­­­**3GPP TSG-RAN WG4 Meeting #94-e R4-200xxxx**

**Online, 24th February – 6th March, 2020**

Agenda Item: 9.18.1

**Source:** Murata manufacturing Co Ltd.

**Title:** REFSENS evaluation for n28 30MHz CBW

**Document for:** Approval

# 1. Introduction

A new WID in [1] has been approved in RAN#85. Based on WF [2], n28 supporting 30MHz REFSENS are proposed [3-6]. This contribution provides transmitter (TX) noise measurements in receiver (RX) band, and proposes REFSENS and UL configurations for UE operation in n28.

# 2. Discussion

According to WF[2], REFSENS are characterized with same configuration and two cases below:

* Evaluate two cases in band n28 with same UL allocation (assumption: 25RB for 15KHz SCS, 10RB for 30KHz SCS).
	+ Case 1: asymmetric channel bandwidth (UL 20MHz/DL 30MHz)
	+ Case 2: symmetric 30 MHz channel bandwidth
* For uplink configuration and assumptions, following MPR/AMPR characterization waveform is used:
	+ PA calibrated to deliver -30dBc ACLR for a fully allocated QPSK DFT-S-OFDM waveform at 1 dB MPR,
	+ -28 dBc image and carrier rejection,
	+ 30 MHz channel bandwidth located at the lowermost channel (703~733) (Center frequency is 718 MHz.)
	+ CIM3: 60 dBc
* CIM5 set to 70dBc.

UL configuration is agreed to set for n28 30MHz as below.

Table 2-1: Uplink configuration for reference sensitivity for case 2

| Operating band / SCS / Channel bandwidth / Duplex mode |
| --- |
| Operating Band | SCS kHz | 5MHz | 10MHz | 15MHz | 20MHz | 25 MHz | 30 MHz | 40MHz | 50MHz | 60MHz | 80MHz | 90MHz | 100 MHz | Duplex Mode |
| n28 | 15 | 25 | 251 | 251 | 251 |  | 251 |  |  |  |  |  |  | FDD |
| 30 |  | 101 | 101 | 101 |  | 101 |  |  |  |  |  |  |

## REFSENS for case 2

Table 2.1-1 shows parameters of receiver performance.

**Table 2.1-1 Parameters of receiver performance**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Unit** |
| Antenna isolation  | 10 | dB |
| Front-end loss  | 4 | dB |
| DPX\_ISO\_Tx freq | 50 | dB |
| DPX\_ISO\_Rx freq | 50 | dB |
| DPX\_ATT\_RX freq | 44 | dB |
| Div\_filter\_ATT | 46 | dB |
| Thermal noise at n28 RX ANT port | -165 | dBm/Hz |
| Transceiver effective phase noise due to wider BW | -144 | dBc/Hz |
| SNR requirement for QPSK | -1 | dB |

The PA output noise power at n28 RX frequency is -95.7dBm/Hz. REFSENS analysis is shown in table 2.1-2.

**Table 2.1-2 REFSENS analysis for case 2**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Main | Diversity | 　 |
| n28 TX power at antenna port (Primary path) | 23 | 23 | dBm |
| n28 PA output noise power at n28 RX freq | -95.7 | -95.7 | dBm/Hz |
| n28 TX noise power at n28 PRX LNA port | -71.1 | NA | dBm/30MHz |
| n28 TX noise power at n28 DRX LNA port | NA | -79.1 | dBm/30MHz |
| n28 receiver reciprocal mixing noise at LNA port | -92.4 | -102.4 | dBm/30MHz |
| TX IM2 due to wider CBW in n28 LNA input port | -87 | -107 | dBm |
| Total noise level refer to receiver LNA input port | -71.0 | -78.9 | dBm |
| REFSENS (30MHz BW) | -76.6 | dBm |

**Proposal 1: n28 REFSENS for case 2, symmetric channel bandwidth (UL 30MHz/DL 30MHz) is proposed highlighted as below:**

Table 2.1-3: n28 REFSENS for case 2

| Operating band / SCS / Channel bandwidth / Duplex-mode |
| --- |
| Operating Band | SCS kHz | 5MHz(dBm) | 10MHz(dBm) | 15MHz(dBm) | 20MHz(dBm) | 25MHz(dBm) | 30 MHz (dBm) | 40MHz(dBm) | 50MHz(dBm) | 60MHz(dBm) | 80MHz(dBm) | 90MHz(dBm) | 100 MHz(dBm) | Duplex Mode |
| n28 | 15 | -98.5 | -95.5 | -93.5 | -90.8 |  | -76.6 |  |  |  |  |  |  | FDD |
| 30 |  | -95.6 | -93.6 | -91.0 |  | -76.7 |  |  |  |  |  |  |

## REFSENS for case 2 (Full band DPX)

The legacy RF Front-End UE architecture for band 28 is based on the dual DPX approach. The dual DPX approach can be used for 30MHz CBW. If 40MHz CBW will be standardized, the full band DPX can be used. Table 2.2-1 shows parameters of receiver performance of full band DPX.

**Table 2.2-1 Parameters of receiver performance of full band DPX**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Unit** |
| Antenna isolation  | 10 | dB |
| Front-end loss  | 4 | dB |
| DPX\_ISO\_Tx freq | 50 | dB |
| DPX\_ISO\_Rx freq | 50 | dB |
| DPX\_ATT\_RX freq | 38 | dB |
| Div\_filter\_ATT | 39 | dB |
| Thermal noise at n28 RX ANT port | -165 | dBm/Hz |
| Transceiver effective phase noise due to wider BW | -144 | dBc/Hz |
| SNR requirement for QPSK | -1 | dB |

The PA output noise power at n28 RX frequency is -95.7dBm/Hz. REFSENS analysis is shown in table 2.2-2.

**Table 2.2-2 REFSENS analysis of full band DPX for case 2**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Main | Diversity | 　 |
| n28 TX power at antenna port (Primary path) | 23 | 23 | dBm |
| n28 PA output noise power at n28 RX freq | -95.7 | -95.7 | dBm/Hz |
| n28 TX noise power at n28 PRX LNA port | -71.1 | NA | dBm/30MHz |
| n28 TX noise power at n28 DRX LNA port | NA | -73.1 | dBm/30MHz |
| n28 receiver reciprocal mixing noise at LNA port | -92.4 | -95.4 | dBm/30MHz |
| TX IM2 due to wider CBW in n28 LNA input port | -87 | -93 | dBm |
| Total noise level refer to receiver LNA input port | -71.0 | -73.0 | dBm |
| REFSENS (30MHz BW) | -72.1 | dBm |

REFSENS of full band DPX is worse than dual DPX architecture. It is challenging to achieve the same characteristics as dual DPX approach. REFSENS of 30MHz CBW should be relaxed again when 40MHz CBW is standardized.

**Proposal 2: REFSENS of 30MHz CBW should be relaxed again when 40MHz CBW is standardized.**

# Conclusion

**Proposal 1: n28 REFSENS for case 2, symmetric channel bandwidth (UL 30MHz/DL 30MHz) is proposed highlighted as below:**

| Operating band / SCS / Channel bandwidth / Duplex-mode |
| --- |
| Operating Band | SCS kHz | 5MHz(dBm) | 10MHz(dBm) | 15MHz(dBm) | 20MHz(dBm) | 25MHz(dBm) | 30 MHz (dBm) | 40MHz(dBm) | 50MHz(dBm) | 60MHz(dBm) | 80MHz(dBm) | 90MHz(dBm) | 100 MHz(dBm) | Duplex Mode |
| n28 | 15 | -98.5 | -95.5 | -93.5 | -90.8 |  | -76.6 |  |  |  |  |  |  | FDD |
| 30 |  | -95.6 | -93.6 | -91.0 |  | -76.7 |  |  |  |  |  |  |

**Proposal 2: REFSENS of 30MHz CBW should be relaxed again when 40MHz CBW is standardized.**

Reference:

1. RP-192261 New WI proposal: Addition of wider channel bandwidth in NR band n28, TSG-RAN Meeting #85
2. R4-1912979 WF for 30MHz channel bandwidth for n28, RAN4#92-bis
3. R4-1911613 n28 supporting 30MHz, RAN4#92-bis
4. R4-1914190 n28 supporting 30MHz REFSENS evaluation, RAN4#93
5. R4-1916062 Experimental Measurements for n28 30MHz CBW REFSENS, RAN4#93
6. R4-1914499 Discussion on UE REFSENS for 30MHz channel bandwidth in band n28, RAN4#93