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

**Electronic Meeting, January 25 – February 5, 2021**

**Agenda item:** 13.1

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [98e][330] FR2\_enhTestMethods

**Document for:** Information

# Introduction

*The email discussion on FS\_FR2\_enhTestMethods is organized into the following topics:*

* Topic #1: Test methodology for high DL power and low UL power test cases
* Topic #2: Solutions to minimize the impact of polarization basis mismatch between the TE and DUT on the RF testing
* Topic #3: Testability enhancements to support the verification of RF requirements for inter-band (FR2+FR2) CA
* Topic #4: Extreme temperature conditions for all applicable FR2 UE RF test cases
* Topic #5: Testability enhancements to support the verification of RF requirements for FR2 DL 256QAM
* Topic #6: Testability enhancements to reduce test time
* Topic #7: Testability aspects for the introduction of the new band n262

We note that Topic #5 did not receive any contributions during this meeting.

# Topic #1: Test methodology for high DL power and low UL power test cases

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2100525](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100525.zip) | Apple Inc. | **TP to TR38.884 on High DL and Low UL power test cases**  Proposal 1: It is proposed to continue discussions related to the applicability of the DNF system to test cases where the beam peak search is performed in the NF.  Proposal 2: It is proposed to capture the following intermediate conclusion: at least with the CFFNF system the enhancement of performing beam peak search in the FF/IFF system and then executing the test case in the NF is considered feasible.  Proposal 3: It is proposed to capture the intermediate conclusion that both DNF and CFFNF systems are feasible enhancements to measure TRP. Further discussions are needed to resolve the source(s) of systematic errors.  Proposal 4: For EIRP measurements using the DNF system and both EIRP and TRP measurements using the CFFDNF system, the declaration of antenna phase centre offset of antenna yielding beam peak leads to a maximum 14 dB measurement system link budget improvement and can be considered feasible.  Proposal 5: For a given test case, non-permitted methods should be only considered if the improvement is better than the potential improvement of the permitted method. |
| [R4-2101485](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2101485.zip) | MVG Industries, Sony | **Overview of the Impact of phase variation for Direct NF Method**  Observation 1: DNF does suffer from a Beam Selection Error. It means beam steered in NF is different than beam steered at classical FF distance.  Observation 2: For the case of 4x1 antenna arrays, the error on Peak EIRP, TRP, and Spherical Coverage is less than 0.5dB when the antenna arrays are on a phone model ground plane (realistic case). The errors are approximately the same when the arrays are in FS (the same offset along X, Y, and Z axis is considered). Errors are DUT dependent.  Observation 3: There is a limit in terms of range length for DNF. This limit seems to be 30cm for the simulated 4x1 antenna array.  Observation []: At distances less than classical FF (ideal case) distance, the selected beams are different with respect to the FF case.  Observation []: With the considered UE models (arrays on a phone size ground plane), figure of merits such as EIRP, TRP, and Spherical Coverage are not influenced dramatically from range length especially if the dynamic beam scenarios is considered.  Observation []: When considering antenna arrays in Free Space, the FoMsâ€™ errors increase especially when the offset is along the beam peak direction.  Observation 4: FoMsâ€™ errors is DUT dependent  Observation 5: Based on the simulated antenna arrays in both FS and the UE model, the distance of 30cm seems to be the minimum range length for DNF test method for FR2.  Observation []: Based on the simulated antenna arrays both FS and UE model, the distance of 30cm seems to be the minimum range length for DNF test method FR2.  Observation 6: In comparison with a CATR with focal length of 1m, the improvement in terms of free space path loss for DNF test method with 45cm, and 30 cm range length is 10.5dB, and 7dB respectively. |
| [R4-2102616](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102616.zip) | Keysight Technologies | **On Test methodology for high DL power and low UL power test cases**  Observation 1: The NF interface distances of 4x1 and 8x2 antenna arrays are in the FF of the single element.  Observation 2: A measurement grid with 5o spacing or better shows almost insignificant differences in the spherical coverage curves for the 8x2 antenna array and max offsets up to 12.5cm.  Observation 3: The measurement uncertainties (mean error and std. deviation) for 50%-ile and 100%-ile CDF the 8x2 antenna array for offsets up to 12.5cm are in excess of 0.5dB for NF distances up to 45cm.  Observation 4: The measurement uncertainties (mean error and std. deviation) for 50%-ile and 100%-ile CDF the 4x1 antenna array for offsets up to 12.5cm are in excess of 0.5dB for NF distances up to 45cm.  Observation 5: The black-box CFFDNF approach with the UBF to activate to steer the beam towards the FF beam peak direction with a separate FF probe is not suitable for EIRP/EIS measurements towards the declared FF BP direction in the NF (even at 45cm range length) due to the very large measurement uncertainties  Observation 6: The black-box DFF/CFFDNF approach while allowing the DUT to optimize the beams, is not suitable for EIRP/EIS measurements towards the declared FF BP direction in the NF (even at 45cm range length) due to the very large measurement uncertainties  Observation 7: The NF testing approach with asymptotic expansion transform shows measurement accuracies of less than 0.2dB (mean error) and less than 0.3dB (std. dev.) and for NF EIRP measurements utilizing the black-box approach  Observation 8: The NF testing approach with asymptotic expansion transform can accurately predict the offset of the antenna array from the centre of QZ.  Observation 9: The black&white box approach (black: geometric centre of DUT is aligned with centre of QZ; white: phase centre offset of active panel is declared) does not require a FF probe to steer and lock the antenna beam towards the FF beam peak direction and has the same advantages in terms of relaxations as the black-box approach over the white-box approach.  Observation 10: The novel NF testing approach with asymptotic expansion transform yields similar measurement accuracies for NF EIRP measurements utilizing the black&white-box approach when compared to the black-box approach  Observation 11: The black&white-box approach exhibits larger MUs without the asymptotic expansion transform (single radius) when compared with the asymptotic expansion transform (two radii).  Observation 12: The black&white-box approach exhibits unacceptable MUs without the asymptotic expansion transform (single radius) for PC1.  Proposal 1: Do not consider the Direct NF methodology as enhanced methodology for spherical coverage test cases and beam peak searches.  Proposal 2: Do not consider the black-box DNF/CFFDNF approach as enhanced methodology for EIRP/EIS-based measurements with known FF BP direction.  Proposal 3: Focus on the CFFNF approach with asymptotic expansion transform  Proposal 4: Feedback from industry is requested whether the combination of black and black&white-box approaches is acceptable to avoid the need for a vendor declaration. |
| [R4-2102620](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102620.zip) | Rohde & Schwarz | **NF based solutions and Enhancement of permitted methods**  Observation 1: an offset correction is not required for TRP measurements on CFFDNF systems if minimum range length respects the Derat distance.  Observation 2: an offset correction is required for EIRP measurements on all types of CFF(D)NF systems.  Observation 3: a local search to maximize EIRP is required on all types of CFF(D)NF systems.  Observation 4: offset correction requires a knowledge of the antenna offset from the center of the DUT.  Observation 5: manufacturer declaration is the easiest and most consistent way to obtain the antenna offset required for offset correction.  Proposal 1: adopt the algorithm described in [12] for offset correction on CFF(D)NF systems.  Proposal 2: manufacturer shall declare antenna phase centre offset with respect to the center of the DUT for the antenna panel that corresponds to the FF beam peak.  Proposal 3: group to prioritize the work for non-permitted methods on the following requirements: |

## Open issues summary

### Sub-topic 1-1: beam management sensitivity study of NF based solutions

*This sub-topic is focused on finding consensus on the conclusions of the beam management sensitivity study of NF based solutions.*

**Issue 1-1-1: conclusions related to the CFFNF system**

* Proposals:
  + Alt 1-1-1-1: Confirm feasibility of the CFFNF system for test cases where the beam peak search is performed in the NF and for TRP measurements
    - At least with the CFFNF system the enhancement of performing beam peak search in the FF/IFF system and then executing the test case in the NF is considered feasible
    - The CFFNF system is a feasible enhancements to measure TRP
  + Alt 1-1-1-2: Confirm feasibility of the CFFNF system with asymptotic expansion transform for test cases where the beam peak search is performed in the NF and the feasibility of the CFFNF system for TRP measurements
    - Do not consider the black-box DNF/CFFDNF approach as enhanced methodology for EIRP/EIS-based measurements with known FF BP direction
    - Focus on the CFFNF approach with asymptotic expansion transform
    - Update comparison of black and black&white box approaches as shown in R4-2102616
  + Alt 1-1-1-3: Confirm feasibility of the CFF(D)NF system for test cases where the beam peak search is performed in the NF and for TRP measurements
    - Beam peak search and UBF are performed with the FF method.
    - Maximum EIRP with (D)NF is measured after a local search to maximize it.
    - Offset correction is implemented as described in R4-2102620
    - An offset correction is not required for TRP measurements on CFFDNF systems if minimum range length respects the Derat distance
    - An offset correction is required for EIRP measurements on all types of CFF(D)NF systems

**Issue 1-1-2: conclusions related to the DNF system**

* Proposal:
  + Alt 1-1-2-1: Confirm feasibility of the DNF system for TRP measurements and FFS for EIRP measurements
    - The DNF system is a feasible enhancements to measure TRP
    - Continue discussions related to the applicability of the DNF system to test cases where the beam peak search is performed in the NF
  + Alt 1-1-2-2: Confirm feasibility of the DNF system for TRP measurements and consider DNF system with path loss compensation for EIRP measurements
    - The DNF system is a feasible enhancements to measure TRP
    - The DNF system with path loss compensation, which depends on the manufacturer declaration of the phase center of the antenna under test (see R4-2101485), is a feasible enhancement to measure EIRP
    - Capture updated simulation results based on DNF (see R4-2101485) with path loss compensation in the TR
    - Capture updated path loss improvement results based on DNF (see R4-2101485) in the TR
  + Alt 1-1-2-3: Do not consider the Direct NF methodology as enhanced methodology for spherical coverage test cases and beam peak searches

**Issue 1-1-3: remaining open issues with NF based solutions**

* Proposals:
  + Alt 1-1-3-1: based on the simulated antenna arrays in both FS and the UE model, the distance of 30cm seems to be the minimum range length for DNF test method for FR2
  + Alt 1-1-3-2: based on the analysis of the minimum FF and NF range lengths for black box conditions and PC3 devices with a 30cm QZ utilizing the fixed aperture approach, capture the min range length calculations as shown in R4-2102616

### Sub-topic 1-2: manufacturer declarations

**Issue 1-2-1: feasibility and efficacy of manufacturer declarations**

* Proposal:
  + Alt 1-2-1-1: For EIRP measurements using the DNF system and both EIRP and TRP measurements using the CFFDNF system, the declaration of antenna phase centre offset of antenna yielding beam peak leads to a maximum 14 dB measurement system link budget improvement and can be considered feasible
  + Alt 1-2-1-2: The manufacturer declaration of the phase center of the antenna under test enables path loss compensation for the DNF system to perform beam peak search
    - Manufacturer shall declare antenna phase centre offset with respect to the center of the DUT for the antenna panel that corresponds to the FF beam peak
  + Alt 1-2-1-3: feedback from industry is requested whether the combination of black and black&white-box approaches is acceptable to avoid the need for a vendor declaration (see R4-2102616)

### Sub-topic 1-3: applicability of permitted and non-permitted methods

**Issue 1-3-1: applicability of non-permitted methods**

* Proposal:
  + Alt 1-3-1-1: For a given test case, non-permitted methods should be only considered if the improvement is better than the potential improvement of the permitted method.
  + Alt 1-3-1-2: Group to prioritize the work for non-permitted methods on the following requirements:
    - 6.3.2 Transmit OFF power
    - 6.5.3.2 Additional spurious emissions
    - 7.4 Maximum input power
    - 7.9 Receiver spurious emissions

**Issue 1-3-2: enhancement of permitted methods**

* Proposal: update the table of potential improvements of current permitted methods in the TR with updates provided in R4-2102620
  + In-band blocking test case: 50MHz: 1.8dB relaxation for power in transmission BW and interferer for band n260; 100MHz: 4.8dB relaxation for power in transmission BW and interferer for band n260; 200MHz and 400MHz are deemed not testable.

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 1-1-1: conclusions related to the CFFNF system | Keysight:  Most of the Issue #1 topics outlined below should differentiate between black-box approach and two different black&white box approaches.   * Black box: no antenna location is declared and the geometric centre of DUT is aligned with the centre of QZ * Black&white box (beam peak search, spherical coverage): all active antenna locations are declared together with the angular ranges (theta, phi) each active antenna performs best (when compared to the remaining antenna panels). The geometric centre of DUT is aligned with the centre of QZ * Black&white box (EIRP/EIS/TRP in known FF beam peak direction): only the antenna location of the antenna that yields the beam peak needs to be declared. The geometric centre of DUT is aligned with the centre of QZ   Additionally, we would like to highlight some of the applicability criteria for CFFNF, CFFDNF, and DNF based on the views presented in the various contributions.  The CFFNF with asymptotic expansion transform has the following applicability:   * Beam peak searches and spherical coverage test cases are performed with black box approach using the FF probe * The low UL power/high DL power EIRP/EIS test cases in known FF BP direction are applicable to the black box approach using local search on radius r1 and very localized searches at r2 and r3 (three radii approach)   + EIRP/EIS can be approximated very accurately with the NF probe at very close distances (~22cm for PC3, ~27cm for PC1) with optimized improvements in relaxations   + The unknown antenna location can be estimated accurately which allows very accurate TRP measurements at very close distances with large improvement in relaxations * The low UL power/high DL power EIRP/EIS test cases in known FF BP direction are applicable to the ‘black&white box (EIRP/EIS/TRP in known FF beam peak direction) approach’ ~~using local search on radius r1 and very localized searches at r2 (two radii approach)~~using a two radii test approach in a fixed test direction   + EIRP/EIS can be approximated very accurately with the NF probe at very close distances (~22cm for PC3, ~27cm for PC1) with optimized improvements in relaxations * The beam peak search and spherical coverage tests are not applicable to ‘Black&white box (beam peak search, spherical coverage)’ approach since these tests are performed using the FF probe without an issue; performing these tests with the NF probe instead would be test time prohibitive and require a detailed vendor declarations * The low UL power TRP test cases are not applicable to asymptotic expansion transform approach (CFFNF) since that approach would be test time prohibitive. However, the known offset (empirical evaluation with black box approach or declared with black&white box approach) can be compensated using CFFDNF approach to obtain very accurate TRP results at very close distances.   CFFDNF has the following applicability:   * Beam peak searches and spherical coverage test cases are performed with black box approach using the FF probe * The low UL power/high DL power EIRP/EIS test cases in known FF BP direction are not applicable to the black box approach   + Per KS (Tables 5 and 6) and R&S (Table 2-1) and MVG (Table 4), uncertainty is too large and therefore not applicable. * The low UL power/high DL power EIRP/EIS test cases in known FF BP direction are applicable to the ‘black&white box (EIRP/EIS/TRP in known FF beam peak direction) approach’   + R&S believes a local search is required (Observation 3 from R4-2102620) while KS does not believe a local search is required and the test direction can be calculated. Measurements are performed with the NF probe at a single radius/range length only   + EIRP/EIS can be approximated ~~accurately~~ at very close distances (~22cm for PC3, ~27cm for PC1) with an increase in MU for PC3 and a rather significant increase in MU for PC1, see figure 42 in R4-2102616. * TRP test cases at very close distances/range lengths require offset compensation and for PC3, range lengths beyond 43cm do not necessarily require offset compensations. However, at those range lengths, the relaxations are not minimized. * The beam peak search and spherical coverage tests are not applicable to ‘Black&white box (beam peak search, spherical coverage)’ since these tests are performed using the FF probe without an issue; performing these tests with the NF probe would require a detailed vendor declaration   DNF has the following applicability:   * The low UL power/high DL power EIRP/EIS test cases in the known FF BP direction as well as spherical coverage and beam peak search are not applicable to the black box approach   + Per KS (Tables 5 and 6 for CFFDNF) and R&S (Table 2-1 for CFFDNF) and MVG (Table 4) contributions, EIRP/EIS uncertainty is too large and therefore not applicable. * The low UL power/high DL power EIRP/EIS test cases in the known BP direction and applicability to the ‘black&white box (EIRP/EIS/TRP in known FF beam peak direction) approach’   + MVG showed in Table 5 that DNF is feasible but showed relatively large measurement uncertainties for large offsets   + KS has not analyzed this case yet since we felt that a FF probe is necessary to make sure the correct beam is selected * The beam peak search and spherical coverage tests and applicability to ‘Black&white box (beam peak search, spherical coverage)’ approach   + MVG showed in Figure 19 for one offset that a compensation approach is able to estimate the spherical coverage curves.   + KS believes that the beam peak could be estimated with path losses of the known antennas compensated but with uncertainties (at 30cm: ~0.4dB std. deviation and 0.2dB mean error); the spherical coverage results, however, would be estimated very poorly with each EIRP measurement compensated. More importantly, the detailed vendor declaration with the declaration of coverage ranges for each antenna seems very problematic.   KS believes that for black&white approach the asymptotic expansion approach (2 radii measurements) yields more accurate measurements than the direct NF approach (1 radius) as outlined in Figures 41&42 and Table 9. A very simple example is given in the following table by looking at the EIRP of the 8x2 antenna in the broadside direction without any offset and comparing it with the FF EIRP. The CFFDNF approach is limited to these types of mean errors while the CFFNF approach with the asymptotic transform can further reduce/eliminate these errors.   |  |  |  | | --- | --- | --- | | **Range Length [m]** | **EIRP Error in broadside direction with 0cm offset w.r.t. FF for [dB]** | | | **Matlab** | **CST** | | **0.2** | 0.20 |  | | **0.22** | 0.16 | 0.13 | | **0.32** | 0.08 | 0.06 | | **0.43** | 0.04 | 0.03 |   Alt 1-1-1-1: CFFNF should assume that beam peak search is performed in FF instead of NF (as stated in first sentence). The two bullets under 1-1-1-1 are correct (see applicability statement earlier)  Alt 1-1-1-2: as outlined in the applicability statements above, the DNF/CFFDNF approach is not suitable for EIRP/EIS measurements with black box approach but CFFDNF could be suitable for EIRP/EIS/TRP test cases with the black&white box approach  Alt 1-1-1-3: we are not convinced that a local search is required. Other offset correction algorithms are not precluded. While at larger NF range lengths, no offset compensation might be necessary for TRP, the relaxations can be further minimized when measuring at shorter range lengths.  R&S: we share part of the analysis done by KS, although some clarification is required to simplify the overall picture and next steps on the discussion.  We think the discussion about *Black&White* or *Black box* approach should be detached from this Issue and treated under Issue 1-2-1. If so, the differences between CFFNF and CFFDNF are very simple:  - CFFDNF assume the range length for the NF is enough to respect Derat Distance. It requires the offset correction (or transform) only for EIRP/EIS measurements, while it’s not a must for TRP measurements.  - CFFNF require an offset correction (or transform) in all cases: EIRP/EIS/TRP.  Which method is used for the correction is FFS.  @Keysight: regarding the comment about the need for a local search for EIRP/EIS on CFFDNF system, we think it is required in the same way it is described above for CFFNF. Whether the local search can be minimized by calculation or existing data from previous measurements can be further discussed.  Samsung: thanks to summarization from R&S, we can see many common part between CFFNF and CFFDNF. CFF(D)NF methods are aligned with the core requirement for high DL low UL test cases which is required to be linked to peak beam transmission/reception status and beam locked.  BTW, it seems “beam peak search is performed in the NF” in alt 1-1-1-1/2/3 should be “beam peak search is performed in the FF”  Keysight:  The above write-up is certainly a first draft and I realize that some adjustments might be necessary. Please note that I made some corrections (highlighted in yellow) in the write-up above due to some copy&paste mistakes.  I would like to point out though that CFFDNF does not necessarily assumes the range length exceeds the Derat distance. We believe that CFFDNF is applicable to much smaller NF distances, e.g., ~20cm, where an offset correction can be used to significantly improve the measurement uncertainties for TRP. As outlined earlier, the uncertainties for EIRP at these measurement distances exceed the uncertainties of the CFFNF approach. Our preference is to refer to offset correction terminology and leave the transform terminology for CFFNF.  The CFFNF methodology requires an asymptotic expansion transform that inherently applies the offset compensation. I would also like to point out that while TRP is feasible with CFFNF, the transforms are not needed given the accuracy and reduced test time with CFFDNF.  Clarification to R&S: while we agree that a local search is required, we believe that this is needed just for the black box approach as outlined in Figure 31 of R4-2102616. Once the offset is declared or known with the black&white box approach, we believe that no search (or previous measurement data) is required as outlined in Figure 38 of R4-2102616 since the highlighted measurement angle/direction can be calculated.    Can R&S confirm that the proposed search for CFFDNF takes path loss and probe antenna pattern compensations into account to determine the peak. Apple: our suggestion for this issue is to try to determine whether each CFF(D)NF approach is feasible from the perspective of beam management and/or TRP errors, assuming the necessary manufacturer declaration is possible. Whether the particular manufacturer declaration is feasible, we suggest handling in Issue 1-2-1. For example, it might be that several approaches exhibit good beam management accuracy, but only a subset depends on manufacturer declarations which are deemed possible.  MVG: to Keysight  Relatively large measurement uncertainties for large offsets was reported for antenna arrays in FS when the offset in the beam direction. When antenna arrays are on UE model, peak EIRP, TRP and spherical coverage errors are not so large.  R&S:  The additional differentiation proposed by Keysight seems fair and could be reflected in the TR with some more clarifications to the write-up.  To Keysight:  - With regards to the uncertainty difference between CFFNF (w/ transform) and CFFDNF (w/ offset correction) for EIRP measurements, we don’t see such major difference in our simulation results so we would need some alignment before reflecting those simulation results in the TR.  - Regarding the local search, we don’t think a calculation is enough unless you have full knowledge of the DUT antenna array (offset, number of elements, orientation, etc.).  - About the last question, we don’t consider probe & path loss compensation during the local search, but the correction is applied after the peak is maximized.  To Apple: we agree with your view. Furthermore, both CFFNF and CFFDNF can be deemed feasible from beam management and TRP error point of view based on the available data, since both of them assume beam management is performed with the FF method. The final implementation (i.e. transform and/or offset correction) has some dependence on the availability of a manufacturer declaration, but this can be clarified under Issue 1-2-1 as proposed.  Keysight:  To R&S: we agree that we could further work offline on some of the simulation assumptions. As outlined above, we believe that the mean error for DNF and 0cm offset is ~0.2dB (based on simple Matlab and CST single-directional measurements/simulations).  To MVG: there are cases where DNF might yield acceptable results for black&white box but we cannot agree that this methodology is a viable enhanced methodology |
| Issue 1-1-2: conclusions related to the DNF system | Keysight  Alt 1-1-2-1: DNF is not feasible to measure TRP for black box as the correct beam cannot be activated. Beam peak searches cannot be performed accurately with DNF for black box. We should instead focus on CFFNF and CFFDNF instead.  Alt 1-1-2-2: DNF is not feasible to measure TRP for black box as the correct beam cannot be activated. Beam peak searches cannot be performed accurately with DNF for black box. We should instead focus on CFFNF and CFFDNF instead.  Alt 1-1-2-3: we believe DNF is not suitable for spherical coverage and beam peak searches (for more information, see applicability discussion above). We should instead focus on CFFNF and CFFDNF instead.  R&S: We support 1-1-2-3.  DNF has been shown as not feasible for TRP measurements in an independent system since the correct beam cannot be selected with a beam peak search performed with DNF. Agree with KS that we should focus on CFF(D)NF approaches.  Samsung:  In MVG contribution (R4-2101485), simulation of DNF shows small EIRP error for dynamic beam status in NF compared with beam peak lock status from FF. based on that, we can see the possibility that DNF method may be possible for single panel UE (single panel per band) with the antenna panel offset declaration. For multi-panel UE (multi-panel per band), it seems complicated manufacture declaration is needed for path loss compensation. In our understanding, the following manufacture declaration is better to be avoided in further DNF study:  - Location of the active panels in any UL/DL test direction and the detailed locations of the panels within the DUT (applicable if the enhanced test methodology does need to perform beam peak search/spherical coverage test cases)  Apple: we would like to understand whether Alt 1-1-2-2 can yield accurate TRP measurement results. This alternative depends on the depends on the manufacturer declaration of the phase center of the antenna under test. Whether the declaration itself is or is not feasible should not influence the answer whether the test method can yield accurate TRP results. We would like to discuss the feasibility of this manufacturer declaration further in Issue 1-2-1.  OPPO:  We have the same view with KS and R&S that DNF is not feasible for TRP measurement due to beam peak not captured correctly. There is no clear analysis on why TRP and spherical coverage have such small differences between dynamic beam in NF and static beam in FF in MVG’s contribution. Is it general conclusion or device dependent conclusion?  MVG: In our contribution (R4-2101485) we have considered two antenna arrays configurations 4x1 and 8x2. Those configurations have been simulated when in FS (not realistic scenario), and on phone size ground plane (realistic scenario used in 3GPP to derive all the FR2 requirements so far). It is shown that for the arrays on UE model, the error on Peak EIRP, Spherical Coverage, and TRP is not very much influenced by the range length. More evident is the impact of range length on the beam selection error (beam ID different between NF and FF) even though this error is very high at the poles where the coverage is very poor.  Different story when the same arrays simulated on ground plane are simulated in FS (again this is not a realistic case). If the arrays offset is in the beam peak direction, mainly the error in peak EIRP, and spherical coverage are increasing. At 30cm range length around 6dB error on peak EIRP (CDF=1) can be observed.  Because of the above, in our contribution we came up with observations 2, 3, and 4 which are highlighted again here:  **Observation 2: With the considered UE models (arrays on a phone size ground plane), figure of merits such as EIRP, TRP, and Spherical Coverage are not influenced dramatically from range length especially if the dynamic beam scenarios is considered.**  **Observation 3: When considering antenna arrays in Free Space, the FoMs’ errors increase especially when the offset is along the beam peak direction.**  **Observation 4: FoMs’ errors are DUT dependent**We have also shown that knowing the active antenna arrays offset with respect to the center of the OTA system setup, the Peak EIRP (CDF=1) and spherical coverage error decrease. This is evident for the case where the offset is in the beam peak direction. From the below 1D plot can be observed the effect of the compensation due to the antenna array offset:  8x2 antenna arrays on UE model – Phi=0deg  Chart  Description automatically generated  Theta=90deg  Chart, histogram  Description automatically generated  8x2 antenna arrays FS (offset 12.5cm in the beam peak direction – worst case scenario  Phi=0deg  Chart  Description automatically generated  Theta=90deg    That is why our observation 5:  **Observation 5: Based on the simulated antenna arrays in both FS and the UE model, the distance of 30cm seems to be the minimum range length for DNF test method for FR2.**  It shall be noted that the offset of the antenna array could potentially be estimated with a certain level of accuracy by either measuring antenna arrays at different radii or using different techniques  To OPPO: In our contribution (R4-2101485) and specifically Observation 4, we stated that conclusion are DUT dependent. It is difficult to draw any conclusions.  Keysight:  We believe the revised ‘90deg/90deg’ HPBW assumption with reduced back lobe corresponds to much more realistic conditions. Again, the lack of FF probe to lock the proper beam and to make the UE apply proper beam management is problematic to consider DNF an enhanced methodology even for black & white box approach. |
| Issue 1-1-3: remaining open issues with NF based solutions | Keysight  Alt 1-1-3-1: as we do not believe DNF is not suitable for black box testing, we cannot support the statement that 30cm seems to be the minimum range length for DNF.  R&S: another definition for minimum range length has been provided in November meeting (Derat distance – R4-2016562), and simulation results presented to this and previous meeting show how CFFDNF is accurate to perform TRP measurements (i.e. beam peak acquired with FF system, and TRP measured in NF without transform or correction).  Therefore, minimum range length for the NF antenna should be captured as shown in past meeting R4-2016562, following the effective radiating aperture concept:   |  |  |  |  | | --- | --- | --- | --- | | f [GHz] | Effective Aperture [cm]  *Deff* | CFFDNF  *Derat Distance* | CFFNF  *Radiative NF boundary* | | 24.25 | 5.10 | 0.32 | 0.19 | | 30 | 4.12 | 0.28 | 0.18 | | 40 | 3.09 | 0.25 | 0.17 | | 43.5 | 2.84 | 0.24 | 0.17 | | 52.6 | 2.35 | 0.23 | 0.17 |   **Range length comparison, PC3 device (8x2 array), QZ size = 30cm, Black box approach**  Keysight:  The effective aperture has not been agreed yet (as assumed in the above table). We have also proposed another NF test distance in our contribution which we might want to add/consider. We can confirm your observation that at 43cm, no offset correction for TRP is needed. Our TRP analyses with maximum offsets of 12.5cm and 10k random offsets distributed uniformly within the 12.5cm radius sphere with a revised ‘90deg/90deg’ HPBW are shown below  Table 1: TRP MU for 2x8 array with ’90x90’ antenna element   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Test distance (cm) | Grid (degree) | With Correction | | No Correction | | | Mean TRP Error [dB] | TRP Std. Dev. [dB] | Mean TRP Error [dB] | TRP Std. Dev. [dB] | | 20 | 5 | -0.01420 | 0.03623 | 0.39449 | 0.24368 | | 7.5 | -0.02402 | 0.12553 | 0.39474 | 0.24664 | | 10 | -0.02944 | 0.16512 | 0.39100 | 0.29085 | | 32 | 5 | -0.02238 | 0.01213 | 0.14085 | 0.08250 | | 10 | -0.03522 | 0.03330 | 0.14109 | 0.08532 | | 43 | 5 | -0.02409 | 0.01027 | 0.07626 | 0.04411 | | 10 | -0.03733 | 0.02504 | 0.07631 | 0.04444 |   Apple: we think it is very helpful to capture the range length calculations in the TR; the defintion of effective aperture was proposed last meeting but was not agreed  MVG: It is shown in our contribution that DNF is affected by manufactured declaration too. Not sure why we want to take DNF from the picture. Looking at simulation results DNF could potentially be used in case of black&white box approach. |
| Issue 1-2-1: feasibility and efficacy of manufacturer declarations | Keysight:  Various vendor declarations need to be discussed (as discussed briefly above)   * Black box: no antenna location is declared and the geometric centre of DUT is aligned with the centre of QZ. The CFFNF approach does not require a vendor declaration. * Black&white box (beam peak search, spherical coverage): all active antenna locations are declared together with the angular ranges (theta, phi) each active antenna performs best (when compared to the remaining antenna panels). The geometric centre of DUT is aligned with the centre of QZ. This is the most extensive vendor declaration and would look something like this:   Table 1: Sample Vendor Declaration for white box approach supporting all conformance test cases   |  |  |  | | --- | --- | --- | | **Number of Antenna  Panels in DUT** | # | | | **Antenna Panel #** | **Phase-centre offset from geometric centre of DUT:** | **Range of Angles covered by Antenna Panel** | | 1 | (*x*off1, *y*off1, *z*off1) | (start1 to end1,start1 to end1) | | 2 | (*x*off2, *y*off2, *z*off2) | (start2 to end2,start2 to end2) | | … | … | … | | N | (*x*offN, *y*offN, *z*offN) | (startN to endN,startN to endN) |   This declaration would be needed for beam peak search and spherical coverage measurements using the DNF system. In CFFNF/CFFDNF, this extensive declaration would not be needed since these tests can be performed with black box approach and FF probe. This declaration should be avoided especially since we eliminated the white box approach in the last meeting which required the same level of vendor declaration.   * Black&white box (EIRP/EIS/TRP in known FF beam peak direction): only the antenna location of the antenna that yields the beam peak needs to be declared. The geometric centre of DUT is aligned with the centre of QZ. The CFFDNF requires this declaration for EIRP/EIS measurements and TRP measurements at very close NF distances. For TRP test cases and larger NF range lengths (~43cm for PC3), this declaration is not required. A rather simple declaration would be sufficient:   Table 1: Sample Vendor Declaration for black&white-box approach   |  |  | | --- | --- | | **Phase-centre offset from geometric centre of DUT of antenna panel yielding TX beam peak:** | **Phase-centre offset from geometric centre of DUT of antenna panel yielding RX beam peak:** | | (*x*off, *y*off, *z*off) | (*x*off, *y*off, *z*off) |   Alt 1-2-1-1: the 14dB link budget improvement is applicable to CFFNF and CFFDNF only; not DNF since MVG suggests a 30cm min range length  Alt 1-2-1-2: manufacturers are not required to declare the antenna offset with CFFNF; if the phase centre offset is declared, the simple declaration, i.e., the single antenna that corresponds to FF beam peak, should be used.  Alt 1-2-1-3: this approach would avoid any vendor declaration while leveraging the advantage of black&white box approach for many test cases.  R&S: We think this Issue should be detached from the CFFNF or CFFDNF.  Based on the proposals presented so far, we only see 2 options:  *Option 1 – Black&White box approach*: manufacturer declares the phase center offset from geometric center of DUT for the antenna panel yielding TX/RX beam peak.  *Option 2 - Black-box approach*: no declaration is provided. Therefore, the phase center offset from geometric center of DUT has to be determined by the test system itself, with the corresponding impact on test time, system complexity, validation, etc.  In both cases:  - The phase center offset (either declared or determined empirically by the test system) is used to correct EIRP/EIS measurements. In case of TRP measurements, the need for a correction depends on the range length.  - DUT geometric center is placed at the center of the coordinate system.  DNF alone is not considered here since correct beam cannot be selected with a beam peak search performed with DNF.  Following this analysis:  Alt 1-2-1-1: maximum 14dB link budget improvement is only applicable to CFF(D)NF.  Alt 1-2-1-2 corresponds to *Option 1 - Black&White box* *approach* above. The system is not required to implement any method to determine the phase center offset.  Alt 1-2-1-3 corresponds to *Option 2 – Black-box approach* above. The system must implement a method to determine the phase center offset. Method if FFS.  Samsung:  On one hand, “*Option 1 – Black&White box approach*: manufacturer declares the phase center offset from geometric center of DUT for the antenna panel yielding TX/RX beam peak” is acceptable for us to reduce test time and test complexity; on the other hand, “*Option 2 - Black-box approach*: no declaration is provided” is also needed because UE vendors may not willing to declare antenna panel offset for some special products. In our view, both “*Option 1 – Black&White box approach”* and “*Option 2 - Black-box approach”* should be captured as enhanced test methods. If there is manufacturer declaration, apply black&white box approach; otherwise apply black-box approach.  Keysight:  We agree that the only practical approaches are black box and black&white box (with just the declaration of the one antenna panel that yields the FF beam peak). However, we feel that all three approaches could be outlined in the TR (here, the Black & White Box section in R4-2016213 could be leveraged and the white box approach could be adjusted to describe the ‘Black&white box (beam peak search, spherical coverage)’ approach mentioned above which as we pointed out, should not be considered further.  We agree with Samsung that both approaches should be captured and considered as enhanced methodology.  vivo: Regarding the antenna declarations, we would suggest the TE vendors to share the test time comparison of CFFNF with black box approach and CFFDNF with black&white box approach. From UE vendor perspective, the black box approach is preferred if the test time is comparable with not significant increased MU.  Apple: we would like to understand whether the “white box” declaration in Keysight’s comment in Table 1 can yield accurate TRP measurement results with DNF; this isn’t yet clear. Furthermore, this approach might have impact on total test time, as vivo has commented. *Option 1 – Black&White box approach* seems to be a reasonable declaration in the context of the enhanced methodology it enables.  OPPO:  We echo vivo’s comments. It is preferable for UE vender not to declare antenna panel information under comparable measurement time and accuracy. We also agree that both black box and black&white box approaches should be captured as enhanced test methods.  MVG: We still believe we should keep DNF into the picture. We have shown that if the array is center with the OTA system setup (no offset – white box approach), there is no peak EIRP error. To Apple, for our understanding yes it can yield good accuracy.  R&S:  Comment to Samsung and Keysight: in order to properly capture *Option 2 – Black-box approach* above we also need to detail the method(s) for antenna offset determination and the verification process inside the actual test system.  Comment to vivo: the test time impact is briefly shown in Table 5.1.3-2 in current draft TR, but additional clarification can be made based on current discussion. For instance, the only solution not adding test time is CFFDNF with *Black&White box approach.*  Keysight:  We could certainly look more into test time impact. There will be some differences between R&S CFFDNF and KS CFFDNF approach since R&S is suggesting a local search while KS does not.  To Apple: the Table 1 was used from last meeting’s contribution R4-2016213 which discussed the white box approach and which dropped from further consideration. The same declaration would be applicable for the ‘Black&white box (beam peak search, spherical coverage)’ approach which, based on KS and R&S view should not be considered further as well. For TRP, only the ‘Black&white box (EIRP/EIS/TRP in known FF beam peak direction)’ approach is necessary and the TRP uncertainties have been presented in Issue 1-1-3 for CFFDNF. These uncertainties do not apply to DNF since the proper beam is not necessarily activated properly. |
| Issue 1-3-1: applicability of non-permitted methods | Keysight:  Alt 1-3-1-2: we cannot agree to limit the scope of test cases as agreed earlier; at this point, all test cases previously identified should be included given the improvements were considered potential. For instance, it is not clear why min output power (still non-zero relaxations) and OBW (MU still under discussion) have been excluded from the list.  R&S: Alt 1-3-1-1 and Alt 1-3-1-2 are not exclusive to each other, so we agree to both of them.  Regarding Alt 1-3-1-2, and considering the broad list details still to clarify for CFF(D)NF systems, we think it’s better to focus on those test cases that will require anyway some sort of NF method.  @Keysight: Min output power has been excluded from the list since most relaxations can be removed. With current relaxations proposed in RAN5, only n260 with 400MHz for PC3 would still require some relaxation. Occupied Bandwidth could be listed until RAN5 finalize the MU work.  Keysight:  Since there is still is a relaxation for min output power and since the improvements based on signal conditioning are not necessarily guaranteed, we cannot agree to limit the scope at this point. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| [R4-2100525](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100525.zip) | Keysight: As outlined earlier, more differentiation between black and black&white box is needed. We are willing to work with Apple on the TP. Concern with P3: DNF does not allow proper beam selection for black box and therefore should not be applicable to TRP. |
| R&S: In addition to the differentiation between black and black&white approach, we also think that further clarification is required for CFFNF and CFFDNF since different “flavors” are proposed for each of them and the applicability is still mixed. |
| Apple: we welcome further collaboration on the TP (will ask for a revision). Regarding different “flavors” of CFF(D)NF, would it make sense to introduce another sub-clause which explains the setups of the enhanced methods (i.e. methods which we select based on the simulation study and feasibility of the related manufacturer declarations) in better detail (with diagrams)? |
| MVG: We should point out the difference seen in the simulation results when considering antenna arrays in FS (not realistic case) and on UE model (realistic case). This difference is more evident for DNF (this method does potentially suffer) from beam selection error. |
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## Summary for 1st round

### Open issues

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

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| --- | --- |
|  | **Status summary** |
| Issue 1-1-1: conclusions related to the CFFNF system | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 1-1-2: conclusions related to the DNF system | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 1-1-3: remaining open issues with NF based solutions | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 1-2-1: feasibility and efficacy of manufacturer declarations | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 1-3-1: applicability of non-permitted methods | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

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

*Scope of the WF:*

* *TBD*

### CRs/TPs

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

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
| [R4-2100525](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100525.zip) |  |

## Discussion on 2nd round (if applicable)

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| **Issue or WF** | **Company comments** |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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# Topic #2: Solutions to minimize the impact of polarization basis mismatch between the TE and DUT on the RF testing

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2100526](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100526.zip) | Apple Inc. | **TP to TR38.884 on polarization mismatch** |
| [R4-2100571](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100571.zip) | Sony, Ericsson | **Views on solutions to minimize the impact of polarization basis mismatch**  Observation 1: The TPC power command is also the only mechanism that the network can use to control the UE output power in real life.  Observation 2: 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: There is no need to introduce additional test methods for Rel-15 nonCoherent UEs and Rel-16 nonCoherent UEs |
| [R4-2100664](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100664.zip) | LG Electronics | **Discussion on enhanced test method for polarization basis mismatch**  Proposal 1: Introduce test mode to trigger Tx diversity as one of the hybrid methods  Proposal 2: Do not introduce additional UE capability for hybrid methods and apply UE declaration for test mode to be used |
| [R4-2100699](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100699.zip) | MediaTek Inc. | **Practical TPMI and 2-port CSI-RS for FR2 SISO test enhancement**  Observation 1: â€œpractical TPMIâ€ is aligned with networkâ€™s capability, and it can further enhance UE performance.  Observation 2: â€œ2-port CSI-RSâ€ is a feasible test method and aligned with networkâ€™s capability, and it can further enhance UE performance.  Proposal 1: For â€œTPMI methodâ€, â€œpractical TPMIâ€ shall be further applied.  Proposal 2: For â€œTPMI methodâ€, â€œ2-port CSI-RSâ€ shall be further applied. |
| [R4-2100894](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100894.zip) | Samsung | **Discussion on FR2 EIRP measurement enhancement**  Observation 1: TPMI method coverage is very limited. If TPMI method is not applicable for clause 6.2 of TS38.101-2, then TPMI method is only applicable for Rel-16 UEs which support uplink full power transmission to verify requirements in UL MIMO section.  Observation 2: given limited coverage of TPMI method, it is necessary to further study other methods including EIRP measurement of UEs supporting TX diversity.  Proposal 1: RAN4 further discuss if TPMI method is applicable for clause 6.2 of TS38.101-2 or not.  Proposal 2: RAN4 further discuss EIRP measurement enhancement for core requirement in clause 6.2 of TS38.101-2 to reflect diversity gain as long as UE supports 2TX TPMI and/or TX diversity, and test mode is a reliable method by locking the 2TX transmission status. |
| [R4-2101759](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2101759.zip) | OPPO | **Solution to minimize the impact of polarization basis mismatch**  Proposal []: For Rel-15 nonCoherent UEs and Rel-16 nonCoherent UEs which do not support full power transmission, the link antenna should keep transmitting with two polarizations simultaneously during EIRP measurement to avoid polarization basis mismatch. |
| [R4-2101830](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2101830.zip) | vivo | **TP to TR38.884 v0.1.0 on polarization basis mismatch** |
| [R4-2102090](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102090.zip) | Rohde & Schwarz | **Discussion on FR2 UL demodulation measurements**  Observation 1: Annex F of TS 38.101-2 and Annex E of TS 38.521-2 must be updated to accommodate the dual polarization measurements.  Proposal 1: RAN4 agrees to define a zero-forcing MIMO receiver for FR2 UL EVM measurements.  Proposal 2: The same receiver architecture shall be used for FR1 and FR2.  Proposal []: |
| [R4-2102674](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102674.zip) | Qualcomm Incorporated | **FR2 testability enhancement for polarization mismatch**  Observation 1: Test modes must not be used as an avenue to trigger special UE behaviour that is not available during deployment conditions.  Observation 2: The associated objective of the study item can be considered complete without identifying a test method enhancement for every UE type. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

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

**Issue 2-1-1: Remaining issues with the TPMI method**

* Proposals
  + Alt 2-1-1-1: Apply practical TPMI method, as described in R4-2100699
    - Test facility sends suitable TPMI from TPMI table based on real channel condition
    - Practical TPMI is aligned with network’s capability, and it can further enhance UE performance
  + Alt 2-1-1-2: RAN4 further discuss if TPMI method is applicable for clause 6.2 of TS38.101-2 or not
    - TPMI method coverage is very limited. If TPMI method is not applicable for clause 6.2 of TS38.101-2, then TPMI method is only applicable for Rel-16 UEs which support uplink full power transmission to verify requirements in UL MIMO section

**Issue 2-1-2: Proposals related to methods other than TPMI**

* Proposals
  + Alt 2-1-2-1: Introduce test mode and UE declaration
    - Introduce test mode to trigger Tx diversity as one of the hybrid methods
    - Do not introduce additional UE capability for hybrid methods
    - Apply UE declaration for test mode to be used
  + Alt 2-1-2-2: there is no need to introduce additional test methods for Rel-15 nonCoherent UEs and Rel-16 nonCoherent UEs
    - 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
    - The TPC power command is also the only mechanism that the network can use to control the UE output power in real life
  + Alt 2-1-2-3: 2-port CSI-RS is a feasible test method enhancement
    - See R4-2100699 for the list of 6 clarifications related to the 2-port CSI-RS method
  + Alt 2-1-2-4: RAN4 further discuss EIRP measurement enhancement for core requirement in clause 6.2 of TS38.101-2 to reflect diversity gain as long as UE supports 2TX TPMI and/or TX diversity, and test mode is a reliable method by locking the 2TX transmission status
  + Alt 2-1-2-5: For Rel-15 nonCoherent UEs and Rel-16 nonCoherent UEs which do not support full power transmission, the link antenna should keep transmitting with two polarizations simultaneously during EIRP measurement to avoid polarization basis mismatch
  + Alt 2-1-2-6: Test modes must not be used as an avenue to trigger special UE behaviour that is not available during deployment conditions
    - The associated objective of the study item can be considered complete without identifying a test method enhancement for every UE type

### Sub-topic 2-2: UL demodulation

**Issue 2-2-1: remaining issues with enhancements related to UL demodulation**

* Proposals
  + Alt 2-2-1-1: enhance the test equipment receiver architecture, such that:
    - Annex F of TS 38.101-2 and Annex E of TS 38.521-2 must be updated to accommodate the dual polarization measurements
    - RAN4 agrees to define a zero-forcing MIMO receiver for FR2 UL EVM measurements
    - The same receiver architecture shall be used for FR1 and FR2

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Issue** | **Company Comments** |
| Issue 2-1-1: Remaining issues with the TPMI method | MediaTek: “Alt 2-1-1-1: Apply practical TPMI method, as described in R4-2100699.” is proposed, because it is based on agreed TPMI method and much aligned with real network behaviour, and can reflect real UE achievable performance. Besides, we think the TPMI method shall be applied to all Tx item test procedures, such as EVM, they all are actually relative.  Qualcomm:  Request to MTK: What does ‘practical TPMI’ mean in context of EIRP tests? Currently we think the network picks the optimal TPMI based on the UE capability set (release, ULFPTx, maxnrofports, etc)  We agree with this observation of 2-1-1-2:  ‘TPMI method coverage is very limited. If TPMI method is not applicable for clause 6.2 of TS38.101-2, then TPMI method is only applicable for Rel-16 UEs which support uplink full power transmission to verify requirements in UL MIMO section’.  FR2 UE assumptions during the Rel-15 work phase included transparent pol. diversity. The implication is that UE self-configures for the necessary form of Tx diversity when it is configured for a single port.  Samsung:  we have similar understanding as Qualcomm that TPMI configuration has been standardized in core requirement for uplink full power transmission in 38.101-2. It seems not necessary to test more TPMI configurations than that. About TPMI applicability, agree with MTK to extend applicability to other Tx items, but first of all, we need to discuss if TPMI method is applicable for single carrier case (clause 6.2 of TS38.101-2).  vivo: Alt 2-1-1-1: we share similar view with QC and Samsung, clarification on how to “select suitable TPMI from TPMI table based on real channel condition” is needed for better understanding. From test procedure perspective, a fixed TPMI index would be good to keep the test consistency.  OPPO:  Agree with observation of Alt 2-1-1-2 and QC’s comment. Devices achieving their maximum power by Tx diversity are not covered by TPMI method.  **Sony:**  Alt 2-1-1-2: We agree with the observation and it is important that RAN4 carefully exam the coverage of TPMI method.  Ericsson: We agree on Alt 2-1-1-2 given the input from papers and the comments above from Qualcomm, Samsung, OPPO. Usage of TPMI seems limited and needs careful further study. |
| Issue 2-1-2: Proposals related to methods other than TPMI | MediaTek: ”Alt 2-1-2-3: 2-port CSI-RS is a feasible test method enhancement” is further proposed. We clarify all raised issues in last meeting, and think it can be further applied on top of TPMI method to further enhance UE test result, that is much aligned to real network behavior. Again, we think the selected enhancement methods(s) shall be applied to all Tx item test procedures, such as EVM, they all are actually relative.  Qualcomm:  Alt: 2-1-2-6.  Also, agree with 2-1-2-2.  To MTK: we agree that 2 port CSIRS can help the Ue get a better picture of the channel. It would be useful to have a high level design, with details like how CSIRS ports are mapped to TE pols, how non-simultaneous CSIRS is supposed to for a UE inside the framework of the standard, etc  LG:  Support Alt 2-1-2-1. To test UEs which do not support TPMI side condition, new test mode to trigger Tx diversity should be considered, and UE declaration can be considered for hybrid method.  Alt 2-1-2-4 also can be considered.  Samsung:  We share similar view as LG and we support Alt 2-1-2-1 and Alt 2-1-2-4  As observed, ‘TPMI method coverage is very limited. If TPMI method is not applicable for clause 6.2 of TS38.101-2, then TPMI method is only applicable for Rel-16 UEs which support uplink full power transmission to verify requirements in UL MIMO section’. We have agreed in last meeting that TPMI method is applicable for Rel-15 coherent UEs and Rel-16 coherent UEs, but there is no test cases to apply for those UEs. So other methods than TPMI is needed.  Apple: Alt 2-1-2-6  **Sony:**  We support Alt 2-1-2-2 and Alt 2-1-2-6: We have re-iterated multiple times the importance of confining the possible enhancement to actual network commands, otherwise the test results are much less meaningful. In addition, we have argued that a correct UE behaviour should ensure the UE transmit with its maximum output power when it receives the power up command continuously, and thus no additional enhancement needed.  2-port CSI-RS might be further investigated if it can improve the condition. However, some more clarification on the port mapping and UE behaviour might be helpful, especially for the 2 ports CSI-RS transmitted sequentially.  Ericsson:  We support alternatives 2-1-2-2 and 2-1-2-6, as stated previously we are in favor of TPC commands as primary method and like to avoid any test method that can’t be used in real deployments.  Alternative 2-1-2-3 might be considered and needs further investigation especially since TPMI methods shows limited usage. UE impact/behavior on using 2-port CSI-RS for sequential transmission will need investigation. |
| Issue 2-2-1: remaining issues with enhancements related to UL demodulation | Qualcomm:  We agree with the comments in R4-2102090 except for the need to align FR1 and FR2. The expectation for alignment is reasonable only if FR1 and FR2 test methodologies also converge (OTA for both). For now, because FR1 TxD is tested with high isolation channels and FR2 is OTA, we prefer to arrive at respective optimal solutions independently. Alignment may still happen, we are not against it. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| [R4-2100526](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100526.zip) | **MediaTek:**  We are fine to further revisit the CR together based on current content and overall discussion result this meeting. Besides, we think the selected measurement enhancement method shall be applied to all Tx item test procedures, such as EVM, they all are actually relative. |
| Apple: we are fine to merge our content into vivo’s further revised TP |
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| [R4-2101830](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2101830.zip) | **MediaTek:**  We are not okay about the statement “only one precoding matrix (i.e. TPMI index 2 [1, 1]T) is selected for EIRP measurement”, as our clarification on “practical TPMI” and “dummy TPMI” in R4-2100699. |
| vivo: we are fine to update the TP to capture the agreements on topic 2 in this meeting. |
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## Summary for 1st round

### Open issues

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

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|  | **Status summary** |
| Issue 2-1-1: Remaining issues with the TPMI method | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 2-1-2: Proposals related to methods other than TPMI | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 2-2-1: remaining issues with enhancements related to UL demodulation | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #2 |  |  |

*WF scope: TBD*

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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| **Issue or WF** | **Company comments** |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
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# Topic #3: Testability enhancements to support the verification of RF requirements for inter-band (FR2+FR2) CA

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2100096](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100096.zip) | Anritsu Corporation | **Impact of offset antenna to quiet zone in FR2 OTA chamber**  Observation 1: An antenna pattern of the feed antenna mainly decides an electric field intensity and QoQZ.  Observation 2: Impact of the offset antenna varies by a pattern of a feed antenna (amplitude taper).  Observation 3: It is possible to limit the impact of the offset antenna to QoQZ by optimizing an antenna arrangement.  Observation 4: It is possible to mitigate the impact of the offset antenna to QoQZ by improving a placement of antenna direction towards a reflector.  Observation 5: As far as the UE is supporting the IBM, and both main antenna and offset antenna are arranged along with the q rotation of the positioner, it is possible to obtain the identical EIS results from either of the two antennas even with the inter-band CA tests.  Observation 6: As far as the UE is supporting the IBM, and both main antenna and offset antenna are arranged along with the q rotation of the positioner, choice of relative UE beam direction should be same between the measurement from the main antenna and the offset antenna.  Observation 7: There is a fair chance to apply the offset antenna test system also to the inter-band CA with CBM UE. |
| [R4-2100097](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100097.zip) | Anritsu Corporation | **TP to TR 38.884 on Inter-band DL CA in FR2**  Proposal 1: It is proposed to approve the text proposal related to the feasibility of inter-band DL CA (FR2 + FR2). |
| [R4-2100527](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100527.zip) | Apple Inc. | **Impact of AoA offset on inter-band CA PSD difference**  Observation 1: For CBM inter-band CA requirements, AoA offsets of up to 7 degrees between two FR2 CA component carriers increase the PSD difference between spatially filtered carriers by up to 1.7 dB. This effect compounts with the beam squint impairment.  Proposal 1: The impact of AoA offset on the assumption of PSD difference for CBM CA made in the core requirement definition should be taken into account either together with the core requirement definition or as part of the measurement uncertainty and test tolerance for the applicable test case. |
| [R4-2102673](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102673.zip) | Qualcomm Incorporated | **On impact of non-co-located test antennae for FR2 inter-band testing**  Observation 1: For a given source antenna angular offset, it is possible to optimize the QZ illumination by adjusting distance between source and mirror  Observation 2: Band-selective beam tilt penalizes CBM inter-band UEs with dense beam packing.  Observation 3: For a given source antenna angular offset from focus, it is possible to flatten the wavefront by optimizing the distance between source and mirror.  Observation 4: It is advantageous for the antenna serving the highest frequency to be prioritized for ideal (on-focus) location.  Observation []: captures a serious problem with utilizing an offset antenna approach for UEs that employ CBM. The mechanism impacts a UEâ€™s beam management differently based on probability of finding a beam boundary. Beam boundaries are intimately tied to UE design, so ultimately, the effects of offset antennae for CBM testing will manifest differently from UE design to UE design.  Observation []: For a given source antenna angular offset it is possible to optimize the QZ illumination by adjusting distance between source and mirror.  Observation []: implies that it is not feasible to expose the CBM UE to band-selective beam tilt and simultaneously put reasonable bounds on MU.  Proposal []: An IFF test set up with multiple test antennae is feasible for inter-band CA testing of UEs with CBM limitation, but only for band combinations that share the same TE antenna. |

## Open issues summary

### Sub-topic 3-1: Offset test antennae for FR2 inter-band testing

**Issue 3-1-1: offset antenna impact to QoQZ**

* Proposals
  + Alt 3-1-1-1: Impact of the offset antenna varies by a pattern of a feed antenna (amplitude taper)
    - It is possible to mitigate the impact of the offset antenna to QoQZ by improving a placement of antenna direction towards a reflector
  + Alt 3-1-1-2: recover desired QZ illumination by adjusting the source location distance from mirror in concert with angular offset

**Issue 3-1-2: potential to trigger different choice of optimum UE beam**

* Proposals
  + Alt 3-1-2-1: choice of the relative UE beam direction from the viewpoint of UE should be same
    - As far as the UE is supporting the IBM, and both main antenna and offset antenna are arranged along with the θ rotation of the positioner, choice of relative UE beam direction should be same between the measurement from the main antenna and the offset antenna
    - Choice of the beam by UEs with common beam management (CBM) should be further studied
  + Alt 3-1-2-2: on-focus offset source location optimization
    - For a given source antenna angular offset from focus, it is possible to flatten the wavefront by optimizing the distance between source and mirror
    - It is advantageous for the antenna serving the highest frequency to be prioritized for ideal (on-focus) location
    - An IFF test set up with multiple test antennae is feasible for inter-band CA testing of UEs with CBM limitation, but only for band combinations that share the same TE antenna

**Issue 3-1-3: impact on PSD difference**

* Proposals
  + Alt 3-1-3-1: The impact of AoA offset on the assumption of PSD difference for CBM CA made in the core requirement definition should be taken into account either together with the core requirement definition or as part of the measurement uncertainty and test tolerance for the applicable test case
    - For CBM inter-band CA requirements, AoA offsets of up to 7 degrees between two FR2 CA component carriers increase the PSD difference between spatially filtered carriers by up to 1.7 dB. This effect compounts with the beam squint impairment.

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 3-1-1: offset antenna impact to QoQZ | Anritsu: From both alt 3-1-1-1 and 3-1-1-2, we suppose that we can conclude that the impact of offset antenna to QoQZ can be mitigated within an acceptable range by a design of an antenna arrangement. A discussion regarding whether the different QoQZ MU needs to be applied compared to the single carrier case can be left to RAN5.  R&S: neither of both proposals fully assess the impact in the QoQZ since there are no references to the diffraction created by the paraboloid edges and the size of the paraboloid itself, what will be one of the main contributions to the QoQZ when trying to optimize the antenna placement to correct for the QZ shift.  Questions for clarification to Anritsu:  1. Were these effects considered in the results presented in the contribution?  2. Are the QoQZ results presented in R4-2100096 representing the full 30cm QZ volume?  Qualcomm: The alternatives do not conflict with each other. We however point out that it is more crucial to flatten the phase front from offset sources.  Keysight:  While we agree that there are mitigation approaches (thanks to Anritsu and QC for the excellent contributions) to improve QoQZ and phase fronts with offset antennas, we believe that (in-band) offset antennas are not required and the single antenna solution should be considered as baseline for all FR2 bands.  Anritsu: Reply to R&S questions   1. As for an impact of roll edge around a reflector, we agree that this becomes one of factors to decide the QoQZ characteristics. In that sense there should be some limitations with antenna offset ranges and angles to tilt the offset antenna. However since we are not thinking of using such an edge area on the reflector for the offset antenna test system, we didn’t include that influence in our provided data. And this optimization should depend on a relationship between reflector size, measurement antenna offset and range length, and should be considered in the design. 2. Yes, estimated QoQZ results are representing the full 30 cm QZ volume. |
| Issue 3-1-2: potential to trigger different choice of optimum UE beam | Anritsu: We assume we can conclude at least for measurement with IBM UEs. i.e. There is a way to make IBM UEs to choose same relative beam direction and conduct spherical coverage tests properly like a single test antenna system. On a test for UEs supporting inter-band CA with CBM, there might be a limitation with the feasibility by the offset antenna test system. But this also relates to the current WI discussion on the necessity of spherical coverage requirements with CBM UEs supporting a same band group.  R&S:  Regarding Alt 3-1-2-2, the mentioned optimization doesn’t take into account the scattering and diffraction from the offset feed antenna. In addition, 3rd bullet (i.e. inter-band CA with CBM) correspond exactly to the case where no offset antenna is considered so it seems to imply that offset feed is not feasible for CBM at all.  We agree with Alt 3-1-2-1, although CBM might not be testable with offset feed antennas.  Qualcomm:  To R+S: 3rd bullet of 3-1-2-2: Offset feed is feasible for CBM UEs only if both bands use the same feed. You however are correct that the recommendations are based on an optics model, rather than one that accounts for diffraction. We agree diffraction considerations may be necessary, thank you for the comment.  Keysight:  We obviously cannot comment on UE behavior but have to acknowledge QC’s concern “An IFF test set up with multiple test antennae is feasible for inter-band CA testing of UEs with CBM limitation, but only for band combinations that share the same TE antenna” Based on our system analyses and findings presented in R4-2102619 that 24GHz through 49GHz can be supported with a single antenna with no impact in QoQZ performance, we believe that Inter-band CA (FR2+FR2) is possible with a single antenna. |
| Issue 3-1-3: impact on PSD difference | Qualcomm: Request for clarification: Is the 1.7 dB conclusion applicable only to PC3?  Apple: yes, it is applicable to PC3 only |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| [R4-2100097](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100097.zip) | Anritsu: This TP needs a revision to capture contents from new contributions submitted to this meeting(R4-2100527 and R4-2102673).  Qualcomm: For the TR, we think it makes sense to streamline the tense used to passive. |
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## Summary for 1st round

### Open issues

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

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|  | **Status summary** |
| Issue 3-1-1: offset antenna impact to QoQZ | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 3-1-2: potential to trigger different choice of optimum UE beam | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 3-1-3: impact on PSD difference | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #3 |  |  |

*Scope: TBD*

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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| **Issue or WF** | **Company comments** |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
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# Topic #4: Extreme temperature conditions for all applicable FR2 UE RF test cases

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2100098](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100098.zip) | Anritsu Corporation | **DUT repositioning during ETC measurement in FR2**  Observation 1: Though the 3D scan of DUT under ETC is possible similar to NTC, there are cases that a test procedure may become complicated and test time takes longer than NTC when we need to reposition the DUT during beam peak search and spherical coverage test.  Observation 2: The procedure to return to the normal temperature in a case the UE needs to be repositioned cannot be skipped to avoid malfunctions of the DUT and the positioner.  Observation 3: A necessity of the DUT repositioning during beam search under ETC depends on the outcome of the current study with impacts of temperature on FR2 beamforming.  Observation 4: Test time of beam peak search can be less than half under ETC if we can omit the DUT repositioning.  Observation 5: From an idea that a UE shall be tested under the black box condition, and also a nature of the UE spherical coverage performance, DUT repositioning cannot be omitted during the spherical coverage test, which means that we need to accept a test time of spherical coverage under ETC becomes longer than NTC.  Proposal 1: In a case an outcome of the study on impacts of temperature on FR2 beamforming has resulted that an EIRP/EIS beam peak position under ETC can be within a certain amount of ranges from the peak position under NTC, allow to limit the beam peak search range under ETC. The range to limit shall follow an outcome of the study above.  Proposal 2: The group clarifies whether the spherical coverage test is really necessary under ETC. Companies are encouraged to bring views if an impact of temperature may really cause changes with the spherical coverage performance of the UE.  Proposal []: The group should clarify whether the spherical coverage test is really necessary under ETC. Companies are encouraged to bring views if an impact of temperature may really cause changes with the spherical coverage performance of the UE. |
| [R4-2100528](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100528.zip) | Apple Inc. | **Impact of ET on measurement uncertainty and test tolerance of spherical coverage EIRP and EIS**  Observation 1: The REFSENS requirement is derived under normal temperature condition (NTC) assumption and testing it in extreme temperature condition (ETC) will result in 0.5dB difference in noise floor.  Observation 2: In addition to impact on thermal noise floor which impacts magnitude error, TX/RX VGA gain control and phase shifter loss variation also impact magnitude error. It is expected to observe 0.1 dB under NTC and 1.0 dB under ETC.  Observation 3: Phase error from TX/RX VGA phase variation which impacts beam forming is 1.5Â° under NTC and 2.0Â° under ETC.  Observation 4: RSRP measurement accuracy for RRM specification in FR2 is derived from TS 38.133 clauses 10.1.3 is 6 dB for NTC and 9 dB for ETC. The RRM requirement is defined as low SNR. The beam correspondence tolerance requirement is defined over the link angles â€œcorresponding to the top 50% of the EIRP measurement over the whole sphere.â€ This, the BC requirement is defined as high SNR, so RSRP error is expected to be less than 6 dB for NTC and less than 9 dB for ETC.  Observation 5: Based on our initial simulations with all impairment models, maximum difference magnitude and angle in beam peak direction between ETC and NTC for worst case of 9 beam code books and 21 beam code books is 0.9 dB and 14Â°.  Observation 6: With proposed procedure by locking beam peak in NTC, then apply ETC. RSRP error between ETC and NTC shall be negligible; however, the impact of magnitude error and phase error is expected. The maximum difference in beam peak direction between ETC and NTC with magnitude error and phase error for worst case of 9 beam code books and 21 beam code books is 0.7 dB and 12Â°.  Proposal 1: Perform a beam peak search refinement over conical region spanning +/- 12Â° around beam peak direction which was found under NTC.  Proposal 2: In case that the chamber isnâ€™t able to move positioner in conical region spanning +/- 12Â° inside a temperature control bubble, we propose to increase test tolerance for ETC by 0.9 dB for MOP and REFSENs test cases.  Proposal 3: A simulation campaign is needed to quantify the impact of ETC on measurement uncertainty and test tolerance. RAN4 shall provide a recommendation to RAN5 based on the results. |
| [R4-2101828](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2101828.zip) | vivo | **Discussions on FR2 Extreme temperature conditions**  Observation 1: The shape of reflector in IFF test system is very sensitive to the temperature variation, thermal deformation may appear if the isolation effect of the ETC enclosure is not Long-term stable for the time-consuming test case, e.g. EIS beam peak searching.  Observation 2: The effect of the ETC enclosure surrounding the DUT may have impacts on the UE performance under ETC, which could be different under different frequency.  Observation 3: For the EIRP or EIS values at low performance area of the CDF curve, the performance may be impacted greater under ETC, compare with the peak EIRP beam.  Proposal 1: For IFF based ETC test system, the impacts on UE performance due to non-perfect isolation and electromagnetic wave absorption effect of ETC enclosure should be studied.  Proposal 2: A MU element (systematic error) related to ETC testing of 3D scan is required. Analysis on the value of this MU element is encouraged.  Proposal 3: The testing time under ETC 3D scan should also be considered.  Proposal 4: In case the spherical coverage is tested under ETC, consider a 2dB relaxation in the spherical coverage requirement to address the impact of extreme temperature conditions. |
| [R4-2102617](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102617.zip) | Keysight Technologies | **On extreme temperature condition testing**  Proposal 1: For the IFF methodology with a 30cm Quiet Zone, set the MU element of Quality of Quiet Zone for FR2\_A and FR2\_B to [0.7]dB for Stage 2 (EIRP, EIS) and to [0.4]dB for Stage 1 (EIRP, EIS) for test cases with ETC.  Proposal 2: For the IFF methodology with a 30cm Quiet Zone, introduce a new MU element (systematic error) â€˜Influence of ETC on EIRP/EISâ€™ based on the mean EIRP differences of the QoQZ measurements and set this MU element to [0.4]dB for FR2\_A and FR2\_B. Alternate approaches to further improve or completely compensate this systematic error, e.g., considering the difference of the P1 data compared to the mean of the QoQZ data, are FFS. The use case where the ETC environment is used for the NTC test cases, i.e., leveraging the ETC enclosure at all times for NTC and ETC test cases, is FFS.  Proposal 3: Adjust the editor notes in 38.521-2 and remove statements that test procedure for EIRP/EIS beam peak extreme conditions are FFS.  Proposal 4: RAN5 acknowledges that ETC shall be tested. The new target completion date for TE vendors to complete MU on ETC is RAN5#90-e.  Proposal []: RAN4 should assume that ETC testing is feasible from a testability perspective for all applicable FR2 UE RF test cases  Proposal []: 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 as the ETC testability has been confirmed  Proposal []: RAN4 to clarify whether other core requirements (different from the ones in Proposal 2) will require any relaxation in case of ETC |
| [R4-2102675](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102675.zip) | Qualcomm Incorporated | **FR2 testability in ETC**  Observation 1: A TE capable of testing at ETC must be capable of performing the 3D scan at any temperature and be able to hold the test temperature static.  Observation 2: UE behaviour is already defined over ETC, so no further study on UE beam behaviour is necessary when using TE capable of testing at ETC.  Proposal 1: RAN4 to establish tolerance around target temperature as limits for â€˜staticâ€™ thermal regulation by TE.  Proposal 2: TE vendors are encouraged to share thermal regulation schemes and anticipated thermal regulation capabilities. |

## Open issues summary

### Sub-topic 4-1

**Issue 4-1-1: impact on measurement system**

* Proposals
  + Alt 4-1-1-1: For IFF based ETC test system, the impacts on UE performance due to non-perfect isolation and electromagnetic wave absorption effect of ETC enclosure should be studied
  + Alt 4-1-1-2: In a case an outcome of the study on impacts of temperature on FR2 beamforming has resulted that an EIRP/EIS beam peak position under ETC can be within a certain amount of ranges from the peak position under NTC, allow to limit the beam peak search range under ETC. The range to limit shall follow an outcome of the study above.
  + Alt 4-1-1-3: improvement to the test procedure is considered, as described in R4-2100528:
    - Perform a beam peak search refinement over conical region spanning +/- 12° around beam peak direction which was found under NTC
    - In case that the chamber isn’t able to move positioner in conical region spanning +/- 12° inside a temperature control bubble, we propose to increase test tolerance for ETC by 0.9 dB for MOP and REFSENs test cases
  + Alt 4-1-1-4: test equipment capable of testing at ETC must be capable of performing the 3D scan at any temperature and be able to hold the test temperature static
    - RAN4 to establish tolerance around target temperature as limits for ‘static’ thermal regulation by test equipment
    - Test equipment vendors are encouraged to share thermal regulation schemes and anticipated thermal regulation capabilities

**Issue 4-1-2: impact on UE performance**

* Proposals
  + Alt 4-1-2-1: In case the spherical coverage is tested under ETC, consider a 2dB relaxation in the spherical coverage requirement to address the impact of extreme temperature conditions
  + Alt 4-1-2-2: The group clarifies whether the spherical coverage test is really necessary under ETC. Companies are encouraged to bring views if an impact of temperature may really cause changes with the spherical coverage performance of the UE
  + Alt 4-1-2-3: 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 as the ETC testability has been confirmed
    - RAN4 should assume that ETC testing is feasible from a testability perspective for all applicable FR2 UE RF test cases
  + Alt 4-1-2-4: UE behaviour is already defined over ETC, so no further study on UE beam behaviour is necessary when using test equipment capable of testing at ETC

**Issue 4-1-3: impact on measurement uncertainty**

* Proposals
  + Alt 4-1-3-1: A MU element (systematic error) related to ETC testing of 3D scan is required. Analysis on the value of this MU element is encouraged
  + Alt 4-1-3-2: A simulation campaign is needed to quantify the impact of ETC on measurement uncertainty and test tolerance. RAN4 shall provide a recommendation to RAN5 based on the results
  + Alt 4-1-3-3: RAN4 should assume that ETC testing is feasible from a testability perspective and that MUs will be finalized shortly in RAN5

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 4-1-1: impact on measurement system | Keysight:  Alt 4-1-1-1: we believe these effects are included in the QoQZ MU with the “bubble” surrounding the reference antenna in all 7 reference positions. It was shown that the QoQZ MU difference with and without bubble is very small.  Alt 4-1-1-2: we believe a full 3D scan should be performed to avoid vendor declarations or measurements within certain ranges.  Alt 4-1-1-3: Based on the agreements in RAN5, it should be assumed that spherical coverage test in 3D can be performed and that no test tolerance adjustment is needed.  Alt 4-1-1-4: we agree that a temperature tolerance is needed to consider the temperature “static.” We propose a +/-4C tolerance.  Anritsu:  Alt 4-1-1-1: Similar view with Keysight. The impacts of ETC enclosure can be seen by verifying the QoQZ MU. Actual MU discussion can be left to RAN5.  Alt 4-1-1-2: Since anyway we need to run the beam peak search under NTC, we can reuse the result of the beam peak position when running the peak search under ETC, which does not require the vendor declaration for ETC. This is related to the topic of test time reduction and from a feasibility point of view, we are fine to choose either full 3D scan or limited scan. But the group needs to accept a trade-off in a case of full 3D scan since there is a need to reposition the DUT, and that requires more complicated test procedure especially under ETC.  Alt 4-1-1-3: Spherical coverage test with 3D scan is feasible under ETC. So no need the proposed test tolerance.  Alt 4-1-1-4: To decide temperature tolerance, we suppose following factors need to be considered, 1) an accuracy of temperature control by an air conditioner, 2) accuracy of a thermocouple to measure a temperature in the ETC enclosure, and 3) temperature deviation at the center of the QZ. The proposal of +/- 4 degrees C tolerance from Keysight looks reasonable to us but we would like to be a little careful and prefer to keep it in brackets for a moment to confirm from a product guarantee point of view.  R&S:  We agree with 4-1-1-2, and therefore 4-1-1-3 as far as it presents the effect and proposed scan region, since it will improve test time and minimize the potential effects raised in Alt 4-1-1-1 for very long test runs under ETC.  The electromagnetic wave absorption effect of ETC enclosure highlighted in 4-1-1-1 is already included in the QoQZ MU.  Regarding Alt 4-1-1-4, we need time to check the exact range for the tolerance.  Qualcomm:  4-1-1-1: agree  4-1-1-2: this may be an optimization but the baseline should be that TE is capable of beam search at ETC  4-1-1-3: The ‘ETC search cone’ may be evaluated as a test optimization  4-1-1-4: agree  Samsung:  We share similar view as R&S, it is not necessary to do full 3D beam peak search under ETC with already known beam peak direction under NTC. So we agree with alt 4-1-1-2 and alt 4-1-1-3.  4-1-1-1: agree that the QoQZ MU can reflect the electromagnetic wave absorption effect and the performance of reflector. However, another aspect we may also need to consider is whether the QoQZ can be stable with long-term testing under ETC.  4-1-1-2 and 4-1-1-3: Regarding the limited beam peak search range approach, we prefer to consider additional TT without beam peak searching under ETC, given the beam peak searching (EIRP/EIS) is the most time-consuming test case under NTC. So, increase test tolerance for ETC by 0.9 dB for MOP and REFSENs test cases from Alt 4-1-1-3 is preferred.  4-1-1-4: agree to study and define this criteria of ETC test system  CAICT:  Alt 4-1-1-1: agree to study the stability of QoQZ and potential effects when testing under ETC for a long time.  Alt 4-1-1-2: we share similar views as QC, the base line should be that TE is capable of 3D beam search under ETC. Limited scan range approach can be an optimization to reduce the test time.  Alt 4-1-1-4: agree to define the temperature tolerance.  Apple: if we proceed with Alt 4-1-1-2 (which promises test time reduction), then we would need to quantify the effect of ETC relative to NTC in terms of beam peak direction and realized gain under ETC in the beam peak direction determined under NTC. |
| Issue 4-1-2: impact on UE performance | Keysight:  Alt 4-1-2-2: since spherical coverage is listed in the SID [RP-201862], we believe that has been confirmed already that spherical coverage test is necessary under ETC  Alt 4-1-2-3: we support  MediaTek:  About spherical coverage (spherical EIRP/EIS), there is a note in Tx and Rx relative table in 38.101-2, the note concept is “the requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1.”. Hence, if we plan to verify spherical coverage under ETC, further discussion on requirement relaxation is needed due to ETC condition.  Anritsu:  Alt 4-1-2-2: Just to note, we are fine to run spherical coverage test under ETC. But it is just a matter of test time.  Alt 4-1-2-3: Agree with the proposals. But the group should be careful before applying the ETC condition to all TCs.  Qualcomm:  4-1-2-3: agree  4-1-1-4: agree.  Samsung:  We are fine with Alt 4-1-2-2 but object Alt 4-1-2-3. The testability SI could not determine core requirement. Whether the restriction in 38.101-2 shall be removed or not should be discussed in UE RF section. Moreover, in our view, it is enough to verify UE performance under ETC with peak EIRP.  vivo:  We support Alt 4-1-2-1 and Alt 4-1-2-2. For Alt 4-1-2-3, the supporting of FR2 test under ETC from test system capability perspective can be confirmed, however, the impacts of test system and UE performance have not been well studied, it is not reasonable to remove the restrictions in 38.101-2 at this stage.  CAICT:  Alt 4-1-2-2: agree.  Alt 4-1-2-3: not sure whether the restrictions in 38.101-2 should be determined in this SI or not. However, after the ETC testing is feasible from test system perspective, it is worth discussing whether it can be applied to all TCs and remove the existing restrictions.  Apple: we agree with MediaTek’s comment that the Rel-15 spherical coverage requirements were defined under NTC. This is now “baked in” to the spherical coverage EIRP values from the core requirement perspective, regardless of test method capability. We now have information from test equipment vendors that a 3D scan under ETC is feasible to implement in a chamber, but this does not change the underlying assumptions used in the core requirement derivation. In our understanding, the UE performance will be different, and we have some choices: (1) relax the core requirement and remove the note; (2) keep the core requirement as it is and increase MU/TT for the same test case when verified under ETC; (3) introduce a new test case for spherical coverage under ETC.  Since this is a study item, we think it is not possible to make any changes to TS38.101-2, but we can draw conclusions on the impact of ETC onto MU, and the group can recommend to RAN5 an analysis which lists the factors that increase MU and TT for the test case under ETC.  OPPO:  Support Alt 4-1-2-1 and Alt 4-1-2-2. More inputs are encouraged on temperature rise v.s. spherical coverage performance change.  Keysight: we would prefer for the core requirements to be defined/relaxed for ETC based on the outcome of the SI instead of adjusting TT (not sure why MU is affected) |
| Issue 4-1-3: impact on measurement uncertainty | Keysight: Alt 4-1-3-1: currently, a systematic MU element has already been defined in RAN5 [38.903]. Additional discussions will be held in the upcoming meeting on this systematic MU element.  Alt 4-1-3-2: we believe these simulation results should be used to define impact of ETC on core requirements rather than impact of ETC on MU/TT.  Alt 4-1-3-3: we support  R&S:  Regarding Alt 4-1-3-1, we agree to Keysight. Further discussion about it should wait the outcome from RAN5.  On Alt 4-1-3-3, the agreement mentioned in R4-2102617 only cover those requirements currently defined for ETC (i.e. EIRP/EIS with corresponding beam peak search). Therefore, full testability coverage of ETC testing cannot be assumed based on that agreement.  Keysight:  Comment to R&S’s Alt 4-1-3-3 feedback. If beam peak search was confirmed to be testable under ETC, we believe that this confirms testability of test cases that require 3D scans such as TRP and spherical coverage.  Vivo: We support Alt 4-1-3-1 and Alt 4-1-3-2. Do not support Alt 4-1-3-3: given the potential relaxation of core requirement is under discussion in RAN4, which could be related to a new TT for ETC. After finalizing the TT, RAN4 should inform RAN5 the confirmation of testability with agreed TT.  Apple: As we pointed out in our comment to Issue 4-1-2, Alt 4-1-3-2 might be a reasonble way to reach a conclusion on ETC. This is especially true if we combine the test time reduction technique of perfomring 3D scan under NTC, then enabling ETC, then performing a limited sweep to refine the beam peak direction under ETC. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| Issue 4-1-1: impact on measurement system | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 4-1-2: impact on UE performance | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 4-1-3: impact on measurement uncertainty | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #4 |  |  |

*Scope: TBD*

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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| --- | --- |
| **Issue or WF** | **Company comments** |
|  |  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
|  |  |

# Topic #5: Testability enhancements to support the verification of RF requirements for FR2 DL 256QAM

## Companies’ contributions summary

No contributions were submitted

# Topic #6: Testability enhancements to reduce test time

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2100161](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100161.zip) | Fraunhofer HHI, Fraunhofer IIS | **Test time reduction in FR2 using beam sweeping**  Observation []:Issue to be addressed - reduction of measurement uncertainty.  Observation []:Issue to be addressed - reduction of measurement time.  Observation []:Beam sweeping can be used to reduce the time needed for FR2 testing.  Observation []:Beam sweeping is used in the “Tx direction search and EIRP spherical coverage” conformance test.  Observation []:Beam sweeping can be used to reduce the time needed for FR2 development testing.  Observation []:Beam sweeping methods can be used to reduce the time needed for FR2 measurements which are at present undefined.  Proposal []: As part of the enhanced test methods for FR2 study item, RAN4 should consider beam sweeping techniques as a method suitable for non-conformance tests (i.e., those beyond “Tx direction search and EIRP spherical coverage” [see TR 38.810 Sect. 5.2.1.3.7]) and for conformance tests which are as yet undefined. |
| [R4-2100245](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100245.zip) | Anritsu Corporation | **Test time reduction in OTA measurement**  Observation 1: Declaration of an approximate beam peak location also has a benefit which simplifies a test procedure under the extreme temperature condition (ETC).  Proposal 1: Add Option 7 to reduce test time of the Tx/Rx beam peak search. OEMs may declare search ranges where a beam peak is possibly located (e.g. hemisphere) along with applicable DUT alignment options. |
| [R4-2100665](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100665.zip) | LG Electronics | **Discussion on enhance test method to reduce FR2 OTA test time**  Proposal 1: Introduce additional measurement grid based on 4X2 antenna array as Option 3  Proposal 2: Update EIRP test for UL MIMO with single link polarization as Option 5  Proposal 3: Need further study test procedure using single link polarization for ULFPTx mode UE  Observation 1: RSRP measurement accuracy at each measurement grid point can be unstable due to UE beam direction.  Proposal 4: Introduce concept of RSRPB based scan to Rx beam peak direction search instead of EIS based Rx beam peak search in RF test |
| [R4-2100895](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100895.zip) | Samsung | **Discussion on FR2 test time reduction**  Observation 1: 4x2 antenna array assumption based measurement grid is a practical and promising candidate test time saving method for PC3 UE and test time could be saved for all TX and RX test cases.  Observation 2: Our simulation based on 8x2 shows generally aligned results with that of TR38.810, and hence it is reliable for measurement grid derivation based on 4x2 array assumption.  Observation 3: for RX beam peak search, the SNR is about 20dB better than -3dB and hence RSRP measurement accuracy is significantly improved.  Observation 4: for RX beam peak search, RSRP accuracy at RX beam peak can be expected within 1dB  Observation 5: UE determines RX beam based on RSRP measurement results ranking and EIS scan has not any contribution to RX beam selection.  Observation 6: RX beam peak direction is defined based on RSRP in core specification and aligns with practical UE behaviour in filed.  Proposal 1: reuse the simulation assumption and rules for measurement grid derivation in TR38.810 except changing the array configuration from 8x2 to 4x2.  Proposal 2: based on simulation results of 4x2 antenna array assumption, constant step size grid with at least 422 grid points (corresponding to an angular step size of 12Âº) is adopted for beam peak search.  Proposal 3: RAN4 adopts RSRP based approach into RX beam peak search test procedure.  Proposal 4: Only one link polarization EIRP test should be allowed for 2TX scenarios in principle.  Proposal 5: beam sweeping further enhancement is necessary to save FR2 antenna test time for development and industry, and can be considered as one of test time saving approaches for FR2 test method enhancement SI. |
| [R4-2101829](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2101829.zip) | vivo | **Discussions on Test Time Reduction for NR FR2 RF**  Observation 1: The 8x2 reference antenna pattern does not represent the worst-case antenna patterns of FR2 PC3 smartphone UEs properly, which is grossly overestimated.  Observation 2: It is reasonable to assume a narrower beam pattern (compared with typical FR2 smartphone with 4x1 or 2x2 antenna array) to derive FR2 measurement grids and MU assessment. But the adopted 8x2 antenna array is nearly 3 times thinner than the real case.  Observation 3: The testing time of FR2 RF test case is dramatically increased, the main reason is the large number of measurement grid points, which is derived from the unreasonable FR2 UE antenna array assumption.  Observation 4: If the measurement grids is derived based on new antenna assumption but without changing the MU of maximum standard deviation, then there is no impact on RAN5 FR2 MU and TT assessment work.  Observation 5: Rx test cases are playing the dominate role of RF conformance testing time, which is several times longer than Tx test cases.  Observation 6: For LTE SISO OTA, to reduce the testing time, the number of sampling points for Rx test case is much smaller.  Proposal []: SEQ Proposal \\* ARABIC 1: Study whether the worst-case antenna pattern assumption (8x2) of PC3 smartphone UEs should be relaxed in order to reduce the min number of grid points and thus test time.  Proposal 2: Revisit the worst-case antenna assumptions for smartphone UEs to a reasonable one could yield an improvement in test time by reducing the minimum number of test points without affecting the MU and TT in RAN5.  Proposal []:  Proposal 3: 4x2 antenna array should be selected as the reference assumption of FR2 PC3 for deriving measurement grid.  Proposal 4: To reduce the testing time, the number of measurement sampling points for Rx should be defined smaller than Tx test cases.  Proposal 5: Alternative search algorithms (e.g., coarse and fine measurement grid) could be adopted by UE declaration to improve beam peak search test time.  Proposal 5: Alternative search algorithms (e.g., coarse and fine measurement grid) could be adopted by UE declaration to improve beam peak search test time. |
| [R4-2102088](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102088.zip) | Rohde & Schwarz | **Discussion on test time reduction methods**  Proposal 1: RAN4 agrees to allow the fast spherical coverage method as an optimized method for the spherical coverage tests. |
| [R4-2102401](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102401.zip) | Huawei, HiSilicon | **Analysis on reduce test time for FR2**  Observation 1: compared with 8x2, 4x2 UE antenna array assumption can significantly reduce the required grid number. For constant density grid, around 200 grids points seem to be able to meet the 0.5dB systematic error criteria.  Observation 2: in case of 8x2 UE antenna array assumption, the simulation assumptions used in this document significantly reduce the required grid number, i.e. around 400 compared with 800 in TR38.810 Table G.2.3-3 for constant density grid.  Proposal 1: in the WF [1], option2 and option3 with 4x2 array should be further studied considering the above results that 4x2 antenna array can significantly reduce the required number of measurement grids, compared with 8x2.  Proposal 2: beside the â€œDetailed parameters of 4x2 antenna array assumption for PC3 should be aligned in next meetingâ€ [1], the simulation assumptions for 8x2 antenna array may also need to be discussed considering the above results that different assumptions can have very different required number of measurement grids, for the same 8x2 antenna array. |
| [R4-2102618](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102618.zip) | Keysight Technologies | **On Test Time Enhancements based on different Antenna Array Assumptions**  Observation 1: Revised antenna assumptions (4x2 vs 8x2) for PC3 devices yield a reduction of grid points of ~3 for beam peak searches.  Proposal 1: Do not adopt the 4x2 array assumption to replace the worst-case 8x2 antenna assumption due to the impact in RAN5 and industry  Proposal 2: Keep the system-related assumptions unchanged in RAN5, i.e., based on the previously agreed worst case 8x2 assumptions.  Proposal 3: Inform RAN5 via LS to allow only the beam peak search measurement grid requirements to be relaxed based on an optional vendor declaration. |

## Open issues summary

### Sub-topic 6-1: Potential test time reduction techniques

*NOTE: each issue below corresponds to each option in the WF R4-2017597*

**Issue 6-1-1: beam sweeping techniques (Option 1)**

* Proposals
  + Alt 6-1-1-1: beam sweeping further enhancement is necessary to save FR2 antenna test time for development and industry, and can be considered as one of test time saving approaches for FR2 test method enhancement SI
  + Alt 6-1-1-2: Beam sweeping is used in the “Tx direction search and EIRP spherical coverage” conformance test.
    - it is envisioned that electronic beam sweeping techniques can be used to reduce the test time of measurements that are at present undefined, for example enhanced beam correspondence measurements and multi-beam measurements

**Issue 6-1-2: measurement grid based on 4x2 array antenna assumption for PC3 (Option 2)**

* Proposals
  + Alt 6-1-2-1: reuse the simulation assumption and rules for measurement grid derivation in TR38.810 except changing the array configuration from 8x2 to 4x2
    - based on simulation results of 4x2 antenna array assumption, constant step size grid with at least 422 grid points (corresponding to an angular step size of 12º) is adopted for beam peak search
    - Beam peak search mean error results provided in R4-2100895; spherical coverage is FFS
  + Alt 6-1-2-2: Study whether the worst-case antenna pattern assumption (8x2) of PC3 smartphone UEs should be relaxed in order to reduce the min number of grid points and thus test time
    - It is reasonable to assume a narrower beam pattern (compared with typical FR2 smartphone with 4x1 or 2x2 antenna array) to derive FR2 measurement grids and MU assessment. But the adopted 8x2 antenna array is nearly 3 times thinner than the real case
    - Revisit the worst-case antenna assumptions for smartphone UEs to a reasonable one could yield an improvement in test time by reducing the minimum number of test points without affecting the MU and TT in RAN5
  + Alt 6-1-2-3: 4x2 antenna array can significantly reduce the required number of measurement grids, compared with 8x2
    - compared with 8x2, 4x2 UE antenna array assumption can significantly reduce the required grid number. For constant density grid, around 200 grids points seem to be able to meet the 0.5dB systematic error criteria
    - in case of 8x2 UE antenna array assumption, the simulation assumptions used in this document significantly reduce the required grid number, i.e. around 400 compared with 800 in TR38.810 Table G.2.3-3 for constant density grid
    - Simulation assumptions need to be discussed based on analysis in R4-2102401
  + Alt 6-1-2-4: Do not adopt the 4x2 array assumption to replace the worst-case 8x2 antenna assumption due to the impact in RAN5 and industry
    - Keep the system-related assumptions unchanged in RAN5, i.e., based on the previously agreed worst case 8x2 assumptions
    - Inform RAN5 via LS to allow only the beam peak search measurement grid requirements to be relaxed based on an optional vendor declaration

**Issue 6-1-3: measurement grids based on 8x2 and 4x2 array antenna assumptions and UE declaration (Option 3)**

* Proposals
  + Alt 6-1-3-1: Introduce additional measurement grid based on 4X2 antenna array as Option 3

**Issue 6-1-4: RSRP based RX beam peak search (Option 4)**

* Proposals
  + Alt 6-1-4-1: Introduce concept of RSRPB based scan to Rx beam peak direction search instead of EIS based Rx beam peak search in RF test
    - RSRP measurement accuracy at each measurement grid point can be unstable due to UE beam direction
  + Alt 6-1-4-2: RAN4 adopts RSRP based approach into RX beam peak search test procedure
    - for RX beam peak search, RSRP accuracy at RX beam peak can be expected within 1dB

**Issue 6-1-5: For EIRP test of UL MIMO including TX beam peak search, only one link polarization is enough (Option 5)**

* Proposals
  + Alt 6-1-5-1: Only one link polarization EIRP test should be allowed for 2TX scenarios in principle
  + Alt 6-1-5-2: Update EIRP test for UL MIMO with single link polarization as Option 5

**Issue 6-1-6: For EIRP test when TX diversity (dual polarization transmission) is activated, only one link polarization is enough (Option 6)**

* Proposals
  + Alt 6-1-6-1: Only one link polarization EIRP test should be allowed for 2TX scenarios in principle
  + Alt 6-1-6-2: Need further study test procedure using single link polarization for ULFPTx mode UE

**Issue 6-1-7: New options**

* Proposals
  + Alt 6-1-7-1: Add Option 7 to reduce test time of the Tx/Rx beam peak search. OEMs may declare search ranges where a beam peak is possibly located (e.g. hemisphere) along with applicable DUT alignment options
    - Declaration of an approximate beam peak location also has a benefit which simplifies a test procedure under the extreme temperature condition (ETC)
  + Alt 6-1-7-2: To reduce the testing time, the number of measurement sampling points for Rx should be defined smaller than Tx test cases
  + Alt 6-1-7-3: Alternative search algorithms (e.g., coarse and fine measurement grid) could be adopted by UE declaration to improve beam peak search test time
  + Alt 6-1-7-4: RAN4 agrees to allow the fast spherical coverage method as an optimized method for the spherical coverage tests
    - The procedure in R4-2102088 requires to measure at least 50% of the points (i.e. half-sphere) but also allows to measure only a reduced number of test points in the 2nd hemisphere in case the UE meets the limit before completing the whole scan

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Issue** | **Company Comments** |
| Issue 6-1-1: beam sweeping techniques (Option 1) | R&S: the beam sweeping techniques described in R4-2100161 are related to UE behavior rather than conformance testing methods. Therefore, the proposal fall outside the scope of this work.  Qualcomm:  Alt 6-1-1-1: beam sweeping may not be ‘necessary’, but it is interesting enough to study. Some comments:   1. uplink beam sweeping is an optional feature, so applicability of such an enhancement may not be uniform for all UEs. 2. Is it envisioned that a beam sweep path be used to speed tests? If so what framework and assumptions are necessary?   Alt 6-1-1-2: FFS pending detail. Existing spherical coverage test uses UL beam sweeping for bit 0 UEs, but is designed to also verify beam correspondence.  Samsung:  3D antenna pattern test of every beam one by one consumes even more time than conformance test cases but is needed during development. We see the benefit for the industry to save test time by adopting the beam sweeping techniques. Though it may be not applied to conformance test cases as of now, it is still beneficial for product development which is a heavy burden.  Keysight: we agree with R&S  Vivo: we share the same view with R&S.  Fraunhofer:  Response to Qualcomm:  1. At least for UEs supporting the optional feature of beam sweeping, test time reduction can be achieved.  2. Yes, it is envisioned that beam sweeping is used to reduce test time. UEs supporting the optional feature of uplink beam sweeping can signal this capability before or during a test procedure. Capability signaling forms the basis of the framework, details and assumptions are FFS.  Response to Samsung:  1. For conformance testing with multi panel operation, beam sweeping may be necessary for spherical coverage measurements.  2. Beyond the obvious benefits for product development tests, beam sweeping has the potential of significantly reducing test time when testing more than one beam simultaneously. Such tests will be FFS, for example for spherical coverage and multi beam correspondence using both single and multiple panels. Multi beam transmission will be a feature that provides benefits in multi-TRP scenarios, like industrial IoT, for enhanced reliability. |
| Issue 6-1-2: measurement grid based on 4x2 array antenna assumption for PC3 (Option 2) | Huawei2:   * + Alt 6-1-2-3: 4x2 antenna array can significantly reduce the required number of measurement grids, compared with 8x2   Below left table is our further simulation results, compared with the results in R4-2102401(below right table), the difference of new results is “UE beam steering is not applied”. The new results are in line with TR 38810 section “G.2 Beam Peak Search Measurement Grids”.  However, in the same TR 38810, section “5.2.1.3.7 TX Beam Peak direction search and EIRP Spherical Coverage”, UE applies “beam correspondence” during the test.  So we propose to discuss whether UE beam steering/beam correspondence should be applied in the simulation of UE beam peak search?    w/o UE beam steering with UE beam steering (as in R4-2102401)  MediaTek:  We think “measurement grid based on 4x2 array antenna assumption for PC3” can be considered if we cannot achieve consensus on other potential methods.  R&S: we acknowledge the gain in test time due to the change from 8x2 to 4x2 for the array antenna assumption, but this improvement can only be applied under either of the following cases:  1. It can be ensured that ALL PC3 devices will implement 4x2 antenna arrays, or with less elements.  2. If #1 cannot be agreed, the array size configuration has to be part of a manufacturer declaration (following Issue 6-1-3).  We don’t think Option 1 can be agreed considering the extensive discussion required to agree on the 8x2 assumption when deriving the grids the first time. In addition, there is an obvious impact on the work already achieved in RAN5 by changing now the antenna assumptions. Therefore, we agree to Alt 6-1-2-4.  Qualcomm:  Alt 6-1-2-4  We find the element beam assumption in 38.810 is too optimistic in spherical coverage which the 8x2 assumption partially counteracts at a spatially combined beam level. We could revisit along with refining element patten assumption for future work.  Samsung:  We support Alt 6-1-2-1, Alt 6-1-2-2 and Alt 6-1-2-3.  In our view, we should not be restricted to the work already achieved. The already achieved work is based on 8x2 array which is over-estimated for PC3. We agree the observation that " Revisit the worst-case antenna assumptions for smartphone UEs to a reasonable one could yield an improvement in test time by reducing the minimum number of test points without affecting the MU and TT in RAN5”, because the new measurement grid simulation and derivation is based on the same system error assumption (0.5dB system error).  Moreover, Huawei has identified that the beam peak measurement grid derivation is not aligned with the beam peak search test procedure. By considering beam steering in the measurement grid derivation, the measurement grid will rely more on UE beam book, and the UE antenna array will not be so sensitive. From this point of view, it is better for defining a reasonable measurement grid for UEs with more antenna elements such as PC1  Keysight:  Alt 6-1-2-1: KS obtained very similar results in R4-2102618 as those presented in R4-2100895. We cannot agree to blindly adopt the new grids due to the impact a change in antenna assumptions has in RAN5.  Alt 6-1-2-2: KS is not comfortable to adopt new antenna assumptions as baseline given the impact in RAN5  Alt 6-1-2-3: based on how the MU element has been defined, we believe that beam forming effects should not be considered for beam peak search MU and min. number of test points.  Alt 6-1-2-4: we support  Vivo: based on the simulation analysis from several contributions, 4x2 antenna array can significantly reduce the required number of measurement grids. hence the only issue is how to treat the new 4x2 antenna array assumption in RAN5, replace 8x2 or add 4x2 as an additional one.  The MU and TT work in RAN5 will not be affected, considering there is already technical content related to 8x2 antenna assumption in RAN5 conformance spec. Therefore, it would be better to add 4x2 as additional PC3 antenna assumption, and this assumption and new measurement grid should be set as Baseline for FR2 RF conformance testing.  Sony:  We in general support to adopt 4\*2 or more any other more realistic array configuration to derive the measurement grid for PC3. |
| Issue 6-1-3: measurement grids based on 8x2 and 4x2 array antenna assumptions and UE declaration (Option 3) | LG:  Since 8X2 or 4X2 array antenna is for UE implementation issues, we prefer additional measurement grid based 4X2 antenna array.  Samsung:  We prefer to change the worst array assumption from 8x2 to 4x2. However, UE declaration can also be kept as a compromise option.  Keysight:  We agree that 4x2 could be considered an option as outlined in Alt 6-1-2-4  Vivo: support Alt 6-1-3-1.  CAICT: support introducing additional measurement grids based on 4x2 antenna array assumptions and UE declaration.  Apple: we support the notion of a manufacturer declarations to select a different grid assumption |
| Issue 6-1-4: RSRP based RX beam peak search (Option 4) | R&S: we support Alt 6-1-4-1. An approach based on RSRPB is already specified in TS 38.533 and 38.521-4 and could be leveraged for RF testing. We propose to focus on this RSRPB measurement and not introduce RSRP as an additional metric.  Qualcomm: Alt 6-1-4-2. The wordings of the two alternatives are close. We are ok with either, with the following caveat. RSRP sweeps can be used to narrow down approximate candidate regions before EIS is used to check beam beak. RSRP cannot replace EIS because RSRP does not account for noise figure.  LG:  Both Alts can be studied. But for Alt 6-1-4-2, we need further study whether 1dB RSRP accuracy can be expected for all spherical coverage.  Samsung: there is no much difference between the two alternatives. Considering RSRPB is already adopted in RAN5, we also support Alt 6-1-4-1. Agree with Qualcomm that RSRP does not account for noise figure, but for RX beam peak search scenario, only RSRP ranking among RX beams matter. Anyway, EIS has to be performed at the RX beam peak direction obtained from RSRPB scan.  Vivo: support to include RSRP based approach into RX beam peak search test procedure. However, the accuracy of RSRP at high power level should be studied in RAN4 RRM session, based on simulation campaign.  Sony: We in general positive to the RSRP based RX beam peak search. Detail can be further studied.  Keysight: Alt 6-1-4-2 provided RAN4 can define a reasonable RSRP accuracy at high power levels |
| Issue 6-1-5: For EIRP test of UL MIMO including TX beam peak search, only one link polarization is enough (Option 5) | Qualcomm:  Alt 6-1-5-1: Agree  Alt 6-1-5-2: Agree  LG:  For UL MIMO, we are fine with only one link polarization, but we need to check Issue 6-1-6 together.  Samsung:  Alt 6-1-5-1: Agree  Alt 6-1-5-2: Agree  Vivo: support Alt 6-1-5-1 and Alt 6-1-5-2.  CAICT: We support alt 6-1-5-1 and alt 6-1-5-2. |
| Issue 6-1-6: For EIRP test when TX diversity (dual polarization transmission) is activated, only one link polarization is enough (Option 6) | Qualcomm:  Alt 6-1-6-1: Agree  LG:  RAN4 needs further study whether UEs supporting ULFPTx mode can be used for one link polarization test procedure  Samsung:  Alt 6-1-6-1: Agree  Alt 6-1-6-2: at least for Mode-1 of ULFPTx, only one link polarization is enough which is one of the 2Tx scenarios.  vivo: given TPMI approach is adopted for EIRP TX diversity, one polarization for link is sufficient.  CAICT: we support alt 6-1-6-1. |
| Issue 6-1-7: New options | Anritsu:  Alt 6-1-7-1: I withdraw a part of sentence above “Declaration of an approximate beam peak …” since we anyhow can reuse the beam peak search result under NTC when measuring under ETC. (Of course there needs to be a pre-condition that the peak position under ETC exists in close proximity from NTC.)  Alt 6-1-7-4: Support the proposal since it is a reasonable choice as a procedure.  Qualcomm:  Alt 6-1-7-4: Agree  Samsung:  Alt 6-1-7-1: it is a good idea to save test time from development to conformance, especially, hemisphere declaration will not bring more MU but test time could be reduced to half.  Alt 6-1-7-2: in FR1, measurement grid for TIS is less than that of TRP, it may also be considerable way for FR2.  Alt 6-1-7-4: it is implementable as long as companies are fine with no EIRP/EIS spherical coverage final test data in test report but only with pass or fail verdict.  Keysight:  Alt 6-1-7-1: we believe the declaration of possible locations should not be considered and the beam peak should be properly determined  Alt 6-1-7-3: we support the use of alternative search algorithms such as coarse and fine measurements grids KS previously proposed. It is not clear why a UE declaration is needed for these algorithms.  Vivo: Support Alt 6-1-7-2, Alt 6-1-7-3 and Alt 6-1-7-3. For Alt 6-1-7-1, this is related to the decisions in Topic 4 ETC of beam peak searching procedure (search or reuse NTC direction).  Apple: agree with 6-1-7-1 for ETC; also agree with Keysight’s comment about coarse/fine grid searches: these are not dependent on manufacturer declarations |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
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| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

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

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|  | **Status summary** |
| Issue 6-1-1: beam sweeping techniques (Option 1) | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 6-1-2: measurement grid based on 4x2 array antenna assumption for PC3 (Option 2) | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 6-1-3: measurement grids based on 8x2 and 4x2 array antenna assumptions and UE declaration (Option 3) | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 6-1-4: RSRP based RX beam peak search (Option 4) | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 6-1-5: For EIRP test of UL MIMO including TX beam peak search, only one link polarization is enough (Option 5) | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 6-1-6: For EIRP test when TX diversity (dual polarization transmission) is activated, only one link polarization is enough (Option 6) | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| Issue 6-1-7: New options | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #6 |  |  |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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| **Issue or WF** | **Company comments** |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
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# Topic #7: Testability aspects for the introduction of the new band n262

## Companies’ contributions summary

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| T-doc number | Company | Proposals / Observations |
| [R4-2100529](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100529.zip) | Apple Inc. | Extending the applicability of permitted methods to band n262  **Document is withdrawn** |
| [R4-2102619](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2102619.zip) | Keysight Technologies | **On Testability for band n262**  Observation 1: The abbreviated QoQZ scan with 14 measurement points shows good correlation with the full scan for the EIRP QoQZ MU.  Observation 2: The preliminary QoQZ MU at 49Â GHz is within the example MU value defined in RAN5.  Observation 3: Little to no increase in QoQZ MU is expected for 49Â GHz.  Proposal 1: No additional MU elements are needed for n262 but several MU elements need to be further analysed. |
| [R4-2100530](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100530.zip) | Apple Inc. | **TP to TR38.884 on structure updates related to band n262**  Proposal 1: It is proposed to approve the text proposal related to the structure updates related to band n262 testability. |

## Open issues summary

### Sub-topic 7-1: uncertainty analysis

**Issue 7-1-1: further analysis of existing MU elements**

* Proposals:
  + Alt 7-1-1-1: The preliminary QoQZ MU at 49 GHz is within the example MU value defined in RAN5
    - The abbreviated QoQZ scan with 14 measurement points shows good correlation with the full scan for the EIRP QoQZ MU
    - Little to no increase in QoQZ MU is expected for 49 GHz

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 7-1-1: further analysis of existing MU elements | Keysight: the revision of KS contribution R4-2102619 uploaded to the inbox replaced the preliminary MU results using an abbreviated QoQZ MU evaluation with results from a full QoQZ MU evaluation and confirmed that the sample QoQZ MU for n262 will not have to be raised. While the MU element will not increase, other test equipment and component based MU elements will need to be studied in more detail.  R&S:  clarification comment to R4-2102619: "Multiple antenna" MU element only serves to account for systems where multiple antennas to cover different frequency bands (e.g. spurious emissions testing), while offset antennas has many more implications as discussed under Topic #3 (impact on QoQZ, AoA offset) and require a separate assessment.  Keysight:  We agree that the existing ‘Multiple antenna’ MU element covers primarily spurious emissions testing and that the implications of having multiple in-band antennas on QoQZ are different. However, in the end, the effect of leveraging multiple antennas is captured in the QoQZ evaluation. As we pointed out, the goal is to leverage the ‘Multiple antenna’ MU element but make significant changes to the MU element description, the applicability, and potentially the MU element sample value (“While this MU element is currently applicable to spurious emissions, it could be augmented/adjusted for offset antennas to split FR2 testing among multiple probe antennas. The value and applicability of this MU element is FFS.”) |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| [R4-2100530](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Docs/R4-2100530.zip) |  |
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## Summary for 1st round

### Open issues

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

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|  | **Status summary** |
| Issue 7-1-1: further analysis of existing MU elements | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #7 |  |  |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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| **Issue or WF** | **Company comments** |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
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