**3GPP TSG-RAN WG4 Meeting # 109 revR4-2320992**

**Chicago, USA, 13th November – 17th, 2023**

**Title:** PC5 CA\_NS\_58 A-MPR

**Agenda Item:** 7.1.1.1

**Source: Skyworks Solutions, Inc.**

**Document for:** Approval

# 1 Introduction

Support for intra-band uplink (UL) carrier aggregation (CA) has recently been requested for Power Class 5 (PC5), Class B and Class C operations, in Band n102, which is also known as CA\_n102B, CA\_n102C. This band is subject to NS\_58 protection requirements. This document is a revision of R4-2320992 in which power amplifier (PA) measurements and A-MPR requirements for CA\_NS\_58 are revisited based on NS\_58 gating level of -22dBm/MHz.

# Discussion

## 2.1 Background

Table 1 summarizes the supported uplink (UL) configuration sets for CA\_n102B and CA\_n102C.

Table 1: CA\_n102B / CA\_n102C uplink configuration sets

|  |
| --- |
| **NR CA configuration / Bandwidth combination set** |
| **NR CA configuration** | **Uplink CA configurations or single uplink carrier5** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Maximum aggregated bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n102B | CA\_n102B | 20, 40 | 20, 40, 60, 80 |  |  |  | 100 | 0 |
| CA\_n102C | CA\_n102C | 80 | 40, 60, 80 |  |  |  | 160 | 0 |

Table 2 and Table 3 respectively, capture the in-band and the out-of-band (OOB) power spectral density (PSD) requirements expressed in dBm/MHz for CA\_NS\_58.

Table 2: CA\_n102B / CA\_n102C in-band PSD requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA Band** | **NS value** | **Aggregated channel bandwidth (MHz)** | **Frequency range (MHz)** | **Maximum mean power density (dBm/MHz)** |
| CA\_n102 | CA\_NS\_58 | 40, 60, 80, 100, 120, 140, 160 | 5945 – 6425 | 10 |

Table 3: CA\_n102B / CA\_n102C out-of-band PSD requirements

|  |  |  |
| --- | --- | --- |
| **Frequency band****(MHz)** | **Spectrum emission limit****(dBm)** | **Measurement bandwidth** |
| 87.5 ≤ f ≤ 118 | -54 | 100 kHz |
| 174 ≤ f ≤ 230 | -54 | 100 kHz |
| 470 ≤ f ≤ 694 | -54 | 100 kHz |
| f ≤ 5935 | -22 | 1 MHz |

It can be calculated that the in-band requirement of +10 dBm/MHz does not require any PA output-back-off (OBO) for any UL configurations. Hence:

* the A-MPR for CA\_NS\_58 is driven only by the out-of-band (OOB) -22 dBm/MHz requirements over the frequency range of f≤ 5935 MHz,
* only the lowermost channels of Band n102 are impacted by this OOB requirement.

Figure 1 shows several examples of primary component carrier (PCC) / secondary component carrier (SCC) configurations which experience the lowest gap or frequency separation distance to/from the out-of-band frequency range, where the -22 dBm/MHz OOB requirement applies.



Figure 1: Some CA\_n102B / CA\_n102C lowermost uplink channels with the lowest gap to OOB PSD frequency range.

**Observation 1: The A-MPR for CA\_NS\_58 is driven by the out-of-band (OOB) -22dBm/MHz requirements over the range f ≤ 5935 MHz. This requirement impacts only the lowermost channels for which the minimum "gap"/frequency separation distance to the frequency range of f ≤ 5935 MHz is 10 MHz.**

## 2.2 Measurement results and A-MPR proposal

#### Power Amplifier (PA) calibration

* Power Class: PC5
* Calibration point: 1 dB MPR for QPSK DFT-s-OFDM, 20 MHz 100RB3 waveform at 27 dB ACLR
* Post PA losses of 4 dB
* ACLR: 27 dB
* IQ image: -28 dB
* Carrier leakage: -28 dBc

Measurement results are presented as raw PA output back-off (OBO).

No back-off is needed to meet the in-band PSD requirement of +10 dBm/MHz for any UL CA aggregated BW.

The measured OBO required to meet the OOB -22 dBm/MHz requirements for a 10 MHz gap is plotted in Figure 2 for DFT-s-OFDM and CP-OFDM vs the agreed PC5 UL-CA MPR.



**Figure 2:** PC5 QPSK OBO to meet CA\_NS\_58 -27 dBm/MHz out-of-band requirements for 10 MHz gap vs PC5 UL-CA MPR for DFT-s-OFDM (blue line) and MPR for CP-OFDM (green line).

**Observation 2: The PC5 intra-band contiguous UL-CA MPR is sufficient to meet the out of band -22dBm/MHz requirements.**

Figure 3 compares the agreed 1UL A-MPR for NS\_58 vs the PC5 intra-band contiguous CA class B/C MPR. The NS\_58 1UL A-MPR is greater than the 2UL MPR for the following Partial RB allocations:

* DFT-s-OFDM QPSK, 16QAM,
* CP-OFDM QPSK.



|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |

Figure 3: NS\_58 A-MPR (left-Table 6.2F.3.8-1) vs PC5 UL-CA MPR (right-Table 6.2F.2A.2-1)

**Observation 3: The 1UL NS\_58 A-MPR is greater than the 2UL intra-band contiguous CA MPR for partial DFT-s-OFDM QPSK and 16QAM, and CP-OFDM QPSK RB allocations. Further discussions are needed to capture consistent A-MPR requirements between NS\_58 and CA\_NS\_58.**

# Conclusion

|  |  |  |
| --- | --- | --- |
| In this contribution, we present revised PA output back-off measurement results for CA\_NS\_58 A-MPR and we make the following observations. |  |  |
|  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |

**Observation 1: The A-MPR for CA\_NS\_58 is driven by the out-of-band (OOB) -22dBm/MHz requirements over the range f ≤ 5935 MHz. This requirement impacts only the lowermost channels for which the minimum "gap"/frequency separation distance to the frequency range of f ≤ 5935 MHz is 10 MHz.**

**Observation 2: The PC5 intra-band contiguous UL-CA MPR is sufficient to meet the out of band -22dBm/MHz requirements.**

**Observation 3: The 1UL NS\_58 A-MPR is greater than the 2UL intra-band contiguous CA MPR for partial DFT-s-OFDM QPSK and 16QAM, and CP-OFDM QPSK RB allocations. Further discussions are needed to capture consistent A-MPR requirements between NS\_58 and CA\_NS\_58.**

# References