**3GPP T****SG-RAN WG4 Meeting#111**

**Fukuoka, Japan, 20 – 24 May 2024**

**Agenda item:** 6.1

**Source:** Moderator (Skyworks Solution Inc.)

**Title:** OfflineCommentTopic1-4 MSD test points and values [110][105] NR\_Baskets\_Part\_1

**Document for:** Offline comment

# Introduction

AI 6.1 Issues arising from basket WIs but not subject to block approval

* AI 6.1 Topic 1: MSD proposal for band combination with intra-band ULCA
* AI 6.1 Topic 2: Discussion on MSD test point for band combination with intra-band ULCA
* AI 6.1 Topic 3: Band combination with close proximity issues
* AI 6.1 Topic 4: Harmonic mixing

# AI 6.1 Topic #1: Band combination with intra-band ULCA

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2407072**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407072.zip) | MSD Analysis for CA\_n40A-n41C | Apple | **Proposal:** Adopt CA\_n25A-n77A MSD Levels proposed in Table 3-1 shown below.

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| --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | **Source of IMD** |
| NR CA band combination | NR band | UL Fc (MHz) | UL/DL BW (MHz) | UL LCRB | DL Fc (MHz) | MSD (dB) | Duplex mode |  |
| CA\_n40-n41 | n40 | N/A | 5 | N/A | 2358.5 | **55** | TDD | IMD3 |
|  | n41 | 2545 | 60 | 1 (RBSTART= 0) | 2545 | N/A | TDD | N/A |
|  |  | 2625 | 100 | 1 (RBSTART= 272) | 2625 |  |  |  |

**Table 3.1**: IMD3 MSD proposal for CA\_n40A\_41C |
| [**R4-2407073**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407073.zip) | MSD Analysis for CA\_n41C-n79A | Apple | **Proposal:** Adopt CA\_n25A-n77A MSD Levels proposed in Table 3-1 shown below.

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| --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | **Source of IMD** |
| NR CA band combination | NR band | UL Fc (MHz) | UL/DL BW (MHz) | UL LCRB | DL Fc (MHz) | MSD (dB) | Duplex mode |  |
| CA\_n41-n79 | n41 | 2545 | 60 | 1 (RBSTART= 0) | 2545 | N/A | TDD | N/A |
|  |  | 2625 | 100 | 1 (RBSTART= 272) | 2625 |  |  |  |
|  | n79 | N/A | 40 | N/A | 4872.5 | **8.415** | TDD | IMD4 |
| NOTE 15: This band is subject to IMD6 also which MSD is not specified |

**Table 3.1**: IIMD4 MSD proposal for CA\_n41C\_n79A |
| [**R4-2407154**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407154.zip) | CA\_n41C-n79 MSD | Skyworks Solutions Inc. | **Proposal:** Consider adopting the PC3 CA\_n41C-n79A MSD/REFSENS test point captured in the table below.

|  |
| --- |
| **Band / Channel Bandwidth / NRB / Duplex mode** |
| **NR CA Band combination** | **NR Band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** | **Source of IMD** |
| CA\_n41-n79 | n41 | 2545 | 60 | 1 (RBSTART= 0) | 2545 | N/A | TDD | N/A |
|  |  | 2625 | 100 | 1 (RBSTART= 272) | 2625 |  |  |  |
|  | n79 | N/A | 40 | N/A | 4872.5 | 4.215 | TDD | IMD4 |
| NOTE 15: This band is subject to IMD6 also which MSD is not specified. |

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| [**R4-2407155**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407155.zip) | CA\_n40A-n41C MSD | Skyworks Solutions Inc., ZTE Corporation | **Proposal:** Consider adopting the power class 3 CA\_n40A-n41C MSD/REFSENS test point captured in Table 3.**Table 3:** PC3 Band n40 MSD/REFSENS for CA\_n40A-n41C.

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| --- |
| **Band / Channel Bandwidth / NRB / Duplex mode** |
| **NR CA Band combination** | **NR Band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** | **Source of IMD** |
| CA\_n40-n41 | n40 | N/A | 5 | N/A | **2358.5** | **42.5** | TDD | IMD3 |
|  | n41 | 2545 | 60 | 1 (RBSTART= 0) | 2545 | N/A | TDD | N/A |
|  |  | 2625 | 100 | 1 (RBSTART= 272) | 2625 |  |  |  |

 |
| [**R4-2407172**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407172.zip) | Discussion on IMD4 MSD for CA\_n41A-n79C and CA\_n41C-n79A | MediaTek Inc. | **Proposal 1: IMD4 MSD due to UL\_CA\_n41C in n79 DL as the value below,**

|  |  |
| --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | **Source of IMD** |
| NR CA band combination | NR band | UL Fc (MHz) | UL/DL BW (MHz) | UL LCRB | DL Fc (MHz) | MSD (dB) | Duplex mode |  |
| **CA\_n41-n79** | **n41** | **2545** | **60** | **1 (RBSTART= 0)** | **2545** | **N/A** | **TDD** | **N/A** |
|  |  | **2625** | **100** | **1 (RBSTART= 272)** | **2625** |  |  |  |
|  | **n79** | **N/A** | **40** | **N/A** | **4872.5** | **12.615** | **TDD** | **IMD4** |
| **NOTE 15: This band is subject to IMD6 also which MSD is not specified** |

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| [**R4-2407578**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407578.zip) | CA\_n71B BCS4/5 PC3, PC2 1TX, PC2 2TX | Murata Manufacturing Co Ltd. | **Proposal 1**: Use PC3, 1TX PC2, and 2TX PC2 REFSENS relaxation values as shown in Table 2-3 and 2-4.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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) | [4.9] | FDD |

**Tabe 2-3:** **ΔRIBC** for PC3

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **Aggregated channel bandwidth (PCC+SCC)** | **UL PCC allocation** | **ΔRIBNCX (dB)** | **ΔRIBNCY (dB)** | **Duplex mode** |
| CA\_n71B**Z** | 15/15 | 30 MHz + 5 MHz | 20 (RBstart = 0) | [7.0] | [8.4] | FDD |
| NOTE X: Applicable to UE supporting PC2 with single Tx. NOTE Y: Applicable to UE supporting PC2 with dual Tx.NOTE Z: Applicable only to BCS 4 and 5 and UEs supporting the optional symmetrical UL/DL bandwidths. |

**Tabe 2-4:** **ΔRIBC** for PC2 |
| **[R4-2408380](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408380.zip)** | TP for TR38.718-02-01\_CA\_n40A-n41C | ZTE Corporation, Skyworks Solutions, Inc. | Moderator: TP according to MSD proposals in [**R4-2407155**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407155.zip) |
| **[R4-2408381](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408381.zip)** | TP for TR38.718-02-01\_CA\_n41A-n79C and CA\_n41C-n79A | ZTE Corporation, Mediatek,Sanechips | Moderator: TP according to MSD proposals in [**R4-2407172**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407172.zip) |
| [**R4-2408858**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408858.zip) | Missing MSD for PC3 CA\_n71B BCS4/5 | Qualcomm France | **Proposal 1**: Add the following MSD test point for PC3 n71B:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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)  | 4.5 | FDD |

**Proposal 2**: Add the following text into 7.3A.2.1:For specific uplink and downlink test points which are specified in Table 7.3A.2.X-Y and the reference sensitivity power level increased by ΔRIBC. 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. |
| [**R4-2409317**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409317.zip) | Discussion on MSD for CA\_n41C-n79A with intra-band UL CA\_n41C | Huawei, HiSilicon | Proposal 1: The REFSENS degradation will not be higher than 1dB for CA\_n41C-n79A with UL intra-band CA\_n41C for 1RB+1RB allocations.Proposal 2: There is no need to specify MSD with fully allocated maximum aggregated BW for CA\_n41C-n79A with UL intra-band CA\_n41C. |

## Open issues summary

### Sub-topic 1-1 CA\_n40-n41C

**Issue 1-1:**

* Proposals:
* Proposal: the following table summarizes the inputs from all companies proposing MSD

|  |  |
| --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** |  |
| NR CA band combination | NR band | UL Fc (MHz) | UL/DL BW (MHz) | UL LCRB | DL Fc (MHz) | MSD (dB) | Duplex mode | Source of IMD |
| CA\_n40-n41 | n40 | N/A | 5 | N/A | 2358.5 | **Apple: 55****Skyworks, ZTE: 42.5** | TDD | IMD3 |
|  | n41 | 2545 | 60 | 1 (RBSTART= 0) | 2545 | N/A | TDD | N/A |
|  |  | 2625 | 100 | 1 (RBSTART= 272) | 2625 |  |  |  |

* Note a different proposal in Topic 2 for allocation in : R4-2409316 Discussion on MSD for CA\_n40A-n41C with intra-band UL CA\_n41C Huawei, HiSilicon
	+ Proposal 1: As RAN4 has specified the MSD due to cross band isolation from ACLR2 for the fallback CA\_n40A-n41A, RAN4 can consider the similar method to specify the MSD due to cross band isolation from ACLR1 for CA\_n40A-n41C with UL intra-band CA\_n41C instead of 1RB+1RB allocations.
* Note that MSD differences vs Allocation is discussed in Topic 2 in Document: R4-2407372 On UL configuration for intra-band ULCA IMDs Skyworks Solutions Inc. and shows with measurements that once MPR is accounted for (which is the guideline) the MSDs are similar for different allocations and 1RB+1RB enables direct estimation of IMDs and ease the test point. Also 1RB+1RB conforms to current guidelines.
* Recommended WF
* Discuss if RB allocation should be revisited?
* MSD Values are discussed amongst experts.
* Agreements are captured in revision of with potential co-signees: TP for TR38.718-02-01\_CA\_n40A-n41C ZTE Corporation, Skyworks Solutions, Inc.
* If no agreement based on current guidelines, the band combination is postponed to R19.

Offline discussion comments

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| **Company/Delegate** | **Comment** |
| XXX/YYY |  |
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### Sub-topic 1-2 CA\_n41C-n79

**Issue 1-2:**

* Proposals:
* Proposal: the following table summarizes the inputs from all companies proposing MSD

|  |
| --- |
| **Band / Channel Bandwidth / NRB / Duplex mode** |
| **NR CA Band combination** | **NR Band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** | **Source of IMD** |
| CA\_n41-n79 | n41 | 2545 | 60 | 1 (RBSTART= 0) | 2545 | N/A | TDD | N/A |
|  |  | 2625 | 100 | 1 (RBSTART= 272) | 2625 |  |  |  |
|  | n79 | N/A | 40 | N/A | 4872.5 | **Apple: 8.415****MediaTek: 12.615****Skyworks: 4.215** | TDD | IMD4 |
| NOTE 15: This band is subject to IMD6 also which MSD is not specified. |

* Proposal from Huawei:
	+ Proposal 1: The REFSENS degradation will not be higher than 1dB for CA\_n41C-n79A with UL intra-band CA\_n41C for 1RB+1RB allocations.
	+ Proposal 2: There is no need to specify MSD with fully allocated maximum aggregated BW for CA\_n41C-n79A with UL intra-band CA\_n41C.
* Note that IMD4 measurements vs allocations are in Topic 2 in Document: R4-2407372 On UL configuration for intra-band ULCA IMDs Skyworks Solutions Inc. and shows with measurements that once IMD4 of any allocation are not negligible.
* Recommended WF:
* Discuss if RB allocation should be revisited?
* MSD Values are discussed amongst experts.
* Agreements are captured in revision of with potential co-signees: R4-2408381 TP for TR38.718-02-01\_CA\_n41A-n79C and CA\_n41C-n79A ZTE Corporation, Mediatek, Sanechips
* If no agreement based on current guidelines, the band combination is postponed to R19.

Offline discussion comments

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| **Company/Delegate** | **Comment** |
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### Sub-topic 1-3 CA\_n71B

**Issue 1-3:**

* Proposals: from Qualcomm on CA\_n71B
	+ Proposal 1: Add the following MSD test point for PC3 n71B:

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| --- | --- | --- | --- | --- | --- |
|  **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)  | 4.5 | FDD |

* + Proposal 2: Add the following text into 7.3A.2.1:

For specific uplink and downlink test points which are specified in Table 7.3A.2.X-Y and the reference sensitivity power level increased by ΔRIBC. 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.

* Recommended WF: Discuss proposals amongst experts. If agreeable see if this should be captured in a CR
* Moderator, Murata PC3 [R4-2407578](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407578.zip) input and Skyworks PC3 R4-2407157 input should also be accounted for
* PC3 n71(2A) inputs should also be collected (Skyworks R4-2407158, others?)

Offline discussion comments

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| --- | --- |
| **Company/Delegate** | **Comment** |
| Moderator | **PC3 inputs of other companies that are in different agendas should be considered. Maybe one of the companies can collect all inputs for the Ad hoc. In any case companies should let me know if there are other PC3 inputs on n71 intra-cases that should be discussed here** |
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# Topic #2: Discussion on MSD test point for band combination with intra-band ULCA

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| **[R4-2407082](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407082.zip)** | On MSD requirements with intra-band contiguous UL CA | Apple | **Proposal 1:** For NR FDD band intra-band contiguous UL CA, REFSENS requirement does not need to be specified.**Proposal 2:** Remove NR FDD band intra-band contiguous UL CA REFSENS requirements from the earliest release of the specifications (Rel-16).**Proposal 3:** There is no need to introduce cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW if the cross-band MSD requirement has been specified with single carrier UL aggressor at maximum channel BW.**Proposal 4:** Remove the MSD requirements for both inter-band CA/EN-DC with cross-band DL interference and triple-beat issue from the earliest release of specifications (Rel-17) to avoid the unnecessary RAN4 workload in future and reduce the already heavily loaded UE test burden. |
| [**R4-2407083**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407083.zip) | CR to 38.101-1 on removing MSD requirements with intra-band contiguous UL CA | Apple | Moderator: CR according to [**R4-2407082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407082.zip) |
| [**R4-2407084**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407084.zip) | CR to 38.101-1 on removing MSD requirements with intra-band contiguous UL CA | Apple | Moderator: CR according to [**R4-2407082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407082.zip) |
| [**R4-2407085**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407085.zip) | CR to 38.101-1 on removing MSD requirements with intra-band contiguous UL CA | Apple | Moderator: CR according to [**R4-2407082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407082.zip) |
| [**R4-2407086**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407086.zip) | CR to 38.101-3 on removing MSD requirements with intra-band contiguous UL CA in EN-DC | Apple | Moderator: CR according to [**R4-2407082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407082.zip) |
| [**R4-2407087**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407087.zip) | CR to 38.101-3 on removing MSD requirements with intra-band contiguous UL CA in EN-DC | Apple | Moderator: CR according to [**R4-2407082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407082.zip) |
| **[R4-2407372](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407372.zip)** | On UL configuration for intra-band ULCA IMDs | Skyworks Solutions Inc. | **Proposal 1:** If RB allocation (1RB+1RB) is re-considered for intra-band ULCA within an inter-band DL CA, it should be for intra-band TDD ULCA only.**Proposal for TDD:** MPR0 is not used for MSD evaluation of TDD intra-band contiguous and non-contiguous ULCA due to IMD or triple beat. IMD order with up to IMD7 is analyzed but IMD9 may require expert attention especially in the NS\_04 case.**Proposal for FDD:** According to current guidelines MPR0 is used for MSD evaluation of FDD intra-band ULCA due to IMD or triple beat. IMD order with up to IMD13 is analyzed, but IMD15/17 may require expert attention.**Proposal for band coexistence with intra-band ULCA:** MPR is allowed to meet general emission (SEM) and only IMD3 need evaluation whether -50dBm/MHz can be achieved. With this approach, band coexistence can be made independent of from the intra-band ULCA band and inter-band power class.**Proposal for TDD RB allocation for ULCA IMD MSD test point:** • The 1RB+1RB allocation is retained as per current guidelines and assuming MPR is applied, is consistent with the IMD orders that are requested for analysis.• This approach results in the MSD being independent from the TDD intra-band ULCA band and inter-band power class• This is valid for Release 18 and the start of Release 19. • If other approaches are to be evaluated for Release 19, this should be part of a specific WI as it will require extensive studies including measurements and simulations that is not compatible with block approval and will result in re-evaluating all currently specified intra-band ULCA related IMD and triple beat cases. |
| **[R4-2407622](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407622.zip)** | Discussion on the MSD requirements of intra-band contiguous UL CA with non-contiguous RB allocation | Huawei, HiSilicon | *Observation 1: In TS 38.101-1, the triple beat is specified with the UL configuration of only one RB in each of the intra-band carriers.**Observation 2: As network vendor, we don't see the scheduling strategy that leads to triple beat, is typical.****Proposal 1:*** ***F****urther justify the necessity of specifying triple beat is required based on the commercial value.* |
| [**R4-2408731**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408731.zip) | Discussion on MSD requirements with intra-band contiguous UL CA | CMCC | Observation 1: The test case that 1 RB is specified for each carrier of the intra-band CA will not appear in realistic network resource allocations, because one single carrier could achieve the throughput.Observation 2: The test case that 1 RB is specified for each carrier of the intra-band CA is an extreme scenario that doesn't occur in operators’ networks.**Proposal 1:** Do not consider only the MSD requirements resulting from intra-band contiguous UL CA configured with 1RB+1RB allocations, and cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW should be introduced.**Proposal 2:** Discuss the above test configuration first before the MSD value discussion. |
| [**R4-2409319**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409319.zip) | Discussion on MSD test point trade-off for intra-band UL CA | Huawei, HiSilicon | **Proposal 1:** from RF and scheduling perspective, it’s encouraged for RAN4 to further discuss how to specify MSD test configuration due to IMD from intra-band UL CA. **Proposal 2:** If RAN4 need to specify some requirements to guarantee the IIP2/ IIP3/ IIP4 of PA performance, maybe RAN4 can further discuss the other methodology instead of leveraging REFSENS degradation. |
| [R4-2408357](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408357.zip) | On MSD requirements with intra-band contiguous UL CA | ZTE Corporation, Sanechips | **Proposal 1:** No change from TR 38.862 guidelines unless there are updates for the existing guidelines in the WF. **Proposal 2:** MSD in the spec should be defined for practical scenarios, we slight prefer not to consider the MSD for intra-band contiguous UL CA configured with non-contiguous allocations.**Proposal 3:** Rel-19 seems to be more safe way to remove all the MSD for intra-band contiguous UL CA configured with non-contiguous allocations.**Proposal 4:** Technical speaking, there is a need to define the cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW.- Only to define new cross band isolation MSD for ACLR1/ACLR2 interference source- To reuse cross band isolation MSD of single carrier for >ACLR2 interference source |
| [**R4-2408853**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408853.zip) | MSD requirements with intra-band contiguous CA | Qualcomm France | Proposal 1: Keep current practices in MSD test points for Intra-band contiguous UL CAProposal 3: Option 2 (moderator: no need to introduce cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW) |
| **[R4-2409316](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409316.zip)** | Discussion on MSD for CA\_n40A-n41C with intra-band UL CA\_n41C | Huawei, HiSilicon | **Proposal 1:** As RAN4 has specified the MSD due to cross band isolation from ACLR2 for the fallback CA\_n40A-n41A, RAN4 can consider the similar method to specify the he MSD due to cross band isolation from ACLR1 for CA\_n40A-n41C with UL intra-band CA\_n41C instead of 1RB+1RB allocations. |

## Open issues summary

### Sub-topic 2-1 Need for specifying MSD for intra-band ULCA

**Issue 2-1:**

* Proposals: **Apple**:
	+ **Proposal 1:** For NR FDD band intra-band contiguous UL CA, REFSENS requirement does not need to be specified.
	+ **Proposal 2:** Remove NR FDD band intra-band contiguous UL CA REFSENS requirements from the earliest release of the specifications (Rel-16).
	+ Note from moderator: the related requirements have been discussed, and WF approved on how to specify these cases (RB allocation) in recent meetings. A few cases have already been specified.
* Recommended WF
* Discuss whether guidelines should be changed in R18
* Discuss proposal and depending on agreement, agree, revise, postpone, not pursue related part of the Apple CRs: R4-2407082, R4-2407083, R4-2407084, R4-2407085, R4-2407086, R4-2407087
	+ Check impact on on-going CRs, TPs
	+ If not agreeable the discussion may be continued in R19.

Offline discussion comments

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| --- | --- |
| **Company/Delegate** | **Comment** |
| SKyworks/Dominique | **As we show in our measurements in this meeting, Intra-band ULCA related IMDs are significant whatever the allocation chosen especially if MPR is not applied. Also the mechanism is different from 1CC UL MSD as in for intra-CA the MSD does not depend on the transceiver image and carrier leakage performance. So do not see what is wrong with what has been done for at least two releases and with contributions still in this meeting. We are open to remove any MSD due to intra-band UL CA (IMD and triple beat) in Release 19 but this should be given time to make clear that MSD will be there and worst than 1CC UL cases and instruct RAN5 properly that intra-band ULCA configuration should never be used for REFSENS measurements. Finally if we understand that removing the inter-band cases is probably fine, we do not think the FDD intra-band DL+UL CA should be discarded as the MSD issue can be so large that the usefulness of the combination is questionable. Finally, even if RAN$ decides that such MSDs should not be defined and tested, there are cases that will still be very bad if IMD3/5 range is involved. Also if removing this type of MSD is agreed does this mean they should be removed from all releases?** |
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### Sub-topic 2-2 Need for specifying MSD, applicable test points for inter-band BC with intra-band ULCA in one band.

**Issue 2-2:**

* Proposals 1: No need to specify MSD **Apple**:
	+ **Proposal 1:** There is no need to introduce cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW if the cross-band MSD requirement has been specified with single carrier UL aggressor at maximum channel BW.
	+ **Proposal 2:** Remove the MSD requirements for both inter-band CA/EN-DC with cross-band DL interference and triple-beat issue from the earliest release of specifications (Rel-17) to avoid the unnecessary RAN4 workload in future and reduce the already heavily loaded UE test burden.
* Proposals 2: Proposing fully allocated CCs **CMCC**
	+ **Proposal 1**: Do not consider only the MSD requirements resulting from intra-band contiguous UL CA configured with 1RB+1RB allocations, and cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW should be introduced.
	+ **Proposal 2**: Discuss the above test configuration first before the MSD value discussion.
* Proposals 3: Find ways to avoid REFSENS related requirement **Huawei**
	+ **Proposal 1:** from RF and scheduling perspective, it’s encouraged for RAN4 to further discuss how to specify MSD test configuration due to IMD from intra-band UL CA.
	+ **Proposal 2:** If RAN4 need to specify some requirements to guarantee the IIP2/ IIP3/ IIP4 of PA performance, maybe RAN4 can further discuss the other methodology instead of leveraging REFSENS degradation.
	+ **additional input on CA\_n40-n41C: Proposal 1:** As RAN4 has specified the MSD due to cross band isolation from ACLR2 for the fallback CA\_n40A-n41A, RAN4 can consider the similar method to specify the he MSD due to cross band isolation from ACLR1 for CA\_n40A-n41C with UL intra-band CA\_n41C instead of 1RB+1RB allocations.
* Proposals 4: NO change to TDD guidelines, Keep 1RB+1RB for case with TDD intra-band **Qualcomm, Skyworks. Skyworks:** additional input on FDD and others
	+ **QCOM Proposal 1:** Keep current practices in MSD test points for Intra-band contiguous UL CA
	+ **QCOM Proposal 3:** Option 2 (moderator: no need to introduce cross-band MSD requirementsresulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW)
	+ **SKW Proposal 1:** If RB allocation (1RB+1RB) is re-considered for intra-band ULCA within an inter-band DL CA, it should be for intra-band TDD ULCA only.
	+ **SKW Proposal for TDD:** MPR0 is not used for MSD evaluation of TDD intra-band contiguous and non-contiguous ULCA due to IMD or triple beat. IMD order with up to IMD7 is analyzed but IMD9 may require expert attention especially in the NS\_04 case.
	+ **SKW Proposal for FDD:** According to current guidelines MPR0 is used for MSD evaluation of FDD intra-band ULCA due to IMD or triple beat. IMD order with up to IMD13 is analyzed, but IMD15/17 may require expert attention.
	+ **SKW Proposal for band coexistence with intra-band ULCA:** MPR is allowed to meet general emission and only IMD3 need evaluation whether -50dBm/MHz can be achieved. With this approach, band coexistence can be made independent of from the intra-band ULCA band and inter-band power class.
	+ **SKW Proposal for TDD RB allocation for ULCA IMD MSD test point:**

• The 1RB+1RB allocation is retained as per current guidelines and assuming MPR is applied, is consistent with the IMD orders that are requested for analysis.

• This approach results in the MSD being independent from the TDD intra-band ULCA band and inter-band power class

• This is valid for Release 18 and the start of Release 19.

• If other approaches are to be evaluated for Release 19, this should be part of a specific WI as it will require extensive studies including measurements and simulations that is not compatible with block approval and will result in re-evaluating all currently specified intra-band ULCA related IMD and triple beat cases.

* Proposals 5: **ZTE** proposing no change to guidelines, looking for better scenario on allocation (fully allocated) for R19
	+ **Proposal 1:** No change from TR 38.862 guidelines unless there are updates for the existing guidelines in the WF.
	+ **Proposal 2:** MSD in the spec should be defined for practical scenarios, we slight prefer not to consider the MSD for intra-band contiguous UL CA configured with non-contiguous allocations.
	+ **Proposal 3:** Rel-19 seems to be more safe way to remove all the MSD for intra-band contiguous UL CA configured with non-contiguous allocations.
	+ **Proposal 4:** Technical speaking, there is a need to define the cross-band MSD requirements resulting from intra-band contiguous UL CA configured with fully allocated maximum aggregated BW.
		- - Only to define new cross band isolation MSD for ACLR1/ACLR2 interference source
		- - To reuse cross band isolation MSD of single carrier for >ACLR2 interference source
* Note from moderator: Beyond the TDD intra-band ULCA case which has agreed guidelines since R17 using 1RB+1RB with MPR, there is RAN4 agreement to use no MPR and total allocation = REFSENS UL config at same BW for FDD cases. Also agreed templates in R4#110b are based on these guidelines.
* Recommended WF
* Discuss whether guidelines should be changed in R18
* Discuss new proposals for allocations for MSD or no MSD at all and associated timeline: R18 or R19
	+ Depending on agreement, agree, revise, postpone, not pursue related part of the Apple CRs: R4-2407082, R4-2407083, R4-2407084, R4-2407085, R4-2407086, R4-2407087
	+ Check impact on on-going CRs, TPs and related MSDs proposed in Topic 1:
	+ If not agreement the discussion may be continued in R19.

Offline discussion comments

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| --- | --- |
| **Company/Delegate** | **Comment** |
| Skyworks/Dominique | **As discussed in the previous issue, we do not see the benefit of changing the allocation to be used at the end of R18. Also we have shown that full allcocation would result into more work needed to derive MSD without reducing the MSD especially if 0dB MPR is applied and REFSENS/MSD test are not to be representative of network “typical” allocation but rather designed to reveal issues related to the UE linearity and selectivity behavior. As such we are open to discuss what to do in R19, including not specifying these MSDs (we would prefer that than changing the current guidelines that have worked for us for at least two releases). Changing the allocations will not change MSD significantly but only make it more effort in simulation/measurements** |
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# AI 6.1 Topic 3: Band combination with close proximity issues

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2408849**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408849.zip) | Considerations on CA\_n3A-n39A | Qualcomm France | **Proposal 1**: Use the following analysis results as part of considering MSD for CA\_n3A-n39A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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)** |
| n3 | n39 | 1770 | 30 | 15 | 50 (RBstart=110) | 1877.5 | 5 | 2.7 | >ACLR2 |

**Proposal 2**: Assume Fdl\_low and Fdl\_high for UE supporting CA\_n3-n39 should be according to n3 Fdl\_low and n39 Fdl\_high |
| [**R4-2409311**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409311.zip) | Discussion and TP for TR 38.718-02-01 to introduce CA\_n3A-n39A | Huawei, HiSilicon | Thus, the following MSD test configuration can be considered.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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) |
| n3 | n39 | 1770 | 30 | 15 | 160 (RBstart=0) | 1882.5 | 5 | 1.5 dB | >ACLR2 |

 |

## Open issues summary

### Sub-topic 3-1 CA\_n3-n39 MSD

**Issue 3-1:**

* Proposals 1: **Qualcomm**
* Use the following analysis results as part of considering MSD for CA\_n3A-n39A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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)** |
| n3 | n39 | 1770 | 30 | 15 | 50 (RBstart=110) | 1877.5 | 5 | 2.7 | >ACLR2 |

* Assume Fdl\_low and Fdl\_high for UE supporting CA\_n3-n39 should be according to n3 Fdl\_low and n39 Fdl\_high
* Proposals 2: **Huawei**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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) |
| n3 | n39 | 1770 | 30 | 15 | 160 (RBstart=0) | 1882.5 | 5 | 1.5 dB | >ACLR2 |

* Recommended WF: Discuss test point
* Discuss UL configuration (Note from moderator, usually this is UL REFSENS configuration at test point CBW)
* Discuss MSD value based on aligned UL configuration
* Check id proposal 2 from Qualcomm should be added as a note
* I agreement need to ask for a CR as this is the last meeting for R18 band combination otherwise postpone to R19.

Offline discussion comments

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| --- | --- |
| **Company/Delegate** | **Comment** |
| XXX/YYY |  |
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### Sub-topic 3-2 three band cases depending on CA\_n3-n39 approval

The following 3band TPs are depending on agreement on CA\_n3-n39 and should be reviewed

|  |  |  |  |
| --- | --- | --- | --- |
| [**R4-2409312**](https://urldefense.com/v3/__https%3A/www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409312.zip__;!!MyQQGECaxY11k7S_!ZOqRL34GFPMG2ajbXt1SO8n1hXltpMGN-riBrg0KNzlGbWw6oEALNEJ4oLYF0Lje7twOZOdX5KrSvTKdspYLuE5fVnLwttVp$) | TP for TR 38.718-03-01 to introduce CA\_n3A-n8A-n39A | Huawei, HiSilicon | CA\_n3A-n39 not yet finalyzed. May be need to be moved to [105] to endorse if CA\_n3A-n39 can be finalyze |
| [**R4-2409313**](https://urldefense.com/v3/__https%3A/www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409313.zip__;!!MyQQGECaxY11k7S_!ZOqRL34GFPMG2ajbXt1SO8n1hXltpMGN-riBrg0KNzlGbWw6oEALNEJ4oLYF0Lje7twOZOdX5KrSvTKdspYLuE5fVi0hR3_3$) | TP for TR 38.718-03-01 to introduce CA\_n3A-n39A-n41A | Huawei, HiSilicon | CA\_n3A-n39 not yet finalyzed. Need to discuss how band n41 is multiplexed on top of n3-n39 May be need to be moved to [105] to endorse if CA\_n3A-n39 can be finalyze.  |
| [**R4-2409314**](https://urldefense.com/v3/__https%3A/www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409314.zip__;!!MyQQGECaxY11k7S_!ZOqRL34GFPMG2ajbXt1SO8n1hXltpMGN-riBrg0KNzlGbWw6oEALNEJ4oLYF0Lje7twOZOdX5KrSvTKdspYLuE5fVpU0v5Tq$) | TP for TR 38.718-03-01 to introduce CA\_n3A-n39A-n79A | Huawei, HiSilicon | CA\_n3A-n39 not yet finalyzed. May be need to be moved to [105] to endorse if CA\_n3A-n39 can be finalyze |

Recommended WF: Review TPs and comment in table below.

|  |  |
| --- | --- |
| **T-doc**  | **Company/Review comment** |
| [**R4-2409312**](https://urldefense.com/v3/__https%3A/www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409312.zip__;!!MyQQGECaxY11k7S_!ZOqRL34GFPMG2ajbXt1SO8n1hXltpMGN-riBrg0KNzlGbWw6oEALNEJ4oLYF0Lje7twOZOdX5KrSvTKdspYLuE5fVnLwttVp$)TP for TR 38.718-03-01 to introduce CA\_n3A-n8A-n39A | Company A |
|  |
|  |
| [**R4-2409313**](https://urldefense.com/v3/__https%3A/www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409313.zip__;!!MyQQGECaxY11k7S_!ZOqRL34GFPMG2ajbXt1SO8n1hXltpMGN-riBrg0KNzlGbWw6oEALNEJ4oLYF0Lje7twOZOdX5KrSvTKdspYLuE5fVi0hR3_3$)TP for TR 38.718-03-01 to introduce CA\_n3A-n39A-n41A | Company A |
|  |
|  |
| [**R4-2409314**](https://urldefense.com/v3/__https%3A/www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409314.zip__;!!MyQQGECaxY11k7S_!ZOqRL34GFPMG2ajbXt1SO8n1hXltpMGN-riBrg0KNzlGbWw6oEALNEJ4oLYF0Lje7twOZOdX5KrSvTKdspYLuE5fVpU0v5Tq$)TP for TR 38.718-03-01 to introduce CA\_n3A-n39A-n79A | Company A |
|  |
|  |

# AI 6.1 Topic 4: Harmonic mixing

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2407577**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407577.zip) | UL(n)/DL3 Harmonic Mixing Considerations | Murata Manufacturing Co Ltd. | **Observation 1**: Harmonic mixing MSD for higher orders > 5 should only be considered when there is sufficient margin to pass the OOB blocking exception level and as well as to pass the general spurious at the emission limit aggressor frequency.**Observation 2**: At least 55dB of RX selectivity is required to pass the OOB blocking exception level with sufficient margin.**Observation 3**:* CA\_n28-n40 UL1/DL3. The MSD is 37.8dB, but the RX selectivity is at least 10dB lower than other comparable low band combinations because the aggressor level is fixed at the fundamental TX power level. Increasing the RX selectivity brings the MSD value within the acceptable range of peers.
* CA\_n46-n48, CA\_n46-n77/n78 UL2/DL3. The MSD is ~22dB, but the RX selectivity is at a value with 0dB margin for OOB to pass the exception level AND there is also no margin to the spurious response limit.
* CA\_n39-n41 UL4/DL3. For the given 8.1dB MSD, the spurious emission is ~4dB below the limit which is unusual for UL4 (-19dBc harmonic level at the PA output). More spurious margin is available if less RX selectivity is assumed, but that would mean less margin to pass the OOB blocking exception level.

**Proposal 1:** Harmonic mixing MSD analysis for orders > 5 is justified if the victim band passes the minimum RX selectivity criteria and the general spurious emission limit for the UL harmonic aggressor is met with sufficient margin. |
| [**R4-2407579**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407579.zip) | CA\_n25-n41 UL n25 harmonic mixing PC3 and PC2 | Murata Manufacturing Co Ltd. | **Proposal 1:** Use CA\_n25-n41 harmonic mixing MSD for PC3, 1TX PC2, and 2TX PC2 as shown in Table 2-2, 2-3, and 2-4.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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) | 5 | [2.5] | NOTE 11 | UL4/DL3 |

**Table 2-2**: CA\_n25-n41 power class 3 UL4/DL3 Rx harmonic mixing test points

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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) | 5 | [3.7] | NOTE 11 | UL4/DL3 |

**Table 2-3**: CA\_n25-n41 1TX power class 2 UL4/DL3 Rx harmonic mixing test points

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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) | 5 | [5.3] | NOTE 11 | UL4/DL3 |

**Table 2-4**: CA\_n25-n41 2TX power class 2 UL4/DL3 Rx harmonic mixing test points |

## Open issues summary

### Sub-topic 4-1 Additional criteria for harmonic mixing

**Issue 4-1:**

* Proposals 1: Harmonic mixing MSD analysis for orders > 5 is justified if the victim band passes the minimum RX selectivity criteria and the general spurious emission limit for the UL harmonic aggressor is met with sufficient margin.
* Recommended WF: Experts discuss whether this proposal should be part of guidelines or note on the harmonic mixing template for orders >5 (Moderator: > 5 means DL+UL order >5)

### Sub-topic 4-2 CA\_n25-n41 UL n25 Harmonic mixing MSD for PC3 and PC2

**Issue 4-2a: PC3 MSD**

* Proposals 1:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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) | 5 | [2.5] | NOTE 11 | UL4/DL3 |

* Recommended WF: Experts discuss this MSD proposal together with previous inputs if any

**Issue 4-2b: PC2 1Tx MSD**

Moderator: this may have to be coordinated with thread [113]

* Proposals 1:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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) | 5 | [3.7] | NOTE 11 | UL4/DL3 |

* Recommended WF: Experts discuss this MSD proposal together with previous inputs if any

**Issue 4-2c: PC2 2Tx MSD**

Moderator: this may have to be coordinated with thread [113]

* Proposals 1:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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) | 5 | [5.3] | NOTE 11 | UL4/DL3 |

* Recommended WF: Experts discuss this MSD proposal together with previous inputs if any

Offline discussion comments

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| --- | --- |
| **Company/Delegate** | **Comment** |
| XXX/YYY |  |
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