**3GPP TSG-RAN WG4 Meeting # 102-e R4-22xxxxx**

**Electronic Meeting, February 21 – March 3, 2022**

**Agenda item:** 10.5.2

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [102-e][305] NR\_Repeater\_RF\_Part1

**Document for:** Information

# Introduction

RAN#90e approved a new “New WID on NR Repeaters” with RAN4 as the responsible WG, which includes development of FR1 FDD specifications as well as TDD specifications for FR1 and FR2. The scope of this email discussion focuses on RF conducted core requirements, the same as the agenda 8.5.2 for current meeting.

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: discuss the open issues and strive to minimize the open issues
* 2nd round: according to 1st round discussion, discuss left open issues for 2nd round, and strive to minimize the open issues, and strive to approve WF.

# Topic #1: power related conducted requirements

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2205971** | Huawei | TP to TS 38.106 clause 6.1 and 6.2 |

## Open issues summary

There is no power related issue in this meeting. Companies are encouraged to show comments about the only TP.

## Companies views’ collection for 1st round

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| R4-2205971 | Ericsson: The term “maximum carrier output power” should be removed as it is not used. Or if it is used, the word “carrier” should be dropped as there are no carriers for a repeater. |
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## Summary for 1st round

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

1. Topic #2: Emission related conducted requirements

NR repeater emission related conducted requirements are discussed in this thread, including UL ACLR/CACLR channel bandwidth definition, co-existence spurious and protection of FDD receiver spurious requirements.

* 1. Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2204557**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204557.zip) | CMCC | Proposal 1: the channel bandwidth for UL ACLR/CACLR is suggested as Min (BW of the highest or lowest carrier in the edge of passband, passband bandwidth).Observation 1: the principle to define inside OBUE is to choose the more stringent limit between gNB OBUE and ACLR. Here the ACLR is the more relax one between relative ACLR and absolute ACLR.Proposal 2: it’s suggested to define inside OBUE with following limit:-12dBm/MHz for WA, -25dBm/MHz for MR, -32dBm/MHz for LA.Observation 2: in-band emission requirements maybe lower than amplified noise in some case, making the requirements un-measurable.Observation 3: SEM as in UE spec is above noise floor when the frequency offset is less than channel BW.Proposal 3: it’s suggested that use the SEM limits as in UE spec with the frequency offset less than channel BW for inside OBUE.Proposal 4: it’s suggested to reuse the same co-existence spurious limit as NR gNB spec. such requirements are applicable for FDD UL and DL, DL for un-synchronized TDD and UL for synchronized TDD with maximum gain assumption to avoid extra interference to coexisting gNB receiver. Proposal 5: it’s suggested to define [-53]dBm/100KHz FDD spurious emission requirement for FDD repeater UL to protect the receiver of FDD gNB with 73dB CL assumption. Besides, it’s suggested to add some note into the spec like:NOTE: The requirements of [-53]dBm/100kHz in Table xxx for the up link direction of the Repeater reflect what can be achieved with present state of the art technology and are based on a coupling loss of 73 dB between a Repeater and a UTRA TDD BS receiver.NOTE: The requirements of [-53]dBm/100kHz in Table xxx shall be reconsidered when the state of the art technology progresses. |
| [**R4-2205203**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205203.zip) | Nokia, Nokia Shanghai Bell | TP to TS 38.106 clause 6.5 Unwanted emissions conducted |

* 1. Open issues summary

Agenda 10.5.2.2

Inside OBUE related issues are listed in topic #3.

* + 1. Sub-topic 2-1 bandwidth definitoin

**Issue 2-1: bandwidth for ACLR/CACLR/ACRR requirement definition**

* Proposals
	+ Option 1: min(100 MHz, BWpassband) (Nokia as in TP R4-2205203)
	+ Option 2: min (BW of the highest or lowest carrier in the edge of passband, BWpassband)

considering the scenarios when repeater hold several carriers but with different channel BWs, e.g. 160MHz passband with 100+60MHz carriers. (CMCC)

* Recommended WF
	+ Option 2.
	+ From moderator’s understanding, this definition applies for ACLR/CACLR and ACRR definition.

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| **Company** | **Comments** |
| CATT | We may be lost in the last meeting’s discussion. But as we used BS ACLR requirement, why don’t use BS approach? BWChannel and BWConfig are the *BS channel bandwidth* and *transmission bandwidth configuration* of the *lowest/highest carrier* transmitted on the assigned channel frequency.The wording may need some update for repeater. But it seems clearer to our understanding. For 100+60MHz case, two cases may need to be measured. B, M and T should be tested for BS as defined in TS 38.141. So the option 1 and option 2 are proposing only test one case?  |
| Ericsson | Option 2 does not work, because the repeater has no concept of carriers and carrier bandwidths. We think option 1 is fine, and it will not in general prevent problems for operators deploying different carrier bandwidths. If there is a concern on the 100MHz in option 1 it could be changed to something smaller, e.g., 50 or 60MHz. |
| Huawei | As the repeater does not generate carriers then it has no maximum channel BW other than the pass bandwidth. As such definitions with channel BW’s don’t really make sense. |

* + 1. Sub-topic 2-2 spurious requirements

**Issue 2-2-1: protection of the FDD BS receiver**

* Proposals
	+ Option 1: the same as LTE repeater spec, i.e. [-53dBm/100kHz] with 73dB CL assumption. (CMCC)
	+ Option 2: RAN4 needs to set requirements (Nokia)
* Recommended WF
	+ Option 1.

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| **Company** | **Comments** |
| CATT | Ok with Option 1. |
| Ericsson | This does not of course prevent interference to an FDD BS that is co-located with 30dB coupling loss. One possibility is to have an optional requirement based on assuming 30dB CL (presumably -13dBm/100MHz ?). The repeater can declare then whether it supports “normal” co-location to an FDD receiver (i.e. the stricter requirement) or an increase CL is needed to be achieved. |
| Huawei | To clarify we are talking about co-locating a repeater with FDD BS in same band? If this is only possible with increased isolation then are they really co-located? And if so what scenario does 73dB isolation represent? This isolation is much closer to co-existence type isolation figures? As co-location is optional if implementation cannot achieve it then that’s ok just don’t declare it. But it seems odd to change the co-location definition for just this case? And as its not that different from c-o-existence is there any point in having it (i.e. just use the note with the co-existence requirement) |

**Issue 2-2-2: if approve [-53dBm/100kHz] for FDD gNB, please further check whether to add following note into the spec**

* Proposals
	+ Option 1: the same as LTE repeater spec
		- NOTE: The requirements of [-53]dBm/100kHz in Table xxx for the up link direction of the Repeater reflect what can be achieved with present state of the art technology and are based on a coupling loss of 73 dB between a Repeater and a UTRA TDD BS receiver.
		- NOTE: The requirements of [-53]dBm/100kHz in Table xxx shall be reconsidered when the state of the art technology progresses.. (CMCC)
	+ Option 2: TBD
* Recommended WF
	+ Option 1.

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| **Company** | **Comments** |
| Ericsson | It may be better to create an optional, declared support for a closer co-location (30dB) with a stricter requirement. The note could then be updated to state that if this support is not declared then a larger coupling loss up to 73dB needs to be achieved if the optional requirement is not supported. The second note about technology progressing could then be skipped. |
| Huawei | Discuss the requirement be for the note, but whatever the conclusion it is possible to include such a note to explain the limitation. |

**Issue 2-2-3: co-existence spurious applicable scenarios**

* Proposals
	+ Option 1: FDD DL and UL, unsynchronized TDD DL with maximum gain (CMCC)
	+ Option 2: TBD
* Recommended WF
	+ Option 1.

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| **Company** | **Comments** |
| CATT | For TDD band, does it mean the same band or different band? If different band, why need to separate DL and UL? |
| Ericsson | Unlike a BS, which has only a DL transmitter a repeater has transmitters in both DL and UL. Presumably if emissions from either transmitter exceed the limits for enabling co-existence in the same geographic area at a particular out of band frequency range, then there could be interference. So our preliminary view is that there should not be a differentiation related to the UL/DL direction or the type of the other deployment, and requirements should be applied for both DL and UL.For the UL, it could possibly be argued that the deployment scenario may look different to DL, but in the absence of analysis we think it is prudent to apply the same limits to co-existence in the same geographical area as for DL.Note that compliance to these requirements is declared and could be declared separately for the DL (UE side) and UL (BS side) of the repeater. |

* 1. Companies views’ collection for 1st round
		1. Open issues

**Sub topic 2-1**

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| **Company** | **Comments** |
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**Sub topic 2-2**

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| **Company** | **Comments** |
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* + 1. CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| R4-2205203 | Ericsson:Note 1 in the tables needs attention as it refers to transmission bandwidth configuration and carriers. It needs to refer to the nominal bandwidth.For the CACLR table, the rows are not clear. Somewhere in the text it needs to be stated that the nomnial channel bandwidth is calculated as min(100MHz, passband). Then in the CACLR table the first column should refer to nominal channel bandwidth <= 20MHz or nominal channel bandwidth >20MHz. Currently it looks like two definitions for nominal channel bandwidth.For the OBUE section, “channel edge” is referred to in some places; this should be “passband edge”There is no need to use the term “basic limits” due to only type 1-C (although maybe OK for future proofing) |
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* 1. Summary for 1st round
		1. Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | Status summary  |
| Sub-topic #2-1 |  |
| Sub-topic #2-2  |  |

* + 1. CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

* 1. Discussion on 2nd round (if applicable)
1. Topic #3: other RF conducted requirements

NR repeater other RF conducted requirements are discussed in this thread, including low-power EVM, inside OBUE, IMD requirements, out of band gain and ACRR requirements.

* 1. Companies’ contributions summary

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| T-doc number | Company | Proposals / Observations |
| [**R4-2203947**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203947.zip) | CATT | Proposal 1: Option 2 is used with 35 dB below the maximum output power with the maximum gain set up.Proposal 2: 35 dB dynamic range is used for all of the BW. 8% EVM for QPSK can be the typical case for this requirement.Proposal 3: FR1 OBUE within pass band requirements follow FR2 agreement. |
| [**R4-2203945**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203945.zip) | CATT | Observation 1: The BS Tx filter rejection for the adjacent channel is less than the ACLR dB number.Observation 2: If there’s an ACRR requirement for BS, the number is estimated less than ACLR.Observation 3: The frequency offset for the out of band gain should be defined as the relative offset compared with BW not the absolute offset. |
| [**R4-2204558**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204558.zip) | CMCC | Proposal 1: the breakpoint of frequency to differentiate OOB gain requirements is suggested as 2.5GHz instead of 2GHz.Proposal 2: for LA repeater, there is no OOB gain requirement for the repeaters in which the operator owns the whole band or collaborates with operators in the whole band.Proposal 3: for ACRR, it is suggested to approve the option 2 in last meeting WF.Proposal 4: input IMD general requirement is applicable for FDD DL and UL and synchronized TDD DL at maximum gain. and the interference signal level for input IMD general requirements is -40dBm. Proposal 5: the general input intermodulation requirement is suggested as below:Table 2. Input intermodulation requirement

|  |  |  |  |
| --- | --- | --- | --- |
| f1 offset | Interfering Signal Levels | Type of signals | Measurement bandwidth |
| 1,0 MHz | -40 dBm | 2 CW carriers | 1 MHz |

Observation 1: if we don’t test equivalent NF into the conformance part, it seems better to just define NF into the spec rather than use low power EVM as the alternative because modulation scheme and BW factors into the formula is not constant and if they are just listed there as variate then the final formula just regulate NF.Proposal 6: NF equivalent requirements is defined based on different BW and is calculated based on EVM formula with the assumption that noise contribute to 50% EVM and the same NF assumption as gNB.For WA/dBm

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| EVM | 5MHz | 10MHz | 15MHz | 20 MHz | 25 MHz | 30MHz | 40 MHz | 50 MHz | 60 MHz | 70MHz | 80 MHz | 90MHz | 100 MHz |
| 8% | -77.01 | -74.00 | -72.24 | -70.99 | -70.02 | -69.23 | -67.98 | -67.01 | -66.22 | -65.55 | -64.97 | -64.46 | -64.00 |
| 3.5% | -70.01 | -67.00 | -65.24 | -63.99 | -63.02 | -62.23 | -60.98 | -60.01 | -59.22 | -58.55 | -57.97 | -57.46 | -57.00 |

 For MR/dBm

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| EVM | 5MHz | 10MHz | 15MHz | 20 MHz | 25 MHz | 30MHz | 40 MHz | 50 MHz | 60 MHz | 70MHz | 80 MHz | 90MHz | 100 MHz |
| 8% | -72.01 | -69.00 | -67.24 | -65.99 | -65.02 | -64.23 | -62.98 | -62.01 | -61.22 | -60.55 | -59.97 | -59.46 | -59.00 |
| 3.5% | -65.01 | -62.00 | -60.24 | -58.99 | -58.02 | -57.23 | -55.98 | -55.01 | -54.22 | -53.55 | -52.97 | -52.46 | -52.00 |

For LA/dBm

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| EVM | 5MHz | 10MHz | 15MHz | 20 MHz | 25 MHz | 30MHz | 40 MHz | 50 MHz | 60 MHz | 70MHz | 80 MHz | 90MHz | 100 MHz |
| 8% | -69.01 | -66.00 | -64.24 | -62.99 | -62.02 | -61.23 | -59.98 | -59.01 | -58.22 | -57.55 | -56.97 | -56.46 | -56.00 |
| 3.5% | -62.01 | -59.00 | -57.24 | -55.99 | -55.02 | -54.23 | -52.98 | -52.01 | -51.22 | -50.55 | -49.97 | -49.46 | -49.00 |

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| [**R4-2204559**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204559.zip) | CMCC | TP to TS 38.106 conducted EVM and input IMD |
| [**R4-2205025**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205025.zip) | Ericsson | Proposal 1: The lower power limit for EVM applicability is a requirement, not a declarable parameterProposal 2: The lower power limit should be applicable for all SCS and bandwidths. It is acceptable if the limit scales with bandwidth or SCS though.Proposal 3: The lower power limit may differ for different repeater classes (if it is absolute)Proposal 4: The lower power limit for EVM applicability may depend on the EVM level.Proposal 5: For OOB gain and ACLR, adopt option 2 from [2] |
| [**R4-2205026**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205026.zip) | Ericsson | Proposal 1: Adopt the OBUE level for the in passband “emissions” requirement.Proposal 2: For DL, adopt the same class specific OBUE as for the BSProposal 3: For UL, adopt the BS WA OBUE for the WA class Proposal 4: For UL, adopt UE SEM for the LA class. |
| [**R4-2205027**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205027.zip) | Ericsson | Draft TP to TS 38.106: Frequency stability and out of band gain requirements |
| [**R4-2205464**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205464.zip) | ZTE Corporation | **Observation 1:** for band 7, band 22 and band 30 in LTE based repeater spec, its frequency range is above 2GHz with its expected pass-band bandwidth larger than 20MHz in band 7 and band 22, the same frequency offset breaking point for out of band gain is reused. **Proposal 1:** **for the out of band gain for WA/MR class:** **Table 1: Out of band gain limits 1 for FDL,high – FDL,low ≤ 200 MHz**

|  |  |
| --- | --- |
| **Frequency offset, f\_offset\_CW** | **Maximum gain** |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 5,0 MHz | 45 dB |
| 5,0 ≤ f\_offset\_CW < 10,0 MHz | 45 dB |
| 10,0 MHz ≤ f\_offset\_CW | 35 dB |

**Table 2: Out of band gain limits 2 for 200 MHz < FDL,high – FDL,low ≤ 900 MHz**

|  |  |
| --- | --- |
| **Frequency offset, f\_offset\_CW** | **Maximum gain** |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 20,0 MHz | 45 dB |
| 20,0 ≤ f\_offset\_CW < 40,0 MHz | 45 dB |
| 40,0 MHz ≤ f\_offset\_CW | 35 dB |

**Proposal 2: for the repeater covers the whole 3GPP bands, to follow OOB gain in the table 1 and table 2 for further away from first 20MHz.** **Proposal 3: for LA UL, 20dB could be applied if pass-band is only part of band;.****Proposal 4: for WA/MR/LA DL, LTE ACRR requirement could be reused for NR ACRR requirement for below 2.5GHz.** **Proposal 5: for WA/MR/LA DL, NR ACRR requirement above 2.5GHz could be defined as following:** * **For above 2.5GHz with FDL,high – FDL,low ≤ 200 MHz, the ACRR requirement could be reused.**
* **For above 2.5GHz with 200 MHz < FDL,high – FDL,low ≤ 900 MHz, ACRR requirement could be defined as following**

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| **Repeater maximum output power** | **Channel offset from the centre frequency of the first or last 20MHz channel within the pass band.** | **ACRR limit** |
| P ≥ 31 dBm | 20 MHz | 33dB |
| P ≥ 31 dBm | 40 MHz | 33dB |
| P < 31 dBm | 20 MHz | 20dB |
| P < 31 dBm | 40 MHz | 20dB |

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| [**R4-2205465**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205465.zip) | ZTE Corporation | TP to TS 38.106 clause 6.9 ACRR requirement |
| [**R4-2205967**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205967.zip) | Huawei | **Proposal 1:** The minimum power EVM requirement is as follows:The EVM requirement is valid from the input level that produces the maximum *rated output power* (Prated,in) to the minim input power for a 5MHz channel shown in table x.x-1**Table : x.x-1 Minimum input power for EVM**

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| --- | --- |
| BS class | Minimum input power for a 5MHz channel (dBm) |
| Up to 64 QAM | 256QAM note 1 |
| WA | --75 | -68 |
| MR | -70 | -63 |
| LA | -67 | -60 |
| Note 1: 256 QAM optional by manufacturers declaration |

**Proposal 2:** The DL OBUR inside passband limits can be the same as the BS limits (for the appropriate class)**Proposal 3:** The UE SEM limit (-25dBm/MHz) can be used for the UL LA class**Proposal 4:** The BS WA OBUE limit is used for the UL WA class. |
| [**R4-2205970**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205970.zip) | Huawei | Proposal 1: Use the breakpoint of 2.5GHzProposal 2: if any part of the pass-band is below 2.5GHz use the requirements for below 2.5GHz. Proposal 3: Maintain 45dBc ACRR in DL above 2.5GHzProposal 4: We do not wish to change any agreements on ACRR unless they are open in this WF but there seems to be some contradictions, we agree with option 1 for OOB gain section that UL ACRR should at least as good as ACLR i.e. 45dBc.Proposal 5: For UL LA ACRR option 1 is preferred (although the agreed 31dBc for UL LA ACLR is also ok).Proposal 6: For DL ACRR option 1 is preferred |
| [**R4-2206045**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206045.zip) | Nokia, Nokia Shanghai Bell | **Observation 1: In maximum output power case thermal noise has minor impact on EVM with the given assumptions (20 dBm output power, 70 dB gain, 100 MHz bandwidth)****Proposal 1: Specify 64QAM EVM of 8% to be applicable down to** * **-81 dBm/MHz input PSD levels for wide area repeaters, both in UL and DL**
* **-76 dBm/MHz input PSD levels for medium range repeaters, in DL**
* **-73 dBm/MHz input PSD levels for local area repeaters, both in UL and DL**

**Proposal 2: Apply E-UTRA OOB gain requirements below 2.5 GHz for both WA/MR repeater class both for DL and UL.****Proposal 3: Apply the following OOB gain requirement above 2.5 GHz for both WA/MR repeater class both for DL and UL.**

|  |  |
| --- | --- |
| **Frequency offset, f\_offset\_CW** | **Maximum gain** |
| 0,2 MHz < f\_offset\_CW ≤ 4,0 MHz | 60 dB |
| 4,0 MHz < f\_offset\_CW ≤ 15,0 MHz | 45 dB |
| 15,0 MHz ≤ f\_offset\_CW | 35 dB |

**Observation 2: It is preferable to have a single requirement which is not dependent on operator coordination or spectrum ownership.****Proposal 4: Consider manufacturer declaration to state the limitations for repeaters using the less stringent requirement set.** **Proposal 5: UL ACRR is set to 33 dB for all classes. DL ACRR is set to 45 dB for WA and MR classes and to 39 dB for LA class.****Proposal 6: ACRR is specified over min(passband bandwidth, 100 MHz) of bandwidth immediately adjacent to repeater passband.** |

* 1. Open issues summary

Agenda 10.5.2.3.

* + 1. Sub-topic 3-1 low-power EVM

**Issue 3-1-1: lower power limit for EVM: a requirement or a declarable parameter**

* Proposals
	+ Option 1: The lower power limit for EVM applicability is a requirement, not a declarable parameter. (Ericsson)
* Recommended WF
	+ The lower power limit for EVM applicability is a requirement, not a declarable parameter.

Note: We have agreement in last meeting that “Define core requirement for input level range for which EVM needs to be met, but test only maximum power”. above recommended WF is listed for further check.

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| **Company** | **Comments** |
| CATT | Support the WF. More discussion is needed, if there’s difference for different class. |
| Ericsson | To respond to CATT, we think there may be several limits dependent on the EVM level and class. The point though is that even if there are several class / EVM dependent lower limits, these should be requirements for each case (i.e., the repeater vendor declares the scenario and then conforms to the corresponding requirement). |
| Huawei | Agree with WF |

**Issue 3-1-2: lower power limit for EVM**

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| **Lower power limit for EVM****Candidate value** | **Margin below maximum output power** | **Absolute value** |  |
| **Equation** | **NF used for calculation** | **IM** | **CBW** | **EVM limits** |
| **Candidate value** | 35dB below maximum output power for all BW. This is dynamic range limit as defined in CCSA8% EVM for QPSK can be the typical case | Equation 1 | The same as gNB:5dB for WA10dB for MR13dB for LA | Option 1: sum of two part: 50% noise contribution to EVM corresponding to 3dB IM and extra 2dB IMOption 2: 3dB IM corresponding to 50% noise contribution to EVM | Option 1: 5MHzOption 2: The limit scales with bandwidth or SCS.Option 3: PSD level | Both consider 8% for up to 64QAM and 3.5% for 256QAM |
| Note: Equation 1: Minimum input power = -174 + 10\*log10(CBW) + NF - 20\*log10(EVM/100)+IM |
| **Company**  | **comment** | **comment** | **comment** | **comment** | **comment** | **comment** |
| Ericsson | We are OK with this approach, but we would also be OK to take an absolute limit instead |  |  |  | Ericsson: Option 3, the Nokia proposal of a PSD level is probably best (and is kind of equivalent to option 2) | Ericsson: We should consider both, but the lower limit will differ depending on the EVM level |
| Huawei | Absolute figure better links to a NF |  |  |  | By fixing BW we can avoid an equation in the requirement level, the advantages of this seem to outweigh the disadvantages but ultimately its same thing if we use PSD | Different power levels for different capabilities seems the best approach |

Please show your comment in above table: choose your preference method between “**margin below maximum output power**” and “**absolute value**”. Besides, choose your preference assumption.

Based on the assumption in above table, some proposals about low-power EVM are listed as below.

Moderator suggest to discuss above table at 1st round discussion. Once we have conclusion, we could choose final values from below options.

* Option 1: 35 dB below the maximum output power with the maximum gain set up. (CATT)
* Option 2: absolute value with 5dB IM, 5dB CBW assumption as in R4-2205967. (Huawei).
* **Table : x.x-1 Minimum input power for EVM**

|  |  |
| --- | --- |
| BS class | Minimum input power for a 5MHz channel (dBm) |
| Up to 64 QAM | 256QAM note 1 |
| WA | --75 | -68 |
| MR | -70 | -63 |
| LA | -67 | -60 |
| Note 1: 256 QAM optional by manufacturers declaration |

* Option 3: absolute value with 3dB IM, PSD assumption as in R4-2206045. (Nokia)
	+ -81 dBm/MHz input PSD levels for wide area repeaters, both in UL and DL
	+ -76 dBm/MHz input PSD levels for medium range repeaters, in DL
	+ -73 dBm/MHz input PSD levels for local area repeaters, both in UL and DL
* Option 4: absolute value with 3dB IM, all CBW configuration assumption as in R4-2204558. (CMCC)

**Issue 3-1-3: low-power EVM applicable gain**

* Proposals
	+ Option 1: Low-power EVM is defined with maximum gain set up. (CATT)
* Recommended WF
	+ Option 1: Low-power EVM is defined with maximum gain set up.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Ok with the WF |
| Ericsson | Not sure if there is a need to specify maximum gain in the requirement; isn’t it the lowest possible power at which EVM is met and the EVM should also be met over the rest of the range up to maximum power, regardless of how gain is set ? |
| Huawei | As it’s dependent on the input power does the gain matter? Certainly conformance can/should be done at max gain but the core should be valid for all gain settings? |

* + 1. Sub-topic 3-2 inside OBUE

**Issue 3-2-1: UL inside OBUE**

* Proposals
	+ Option 1: BS WA OBUE for WA and UE SEM for LA. (Ericsson)
	+ Option 2: BS WA OBUE for WA and UE SEM limit (-25dBm/MHz) for LA. (Huawei)
	+ Option 3: UE SEM within frequency offset less than channel BW. i.e. only consider -10dBm/MHz and -13dBm/MHz exclude -25dBm/MHz (CMCC)
* Recommended WF
	+ for WA, reuse BS OBUE requirements.
	+ for LA, reuse UE SEM requirements but further discuss which frequency offset ranges would be captured.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Ok with the WF. |
| Ericsson | OK with the WF |
| Huawei | WF ok |

**Issue 3-2-2: DL inside OBUE**

* Proposals
	+ Option 1: adopt the same class specific OBUE as for the BS. (Ericsson, Huawei)
	+ Option 2: -12dBm/MHz for WA, -25dBm/MHz for MR, -32dBm/MHz for LA to choose the more stringent limit between gNB OBUE and ACLR. Here the ACLR is the more relax one between relative ACLR and absolute ACLR (CMCC)
* Recommended WF
	+ TBA.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Option 1 seems reasonable. |

* + 1. Sub-topic 3-3 input IMD

**Issue 3-3-1: measurement bandwidth for input IMD**

* Proposals
	+ Option 1: 1MHz, the same as LTE repeater spec (CMCC)
	+ Option 2: TBD
* Recommended WF
	+ Option 1: 1MHz measurement bandwidth for FR1 input IMD.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Ok with the WF. |
| Ericsson | OK |
| Huawei | WF ok |

**Issue 3-3-2: testing points for input IMD**

* Proposals
	+ Option 1: only in the center of the passband (ZTE)
	+ Option 2: TBD
* Recommended WF
	+ Only test input IMD at the center of the passband.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Ok with the WF. |
| Ericsson | We think that it may be useful to discuss more the number of test points, but this is for the conformance discussion. We already agreed that the core requirement is applicable over the whole passband. |
| Huawei | Clearly a conformance issue, Gain is probably highest at centre and this is probably worst case for input IMD so probably ok. But we don’t need to discuss now, core should cover whole band. |

**Issue 3-3-3: applicable scenario for input IMD**

* Proposals
	+ Option 1: FDD DL and UL and synchronized TDD DL at maximum gain. (CMCC)
	+ Option 2: TBD
* Recommended WF
	+ Option 1.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Ok with the WF. |
| Ericsson | In our view, input IMD should always be met in both directions in order to be confident that the repeater is robust to other signals for both the UE and the BS sides. |
| Huawei | OK but again maybe this is conformance issue? |

* + 1. Sub-topic 3-4 out of band gain

[R4-2203024](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2203024.zip) is the approved WF on OOB gain in last meeting.

**Issue 3-4-1: frequency breakpoint to differentiate different limits**

* Proposals
	+ Option 1: 2.5GHz
		- Some clarification: If any part of the pass-band is below 2.5GHz use the requirements for below 2.5GHz
	+ Option 2: 2GHz
	+ Option 3: no frequency breakpoint. Instead using operation band frequency range to differentiate different limits (ZTE)
* Recommended WF
	+ TBA.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We support 2.5GHz, but to avoid the complication mentioned by Huawei we could more specifically set the breakpoint to 2496MHz (and then skip the part about the pass band being above/below the limit…) |
| Huawei | Option 1 or Ericsson idea, but option 1 seems more future proof (2496 might be ok for now but in future?), but it’s not a big deal |
| CMCC | 2.5GHz or 2496MHz are both OK for us. |

**Issue 3-4-2: WA/MR frequency offset for both DL and UL**

* Proposals
	+ Option 1: remove bracket in last WF, note: the discussion of frequency break point is in issue 3-4-1



* + Option 2: frequency offset to be aligned with that of OBUE requirements (ZTE)

Table 1: Out of band gain limits 1 for FDL,high – FDL,low ≤ 200 MHz

|  |  |
| --- | --- |
| Frequency offset, f\_offset\_CW | Maximum gain |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 5,0 MHz | 45 dB |
| 5,0 ≤ f\_offset\_CW < 10,0 MHz | 45 dB |
| 10,0 MHz ≤ f\_offset\_CW | 35 dB |

Table 2: Out of band gain limits 2 for 200 MHz < FDL,high – FDL,low ≤ 900 MHz

|  |  |
| --- | --- |
| Frequency offset, f\_offset\_CW | Maximum gain |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 20,0 MHz | 45 dB |
| 20,0 ≤ f\_offset\_CW < 40,0 MHz | 45 dB |
| 40,0 MHz ≤ f\_offset\_CW | 35 dB |

* + Option 3: frequency offset relative to passband BW (CATT)
* Recommended WF
	+ TBA.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | We think option 3 is reasonable which is based on the filter theory. We would not object other options if we’re the only company think option 3 is reasonable. |
| Ericsson | We are OK with option 1 (possibly changing 2.5GHz to 2496MHz) as long as the ACRR is set reasonably in addition (see comments on ACRR). We should consider together with ACRR. |

**Issue 3-4-3: LA frequency offset for both DL and UL**

* Proposals
	+ Option 1: relative offset to passband BW (CATT)
	+ Option 2: for further away from first 20MHz when repeater covers the whole 3GPP bands: frequency offset to be aligned with that of OBUE requirements (ZTE)

Table 1: Out of band gain limits 1 for FDL,high – FDL,low ≤ 200 MHz

|  |  |
| --- | --- |
| Frequency offset, f\_offset\_CW | Maximum gain |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 5,0 MHz | 45 dB |
| 5,0 ≤ f\_offset\_CW < 10,0 MHz | 45 dB |
| 10,0 MHz ≤ f\_offset\_CW | 35 dB |

Table 2: Out of band gain limits 2 for 200 MHz < FDL,high – FDL,low ≤ 900 MHz

|  |  |
| --- | --- |
| Frequency offset, f\_offset\_CW | Maximum gain |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 20,0 MHz | 45 dB |
| 20,0 ≤ f\_offset\_CW < 40,0 MHz | 45 dB |
| 40,0 MHz ≤ f\_offset\_CW | 35 dB |

* + Option 3: for further away from first 20MHz when repeater covers the whole 3GPP bands: no OOB requirements (CMCC)
* Recommended WF
	+ TBD.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | The same comment as above issue. |

**Issue 3-4-4: how to capture operator coordination or spectrum ownership into the spec?**

* Proposals
	+ Option 1: Consider manufacturer declaration to state the limitations for repeaters using the less stringent requirement set. (Nokia)
	+ Option 2: Capture “operator coordination or spectrum ownership” related content into the spec to differentiate applicable scenario for two set of requirements
* Recommended WF
	+ TBA.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Option 1; a declaration is needed that the repeater is intended only for operation when all operators collaborate (or not) |
| CMCC | Option 1 is preferred. |

* + 1. Sub-topic 3-5 ACRR

[R4-2203024](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2203024.zip) is the approved WF on ACRR in last meeting. And there are some contradictions of option 1 for ACRR in this WF. For example, in OOB gain part it states that for >20MHz to define 45dB ACRR but in ACRR part it states only 33dB. Besides, two options are listed in last meetings, so moderator’s suggestion is to continue ACRR discussion based on last meeting’s WF and proposals listed in this meeting.

**Issue 3-5-1: UL ACRR**

|  |  |  |
| --- | --- | --- |
| UL ACRR values | WA | LA |
| Passband is the whole band | Passband is part of the band |
| Option 1 (original option 1 in WF) | 45dB or 33dBThere is contradiction in last WF. | 33dB is not applicable | 33dB |
| Option 2 (original option 2 in WF) | 33dB | 20dB | 33 dB |
| Option 3 (Huawei) | 45dB | 33dB or 31dB |
| Option 4 (ZTE) | 33dB | 20 dB | 20 dB |
| Option 5 (Nokia) | 33dB | 33 dB | 33 dB |
| Option 6 (CATT) | Less than 45dB |

 **Recommended WF:**

* For WA, 33dBc ACRR.
* For LA,
	+ <2.5GHz and part of the band: 33dBc
	+ >2.5GHz and part of the band: 20dBc
	+ Whole passband: no ACRR

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Ok with the WF. |
| Ericsson | OK with 33dB for wide area, for local area below 2.5GHz and not full passband 33dB, above 2.5GHz and not full passband 20dB, no ACRR for LA if repeater covers the whole passband (all operators collaborate) |
| Huawei | Not clear why ACRR should be relaxed more than ACLR but we are ok to go along with majority. |

**Issue 3-5-2: DL ACRR**

|  |  |  |
| --- | --- | --- |
| DL ACRR values | Below 2.5GHz | Above 2.5GHz |
| WA/MR | LA | WA/MR | LA |
| Option 1 (original option 1 in WF) | [45]dB for WA/MR and LA with some exception:No ACRR if passband is the whole band for LA |
| Option 2 (original option 2 in WF) | [45]dB | NA if the whole band[45]dB for part of band | [33]dB | [20]dB |
| Option 3 (Nokia) | 45dB | 39 dB | 45 dB | 39 dB |
| Option 4 (ZTE) | The same as LTE repeater spec.33dB for not less than 31dBm output power20dB for less than 31dBm output power | **FDL,high – FDL,low ≤ 200 MHz: the same as LTE repeater spec****200 MHz < FDL,high – FDL,low ≤ 900 MHz** |
| Option 5 (CATT) | If there’s an ACRR requirement for BS, the number is estimated less than ACLR, i.e. <45dB |

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are OK with option 2, but there seems to be an error in the way it is stated. For LA below 2.5GHz it should be 45dB if part of band or NA if whole band. |
| CMCC | To Ericsson, Yes, there is an error in option 2 and I update it. We also prefer option 2. |

* 1. Companies views’ collection for 1st round
		1. Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

**Sub topic 3-1**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

**Sub topic 3-2**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

**Sub topic 3-3**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

**Sub topic 3-4**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

**Sub topic 3-5**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

* + 1. CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2204559 | Ericsson:For the EVM, there needs to be a description of the range of input power over which the core EVM requirement applies (for now, pending agreement a placeholder could be added)Since in this case the repeater receives an input from test equipment, maybe the description in 6.6.1 could be updated to:*The Error Vector Magnitude (EVM) is a measure of the difference between the symbols provided at the input of the repeater and the measured signal symbols at the output of the repeater after the equalization by the measurement equipment*.For 6.6.1.2, in the following sentence, since RBs are not allocated to a repeater maybe it is better to use the word “input” instead of “allocated”:*EVM requirements shall apply over all allocated resource blocks. Different modulation schemes listed in table 6.6.1.1-1 shall be considered for rank 1.*For the input intermodulation, we propose to change the sentence about the frequency applicability from:*The frequency separation between the two interfering signals shall be adjusted so that the 3rd order intermodulation product could fall into the whole pass band.*To:*The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the pass band*. |
| Company B |
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|  |
| R4-2205027 | Company A |
| Company B |
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| R4-2205465 | Ericsson: It is not obvious why the sentence “The carrier in the *pass band* and in the adjacent channel shall be of the same type (reference carrier)” is needed; from the fact that the spec is NR it is obvious that the input signal will be NR, and for the adjacent channel to the passband the requirement is on a gain.The section 6.9.1.1 should be removed as there is an agreement to define a minimum requirement. Also 6.9.2 should be removed as the requirement is not a co-existence requirement. 6.9.2.1 should then become 6.9.1.1In 6.9.2.1 (which becomes 6.9.1.1), there is a need to update according to agreements. Also, refer to the nominal bandwidth as agreed and also adjust the offset for the adjacent channel accordingly.  |
| Company B |
|  |
|  |
|  |

* 1. Summary for 1st round
		1. Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | Status summary  |
| Sub-topic #3-1 |  |
| Sub-topic #3-2 |  |
| Sub-topic #3-3 |  |
| Sub-topic #3-4 |  |
| Sub-topic #3-5 |  |

* + 1. CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

* 1. Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
|  |  |  |
|  |  |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)