3GPP TSG-RAN WG4 Meeting # 99-e R4-2110697

**Electronic Meeting, May. 19-27, 2021**

**Title: TP to TR 38.717-03-02: Addition of CA\_n25-n48-n66**

**Source: Nokia, T-Mobile USA**

**Agenda item: 8.13.2**

**Document for: Approval**

# 1 Introduction

This is a TP to TR 38.717-03-01 to add CA\_n25-n48-n66 with 2UL

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## 5.1.x CA\_n25-n48-n66

5.1. x.1 Operating bands for CA

Table 5.1.x.1-1: Inter-band CA operating bands of CA\_n25-n48-n66

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA Band** | **NR Band** | **Uplink (UL) operating band** | **Downlink (DL) operating band** | **Duplex Mode** |
| **BS receive / UE transmit** | **BS transmit / UE receive**  |
| **FUL\_low – FUL\_high** | **FDL\_low – FDL\_high** |
| CA\_n25A-n48A-n66A | n25 | 1850 MHz | – | 1915 MHz | 1930 MHz | – | 1995 MHz | FDD |
| n48 | 3550 MHz | – | 3700 MHz | 3550 MHz | – | 3700 MHz | TDD |
| n66 | 1710 MHz | – | 1780 MHz | 2110 MHz | – | 2200 MHz | FDD |

#### 5.1.x.2 Channel bandwidths per operating band for CA

Table 5.1.x.2-1: Supported bandwidths per CA\_n25-n48-n66

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NR CA Configuration** | **UL Config** | **NR Band** | **SCS [kHz]** | **5** | **10** | **15** | **20** | **25** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **Bandwidth combination set** |
| CA\_n25A-n48A-n66A | CA\_n25A-n48ACA\_n25A-n66ACA\_n48A-n66A | n25 | 15 | 5 | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  |
| 60 |  | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  |
| n48 | 15 | 5 | 10 | 15 | 20 |  |  | 40 | 50 |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  | 40 | 50 | 60 |  | 80 | 90 | 100 |
| 60 |  | 10 | 15 | 20 |  |  | 40 | 50 | 60 |  | 80 | 90 | 100 |
| n66 | 15 | 5 | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  |
| 60 |  | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  |
| n25 |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 1 |
| n48 |  | 5 | 10 | 15 | 20 |  |  | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 1 |
| n66 |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 1 |
| CA\_n25A-n48(2A)-n66A | CA\_n25A-n48ACA\_n25A-n66ACA\_n48A-n66A | n25 | 15 | 5 | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  |
| 60 |  | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  |
| n48 | See CA\_n48(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 | 0 |
| n66 | 15 | 5 | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  |
| 60 |  | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  |
| n25 |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 1 |
| n48 |  | See CA\_n48(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 | 1 |
| n66 |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 1 |
| CA\_n25A-n48C-n66A | CA\_n25A-n48ACA\_n25A-n66ACA\_n48A-n66A | n25 | 15 | 5 | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  |
| 60 |  | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  |
| n48 | See CA\_n48C Bandwidth Combination Set 0 in Table 5.5A.1-1 | 0 |
| n66 | 15 | 5 | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  | 0 |
| 30 |  | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  |
| 60 |  | 10 | 15 | 20 |  |  | 40 |  |  |  |  |  |  |
| n25 |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 1 |
| n48 |  | See CA\_n48C Bandwidth Combination Set 0 in Table 5.5A.1-1 | 1 |
| n66 |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 1 |

#### 5.1.x.3 UE co-existence study

For 3DL/2UL NR CA, only the IMD issues due to dual uplink operation of two bands falling into the DL of the third band shall be verified.

Co-existence studies for dual uplink operation of two bands, i.e. CA\_n25A-n66A and CA\_n48A-n66A have been captured in TS 38.101-1, Table 7.3A.5-1, where:

* IMD3 products produced by Band n25 and n66 might fall in Rx of band n25 and n66. Also, IMD5 products of n25 may fall into band n66
* IMD5 products produced by Band n48 might fall in Rx of band n66.

Co-existence studies for dual uplink operation of two bands CA\_n25A-n48A is captured in provided TP R4-2110696

* For 2UL CA\_n25A-n48A into n66A the 4th order IMD product may fall inside band n66 as seen in Table 5.1.x.3-1

**Table 5.1.x.3-1: Band n25 and Band n48 UL harmonics and IMD products into Band n66**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL Frequency [MHz] | 1850 | 1915 | 3550 | 3700 |
| DL Frequency [MHz] | 1930 | 1995 | 3550 | 3700 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | 2\* fy\_low | 2\* fy\_high |
| 2nd harmonics frequency limits (MHz) | 3700 | 3830 | 7100 | 7400 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | 3\* fy\_low | 3\* fy\_high |
| 3rd harmonics frequency limits (MHz) | 5550 | 5745 | 10650 | 11100 |
| 4th harmonics frequency limits | 4\*fx\_low | 4\*fx\_high | 4\* fy\_low | 4\* fy\_high |
| 4th harmonics frequency limits (MHz) | 7400 | 7660 | 14200 | 14800 |
| 5th harmonics frequency limits | 5\*fx\_low | 5\*fx\_high | 5\* fy\_low | 5\* fy\_high |
| 5th harmonics frequency limits (MHz) | 9250 | 9575 | 17750 | 18500 |
| 6th harmonics frequency limits | 6\*fx\_low | 6\*fx\_high | 6\* fy\_low | 6\* fy\_high |
| 6th harmonics frequency limits (MHz) | 11100 | 11490 | 21300 | 22200 |
| 7th harmonics frequency limits | 7\*fx\_low | 7\*fx\_high | 7\* fy\_low | 7\* fy\_high |
| 7th harmonics frequency limits (MHz) | 12950 | 13405 | 24850 | 25900 |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 1635 | 1850 | 5400 | 5615 |
| 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) | 0 | 280 | 5185 | 5550 |
| 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) | 7250 | 7530 | 8950 | 9315 |
| 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) | 1850 | 2195 | 8735 | 9250 |
| 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) | 3700 | 3270 | 10800 | 11230 |
| 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) | 9100 | 9445 | 12500 | 13015 |
| 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) | 12950 | 12285 | 4110 | 3700 |
| 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) | 7400 | 6820 | 1355 | 1850 |
| 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) | 16050 | 16715 | 10950 | 11360 |
| 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) | 14350 | 14930 | 12650 | 13145 |

* For 2UL CA\_n25A-n66A into n48A the 2nd order harmonic is captured in 38.101-1 for the combination CA\_n48A-n66A, while the 2nd order IMD product may fall inside band n66 as seen in Table 5.1.x.3-2

**Table 5.1.x.3-2: Band n25 and Band n66 UL harmonics and IMD products into Band n48**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL Frequency [MHz] | 1850 | 1915 | 1710 | 1780 |
| DL Frequency [MHz] | 1930 | 1995 | 2110 | 2200 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | 2\* fy\_low | 2\* fy\_high |
| 2nd harmonics frequency limits (MHz) | 3700 | 3830 | 3420 | 3560 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | 3\* fy\_low | 3\* fy\_high |
| 3rd harmonics frequency limits (MHz) | 5550 | 5745 | 5130 | 5340 |
| 4th harmonics frequency limits | 4\*fx\_low | 4\*fx\_high | 4\* fy\_low | 4\* fy\_high |
| 4th harmonics frequency limits (MHz) | 7400 | 7660 | 6840 | 7120 |
| 5th harmonics frequency limits | 5\*fx\_low | 5\*fx\_high | 5\* fy\_low | 5\* fy\_high |
| 5th harmonics frequency limits (MHz) | 9250 | 9575 | 8550 | 8900 |
| 6th harmonics frequency limits | 6\*fx\_low | 6\*fx\_high | 6\* fy\_low | 6\* fy\_high |
| 6th harmonics frequency limits (MHz) | 11100 | 11490 | 10260 | 10680 |
| 7th harmonics frequency limits | 7\*fx\_low | 7\*fx\_high | 7\* fy\_low | 7\* fy\_high |
| 7th harmonics frequency limits (MHz) | 12950 | 13405 | 11970 | 12460 |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 205 | 70 | 3560 | 3695 |
| 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) | 1920 | 2120 | 1505 | 1710 |
| 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) | 5410 | 5610 | 5270 | 5475 |
| 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) | 3770 | 4035 | 3215 | 3490 |
| 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) | 140 | 410 | 7120 | 7390 |
| 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) | 7260 | 7525 | 6980 | 7255 |
| 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) | 5270 | 4925 | 5950 | 5620 |
| 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) | 1640 | 1300 | 2325 | 1990 |
| 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) | 8690 | 9035 | 9110 | 9440 |
| 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) | 8830 | 9170 | 8970 | 9305 |

* For 2UL CA\_n48A-n66A into n25A the 2nd and the 5th order IMD product may fall inside band n25 as seen in Table 5.1.x.3-3

**Table 5.1.x.3-3: Band n48 and Band n66 UL harmonics and IMD products into Band n25**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL Frequency [MHz] | 3550 | 3700 | 1710 | 1780 |
| DL Frequency [MHz] | 3550 | 3700 | 2110 | 2200 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | 2\* fy\_low | 2\* fy\_high |
| 2nd harmonics frequency limits (MHz) | 7100 | 7400 | 3420 | 3560 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | 3\* fy\_low | 3\* fy\_high |
| 3rd harmonics frequency limits (MHz) | 10650 | 11100 | 5130 | 5340 |
| 4th harmonics frequency limits | 4\*fx\_low | 4\*fx\_high | 4\* fy\_low | 4\* fy\_high |
| 4th harmonics frequency limits (MHz) | 14200 | 14800 | 6840 | 7120 |
| 5th harmonics frequency limits | 5\*fx\_low | 5\*fx\_high | 5\* fy\_low | 5\* fy\_high |
| 5th harmonics frequency limits (MHz) | 17750 | 18500 | 8550 | 8900 |
| 6th harmonics frequency limits | 6\*fx\_low | 6\*fx\_high | 6\* fy\_low | 6\* fy\_high |
| 6th harmonics frequency limits (MHz) | 21300 | 22200 | 10260 | 10680 |
| 7th harmonics frequency limits | 7\*fx\_low | 7\*fx\_high | 7\* fy\_low | 7\* fy\_high |
| 7th harmonics frequency limits (MHz) | 24850 | 25900 | 11970 | 12460 |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 1990 | 1770 | 5260 | 5480 |
| 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) | 5320 | 5690 | 280 | 10 |
| 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) | 8810 | 9180 | 6970 | 7260 |
| 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) | 8870 | 9390 | 1430 | 1790 |
| 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) | 3540 | 3980 | 10520 | 10960 |
| 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) | 12360 | 12880 | 8680 | 9040 |
| 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) | 3570 | 3140 | 13090 | 12420 |
| 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) | 1760 | 2270 | 7680 | 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) | 10390 | 10820 | 15910 | 16580 |
| 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) | 12230 | 12740 | 14070 | 14660 |

#### 5.1.x.4 REFSENS requirements

The required MSD is based on already completed CA\_n25A-n66A-n77A, since n48 is a subset of the frequency ranges in n77. This is also considered in the table as this reduces some of the 2nd 4th and 5th order IMD products of the reference combination when replacing n77 with n48.

**5.1.x.4-1: MSD due to IMD issue**

| **NR CA band combination** | **NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL CLRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** | **Source of IMD** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CA\_n25-n48-n66 | n25 | 1900 | 5 | 25 | 1980 | N/A | FDD | N/A |
| n48 | 3540 | 10 | 50 | 3540 | N/A | TDD | N/A |
| n66 | 1760 | 5 | 25 | 2160 | 10.4 | FDD | IMD4 |
| n25 | 1880 | 5 | 25 | 1960 | N/A | FDD | N/A |
| n48 | 3620 | 10 | 50 | 3620 | 29.4 | TDD | IMD2 |
| n66 | 1740 | 5 | 25 | 2140 | N/A | FDD | N/A |
| n25 | 1880 | 5 | 25 | 1960 | 32.1 | FDD | IMD2 |
| n48 | 3700 | 10 | 50 | 3700 | N/A | TDD | N/A |
| n66 | 1740 | 5 | 25 | 2140 | N/A | FDD | N/A |
| n25 | 1880 | 5 | 25 | 1960 | 2.1 | FDD | IMD5 |
| n48 | 3620 | 10 | 50 | 3620 | N/A | TDD | N/A |
| n66 | 1760 | 5 | 25 | 2160 | N/A | FDD | N/A |

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