**3GPP TSG-****RAN WG4 Meeting** **#102-e R4-2205036  
E-meeting, 21st Feb. – 3rd March, 2022**

**Agenda item: 10.1.3.3**

**Source: CAICT, SAICT**

**Title:** **Views on PDP reference and pass/fail limits for FR1 MIMO OTA channel model validation**

**Document for: Discussion**

# 1 Introduction

In the last RAN4 meeting, PDP reference and pass/fail limits for FR1 MIMO OTA channel model validation have been discussed, but some issues are still unsettled and to be determined in the RAN4 #102-e meeting [1], as shown below.

**Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**

* RAN4 will make decision on the PDP target values for 2.45GHz and 3.6GHz UMi channel model in RAN4#102-e meeting.

**Issue 1-1-2: PDP pass/fail limits for FR1** **CDL-C UMa channel model validation**

*Agreement:*

* Option 2: Adopt the following relaxed PDP pass/fail limits

|  |  |  |
| --- | --- | --- |
|  | **Power Tolerance** | **Delay Tolerance** |
| **Paths from 0dB to 10dB** | [±1dB] | [±6ns] |
| **Paths from 10dB to 20dB** | [±2.5dB] | [±6ns] |
| **Paths from 20dB to 30dB** | [±5dB] | [±6ns] |
| **Paths from 30dB to 40dB** | TBD  Option 1: \_+/-10 dB  Option 2:   * +/-10 dB at 290 ns for UMa * +/-5 dB for others | [±6ns] |

* Note: above agreement with TBD has no impact on MIMO OTA lab alignment activity and timeline.
* RAN4 will make decision on remaining open issues on PDP pass/fail limit in RAN4#102-e meeting.

New PDP reference values for FR1 CDL-C UMa are determined in the last meeting [1]. Although CAICT has submitted FR1 CDL-C UMa channel model validation results in the last two RAN4 meetings [2, 3], we’d like to present our PDP measurement results again compared with the new PDP reference values for clearer demonstration. Besides, we share our views and considerations on the PDP reference values and pass/fail limits in this paper.

In addition, we provide our power validation results for FR1 CDL-C UMa channel model. Together with our previous contributions [2, 3], CAICT has provided a complete set of measurement results for FR1 CDL-C UMa channel model validation including Temporal correlation, Spatial correlation, PDP, Cross-polarization, and Power validation.

# 2 Discussion

2.1 FR1 channel model validation results

2.1.1 Power Delay Profile (PDP)

The PDP measurement results compared with the new PDP reference values in [1] are presented as follows. The PDP measurement results are the same as those submitted to the last RAN4 meeting in [3], and measured with a CE BW of 100MHz.

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(a) Beam 1 (b) Beam 2

**Figure 1. PDP measurement results and reference values for** **CDL-C UMa, fc** **≤ 2.5 GHz.**

**Table 1(a). PDP verification results for CDL-C UMa with Beam 1 and ≤ 2.5 GHz**

|  |  |  |  |
| --- | --- | --- | --- |
| **CDL-C UMa, Beam 1, X2V, 2450 MHz** | | | |
| **Delay (ns)** | **Reference PDP (dB)** | **Measured PDP (dB)** | **Delta (dB)** |
| 0 | -34.3 | -34.8542 | 0.5542 |
| 80 | -19.5 | -19.7636 | 0.2636 |
| 235 | 0 | 0 | 0 |
| 290 | -33 | -28.0233 | -4.9767 |
| 450 | -35.8 | -34.0147 | -1.7853 |
| 480 | -34 | -36.27 | 2.27 |

**Table 1(b). PDP verification results for CDL-C UMa with Beam 2 and** **≤ 2.5 GHz**

|  |  |  |  |
| --- | --- | --- | --- |
| **CDL-C UMa, Beam 2, X2V, 2450 MHz** | | | |
| **Delay (ns)** | **Reference PDP (dB)** | **Measured PDP (dB)** | **Delta (dB)** |
| 0 | -27.9 | -27.2592 | -0.6408 |
| 80 | 0 | 0 | 0 |
| 235 | -18.4 | -17.2282 | -1.1718 |
| 290 | -27.8 | -26.3147 | -1.4853 |
| 450 | -27.9 | -26.0239 | -1.8761 |
| 480 | -28 | -29.2896 | 1.2896 |

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(a) Beam 1 (b) Beam 2

**Figure 2. PDP measurement results and reference values for CDL-C UMa, fc** **> 2.5 GHz.**

**Table 2(a). PDP verification results for CDL-C UMa with Beam 1 and** **> 2.5 GHz**

|  |  |  |  |
| --- | --- | --- | --- |
| **CDL-C UMa, Beam 1, X2V, 3600 MHz** | | | |
| **Delay (ns)** | **Reference PDP (dB)** | **Measured PDP (dB)** | **Delta (dB)** |
| 0 | -34.2 | -34.98 | 0.78 |
| 80 | -19.3 | -19.4797 | 0.1797 |
| 235 | 0 | 0 | 0 |
| 290 | -34.7 | -28.1937 | -6.5063 |
| 450 | -35.8 | -34.1304 | -1.6696 |
| 480 | -34.7 | -36.8272 | 2.1272 |

**Table 2(b).** **PDP verification results for CDL-C UMa with Beam 2 and > 2.5 GHz**

|  |  |  |  |
| --- | --- | --- | --- |
| **CDL-C UMa, Beam 2, X2V, 3600 MHz** | | | |
| **Delay (ns)** | **Reference PDP (dB)** | **Measured PDP (dB)** | **Delta (dB)** |
| 0 | -27.8 | -27.3774 | -0.4226 |
| 80 | 0 | 0 | 0 |
| 235 | -18.3 | -16.9056 | -1.3944 |
| 290 | -28.9 | -26.9654 | -1.9346 |
| 450 | -28.1 | -25.9485 | -2.1515 |
| 480 | -28.8 | -30.0047 | 1.2047 |

2.1.2 Power Validation

The settings and test procedures are according to TS 38.151. The power validation results for band n41 and n78 are listed in Table 3.

**Table 3(a). Power validation results for CDL-C UMa, band n41 (Unit: dBm/30kHz)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CDL-C UMa, 2593 MHz** | | | | |
| **Measured V power** | **Measured H power** | **Measured total power** | **Expected** | **Delta** |
| -79.6244 | -79.5959 | -76.5999 | -77 | 0.4001 |

**Table 3(b). Power validation results for CDL-C UMa, band n78 (Unit: dBm/30kHz)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CDL-C UMa, 3550 MHz** | | | | |
| **Measured V power** | **Measured H power** | **Measured total power** | **Expected** | **Delta** |
| -79.9988 | -79.6618 | -76.8168 | -77 | 0.1832 |

2.2 Views on PDP reference and pass/fail limits

It can be observed from the PDP measurement results of beam 1 (Figures 1(a) and 2(a)) that the clusters around 290ns are overwhelmed by the sidelobes of the strongest cluster due to the filtering effect of the narrow CE BW. The clusters around 290ns are much weaker than the strongest one in power (<-30dB), but close to the strongest cluster in delay (<60ns). It is reasonable to define larger power tolerances for such kind of clusters.

Compared with CDL-C UMa, the weaker clusters in CDL-C UMi are closer to the strongest one in delay, as shown in Figure 3 and Table 4. The weaker clusters in CDL-C UMi are more likely to be overwhelmed by the sidelobes of the strongest cluster in measurement, which require larger power tolerance. Thus, for CDL-C UMi, +/-10dB power tolerance should be applied for all taps with path loss from 30 to 40dB.

**Proposal 1: Apply +/-10dB power tolerance for all taps with path loss from 30 to 40dB for FR1 CDL-C UMi channel model validation.**



1. CDL-C UMa (b) CDL-C UMi

Figure 3. Previous Reference X2V PDP of CDL-C UMa and CDL-C UMi beam 1 at ≤ 2.5 GHz [4, 5]

Table 4(a). Previous Reference X2V PDP table of CDL-C UMa beam 1 at ≤ 2.5 GHz [4]

|  |  |
| --- | --- |
| **Delay [ns]** | **Power [dB]** |
| 0.0 | -31.4 |
| 76.6 | -28.1 |
| 79.4 | -20.7 |
| 81.0 | -20.5 |
| 85.0 | -25.9 |
| 232.4 | 0.0 |
| 235.4 | -2.8 |
| 239.4 | -3.9 |
| 289.6 | -30.8 |
| 299.8 | -38.7 |
| 448.4 | -32.9 |
| 477.5 | -31.1 |

Table 4(b). Previous Reference X2V PDP of CDL-C UMi beam 1 ≤ 2.5 GHz [5]

|  |  |
| --- | --- |
| **Delay [ns]** | **Power [dB]** |
| 0.0 | -27.7 |
| 21.0 | -27.9 |
| 21.8 | -19.6 |
| 22.2 | -20.9 |
| 23.3 | -25.2 |
| 63.7 | 0.0 |
| 64.5 | -2.4 |
| 65.6 | -3.9 |
| 65.8 | -35.7 |
| 79.4 | -30.0 |
| 122.9 | -34.0 |
| 130.8 | -29.9 |
| 217.0 | -37.8 |
| 460.0 | -38.5 |

In the last RAN4 meeting, it was agreed to adopt the approach in R4-2118587 to generate the PDP reference values and the corresponding reference values for CDL-C UMa channel model have been determined. This approach can preclude the effect of the different CE BWs.

**Proposal 2: Adopt the approach in R4-2118587 to generate the PDP reference values for FR1 CDL-C UMi channel model.**

# 3 Conclusion

**Proposal 1: Apply +/-10dB power tolerance for all taps with path loss from 30 to 40dB for FR1 CDL-C UMi channel model validation.**

**Proposal 2: Adopt the approach in R4-2118587 to generate the PDP reference values for FR1 CDL-C UMi channel model.**

# References

1. R4-2203063, “WF on NR MIMO OTA”, CAICT, vivo, 3GPP RAN4#101-bis-e, Jan. 2022.
2. R4-2119558, “FR1 MIMO OTA channel model validation results”, CAICT, 3GPP RAN4#101-e, Nov. 2021.
3. R4-2201591, “FR1 MIMO OTA channel model validation results and views on PDP pass/fail limits”, CAICT, 3GPP RAN4#101-bis-e, Jan. 2022.
4. R4-2119379, “Beam Specific Reference Channel Emulation Curves for Validation Purposes for FR1 CDL-C UMa”, Keysight Technologies, Spirent Communications, CMCC, CAICT, 3GPP RAN4#101-e, Nov. 2021.
5. R4-2115759, “Reference Channel Emulation Curves for Validation Purposes”, Keysight Technologies UK Ltd, Spirent Communications, CMCC, CAICT, 3GPP RAN4#100-e, Aug. 2021.