**3GPP TSG-RAN WG4 Meeting # 112 R4-2413347**

**Maastricht Meeting, Aug. 19th – Aug 23rd, 2024**

**Title: TP to TR 38.719-02-01 Addition of CA\_n20A-n77A and CA\_n20A-n77(2A)**

**Source: Nokia, Mobility**

**Agenda item: 7.3.3**

**Document for: Approval**

# 1 Introduction

This is a TP to TR 38.719-02-01 to add CA\_n20A-n77A and CA\_n20A-n77(2A) with ULCA.

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## 5.x CA\_n20-n77

### 5.x.1 Common for 1 band UL and 2 bands UL CA

#### 5.x.1.1 Operating bands for CA

Table 5.x.1.1-1: CA band combination of band n20+n77

|  |  |  |  |
| --- | --- | --- | --- |
| NR Band | Uplink (UL) band | Downlink (DL) band | Duplexmode |
| BS receive / UE transmit | BS transmit / UE receive |
| FUL\_low – FUL\_high | FDL\_low – FDL\_high |
| n20 | 832 MHz | – | 862 MHz | 791 MHz | – | 821 MHz | FDD |
| n77 | 3300 MHz | – | 4200 MHz | 3300 MHz | – | 4200 MHz | TDD |

#### 5.x.1.2 Channel bandwidths per operating band for CA

Table 5.x.1.2-1: Supported bandwidths per CA band combination of band n20+n77

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n20A-n77A | CA\_n20A-n77A | n20 | 5, 10, 15, 20 | 0 |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
| CA\_n20A-n77(2A) | CA\_n20A-n77A | n20 | 5, 10, 15, 20 | 0 |
|  |  | n77 | CA\_n77(2A)\_BCS0 |  |

#### 5.x.1.3 UE co-existence studies

Table 5.x.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_n20-n77.

**Table 5.x.1.3-1 UL/DL harmonics/harmonic mixing analysis**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL/DL** | **n20** | **UL12** | **UL2** | **UL33** | **UL4** | **UL5** |   |
| **harmonics** | **832** | 832 | 1664 | 2496 | 3328 | 4160 | **MSD type** |
| **n77** | **3300** | **4200** | 862 | 1724 | 2586 | 3448 | 4310 |   |
| **DL1** | **3300** | **4200** | N/A | Clear | Clear | D | D | **UL harmonic** |
| **DL23** | 6600 | 8400 | Clear | N/A | Clear | N/A | N/A | **Harmonic mixing** |
| **DL34** | 9900 | 12600 | Clear | Clear | N/A | Clear | N/A |
| **DL4** | 13200 | 16800 | Clear | N/A | N/A | N/A | N/A |
| **DL54** | 16500 | 21000 | Clear | Clear | N/A | N/A | N/A |
| **Analysis** | UL4 and UL5 falls inside n77 DL |
| **UL/DL** | **n77** | **UL14** | **UL2** | **UL33** | **UL4** | **UL5** | **MSD type** |
| **harmonics** | **3300** | 3300 | 6600 | 9900 | 13200 | 16500 |
| **n20** | **832** | **862** | 4200 | 8400 | 12600 | 16800 | 21000 |
| **DL1** | **791** | **821** | N/A | Clear | Clear | Clear | Clear | **UL harmonic** |
| **DL23** | 1582 | 1642 | Clear | N/A | Clear | N/A | N/A | **Harmonic mixing** |
| **DL34** | 2373 | 2463 | Clear | Clear | N/A | Clear | N/A |
| **DL4** | 3164 | 3284 | Clear | N/A | N/A | N/A | N/A |
| **DL54** | 3955 | 4105 | D | Clear | N/A | N/A | N/A |
| **Analysis** | DL5 falls inside n77 DL |
| Note 1: ULx means UL xth harmonic frequency, and DLy means DL yth harmonic frequency rangeNote 2: When a collision is detected with an overlap >0Hz between the ULx with DLy frequency ranges, the ULx/DLy cell is marked “D” for direct hit. When the gap between ULx and DLy frequency range is from 0Hz to x\*MinULCBW, the ULx/DLy cell is marked “N” for Near miss.Note 3: UL3/DL2 harmonic mixing direct hit case for PC3/5 only apply for DL>3GHzNote 4: For harmonic mixing, near-miss cases only apply for UL1 and odd DLy orders. |

Table 5.x.1.3-2 summarizes frequency ranges where cross band isolation may occur for CA\_n20-n77.

Table 5.x.1.3-2: Cross-band isolation analysis

|  |  |  |
| --- | --- | --- |
| **Bands** | **n20** | **n77** |
| **Frequency limit** | **flow** | **fhigh** | **flow** | **fhigh** |
| **fUL (MHz)** | 832 | 862 | 3300 | 4200 |
| **fDL (MHz)** | 791 | 821 | 3300 | 4200 |
| **UL CBW (MHz)2** | Minimum CBW | Maximum CBW | Minimum CBW | Maximum CBW |
| 5 | 20 | 10 | 100 |
| **ACLR1 range** | fxULlow-maxULCBWx | fxULhigh+maxULCBWx | fyULlow-maxULCBWy | fyULhigh+maxULCBWy |
| **ACLR1 (MHz)** | 812 | 882 | 3200 | 4300 |
| **ACLR2 range** | fxULlow-2\*maxULCBWx | fxULhigh+2\*maxULCBWx | fyULlow-2\*maxULCBWy | fyULhigh+2\*maxULCBWy |
| **ACLR2 (MHz)** | 792 | 902 | 3100 | 4400 |
| **ACLR3 range** | fxULlow-3\*maxULCBWx | fxULhigh+3\*maxULCBWx | fyULlow-3\*maxULCBWy | fyULhigh+3\*maxULCBWy |
| **ACLR3 (MHz)** | 772 | 922 | 3000 | 4500 |
| **ACLR4 range** | fxULlow-4\*maxULCBWx | fxULhigh+4\*maxULCBWx | fyULlow-4\*maxULCBWy | fyULhigh+4\*maxULCBWy |
| **ACLR4 (MHz)** | 752 | 942 | 2900 | 4600 |
| **ACLR5 range1** | fxULlow-5\*maxULCBWx | fxULhigh+5\*maxULCBWx | fyULlow-5\*maxULCBWy | fyULhigh+5\*maxULCBWy |
| **ACLR5 (MHz)** | 732 | 962 | 2800 | 4700 |
| **Analysis** | No overlap | No overlap |
| NOTE 1: Even if there is no overlap up to ACLR5, MSD beyond the ACLR5 range should be evaluated further if:- The UL aggressor band and DL aggressor band are part of the same or adjacent band group as described in table A.1- If the DL band is above the UL band, it’s lower frequency edge must be below the UL lowest 2nd harmonic frequency- As an indicative threshold, if >45dB UL rejection at the DL band frequency can be guaranteed, assuming a -130dBm/Hz TX noise floor level, the transmitter noise floor related MSD should be negligibleNOTE 2: The maximum UL channel bandwidth of the BCS (noted maxULCBW) is used to calculate the band ACLR ranges while the minimum DL channel bandwidth of the BCS (noted minDLCBW) is used for the DL band victim channel bandwidth. |

5.x.1.4 ∆TIB,c and ∆RIB,c values

For CA\_n20-n41, the ΔTIB,c and ΔRIB,c values are given in the tables below re-used from DC\_20\_n77.

Table 5.x.1.4-1: ΔTIB,c

|  |  |
| --- | --- |
| Inter-band CA combination | ΔTIB,c for NR bands (dB)\* |
| Component band in order of bands in configuration\*\* |
| CA\_n20-n77 | 0.6 | 0.8 |
| NOTE \*: “-” denotes ΔTIB,c = 0.NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands, such as for CA\_n1-n3 the band order from left to right is n1 and n3. |

Table 5.x.1.4-2: ΔRIB,c

|  |  |
| --- | --- |
| Inter-band CA combination | ΔRIB,c for NR bands (dB)\* |
| Component band in order of bands in configuration\*\* |
| CA\_n20-n77 | - | 0.5 |
| NOTE \*: “-” denotes ΔRIB,c = 0.NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands, such as for CA\_n1-n77 the band order from left to right is n1 and n77. |

#### 5.x.1.5 REFSENS requirements

Based on the co-existence studies n20 fourth and fifth harmonic uplink falls into the n77 downlink. The UL harmonic MSD value is based on CA\_n20A\_n78A, from current meeting document R4-2413019 CR to TS 38.101-1 Rel-18 NR CA Uplink Harmonic clean-up PC3.

**Table 5.x.1.5-1: Reference sensitivity exceptions and uplink/downlink configurations due to UL harmonic from a PC3 aggressor NR UL band for NR DL CA FR1**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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) |
| n20 | n77 | 5 | 15 | 6 | 10 | 10.8 | NOTE 4 | UL4/DL1direct-hit |
| n20 | n77 | 5 | 15 | 6 | 100 | 3.1 | NOTE 4 | UL4/DL1direct-hit |
| NOTE 4: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band. |

Based on the co-existence studies n77 falls into the fifth harmonic n20 downlink. The harmonic mixing MSD value is based on CA\_n28A\_n77A, from current meeting document R4-2412621 CR for EN-DC Harmonic Mixing clean-up PC3.

Table 5.x.1.5-2: Reference sensitivity exceptions and uplink/downlink configurations due to harmonic mixing from a PC3 aggressor NR UL band for DL NR CA FR1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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) |
| n77 | 20 | 10 | 15 | 25 | 5 | 31 | NOTE 2 | UL1/DL5 |
| n77 | 20 | 10 | 15 | 25 | 20 | 23.5 | NOTE 2 | UL1/DL5 |
| NOTE 2: The requirements should be verified for DL NR-ARFCN of the Victim (lower) band (superscript LB) such that and with the UL carrier frequency and the channel bandwidth configured in the higher band, both in MHz. |

#### 5.x.1.6 OOB blocking exception requirements

No additional OOB blocking exceptions are required for this CA band combination.

### 5.x.2 Specific for 2 bands UL CA

#### 5.x.2.1 Maximum output power for inter-band CA

**Table 5.x.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| **Uplink CA Configuration** | **Class 3 (dBm)** | **Tolerance (dB)**  |
| CA\_n20A-n77A | 23 | +2/-3 |

#### 5.x.2.2 UE co-existence studies

Table 5.x.2.2-1 lists Band n20 + Band n77 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis, where only n20 can fall victim, since it is FDD+TDD.

**Table 5.x.2.2-1: Band n20 and Band n41 UL IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 2438 - 3368 | 4132 - 5062 |
| 3rd order IMD products | |2\*fx\_low – fy\_high| | |2\*fx\_high – fy\_low| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 2536 - 1576 | 5738 - 7568 |
| 3rd order IMD products | |2\*fx\_low + fy\_low| | |2\*fx\_high + fy\_high| | |2\*fy\_low + fx\_low| | |2\*fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 4964 - 5924 | 7432 - 9262 |
| Two-tone 3rd order IMD products | (fx\_low – max BW fy) | (fx\_high + max BW fy) | (fy\_low – max BW fx) | (fy\_high + max BW fx) |
| IMD frequency limits (MHz) | 732 - 762 | 3280 - 4180 |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | 1704 - 714 | 9038 - 11768 |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| |   |   |
| IMD frequency limits (MHz) | 6736 - 4876 |   |   |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high + 1\*fy\_high| | |3\*fy\_low + 1\*fx\_low| | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | 5796 - 6786 | 10732 - 13462 |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |   |   |
| IMD frequency limits (MHz) | 8264 - 10124 |   |   |
| Two-tone 5th order IMD products | |fx\_low – 4\*fy\_high| | |fx\_high – 4\*fy\_low| | |fy\_low – 4\*fx\_high| | |fy\_high – 4\*fx\_low| |
| IMD frequency limits (MHz) | 15968 - 12338 | 148 - 872 |
| Two-tone 5th order IMD products | |2\*fx\_low - 3\*fy\_high| | |2\*fx\_high - 3\*fy\_low| | |2\*fy\_low - 3\*fx\_high| | |2\*fy\_high -3\*fx\_low| |
| IMD frequency limits (MHz) | 10936 - 8176 | 4014 - 5904 |
| Two-tone 5th order IMD products | |fx\_low + 4\*fy\_low| | |fx\_high + 4\*fy\_high| | |fy\_low + 4\*fx\_low| | |fy\_high + 4\*fx\_high| |
| IMD frequency limits (MHz) | 14032 - 17662 | 6628 - 7648 |
| Two-tone 5th order IMD products | |2\*fx\_low + 3\*fy\_low| | |2\*fx\_high + 3\*fy\_high| | |2\*fy\_low + 3\*fx\_low| | |2\*fy\_high + 3\*fx\_high| |
| IMD frequency limits (MHz) | 11564 - 14324 | 9096 - 10986 |
| NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute. |

The analysis shows IMD4 and IMD5 will fall inside n20 DL.

Based on the table 5.x.2.2-1, the 4th order and 5th order intermodulation product fall inside the RX band of n20.

The two bands are not part of the same or adjacent band groups, so the Triple beat analysis is omitted.

As agreed, there’s no regulatory requirements that need to be protected in the geographically area that this combination is used.

#### 5.x.2.3 REFSENS requirements

Table 5.x.2.3-1 lists the MSD required due to the 4rd and 5th IMD product for the dual uplink configuration. It is based on the similar case of DC\_20A\_n77A.

**Table 5.x.2.3-1: MSD due to IMD issue**

|  |  |
| --- | --- |
| **Operating band / Channel bandwidth / NRB / Duplex mode** | **Source of IMD** |
| **NR CA band combination** | **NR band** | **UL Fc(MHz)** | **UL/DL BW (MHz)** | **UL CLRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** |
| CA\_n20-n77 | n20 | 850 | 5 | 25 | 809 | 11 | FDD | IMD4 |
|  | n77 | 3359 | 10 | 50 | 3359 | N/A | TDD | N/A |
|  | n20 | 840 | 5 | 25 | 790.5 | 6.5 | FDD | IMD5 |
|  | n77 | 4159 | 10 | 50 | 4159 | N/A | TDD | N/A |

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