**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-21xxxxx**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 9.1.1

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [98-bis-e][327] FR2\_enhTestMethods

**Document for:** Information

# Introduction

*The email discussion is separated into the following topics:*

* *Topic 1: high DL and low UL power*
* *Topic 2: polarization basis mismatch*
* *Topic 3: inter-band (FR2+FR2) CA*
* *Topic 4: extreme temperature conditions*
* *Topic 5: enhancements to reduce test time*
* *Topic 6: extension of permitted methods to band n262*
* *Topic 7: rapporteur input*

This contribution captures the outcome of the 2nd round of discussions.

# Topic #1: high DL and low UL power

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104522](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104522.zip) | vivo | **Discussions on test procedure of FR2 enhanced test methods**Observation 1: the overall applicability of these test methods is still very complicated, clear guidance on how to select the enhanced approach is needed.Observation []: the overall applicability of these test methods is still very complicated, clear guidance to RAN5 on how to select the enhanced approach is needed.Proposal 1: The detailed test procedure and rationale of CFFNF system should be added to the TR 38.884.Proposal 2: Further study whether the combination of DFF and NF system would increase the MU or not. |
| [R4-2104684](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104684.zip) | Huawei, HiSilicon | **On black box test**Observation 1: the field or power distribution close to device surface could be used to determine antenna locations within a few millimetres.Observation 2: the far field distances for various frequencies seem to be acceptable compared to those in Table 6 of [7].Proposal []: further study on this approach may be worth pursuing. |
| [R4-2106695](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106695.zip) | MVG Industries, Sony | **DNF Method**Observation 1: For this simulated antenna arrays config, EIRP and TRP errors are very minor.Observation 2: Path Loss and Beam pattern compensation would help to decrease the errors. |
| [R4-2107130](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107130.zip) | Keysight Technologies | **On CFFNF and CFFDNF test methodologies for high DL power and low UL power test cases**Observation 4: When performing measurements in the NF with CFFDNF methodology assuming the black&white-box approach, the path loss and probe antenna pattern must be compensatedObservation 5: CFFDNF simulations with 250 random offsets approximate the MUs (mean error and standard deviation) very wellObservation 6: CFFDNF simulations at 49GHz yield smaller MUs than at 28GHz.Observation 7: A local search to determine the optimized NF beam peak direction/EIRP after pathloss and feed pattern compensation is not necessary.Observation 8: The Matlab and CST antenna array patterns in the NF and FF are very similar.Observation 9: The Matlab and CST MU analyses for CFFDNF with black&white-box approach yield very similar MU results.Observation []: The CFFDNF methodology assuming the black&white-box approach with array offsets and the probe antenna pattern compensated is suitable for EIRP/EIS measurements with insignificant MU for PC3 devices with 8x2 antenna configuration when range length is greater or equal to 45cm. At smaller range lengths, small MUs (0dB) must be applied to the measurements.Observation 10: The CFFDNF methodology assuming the black&white-box approach with array offsets and the probe antenna pattern compensated is suitable for EIRP/EIS measurements with insignificant MU for PC3 devices with 4x1 antenna configuration when range length is greater or equal to 20cm.Observation 11: The CFFDNF methodology assuming the black&white-box approach with array offsets and the probe antenna pattern compensated is suitable with small MUs (0dB) for EIRP/EIS measurements for PC1 devices with 12x12 antenna configuration when range length is greater or equal to 45cm.Observation []: For PC3 TRP analyses based on the CFFDNF approach, - no additional MU is needed for range lengths exceeding 20cm if the path loss correction is applied for measurement grids with step size of at most 10o- no additional MU is needed for range lengths exceeding 43cm if the path loss correction is not applied for measurement grids with step size of at most 10oObservation []: For PC1 TRP analyses based on the CFFDNF approach, - no additional MU is needed for range lengths exceeding 20cm if the path loss correction is applied for measurement grids with step size of at most 5o- no additional MU is needed for range lengths exceeding 43cm if the path loss correction is not applied for measurement grids with step size exceeding 5oObservation 12: The CFFNF methodology with the black&white-box approach yields smaller MUs than the CFFDNF methodology.Observation 13: The CFFNF methodology assuming the black&white-box approach with array offsets and the probe antenna pattern compensated is suitable for EIRP/EIS measurements with insignificant MU for PC3 devices with 8x2 antenna configuration when range length is greater or equal to 21cm.Observation 14: Local Searches of the CFFNF methodology using black box approach can be accelerated using coarse&fine search grids and continuous scan measurements.Observation 12: The CFFNF methodology with the black&white-box approach yields smaller MUs than the CFFDNF methodology.Observation 13: The CFFNF methodology assuming the black&white-box approach with array offsets and the probe antenna pattern compensated is suitable for EIRP/EIS measurements with insignificant MU for PC3 devices with 8x2 antenna configuration when range length is greater or equal to 21cm.Observation 14: Local Searches of the CFFNF methodology using black box approach can be accelerated using coarse&fine search grids and continuous scan measurements.Proposal 1: Incorporate the presented MU results into TR 38.884Proposal 2: Capture in TR 38.884 that CFFNF and CFFDNF methodologies require the compensation of the path loss (w.r.t. to the active antenna array) and the compensation of the probe antenna patternRevision: Number of CFFNF and CFFDNF offset simulations were adjusted from 369 to 500 for 8x2 (PC3); additionally, 52 offset simulations for 12x12 (PC1) were included in the revisionRevision (v2): ‘Annex E: Additional Background on CFFNF Methodology/Asymptotic Expansion Approach’ was added to provide additional background and clarifications on the asymptotic expansion approach |
| [R4-2107187](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107187.zip) | Rohde & Schwarz | **Analysis of NF based solutions**Observation 1: the asymptotic expansion approach definition is not complete and has fundamental issues in the formulation.Observation 2: E-field dependence to and imply very small antenna aperture size.Observation 3: measurement distance close to reactive NF boundary requires NF to FF transform techniques based on magnitude and phase measurements, necessary to reliably reconstruct the Far Field data.Observation 4: manufacturer declaration is the easiest and most consistent way to obtain the antenna offset required for offset correction.Observation []: E-field dependence to and imply very small antenna aperture size.Proposal 1: do not consider CFFNF with transform as enhanced methodology for FR2 testing.Proposal 2: define 32 cm as minimum range length for CFFDNF systems to perform EIRP/EIS and TRP measurements for PC3.Proposal 3: adopt Black&white box approach as manufacturer declaration. |

## Open issues summary

### Sub-topic 1-1: CFFNF

**Issue 1-1-1: Determining the unknown antenna location in CFFNF setup**

- Alt 1-1-1-1: The detailed antenna location can be estimated by the three radii approach only
NOTE: this approach is already captured in TR 38.884 at the high level as “Three radii approach (i.e. local search on radius r1 and very localized searches at r2 and r3) can be used”

- Alt 1-1-1-2: In addition to the three radii approach, consider a scan of the field or power distribution close to device surface to determine antenna locations within a few millimetres

**Issue 1-1-2: CFFNF test procedure and rationale**

- Proposal: The detailed test procedure and rationale of CFFNF system should be added to the TR 38.884

**Issue 1-1-3: CFFNF MU elements**

Moderator’s note: the intention of this issue is to collect inputs on all proposed MU elements (or mechanisms which contribute to an MU element) for further investigation; round 2 of the discussion can be used to converge on the agreed set of MU elements which are applicable to CFFNF.

- Alt 1-1-3-1: compensation of the path loss (w.r.t. to the active antenna array)

- Alt 1-1-3-2: compensation of the probe antenna pattern

- Alt 1-1-3-3: switching between the FF and NF signal paths

- Alt 1-1-3-4: estimation of DUT antenna location

- Alt 1-1-3-5: EIRP measurement error
NOTE: this option added by the moderator; the assessment of this uncertainty element is covered in Issue 1-1-4

**Issue 1-1-4: Preliminary assessment of CFFNF MU**

- Alt 1-1-4-1: consider the preliminary assessment below as the starting point:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Antenna Configuration** | **Methodology** | **Number of Offsets** | **Range Length [m]** | **|Mean EIRP Error| w.r.t. FF [dB]** | **Std. Dev of EIRP at NF BP [dB]** |
| **8x2** | **CFFNF with black box approach** | **369** | 0.22 |  |  |
| 0.27 |  |  |
| 0.32 |  |  |
| **8x2** | **CFFNF with black&white-box approach** | **369** | 0.21 | 0.04 | 0.04 |
| 0.26 | 0.03 | 0.03 |
| 0.31 | 0.02 | 0.03 |

- Alt 1-1-4-2: Simple expansion techniques are too much sensitive to extrapolation error, as summarized below, and may only be feasible under high SNR conditions. Therefore, they are not suitable to solve the kind of testability issues defined in the scope of this SI

|  |  |  |  |
| --- | --- | --- | --- |
| SNR (dB) | Peak to Peak error (dB) | Mean error (dB) | Std. Deviation (dB) |
| 40 | 0.069 | -0.072 | 0.012 |
| 10 | 2.985 | 0.381 | 0.747 |
| 6 | 6.656 | 0.941 | 1.424 |

### Sub-topic 1-2: CFFDNF

**Issue 1-2-1: CFFDNF MU elements**

Moderator’s note: the intention of this issue is to collect inputs on all proposed MU elements (or mechanisms which contribute to an MU element) for further investigation; round 2 of the discussion can be used to converge on the agreed set of MU elements which are applicable to CFFNF.

- Alt 1-2-1-1: compensation of the path loss (w.r.t. to the active antenna array)

- Alt 1-2-1-2: compensation of the probe antenna pattern

- Alt 1-2-1-3: switching between the FF and NF signal paths

- Alt 1-2-1-4: EIRP measurement error
NOTE: this option added by the moderator; the assessment of this uncertainty element is covered in Issue 1-2-2

- Alt 1-2-1-5: TRP measurement error
NOTE: this option added by the moderator; the assessment of this uncertainty element is covered in Issue 1-2-3

**Issue 1-2-2: Preliminary assessment of CFFDNF MU (EIRP/EIS test cases)**

Moderator’s note: companies are encouraged to consider the below analyses as starting points to define the preliminary uncertainty estimate for the corresponding MU element for CFFDNF. In the end, a single value (or a set of values corresponding to certain frequencies of operation) is needed for the preliminary assessment of the MU budget.

- Alt 1-2-2-1: consider the preliminary assessment below as the starting point:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Antenna Configuration** | **Methodology** | **Number of Offsets** | **Range Length [m]** | **|Mean EIRP Error| w.r.t. FF [dB]** | **Std. Dev of EIRP at NF BP [dB]** |
| **8x2** | **CFFDNF with black&white-box approach** | **369** | 0.2 | 0.42 | 0.19 |
| 0.25 | 0.22 | 0.07 |
| 0.3 | 0.14 | 0.04 |

- Alt 1-2-2-2: consider the preliminary assessment below as the starting point:

|  |  |  |
| --- | --- | --- |
| Range Length | Mean EIRP error (dB) | EIRP Std. Deviation (dB) |
| 20cm | -0.555 | 0.538 |
| 25cm | -0.209 | 0.400 |
| 30cm | -0.049 | 0.360 |
| 35cm | 0.007 | 0.364 |
| 40cm | 0.076 | 0.418 |
| 45cm | 0.094 | 0.391 |
| 20m | 0.036 | 0.058 |

- NOTE from authors of [R4-2107187]: After a first analysis, it was confirmed that the limited performance in terms of EIRP can be explain by the 5º step grid selected for these simulations. Thus, revised results with a smaller grid together with the corresponding simulation results for 4x2 and 12x12 antenna array cases will be shared in a revised (late) contribution for this meeting.

**Issue 1-2-3: Preliminary assessment of CFFDNF MU (TRP test cases)**

Moderator’s note: companies are encouraged to consider the below analyses as starting points to define the preliminary uncertainty estimate for the corresponding MU element for CFFDNF. In the end, a single value (or a set of values corresponding to certain frequencies of operation) is needed for the preliminary assessment of the MU budget.

- Alt 1-2-3-1: consider the preliminary assessment below as the starting point:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Antenna Configuration** | **Range Length [cm]** | **Constant Density Grid Step Size = [o]** | **With Path Loss Correction** | **Without Path Loss Correction** |
| **|Mean TRP Error| [dB]** | **TRP Std. Dev. [dB]** | **|Mean TRP Error| [dB]** | **TRP Std. Dev. [dB]** |
| **8x2** | **20** | 5 | 0.01 | 0.04 | 0.39 | 0.24 |
| 7.5 | 0.02 | 0.13 | 0.39 | 0.25 |
| 10 | 0.03 | 0.17 | 0.39 | 0.29 |
| **32** | 5 | 0.02 | 0.01 | 0.14 | 0.08 |
| 10 | 0.04 | 0.03 | 0.14 | 0.09 |
| **43** | 5 | 0.02 | 0.01 | 0.08 | 0.04 |
| 10 | 0.04 | 0.03 | 0.08 | 0.04 |
| **12x12** | **20** | 5 | 0.02 | 0.07 | 0.29 | 0.17 |
| 7.5 | 0.01 | 0.24 | 0.29 | 0.21 |
| 10 | 0.01 | 0.36 | 0.27 | 0.39 |
| **32** | 5 | 0.04 | 0.13 | 0.11 | 0.06 |
| 10 | 0.09 | 0.63 | 0.07 | 0.64 |
| **43** | 5 | 0.06 | 0.13 | 0.06 | 0.03 |
| 10 | 0.12 | 0.65 | 0.01 | 0.66 |

- Alt 1-2-3-2: consider the preliminary assessment below as the starting point:

|  |  |  |
| --- | --- | --- |
| Range Length | Mean TRP error (dB) | TRP Std. Deviation (dB) |
| 20cm | -0.519 | 0.357 |
| 25cm | -0.360 | 0.215 |
| 30cm | -0.274 | 0.145 |
| 35cm | -0.220 | 0.105 |
| 40cm | -0.184 | 0.080 |
| 45cm | -0.159 | 0.063 |
| 20m | -0.015 | 0.014 |

- NOTE from authors of [R4-2107187]: After a first analysis, it was confirmed that the limited performance in terms of EIRP can be explain by the 5º step grid selected for these simulations. Thus, revised results with a smaller grid together with the corresponding simulation results for 4x2 and 12x12 antenna array cases will be shared in a revised (late) contribution for this meeting.

### Sub-topic 1-3: DNF

**Issue 1-3-1: Applicability of the DNF setup**

- Proposal: The applicability of the low UL power/high DL power EIRP/EIS test cases in the known BP direction and with the black&white-box approach is feasible with compensation due to known antenna array offset

### Sub-topic 1-4: Summary of applicable enhancements

**Issue 1-4-1: Clear summary of applicable enhancements**

- Alt 1-4-1-1: Sumamrize the applicability of enhancements as proposed in R4-2107130

|  |  |  |  |
| --- | --- | --- | --- |
| **►Test Case ►** | **BP Searches & Spherical Coverage** | **TRP** | **EIRP/EIS** |
| ►Methodology ►▼Test Approach▼ | CFFDNF | CFFNF | CFFDNF | CFFNF | CFFDNF | CFFNF |
| Black Box | Yes (FF) | Yes (FF) | Yes (Note 1) | No (Note 6) | No (Note 7) | Yes (Note 4) |
| Black & White Box | Yes (FF) | Yes (FF) | Yes (Note 2) | No (Note 6) | Yes (Note 3) | Yes (Note 5) |
| Note 1: At >32cm, no offset compensation is required. If offset is determined from CFFNF approach, range length ≤32cm are applicable with offset approachNote 2: At range length ≤32cm, offset compensation is required while at >32cm, no offset compensation is required. Note 3: Whether a local search to determine the NF test direction and/or optimize EIRP/EIS is FFS; min. range lengths are FFSNote 4: Three radii approach with local searches can be used; EIRP/EIS can be approximated at very close distances (~22cm PC3; ~27cm PC1); unknown offset can be estimate accurately; other approaches no precludedNote 5: Two radii approach without local searches can be used; EIRP/EIS can be approximated at very close distances (~21cm PC3; ~26cm PC1); other approaches no precludedNote 6: not applicable since this approach is test time prohibitiveNote 7: This can be revised whenever empirical methods to determine the offset location are shown feasible |

- Alt 1-4-1-2: do not consider CFFNF with transform as enhanced methodology for FR2 testing.

## Companies views’ collection for 1st round

### 1Open issues

|  |  |
| --- | --- |
| **Issue** | **Company comments** |
| **Issue 1-1-1: Determining the unknown antenna location in CFFNF setup** | Keysight:Alt 1-1-1-1: supportAlt 1-1-1-2: while technically feasible, the implementation of the outlined approach would increase test system complexity and MU significantly since the proposed scan will have to be performed inside the chamber after the beam was locked to the FF BP. The applicability of this approach to non-planar devices, e.g., laptops with open screen, or devices with phantoms is likely rather limited |
| vivo: it would be beneficial if CFFNF proponents could share the impacts on the total measurement time, for both Alt 1 and Alt 2 approach. |
| Samsung: it is good to see black-box approach. A question to Alt 1-1-1-2: does the test range varies with the DUT surface shape for different test grid points? |
| OPPO:Similar view with vivo and Samsung. Alt 1-1-1-1 and Alt 1-1-1-2 can benefit the black box approach, but the cost is testing time increase. So the knowledge of total testing time increase will be helpful to make the comparison with the advantage of black box approach. |
| MVG: Alt 1-1-1-1: It is a possible solution. There are other techniques which should not be precludedAlt 1-1-1-2: we do share the same view as KYS. Holography is a valid technique but test system complexity would increase a lot as long as potentially MU. |
| R&S: The determination of the offset location should be left open for manufacturers to decide and make the conformance testing independent of it, thus implementing Black&white box approach with a vendor declaration.In addition, we still have concerns about the sensibility to extrapolation of the method in Alt 1‑1‑1‑1 since we are trying to determine by least square fitting the terms b1 and d1 with only 3 measurements at very close distances.Transforming the 1/d parameter into *x=1/d*, what we are actually doing is a linear regression *y=ax+b*, and trying to estimate best fitting *a* coefficient. From known publications (https://mathworld.wolfram.com/LeastSquaresFitting.html), the standard deviation of the estimate of *a* equals *sqrt(stdv(y)/(N-2))\*sqrt(1/N +avg(x)^2/(N\*stdv(x)))*. In the proposed application with asymptotic expansion, N=3. Taking the example with distances at 20, 21 and 22cm and then supposing a standard deviation on the measurements of 0.5 dB (the uncertainty of the RF measurement equipment is set to 1.08dB with σ=1), the uncertainty on the estimation of the *a = b1* coefficient with such a setup is no less than 6 dB. |
| Keysight: Comment to R&S: Alt 1-1-1-1: while we agree that other techniques should not be precluded, each technique should be introduced in the TR. We are planning to provide more test procedure details and results of the CFFNF methodology using black box approach in the next meeting. While we believe that the black&white-box approach with a vendor declaration is a valuable approach, we also believe that the black-box approach should be kept as an option since not every OEM might have detailed knowledge of the antenna architecture and the location of the antenna that contributes to the BP direction. Regarding the feedback from R&S: the fitting approach is certainly an integral feature of the asymptotic expansion approach. For the black-box approach, we are solving for three unknowns *b*1, *b*2 (of the asymptotic expansion formulation) and *d*1 (distance between array and probe antenna) which requires at least three radial measurements; while we agree that more measurements could be used to improve the accuracy, our data and previous empirical experience shows that we do not need to N>3, i.e., N=3 is sufficient. We have not observed the uncertainties highlighted above in any of our simulations and experimental verifications of the black&white-box approach (N=2) using base stations; we believe the data presented clearly shows the validity of this approach.We appreciate R&S’ detailed review of the asymptotic expansion approach and valuable feedback provided. We still do not see how some of the highly theoretical concerns not encountered in our analyses and experiments suggest limiting the applicability to CFFDNF only.Comment to vivo:We will present estimates of the black-box approach for CFFNF in terms of the number of grid points needed for the local searches around the FF BP direction and corresponding impact on MU at the next meeting. |
| R&S (in response to Keysight):We think that defining the black&white-box approach as the baseline for conformance testing is the easiest and most consistent way, which gives the UE manufacturers the freedom to decide the method to determine the offset. It gives also the ability to TE vendors to develop their own methods to determine the antenna offset and provide them to UE manufacturers and labs eventually, but always making sure the final declaration for conformance is done by UE manufacturer. With regards to the three radii approach, we just want to make sure the extrapolation method is fully assessed under realistic conditions to fully characterize what is the expected performance in the final implementation. As mentioned in our contribution and other comments under topic #1, we understand that any expansion/extrapolation technique is very much sensitive to many factors compared to a direct measurement, and thus it is affected by MU contributors that otherwise can be treated independently as done in direct measurements. |
| Huawei: (To answer questions on alt 1-1-1-2)A scan to estimate the antenna position takes less than an hour. The MU in this approach would be due to the antenna position estimation errors of a few millimeters and should not result in significant increase for the overall MU. Once the antenna position estimation is done, its location information can be used in scenarios such as open laptops or devices to be tested with phantoms. |
| **Issue 1-1-2: CFFNF test procedure and rationale** | Keysight: Details/rationale of the asymptotic expansion approach are provided in a revision (v2) of R4-2107130; a more extensive write-up of the test procedures can be provided in RAN4#99-e.  |
| R&S: Besides the discussion about the applicability of CFFNF in Sub-topic 1-4, we agree to this proposal since our analysis in R4-2107187 reveal several issues of the CFFNF approach following the information provided so far. |
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| **Issue 1-1-3: CFFNF MU elements** | Keysight: Alt 1-1-3-1: not clear this corresponds to an MU element as the compensation of path loss to centre of QZ does not have an MU elementAlt 1-1-3-2: as long as the NF pattern of the probe antenna is known, the MU should be small or insignificantAlt 1-1-3-3: since each path is calibrated, it is not clear how this corresponds to an MU element Alt 1-1-3-4: agreed (applies to black box and black&white box)Alt 1-1-3-5: covered in 1-1-4 |
| Vivo：Alt 1-1-3-2 if the compensation of probe antenna is not considered in the test procedure, then an additional MU element due to probe pattern in the NF distance maybe needed. Alt 1-1-3-4: agree that this aspect should be considered  |
| OPPO:Alt 1-1-3-1: a clarification question to check if my understanding is correct: is it going to introduce an MU element to evaluate the accuracy of path loss compensation between the center of QZ and the active antenna array? If yes, this Alt is highly related to Alt 1-1-3-4, and they can be combine into one MU element. |
| MVG:Alt 1-1-3-1: we don’t see the need of considering an MU element for the path loss compensationAlt 1-1-3-2: Based on the NIST 18-terms measurement uncertainty budget for NF pattern measurements, there is an MU element “Relative probe pattern”. This term is not used in case of NF to FF transform and if probe/AUT is several times smaller than the minimum range length then the probe pattern effects are small, especially in the main component.Alt 1-1-3-3: We are supporting the comments from KYS.Alt 1-1-3-4: this MU element shall be considered |
| R&S: all MU elements identified by the moderator should be considered, except for 1-1-3-3 (switching FF to NF). In addition, we have the following comments.Alt 1-1-3-1: compensation of the path loss error should take into account the imperfect determination of the FSPL compensation on either black-box or black&white box approaches. Alt 1-1-3-2 We agree that MU should be small, but different methods to determine the probe compensation and the corresponding correction might have different MU.We don’t think Alt 1-1-3-3 shall be considered as MU element since the measurements are not a combination of FF and NF measurements, but obtained only from the NF probe. Considering the DFF MU budget as starting point, NF path will be fully assessed (e.g. mismatch) with the contributions already in the budget.Alt 1-1-3-4 is only applicable under Black-box approach assumption, while we think that Black&white box approach is a better choice.Alt 1-1-3-5 shall consider the extrapolation error due to the expansion technique used for CFFNF, including but not limited to the SNR impact presented in R4‑2107187 and further discussed under Issue 1-1-4. In addition, and considering that all simulation results so far have assumed ideal probe antenna (“electromagnetically invisible field probe”), we propose an additional MU term related to the interaction between probe antenna and DUT antenna at these near distances from the DUT. I.e. the coupling between the probe antenna and the DUT might affect the S11 perceived at DUT antenna and therefore the behavior of the active components in the Tx chain.  |
| Keysight: response to R&SOn Alt 1-1-3-1: The argumentation for FSPL MU seems to take the unknown/known offset into account; we believe the MU related to offsets determination/declaration is already addressed in Alt 1-1-3-4On Alt 1-1-3-4: We believe the MU related to offset determination applies to both black-box and black&white-box approach since the location of the phase centre of the antenna does not necessarily correspond to the geometric centre. |
|  |
| **Issue 1-1-4: Preliminary assessment of CFFNF MU** | Keysight: Alt 1-1-4-1: support; black-box CFFNF data will likely be presented in RAN4#99Alt 1-1-4-2: not agree with the results presented in R4-2107187. Looking at Figure 2.3 2 for instance, it seems that the R&S simulations show that normalized power is decreasing as a function of distance while in KS simulations, the normalized power is increasing as a function of distance, e.g., Figure 19 of the revision (v2) of R4-2107130Our analyses of impact of SNR on EIRP shows the following results based on applying the asymptotic expansion approach at two sets of radii.

|  |  |  |  |
| --- | --- | --- | --- |
| **SNR (dB)** | **FF Power Reference (dBm)** | **(*r*1, *r*2, *r*3)=(7.5, 8.5, 9.5)cm** | **(*r*1, *r*2, *r*3)=(20, 21, 22)cm** |
| |Mean Err to FF Reference| (dB) | Est Std. Dev. (dB) | |Mean Err to FF Reference| (dB) | Est Std. Dev. (dB) |
| 6 | 83.28 | 0.01 | 0.08 | 0.10 | 0.22 |
| 10 | 83.28 | 0.05 | 0.05 | 0.04 | 0.14 |
| 15 | 83.28 | 0.08 | 0.03 | 0.01 | 0.08 |
| 20 | 83.28 | 0.09 | 0.02 | 0.00 | 0.04 |
| 25 | 83.28 | 0.09 | 0.01 | 0.01 | 0.02 |
| 30 | 83.28 | 0.09 | 0.00 | 0.01 | 0.01 |

In these results, the 8x2 antenna array was analysed using 10k different AWGN simulations and 10 averages were taken for each EIRP analysed. In each of the 10k AWGN simulations, we first generated a signal with 1000 samples, applied AWGN with specified SNR (e.g., 6dB, 10dB,…) on the signal, then measured the power of signal + AWGN at three distances r1, r2 and r3 to perform asymptotic expansion estimation.Clarification question regarding R4-2107187: How exactly was the noise applied? Did R&S apply noise using the approach as we did (described above), or was the noise directly applied to the three measured powers at r1, r2 and r3? We believe the approach outlined above is more closely aligned to actual OTA measurements  |
| Vivo: Alt 1-1-4-1 agree to consider the preliminary MU assessment. Besides, the minimum range length could be standardized for CFFNF. |
| R&S: The simulation results presented so far for CFFNF assume very much ideal conditions (e.g. unlimited SNR, ideal measurement probe with no NF impact on UE, etc.), and therefore missing key elements for the preliminary MU assessment. Therefore, it is required to make all those conditions clear to consider the results in Alt 1-1-4-1 part of the preliminary assessment. Extrapolation error due to the expansion technique used for CFFNF, including but not limited to the SNR impact presented in Alt 1-1-4-2, must be also included in the TR. To Keysight comments:* Figures 2.3-1(a) to 2.3-3(a) show the derivative of power to distance and not the normalized power. They are equivalent to the following plot in Keysight’s revised contribution (v2):

* We are actually curious about the results in your table above since the statistical behavior is quite different between 7.5 and 20cm cases.
	+ Did you assume some sort of correction of the SNR range at closer distances? If so, what is the reference point to add the SNR?
	+ We would expect that the derivative of power to distance suffer more from extrapolation errors at closer distances, but it’s actually the opposite according to your results.
* While we check our simulation results with the new assumptions (new formulation, averaging of 10 measurements, etc.) we would like to see the SNR evaluation for the 2 radii case (i.e. Black&White box approach) since we understand it is the proposed implementation for most test cases after the offset displacement is known (either by manufacturer declaration or the proposed 3 radii method).
* On the clarification question: the SNR was applied using the AWGN function in Matlab adding noise corresponding to the SNR point directly to the maximum EIRP obtained from each of the 3 distances, but no averaging was considered. In fact, the idea of averaging 10 measurements is new to the method and should be documented properly as discussed on Issue 1-1-2. Actually, most details of the method are still unclear to perform thorough evaluation to confirm its applicability.
 |
| Keysight (feedback to R&S):We assumed the same SNR regardless of distance and we believe the results are more sensitive to noise if the difference in power levels between *r*1, *r*2 and *r*3 is smaller when comparing with the power measurement error contributed by noise. At shorter distances, the rate of decay is greater and thus the difference in power levels is greater. Based on the feedback provided above, R&S used a different approach to apply SNR, i.e., directly to the measured EIRP, compared to KS, i.e., SNR was applied to the simulated signal before the measurements. As outlined earlier, we believe that our approach is more realistic. We are planning to provide additional simulations like the one suggested by R&S in round 2. Additionally, we are planning to demonstrate the effect of a fixed SNR at small *r* on SNR at larger *r* and thus the effect on measurement uncertainties. Additionally, we are planning to demonstrate how a fixed SNR at a small *ra* decreases at larger *rb>ra* and the effect on measurement uncertainties. |
| R&S (in response to Keysight):We understand the SNR is actually a function of the measurement equipment and that is the assumption in all studies for the influence of noise. We just care about the actual available SNR at the measurement receiver.Therefore, for the simulations, the SNR should be added to the measured EIRP and not the simulated signal. Therefore, it seems we need some further discussion to align on the simulation assumptions.  |
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| **Issue 1-2-1: CFFDNF MU elements** | Keysight: Alt 1-2-1-1: not clear this corresponds to an MU elementAlt 1-2-1-2: as long as the NF pattern of the probe antenna is known, the MU should be small or insignificantAlt 1-2-1-3: since each path is calibrated, it is not clear how this corresponds to an MU element Alt 1-2-1-4: covered in 1-2-2Alt 1-2-1-5: covered in 1-2-3 |
| MVG:Alt 1-2-1-1: Same comment as Alt 1-1-1-1Alt: 1-2-1-2: Same comment as Alt 1-1-1-2Alt 1-2-1-3: Same comment as Alt 1-1-1-3 |
| R&S: all MU elements identified by the moderator should be considered, except for 1-2-1-3 (switching FF to NF). In addition, we have the following comments.Alt 1-2-1-1: compensation of the path loss error should take into account the imperfect determination of the FSPL compensation on either black-box (when applicable) or black&white box approaches. Alt 1-2-1-2: we agree that MU should be small, but different methods to determine the probe compensation and the corresponding correction might have different MU.We don’t think Alt 1-2-1-3 shall be considered as MU element since the measurements are not a combination of FF and NF measurements, but obtained only from the NF probe. Considering the DFF MU budget as starting point, NF path will be fully assessed (e.g. mismatch) with the contributions already in the budget.Alt 1-2-1-4 and Alt 1-2-1-5 are fine and discussed separately. In addition, and considering that all simulation results so far have assumed ideal probe antenna (“electromagnetically invisible field probe”), we propose an additional MU term related to the interaction between probe antenna and DUT antenna at these near distances from the DUT. I.e. the coupling between the probe antenna and the DUT might affect the S11 perceived at DUT antenna and therefore the behavior of the active components in the Tx chain. |
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| **Issue 1-2-2: Preliminary assessment of CFFDNF MU (EIRP/EIS test cases)** | Keysight: Alt 1-2-2-1: the Matlab results with the 100k offset simulations might be more appropriate to be used as a baseline. The CST simulations were performed with a grid step size of 1deg (very fine) but the Matlab results calculated the EIRPs in the exact NF BP directions.Alt 1-2-2-2: once the grid step size is reduced, the data will likely converge with the data in Alt 1-2-2-1. Some clarification questions regarding the results in R4-2107187:* The results presented are after probe pattern compensation, i.e., probe antenna is assumed isotropic?
* Was the NF BP direction found after a local search or calculated (and then interpolated based on the 5deg grid step size)?
* How was the reference defined considering the mean EIRP error is <>0 or was this due to the 5deg grid step size
 |
| MVG:Alt 1-2-2-1: As far as we have understood the errors have been computed after the compensating the measured beam in NF, is it correct understanding? At least when range length is less than 43cm. how was the sampling grid? 1deg? What happen if 5deg is used as sampling grid?Alt 1-2-2-2: As pointed out by KYS, it would be nice to understand if the errors have been computed after applying any compensation. Was a compensation applied? what was the used sampling grid? What happens if a finer sampling grid (say 1deg) is used for? |
| R&S: Until additional results are available, we propose another alternative using the results in R4‑2107130 Table 4 which provide a better overview over different distances. Regarding results from R4-2107187 in Alt 1-2-2-2, please note that those results can be disregarded at this point given the issues we identified in our simulations. We are working to get updated results and they will be provided when ready.To Keysight questions:* Yes, the results are presented assuming an isotropic probe antenna.
* NF BP direction found after a local search, but we are checking the option to calculate it.
* The reference was defined as the FF peak directivity, equivalent to EIRP, at boresight and no DUT antenna offset. The mean EIRP error <>0 is due to the offset correction that was also applied at 20m. Even at these large distances there are small differences due to the change in FSPL and slightly different angles for peak directivity.
 |
| KeysightFeedback to MVG: In Matlab, we generally did not evaluate the EIRP pattern using a measurement grid as we calculated the EIRP at the theoretical NF BP direction for each range length and for each offset simulation. The one exception is the study summarized in Figure 16, where a scan using a 1deg step size around the FF BP direction was used to determine whether a local search (originally suggested by R&S) is needed or whether it is sufficient to calculate the NF BP direction (KS opinion). With CST, we performed a full 3D pattern evaluation for each offset and each range length, and this pattern used a 1deg step size. This step size was the same for each range length, i.e., even for range lengths less than 45cm. The EIRP results presented this meeting were all based on applying the offset compensation; the results in Annex B included results with and without the pattern gain offsets. In the last meeting (R4-2102616), we presented results of CFFDNF without pathloss compensation, e.g., Table 5, which clearly showed that the pathloss compensation is needed to achieve reasonable MUs with CFF(D)NF. Feedback to R&S:Thanks for the confirmation that your data should be discarded for now. We suggest to compare CFFDNF & CFFNF results in RAN4#99 meeting for the various simulation assumptions and to work offline on any additional questions/alignments. |
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| **Issue 1-2-3: Preliminary assessment of CFFDNF MU (TRP test cases)** | Keysight:Alt 1-2-3-1: preferred as baseline as the assessment includes with and without path loss correction Alt 1-2-3-2: considering a 5deg grid step size was used, the TRP MU results should match those from Alt 1-2-3-2 but they seem to be much higher (even higher than the results without pass loss correction). An analysis with different grid step sizes and with/without path loss correction would be good |
| MVG: Alt 1-2-3-1: We support KYS view to consider the assessment with and without compensationAlt 1-2-3-2: Specifically, TRP sampling grid does play a role. We would like to see on the errors go with sampling grid and compensation. You might think of fixing the sampling grid to 1deg and show the errors with and without compensation |
| R&S: Until additional results are available, we are fine with Alt 1-2-3-1.Regarding results from R4-2107187 in Alt 1-2-3-2, please note that those results can be disregarded at this point given the issues we identified in our simulations. We are working to get updated results and they will be provided when ready. |
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| **Issue 1-3-1: Applicability of the DNF setup** | Keysight: Alt 1-3-1: we do not agree with this proposal as the corresponding contribution R4-2106695 describes the CFFDNF methodology instead of DNF methodology in step 1a*To summarize, the following is the test/simulation procedure:**1. Beam peak search is performed in FF system setup**a. Beam is locked in the BP direction**2. Locked Beam is measured in NF system setup*We agree with this proposal once applied to CFFDNF which matches the observations made in R4-2107130 |
| MVG:The aim of our contribution was to show the EIRP and TRP errors when doing such measurement in NF for a beam locked in the FF BP direction (1a). Yes, this is the so called CFFDNF and errors are in line with R4-2107130 |
| R&S: Based on R4‑2106695, the simulation results supporting this proposal focus on “the black&white box approach and EIRP and TRP error when measuring the beam in NF. The difference with the previously reported simulation is that now BP direction is known from a FF measurement, and it is locked before being measured with the probe in NF.”Therefore, the system described is actually a CFFDNF and not a DNF system. |
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| **Issue 1-4-1: Clear summary of applicable enhancements** | Keysight: Alt 1-4-1-1: support. This table captures agreements (in written form) from last meeting; additional updates will likely be necessary based on analyses presented this meeting and nextAlt 1-4-1-2: do not support. A couple of important aspects of the asymptotic expansion approach should be pointed out: * The asymptotic expansion approach is suitable to estimate EIRP/EIS measurements at/near the beam peak using NF measurements. For arbitrary measurement directions or full FF pattern determination, a NF to FF transform is more suitable
* The asymptotic expansion approach is based on EIRP/EIS measurements in the radiative NF and not the reactive NF
* In theory, R&S is correct that electromagnetic field theory suggests that the fields follow a series of terms in the NF, especially the reactive NF. The asymptotic expansion approach was not meant to solve for the fields/power exactly but to approximate the rate of decay in the NF and thus estimate the FF based on a series of NF measurements for the BP direction only. Our results clearly show that the expansion approach is suitable to perform those approximations in the beam peak direction accurately even for not so small antenna apertures.

As outlined in the revision (v2) of R4-2107130, an even more accurate approximation was determined previously which yields a field/power dependence w.r.t (*kr*) that is commonly found in literature for the radiative NF |
| R&S: we don’t think CFFNF can be considered as applicable enhancement for FR2 testing given the analysis provided in R4‑2107187. In addition, there are other multiple unclear points which we find quite risky:* It implicitly assumes that the influence of the probe on the DUT can be neglected. It shall be verified starting from which distance this assumption can be reputed as valid. All simulations involve an electromagnetically invisible field probe.
* It supposes that all terms above 1/d^3 dependence in power can be neglected.
* It underestimates the uncertainty related to the least square fitting process, trying to identify two unknowns out of 2 or 3 measurements being very closely spaced together. Previous studies [[Newell, Baird, Wacker](https://ieeexplore.ieee.org/document/1140519)] to determine gain with similar experimental technique speak about a factor of 4 between the max and min distance of measurement necessary for a good fitting, as well as more than a 100 points.

Then regarding CFFDNF, and given the simulation results referred on Issues 1-2-2 and 1-2-3, the applicability definition can be simplified by defining a minimum range length of [32]cm for CFFDNF. Results for EIRP has been provided for 30 and 35cm, and can be extended to 32cm to confirm the concrete results for EIRP. Similar approach could be followed to determine the mean error and std deviation for TRP at 35cm.If so, the applicability for CFFDNF could be defined as follows:

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| ►Test Case ►▼Test Approach▼ | BP Search & Spherical Coverage | TRP | EIRP / EIS |
| Black Box | Yes (FF) | Yes (Note 1) | No (Note 4) |
| Black & White Box | Yes (FF) | Yes (Note 2) | Yes (Note 3) |
| Note 1: At >32cm, no offset compensation is required. Not applicable for range length ≤32cm. This can be revised whenever empirical methods to determine the offset location are shown feasible.Note 2: At range length ≤32cm, offset compensation is required while at >32cm, no offset compensation is required. Note 3: Applicable at range length >[32] cm. Whether a local search to determine the NF test direction and/or optimize EIRP/EIS is FFS.Note 4: This can be revised whenever empirical methods to determine the offset location are shown feasible |

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| Keysight: At this point, we cannot agree to downscope the applicability to CFFDNF only. We encourage R&S to implement the asymptotic expansion approach (or similar) once the issues with the CFFDNF methodology have been resolved. It should be highlighted that a subset of the CFFNF simulations (which R&S questions) were used to determine the CFFDNF MU (which R&S agrees to use as baseline); we believe that some theoretical issues of the asymptotic expansion approach highlighted by R&S are not justified given the CFFNF improvement in MU and the ability to perform measurements at closer distances compared to CFFDNF. Over the last three meetings, we have presented very promising results of the CFFNF methodology using black and black&white-box approaches. This work has been published and applied to FR2 base station OTA tests in the past, e.g., empirical results clearly showed the applicability and the accuracy [Hongwei Kong, Ya Jing, Zhu Wen, Li Cao, “Mid-field OTA RF test method: new developments and performance comparison with the compact antenna test range (CATR)”, 2020 14th European Conference on Antennas and Propagation (EuCAP)]. We believe that some of the arguments (impact of probe) above are applicable to CFFDNF as well and/or have been addressed already, e.g., NF testing based on NFFF transform, which R&S is a proponent of, performs measurements at even closer distances. We also believe that neglecting higher order 1/(*kr*)*i* terms is acceptable for measurements in the radiative near field and R&S previously supported this view [R4-1700531]. Again, we acknowledge that higher order terms need to be considered (especially in the reactive NF) to determine the exact field/power behavior. Our proposed approach is mainly focused on measurements in the radiative NF to estimate the FF EIRP/EIS. |
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### CRs/TPs comments collection

*N/A*

## Summary for 1st round

### Open issues

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| **Issue** | **Status summary**  |
| **Issue 1-1-1: Determining the unknown antenna location in CFFNF setup** | *Candidate options:*- Alt 1-1-1-1: The detailed antenna location can be estimated by the three radii approach onlyNOTE: this approach is already captured in TR 38.884 at the high level as “Three radii approach (i.e. local search on radius r1 and very localized searches at r2 and r3) can be used”Support: Keysight, MVG (other approaches are not precluded)Oppose: R&SRequest more information on the impact on measurement time: vivo, OPPO- Alt 1-1-1-2: In addition to the three radii approach, consider a scan of the field or power distribution close to device surface to determine antenna locations within a few millimetresSupport: HuaweiOppose: Keysight, MVGRequest more information on the impact on measurement time and other parameters (such as test range variability with DUT surface shape): vivo, OPPO, Samsung*Tentative agreements:*- Antenna location for the black&white box approach can be based on manufacturer declaration as a baseline; for this method the contribution to MU is FFS- Antenna location for the black box approach can be based on the three radii method; for this method the contribution to MU and impact on measurement time are FFS- Whether antenna location for the black box approach can be determined using a scan of the field or power distribution close to the device surface is FFS pending an understanding of the impact on MU, measurement time, test range, and system complexity. - The antenna location for the black&white box approach based on manufacturer declaration as a baseline should be captured in the TR as part of the detailed test procedure and rationale of the CFFNF system (see Issue 1-1-2): a TP is needed for the next meeting*Recommendations for 2nd round:*- Agreements are needed on the next steps for the three radii and field scan methods |
| **Issue 1-1-2: CFFNF test procedure and rationale** | *Candidate options:**Tentative agreements:*- The detailed test procedure and rationale of CFFNF system should be added to the TR 38.884: a TP is needed for the next meeting*Recommendations for 2nd round:*None |
| **Issue 1-1-3: CFFNF MU elements** | *Candidate options:*Moderator’s note: the intention of this issue is to collect inputs on all proposed MU elements (or mechanisms which contribute to an MU element) for further investigation; round 2 of the discussion can be used to converge on the agreed set of MU elements which are applicable to CFFNF.- Alt 1-1-3-1: compensation of the path loss (w.r.t. to the active antenna array)Applicable: R&SNot applicable: Keysight, MVGIf this MU element is used to evaluate the accuracy of path loss compensation between the center of QZ and the active antenna array, this it is already part of Alt 1-1-3-4: OPPO- Alt 1-1-3-2: compensation of the probe antenna patternApplicable: Keysight, vivo, R&SNot applicable: MVG- Alt 1-1-3-3: switching between the FF and NF signal pathsApplicable: Not applicable: Keysight, MVG, R&S- Alt 1-1-3-4: estimation of DUT antenna locationApplicable (black box and black&white box): Keysight, MVGApplicable (black box only): R&SApplicable (generally): vivoNot applicable: - Alt 1-1-3-5: EIRP measurement errorNOTE: this option added by the moderator; the assessment of this uncertainty element is covered in Issue 1-1-4Applicable: Keysight, R&SNot applicable: - Alt 1-1-3-6 (new): interaction between probe antenna and DUT antenna at the near distances from the DUT (proposed by R&S)*Tentative agreements:*- Merge Alt 1-1-3-1 and Alt 1-1-3-4, such that the new MU element relates to the estimation of DUT antenna location, including compensation of the path loss with respect to the active array, and is applicable to CFFNF using the black box approach - Alt 1-1-3-2: compensation of the probe antenna pattern- Alt 1-1-3-5: EIRP measurement error (covered in Issue 1-1-4)- Whether Alt 1-1-3-6 (new): interaction between probe antenna and DUT antenna at the near distances from the DUT can be introduced is FFS*Recommendations for 2nd round:*- Agreements are needed on the next steps to collect MU element descriptions and preliminary estimates of their values |
| **Issue 1-1-4: Preliminary assessment of CFFNF MU** | *Candidate options:*- Alt 1-1-4-1: see table in summarySupport: Keysight, vivoOppose: R&S- Alt 1-1-4-2: see table in summarySupport: R&SOppose: Keysight- R&S further clarified that simulations should take the SNR at the measurement receiver into account- Keysight further clarified that SNR should be assumed the same regardless of distance (i.e. noise applied to the simulated signal before measurements)*Tentative agreements:*None*Recommendations for 2nd round:*- Companies are encouraged to find a way forward on resolving the large discrepancy in uncertainty estimates for EIRP measurement error  |
| **Issue 1-2-1: CFFDNF MU elements** | *Candidate options:*Moderator’s note: the intention of this issue is to collect inputs on all proposed MU elements (or mechanisms which contribute to an MU element) for further investigation; round 2 of the discussion can be used to converge on the agreed set of MU elements which are applicable to CFFNF.- Alt 1-2-1-1: compensation of the path loss (w.r.t. to the active antenna array)Applicable: R&SNot applicable: Keysight- Alt 1-2-1-2: compensation of the probe antenna patternApplicable: Keysight, R&SNot applicable: - Alt 1-2-1-3: switching between the FF and NF signal pathsApplicable: Not applicable: Keysight, R&S- Alt 1-2-1-4: EIRP measurement errorNOTE: this option added by the moderator; the assessment of this uncertainty element is covered in Issue 1-2-2Applicable: Keysight, R&SNot applicable: - Alt 1-2-1-5: TRP measurement errorNOTE: this option added by the moderator; the assessment of this uncertainty element is covered in Issue 1-2-3Applicable: Keysight, R&SNot applicable: - Alt 1-1-3-6 (new): interaction between probe antenna and DUT antenna at the near distances from the DUT (proposed by R&S)*Tentative agreements:*- Whether Alt 1-2-1-1: compensation of the path loss (w.r.t. to the active antenna array) is applicable is FFS - Alt 1-2-1-2: compensation of the probe antenna pattern- Alt 1-2-1-4: EIRP measurement error (covered in Issue 1-2-2)- Alt 1-2-1-5: TRP measurement error (covered in Issue 1-2-3)- Whether Alt 1-1-3-6 (new): interaction between probe antenna and DUT antenna at the near distances from the DUT can be introduced is FFS*Recommendations for 2nd round:*- Agreements are needed on the next steps to collect MU element descriptions and preliminary estimates of their values |
| **Issue 1-2-2: Preliminary assessment of CFFDNF MU (EIRP/EIS test cases)** | *Candidate options:*- Alt 1-2-2-1: see table in summarySupport: Oppose: - Alt 1-2-2-2: see table in summarySupport: Oppose: - Alt 1-2-2-3 (new): R&S proposed to refer to Table 4 in R4-2107130:Table 4: CFFDNF simulation results utilizing black&white-box with antenna array offset and feed antenna pattern compensated.

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| **Antenna Configuration** | **Range Length [m]** | **|Mean EIRP Error| w.r.t. FF [dB]** | **Std. Dev of EIRP at NF BP [dB]** |
| 4x1 | 0.2 | 0.04 | 0.02 |
| 0.25 | 0.02 | 0.01 |
| 0.3 | 0.01 | 0.00 |
| 0.35 | 0.01 | 0.00 |
| 0.4 | 0.01 | 0.00 |
| 0.45 | 0.00 | 0.00 |
| 20 | 0.00 | 0.00 |
| 8x2 | 0.2 | 0.48 | 0.22 |
| 0.25 | 0.23 | 0.08 |
| 0.3 | 0.14 | 0.04 |
| 0.35 | 0.09 | 0.02 |
| 0.4 | 0.07 | 0.01 |
| 0.45 | 0.05 | 0.01 |
| 20 | 0.00 | 0.00 |
| 12x12 | 0.2 | 3.41 | 1.09 |
| 0.25 | 1.84 | 0.44 |
| 0.3 | 1.16 | 0.22 |
| 0.35 | 0.80 | 0.13 |
| 0.4 | 0.59 | 0.08 |
| 0.45 | 0.45 | 0.05 |
| 20 | 0.00 | 0.00 |

*Tentative agreements:*- Take Alt 1-2-2-3 as the baseline and finalize the MU element description and preliminary assessment of the value next meeting*Recommendations for 2nd round:*None |
| **Issue 1-2-3: Preliminary assessment of CFFDNF MU (TRP test cases)** | *Candidate options:**Tentative agreements:*- Take Alt 1-2-3-1 as the baseline and finalize the MU element description and preliminary assessment of the value next meeting*Recommendations for 2nd round:*None |
| **Issue 1-3-1: Applicability of the DNF setup** | *Candidate options:*Some companies commented that the described system is actually a CFFDNF system, and no candidate options related to the DNF setup were identified.*Tentative agreements:*None*Recommendations for 2nd round:*None |
| **Issue 1-4-1: Clear summary of applicable enhancements** | *Candidate options:*- Alt 1-4-1-1: Sumamrize the applicability of enhancements as proposed in R4-2107130Support: KeysightOppose: R&S- Alt 1-4-1-2: do not consider CFFNF with transform as enhanced methodology for FR2 testing.Support: R&SOppose: Keysight*Tentative agreements:*None*Recommendations for 2nd round:*- Companies are encouraged to discuss ways to seek convergence of this issue during the 2nd round. |

### CRs/TPs

*N/A*

## Discussion on 2nd round (if applicable)

### Open issues

**Issue 1-1-1: Determining the unknown antenna location in CFFNF setup**

*Recommendations for 2nd round:*

- Agreements are needed on the next steps for the three radii and field scan methods

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| **Company**  | **Comments** |
| Keysight | * More time is needed to finalize the approach to determine the unknown phase centre of the antenna array. Those results will be presented in RAN4#99-e
* The simulation assumptions are the same as those outlined in Table 3 of R4-2107130
* The asymptotic expansion approach follows the write-up in Annex E of the revision of R4-2107130; other approaches are not precluded
 |
| R&S | We support the definition of black&white box approach as the baseline, for both CFFNF and CFFDNF. The contribution to MU can be covered by estimation of DUT antenna location (Issue 1-1-3, Alt 1-1-3-4). |
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**Issue 1-1-3: CFFNF MU elements**

*Recommendations for 2nd round:*

- Agreements are needed on the next steps to collect MU element descriptions and preliminary estimates of their values

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| **Company**  | **Comments** |
| Keysight | We encourage OEMs to provide feedback on the maximum expected offsets between the geometric centre and the phase centre of antenna arrays |
| R&S | We join Keysight on the request for the maximum expected offset between geometric center **of the antenna array** with respect to the phase center, in order to perform an accurate evaluation of the error due to DUT antenna location in case of black&white box approach. |
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**Issue 1-1-4: Preliminary assessment of CFFNF MU**

*Recommendations for 2nd round:*

- Companies are encouraged to find a way forward on resolving the large discrepancy in uncertainty estimates for EIRP measurement error

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| **Company**  | **Comments** |
| Keysight | Progress on the SNR/Influence of Noise analyses was made. We are planning to provide a detailed overview and a description of our assumptions in RAN4#99-e. The following table summarized our key findings for CFFNF, CFFDNF, and DFF/IFF. For an *r*1=20cm CFFNF range length (distance between probe and centre of QZ), the min (max) distance between the probe and the antenna array is *d*CFFNF,min= *r*1-12.5cm (max offset)=7.5cm (*d*CFFNF,max=*r*1=20cm). Similarly, for the CFFDNF methodology with a range length of *r*CFFDNF=32cm, the min (max) distance between the probe and the antenna array is *d*CFFDNF,min = *r*CFFDNF-12.5cm=19.5cm (*d*CFFDNF,max = *r*CFFDNF=32cm). For the DFF/IFF calculations, we simply considered a *r*DFF/IFF=1m range length to simplify the table. In our calculations, we assumed an SNR of 6dB at *d*CFFNF,min=7.5cm from the antenna array and calculated the SNR at the various measurement distances between the measurement probe and the antenna array. The results clearly show that the impact of SNR on EIRP with the asymptotic expansion approach using two range lengths (*r*1=20cm, *r*2=21cm) is less than for the CFFDNF methodology with a single range length of 32cm and significantly less than for the DFF/IFF methodology.

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| **CFFNF (*r*1=20cm, *r*2=21cm)** | **CFFDNF (*r*CFFDNF=32cm)** | **DFF/IFF *r*DFF/IFF=100cm** |
| **(*d*CFFNF,min, *d*CFFDNF,min+1cm)=(7.5, 8.5)cm** | **(*d*CFFNF,max, *d*CFFDNF,max+1cm)=(20, 21)cm** | ***d*CFFDNF,min=19.5cm** | ***d*CFFDNF,max=32cm** |
| **SNR @ *d*min (dB)** | **SNR @ *d*min+1cm (dB)** | **|Mean Err to FF Ref.| (dB)** | **SNR @ *d*max (dB)** | **SNR @ *d*max+1cm (dB)** | **|Mean Err to FF Ref.| (dB)** | **SNR @ *d*min (dB)** | **|Mean Err to FF Ref.| (dB)** | **SNR @ *d*max (dB)** | **|Mean Err to FF Ref.| (dB)** | **SNR @ *r*DFF/IFF (dB)** | **|Mean Err to FF Ref.| (dB)** |
| 6 | 4.91 | 1.70 | -2.52 | -2.94 | 6.70 | -2.30 | 4.14 | -6.60 | 7.39 | -16.50 | 16.59 |
| 10 | 8.91 | 0.70 | 1.48 | 1.06 | 3.92 | 1.70 | 2.07 | -2.60 | 4.44 | -12.50 | 12.73 |
| 15 | 13.91 | 0.16 | 6.48 | 6.06 | 1.64 | 6.70 | 0.67 | 2.40 | 1.91 | -7.50 | 8.21 |
| 20 | 18.91 | 0.03 | 11.48 | 11.06 | 0.59 | 11.70 | 0.11 | 7.40 | 0.66 | -2.50 | 4.44 |
| 25 | 23.91 | 0.09 | 16.48 | 16.06 | 0.19 | 16.70 | -0.08 | 12.40 | 0.18 | 2.50 | 1.94 |
| 30 | 28.91 | 0.10 | 21.48 | 21.06 | 0.06 | 21.70 | -0.15 | 17.40 | 0.01 | 7.50 | 0.71 |

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| R&S | We agree that a detailed overview of the impact of SNR for next meeting is highly recommended, although we think the results presented in the table above are wrong. They assume that SNR level is injected at the output of the UE but, in that case, it should remain the same independent of the pathloss.As mentioned during 1st round, SNR/Influence of noise for testability analysis is a function of the measurement equipment (e.g. power sensor or spectrum analyzer for Tx measurements), and not the SNR of the transmitted signal by the UE. The latter will certainly affect the test results in case of poor UE design (e.g. by not meeting EVM requirements), but shall not be used to determine the accuracy of a method. Otherwise, the results from Keysight suggest that IFF method can only be used under >30dB SNR conditions, what would preclude almost any testing of current core requirements.Our request to assess the SNR for the asymptotic expansion is actually to confirm what is the impact on the extrapolation due to imperfect measurements by TE, mostly affected by the available SNR at the receiver but also by the receiver absolute accuracy. Therefore, for simulation purposes, the SNR must be added to the EIRP measurements used to calculate the best fitting coefficients at each of the distances.The noise effect is different in case of direct measurements (like CFFDNF or IFF/DFF) and already included in the “Influence of noise” MU contributor.  |
| Keysight | We suggested for R&S and KS to work offline to align on the SNR assumptions |
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**Issue 1-2-1: CFFDNF MU elements**

*Recommendations for 2nd round:*

- Agreements are needed on the next steps to collect MU element descriptions and preliminary estimates of their values

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| **Company**  | **Comments** |
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**Issue 1-4-1: Clear summary of applicable enhancements**

*Recommendations for 2nd round:*

- Companies are encouraged to discuss ways to seek convergence of this issue during the 2nd round.

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| **Company**  | **Comments** |
| Keysight | We cannot agree to removing CFFNF methodology from the list of permitted NF test methods. We encourage R&S to properly implement the CFFDNF approach and then determine the MU when combining two CFFDNF simulations at r1 & r2 using the asymptotic expansion approach (or similar). Discarding CFFNF purely based on arguments that some research suggests the fitting approach cannot work with small MUs for N=3 (N: number of radii) and that (*kr*)*i* terms are required to estimate EIRP while we can clearly show advantages in terms of MU is not reasonable.  |
| R&S | We are ok to hold any decisions about applicability until next meeting and looking at the additional assessment on SNR impact, NF probe interaction, etc.In the meantime, we will work on our CFFNF implementation based on the most recent changes Keysight have presented (late) this meeting. We encourage Keysight to share any additional details that will help with such implementation, and consider them for the CFFNF test procedure and rationale description as discussed on Issue 1-1-2.Note: there seems to be a typo on Keysight’s comment when referring to “properly implement the CFFDNF approach and then determine the MU when combining two CFFDNF simulations at r1 & r2 using the asymptotic expansion approach”, where it should say CFFNF instead. |
| Keysight | The idea is that two CFFDNF CST simulations (one at r1 and one at r2) are used for post processing in order to determine b1, b2 for CFFNF and subsequently perform CFFNF MU analyses.  |
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### Summary for 2nd round

**Issue 1-1-1: Determining the unknown antenna location in CFFNF setup**

**Issue 1-1-3: CFFNF MU elements**

**Issue 1-1-4: Preliminary assessment of CFFNF MU**

**Issue 1-2-1: CFFDNF MU elements**

**Issue 1-4-1: Clear summary of applicable enhancements**

# Topic #2: polarization basis mismatch

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104489](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104489.zip) | Qualcomm Incorporated | **Transmit signal quality measurements by TE with dual pol Rx**Observation 1: The proposed demodulation procedure does not inject any amplitude flatness or phase artefacts in measurements of UE from a UE that uses transparent diversity schemes.Observation 2: The proposed demodulation procedure has strong continuity with legacy methods owing to retention of ZF equalization and LSE-based channel estimation.Observation 3: The proposed demodulation procedure gracefully scales between 2L UL and single layer UL operation.Observation 4: Transmit modulation quality metrics (EVM, IBE, carrier leakage) are calculated by the proposed demodulation procedure in per layer form as required by the standard.Proposal 1: The 2L MIMO demodulation scheme in figure 2.2.1-2 is proposed as the basis for TE employing dual receive chains.Proposal []: The 2L MIMO demodulation scheme pictured below is proposed as the basis for TE employing dual receive chains. |
| [R4-2104558](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104558.zip) | MediaTek Inc. | **TPMI, 2-port CSI-RS, and EVM issues about polarization basis mismatch**Observation 1: “Optimal TPMI” can reflect UE achievable EIRP performance well compared to “Fixed TPMI”. In the case study, the differences are 0.6 dB @peak and 2 dB @50-tile, respectively.Observation 2: Same UE but different polarization basis mismatch conditions with current EVM test procedure can lead to quite different test results, even affect pass/fail results.Observation 3: The EVM test result period is about 90 degree as expected, due to the inherent possible polarization basis mismatch is 0 to 90 degree.Proposal 1: Define option-2 “Optimal TPMI index”.Proposal 2: Define 2-port CSI-RS configuration as below:Proposal 3: RAN4 shall define solution(s) for EVM issue due to polarization basis mismatch.Proposal 4: For EVM test, different polarization angles shall be applied to avoid test results be affected due to polarization basis mismatch.Proposal 5: The conceptual EVM test conditions and flow are proposed as Fig 3.Proposal 6: RAN4 shall send LS to RAN5 to notify the EVM issue and the agreed solution(s). |
| [R4-2104569](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104569.zip) | Anritsu Corporation | **Considerations on test with TPMI method**Observation 1: There is a need to clarify the expected functionality of a test equipment (TE) when configuring a UE with SRS resources.Observation 2: There is a need to clarify conditions when configuring SRS - actual SRS configurations to set, assumptions to judge the best grid point and the best TPMI index finally.Observation 3: It is not clear whether the coherent UEs are always activating dual Tx paths or not.Observation 4: Implementation of the test feature may become complicated depending on the condition of SRS configuration.Observation 5: Relationship of measurement time is expected as follows.Observation 6: Option 1 would be the simplest and likely to be the shortest test time method within 3 options.Observation 7: Option 2-A would be the similar or longer test time method than option 1. It would be the most complicated method and requires more time to complete this discussion.Observation 8: Option 2-B would be the 2nd simplest test method. But requires the longest test time in 3 options, approximately 4 times than others.Observation 9: Our preference is option 1 and option 2-B as a second choice.Proposal 1: Clarify an expected functionality of a test equipment when configuring SRS in a UE - actual SRS configurations to set, and assumptions to judge the best grid point and the best TPMI index. |
| [R4-2104701](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104701.zip) | Sony, Ericsson | **Views on solutions to minimize the impact of polarization basis mismatch**Observation 1: TPMI method is applicable for clause 6.2 of TS 38.101-2 for Rel-15 and Rel-16 coherent UEs and is applicable for clause 6.2D for Rel-16 nonCoherent UEs with uplink full power transmission.Observation 2: There could be a difference in antenna performance between different TPMI precoding matrices, but the impact is limited.Observation 3: the TPC power command is also the only mechanism that the network can use to control the UE output power in real life.Observation 4: The power UP command has been adopted in the RF test to ensure the UE reaches its maximum output power.Proposal 1: Any potential command or setting (test mode) for the EIRP test enhancement shall be avoided. The Test Equipment shall use the same signaling/commands to the UE as used in a real network deployment.Proposal 2: No test mode should be introduced for polarization basis mismatch enhancement.Proposal 3: There is no need to introduce additional test methods for Rel-15 nonCoherent UEs and Rel-16 nonCoherent UEs. |
| [R4-2105043](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105043.zip) | Samsung | **Discussion on TPMI configuration in EIRP measurement**Proposal 1: TPMI method is applicable for clause 6.2 of TS38.101-2 and other transmitter test cases and 2TX TPMI shall be configured for coherent UEs and nonCoherent UEs supporting full power transmission (mode-1, mode-full power). For nonCoherent UEs which do not support full power transmission (mode-1, mode-full power), 2-port transmission shall be not configured.Proposal 2: When 2-port transmission is configured for EIRP measurement for test cases in clause 6.2 of TS38.101-2, fixed TPMI index=2 shall be configured. |
| [R4-2106570](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106570.zip) | OPPO | **Solution to minimize the impact of polarization basis mismatch**Proposal []: consider the test system having the following functions for the EIRP test cases to minimize the impact of polarization basis mismatch. |
| [R4-2107111](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107111.zip) | Rohde & Schwarz | **Text proposal to TR38.884: FR2 UL EVM measurements**Proposal []:Proposal 1: RAN4 agrees on the presented approach for FR2 UL MIMO EVM measurements.Proposal 2: The 1-layer measurement presented in this paper extends the currently defined approach, where EVM is measured separately for each measurement polarization.Proposal 3: The attached text proposal to TR 38.884 is agreed. |

## Open issues summary

### Sub-topic 2-1: EIRP measurement

**Issue 2-1-1: TPMI method**

- Alt 2-1-1-1: adopt optimal TPMI approach, as proposed in [R4-2104558]

- Alt 2-1-1-2: Clarify an expected functionality of a test equipment when configuring SRS in a UE - actual SRS configurations to set, and assumptions to judge the best grid point and the best TPMI index [R4-2104569]

- Alt 2-1-1-3: TPMI method is applicable for clause 6.2 of TS 38.101-2 for Rel-15 and Rel-16 coherent UEs and is applicable for clause 6.2D for Rel-16 nonCoherent UEs with uplink full power transmission. [R4-2104701]

- Alt 2-1-1-4 [R4-2105043]:

- TPMI method is applicable for clause 6.2 of TS38.101-2 and other transmitter test cases and 2TX TPMI shall be configured for coherent UEs and nonCoherent UEs supporting full power transmission (mode-1, mode-full power). For nonCoherent UEs which do not support full power transmission (mode-1, mode-full power), 2-port transmission shall be not configured.

- When 2-port transmission is configured for EIRP measurement for test cases in clause 6.2 of TS38.101-2, fixed TPMI index=2 shall be configured.

**Issue 2-1-2: 2-port CSI-RS**

- Proposal: define 2-port CSI-RS configuration, as proposed in [R4-2104558]:

- Repetition = ON

- Repetition number = 8

- Density = 2

**Issue 2-1-3: Other methods**

- Proposal [R4-2106570]:

1. TE transmits downlink signals with circular polarization.

2. TE measures uplink signals with two linear orthogonal polarizations.

### Sub-topic 2-2: Demodulation of UL signal with dual polarizations

**Issue 2-2-1: EVM measurement setup (2L MIMO)**

- Alt 2-2-1-1: adopt 2L MIMO demodulation scheme in [R4-2104489] as the basis for TE employing dual receive chains



- Alt 2-2-1-2: adopt 2L MIMO demodulation scheme in [R4-2107111] as the basis for TE employing dual receive chains



**Issue 2-2-2: EVM measurement setup (1L MIMO)**

- Alt 2-2-2-1: adopt 1L MIMO demodulation scheme in [R4-2104489] as the basis for TE employing dual receive chains



- Alt 2-2-2-2: adopt 1L MIMO demodulation scheme in [R4-2107111] as the basis for TE employing dual receive chains



**Issue 2-2-3: EVM measurement parameters**

- Proposal:

- For EVM test, different polarization angles shall be applied to avoid test results be affected due to polarization basis mismatch

- RAN4 shall send LS to RAN5 to notify the EVM issue and the agreed solution(s)

- Proposed procedure in [R4-2104558] is below:



## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company comments** |
| **Issue 2-1-1: TPMI method** | Qualcomm: The alternatives are not mutually exclusive, so the comments are against each of the listed alternatives:1. -1 is not complete without resolving -2.
2. Alt -3 is agreeable.
3. Alt -4: we agree with this aspect ‘For nonCoherent UEs which do not support full power transmission (mode-1, mode-full power), 2-port transmission shall be not configured’ . Our understanding however is that RAN5 expects the opposite, so it would behoove us to invite them into the conversation if we pursue this route.
 |
| Vivo: support Alt 2-1-1-3 and Alt 2-1-1-4. Regarding the test procedure. We share similar view with proposal in R4-2104569 that Option1: Fixed TPMI index is preferred for TPMI-based EIRP test, to keep the test consistency and the reduced test time. |
| Samsung: we think Alt-1(optimal TPMI) is not necessary in conformance test, a fixed TPMI index=2 is simple and enoughwe support Alt-4. About ‘For nonCoherent UEs which do not support full power transmission (mode-1, mode-full power), 2-port transmission shall be not configured’, it is helpful to inform RAN5 if agreement in RAN4 is achieved, otherwise there will be power scaling. |
| OPPO:Support Alt 2-1-1-3, Alt 2-1-1-4. Fixed TPMI index is preferred. |
| Sony: We support Alt-3 and Alt-4. We are also okay to have RAN5 included as Qualcomm suggest clarifying on the configuration for noncoherent UEs.We also preferred a fixed TPMI for the test. We do observe slightly variation in terms of different TPMI code book for a poorly designed dual polarized antenna. However, considering all the issues mentioned in [R4-2104569](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104569.zip) and a real implementation shall have better dual polarization isolation, we think it would be more straightforward to go with a fixed TPMI method. |
| R&S: We agree with Qualcomm that Alt 2-1-1-1 “Optimal TPMI” cannot be adopted until further clarification is provided on the expected step by step procedure and test equipment configuration details, like Alt 2-1-1-2. |
| CAICT:Support Alt 2-1-1-3 and Alt 2-1-1-4. A fixed TPMI index is helpful to control the complexity of the test procedure. |
| Ericsson: Supportive of Alt 2-1-1-3 and Alt 2-1-1-4. And support of fixed TPMI. |
| MediaTek: We share similar view with Qualcomm on “the alternatives are not mutually exclusive”. Hence, we share our views on each one as below:(1) About “Alt 2-1-1-1 & Alt 2-1-1-2”:No matter whether apply optimal TPMI or not in the end, we believe it is agreeable to say “optimal TPMI can reflect UE achievable EIRP performance well compared to fixed TPMI” as the case study shown in R4-2104558. Hence, we’d like to further focus on test details discussion.Hence, we think “(Alt 2-1-1-2) Clarify an expected functionality of a test equipment when configuring SRS in a UE - actual SRS configurations to set, and assumptions to judge the best grid point and the best TPMI index.” is fine.We also appreciate the detailed study by Anritsu (R4-2104569), and would like to share our view as below:About “a) Further ramification to apply the TPMI index (for two antenna port) method?” & “Observation 3: It is not clear whether the coherent UEs are always activating dual Tx paths or not.”→bfor min Peak EIRP test, we believe “activate dual Tx paths” is the typical caseAbout “b) Periodic SRS or Aperiodic SRS?”→ No strong view, but select “periodic SRS” is fine.About “c) Measurement time”→ We agree “Option 1 < Option 2-A < Option 2-B”, however, we believe Option 2-A only add a few millisecond (ms) per AoA, it would be not so long compared to whole test time.(2) About “Alt 2-1-1-3 & Alt 2-1-1-4”: We support the applicability part.  |
| **Issue 2-1-2: 2-port CSI-RS** | Qualcomm: More details are needed…. For example how do we ensure that CSIRS port to polarization mapping matches that of PDSCH?Also would proponent (MediaTek) kindly provide reference for definition of density = 2? |
| MediaTek: Thanks to Qualcomm’s comment.1) About “how do we ensure that CSIRS port to polarization mapping matches that of PDSCH”→ We don’t have concern on CSIRS mapping, it can up to TE implementation.2) About “definition of density = 2”→ We don’t have strong view on the exact number, just propose “2” to make CSI-RS configuration be clearer. |
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| **Issue 2-1-3: Other methods** | Qualcomm: 1. The reference cited by the proponent itself says ‘The use of circular polarization in wireless telecommunications is very untypical’. In our view unless gNBs are restricted to using CP for DL, it is not good practice to use CP in TE as representative of a typical deployment in LOS condition.
2. UE UL is already captured by two orthogonally polarized antennae. So would proponent (Oppo) kindly elaborate on what their proposal 2 would change.
 |
| Keysight: similar comments as QC. The KS contribution R4-1904192 lists Observations 5 through 14 commenting on the adverse effects of CP.  |
| vivo: based on previous discussion, the circular polarization approach was excluded, which was identified as not a proper enhanced test method. |
| Samsung: circular polarization has be discussed before together with polarization scan, conclusion has already been made that CP does not work for polarization mismatch objective. |
| OPPO:More clarifications are given below about the proposal, and try to answer the question from QC.As statement in R4-2106570, both of the following two functions or configurations should be provided and the two functions work together to achieve the goal of minimizing the polarization basis mismatch. 1. TE transmits downlink signals with circular polarization.2. TE measures uplink signals with two linear orthogonal polarizations.The first bullet “TE transmits downlink signals with circular polarization” is in order to guarantee the two polarizations of UE activated reliably, on the basis of contribution R4-1904192 as below.The figure illustrates that DL signals with circular polarization from test equipment can successfully activate Tx0 and Tx1 of UE.We do not think it is necessary to align the TE and gNB with the same configurations, because the effect of TE is to help constructing the required test environment.The second bullet “TE measures uplink signals with two linear orthogonal polarizations” is in order to collect the total power radiated from the UE. Usage of two linear orthogonal polarizations to measure total radiated power is mature practice, evidence of which can also be found in contribution R4-1904192.The figure illustrates that as long as UE transmitted with Tx0 and Tx1, the total power will be measured by TE with two linear orthogonal polarizations.Together with the two functions/configurations, polarization basis mismatch can be minimized. |
| Sony: 1. We share similar view as Qualcomm, CP is not a typical polarization used by gNB, we don’t think using CP is a proper solution
2. We also have the same understanding as Qualcomm that TE measures the two polarizations and sum the power from each polarization already as it is today (EIRP = EIRP\_theta+EIRP\_phi). We don’t see any change would be needed in this case.
 |
| R&S: The options for different DL polarization has been extensively discussed in previous meetings and none of those options was deemed feasible.Our comments to the concrete proposals in R4‑2106570:Proposal 1: TE cannot provide pure circular polarization in the downlink. This would require either: * Accurate phase coherent transmission from the 2 linear polarizations, with calibration/correction over frequency. This will impose major changes in current systems.
* Physically switch between current feed antennas (linear polarized) and a circular polarized antenna only for DL. This will impose major changes in current systems, and even several circular polarized antennas since the operating BW for these antennas is quite limited.

Proposal 2: TE already perform the measurements with 2 linear orthogonal polarizations.  |
| Ericsson: Same view as Qualcomm, Keysight and Sony  |
| Anritsu: Agree with Qualcomm, Keysight, Sony and Ericsson |
| **Issue 2-2-1: EVM measurement setup (2L MIMO)** | Qualcomm: Prefer Alt 2-2-1-1.Our concern with Alt -2 is that it has fundamentally different structure than the legacy method, and in our estimation, will yield a pessimistic result for the UE.Recall that in the legacy method (and in alt -1), an LS estimator is used to estimate the channel. In alt-1, the LS estimator estimates all 4 elements of the channel estimate. The LS estimate is an average over multiple symbols which minimizes error in all 4 elements. In the Alt-2 method, a 2 stage method is applied, where the first stage uses only DMRS for bulk of the channel inversion process, with a second LSE based ‘refinement’ stage that only operates on each layer individually. Estimation from DMRS is inherently noisy (compared to an LSE estimate derived from averaging over multiple symbols), i.e each of the 4 elements in the channel matrix has some random error associated with it. Now, the second stage only acts on individual layers (effectively the refinement stage is a diagonal matrix). We would need 4 degrees of freedom to individually adjust each of the 4 noisy DMRS-based channel estimate elements, but the diagonal matrix of the refinement stage only provides 2 degrees of freedom. Consequently, this method does not have an effective refinement method, and will have an inferior channel estimate that will lead to pessimistic results. |
| Rohde & Schwarz: Prefer Alt 2-2-1-2.In our understanding, DMRS based channel estimation is essential since, as Qualcomm discussed in their paper, the autocorrelation matrix may not be invertible if we apply the Qualcomm approach. The EVM calculation needs to work also small numbers of OFDM symbols, where the probability of having a non-invertible matrix is high.Our proposal is an extension of the single layer method already used and existing algorithms can be reused.In the RMCs today there are 3 DMRS symbols available, so averaging in the time domain is possible. Also averaging in the frequency domain can be used, which is not a new method, this has been used for basestation EVM for a long time (see TS 38.104). In general, there are no significant differences in the results from Alt 1 & 2, while our approach has some clear advantages.Regarding the Observation on Carrier Leakage and IBE in Alt 2-2-1-1 [Qualcomm R4-2104489]: We are ok to also measure carrier leakage on a per layer basis, this works well with our proposal. On IBE, we do not think that it is appropriate to measure this on a per layer basis. IBE represents measurements on allocated vs. non-allocated RBs, it does not matter from which layer the RBs come, therefore it shall be measured as the sum of powers over both polarizations. |
| Anritsu: As for the block diagram of EVM calculation from both R&S and Qualcomm, we basically agree with their contents if we consider FR1 MIMO, FR2 MIMO and Tx diversity totally.However, if we only focus on FR2 UL-MIMO, we suppose that we might be able to design the block a little differently by for example improving the calculation procedures in the future. (e.g. test time reduction)In a case of FR2 UL MIMO, since we can assume that there would not be large delay between channels thanks to the effect of anechoic chamber, then we might not need to take into account of the delay.Could the block diagram be introduced as a general one or as an example and so allow to have a flexibility with the actual implementation? |
| MediaTek: Both Alts are actually fine for us, if need to make it clearer, we would prefer “Alt 2-2-1-1: adopt 2L MIMO demodulation scheme in [R4-2104489] as the basis for TE employing dual receive chains”. Moreover, both EVM and spectrum flatness shall be considered. |
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| **Issue 2-2-2: EVM measurement setup (1L MIMO)** | Qualcomm: 2-2-2-12L and single layer treatment would have to be treated as a package.  |
| Rohde & Schwarz: 2-2-2-2Agree that the same approach as for UL MIMO shall be used. |
| MediaTek: Both Alts are actually fine for us, if need to make it clearer, we would prefer “Alt 2-2-2-1: adopt 1L MIMO demodulation scheme in [R4-2104489] as the basis for TE employing dual receive chains”. Moreover, both EVM and spectrum flatness shall be considered. |
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| **Issue 2-2-3: EVM measurement parameters** | Qualcomm: Proposal not necessary. Prefer to resolve through 2-2-1 and 2-2-2 |
| Keysight: support polarization scan if 2-2-1 and 2-2-2 are not agreed |
| Samsung: one of the polarization mismatch objective is to solve EVM related UL Demod issue, and the issue will be addressed by the enhanced methods. For the Rel-15 EVM metric = min(EVMtheta, EVMphi), it is not ideal, but usually it works for most cases. we’d better be careful to re-visit polarization scan method for this issue. |
| Rohde & Schwarz: Agree with Qualcomm. We prefer to resolve this issue through our proposals in 2-2-1 and 2-2-2.The description in R4-2104558 is related to the “DL polarization scan” method that was deemed not valid already a few meetings ago.  |
| MediaTek: If issue 2-2-1 and 2-2-2 can be agreed and reflect to corresponding RAN4/5 TS/TR completely, we are fine to apply issue 2-2-1 and 2-2-2 methods, and we do support with Keysight’s comment. |

### CRs/TPs comments collection

Moderator’s note: Although R4-2107111 “Text proposal to TR38.884: FR2 UL EVM measurements” was submitted to the meeting as a text proposal to the TR, it is recommended to first align on the technical details of the UL EVM measurement scheme before drafting/editing the TP. TP discussion can follow in Round 2.

## Summary for 1st round

### Open issues

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| **Issue** | **Status summary**  |
| **Issue 2-1-1: TPMI method** | *Candidate options:*- Alt 2-1-1-1: adopt optimal TPMI approach, as proposed in [R4-2104558]Support: MediaTekOppose: Samsung, OPPO, CAICT, EricssonConditioned on resolution of Alt 2-1-1-2: Qualcomm, R&S- Alt 2-1-1-2: Clarify an expected functionality of a test equipment when configuring SRS in a UE - actual SRS configurations to set, and assumptions to judge the best grid point and the best TPMI index [R4-2104569]Support: MediaTek- Alt 2-1-1-3: TPMI method is applicable for clause 6.2 of TS 38.101-2 for Rel-15 and Rel-16 coherent UEs and is applicable for clause 6.2D for Rel-16 nonCoherent UEs with uplink full power transmission. [R4-2104701]Support: vivo, OPPO, Sony, CAICT, Ericsson, MediaTek- Alt 2-1-1-4 [R4-2105043]:Support: vivo, OPPO, Sony, CAICT, Ericsson, MediaTek- TPMI method is applicable for clause 6.2 of TS38.101-2 and other transmitter test cases and 2TX TPMI shall be configured for coherent UEs and nonCoherent UEs supporting full power transmission (mode-1, mode-full power). For nonCoherent UEs which do not support full power transmission (mode-1, mode-full power), 2-port transmission shall be not configured.- When 2-port transmission is configured for EIRP measurement for test cases in clause 6.2 of TS38.101-2, fixed TPMI index=2 shall be configured.*Tentative agreements:*- Alt 2-1-1-3 and Alt 2-1-1-4 seem agreeable*Recommendations for 2nd round:*- Companies are encouraged to determine whether further investigation into the optimal TPMI approach should be undertaken (e.g. utilizing the approach recommended in Alt 2-1-1-2) |
| **Issue 2-1-2: 2-port CSI-RS** | *Candidate options:*- Proposal: define 2-port CSI-RS configuration, as proposed in [R4-2104558]:- Repetition = ON- Repetition number = 8 - Density = 2 (definition missing)- CSIRS mapping up to TE implementation*Tentative agreements:*None*Recommendations for 2nd round:*None |
| **Issue 2-1-3: Other methods** | *Candidate options:*- Proposal [R4-2106570]:1. TE transmits downlink signals with circular polarization.2. TE measures uplink signals with two linear orthogonal polarizations. Support: OPPOOppose: Qualcomm, Keysight, vivo, Samsung, Sony, R&S, Ericsson, Anritsu*Tentative agreements:*None*Recommendations for 2nd round:*None |
| **Issue 2-2-1: EVM measurement setup (2L MIMO)** | *Candidate options:*- Alt 2-2-1-1: adopt 2L MIMO demodulation scheme in [R4-2104489] as the basis for TE employing dual receive chainsSupport: Qualcomm, MediaTek- Alt 2-2-1-2: adopt 2L MIMO demodulation scheme in [R4-2107111] as the basis for TE employing dual receive chainsSupport: R&S- Alt 2-2-1-3 (new): allow for more flexibility with the actual implemenation in the 2L MIMO demodulation scheme block diagram*Tentative agreements:*None*Recommendations for 2nd round:*- Companies are encouraged to converge on a common understanding; if achieved, a revision of the TP in R4-2107111 can be requested to capture the common understanding in the TR |
| **Issue 2-2-2: EVM measurement setup (1L MIMO)** | *Candidate options:**Tentative agreements:*2L and 1L should be agreed as a package*Recommendations for 2nd round:*- Companies are encouraged to converge on a common understanding; if achieved, a revision of the TP in R4-2107111 can be requested to capture the common understanding in the TR |
| **Issue 2-2-3: EVM measurement parameters** | *Candidate options:*- Proposal:- For EVM test, different polarization angles shall be applied to avoid test results be affected due to polarization basis mismatch- RAN4 shall send LS to RAN5 to notify the EVM issue and the agreed solution(s)- Proposed procedure in [R4-2104558]Support (if 2-2-1 and 2-2-2 are not agreed): Keysight, MediaTekOppose: Qualcomm, R&S, Samsung*Tentative agreements:*- Focus on reaching agreement on Issues 2-2-1 and 2-2-2 and revisit this proposal if no agreement is reached*Recommendations for 2nd round:*None |

### CRs/TPs

*N/A*

## Discussion on 2nd round (if applicable)

### Open issues

**Issue 2-1-1: TPMI method**

*Recommendations for 2nd round:*

- Companies are encouraged to determine whether further investigation into the optimal TPMI approach should be undertaken (e.g. utilizing the approach recommended in Alt 2-1-1-2)

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| **Company**  | **Comments** |
| MediaTek | We did analysis to address the raised clarification question about test result difference between optimal TPMI and fixed TPMI, and the study result clearly shows there is difference between the two TPMI settings. Moreover, we clarified issues raised by companies, at least from a UE vendor view. After these discussions, in our understanding, there are some potential agreements:* Potential agreement: “optimal TPMI can reflect UE achievable EIRP performance well compared to fixed TPMI”
* Potential agreement: “optimal TPMI is feasible”

We are not sure how detailed items shall be discussed and specified in 3GPP document, especially for the items that could be up to TE implementation. Hence, We think one way forward could be:* WF proposal: “agree to apply optimal TPMI, and reserve implementation flexibility for TE facility.

Further comment on “Alt 2-1-1-3 and Alt 2-1-1-4 seem agreeable”:* The applicability is agreeable, and be more accurate, in our understanding: “Alt 2-1-1-3 and Alt 2-1-1-4 are agreeable about applicability.”

**About 2-port CSI-RS (please aloe me to clarify it here):**To Moderator/Qualcomm, it seems that I misunderstood Qualcomm’s question, so I answered “why 「2」 is selected.” In 1st round email discussion. Anyway, the formal definition of “density” in TS38.211 7.4.15.3 (CSI reference signal) is:* **The value of  is given by the higher-layer parameter *density* in the *CSI-RS-ResourceMapping* IE or the *CSI-RS-CellMobility* IE** and the number of ports is given by the higher-layer parameter *nrofPorts*.
 |
| R&S | We think that a fixed TPMI approach is safer and will provide more consistent results, in a similar way that a fixed MCS is always used for RF testing, and therefore it should be considered the baseline. In order to study the concept of “optimal TPMI” implementation, we need further clarification as proposed in Alt 2-1-1-2, in addition to:* Is it intended to perform the “optimal TPMI” determination at each grid point for Spherical Coverage?
* What is expected to change in the procedure between “UL beam sweeping” and “Beam correspondence” modes for Spherical coverage?

We don’t think that leaving everything open to TE implementation is the right approach since we might end up with inconsistent results among test systems. |
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**Issue 2-2-1: EVM measurement setup (2L MIMO)**

*Recommendations for 2nd round:*

- Companies are encouraged to converge on a common understanding; if achieved, a revision of the TP in R4-2107111 can be requested to capture the common understanding in the TR

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| **Company**  | **Comments** |
| Anritsu | While we admit the big benefit to reuse existing methods, we also see an appropriateness of the QC method.So we aren’t able to make a decision at this moment and would like to spend some time to analyze pros/cons between the two methods.There is one point that we would like to ask R&S’s help to understand more regarding the following comment in the 1st round summary.>The EVM calculation needs to work also small numbers of OFDM symbols, where the probability of having a non-invertible matrix is high.We are currently having a difficulty in understanding on the reason how R&S came to the conclusion that the probability of having a non-invertible matrix is high if we follow the QC method and also in a case with small number of symbols.Could R&S give us a little more detailed explanation on this point, please?My current suggestion is that we carry out the study to compare two methods (blocks) and bring the view to the next meeting in May.We are also fine to keep the offline discussion during the preparation period toward the May meeting. |
| MediaTek | If the proposals of issues 2-2-1 and 2-2-2 cannot be agreed in this meeting in the end. We’d like to propose to add a potential agreement to WF.* WF Proposal
	+ For EVM and spectrum flatness test, different polarization angles shall be applied to avoid test results be affected due to polarization basis mismatch before new MIMO demodulation scheme is applied to address the polarization basis mismatch issue.

Besides, We think Qualcomm’s position is not “oppose”, actually, we also think the proposals of issue 2-2-1 and 2-2-2 is better, but just have larger impact. In our understanding, the position is much like:* Support (if 2-2-1 and 2-2-2 are not agreed): Keysight, MediaTek, Samsung
* Prefer apply proposals of issue 2-2-1 and 2-2-2 if agreeable: Qualcomm, R&S

To Qualcomm and R&S, may you please correct me if my understanding is wrong. |
| R&S | After some offline discussions, we propose to include both Alt 2-2-1-1 and 2-2-1-2 in the TR, and further discuss the benefits and drawbacks for each of them next meeting in order to provide final recommendation to RAN5.Whether to down select one of the options or define compromise solution between both is FFS.To Anritsu: regarding your question on the non-invertible matrix, we think it is better to have further offline discussions to clarify the issue. To MediaTek: the dual coherent receiver was agreed as the only solution for the polarization mismatch for EVM measurements since RAN4#96-e meeting (August 2020). Following this agreement, the zero-forcing MIMO receiver architecture was included in the draft TR 38.884 at RAN4#98-e meeting (February 2020).To further progress on this TE MIMO receiver, we now we have 2 slightly different proposals submitted to this meeting that intent to provide further details on the implementation.We don’t think the polarization scan approach is a suitable solution, neither as interim, and as such it was removed from the list of potential solutions at RAN4#96-e meeting (August 2020). Therefore, we should only focus on the zero-forcing MIMO receiver architecture. |
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**Issue 2-2-2: EVM measurement setup (1L MIMO)**

- Companies are encouraged to converge on a common understanding; if achieved, a revision of the TP in R4-2107111 can be requested to capture the common understanding in the TR

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| **Company**  | **Comments** |
| R&S | We agree with the tentative agreement to treat 1L and 2L setup as a package. |
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**TP drafting**

Moderator’s note: Although R4-2107111 “Text proposal to TR38.884: FR2 UL EVM measurements” was submitted to the meeting as a text proposal to the TR, it is recommended to first align on the technical details of the UL EVM measurement scheme before drafting/editing the TP. TP discussion can follow in Round 2.

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| **CR/TP number** | **Comments collection** |
| R4-2107111 Text proposal to TR38.884: FR2 UL EVM measurements | Company A |
| Company B |
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### Summary for 2nd round

**Issue 2-1-1: TPMI method**

**Issue 2-2-1: EVM measurement setup (2L MIMO)**

**Issue 2-2-2: EVM measurement setup (1L MIMO)**

**TP drafting**

# Topic #3: inter-band (FR2+FR2) CA

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104958](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104958.zip) | Anritsu Corporation | **TP to TR 38.884 on Inter-band DL CA in FR2**Observation 1: The shortest distance between antennae is around 40 to 50 mm when we take into consideration of the mutual coupling effect and the system assembly procedures.Observation 2: A post processing of obtained data and an adjustment of start/ stop coordinates to measure are necessary.Observation 3: Care must be taken to avoid diffraction and/or scattering effects created by the reflector’s paraboloid edges when fixing the offset antenna with a tilt.Observation 4: The best distance of each antenna and a reflector varies with the test system depending on the frequency coverage in FR2.Observation 5: When we consider a design that a placement of the offset antenna is above the main antenna, there might be another factor to increase the measurement uncertainty since coordinates of the measurement grid changes.Proposal 1: It is proposed to approve the text proposal related to the design of offset antenna test system for inter-band DL CA (FR2 + FR2) tests. |

## Open issues summary

Since the only submitted contribution to this topic is a text proposal, it is recommended to focus on stabilizing the TP contents during the email discussion.

### Sub-topic 3-1

*N/A*

## Companies views’ collection for 1st round

### Open issues

*N/A*

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2104958 TP to TR 38.884 on Inter-band DL CA in FR2 | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*N/A*

### CRs/TPs

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| R4-2104958 TP to TR 38.884 on Inter-band DL CA in FR2 | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*The TP is agreeable |

## Discussion on 2nd round (if applicable)

*N/A*

# Topic #4: extreme temperature conditions

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104521](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104521.zip) | vivo | **TP to TR38.884 v0.2.0 on ETC system** |
| [R4-2104570](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104570.zip) | Anritsu Corporation | **Considerations on ETC MUs and a testability**Observation 1: Since there are no agreements on common assumptions regarding the ETC enclosure, we cannot apply in ETC the same MUs as used under normal temperature condition (NTC).Observation 2: Since there are no agreements on common assumptions regarding the ETC enclosure, it is difficult to discuss ETC MUs and test requirements among vendors under equal conditions.Observation 3: Assumptions of ETC test environment may already vary between vendors and it could be difficult to align them anymore.Observation 4: We need to consider the differences between vendors when discussing MUs, test environments and requirements under ETC.Observation 5: There is no significant difference of path loss between the NTC and ETC environment up to 49 GHz, approximately 0.1 dB at most.Observation 6: For ETC tests with band n262, it is expected that we can use same variety of ETC measurement uncertainty contributions for lower frequency bands. Actual MU values are FFS. |
| [R4-2107128](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107128.zip) | Keysight Technologies | **On extreme temperature condition testing**Observation 1: The measurement uncertainty work on the MOP-EIRP and REFSENS-EIS test cases performed under ETC have been finalizedObservation 2: ETC testing including full 3D beam peak searches can proceed as planned with Release 15Observation 3: The restrictions in 38.101-2 that UE EIRP and EIS spherical coverage, Power control, EVM, and UE beam correspondence are not testable should be revised and test cases applicable to ETC in FR1 should be considered applicable to ETC in FR2 as part of Release 15 maintenance.Proposal 1: Consider full 3D scans the default approach for BP searches and have RAN5 consider partial scans based on vendor declarations at a later timeProposal 2: RAN4 should assume that ETC testing is feasible from a testability perspective for all FR2 UE RF test casesProposal 3: Define the temperature tolerance to be ±4oC as the RAN4 recommendation and inform RAN5 via an LS. |

## Open issues summary

### Sub-topic 4-1

**Issue 4-1-1: Applicability of ETC**

- Proposal [R4-2107128]:

- The restrictions in 38.101-2 that UE EIRP and EIS spherical coverage, Power control, EVM, and UE beam correspondence are not testable should be revised and test cases applicable to ETC in FR1 should be considered applicable to ETC in FR2 as part of Release 15 maintenance.

- Consider full 3D scans the default approach for BP searches and have RAN5 consider partial scans based on vendor declarations at a later time

- RAN4 should assume that ETC testing is feasible from a testability perspective for all FR2 UE RF test cases

**Issue 4-1-2: ETC MU**

- Alt 4-1-2-1 [R4-2104570]

- Need to consider the differences between vendors when discussing MUs, test environments and requirements under ETC

- Max difference of path loss between the NTC and ETC environment up to 49 GHz is ~0.1 dB

- For ETC tests with band n262, it is expected that we can use same variety of ETC measurement uncertainty contributions for lower frequency bands. Actual MU values are FFS

- Alt 4-1-2-2 [R4-2107128]

- The measurement uncertainty work on the MOP-EIRP and REFSENS-EIS test cases performed under ETC have been finalized

- Define the temperature tolerance to be ±4oC as the RAN4 recommendation and inform RAN5 via an LS.

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company comments** |
| **Issue 4-1-1: Applicability of ETC** | Qualcomm: Agree  |
| Keysight: support |
| Vivo: as guidance by session Chair, we believe the applicability of RF ETC should be discussed in Rel-15 FR2 maintenance part. We will initiate the discussion of ETC applicability of RF requirements next meeting for R15 maintenance.Regarding partial scan or 3D scan, the decision has been made in the WF R4-2103920 last meeting that, “if UE declaration present, then the partial scan should be used”. Therefore, we do not think RAN5 should consider vendor declarations at a later time. |
| Samsung: we share similar view as vivo. Especially we have concern on the first bullet about the restrictions removal in 38.101-2. Firstly of all it is an Observation rather than Proposal in the contribution R4-2107128. Secondly, it was agreed in last meeting that the core requirement revision is out of the scope of a test SI. we would suggest to remove the 1st bullet. |
| OPPO:Echo with vivo’s views on the applicability of RF ETC and 3D scan.  |
| CAICT: echo vivo’s comments. |
| Anritsu: Share Vivo’s views. |
| Apple: agree with vivo’s comments related to the scope of this study item; based on the Chair’s guidance last meeting, we should not aim to modify core requirements in this study |
| **Issue 4-1-2: ETC MU** | Keysight:Alt 4-1-2-1: do not support that differences between vendors need to be considered. Every vendor is free to make certain design decisions. The ETC enclosure should not be considered differently than for instance IFF reflector size, absorbers, chamber size, etc. Alt 4-1-2-2: support |
| Vivo:Alt 4-1-2-1: given the MU assessment in RAN5 is only up to 40.8GHz, it is still valuable to perform the preliminary MU assessment of ETC to 49GHz in this SI, to cover the new n262 band, and conclude the ETC feasibility of this band.Alt 4-1-2-2: Agree that the ETC MU assessment (23.45GHz - 40.8GHz) of EIRP and EIS has been finalized in RAN5. The additional 0.28dB MU induced by ETC system can be considered as an example conclusion added to TR38.884. Regarding double the temperature tolerance of FR2 (Temperature: 4 degrees) compare with FR1, is there any impacts on MU or UE performance (If we assume 2 degrees tolerance is negligible) ? |
| Anritsu:Alt 4-1-2-1: Yes, the same specifications should apply to all vendors, but we wanted simply to point out that different vendors will have some differences in performance for the various parameters due their variety and the different implementations.  |
| Apple: we support a transparent process to determine the preliminary uncertainty assessment for the ETC method, where all test equipment vendors should have the chance to contribute their analysis. Alt 4-1-2-1 seems to provide a framework for such an approach, and it can probably be fine-tuned as a next step. |
| Keysight: we support Anritsu’s view in Observation 6 of R4-2104570 and do not believe that it is necessary to present a full ETC QoQZ MU assessment for n262 in RAN4. Given the progress made in RAN5 on ETC and previous NTC QoQZ data for n262 which showed that QoQZ MU can be well within the current example MU values defined in RAN5 [R4-2103917], ETC should be considered testable including n262 with MUs to be defined in RAN5. |
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### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2104521 TP to TR38.884 v0.2.0 on ETC system | Keysight:* Figure 5.4.1-1 is misleading as it seems to indicate that the ETC enclosure contains the positioning system as well
* Clause 5.4.1: last sentence/bullet is not applicable since QoQZ MU was specified in RAN5#90
* Clause 5.4.4: should take conclusion of R4-2107128 into account
 |
| vivo: The TP can be revised, we will work with KS to capture additional conclusions and update the illustration of system. |
| Anritsu: The TP can be revised. |

## Summary for 1st round

### Open issues

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|  | **Status summary**  |
| **Issue 4-1-1: Applicability of ETC** | *Candidate options:*- Proposal [R4-2107128]:Support: Qualcomm, KeysightOppose: vivo, Samsung, OPPO, CAICT, Anritsu, Apple- The restrictions in 38.101-2 that UE EIRP and EIS spherical coverage, Power control, EVM, and UE beam correspondence are not testable should be revised and test cases applicable to ETC in FR1 should be considered applicable to ETC in FR2 as part of Release 15 maintenance.- Consider full 3D scans the default approach for BP searches and have RAN5 consider partial scans based on vendor declarations at a later time- RAN4 should assume that ETC testing is feasible from a testability perspective for all FR2 UE RF test cases*Tentative agreements:**None**Recommendations for 2nd round:*None |
| **Issue 4-1-2: ETC MU** | *Candidate options:*- Alt 4-1-2-1 [R4-2104570]Support: Anritsu, vivo, Apple- Need to consider the differences between vendors when discussing MUs, test environments and requirements under ETC- Max difference of path loss between the NTC and ETC environment up to 49 GHz is ~0.1 dB- For ETC tests with band n262, it is expected that we can use same variety of ETC measurement uncertainty contributions for lower frequency bands. Actual MU values are FFS- Alt 4-1-2-2 [R4-2107128]Support: Keysight- The measurement uncertainty work on the MOP-EIRP and REFSENS-EIS test cases performed under ETC have been finalized- Define the temperature tolerance to be ±4ºC as the RAN4 recommendation and inform RAN5 via an LS.*Tentative agreements:**None**Recommendations for 2nd round:*- Companies are urged to reach a conclusion on this issue; the moderator’s suggestion based on company comments can be to take the following as the starting point of further discussions in the second round:- Given that ETC MU assessment (23.45GHz - 40.8GHz) of EIRP and EIS has been finalized in RAN5, the additional 0.28dB MU induced by ETC system can be considered as an example conclusion added to TR38.884.- Given the MU assessment in RAN5 is only up to 40.8GHz, it is still valuable to perform the preliminary MU assessment of ETC to 49GHz in this SI, to cover the new n262 band, and conclude the ETC feasibility of this band.- FFS whether additional 2 degrees of temperature tolerance introduce additional MU- FFS whether max difference of path loss between the NTC and ETC environment should be taken into account in the ETC MU |

### CRs/TPs

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| R4-2104521 TP to TR38.884 v0.2.0 on ETC system | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*To be revised |

## Discussion on 2nd round (if applicable)

### Open issues

**Issue 4-1-2: ETC MU**

*Recommendations for 2nd round:*

- Companies are urged to reach a conclusion on this issue; the moderator’s suggestion based on company comments can be to take the following as the starting point of further discussions in the second round:

- Given that ETC MU assessment (23.45GHz - 40.8GHz) of EIRP and EIS has been finalized in RAN5, the additional 0.28dB MU induced by ETC system can be considered as an example conclusion added to TR38.884.

- Given the MU assessment in RAN5 is only up to 40.8GHz, it is still valuable to perform the preliminary MU assessment of ETC to 49GHz in this SI, to cover the new n262 band, and conclude the ETC feasibility of this band.

- FFS whether additional 2 degrees of temperature tolerance introduce additional MU

- FFS whether max difference of path loss between the NTC and ETC environment should be taken into account in the ETC MU

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| **Company**  | **Comments** |
| Keysight | * We believe that the feasibility of ETC measurements up to 49GHz can be assumed without MU assessments (based on feedback from KS and Anritsu).
* The third bullet regarding the tolerance should be rephrased to: “UE vendors to provide feedback whether +/-4 degrees of temperature tolerance (compared to +/-2 for FR1) introduces additional MU” This is an action specifically for UE vendors and not for TE vendors. It is furthermore questionable whether this tolerance affects ETC MU or rather ETC TT or core requirements.
* We believe the 4th bullet is not necessary since the path loss between NTC and ETC environment is calibrated out and no comparison between NTC and ETC environments are made for MU purposes. Additionally, since it is permitted to perform the NTC measurements in the ETC environment, the difference in path loss might never be evaluated.
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**TP drafting**

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| **CR/TP number** | **Comments collection** |
| R4-21xxxx TP to TR38.884 v0.2.0 on ETC system | R&S: We have provided additional changes to section 5.4.2 in order to clarify the procedure for range path loss calibration.  |
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### Summary for 2nd round

**Issue 4-1-2: ETC MU**

**TP drafting**

# Topic #5: enhancements to reduce test time

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104518](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104518.zip) | vivo | **(draft) LS on antenna assumption and measurement grids for FR2 PC3 UE**LS to 3GPP RAN51 Overall descriptionThe antenna assumption of UE is important to define corresponding measurement grids which has great impacts on FR2 conformance testing time. In the FR2 test method enhancement SI, RAN4 has studied some approaches to reduce the test time [1]. New measurement grids based on reasonable antenna assumption of FR2 PC3 UE is one of the basic approaches to reduce the measurement time.RAN4 has agreed the new antenna assumption [2]:For PC3 UE, antenna assumption of 4x2 array is agreed.Keeping the same upper bound of measurement grid MU, the new measurement grids based on 4x2 antenna array for spherical coverage, TRP and Tx/Rx beam peak search measurement, need be defined.The new measurement grids can be adopted for FR2 RF conformance test case as an additional option.The selection of the new measurement grid with 4x2 array is based on optional vendor declaration.To reduce the impacts on RAN5 test spec, the system-related assumptions are kept unchanged in RAN5, i.e., based on the previously agreed worst case 8x2 assumptions.An example of Min Number of Grid Points for TX/RX Beam Peak Search (366 for constant-step type, 275 for constant density type) is presented in the following table, which shows ~3 times improvement.

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| --- | --- | --- | --- |
|  **Antenna**  **AssumptionGrid Type** | **8x2** | **4x2** | **Factor of Improvement** |
| **Constant-Step Size** | 1106 | 366 | 3.0 |
| **Constant-Density** | 800 | 275 | 2.9 |

The new measurement grids can be used for both NTC and ETC.Currently, RAN4 is also working on other approaches to reduce FR2 test time.Reference:[1] R4-2017597 WF on testability enhancements to reduce test time, vivo, Samsung[1] R4-2103920 WF on ETC and test time reduction, vivo2 ActionsTo RAN5:ACTION: RAN4 respectfully asks RAN5 to take the new antenna assumption and measurement grids into account in FR2 test conformance test cases. |
| [R4-2104519](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104519.zip) | vivo | **Discussion and TP to TR38.884 on FR2 test time reduction**Observation 1: Several DUT antenna location assumptions have been used for FR2 simulation.Observation 2: Absolute and Relative SS RSRP in 38.133 are defined only for test purposes different than beampeak search and they cannot be used to determine the beampeak search accuracy.Observation 3: The new accuracy of RSRP for Rx beam peak search at high power level should not be defined according to the same simulation procedure for RRM.Observation 4: Even consider a bad UE performance which just pass the requirement of peak EIS and spherical coverage (i.e. gain drop ~12.8dB), for the beam directions fulfil spherical coverage, the SNR is larger than 17.2dB in a typical FR2 RF test system.Proposal 1: The TRP and spherical coverage measurement grids based on 4x2 antenna array assumption should be derived.Proposal []: 2：RAN4 should decide the antenna location of 4x2 antenna array for spherical coverage measurement grids simulation, three options can be considered:Proposal 3: Adopt RSRP(B)&EIS-based measurement for Rx beam peak search.Proposal 4: RAN4 should discuss a reasonable threshold value [x]dB for 2nd step EIS searching, after 1st step 3D RSRP scan.Proposal 5: RAN4 should develop a reasonable RSRP accuracy value for Rx beam peak search.Proposal 6: For RSRP accuracy analysis, the SNR17dB condition should be considered.Proposal 6: For RSRP accuracy analysis, the SNR17dB condition should be considered. |
| [R4-2105001](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105001.zip) | LG Electronics | **Discussion on test time reduction for FR2 OTA test time**Proposal 1: Reuse test procedure of Rx beam peak search based on RSRPB for demodulation and CSI testingProposal 2: It should be considered to determine which single link polarization to be used for the test based on UE declaration.Proposal 3: The UEs supporting Mode-2 and Mode-full power for ULFPTx should be tested by existing test method using two link polarization. |
| [R4-2105044](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105044.zip) | Samsung | **Discussion on prioritized methods for test time reduction**Observation 1: our simulation shows that the 8x2 array based measurement grids in TR38.810 corresponds to the same 0.5dB system error at 95% confidence level, though the standard deviation may be different for different test cases.Proposal 1: adopt new measurement grid for spherical coverage based on 4x2 array as 146 points (20º step size) for constant step size grid type.Proposal 2: For the RX beam peak search test case, both RSRP and RSRPB are doable, and it is slightly preferred to reuse previously defined SS-RSRPB.Proposal 3: only RSRP(B)-based measurement is enough for RX beam peak search and additional EIS local scan is not necessary.Proposal 4: for EIRP test of UL MIMO and Tx diversity, by default single Pollink can be randomly selected from either theta Pollink or phi Pollink. |
| [R4-2107110](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107110.zip) | Rohde & Schwarz | **Text proposal to TR38.884: Fast Spherical Coverage Method** |
| [R4-2107129](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107129.zip) | Keysight Technologies UK Ltd | Draft LS to RAN5 on Test Time ReductionLS to RAN WG5The enhanced testability SI (Acronym: FS\_FR2\_enhTestMethods; Latest approved SID: RP-210633) includes one topic/objected related to test time reduction

|  |
| --- |
| 5. Study testability enhancements to reduce test time- Including RF test method enhancement with reduced test time, and possible test time saving approach for UE Demodulation test and RRM test |

One suitable approach to reduce overall test time for conformance testing was related to the antenna array assumption; other approaches are still under discussion. In RAN4, antenna array configurations ranging from 4x1 to 8x2 were considered for testability and preliminary MU assumptions. In the end, the 8x2 antenna array assumptions were selected as worst case which was also adopted in RAN5 to finalize MUs, the Maximum Test System Uncertainty (MTSU), and Test Tolerances (TTs). Based on feedback from OEMs in RAN4, many PC3 UE implementations utilize antenna array configurations with fewer elements than 8x2, e.g., one OEM highlighted that “only 4 antenna elements are the dominant configuration in commercial PC3 UE.” Thus, measurement grid analyses were performed for the beam peak searches, a pre-requisite for all NR FR2 UE RF and many RRM test cases and a large contributor in terms of overall test time, to quantify the test time reduction impact of the relaxed 4x2 array configuration. Those results for the minimum number of grid points of the TX/RX beam peak searches are summarized below; clearly, the reduction of grid points by ~1/3 yields a significant improvement in test time.

|  |  |  |  |
| --- | --- | --- | --- |
|  Antenna AssumptionGrid Type | 8x2 | 4x2 | Factor of Improvement |
| Constant-Step Size | 1106 | 366 | 3.0 |
| Constant-Density | 800 | 275 | 2.9 |

Since RAN5 has finalized maximum test system uncertainties (MTSUs) and test tolerances (TTs) for many test cases already, it is not suggested to change the baseline antenna array assumptions at this point as this will have significant impact in RAN5 and industry since changes in MU/MTSU could have impact on certifications and test platform validations. It is furthermore proposed for RAN5 to keep all system-related assumptions, e.g., related to max antenna aperture of D=5cm for PC3, based on the 8x2 antenna array assumptions. Given the improvement in test time, it is suggested for RAN5 to support a relaxation of the beam peak search measurement grid requirements for the beam peak searches, TRP, and spherical coverage based on an optional vendor declaration. 2. ActionsTo RAN WG5RAN4 respectfully asks RAN5 to take the above information into consideration to support test time reduction efforts and to determine the min required number of grid points for TRP, spherical coverage, beam peak search for the 4x2 antenna configuration. |
| [R4-2107296](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107296.zip) | Huawei, HiSilicon | **Discussion on enhance test method to reduce FR2 OTA test time**Observation 1: ：An important prerequisite for single link polarization measurement is that dual polarization receiving antennas have the same beam.Proposal 1: Single link polarization measurement can be selected based on manufacturer declarations. |

## Open issues summary

### Sub-topic 5-1: prioritized potential solutions

**Issue 5-1-1: New measurement grid (1-MG)**

- Alt 5-1-1-1: Simulation assumptions to derive MU contribution of the 4x2 measurement grid need to be further aligned based on the following options:

- Option 1: reuse the antenna array location defined in TR38.810 for Rel-15 spherical coverage measurement grid to keep the simulation parameters consistency (front and back, in the centre)

- Option 2: the antenna array location is aligned with that for Rel-15 spherical coverage requirement definition (left and right)

- Option 3: reuse the antenna array location in TR 38.884 for beam management sensitivity study (front and back, in the corner)

- Alt 5-1-1-2: to keep the same MU (0.5dB at 95% confidence level), simulation for spherical coverage measurement grid based on 8x2 array and 4x2 array are performed respectively. 8x2 array with 15º step size shows 0.247dB standard deviation and 4x2 array with 20º step size shows 0.254dB standard deviation

|  |  |  |  |
| --- | --- | --- | --- |
|  **Antenna AssumptionGrid Type** | **8x2** | **4x2** | **Factor of Improvement** |
| **Constant-Step Size** | 266(15o step)(σ=0.247dB) | 146(20o step)(σ=0.254dB) | 1.8 |

**Issue 5-1-2: RSRP(B) based RX beam peak search (2-RSRP)**

- Alt 5-1-2-1: adopt the measurement procedure proposed in [R4-2104519], including:

- RAN4 should discuss a reasonable threshold value [x]dB for 2nd step EIS searching, after 1st step 3D RSRP scan.

- For RSRP accuracy analysis, the SNR>17dB condition should be considered.

- Alt 5-1-2-2: reuse test procedure of Rx beam peak search based on RSRPB for demodulation and CSI testing

**Issue 5-1-3: 3-Single Pollink**

- Alt 5-1-3-1: for EIRP test of UL MIMO and Tx diversity, by default single Pollink can be randomly selected from either theta Pollink or phi Pollink

- Alt 5-1-3-2: consider using a single link polarization based on UE declaration

- Alt 5-1-3-3: UEs supporting Mode-2 and Mode-full power for UL MIMO should be tested by existing test method using two link polarization

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Issue** | **Company comments** |
| **Issue 5-1-1: New measurement grid (1-MG)** | Qualcomm: Option 1 in Alt 5-1-1-1 makes more sense. Per our understanding, Alt 5-1-1-2 is based on the assumptions used in TR38.810 for Rel-15 spherical coverage measurement, i.e., option 1. |
| Keysight: Alt 5-1-1-1: support Option 1 to keep consistency with how MU was defined in RAN4 and RAN5. Alt 5-1-1-2: as highlighted in Table M.3.1.1.3-2 of TS38.521-2, the spherical coverage MU (std. deviation) for the 8x2 array with 15deg step size is 0.12dB. The results in R4-2105044 do not reflect this MU. However, a spherical coverage analysis with the 4x2 array and constant-density grid yields the following results

|  |  |  |  |
| --- | --- | --- | --- |
| **Step Size [o]** | **Number of unique grid points** | **Std. Dev [dB]** | **|Mean Error| [dB]** |
| 10.0 | 614 | 0.04 | 0.00 |
| 12.0 | 422 | 0.04 | 0.01 |
| 15.0 | 266 | 0.05 | 0.01 |
| 20.0 | 146 | 0.08 | 0.03 |
| 22.5 | 114 | 0.11 | 0.03 |
| 30.0 | 62 | 0.13 | 0.04 |
| 45.0 | 26 | 0.27 | 0.13 |

These results yield a grid of 22.5deg step size with ~0.12dB std. deviation, i.e., a similar conclusion as in R4-2105044 can be drawn.  |
| LG: In our understanding, Alt 5-1-1-2 is based on Alt 5-1-1-1 option 1. |
| vivo: Alt 5-1-1-1, option 1 or option 3, both fine to us.Alt 5-1-1-2: Thanks for the simulation results from Samsung and Keysight. For Spherical coverage, the MU upper bound with 8x2 in TR 38.810 is “STD of 0.12dB and 0dB Mean Error”, we would prefer to derive the new measurement grid based on the same MU upper bound. It is beneficial to capture the agreeable measurement grid in the LS to RAN5 and also in TP to TR38.884. |
| Samsung: Alt 5-1-1-1: we also agree option 1 of Alt 5-1-1-1. Alt 5-1-1-2: Thanks LG’s comment, yes, our simulation results in Alt 5-1-1-2 is also based on that.Thanks Keysight sharing simulation results based on 4x2 in above comments. We try to align the MU but our simulation adopts 95% confidence level for spherical coverage measurement grid. Anyway, based on a comparable simulation of 8x2 vs 4x2, our conclusion is aligned, so we would like to capture 22.5deg step size into WF. |
| CAICT: Alt 5-1-1-1: option 1 make more sense, which is consistent with the assumptions of the existing MU analysis in RAN4 and RAN5.Alt 5-1-1-2: we share similar views as vivo. prefer to derive the new measurement grid based on the same MU upper bound as TR38.810/TS38.521-2. |
| **Issue 5-1-2: RSRP(B) based RX beam peak search (2-RSRP)** |  |
| Qualcomm: Option 2 sounds like a potential WF, but we would like some clarifications from Vivo to further develop the idea:1. ‘1.) Perform a 3D RSRP measurement on both polarizations for each point on the measurement grid’: What is ‘on both polarizations’? are you mandating two separate DL measurements (how to construct the composite of the two?). if instead you mean the TE should transmit on both ports, why is this beneficial?
2. We are not sure how [x] dB would be used. Would you list the steps the TE could take if say 3 different directions had peak RSRP readings with say a dB of each other? What procedure would the TE use to identify if all the 3 directions were part of the same peak?
3. Do RSRP measurement and EIS measurement both use the same measurement grid or different ones?
 |
| Keysight:There were concerns raised in the past that the RSRP(B) approach for RX BP search is not applicable since the RSRP(B) measurements are commonly performed on the rough (wide) beams while EIS is performed on the fine (narrow) beams. It is suggested to hold off on the proposed approach until it can be confirmed that RSRP(B) measurements trigger fine beams. |
| LG: Alt 5-1-2-2 is preferred since Rx beam peak direction for RF testing can be reused for demodulation and CSI testing.  |
| Vivo: thanks for the clarification question. 1. Both polarizations means the RSRP should be tested separately for each orthogonal polarization at each point. And the RSRP value is the total component of RSRP.
2. The [x] dB is used for selecting all the directions those are within x dB difference compared with the best direction. If all the 3 directions are part of the same peak, then these three directions should still be measured during 2nd EIS-measurement step to get the best EIS value and direction of this peak beam.
3. Yes, same measurement grid is used.

In TS 38.101-2 clause 3.1, the definition of RX beam peak is:***RX beam peak direction****: direction where the maximum total component of RSRP and thus best total component of EIS is found.*We think RAN4 should confirm that RSRP is available to find the beam peak direction, especially in this approach the RSRP is only for 1st step search, the final direction is determined based on 2nd step EIS double-checking. |
| Samsung: agreed with vivo on “RAN4 should confirm that RSRP is available to find the beam peak direction”Alt 5-1-2-1: if SNR>17dB condition is considered, it seems that RSRP(B) based search is enough and EIS scan is not necessary.Alt 5-1-2-2: no matter RSRP or RSRPB, it is used after beam refinement under NR call connected status, so narrow beam is applied. We have no strong view between RSRP and RSRPB, for convenience RSRPB is slightly preferred. |
| Sony: According to the analysis from previous contribution, the accuracy of RSRP should be good enough at beam peak directions. It is unclear for us if it would be really necessary to perform the two step (RSRP/EIS) procedure. |
| CAICT:Alt 5-1-2-2: either RSRP or RSRPB is acceptable. The advantage of RSRPB is that it is already specified in RAN5. |
| **Issue 5-1-3: 3-Single Pollink** | Qualcomm: 5-1-3-1Alt 5-1-3-2 is not justifiable because the UE cannot pick and choose DL polarization in the field. Alt 5-1-3-3 is a proposal to not change, which is the default condition anyway. |
| LG: even if single link polarization cannot be chosen in the field, we think Alt 5-1-3-2 could be considered for testing.For clarification, is the single link polarization testing method for UL-MIMO and Tx Div test optional by UE declaration? So, still default test method is based on using each link polarization? |
| Vivo: Alt 5-1-3-1, agreeAlt 5-1-3-3: clarification question to LGE, “two link polarization” means using two link path simultaneously or measure twice by switching each orthogonal polarization? |
| Samsung: We prefer 5-1-3-1. In our understanding, the conventional Rel-15 dual Pollink test is always the fallback method in default. |
| Sony: Alt 5-1-3-1 randomly select seems best reflect the real field operation. |
| CAICT: prefer Alt 5-1-3-1 since UE cannot choose DL polarization in the real field.  |
| LG: To Vivo, “two link polarization” means conventional Rel-15 dual Pollink test as measuring twice by switching each orthogonal polarization. |

### CRs/TPs comments collection

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| **CR/TP/LS number** | **Comments collection** |
| R4-2104518 (draft) LS on antenna assumption and measurement grids for FR2 PC3 UE | vivo: we suggest to revise the LS, will work with Keysight to capture additional agreements on this topic. |
| Apple: can we include the step size (in degrees) for the constant step-size approach for information? |
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| R4-2107129 Draft LS to RAN5 on Test Time Reduction | Company A |
| Company B |
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| R4-2104519 Discussion and TP to TR38.884 on FR2 test time reduction | Company A |
| Company B |
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| R4-2107110 Text proposal to TR38.884: Fast Spherical Coverage Method | Keysight (did not realize the note below until after comments were added; thought it would be useful to provide this feedback early just in case): We agree to the early pass approach; however, we cannot agree to allow measurements beyond 90deg if the re-positioning concept is adopted, i.e., as agreed earlier, only measurements in one hemisphere up to 90deg should be considered. In Clause 8.1.2, Steps 17 and 18 should therefore change the 112.5deg to 90deg and in Clause 8.1.3, Steps 10 and 11 should change the 112.5deg to 90deg.  |
| R&S: Thanks for the early feedback, but we don’t agree with the comment. Taking the combined axes systems as example, QoQZ antenna orientations are defined every 45º for α (around +x axis) and β (around +y) so every antenna orientation covers the QZ performance over ±22.5º around the measured antenna orientation, even better justified considering the HPBW of the reference antenna. Therefore, it is fair to assume that the antenna orientations at α = {90º, -90º} and β = {90º, 270º} already assess the QZ performance up to 112.5º in elevation even for the case where re-positioning concept is adopted.Following moderator’s note, we can defer any decisions to this TP during the second round.  |
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Moderator’s note: the submitted text proposal R4-2107110 “Text proposal to TR38.884: Fast Spherical Coverage Method” is related to the “4-others” category of potential solutions. According to the agreed WF last meeting, work on categories 1, 2, and 3 is prioritized. It is recommended to return to this TP during the second round of discussion.

## Summary for 1st round

### Open issues

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| --- | --- |
| **Issue** | **Status summary**  |
| **Issue 5-1-1: New measurement grid (1-MG)** | *Candidate options:*- Alt 5-1-1-1: Simulation assumptions to derive MU contribution of the 4x2 measurement grid need to be further aligned based on the following options:- Option 1: reuse the antenna array location defined in TR38.810 for Rel-15 spherical coverage measurement grid to keep the simulation parameters consistency (front and back, in the centre)Support: Qualcomm, Keysight, LG, vivo, Samsung, CAICT- Option 2: the antenna array location is aligned with that for Rel-15 spherical coverage requirement definition (left and right)- Option 3: reuse the antenna array location in TR 38.884 for beam management sensitivity study (front and back, in the corner) Support: vivo- Alt 5-1-1-2: to keep the same MU (0.5dB at 95% confidence level), simulation for spherical coverage measurement grid based on 8x2 array and 4x2 array are performed respectively. 8x2 array with 15º step size shows 0.247dB standard deviation and 4x2 array with 20º step size shows 0.254dB standard deviationSupport: Samsung*Tentative agreements:*- Simulation assumptions to derive MU contribution of the 4x2 measurement grid need to be further aligned based on the following assumption: reuse the antenna array location defined in TR38.810 for Rel-15 spherical coverage measurement grid to keep the simulation parameters consistency (front and back, in the centre)*Recommendations for 2nd round:*- Check whether the tentative agreement above can be confirmed- Focus the efforts on the LS to RAN5 (see comments to R4-2104518)  |
| **Issue 5-1-2: RSRP(B) based RX beam peak search (2-RSRP)** | *Candidate options:*- Alt 5-1-2-1: adopt the measurement procedure proposed in [R4-2104519], including:Support: vivo, Sony, CAICT- RAN4 should discuss a reasonable threshold value [x]dB for 2nd step EIS searching, after 1st step 3D RSRP scan.- For RSRP accuracy analysis, the SNR>17dB condition should be considered.- Alt 5-1-2-2: reuse test procedure of Rx beam peak search based on RSRPB for demodulation and CSI testingSupport: LG, CAICTSupport with clarifications: Qualcomm*Tentative agreements:*None*Recommendations for 2nd round:*- Further discussion is recommended to converge views on whether one or both approaches can be deemed feasible |
| **Issue 5-1-3: 3-Single Pollink** | *Candidate options:*- Alt 5-1-3-1: for EIRP test of UL MIMO and Tx diversity, by default single Pollink can be randomly selected from either theta Pollink or phi PollinkSupport: Qualcomm, vivo, Samsung, Sony, CAICT- Alt 5-1-3-2: consider using a single link polarization based on UE declarationSupport: LG- Alt 5-1-3-3: UEs supporting Mode-2 and Mode-full power for UL MIMO should be tested by existing test method using two link polarization*Tentative agreements:*- Alt 5-1-3-1: for EIRP test of UL MIMO and Tx diversity, by default single Pollink can be randomly selected from either theta Pollink or phi Pollink*Recommendations for 2nd round:*- Check whether the tentative agreement above can be confirmed |

### CRs/TPs

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| --- | --- |
| **CR/TP/LS number** | **CRs/TPs Status update recommendation**  |
| R4-2104518 (draft) LS on antenna assumption and measurement grids for FR2 PC3 UE | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*To be revised |
| R4-2107129 Draft LS to RAN5 on Test Time Reduction | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*To be merged (into revision of R4-2104518) |
| R4-2104519 Discussion and TP to TR38.884 on FR2 test time reduction | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*Agreeable |

## Discussion on 2nd round (if applicable)

### Open issues

**Issue 5-1-1: New measurement grid (1-MG)**

*Tentative agreements:*

- Simulation assumptions to derive MU contribution of the 4x2 measurement grid need to be further aligned based on the following assumption: reuse the antenna array location defined in TR38.810 for Rel-15 spherical coverage measurement grid to keep the simulation parameters consistency (front and back, in the centre)

*Recommendations for 2nd round:*

- Check whether the tentative agreement above can be confirmed

- Focus the efforts on the LS to RAN5 (see comments to R4-2104518)

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| **Company**  | **Comments** |
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**Issue 5-1-2: RSRP(B) based RX beam peak search (2-RSRP)**

*Recommendations for 2nd round:*

- Further discussion is recommended to converge views on whether one or both approaches can be deemed feasible

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| **Company**  | **Comments** |
| Samsung | Based on 1st round discussion, about RSRP(B) based vs combined RSRP(B)&EIS based, RSRP(B) based RX beam peak search shall not be precluded. Several companies commented that EIS local search is not necessary.We agree the statement that “RAN4 should confirm that RSRP is available to find the beam peak direction” |
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**Issue 5-1-3: 3-Single Pollink**

*Tentative agreements:*

- Alt 5-1-3-1: for EIRP test of UL MIMO and Tx diversity, by default single Pollink can be randomly selected from either theta Pollink or phi Pollink

*Recommendations for 2nd round:*

- Check whether the tentative agreement above can be confirmed

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| **Company**  | **Comments** |
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**Issue 5-1-4: Fast Spherical Coverage Method**

Is the fast spherical coverage method, as proposed in R4-2107110, a feasible enhancement of the test methodology?

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| **Company**  | **Comments** |
| Keysight | (did not realize the note below until after comments were added; thought it would be useful to provide this feedback early just in case): We agree to the early pass approach; however, we cannot agree to allow measurements beyond 90deg if the re-positioning concept is adopted, i.e., as agreed earlier, only measurements in one hemisphere up to 90deg should be considered. In Clause 8.1.2, Steps 17 and 18 should therefore change the 112.5deg to 90deg and in Clause 8.1.3, Steps 10 and 11 should change the 112.5deg to 90deg.  |
| R&S | Thanks for the early feedback, but we don’t agree with the comment. Taking the combined axes systems as example, QoQZ antenna orientations are defined every 45º for α (around +x axis) and β (around +y) so every antenna orientation covers the QZ performance over ±22.5º around the measured antenna orientation, even better justified considering the HPBW of the reference antenna. Therefore, it is fair to assume that the antenna orientations at α = {90º, -90º} and β = {90º, 270º} already assess the QZ performance up to 112.5º in elevation even for the case where re-positioning concept is adopted.Following moderator’s note, we can defer any decisions to this TP during the second round. |
| R&S | (second round)We would appreciate feedback from other companies, but it seems most companies agree this as a feasible test time reduction method to be considered for the TR. Therefore, instead of holding the whole methods just due to the maximum elevation to be tested, we can agree to keep the maximum elevation between [112.5º] and further discuss next meeting.  |
| Keysight | We agree this is a feasible test time reduction method. However, we cannot agree to extend the range of theta for DUT Orientation 1 from 90 to 112.5o; we cannot agree to a TP with [112.5]o either. TS38.521-2 specifies that DUT Orientation 1 ranges from 0o≤≤90o and that DUT Orientation 2 ranges from 90o<≤180o, e.g., K.1.1, K.1.2, K.1.3, K.1.4. Even the procedure for spherical coverage in K.1.5 and K.1.6 indicates that the procedure must follow the procedure in K.1.2 and K.1.3, i.e., limit theta to maximum of 90o for DUT Orientation 1.  |
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**LS to RAN5**

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| **CR/TP/LS number** | **Comments collection** |
| R4-21xxxxx (draft) LS on antenna assumption and measurement grids for FR2 PC3 UE |  |
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### Summary for 2nd round

**Issue 5-1-1: New measurement grid (1-MG)**

**Issue 5-1-2: RSRP(B) based RX beam peak search (2-RSRP)**

**Issue 5-1-3: 3-Single Pollink**

**Issue 5-1-4: Fast Spherical Coverage Method**

**LS to RAN5**

# Topic #6: extension of permitted methods to band n262

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104896](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104896.zip) | Apple | **On permitted test methods for demodulation in band n262**Observation 1: The relative increase in free space path loss from 43.5 GHz to 48.2 GHz is 0.9 dBObservation 2: The relative increase in cable loss per meter from 43.5 GHz to 48.2 GHz is 0.33 dBObservation 3: The values of probe antenna gain and backoff from P1dB need to be further checked with test equipment vendors to verify their applicability to band n262Observation 4: In general, we observe a 3.5 dB degradation in maximum achievable SNR for band n262 relative to the budgeted values in TR38.810.Proposal 1: Finalize the set of band-dependent parameters and values for the demodulation test setup SNR calculation based while taking Table 1 as the baseline.Proposal 2: Calculate the maximum achievable SNR for the RRM test setup once the band-dependent parameters in Table 1 are resolved. |

## Open issues summary

### Sub-topic 6-1: demodulation setup

**Issue 6-1-1: Band-dependent parameters for the demodulation setup**

- Proposal: Finalize the set of band-dependent parameters and values for the demodulation test setup SNR calculation based while taking the table below as the baseline.

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Comment |
| REFSENS | -82.8 dBm/50 MHz | Using REFSENS agreed for band n262 |
| Multi-band relaxation | 1.0 dB | Defined as ceil(.); change from 2.0 dB |
| FS path loss | -63.2 dB | Change from -62.3 dB (scaling from 43.5 to 48.2 GHz) |
| Cable loss | -8.7 dB | Additional 0.33 dB/m in cable loss at 48.2 GHz |
| Probe antenna gain | [12.0] dB | Needs checking |
| Backoff from P1dB | [13.0] dB | Needs checking |

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Issue** | **Company comments** |
| **Issue 6-1-1: Band-dependent parameters for the demodulation setup** | Qualcomm: In general, the SNR calculation is fine. RAN5 has updated the xls from RAN4 to account for additional changes, such as lower cable loss, and FS path loss. Are the parameters listed in the above table in line with latest parameters concluded in RAN5? |
| Rohde & Schwarz: RAN5 is currently intensively discussing the available SNR range for the existing frequency bands. See the outcome from last meeting in R5-211936, R5-211929 and R5‑211950. For FR2b (up to 40 GHz) currently [7.3 dB] is assumed under fading conditions. Further investigation is needed for the higher frequency bands, but we do not think we can define a higher value for 47 GHz than for 40 GHz. |
| Apple: Thank you to Qualcomm and R&S for the RAN5 perspective. Our intention was just to extend the existing SNR calculations in 38.810 up to 48.2 GHz in a traceable way. The outcome could have an impact on the demodulation requirements work for band n262, so we would like to try to determine the correct SNR budget. Would it be reasonable to take the calculations as a preliminary assessment and to share with RAN5 for their comment? We can also ask them to share any updates they can related to FR2b: with this information we can apply the same analysis to scale the budget up to 48.2 GHz. As with TR38.810, the proposed SNR calculation for n262 is still a preliminary assessment, and RAN5 will determine the final value as part of their conformance requirement work. |
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### CRs/TPs comments collection

*N/A*

## Summary for 1st round

### Open issues

|  |  |
| --- | --- |
| **Issue** | **Status summary**  |
| **Issue 6-1-1: Band-dependent parameters for the demodulation setup** | *Candidate options:*- Proposal: Finalize the set of band-dependent parameters and values for the demodulation test setup SNR calculation based while taking the table below as the baseline.*Tentative agreements:*- Take the proposed calculations as a preliminary assessment and share with RAN5 for their comment- Ask RAN5 to share any updates related to FR2b, so that these can be applied to the SNR calculations for n262*Recommendations for 2nd round:*- Check whether the tentative agreement above can be confirmed; if confirmed, a tdoc for an LS to RAN5 can be requested |

### CRs/TPs

*N/A*

## Discussion on 2nd round (if applicable)

### Open issues

**Issue 6-1-1: Band-dependent parameters for the demodulation setup**

*Tentative agreements:*

- Take the proposed calculations as a preliminary assessment and share with RAN5 for their comment

- Ask RAN5 to share any updates related to FR2b, so that these can be applied to the SNR calculations for n262

*Recommendations for 2nd round:*

- Check whether the tentative agreement above can be confirmed; if confirmed, a tdoc for an LS to RAN5 can be requested

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| **Company**  | **Comments** |
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### Summary for 2nd round

**Issue 6-1-1: Band-dependent parameters for the demodulation setup**

# Topic #7: rapporteur input

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104523](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104523.zip) | vivo | **TP to TR38.884 v0.2.0 on MU Annex** |
| [R4-2104897](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104897.zip) | Apple, vivo | **Rapporteur input to TR38.884** |
| [R4-2104898](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104898.zip) | Apple, vivo | **TR38.884 work split** |

## Open issues summary

### Sub-topic 7-1: TR work split

**Issue 7-1-1: TR work split**

Proposal:

|  |  |
| --- | --- |
| Clause | TP Editor Company |
| 5.1         High DL power and low UL power | Keysight and R&S (1) |
| 5.2         Polarizaton basis mismatch between the UE and DUT | Apple |
| 5.3         Inter-band (FR2+FR2) CA | Anritsu |
| 5.4         Extreme temperature conditions | vivo |
| 5.5         Extension of frequency applicability for band n262 [this is the RF part] | vivo |
| 6.1         Extension of frequency applicability for band n262 [this is the RRM part] | Apple |
| 7.1         Extension of frequency applicability for band n262 [this is the demodulation part] | Apple |
| 8            Test time reduction (including RF, RRM, and demodulation scope) | vivo and Huawei (1) |
| B.1         Measurement uncertainty budget for UE RF testing methodology | vivo |
| NOTE 1: For TR clauses where multiple companies are listed as TP editors, the expectation is that they will prepare a single text proposal prior to the start of each meeting based on consensus; any additional or alternative proposals can be submitted in each company’s own and separate discussion paper |

- This work split is separate from WF assignments, since that is very much topic driven depending on the meeting and major issues which come up.

- Clause numbering takes the removal of the 256QAM objective into account (please see R4-2104897)

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Issue** | **Company comments** |
| **Issue 7-1-1: TR work split** | vivo: support the work split.  |
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### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2104523 TP to TR38.884 v0.2.0 on MU Annex | Company A |
| Company B |
|  |
| R4-2104897 Rapporteur input to TR38.884 | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

|  |  |
| --- | --- |
| **Issue** | **Status summary**  |
| **Issue 7-1-1: TR work split** | *Tentative agreements:*The proposed work split seems agreeable*Recommendations for 2nd round:*None |

### CRs/TPs

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| R4-2104523 TP to TR38.884 v0.2.0 on MU Annex | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*The TP is agreeable |
| R4-2104897 Rapporteur input to TR38.884 | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”*The proposal is agreeable |

## Discussion on 2nd round (if applicable)

### Open issues

Moderator’s note: this section is used to collect company comments on the new WF on agreements and remaining issues with FR2 test method enhancements.

**WF on agreements and remaining issues with FR2 test method enhancements**

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| --- | --- |
| **Company**  | **Comments** |
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### Summary for 2nd round

**WF on agreements and remaining issues with FR2 test method enhancements**

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| Title | Source | Comments |
| WF on agreements and remaining issues with FR2 test method enhancements | Apple | Capture the tentative agreements which can be confirmed for all topicsCapture next steps on remaining open issues for all topics |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tdoc number | Title | Source | Recommendation  | Comments |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
| R4-2104522 | Discussions on test procedure of FR2 enhanced test methods | vivo | Noted |  |
| R4-2104684 | On black box test | Huawei, HiSilicon | Noted |  |
| R4-2106695 | DNF Method | MVG Industries, Sony | Noted |  |
| R4-2107130 | On CFFNF and CFFDNF test methodologies for high DL power and low UL power test cases | Keysight Technologies | Revised | Revision to be noted |
| R4-2107187 | Analysis of NF based solutions | Rohde & Schwarz | Noted |  |
|  |  |  |  |  |
| R4-2104489 | Transmit signal quality measurements by TE with dual pol Rx | Qualcomm Incorporated | Noted |  |
| R4-2104558 | TPMI, 2-port CSI-RS, and EVM issues about polarization basis mismatch | MediaTek Inc. | Noted |  |
| R4-2104569 | Considerations on test with TPMI method | Anritsu Corporation | Noted |  |
| R4-2104701 | Views on solutions to minimize the impact of polarization basis mismatch | Sony, Ericsson | Noted |  |
| R4-2105043 | Discussion on TPMI configuration in EIRP measurement | Samsung | Noted |  |
| R4-2106570 | Solution to minimize the impact of polarization basis mismatch | OPPO | Noted |  |
| R4-2107111 | Text proposal to TR38.884: FR2 UL EVM measurements | Rohde & Schwarz | Return to | Depends on the round 2 discussions related to Topic 2 |
|  |  |  |  |  |
| R4-2104958 | TP to TR 38.884 on Inter-band DL CA in FR2 | Anritsu Corporation | Agreeable |  |
|  |  |  |  |  |
| R4-2104521 | TP to TR38.884 v0.2.0 on ETC system | vivo | Revised |  |
| R4-2104570 | Considerations on ETC MUs and a testability | Anritsu Corporation | Noted |  |
| R4-2107128 | On extreme temperature condition testing | Keysight Technologies | Noted |  |
|  |  |  |  |  |
| R4-2104518 | (draft) LS on antenna assumption and measurement grids for FR2 PC3 UE | vivo | Revised |  |
| R4-2104519 | Discussion and TP to TR38.884 on FR2 test time reduction | vivo | Agreeable |  |
| R4-2105001 | Discussion on test time reduction for FR2 OTA test time | LG Electronics | Noted |  |
| R4-2105044 | Discussion on prioritized methods for test time reduction | Samsung | Noted |  |
| R4-2107110 | Text proposal to TR38.884: Fast Spherical Coverage Method | Rohde & Schwarz | Return to | Depends on the round 2 discussions related to Topic 5 |
| R4-2107129 | Draft LS to RAN5 on Test Time Reduction | Keysight Technologies UK Ltd | Merged | Merged into revision of R4-2104518 |
| R4-2107296 | Discussion on enhance test method to reduce FR2 OTA test time | Huawei, HiSilicon | Noted |  |
|  |  |  |  |  |
| R4-2104896 | On permitted test methods for demodulation in band n262 | Apple | Noted |  |
|  |  |  |  |  |
| R4-2104523 | TP to TR38.884 v0.2.0 on MU Annex | vivo | Agreeable |  |
| R4-2104897 | Rapporteur input to TR38.884 | Apple, vivo | Agreeable |  |
| R4-2104898 | TR38.884 work split | Apple, vivo | Agreeable |  |

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