**3GPP TSG-RAN WG4 Meeting # 95-e R4-2008961**

**Electronic Meeting, May 25th – June 5th, 2020**

**Agenda item:** 8.17, 8.19, 8.20

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [95e][133] NR\_BW

**Document for:** Information

# Introduction

The scope of this email discussion is to add channel bandwidth(s) support in bands n1, n3 and n65.

A-MPR regions and limits should be discussed for n1 (topic#1) and n65 (topic#3).

REFSENS desens should be discussed for n3 (topic#2).

# Topic #1: Adding 25MHz and 50MHz channel bandwidth in NR band n1

The scope of this topic is to specify requirements when introducing 50MHz channel BWs in band n1.

In RAN4#94-e meeting, CRs to introduce 25 MHz channel bandwidth were agreed (R4-2002843 and R4-2002845).

For 50 Mhz channel BW, A-MPR regions were defined but not the corresponding values (WF R4-2005185).

For this meeting, the submitted CRs should be agreed.

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2007324 | Huawei, HiSilicon, China unicom | CR to TS 38.101-1 |
| R4-2007325 | Huawei, HiSilicon, China unicom | CR to TS 38.104 |
| R4-2004692  Note this is a tdoc from RAN4#94-e-bis | Apple Inc. | **Proposal:** Use regions found in (*Table 1 below*) and combine (*Table 2 below*) and (Table 3 below) by using the maximum value of the individual cells to define n1 A-MPR. |
| R4-2000108  Note this is a tdoc from RAN4#94-e | Qualcomm | **Proposal 1**: Define n1 AMPR for B39/B34 protection as shown in (*Table 4 and Table 5 below*)  **Proposal 2**: Define n1 AMPR for B33/B34 protection as shown in (*Table 6 and Table 7 below*) |

## Open issues summary

As there was no other contributions else than the CRs for this meeting, it’s proposed to work on the CR directly and agree on A-MPR based on the proposal made in the CR.

### Sub-topic 1-1

Sub-topic description: A-MPR for 50MHz channel bandwidht in band n1.

**Issue 1-1: A-MPR values**

* Proposals
  + It seems the CR and previous proposals are aligned, better to focus on the CRs then.
* Recommended WF
  + Comment the submitted CRs.

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | See comment for CR: R4-2007324 |

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2007324 | Qualcomm:  Need to fix region from Rbend 7.74MHz to 14.4MHz. LCRB shold be max[1.08,max(0,12\*SCS\*Rbend-7.74)], which is kind of complicated. It is better to simplify, just say < max(0,12\*SCS\*Rbend-7.74).  Table 6.2.3.27-1: A-MPR regions for NS\_49   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Channel Bandwidth, MHz | Carrier Center Frequency, Fc, MHz | Regions | | A-MPR | | RBend\*12\*SCS  MHz | LCRB\*12\*SCS  MHz | | 50 MHz | 1945 ≤ FC ≤ 1955 | ≥7.74, <14.4 | <1.08, <max(0, 12\*SCS\*RBend – 7.74)  < max(0,12\*SCS\*Rbend-7.74). | A5 | | ≥36, <39.6 | <1.08 | A5 | | <39.6 | ≥18, <max (0, 12\*SCS\*RBend – 7.74) | A2 | | <39.6 | ≥max (0, 12\*SCS\*RBend – 7.74) | A1 | |
| Huawei: to Qualcomm, the original proposal is < 1.08 and < max(0,12\*SCS\*Rbend-7.74), hence LCRB should be min [1.08, max(0,12\*SCS\*Rbend-7.74)]. Would it be ok to take “< min [1.08, max(0,12\*SCS\*Rbend-7.74)]” ?  Qualcomm: To HW, we are ok with this revision if others are fine with it. I actually meant min instead of max, so let’s go with < min [1.08, max(0,12\*SCS\*Rbend-7.74)]. |
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| R4-2007325 |  |
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## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Sub-topic#1** | A-MPR regions were further discussed and seem to be agreed now, focus should be on agreeing on CRs. |

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | NA | NA |

### CRs/TPs

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2007324 | To be revised |
| R4-2007325 | Would be agreeable but need to be agreed in the 2nd round with revision of R4-2007324. |

## Discussion on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2008912 | Qualcomm: The CR that is revised from R4-2007324 is agreeable. |

## Summary on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2008912  (revision of R4-2007324) | Agreeable |
| R4-2007325 | Agreeable |

# Topic #2: Adding 40 MHz channel bandwidth (15, 30 and 60kHz SCS) in NR band n3

The scope of this topic is to specify REFSENS and A-MPR requirements when introducing 40 MHz channel BWs in band n3.

In RAN4#94-e meeting, it was agreed that no A-MPR requirement was needed. RB allocations for REFSENS were also agreed.

The only remaining open item is REFSENS limits.

For this meeting, the submitted CRs should be agreed.

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2007505 | Ericsson | CR to TS 38.104 |
| R4-2007506 | Ericsson | CR to TS 38.1041-1 |
| R4-2008134 | Skyworks | **Observation 1**: The measured 40MHz n3 Tx noise level in the Rx band reaches a minimum across of RB size allocation “LCRB” ranging approximately from 50 to 70 RBs.  **Observation 2**: At the agreed “LCRB” of 50 RBs (WF[1]), the measured 40MHz n3 Tx noise level in the Rx band is -40.4 dBm.  **Observation 3**: “LCRB” of 50 RBs (WF[1]) is a valid UL configuration for n3 40MHz Reference Sensitivity.  **Proposal 1:**  Table 1: Proposed n3 Two Antenna Port Reference Sensitivity.   | Operating Band | SCS kHz | 5  MHz (dBm) | 10  MHz (dBm) | 15  MHz (dBm) | 20  MHz (dBm) | 25  MHz (dBm) | 30 MHz (dBm) | 40  MHz (dBm) | Duplex Mode | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | n3 | 15 | -97.0 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 | -86.1 | FDD | | 30 |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 | -86.2 | | 60 |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 | -86.3 |  | |
| R4-2000088  Note this is a tdoc from RAN4#94-e | Qualcomm | **Proposal 2**: Use REFSENS values shown in Table 4.   | **Operating Band** | **SCS kHz** | **5**  **MHz (dBm)** | **10**  **MHz (dBm)** | **15**  **MHz (dBm)** | **20**  **MHz (dBm)** | **25**  **MHz (dBm)** | **30 MHz (dBm)** | **40**  **MHz (dBm)** | **Duplex Mode** | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | n3 | 15 | -97 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 | -81.6 | FDD | |  | 30 |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 | -81.7 | FDD | |  | 60 |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 | -81.8 |  | |

## Open issues summary

Agree on limits for 50MHz channel bandwidth.

### Sub-topic 2-1

Sub-topic description: REFSENS limits for 50MHz channel bandwidth

**Issue 2-1: REFSENS limit for 50 MHz channel bandwidth**

* Proposals
  + Option 1:

| **Operating Band** | **SCS kHz** | **5**  **MHz (dBm)** | **10**  **MHz (dBm)** | **15**  **MHz (dBm)** | **20**  **MHz (dBm)** | **25**  **MHz (dBm)** | **30 MHz (dBm)** | **40**  **MHz (dBm)** | **Duplex Mode** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| n3 | 15 | -97 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 | -81.6 | FDD |
|  | 30 |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 | -81.7 | FDD |
|  | 60 |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 | -81.8 |  |

* + Option 2:

| Operating Band | SCS kHz | 5  MHz (dBm) | 10  MHz (dBm) | 15  MHz (dBm) | 20  MHz (dBm) | 25  MHz (dBm) | 30 MHz (dBm) | 40  MHz (dBm) | Duplex Mode |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| n3 | 15 | -97.0 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 | -86.1 | FDD |
| 30 |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 | -86.2 |
| 60 |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 | -86.3 |  |

* Recommended WF
  + From the measurements 1.5dB desens would be needed, and not 6dB.

Further discuss and compromise on the limits.

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| Skyworks | Sub topic 2-1: We’ve had offline discussions where the difference in REFSENS proposals could be explained by different Tx noise in Rx rejection assumptions. Our REFSENS proposal is based on the agreed WF 50dB Tx noise rejection assumption. However, if we consider quadplexer implementation, a lower Tx noise rejection should be assumed. We propose a revised REFSENS level using the following worst case assumptions:   * + - Tx noise rejection in Rx band: 45dB     - Tx noise rejection in Tx to primary antenna port: 40dB     - Primary antenna to Diversity antenna isolation: 10dB.   With these parameters, the measured -40.4dBm Tx noise level falling in Rx band leads to a 4.5dB MSD, ie. the n3 REFSENS for 40MHz CBW operation is -83.1dBm. We have no objection to reverting the agreed WF 50dB isolation and use this new set of RF parameter assumptions to discuss the proposed n3 REFSENS level. |
| Qualcomm | Sub topic 2-1: Thanks Skyworks for performing the measurement. We can consider an average based on your new assessment with the Quad-plexer, but I need to assess the impact internally of REFSENS = -82.3dBm. We may need to wait until 2nd round to approve averaged value. |
| Ericsson | We could wait for the 2nd to conclude on the final value, the CR to 38.101-1 shall be revised anyway. |

### CRs/TPs comments collection

It’s proposed to comment on the CR based on the 2 proposals made for REFSENS (Issue 2-1).

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2007505 |  |
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| R4-2007506 |  |
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## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Sub-topic#1** | Wait for Qualcomm’s feedback on compromised REFSENS values.CR to TS 38.101-1 shall be revised anyway. |

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | NA | NA |

### CRs/TPs

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2007505 | Would be agreeable but need to be agreed in the 2nd round with revision of R4-2007506. |
| R4-2007506 | To be revised |

## Discussion on 2nd round (if applicable)

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| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2007505 | Qualcomm: REFSENS of -82.3dBm is agreeable as it is averaged with Skyworks value. |
| Draft R4-2008913 | Skyworks: We are ok with the proposed -82.3dBm REFSENS for n3 40MHz operation. CR is agreeable. |

## Summary on 2nd round (if applicable)

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| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2007505 | Agreeable |
| R4-2008913  (revision of R4-2007506) | Agreeable |

# Topic #3: Adding 50 MHz channel bandwidth (15, 30 and 60kHz SCS) in NR band n65

The scope of this topic is to specify requirements when introducing 50 MHz channel BWs in band n65.

In RAN#94-e meeting, REFSENS requirements were agreed (R4-2002856). It was also agreed to consider 5MHz offset at the upper edge and that band n3 is protected without A-MPR, assuming that filter reject will be at least 37dB.

For this meeting, the submitted CRs should be agreed.

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2007879 | Ericsson | A-MPR simulation results and proposals, see below. |
| R4-2007507 | Ericsson | CR to TS 38.104 |
| R4-2007508 | Ericsson | CR to TS 38.101-1 |
| R4-2008133 | Skyworks | **Observation 1:**  Band 34 protection highest PA back-off for PC3 operation in n65 50MHz operation is approximately 20dB and 18dB for operation at 1980 and 1975MHz, respectively. |
| R4-2004693  Note this is a tdoc from RAN4#94-e-bis | Apple Inc. | A-MPR simulation results and proposals, see below. |
| R4-2000089  Note this is a tdoc from RAN4#94-e | Qualcomm | A-MPR simulation results and proposals, see below. |

## Open issues summary

REFSENS values for 50MHz channel bandwidth have been also confirmed by measurements (R4-2002856). The only remaining issue is the A-MPR requirements (regions definition and associated limits).

### Sub-topic 3-1

Sub-topic description: A-MPR for 50MHz channel bandwidht in band n65.

**Issue 1-1: A-MPR regions and limits**

* Proposals
  + Option 1 (Qualcomm):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Center Frequency, Fc, MHz | Regions | | A-MPR | Meas. A-MPR DFT/CP |
| RBend\*12\*SCS  MHz | LCRB\*12\*SCS  MHz |
| 50 MHz | Fc = 1945 |  |  |  |  |
| ≤ 9 | > 0 | A3 | 16.5 |
| > 9, < 37.8 | ≥ 9.0 | A4 | 8/9.5 |
| > 9, < 37.8 | < 9.0 | A5 | 4/5.5 |
| ≥ 37.8 | > 0 | A3 | 16.5 |
|  |  |  |  |
| 50 MHz | 1945 < FC ≤ 1980 |  |  |  |  |
| ≤ 18 | > 0 | A1 | 24/22 |
| > 18, < 27.0 | ≥ 0 | A2 | 12.5 |
| ≥ 27.0 | > 0 | A1 | 24/22 |
|  |  |  |  |
|  |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 | A5 |
| Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | 22 | 12.5 | 17 | 8 | 4 |
| DFT-s-OFDM QPSK | 22 | 12.5 | 17 | 8 | 4 |
| DFT-s-OFDM 16 QAM | 22 | 12.5 | 17 | 8 | 4 |
| DFT-s-OFDM 64 QAM | 22 | 12.5 | 17 | 8 | 4 |
| DFT-s-OFDM 256 QAM | 22 | 12.5 | 17 | 8 | 4 |
| CP-OFDM QPSK | 24 | 12.5 | 17 | 9.5 | 5.5 |
| CP-OFDM 16 QAM | 24 | 12.5 | 17 | 9.5 | 5.5 |
| CP-OFDM 64 QAM | 24 | 12.5 | 17 | 9.5 | 5.5 |
| CP-OFDM 256 QAM | 24 | 12.5 | 17 | 9.5 | 5.5 |

* + Option 2 (Apple):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW (MHz) | Carrier Frequency  Fc (MHz) | RBend\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 50 | 1945 | ≤ 9 | > 0 | A3 |
| > 9, < 37.8 | ≥ 9 | A4 |
| > 9, < 37.8 | < 9 | A5 |
| ≥ 37.8 | > 0 | A3 |
| 50 | 1945 < Fc ≤ 1980 | ≤ 18 | > 0 | A1 |
| > 18, < 27 | > 0 | A2 |
| ≥ 27 | > 0 | A1 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Waveform | Modulation | A1 | A2 | A3 | A4 | A5 |
| Outer / Inner | Outer / Inner | Outer / Inner | Outer / Inner | Outer / Inner |
| DFT-s-OFDM | PI/2 BPSK | 14.5 | 10.0 | 14.0 | 5.0 | 5.0 |
| QPSK | 14.5 | 10.0 | 14.0 | 7.0 | 5.0 |
| 16QAM | 14.5 | 10.0 | 14.5 | 7.0 | 5.0 |
| 64QAM | 14.5 | 10.0 | 14.5 | 7.0 | 5.0 |
| 256QAM | 14.5 | 10.0 | 14.5 | 7.0 | 5.0 |
| CP-OFDM | QPSK | 16.5 | 11.5 | 14.5 | 8.5 | 6.0 |
| 16QAM | 16.5 | 11.0 | 14.5 | 8.5 | 6.0 |
| 64QAM | 16.5 | 11.5 | 14.5 | 8.5 | 6.0 |
| 256QAM | 16.5 | 11.5 | 14.5 | 8.5 | 6.0 |

* + Option 3 (Skyworks): Band 34 protection highest PA back-off for PC3 operation in n65 50MHz operation is approximately 20dB and 18dB for operation at 1980 and 1975MHz, respectively
  + Option 4 (Ericsson):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Frequency, Fc, MHz | Regions | | A-MPR |
| (RBend – LCRB + 1)\*12\*SCS  MHz | RBend \*12\*SCS  MHz |
| 50 MHz | FC ≤ 1945 | ≤ 14.4 | < 32.4 | A4 |
| > 14.4 | < 32.4 | A5 |
| ≥ 0 | ≥ 32.4 | A6 |
| 50 MHz | 1945 < FC ≤ 1980 | ≤ 14.4 | < 27 | A1 |
| > 14.4 | < 27 | A2 |
| ≥ 0 | ≥ 27 | A3 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 | A5 | A6 |
| Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | 8.5 | 2.5 | 16.5 | 7 | 1 | 15 |
| DFT-s-OFDM QPSK | 8.5 | 2.5 | 16.5 | 7 | 1 | 15 |
| DFT-s-OFDM 16 QAM | 8.5 | 2.5 | 16.5 | 7 | 1 | 15 |
| DFT-s-OFDM 64 QAM | 8.5 | 2.5 | 16.5 | 7 | 1 | 15 |
| DFT-s-OFDM 256 QAM | 8.5 | 2.5 | 16.5 | 7 | 1 | 15 |
| CP-OFDM QPSK | 9.5 | 4 | 17.5 | 8.5 | 3 | 15.5 |
| CP-OFDM 16 QAM | 9.5 | 4 | 17.5 | 8.5 | 3 | 15.5 |
| CP-OFDM 64 QAM | 9.5 | 4 | 17.5 | 8.5 | 3 | 15.5 |
| CP-OFDM 256 QAM | 9.5 | 4 | 17.5 | 8.5 | 3 | 15.5 |

* Recommended WF
  + Further discuss and align on A-MPR regions and associated limits for new NS to protect B34 and B33.

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| Skyworks | Sub topic 3-1:  **Issue 1-1: A-MPR regions and limits**  About A-MPR values: Our raw PA back-off measured levels tend to match option 1 R4-2000089 A-MPR proposed values, ie 22/24dB DFT/CP for 1945 < Fc ≤ 1980MHz.  About A-MPR regions: For the case where 1945 < Fc ≤ 1980MHz, considering the high A-MPR values, it might be worth considering splitting the A-MPR table into 3 regions, in particular for RB allocations where low A-MPR has been observed (measurements and simulation). |
| Qualcomm | Sub topic 3-1:  **Issue 1-1: A-MPR regions and limits**  Had offline discussion with Ericsson regarding ranges for AMPR.    We can optimize backoffs based on skyworks measurements for region A3 to 21dB/22dB at best for 1945 < Fc ≤ 1980MHz. It is impossible to get the low simulated AMPR for region A2 due to residual wideband noise. Only filtering can help this at Fc=1980MHz. The residual back-off for A2 region remains at 12.5dB. The best region A1 back-off is 14dB.  For Fc=1945MHz, the lowest measured back-off that can ne attained for region A5 is 4.5dB.  A4=7/8.5dB, A5=4.5dB, A6=17dB, and A7=14dB. |
| Ericsson | Ok, so based on previous offlien and Qualcomm’s latest inputs, A-MPR table would look like this:    A2 values look high… let’s finalized during the 2nd round while updating the CR. |
| Skyworks | To Qualcomm and Ericsson offline discussion results: Thank you for considering 3 region split for the case where 1945 < Fc ≤ 1980MHz . As discussed off-line:   1. Region A1: Our measurements indicate close to 15dB back-off is needed. We would like to recommend 15 dB for A1, 2. Region A3: At these levels of back-off, it seems difficult to justify 1dB MPR difference between CP-OFDM and DFT-S-OFDM. We would like to propose adopting 22dB for A3.   These comments are reflected in draft CR R4-2008914. This draftCR is agreeable to us. |

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2007507 | Company A |
| Company B |
|  |
| R4-2007508 | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Sub-topic#1** | The A-MPR regions and most of A-MPR values have been agreed. Remaining values should be confirmed during the 2nd round.  CR to TS 38.101-1 shoud be revised anyway to capture latest agreements. |

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | NA | NA |

### CRs/TPs

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2007507 | Would be agreeable but need to be agreed in the 2nd round with revision of R4-2007508. |
| R4-2007508 | To be revised |

## Discussion on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | Qualcomm: Per offline discussion with Ericsson and Skyworks  A1=15dB, A3=22dB |
|  | Skyworks: Apologies, for posting 2nd round comments in the 1st round section 3.3.1.  Here is a recopy:  To Qualcomm and Ericsson offline discussion results: Thank you for considering 3 region split for the case where 1945 < Fc ≤ 1980MHz . As discussed off-line:   1. Region A1: Our measurements indicate close to 15dB back-off is needed. We would like to recommend 15 dB for A1, 2. Region A3: At these levels of back-off, it seems difficult to justify 1dB MPR difference between CP-OFDM and DFT-S-OFDM. We would like to propose adopting 22dB for A3.   These comments are reflected in draft CR R4-2008914. This draftCR is agreeable to us. |

## Summary on 2nd round (if applicable)

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| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2007507 | Agreeable |
| R4-2008914  (revision of R4-2007508) | Agreeable |