**3GPP TSG-RAN WG4 Meeting # 112 R4-2413342**

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

**Title: TP to TR 38.719-02-01 Addition of CA\_n1A-n71A**

**Source: Nokia, Etisalat UAE**

**Agenda item: 7.3.3**

**Document for: Approval**

# 1 Introduction

This is a TP to TR 38.719-02-01 to add CA\_n1A-n71A with ULCA.

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## 5.x CA\_n1-n71

### 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 n1+n71

|  |  |  |  |
| --- | --- | --- | --- |
| 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 |
| n1 | 1920 MHz | – | 1980 MHz | 2110 MHz | – | 2170 MHz | FDD |
| n71 | 663 MHz | – | 698 MHz | 617 MHz | – | 652 MHz | FDD |

#### 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 n1+n71

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n1A-n71A | CA\_n1A-n71A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n71 | 5, 10, 15, 20 |  |

#### 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\_ n1-n71.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL/DL** | **n1** | **UL12** | **UL2** | **UL33** | **UL4** | **UL5** |   |
| **harmonics** | **1920** | 1920 | 3840 | 5760 | 7680 | 9600 | **MSD type** |
| **n71** | **663** | **698** | 1980 | 3960 | 5940 | 7920 | 9900 |   |
| **DL1** | **617** | **652** | N/A | Clear | Clear | Clear | Clear | **UL harmonic** |
| **DL23** | 1234 | 1304 | Clear | N/A | Clear | N/A | N/A | **Harmonic mixing** |
| **DL34** | 1851 | 1956 | D | Clear | N/A | Clear | N/A |
| **DL4** | 2468 | 2608 | Clear | N/A | N/A | N/A | N/A |
| **DL54** | 3085 | 3260 | Clear | Clear | N/A | N/A | N/A |
| **Analysis** | There is UL1/DL3 harmonic mixing into n71 |
| **UL/DL** | **n71** | **UL14** | **UL2** | **UL33** | **UL4** | **UL5** | **MSD type** |
| **harmonics** | **663** | 663 | 1326 | 1989 | 2652 | 3315 |
| **n1** | **1920** | **1980** | 698 | 1396 | 2094 | 2792 | 3490 |
| **DL1** | **2110** | **2170** | N/A | Clear | Clear | Clear | Clear | **UL harmonic** |
| **DL23** | 4220 | 4340 | Clear | N/A | Clear | N/A | N/A | **Harmonic mixing** |
| **DL34** | 6330 | 6510 | Clear | Clear | N/A | Clear | N/A |
| **DL4** | 8440 | 8680 | Clear | N/A | N/A | N/A | N/A |
| **DL54** | 10550 | 10850 | Clear | Clear | N/A | N/A | N/A |
| **Analysis** | No issues |
| 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\_n1-n71.

|  |  |  |
| --- | --- | --- |
| **Bands** | **n1** | **n71** |
| **Frequency limit** | **flow** | **fhigh** | **flow** | **fhigh** |
| **fUL (MHz)** | 1920 | 1980 | 663 | 698 |
| **fDL (MHz)** | 2110 | 2170 | 617 | 652 |
| **UL CBW (MHz)2** | Minimum CBW | Maximum CBW | Minimum CBW | Maximum CBW |
| 5 | 50 | 5 | 30 |
| **ACLR1 range** | fxULlow-maxULCBWx | fxULhigh+maxULCBWx | fyULlow-maxULCBWy | fyULhigh+maxULCBWy |
| **ACLR1 (MHz)** | 1870 | 2030 | 633 | 728 |
| **ACLR2 range** | fxULlow-2\*maxULCBWx | fxULhigh+2\*maxULCBWx | fyULlow-2\*maxULCBWy | fyULhigh+2\*maxULCBWy |
| **ACLR2 (MHz)** | 1820 | 2080 | 603 | 758 |
| **ACLR3 range** | fxULlow-3\*maxULCBWx | fxULhigh+3\*maxULCBWx | fyULlow-3\*maxULCBWy | fyULhigh+3\*maxULCBWy |
| **ACLR3 (MHz)** | 1770 | 2130 | 573 | 788 |
| **ACLR4 range** | fxULlow-4\*maxULCBWx | fxULhigh+4\*maxULCBWx | fyULlow-4\*maxULCBWy | fyULhigh+4\*maxULCBWy |
| **ACLR4 (MHz)** | 1720 | 2180 | 543 | 818 |
| **ACLR5 range1** | fxULlow-5\*maxULCBWx | fxULhigh+5\*maxULCBWx | fyULlow-5\*maxULCBWy | fyULhigh+5\*maxULCBWy |
| **ACLR5 (MHz)** | 1670 | 2230 | 513 | 848 |
| **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\_n1-n71, the ΔTIB,c and ΔRIB,c values are given in the tables below re-used from CA\_n1-n105.

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\_n1-n71 | 0.3 | 0.6 |
| 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\_n1-n71 | - | 0.3 |
| 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 n1 uplink and n71 third harmonic mixes into the n71 downlink. The value is based on DC\_1A\_n71A, which has similar harmonic issue.

**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)** |
| n1 | n713 | 5 | 15 | 25 (RBstart=0) | 5 | 26.8 | NOTE 4 | UL1/DL3 |
| NOTE 3: These requirements apply when there is at least one individual RE within the downlink transmission bandwidth of the victim (lower) band for which the 3rd harmonic is within the uplink transmission bandwidth or the uplink adjacent channel's transmission bandwidth of an aggressor (higher) band.NOTE 4: The requirements should be verified for UL NR-ARFCN of the aggressor (higher) band (superscript HB) such that  in MHz and  with  the carrier frequency in the victim (lower) band and  the channel bandwidth configured in the higher band. |

#### 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\_n1A-n71A | 23 | +2/-3 |

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

Table 5.x.2.2-1 lists Band n1 + Band n71 2 bands UL CA(2CC) 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.x.2.2-1:** **Band n1 and Band n71 for 2CC 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) | 1317 - 1222 | 2583 - 2678 |
| 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) | 3142 - 3297 | 654 - 524 |
| 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) | 4503 - 4658 | 3246 - 3376 |
| 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) | 1890 - 2010 | 613 - 748 |
| 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) | 5062 - 5277 | 9 - 174 |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| |   |   |
| IMD frequency limits (MHz) | 2444 - 2634 |   |   |
| 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) | 6423 - 6638 | 3909 - 4074 |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |   |   |
| IMD frequency limits (MHz) | 5236 - 5286 |   |   |
| 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) | 872 - 672 | 7257 - 6982 |
| 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) | 1746 - 1971 | 4614 - 4364 |
| 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) | 4572 - 4772 | 8343 - 8618 |
| 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) | 5829 - 6054 | 7086 - 7336 |
| 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 lowest even order and lowest odd order IMD MSDs shall be considered. |

Based on Table 5.x.2.2-1, 3rd order IMD may also fall into Rx frequencies of bands n1 or band n71. The analysis shows IMD3 will fall inside n71 DL.

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 3rd IMD product for the dual uplink configuration. It is based on the similar case of DC\_1A\_n71A.

**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\_n1-n71 | n1 | 1958 | 5 | 25 | 2148 | N/A | FDD | N/A |
|  | n71 | 668 | 5 | 25 | 622 | 15.1 | FDD | IMD3 |

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