 | A2 |
|  |  | <2.52 | ≤0.36 | A3 |
|  |  | <4.14, ≥1.8 | ≥2.52 | A5 |
|  |  | <2.52 | >0.36, ≤0.72 | A5 |
|  | 835 < Fc ≤ 840 | ≥7.2 | >0 | A1 |
|  |  | <7.2, ≥5.22 | ≥4.32 | A2 |
|  |  | <1.08 | ≤0.36 | A3 |
|  |  | <7.2, ≥5.22 | <4.32, ≥3.24 | A5 |
|  |  | <1.44 | >0.36, ≤0.72 | A5 |
| 15MHz | 837.5 < Fc ≤ 841.5 | ≥9.36 | >1.08 | A1 |
|  |  | ≥9.36 | ≤1.08 | A4 |
|  |  | <9.36, ≥4.68 | ≥3.6 | A2 |
|  |  | <3.96 | ≤0.36 | A3 |
|  |  | <4.68, ≥1.8 | ≥2.52 | A5 |
|  |  | <3.96 | >0.36, ≤1.08 | A5 |
|  | 831.5 < Fc ≤ 837.5 | ≥10.8 | >1.08 | A1 |
|  |  | ≥10.8 | ≤1.08 | A4 |
|  |  | <10.8, ≥6.48 | ≥3.6 | A2 |
|  |  | <2.7 | ≤0.36 | A3 |
|  |  | <2.7 | >0.36, ≤0.72 | A5 |
|  | Fc ≤ 831.5 | ≥13.14 | >0 | A1 |
|  |  | <13.14, ≥7.92 | ≥3.6 | A2 |
|  |  | <0.72 | ≤0.36 | A3 |
|  |  | <1.08 | >0.36, ≤0.72 | A5 |
| 20MHz | 835 < Fc ≤ 839 | ≥12.24 | >1.08 | A1 |
|  |  | ≥12.24 | ≤1.08 | A4 |
|  |  | <12.24, ≥8.46 | ≥5.4 | A2 |
|  |  | <5.58 | ≤0.36 | A3 |
|  |  | < 8.46, ≥1.8 | ≥3.6 | A5 |
|  |  | <6.12 | >0.36, ≤1.08 | A5 |
|  |  | <12.24, ≥8.46 | < 5.4, ≥3.6 | A5 |
|  | Fc ≤ 835 | ≥13.68 | >1.08 | A1 |
|  |  | ≥13.68 | ≤1.08 | A4 |
|  |  | <13.68, ≥8.46 | ≥5.4 | A2 |
|  |  | <4.32 | ≤0.36 | A3 |
|  |  | <4.68 | >0.36, ≤1.08 | A5 |

* Proposal for NS\_12, NS\_13 and NS\_15:

Proposal 1: (R4- 2409637, Huawei, HiSilicon) **PC2 A-MPR should cover BW=3MHz for NS\_12, NS\_13 and NS\_15.**

* Recommended WF
	+ For NS\_12/13/14/15 values and regions, consider merging the proposals from this meeting and past meetings (e.g. results recorded in WFs: R4-2406573 WF on A-MPR for FDD PC2 HPUE, China Unicom, RAN4#110bis; R4-2403629 WF on HPUE for FDD bands, China Unicom, RAN4#110; R4-2321715 WF on HPUE for FDD bands, China Unicom, RAN4#109) from different companies.

### Sub-topic 2-3 TPs/Draft CRs

*Open issues and candidate options before meeting:*

**Issue 2-3: TPs/Draft CRs**

* Proposals

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407911 | China Unicom | TP for TR 38.896 to add PC2 for n26 |
| R4-2407913 | China Unicom | TP for TR 38.896 to add PC2 NS\_17 for n28 |
| R4-2407914 | China Unicom, TELUS | TP for TR 38.896 to add PC2 for n7 |
| R4-2407915 | China Unicom | TP for TR 38.896 to add PC2 for n5 |
| R4-2408804 | Qualcomm Inc., Samsung, KDDI Corporation, Rakuten Mobile | CR to TS 38.101-1 Addition of PC2 for n28 and n83Moderator: TDoc type is CR or draft CR? |
| R4-2408805 | Qualcomm | CR to TS 38.101-1 Addition of PC2 for n7Moderator: TDoc type is CR or draft CR? |

* Recommended WF
	+ TBA

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