**3GPP TSG-RAN WG4 Meeting # 110 R4-2402094**

**Athens, Greece, February 26 – March 01, 2024**

**Title: TP to TR 37.718-03-01: Addition of CA\_n1-n78-n102 variants**

**Source: Nokia, BT**

**Agenda item: 7.11.2**

**Document for: Approval**

# 1 Introduction

This is a TP to TR 37.718-03-01 to add CA\_n1-n78-n102 including ULCA combinations of inter and intra-band configurations of n1A and n78A with n102B/C. All fallbacks have been analysed [1],[2]. Unchanged sections of the TR have been omitted.

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#### 5.55.1.2 Channel bandwidths per operating band for CA

Table 5.55.1.2-1: Supported bandwidths per CA band combination of band n1+n78+n102

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n1A-n78A-n102A | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n102 | 20, 40, 60, 80, 100 |  |
| CA\_n1A-n78A-n102B | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n1A-n102B  CA\_n78A-n102B | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n102 | CA\_n102B\_BCS0 |  |
| CA\_n1A-n78A-n102C | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n1A-n102C  CA\_n78A-n102C | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n102 | CA\_n102C\_BCS0 |  |
| CA\_n1A-n78A-n102D | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n102 | CA\_n102D\_BCS0 |  |
| CA\_n1A-n78A-n102E | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n102 | CA\_n102E\_BCS0 |  |
| CA\_n1A-n78A-n102(2A) | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n102 | CA\_n102(2A)\_BCS0 |  |
| CA\_n1A-n78(2A)-n102A | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n78(2A) | n1 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS2 |  |
|  |  | n102 | 20, 40, 60, 80, 100 |  |
| CA\_n1A-n78(2A)-n102B | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A CA\_n78(2A)  CA\_n1A-n102B  CA\_n78A-n102B | n1 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS2 |  |
|  |  | n102 | CA\_n102B\_BCS0 |  |
| CA\_n1A-n78(2A)-n102C | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n78(2A)  CA\_n1A-n102C  CA\_n78A-n102C | n1 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS2 |  |
|  |  | n102 | CA\_n102C\_BCS0 |  |
| CA\_n1A-n78(2A)-n102D | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n78(2A) | n1 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS2 |  |
|  |  | n102 | CA\_n102D\_BCS0 |  |
| CA\_n1A-n78(2A)-n102E | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n78(2A) | n1 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS2 |  |
|  |  | n102 | CA\_n102E\_BCS0 |  |
| CA\_n1A-n78(2A)-n102(2A) | CA\_n1A-n78A  CA\_n1A-n102A  CA\_n78A-n102A  CA\_n78(2A) | n1 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS2 |  |
|  |  | n102 | CA\_n102(2A)\_BCS0 |  |

#### 5.55.2.1 UE co-existence studies

This is a 3-band combination, so uplink harmonic and harmonic mixing analysis is already done in the fallbacks. Only IMD for two uplink configurations is analysed.

Table 5.55.2.2-1 lists Band n1 + Band n78 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE coexistence analysis.

Table 5.55.2.2-2 lists Band n1 + Band n102 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE coexistence analysis.

Table 5.55.2.2-3 lists Band n78 + Band n102 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE coexistence analysis.

**Table 5.55.2.1-1: Band n1 and Band n78 UL IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL Frequency [MHz] | 1920 | 1980 | 3300 | 3800 |
| DL Frequency [MHz] | 2110 | 2170 | 3300 | 3800 |
| 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 |
| 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 |
| 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| | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |
| IMD frequency limits (MHz) | 3760 | 2640 | 10440 | 11560 |
| 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 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) | 7560 | 5940 | 660 | 1840 |
| 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) | 15120 | 17180 | 10980 | 11720 |
| 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 |

**Table 5.55.2.1-2: Band n1 and Band n102 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL Frequency [MHz] | 1920 | 1980 | 5925 | 6425 |
| DL Frequency [MHz] | 2110 | 2170 | 5925 | 6425 |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 3945 | 4505 | 7845 | 8405 |
| 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) | 2585 | 1965 | 9870 | 10930 |
| 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) | 9765 | 10385 | 13770 | 14830 |
| 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) | 665 | 15 | 15795 | 17355 |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |
| IMD frequency limits (MHz) | 9010 | 7890 | 15690 | 16810 |
| 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) | 11685 | 12365 | 19695 | 21255 |
| 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) | 23780 | 21720 | 1995 | 1255 |
| 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) | 15435 | 13815 | 5910 | 7090 |
| 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) | 25620 | 27680 | 13605 | 14345 |
| 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) | 21615 | 23235 | 17610 | 18790 |

**Table 5.55.2.1-3: Band n78 and Band n102 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL Frequency [MHz] | 3300 | 3800 | 5925 | 6425 |
| DL Frequency [MHz] | 3300 | 3800 | 5925 | 6425 |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 2125 | 3125 | 9225 | 10225 |
| 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) | 175 | 1675 | 8050 | 9550 |
| 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) | 12525 | 14025 | 15150 | 16650 |
| 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) | 3475 | 5475 | 13975 | 15975 |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high –2\* fy\_low| | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\* fy\_high| |
| IMD frequency limits (MHz) | 6250 | 4250 | 18450 | 20450 |
| 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) | 15825 | 17825 | 21075 | 23075 |
| 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) | 22400 | 19900 | 9275 | 6775 |
| 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) | 12675 | 10175 | 450 | 2950 |
| 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) | 27000 | 29500 | 19125 | 21625 |
| 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) | 24375 | 26875 | 21750 | 24250 |

Based on the tables above it can be seen that

n1 + n78 IMD5 may affect Rx frequencies of band n102

n78 + n102 IMD2 and IMD5 may affect Rx frequencies of band n1

The non-contiguous uplink IMD interference analysis has been completed in the fallbacks. For CA\_n1A-n78(2A) with ULCA CA\_n78(2A) the analysis was completed in R4-2220561 of RAN4#105 but missed in specification updates. The values are re-iterated below from R4-2220561:

Table 7.3A.5-1: 2DL/2UL inter-band Reference sensitivity QPSK PREFSENS and uplink/downlink configurations for PC3 CA

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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-n78 | n1 | 1950 | 5 | 25 | 2140 | 8.0 | FDD | IMD4 |
|  | n78 | 3710 | 10 | 50 | 3710 | N/A | TDD | N/A |
|  | n1 | N/A | 5 | N/A | 2167.5 | 1.7 | FDD | IMD7Y |
|  | n7812 | 3305 | 10 | 1 (RBstart=0) | 3305 | N/A | TDD | N/A |
|  |  | 3675 | 10 | 1 (RBstart=44) | 3675 |  |  |  |
|  |  |  |  |  |  |  |  |  |
| NOTE 12: This band supports intra-band non-contiguous uplink configuration.  NOTE Y: For a UE which supports this band combination only when the Band n78 frequency range restriction of 3400 – 3800 MHz or 3300 – 3600 MHz applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped. | | | | | | | | |

For the non-contiguous uplink IMD interference analysis of the fallback and CA\_ n78(2a)-n102A with ULCA CA\_n78(2A) the analysis was completed in R4-2310355 of RAN4#107.

Table 5.55.2.1-4 lists Band n1 + Band n102C 2UL bands CA 1st order triple beat (IMD3) for the UE-to-UE coexistence analysis into the third receive band of Band n78, where Band n102C is the uplink band of the separated RB allocations and Band n1 is the contiguous single uplink carrier.

**Table 5.55.2.1-4: Band n1 and Band n102 triple beat IMD products**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| CC location | fU1L | fU2L | fU3L | fU1H |  | CBW |
| Frequency | 5925 | 5945 | 6025 | 6425 |  | 20 |
| CC location | fSCCL | fSCCH | fU2H | fU3H |  | Min ch. separation |
| Frequency | 1920 | 1980 | 6405 | 6325 |  | 0 |
| 1st order TB | IfU3L -fU1L- fSCCL| | IfU2L -fU1L + fSCCL| | IfU2L -fU1L- fSCCH| | IfU3L -fU1L + fSCCH| |  | Max ch. separation |
| Ranges | 1760 | 1940 | 1960 | 2140 |  | 160 |
| 1st order TB | IfU2L+fU1L-fSCCH| | IfU1H+fU2H-fSCCL| | IfU2L +fU1L+fSCCL| | IfU1H +fU2H+fSCCH| |  |  |
| Ranges | 9890 | 10910 | 13790 | 14810 |  |  |

Table 5.55.2.1-5 lists Band n78 + Band n102C 2UL bands CA 1st order triple beat (IMD3) for the UE-to-UE coexistence analysis into the third receive band of Band n1, where Band n102C is the uplink band of the separated RB allocations and Band n78 is the contiguous single uplink carrier.

**Table 5.55.2.1-5: Band n78 and Band n102 triple beat IMD products**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| CC location | fU1L | fU2L | fU3L | fU1H |  | CBW |
| Frequency | 5925 | 5965 | 6025 | 6425 |  | 20 |
| CC location | fSCCL | fSCCH | fU2H | fU3H |  | Min ch. separation |
| Frequency | 3300 | 3800 | 6385 | 6325 |  | 0 |
| 1st order TB | IfU3L -fU1L- fSCCL| | IfU2L -fU1L + fSCCL| | IfU2L -fU1L- fSCCH| | IfU3L -fU1L + fSCCH| |  | Max ch. separation |
| Ranges | 3140 | 3320 | 3780 | 3960 |  | 160 |
| 1st order TB | IfU2L+fU1L-fSCCH| | IfU1H+fU2H-fSCCL| | IfU2L +fU1L+fSCCL| | IfU1H +fU2H+fSCCH| |  |  |
| Ranges | 8070 | 9530 | 15170 | 16630 |  |  |

Based on Table 5.55.2.1-4, 1st order triple beat IMD has no occurrence in band n78. There is no change to the REFSENS requirements as there is no triple beat IMD.

Based on Table 5.55.2.1-5, 1st order triple beat IMD has no occurrence in band n1. There is no change to the REFSENS requirements as there is no triple beat IMD.

### 6.9.1 Configurations for DC\_n1-n78-n102

Table 6.9.1-1: Inter-band NR DC configurations

| NR DC  configuration | Uplink NR DC  configuration |
| --- | --- |
| DC\_n1A-n78A-n102A  DC\_n1A-n78A-n102B  DC\_n1A-n78A-n102C  DC\_n1A-n78A-n102D  DC\_n1A-n78A-n102E | DC\_n1A-n78ADC\_n1A-n102A  DC\_n1A-n102B  DC\_n1A-n102CDC\_n78A-n102A  DC\_n78A-n102B  DC\_n78A-n102C |
| DC\_n1A-n78(2A)-n102A  DC\_n1A-n78(2A)-n102B  DC\_n1A-n78(2A)-n102C  DC\_n1A-n78(2A)-n102D  DC\_n1A-n78(2A)-n102E  DC\_n1A-n78A-n102(2A)  DC\_n1A-n78(2A)-n102(2A) | DC\_n1A-n78A DC\_n1A-n102A  DC\_n1A-n102B  DC\_n1A-n102CDC\_n78A-n102A  DC\_n78A-n102B  DC\_n78A-n102C |

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# References

[1] R4-2321853 TP to TR 38.718-02-01 Addition to CA\_n1-n102 and DC\_n1-n102, Nokia - RAN4#109

[2] R4-2321856 TP to TR 38.718-02-01 Addition to CA\_n78-n102 and DC\_n78-n102, Nokia - RAN4#109