**3GPP TSG-RAN WG4 Meeting # 112 R4-2413345**

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

**Title: TP to TR 38.719-03-01 Addition of CA\_n1A-n41A-n78A**

**Source: Nokia, Etisalat UAE**

**Agenda item: 7.3.4**

**Document for: Approval**

# 1 Introduction

This is a TP to TR 38.719-03-01 to add CA\_n1A-n41A-n78A with ULCA. The combination follows the mandatory simultaneous Rx/Tx capability. It is not clear from TR 38.719-03-01 how the Note on simultaneous Rx/Tx is to be captured, extra care must be taken reading section 5.x.1.1 to capture the Note.

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## 5.x CA\_n1-n41-n78

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

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

When adding CA\_n1-n41-n78 to Table 5.2A.2.2-1 in 38.101-1, it must be marked with Note 3 as CA\_n1-n41-n783.

Table 5.x.1.1-1: CA band combination constituent bands definition

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | Uplink (UL) band | | | Downlink (DL) band | | | Duplex  mode |
| 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 |
| n41 | 2496 MHz | – | 2690 MHz | 2496 MHz | – | 2690 MHz | TDD |
| n78 | 3300 MHz | – | 3800 MHz | 3300 MHz | – | 3800 MHz | TDD |

This combination supports inter-band carrier aggregation with mandatory simultaneous Rx/Tx capability.

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

Table 5.x.1.2-1: Supported bandwidths per CA band combination

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n1A-n41A-n78A | CA\_n1A-n41A  CA\_n1A-n78A  CA\_n41A-n78A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n41 | 10, 15, 20, 40, 50, 60, 80, 100 |  |
|  |  | n78 | 10, 15, 20, 40, 50, 60, 80, 90, 100 |  |

#### 5.x.1.3 ∆TIB,c and ∆RIB,c values

Requirements for CA\_n1-n41-n78, for the TIB,c and RIB,c values are given in the tables below following CA\_n1-n41-n77.

Table 5.x.1.3-1: ΔTIB,c due to NR CA (three bands)

|  |  |  |  |
| --- | --- | --- | --- |
| **Inter-band CA combination** | **ΔTIB,c for NR bands (dB)\*** | | |
| **Component band in order of bands in configuration\*\*** | | |
| CA\_n1-n41-n78 | 0.5 | 0.5 | 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-n5 the band order from left to right is n1, n3 and n5. | | | |

Table 5.x.1.3-2: ΔRIB,c due to NR CA (three bands)

|  |  |  |  |
| --- | --- | --- | --- |
| **Inter-band CA combination** | **ΔRIB,c for NR bands (dB)\*** | | |
| **Component band in order of bands in configuration\*\*** | | |
| CA\_n1-n41-n78 | 0.2 | - | 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-n3-n8 the band order from left to right is n1, n3 and n8. | | | |

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

#### 5.x.2.1 UE co-existence studies

Table 5.x.2.1.1-1 provides the two UL bands with one CC per band IMD interference analysis for CA\_n1A-n41A-n78A with UL CA\_n1A-n4A.

**Table 5.x.2.1.1-1: Two UL bands IMD analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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) | 516 - 770 | | 4416 - 4670 | |
| Two-tone 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) | 1150 - 1464 | | 3012 - 3460 | |
| Two-tone 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) | 6336 - 6650 | | 6912 - 7360 | |
| 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) | 3070 - 3444 | | 5508 - 6150 | |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| |  |  |
| IMD frequency limits (MHz) | 1540 - 1032 | |  | |
| 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) | 8256 - 8630 | | 9408 - 10050 | |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |  |  |
| IMD frequency limits (MHz) | 9220 - 8952 | |  | |
| 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) | 8840 - 8004 | | 5424 - 4990 | |
| 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) | 4230 - 3528 | | 948 - 380 | |
| 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) | 11904 - 12740 | | 10176 - 10610 | |
| 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) | 11328 - 12030 | | 10752 - 11320 | |
| 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.2.1.1-1, 3rd, 4th and 5th order IMD from band n1 and Band n41 may also fall into Rx frequencies of band n78.

**Table 5.x.2.1.1-2: Two UL bands IMD analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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) | 1320 - 1880 | | 5220 - 5780 | |
| Two-tone 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) | 40 - 660 | | 4620 - 5680 | |
| Two-tone 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) | 7140 - 7760 | | 8520 - 9580 | |
| 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) | 1960 - 2640 | | 7920 - 9480 | |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| |  |  |
| IMD frequency limits (MHz) | 3760 - 2640 | |  | |
| 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) | 9060 - 9740 | | 11820 - 13380 | |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |  |  |
| IMD frequency limits (MHz) | 11440 - 10560 | |  | |
| 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) | 13280 - 11220 | | 4620 - 3880 | |
| 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) | 4230 - 3528 | | 948 - 380 | |
| 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) | 7560 - 5940 | | 660 - 1840 | |
| 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) | 13740 - 15360 | | 12360 - 13540 | |
| 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.2.1.1-2, 4th order IMD from band n1 and Band n78 may also fall into Rx frequencies of band n41.

**Table 5.x.2.1.1-3: Two UL bands IMD analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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) | 610 - 1304 | | 5796 - 6490 | |
| Two-tone 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) | 1192 - 2080 | | 3910 - 5104 | |
| Two-tone 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) | 8292 - 9180 | | 9096 - 10290 | |
| 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) | 3688 - 4770 | | 7210 - 8904 | |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| |  |  |
| IMD frequency limits (MHz) | 2608 - 1220 | |  | |
| 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) | 10788 - 11870 | | 12396 - 14090 | |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |  |  |
| IMD frequency limits (MHz) | 12592 - 11980 | |  | |
| 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) | 12704 - 10510 | | 7460 - 6184 | |
| 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) | 6408 - 4520 | | 1470 - 112 | |
| 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) | 15696 - 17890 | | 13284 - 14560 | |
| 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) | 14892 - 16780 | | 14088 - 15670 | |
| 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.2.1.1-3, 4th order IMD from band n41 and Band n78 may also fall into Rx frequencies of band n1.

From the tables it is found that:

- Band n78 may be subject to IMD3, IMD4 and IMD5.

- Band n41 may be subject to IMD4.

- Band n1 may be subject to IMD4.

#### 5.x.2.2 REFSENS requirements

MSD values have been taken from CA\_n1A-n41A-n77A, except the impact in n1 is omitted due to the simultaneous Rx/Tx operation of n41 and n78.

**Table 5.x.2.2-1: MSD due to IMD issue**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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-n41-n78 | n1 | 1970 | 5 | 25 | 2160 | N/A | FDD | N/A |
|  | n41 | 2650 | 10 | 50 | 2650 | N/A | TDD | N/A |
|  | n78 | N/A | 10 | N/A | 3330 | 19.6 | TDD | IMD31,2 |
|  | n1 | 1975 | 5 | 10 | 2165 | N/A | FDD | N/A |
|  | n78 | 3410 | 10 | 50 | 3410 | N/A | TDD | N/A |
|  | n41 | N/A | 10 | N/A | 2515 | 11.5 | TDD | IMD4 |
|  | n1 | N/A | 5 | N/A | 2140 | 9.3 | FDD | IMD4 |
|  | n78 | 3710 | 10 | 50 | 3710 | N/A | TDD | N/A |
|  | n41 | 2640 | 10 | 50 | 2640 | N/A | TDD | N/A |
| NOTE 1: This band is subject to IMD5 also which MSD is not specified.  NOTE 2: This band is subject to IMD4 also which MSD is not specified. | | | | | | | | |

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